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Quicksilver Deposits In Nevada

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AND THE MACKAY SCHOOL OF MINES
JAY A. CARPENTER, *Director*

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PREFACE

There has always been a strong bond of friendship and mutual aid between the Nevada State Bureau of Mines and the U. S. Geological Survey. The Bureau has gladly furnished office, library, and laboratory facilities to visiting Survey geologists, along with technical advice and field trips. The Survey has often given the Bureau the privilege of promptly publishing and distributing to the citizens of Nevada the valuable work of its geologists pertaining to Nevada districts which might otherwise be long delayed in publication, if at all. This is particularly true during the present war emergency with the field work of the Survey on strategic metals and minerals greatly expanded, and with write-up time and publication facilities sharply curtailed.

During 1942 and 1943 the Survey made a geological study of the quicksilver deposits of Nevada as companion work to sampling and exploration projects of the U. S. Bureau of Mines. This geological study was mainly the work of Edgar H. Bailey and David A. Phoenix, and it served the immediate war need of general information concerning these deposits.

As this general study was not in the nature of the technical reports usually published by the Survey, but was the type of information of particular interest and value to Nevada citizens, the Bureau requested the privilege of its publication.

The Survey responded by assigning Messrs. Bailey and Phoenix during a good part of the first half of 1944 to prepare the material for publication, including not only a description of the quicksilver deposits by counties and districts, but also more than twenty maps of the mine workings of the more important mines.

Besides a technical discussion on the origin, distribution, and geologic types of quicksilver deposits in Nevada, they included, at the Bureau's request, a history of quicksilver mining in Nevada with production figures, and a description of the quicksilver minerals and the metallurgical treatment of the ores.

The high cost to the Bureau of printing the maps and the description of all the properties examined will be justified in future years when this valuable information will be sought by those interested in reopening the mines. Since there is also a

demand by prospectors for just general information on the geology of quicksilver deposits and the metallurgical treatment of the ore, an abbreviated form of this bulletin is being issued without the individual mine descriptions and maps.

JAY A. CARPENTER,
Director of the Nevada State Bureau of Mines.

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QUICKSILVER DEPOSITS IN NEVADA*

By EDGAR H. BAILEY and DAVID A. PHOENIX, *Geologists, U. S. Geological Survey*

INTRODUCTION

In 1940 quicksilver mining in Nevada became an industry with an annual output valued at nearly one million dollars. Shortly before this the U. S. Geological Survey began an extensive study of deposits of strategic metals which included quicksilver, a metal essential to a country in time of war and not found in abundance in the United States. The writers have spent much of their time between November 1941 and December 1943 making detailed examinations of the quicksilver deposits in Nevada, and have visited nearly all of the more than 150 mines, prospects, and occurrences of quicksilver minerals described herein.

This bulletin is not intended to take the place of the more technical detailed reports on mining districts issued by the Geological Survey, but rather to supplement these reports by presenting an overall picture of the quicksilver deposits in Nevada, together with brief descriptions of each deposit. The first part of this bulletin includes those general concepts that experience has shown to apply to all of the Nevada deposits; the second part includes brief statements of history, production, and geologic environment of individual districts, mines, and prospects. The geologic aspects and controls of the deposits, as well as suggestions for prospecting for new deposits, have been emphasized, whereas the technology of mining and treating quicksilver ores has been only briefly discussed.

*Published with permission of the Director of the U. S. Geological Survey.

ACKNOWLEDGMENTS

So many individuals have contributed information included in this bulletin that it would be impractical to attempt to mention them all. Particular thanks, however, are due to the many quicksilver miners, prospectors, and mine operators and owners who freely gave of their time, knowledge, and hospitality, thereby increasing both the facility and enjoyment with which the field work was accomplished.

A large part of the field work was done in company with a field party of the Federal Bureau of Mines, and the cooperation and helpful suggestions of Mr. E. Y. Dougherty and Mr. M. Clair Smith, Engineers, and Mr. G. L. Allen, District Engineer, are gratefully acknowledged.

This bulletin was written in the Mackay School of Mines of the University of Nevada where the writers were assisted in various ways by the entire faculty. Mr. Jay A. Carpenter, Director of the School and of the Nevada State Bureau of Mines, cooperated in every way possible and offered many helpful suggestions and criticisms. Mr. Walter S. Palmer, Director of the Nevada State Analytical Laboratory and Curator of the Mackay Museum, assisted with mineral determinations, and made available for study the many specimens of quicksilver ores in the School Museum. Mr. W. I. Smyth, Professor of Metallurgy and Analyst, aided by making several mineral determinations. Dr. V. P. Gianella, Head of the Geology Department, contributed much from his knowledge of many quicksilver deposits in the State and also aided in the field examination of the well-known Steamboat Springs deposit.

Many members of the U. S. Geological Survey have contributed to this bulletin. The writers were aided in the field work for several months by James B. Cathcart, Philip F. Fix, and C. Melvin Swinney; during shorter visits to several of the larger quicksilver districts, H. G. Ferguson and S. W. Muller greatly facilitated the areal mapping through their broad knowledge of the structures and stratigraphy in western Nevada. An unpublished reconnaissance report and bibliography by C. P. Ross was consulted many times. Particular thanks are due to R. G. Yates, Ralph J. Roberts, John Nelson, and Carle Dane, who not only allowed the writers to use and publish their maps of various districts and mines, but also, through unpublished manuscripts,

allowed the writers the benefit of their ideas on various problems connected with quicksilver ore deposits.

The writers are indebted to Jay A. Carpenter and V. P. Gianella of the Mackay School of Mines and G. F. Loughlin, E. B. Eckel, and Miss Juanita Crawford of the Geological Survey for critically reading parts of the manuscript and suggesting many improvements. E. B. Eckel, under whose guidance this bulletin was prepared, helped in many ways during the field work and the preparation of the report; to him the writers feel especially indebted.

Many others through their publications unwittingly aided in the preparation of this bulletin. The bulletins of Lincoln[1] and Stoddard[2] were repeatedly consulted for information on various mining districts, and the technical press and the State Bureau of Mines file of mining news compiled from local newspapers were the sources of much information on the past history of many of the older mines.

[1]Lincoln, F. C., Mining districts and mineral resources of Nevada: Nevada Newsletter Publishing Company, Reno, Nevada, 1923.

[2]Stoddard, Carl, Metal and nonmetal occurrences in Nevada: Nevada State Bureau of Mines, vol. 26, No. 6, December 1932.

HISTORY AND PRODUCTION

The first discovery of cinnabar in Nevada was possibly made by Indians, for in the vicinity of Ione they are reported by early settlers to have used the bright red mineral for body paint. The first discovery of quicksilver minerals by white men will probably never be definitely known. The earliest reference the writers have been able to find is the designation of a locality as "Quicksilver" on Degroot's Map of Nevada Territory published in 1863; this place is fairly near the present Mt. Tobin and Goldbanks quicksilver mines. Four years later native mercury was reported[3] as having been found "near the center of the State."

In 1875 cinnabar was recognized near the center of the State in the Belmont district and south of Reno at the Wheeler ranch and Steamboat Springs localities.[4] These discoveries resulted in the staking of many claims, and at the Steamboat Springs mine a small but unrecorded amount of quicksilver was recovered in the late 1870's. Between 1875 and 1900 cinnabar was doubtless found in several placer-gold deposits, but no lodes were developed until 1906, when deposits in the Humboldt Range and near Goldfield were discovered.

It is somewhat surprising that quicksilver mines in Nevada were not developed earlier, for during the period from 1865 to 1895 a tremendous amount of quicksilver was brought in and used in amalgamating the gold-silver ores of the Comstock Lode. The exact amount of quicksilver used is unknown, but must have been at least 200,000 flasks, or at least four times the amount as yet recovered from all Nevada quicksilver mines.

The real birth of the quicksilver industry in Nevada might be said to be in 1907, for in this year the productive deposits of the Nevada Cinnabar (Shoshone) and Mercury Mining Company mines near Ione were discovered. Together, these two mines yielded nearly 10,000 flasks of quicksilver by the end of 1919, and their productivity doubtless stimulated prospecting for quicksilver. New deposits were found and mined prior to and during the first World War in the Goldbanks, Pilot Mountains, Imlay, and Antelope Springs districts, but the State production steadily

[3]Stretch, Richard H., Annual Report of the State Mineralogist of Nevada for 1866.

[4]Whitehall, H. R., Sixth Biennial Report of the State Mineralogist of Nevada for 1875 and 1876.

declined from 2,500 flasks in 1912 to only a few hundred flasks in 1920. From 1920 to 1927 little quicksilver was recovered.

In 1927 the price of quicksilver rose to more than $100 a flask, and production from the Pershing and Juniper (Nevada Quicksilver) mines in the Antelope Springs district, the B. & B. and Red Rock mines in the Fish Lake Valley district, and the Castle Peak mine in the Castle Peak district resulted in a new high of nearly 5,000 flasks being recovered in 1929. In 1932, however, the price decreased to only $50 a flask, and at the same time, partly because of the exhaustion of several of the known ore bodies, the yearly production decreased to only 500 flasks.

Between 1932 and 1939 a few good deposits were discovered but, because of the prevalent low price of quicksilver, they remained little developed even in 1939 when the price had risen to $150 per flask. In the following year, 1940, many of the new mines, particularly those in the Bottle Creek district, yielded so much quicksilver that production increased from less than 800 flasks in the previous year to a new high of nearly 6,000 flasks. Since 1940 the known ore bodies in the Bottle Creek district and in several mines elsewhere have been exhausted, but, owing to the opening of the Cordero mine in the Opalite district and the mines in the Ivanhoe district as well as the reopening of the Pershing and Red Bird mines in the Antelope Springs district, output remained high through 1943.

Early in 1944 the price of quicksilver again declined to about $130 a flask and almost all of the larger mines ceased development work, and probably will treat only readily available ore. The largest producer, the Cordero mine, has developed considerable ore and is expected to continue production for several years.

QUICKSILVER METAL AND MINERALS

QUICKSILVER METAL

Quicksilver* is a very rare element in the crust of the earth where it is estimated[5] to be only slightly more abundant than silver and gold. Despite its scarcity it commands a relatively low price, for even the exceptionally high value of quicksilver in 1943 amounted to only about $5,000 a ton, whereas the value of a ton of silver was about $25,000, and a ton of gold about $1,000,000.

As compared to the "precious" metals, quicksilver is overwhelmingly more useful to man, and nearly everyone has occasion to use some quicksilver each year either in mercury thermometers, or in amalgam dental fillings, or in such medicines and disinfectants as calomel or corrosive sublimate.

In many of its uses only small amounts of mercury are required, but a few, such as its use in a mercury boiler and turbine, require large amounts in a single installation. Because mercury is a very heavy liquid at ordinary temperatures it is used in thermometers, for floating the lens systems of lighthouses, and in electrical switches and instruments. Because it readily amalgamates with other metals it is widely used in the recovery of gold and silver. Combined with chlorine and oxygen, and even in the metallic state, large amounts of mercury are used for drugs and chemicals. The oxide is widely used in antifouling paint on ship-bottoms, whereas the sulfide is used as a vermillion paint pigment.

Little or no mercury is recovered from most of these uses; hence, it is a constantly diminishing asset which becomes of increasing importance in wartime when it is widely used in drugs and disinfectants, as mercury fulminate in detonators, and as a catalyst in the manufacture of gasses for chemical warfare.

QUICKSILVER MINERALS

Quicksilver occurs in a small number of minerals, and only the red sulfide, cinnabar, is moderately common. Virtually all of the quicksilver production of the world has been derived from

*The element mercury is popularly called "quicksilver" by virtually all men in the mining industry; after it reaches the market it is called "mercury" by chemists, technicians, and others.

[5]Clarks, F. W., and Washington, H. S., The composition of the earth's crust: U. S. Geol. Survey Prof. Paper 127, pp. 21 and 26, 1924.

cinnabar, but in places others of the more than 25 known quicksilver minerals increase the value of cinnabar ore. Exceptionally, a quicksilver mineral other than cinnabar is the principal ore mineral in an unusual quicksilver ore body. The quicksilver minerals that are commonly associated with cinnabar ores, or that are the only valuable constituent of quicksilver ores in a few places, will be described below, along with cinnabar, as it is possible that in the future some of them may become of commercial importance in Nevada.

Cinnabar. Cinnabar, the red mercuric sulfide (HgS), contains by weight about 86 percent of quicksilver. In large masses it is bright red or deep purple in color, but if pulverulent or finely disseminated through a rock it may appear vermillion or carmine. In outcrop, where its surface is tarnished by sunlight, it may become brownish red, or, where finely divided as in opalite ore, bluish grey to black. These discolorations, however, are never more than skin deep, and fresh surfaces invariably show the true red color of the mineral. Cinnabar has a relatively high specific gravity (8.1); it is heavier than pyrite or magnetite, but not as heavy as gold or silver. It is easily panned if it can be freed from light gangue, but in opalite ore the cinnabar crystals are generally so minute that they cannot be freed from silica even with fine grinding. Cinnabar is hexagonal in crystal form, belonging to the same crystallographic system and class as quartz, but well-formed crystals of appreciable size are so rare as to be prized as mineral specimens.

Metacinnabar. Metacinnabar, a black mercuric sulfide with the same composition and content of quicksilver as cinnabar, is a rare mineral, found in Nevada in only a few deposits. In some of the mines in the Belmont district, however, it is as abundant as cinnabar. Dark-colored cinnabar is often reported to be metacinnabar, but the two minerals may be easily distinguished, for metacinnabar gives a black powder or streak, whereas cinnabar gives a red powder or streak. In most places metacinnabar is found as small grains or crystals that are enveloped by cinnabar. Black grains so coated may be suspected of being metacinnabar, but as metacinnabar so closely resembles several other black minerals its identity should be confirmed by chemical test.

Native mercury. Native mercury is a silvery liquid which usually occurs as droplets or globules on cinnabar, but locally, as at the Red Bird mine, it is so finely divided as to resemble soot. It is even heavier than cinnabar (sp. gr. 13.6) and will collect as small globules in the bottom of a pan. Its presence in

cinnabar ore increases the tenor of the ore, but, if present in large amounts, increases the danger of salivation (mercury poisoning).

Chloride and oxychlorides. The chloride and oxychlorides of mercury have been found in small amounts in several Nevada quicksilver deposits. Calomel (Hg_2Cl_2) is a soft, waxy, yellowish-white to pale-green mineral which generally forms small but brilliant crystals. Terlinguaite (Hg_2ClO) and eglestonite (Hg_4Cl_2O) are both soft, heavy, bright-yellow minerals which rapidly darken on exposure to sunlight.

Tiemannite. Tiemannite is a mercuric selenide (HgSe) with metallic luster, and steel-gray to lead-gray color; it is soft and about as heavy as cinnabar. It is a very rare mineral and has not been recognized in any Nevada deposits, although near Marysvale, Utah, it occurred in sufficient abundance to form a small quicksilver ore body.

Livingstonite. Livingstonite is a mercury-antimony sulfide ($HgS.2Sb_2S_3$) which resembles stibnite but has a red-brown streak. Its specific gravity is less than that of most mercury minerals, and is also less than that of pyrite or magnetite. It occurs in commercial amounts in Mexico, and because of its similarity to stibnite may be easily overlooked. The high percentage of antimony causes considerable metallurgical difficulty which may be offset by the recovery of the antimony.

Mercurial tetrahedrite. Some varieties of tetrahedrite, more familiarly known as gray copper ore, contain as much as 17 percent quicksilver. At present none of the deposits in which mercurial tetrahedrite is the only ore mineral is commercial.

Mercurial bindheimite. Bindheimite, the bright yellow lead-antimony oxide, was mined as quicksilver ore at the Red Bird mine in the Antelope Springs district and was a prominent constituent of the ore of the Drew mine in the Pilot Mountains district. In both of these localities some cinnabar occurs with the ore, but analyses of the Red Bird ore made by J. J. Fahey of the Geological Survey indicate the bindheimite itself is probably mercurial.

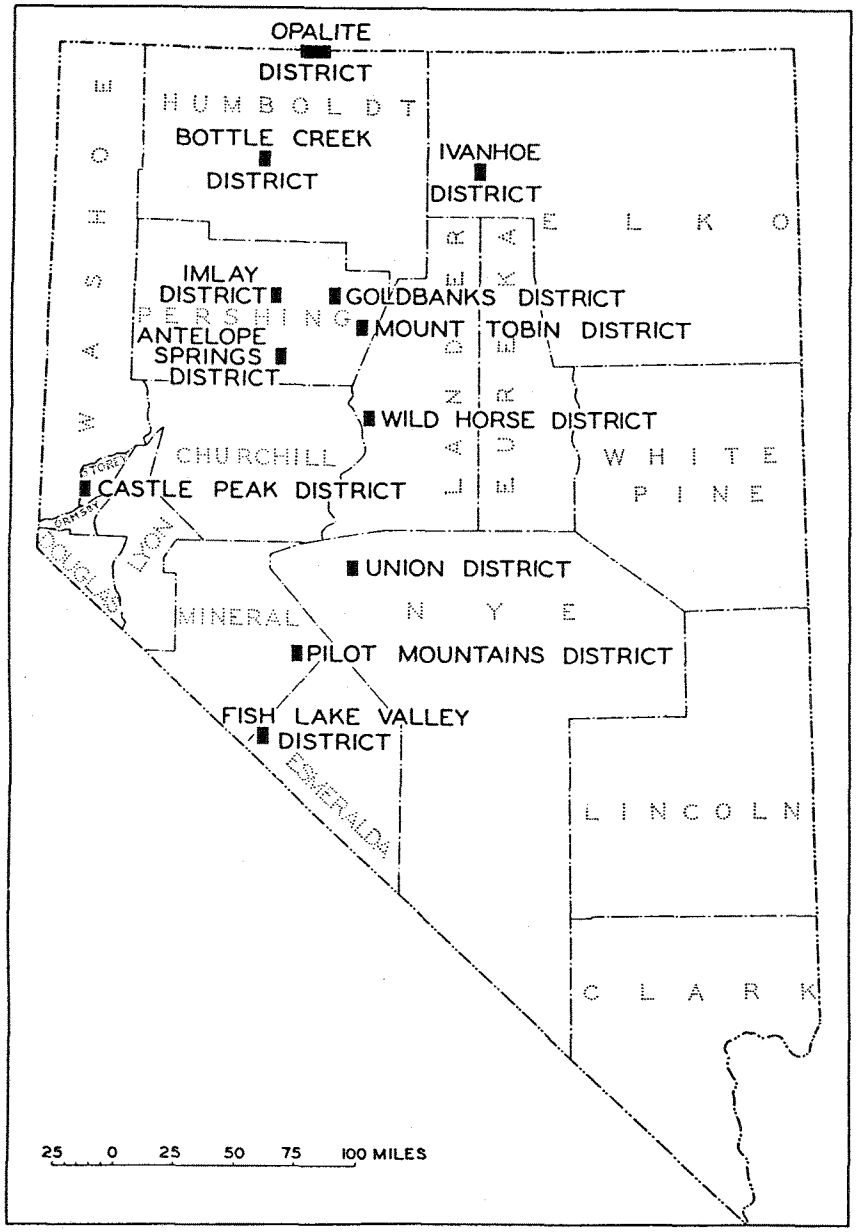

FIGURE 1. Index Map of Nevada Showing Locations of the More Productive Quicksilver Districts.

QUICKSILVER DEPOSITS

ORIGIN

Quicksilver deposits normally contain cinnabar, a mineral which is easily made in the laboratory and for which the conditions necessary for solution and deposition have been repeatedly investigated.[6 7 8 9] These laboratory investigations, as well as independent field studies, have lead geologists to believe that quicksilver deposits are generally formed from ascending alkaline solutions which, although hot (100°–200° C.), are cooler than most magmatic solutions that have given rise to ore bodies.

Because the mercury-bearing solutions are ascending, ore bodies must overlie a channelway that allows the upward migration of the solutions; generally the channelway is a fault or breccia zone, but some ore bodies overlie essentially unbroken porous rocks through which the rising solutions migrated without benefit of well-defined passageways.

Because the mercury-bearing solutions are believed to be alkaline, certain other minerals soluble in alkaline solutions may be expected to occur in, or in some cases to be removed from, the sites of quicksilver ore bodies. Alkaline solutions readily dissolve silica, arsenic sulfide, and antimony sulfide; they also dissolve smaller amounts of gold and the sulfides of iron, zinc, and copper. The general occurrence of silica, antimony, and iron minerals in some types of quicksilver deposits is well known, and small quantities of gold, arsenic, zinc, and copper minerals occur in some Nevada quicksilver ores.

Because the mercury-bearing solutions are relatively cool, ore bodies may be expected to have formed near the surface. The depth of formation of most quicksilver ore bodies in Nevada has not been determined, but, as was pointed out by Becker,[10] cinnabar is contained in sinter deposited essentially at the surface at

[6] Becker, G. F., Quicksilver deposits of the Pacific slope: U. S. Geol. Survey Mon. 13, pp. 419–437, 1888.

[7] Allen, E. T., and Crenshaw, J. L., The sulfides of zinc, cadmium, and mercury; their crystalline form and genetic conditions: Amer. Jour. Sci., 4th ser., vol. 34, pp. 341–396, 1912.

[8] Broderick, T. M., Some experiments bearing on the secondary enrichment of mercury deposits: Econ. Geol., vol. 11, pp. 645–651, 1916.

[9] Dreyer, Robert M., Geochemistry of quicksilver mineralization: Econ. Geol., vol. 35, pp. 17–48 and 140–157, 1940.

[10] Becker, G. F., *op. cit.*, pp. 343–346.

Steamboat Springs. In contrast, appreciable amounts of cinnabar were found at a depth of 1,200 feet at the White Caps gold mine in the Manhattan district. Probably most of the quicksilver deposits in Nevada were formed at depths between these limits; certainly several were formed at depths of only a few hundred feet.

DISTRIBUTION

Geographically, most of the quicksilver deposits in Nevada lie in a northerly trending belt extending through the State from Beatty in the south to McDermitt in the north. (See Plate 1.) The limits of the belt are most easily remembered by visualizing Nevada as divided into thirds by north-south lines; the eastern line would be about half way between Battle Mountain and Elko in the north and would pass east of Beatty in the south, whereas the western line would pass close to Lovelock and Mina. The central third contains most of the quicksilver deposits, and, further, those mines now most productive lie in the northern half of this belt.

Geologically the quicksilver deposits are less confined than they are geographically, for they occur in rocks of nearly all kinds and ages. Generally those rocks that are locally the most brittle are the most favorable sites for quicksilver deposition, but there are so many exceptions to this generalization that it is of little value in prospecting. Rocks that are relatively impervious, such as shales, do not allow the ore-forming solutions ready access and consequently rarely contain quicksilver ore bodies. Other formations that cover large areas and contain no known ore bodies include the alluvium and lake deposits in the broad valleys and the extensive, very young, flows of basalt.

The structures along which most ore bodies have been found are faults of small displacement. The faults of large displacement responsible for the uplift of the basin ranges, so far as is now known, only very locally contain small amounts of cinnabar, but many fractures and crushed zones, along which there can have been at most only a few inches to a few feet of movement, contain mineable quicksilver ore. As will be further emphasized in the "Suggestions for Prospecting," areas containing many hot springs are not particularly favorable places for quicksilver deposition, and no appreciable amounts of quicksilver have been recovered from the proximity of hot springs in Nevada.

LOCALIZATION

Only under certain favorable conditions and only in favorable places are quicksilver minerals deposited in sufficient abundance to form ore bodies. The factors that control this localization of ore bodies are both physico-chemical and structural. The physico-chemical conditions that affect the rising solutions and cause the deposition of cinnabar are not easily studied or well understood, but they doubtless include acidification, dilution, chemical reaction with the wall rock, and the lowering of temperature and pressure. It is fortunate, however, that geologic structures appear to be of greater importance in controlling the localization of the ore, for the structures can be mapped, studied in detail, and followed in mining and prospecting for ore. The kinds of structures that localize ore bodies differ according to the kinds of rocks that enclose the ore bodies, and they are more fully treated in the discussion of the various geologic types of deposits. "Structural traps" and "cap rocks," as emphasized by Schuette,[11] appear to localize some types of ore bodies, but they are strikingly absent from others.

[11] Schuette, C. N., Occurrence of quicksilver ore bodies: A. I. M. E. Tech. Pub. 335, pp. 5–88, 1930.

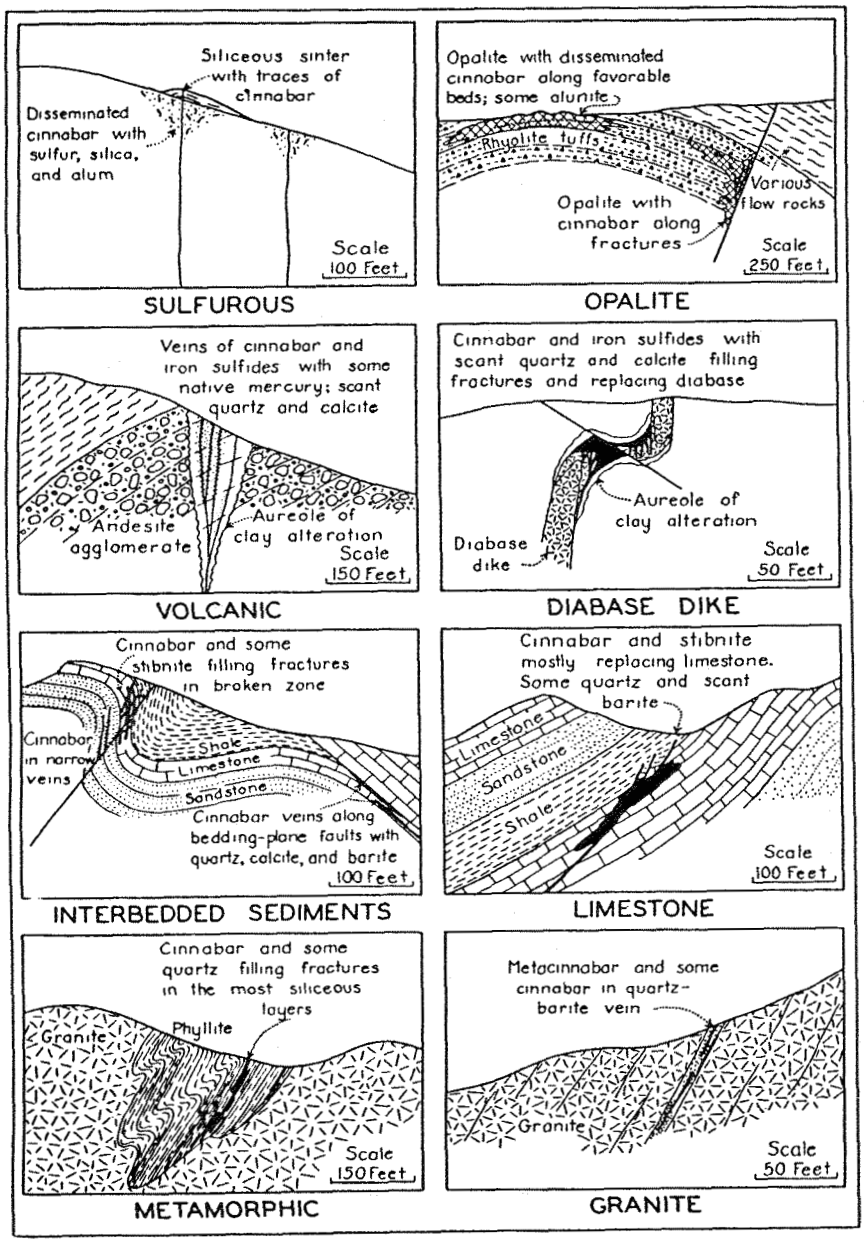

FIGURE 2. Diagrammatic Cross Sections Showing the Characteristic Features of Different Geologic Types of Quicksilver Deposits.

GEOLOGIC TYPES OF QUICKSILVER DEPOSITS IN NEVADA

If one were to make cursory examinations of half a dozen, or perhaps even a dozen, of the quicksilver deposits in Nevada he would no doubt conclude that they were all radically different, and that they were quite unpredictable; in fact, just such conclusions furnish the prevalent beliefs about these deposits. A more extensive study of all of the deposits, however, reveals the fact that the dominant features of each are primarily determined by the kind of rock in which it occurs, and all of the deposits in one kind of rock, regardless of how widely they may be separated geographically, have a surprisingly large number of features in common. These features which are generally much the same for all deposits in the same kind of rock include the general grade and character of the ore, the prevalent gangue minerals, the amount and kind of wall rock alteration, the attitude of the ore body, and the kind of structure that localizes it. Because of the dominant role played by the host rock it has been possible to place each of the approximately 150 quicksilver deposits examined by the writers into one, or in some cases two, of eight geologic types which, with a single exception, are designated by the name of the host rock. (See Figure 2.)

The quicksilver miners in Nevada, apparently recognizing the similarity of deposits occurring in similar rocks and realizing that a single term is sufficient to impart a picture of a deposit, now use such terms as "opalite type" and "volcanic type" in describing a quicksilver deposit. The writers have of necessity added some new terms, but the miner's accepted terms have been retained, even though some are perhaps not the most desirable from a strictly scientific viewpoint.

Among the igneous rocks, quicksilver deposits have been found in "granite," diabase dikes, rhyolitic tuffs and a few flows, and andesitic agglomerates and flows. The first two kinds of rocks contain deposits classed as belonging to the granite or diabase dike type of deposit. Rhyolitic rocks containing quicksilver ore bodies are nearly everywhere silicified to a rock known to miners as "opalite," and because of the prevalence of this rock the deposits are generally said to be of the opalite type. Andesite, and other light-colored volcanic rocks containing no visible quartz, are generally altered in the vicinity of quicksilver deposits almost

beyond recognition as other than volcanic rocks; consequently, the miner's term "volcanic type" is probably preferable to a more specific term such as "andesite type."

Among the sedimentary rocks, quicksilver deposits have been found in limestone, sandstone, chert, intergradational rocks such as limy sandstone, and thinly interlayered sediments of different kinds. The multiplicity of possible combinations of these rocks introduces difficulties in the classification of deposits in sedimentary rocks, but experience has shown that, with a single exception, there are no great differences between the deposits in the different sedimentary rocks. The single exception includes a small but important group of deposits occurring in thick limestone beds and differing in that cinnabar has largely replaced the limestone instead of merely filling fractures and pore spaces as it does in many other deposits in limestone and in all deposits in other sedimentary rocks. For this reason these exceptional deposits are classed as a limestone type, and all the other deposits in sedimentary rocks are grouped together as a single interbedded sediments type.

Among the metamorphic rocks, only a few deposits have been found, and these are grouped as belonging to the metamorphic type of quicksilver deposit, even though this term may be misleading in implying that the deposits themselves have been metamorphosed.

One group of deposits formed on or very near the surface by hot spring water might be expected to occur in almost any kind of rock. The dominant characteristic of these deposits is the abundance of sulfur, and they have been grouped as a sulfurous type of deposit.

SULFUROUS TYPE OF DEPOSIT

The sulfurous type of deposit is characterized by the presence of abundant sulfur, and in several deposits alum and silica, either opal or chalcedony or quartz, are widespread. A few deposits of this type lie in the vicinity of active hot springs, and all are believed to have been formed either at the surface, or within a few tens of feet of the surface, by hot waters which emerged as hot springs. In a few places these solutions have built up surficial deposits of siliceous sinter containing cinnabar.

The sulfurous type of deposit might be found in any rock, but the known deposits in Nevada all lie in either altered tuffs or granitic rocks.

Cinnabar in the sulfurous deposits is generally rather sparsely scattered in openings in the country rock as microcrystalline aggregates and thin crusts and "painty" films. As the cinnabar in these deposits is spread through the rock rather than being confined by a particular structure, the ores are of low grade, and none of these deposits in Nevada has yielded more than a hundred flasks of quicksilver.

OPALITE TYPE OF DEPOSIT

The opalite type of deposit is characterized by opalite as the host rock for the cinnabar. The term "opalite" is widely used by quicksilver prospectors and miners, as well as by mineral collectors, as a name for a rock composed almost wholly of amorphous and cryptocrystalline silica. In spite of its wide use, however, the term has not been strictly defined; in this bulletin it will be applied only to siliceous rocks formed by the nearly complete replacement of volcanic rocks, and it will not be used as synonymous with siliceous sinter.

Formerly opalite bodies were believed to be blankets of siliceous sinter deposited at the surface by hot-spring waters, but the recent studies by Yates,[12] Yates and Roberts,[13] and Nelson and Roberts[14] have clearly demonstrated that in the Opalite and Ivanhoe districts the opalite bodies have been formed by silicification of rhyolitic tuffs. The writers are in complete accord with the new concept, as they have found no opalite deposits that do not show at least a few features indicating their derivation by replacement of quartz-bearing volcanic rock.

Most of the opalite deposits occur in volcanic rocks of Miocene age, but some are in volcanic rocks that may be even younger. As the majority of these Tertiary volcanics in Nevada are nearly horizontal, most opalite deposits are also nearly horizontal, although some are inclined or flexed. Nearly all opalite deposits have been formed in rhyolitic tuffs, or ash beds, but a few that are classed in this group were formed in flows of similar composition.

The typical opalite blanket is from 500–750 feet in maximum

[12] Yates, R. G., Quicksilver deposits of the Opalite district, Malheur County, Oregon, and Humboldt County, Nevada: U. S. Geol. Survey Bull. 931-N, pp. 319–348, 1942.

[13] Yates, R. G., and Roberts, R. J., The "Opalite" type of quicksilver deposit: (abstract) Econ. Geol., vol. 36, p. 839, 1941.

[14] Nelson, John, and Roberts, R. J., Quicksilver deposits of the Ivanhoe district, Elko County, Nevada: U. S. Geol. Survey, unpublished report, 1942.

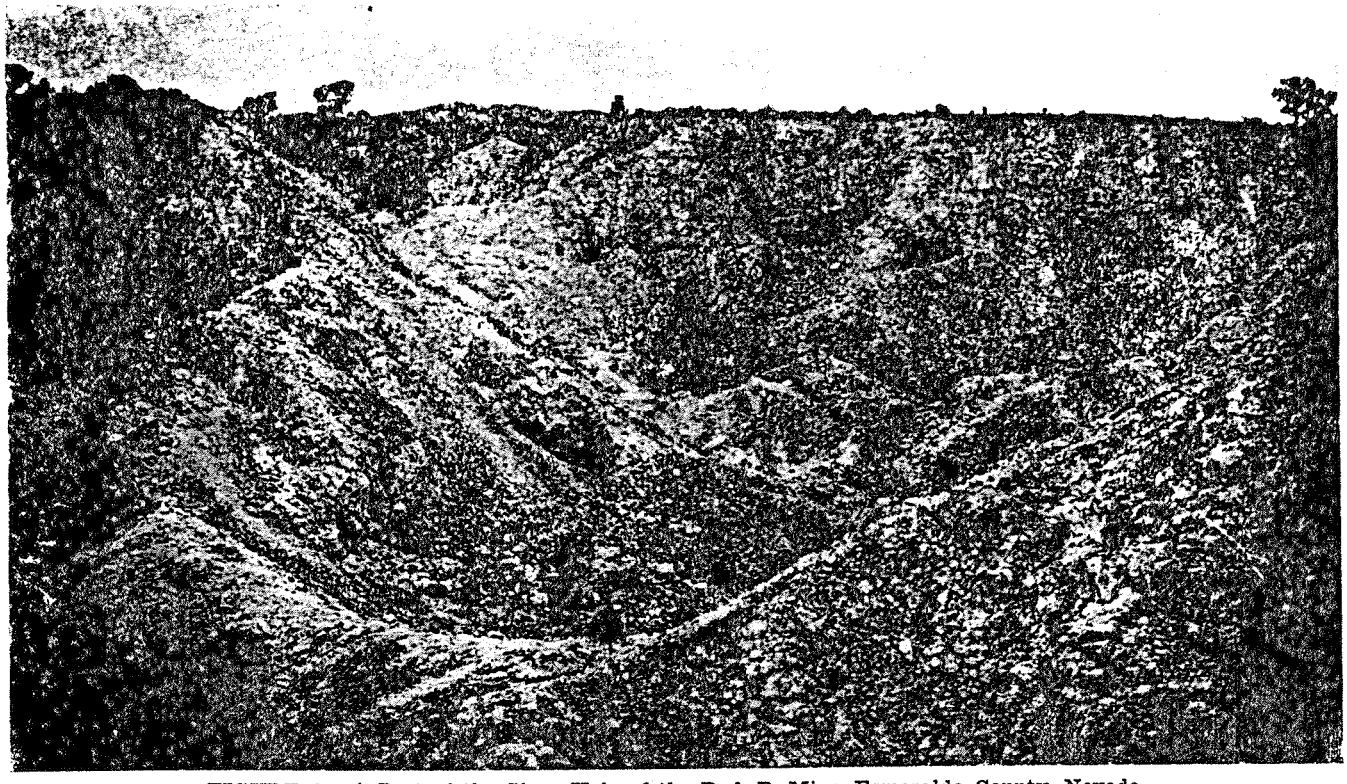

FIGURE 3. A Part of the Glory Hole of the B. & B. Mine, Esmeralda County, Nevada.

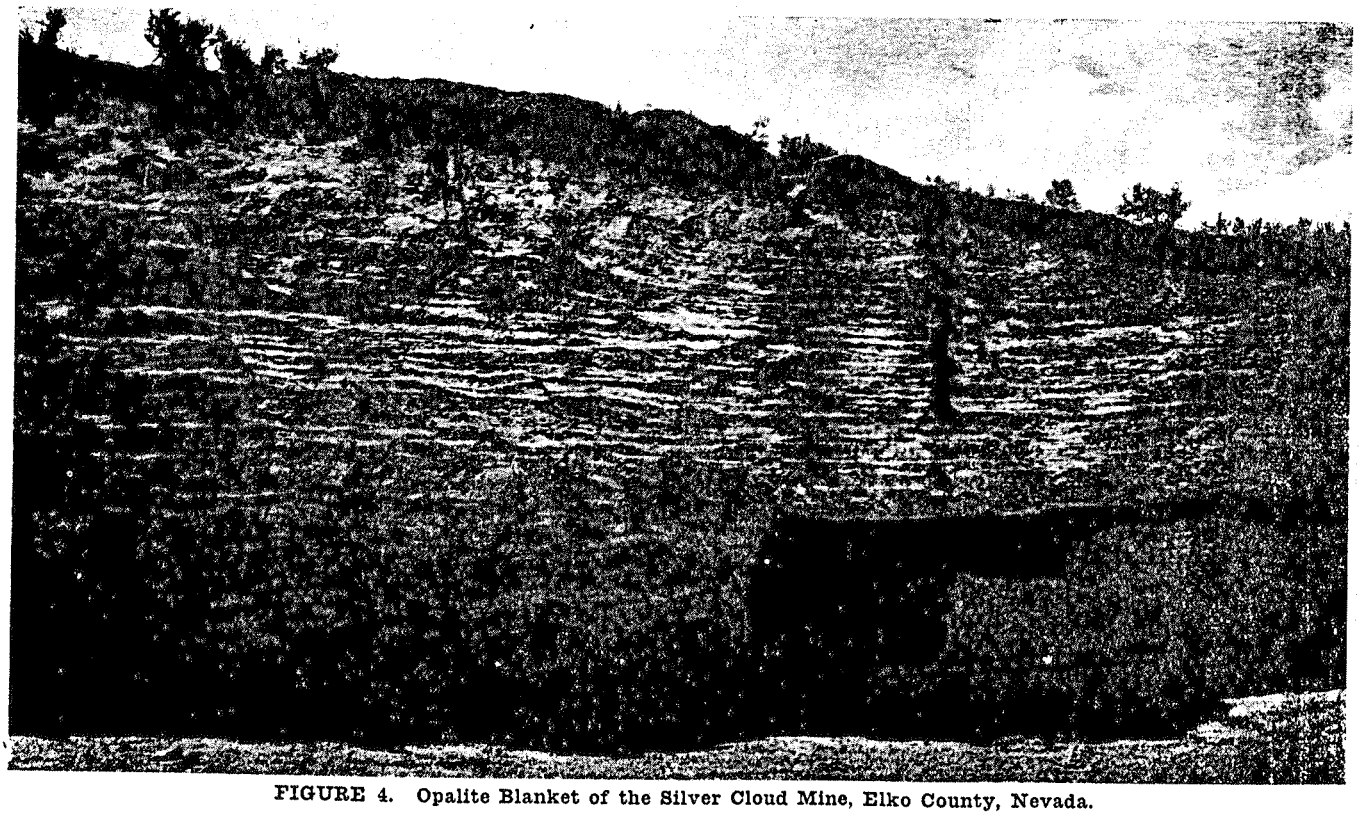

FIGURE 4. Opalite Blanket of the Silver Cloud Mine, Elko County, Nevada.

diameter and 30–50 feet thick, but only a part of the blanket is ore. Most of the opalite bodies that have been mined cropped out as groups of resistant knobs, and because they were of blanket form, they were generally mined by surface cuts or by glory holes. (See Figure 3.)

Cinnabar is the dominant ore mineral, but native mercury, calomel, and oxychlorides are found in small amounts. The gangue—the opalite itself—is either chalcedony, opal, or rarely microcrystalline quartz; and alunite and montmorillonite are widespread in several deposits. Pyrite is typically absent, but one opalite blanket is known to contain a few minute crystals of this mineral.

The distribution of the cinnabar in deposits of this type differs for different deposits, but the cinnabar is generally distributed in one of three ways, any or all of which may form ore in a single opalite blanket. Commonly, it is disseminated as minute crystals in a particularly favorable bed forming a thin blanket of ore that has the same inclination as the enclosing opalite blanket. (See Figure 4.) A good example of this kind of deposit is the Silver Cloud mine described on page 61. In some deposits the distribution of the cinnabar is controlled by steep faults, cracks, or broken zones, and in these deposits the cinnabar forms as crusts or veinlets in openings. This kind of ore was mined in parts of the Governor mine described on page 58. In somewhat more erratic deposits the cinnabar is disseminated in scattered clouds or bunches which may or may not be connected by discernible veinlets or stockworks.

Some opalite deposits in the Ivanhoe district are believed to have formed at depths greater than 500 feet; however, as nearly horizontal opalite blankets can contain only a relatively thin deposit, and, as the known opalite blankets lie near the surface, the ore bodies in them might be said to be "shallow" and "not to go to depth." It is possible that a feeder might be followed downward from one blanket to a deeper one, but extensive exploration by drifting and by drilling beneath several flat opalite blankets has failed to find feeders, deeper blankets, or mineable ore. On the other hand, rich ore of the volcanic type was found to directly underlie irregular inclined opalite masses at the Cordero mine, and it has been followed by drilling to a depth of 600 feet.

The ore bodies of the opalite type are of relatively low grade, but many are of sufficient extent to warrant the installation of a furnace of large capacity. The development of these deposits

requires considerable capital, as few contain ore that might be profitably retorted by a small operator to partly defray his development costs. Selective mining, and in some places hand-sorting, is advantageous; concentration or a process involving flotation is impractical because of the extremely small size of the cinnabar crystals and the hardness and tenacity of the gangue.

VOLCANIC TYPE OF DEPOSIT

The volcanic type of deposit occurs typically in andesite lava flows and agglomerates, but a few deposits in more acid flows are included in this group because they are localized by the same kinds of structures and contain similarly altered rocks. The deposits are characterized by the presence of abundant pyrite or marcasite, the scarcity of silica, and by the alteration of the wall rock to clay.*

Cinnabar is the dominant ore mineral, but in a few deposits native mercury materially increases the tenor of the ore. Pyrite, and possibly also marcasite, is abundant, and because of the prevalence of sulfate in waters near the surface jarosite and gypsum are widespread in the outcrops. Clay minerals of unknown and possibly variable composition are present without exception, and their amount in any deposit seems to be roughly proportional to the amount of cinnabar. Small quantities of chalcedony, quartz, and calcite occur as vein minerals accompanying the cinnabar.

The localization of the cinnabar is controlled by steeply dipping fractures and faults along which there has been only a small amount of movement, and "cap rocks" and "structural traps" are generally not apparent. In the smaller deposits, the cinnabar is confined to the fractures and forms veins or veinlets; in the larger ones it not only fills these larger openings, but is also disseminated through pore spaces that result from the alteration of the enclosing volcanic rock. This disseminated cinnabar locally appears to replace the rock, but replacement is believed to be of far less importance than is the filling of minute open spaces.

The narrow veins that occur in these volcanic rocks are likely to be discontinuous, but in many places they consist of nearly pure cinnabar with only a little silica and pyrite. Where the ore is confined to these veins or, as in some small mines, to a single vein, it is usually hand-sorted and retorted. Where the cinnabar not only fills veins but is also disseminated in the walls,

*As the clay minerals in most of the deposits have not been determined the altered rock is said to be "argillized" rather than "kaolinized."

as in the larger deposits, the ore is generally mined in greater volume and is treated in furnaces.

A typical example of a deposit consisting of a single vein in volcanic rock is the Poinsettia property, described on page 132; a good example of a larger deposit is the Castle Peak mine, described on page 184.

DIABASE DIKE TYPE OF DEPOSIT

Deposits in diabase dikes are not widespread and differ but little from those in andesitic volcanic rocks. Like the deposits of the volcanic type they contain abundant pyrite and a little silica and calcite, and the dikes and their wall rocks are extensively altered to clay minerals. They differ in that the cinnabar, although in part filling fractures, in the better ore bodies replaces the diabase of the dike. A further difference between the deposits in diabase and those in andesite is the importance of geologic structures in localizing the ore in the dikes, for the richest ore bodies have been found in flat "rolls" in the dikes, and in places where the dikes are fractured and overlain by heavy gouge or shale.

The ore bodies in diabase dikes are among the richest found in Nevada, and the ores from them can be profitably retorted; however, the ore bodies in the Bottle Creek district were large enough to justify the installation of small furnaces. The McAdoo, Blue Can, and White Peaks deposits, described on pages 86, 83, and 88, are all good examples of mines developing ore bodies in diabase dikes.

INTERBEDDED SEDIMENTS TYPE OF DEPOSIT

The interbedded sediments type of deposit occurs in bedded limestone and shale, calcareous sandstone, or chert. Fractures are required for the deposition of the ore; consequently, the ore bodies lie along normal and bedding faults, and their localization is in many places affected by the intersection of these faults with favorable beds. The lack of wall-rock alteration, the association of small quantities of stibnite, and the common presence of quartz, calcite, and barite as gangue minerals are other characteristics.

The ore mineral is cinnabar. It generally only fills openings forming networks of irregular veinlets, high-grade lenses along faults, and distinct veins along fractures. Replacement of rock by cinnabar, although uncommon, locally assumes importance in

the more limy rocks; but, if replacement is dominant, as it is in some deposits in limestone, the deposit is classed as a limestone type of deposit.

The ore bodies vary both in size and grade depending upon the kind of sediment in which they formed. As the cinnabar fills openings, and as each filling is nearly pure cinnabar, the character of the ore bodies is also dependent on the number and distribution of the openings. Many ore bodies are of high grade and strictly confined to a narrow zone of broken rock, but in the Pershing mine a low-grade body, partly due to fracture filling and partly due to the replacement of dolomite, was mined for a length of over 1,000 feet.

Sandy limestone or dolomite has yielded the most productive ore bodies of this type. They are especially favorable hosts because their brittleness allows the development of many fractures and their chemical composition favors marginal replacement. Two good examples are the ore bodies of the Mercury Mining Co. mine, described on page 149, and the ore bodies of the Pershing mine, described on page 164.

In sandstone the cinnabar is found along the controlling faults and adjacent bedding planes, and the ore while generally of high grade occurs as small narrow bodies. If the sandstone is porous, cinnabar may be disseminated through the beds to form a large deposit of low-grade ore, but no mineable deposits of this character have been found in Nevada. A good example of a deposit in sandstone is the Mammoth mine, described on page 127.

In chert, cinnabar generally fills breccia zones, but in some ores it locally replaces the rock.[15] The ore bodies commonly lie along rolls in normal faults, and although very small, are of high grade.

Methods used for the recovery of the quicksilver from these ores vary widely. The deposits found in the limy rocks generally contain large quantities of ore averaging three to five pounds of quicksilver to the ton, and their ores commonly are treated in furnaces. On the other hand, the deposits found in sandstone and chert, because they are small but rich, furnish ores treated principally by retorts.

LIMESTONE TYPE OF DEPOSIT

The limestone type of deposit occurs only in relatively thick beds of limestone, and its outstanding feature is the dominance

[15] Foshag, W. F., Quicksilver deposits of the Pilot Mountains, Mineral County, Nevada: U. S. Geol. Survey Bull. 795-E, p. 122, 1928.

of cinnabar replacing the limestone over cinnabar filling fractures and openings. Other characteristic features are the restricted distribution and extreme richness of the ore, the dominance of carbonates as gangue minerals, the presence of abundant stibnite, and the presence of a "capping" of shale or other relatively impervious rock.

Cinnabar is the only commercially important ore mineral, but small amounts of calomel and native mercury are not uncommon. The cinnabar is coarsely crystalline and in the richest ore bodies may locally amount to as much as 50 percent of the ore. These very high-grade ore bodies are related to some ore bodies of the interbedded sediments type found in thinner limestone beds, but they have been grouped separately because they possess special features owing to the mineralization having gone beyond the stage of fracture filling to that of extensive replacement. Their form is generally pipe-like, and their borders are sharply defined. The best examples have been found in the Juniper (Nevada Quicksilver) mine described on page 161, and the Mina Development Co. (Mina Merc.) mine described on page 127.

In some of the ores of deposits of this type at the Red Bird and Drew mines the mineral assemblage is unusual in that it consists of sphalerite, stibnite, and lead antimony sulfides whose alteration has given rise to hemimorphite, antimony oxides, and mercurial bindheimite.

The ore bodies are usually localized along a fault or broken zone in a favorable limestone bed capped by relatively impervious shale. However, several of them that have been mined did not extend to the "capping" but were localized at distances of from 10 to 30 feet below the shale. Because of this, several of the rich ore bodies of the limestone type were missed by exploration directly beneath the "cap," only to be later found by following narrow cinnabar veinlets down from the "cap."

Both furnaces and retorts have been used to treat ores from deposits of the limestone type. Generally the recovery plants are not large; a 20- or 30-ton furnace or a bank of 6 or 8 retorts usually proves adequate.

METAMORPHIC TYPE OF DEPOSIT

The metamorphic type of deposit occurs only in metamorphic rocks such as phyllite and quartzite. The deposits in these rocks are similar in many respects to those in interbedded sedimentary rock, but, because of their unusual occurrence in roof pendants and because they lack any pronounced lithologic control, they are

classed under a separate heading. Only two bodies of this type, those of the Van Ness mine described on page 138 and the Red Rock mine described on page 72, are of economic importance.

The ore mineral found in these deposits is cinnabar. It is locally accompanied by small quantities of stibnite; the commoner gangue minerals are quartz and barite, with some clays. The cinnabar generally forms fillings and encrustations in highly broken and silicified rock, but some occurs in solid masses along faults and beneath altered zones.

The ore bodies are similar to those found in the interbedded sediments type of deposit, and most closely resemble those in the chert of the Pilot Mountains district.

Localization of the ore is controlled by faults, gouge zones, and by easily fractured siliceous beds. The tenor of the ore is highest close to the controlling structure, but adjacent wall rock containing disseminated cinnabar also forms ore of furnace grade.

GRANITE TYPE OF DEPOSIT

The granite type of deposit may be found in any granitic rock, and the prevalent ore mineral is metacinnabar. Deposits of this type have yielded only small amounts of quicksilver and have been found only in the Belmont district.

Although the chief ore mineral is black metacinnabar, the deposits generally also contain cinnabar. The metacinnabar forms coarse crystals in a quartz-barite gangue, whereas the cinnabar coats the metacinnabar and fills minute fractures in the gangue minerals. These gangue minerals include barite, quartz, chalcedony, pyrite, muscovite, jarosite(?), and small quantities of clay.

The known ore bodies lie in composite quartz-barite veins which parallel the local jointing in the granite. They are small but of high grade, for in places the metacinnabar makes up 15 percent of veins several inches wide. Generally, however, the entire width of the composite vein, from two to five feet, has been mined in narrow tabular stopes, and the ore has been hand-sorted before retorting.

Localization of the ore in the veins probably depends on the amount of shearing and on local variations in strike and in dip, for at the Senator mine, described on page 136, these features appear to control the ore shoots.

RELATIVE VALUE OF DEPOSITS OF DIFFERENT GEOLOGIC TYPES

At best it is difficult to estimate the potential worth of a quicksilver mine or ore body while it is still in the prospect or development stage. Because it has been possible to group quicksilver deposits into a few geologic types some pertinent generalities on expectable yield and expectable grade of ore can be drawn. These generalities, however, must be applied with caution for they can only be based on averages, and some individual mines depart rather widely from these averages.

The relative productivity of deposits belonging to each of the eight geologic types is indicated by Figure 5, which shows the

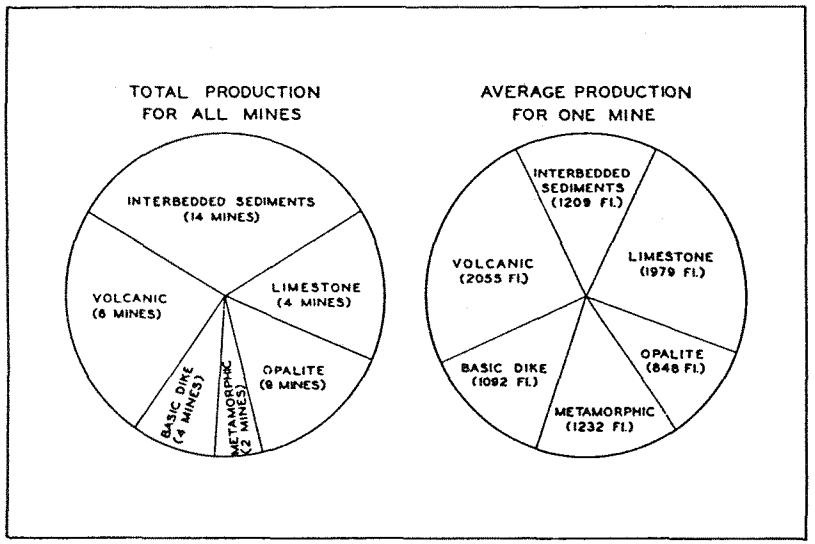

FIGURE 5. Chart Showing the Total Amount of Quicksilver Yielded by the Larger Mines of Each Geologic Type, and the Average Production from a Single Mine of Each Type.

total yield from all of the larger ore bodies of each type and the average yield of each. This chart is based upon mines which produced over 100 flasks of quicksilver, and in the case of a mine having ore bodies of two types the production has been prorated. The average yield from deposits of each type at least partly indicates the relative value of the different types of deposits. For the deposits of the limestone and volcanic types the average yield is about 2,000 flasks; for deposits of the interbedded sediment, basic dike, opalite, and metamorphic types it is about 1,000 flasks. Deposits of the granite and sulfurous types are not represented, for none of these has yielded over 100 flasks of quicksilver;

obviously, they must be considered as the least favorable for further development.

The average production, however, is not the only indicator of the relative value of deposits of each type, for the average grade of the ore and the amount of development necessary to find and mine it must also be taken into consideration.

The ore bodies of the deposits of the limestone and basic dike type have been the richest, but as they are localized in relatively small compact bodies they are the most difficult to find. Ore bodies of these types probably will yield the greatest returns on investments if the profits are not expended in seeking for other ore bodies; certainly, their ores can be mined during periods of normal peacetime prices.

Deposits of the volcanic type in most cases are moderately large and continuous, and they contain a medium grade of ore. Therefore, ore can be blocked out in advance of mining with the result that it is generally possible to determine the most advantageous size of furnace and method of mining. Some of these deposits mined in the past contained ore that would yield a profit when the price of quicksilver was about $130 a flask; others contained ore of a slightly lower grade.

Deposits of the opalite type are large and are cheaply mined, but the ores are nearly everywhere of low grade. While they can be mined on a large scale with good profit during periods of high prices, most of them cannot be mined profitably during periods of low quicksilver prices.

Other types of deposits appear to show such wide variation that it is impractical to make any generalizations about them.

SUGGESTIONS FOR PROSPECTING

The large majority of the productive quicksilver deposits have been found in the central third of Nevada, and the chances of finding new deposits in this area appear to be better than are the chances elsewhere. As has been previously pointed out, certain rocks, such as basalt, and certain structures, such as the basin-range faults, appear to be unfavorable even in the productive belt, and they should be avoided.

Prospecting methods are better known by most prospectors than by the writers. However, it is apparent that many deposits were overlooked for years because the prospector failed to realize the relation between the prevalent rocks in an area and the characteristics of any quicksilver deposit that they might contain. The following suggestions, therefore, will not deal with the techniques of prospecting, such as how to pan up canyons and slopes to a lode, but rather will suggest which methods of prospecting are most likely to be effective in a particular area.

In areas underlain by rhyolitic tuff—a white to gray ashy and often loosely consolidated rock that generally shows bedding—one should expect to find only deposits of the opalite type. To be sure, some unsilicified ash beds locally contain scattered grains of cinnabar which might be found by panning, but no mineable ore bodies are known to occur in beds of essentially fresh tuff. The prospector should, therefore, spend his time in searching for outcrops of opalite and in visually examining such outcrops. As opalite ore turns gray or black on exposure to the sunlight, fresh breaks should be inspected, and the grade of the ore may be visually estimated from the intensity of the pink or red color and the size of the individual crystals of cinnabar. As most deposits of the opalite type are of blanket form and nearly flat they are most economically explored by shallow shafts or by churn drilling.

In areas of andesitic rocks deposits of the volcanic type may be expected. As these are characterized by extensive rock alteration, veins and ore-bearing rock only locally crop out, but, as they also normally contain abundant pyrite, the prevalence of iron stain, jarosite, or gypsum is a favorable sign. The best areas for prospecting, therefore, are areas in which the soil or scattered rock exposures indicate that the underlying rock is abnormally altered. Obviously, since the surface rocks have been disintegrated by weathering, panning is the best way to determine whether such areas contain cinnabar. If a vein is found,

first its surface extent should be determined by trenching and panning; then its underground extent should be determined by shallow drifts.

In areas containing diabase dikes similar suggestions are warranted, but an appreciation of the local geologic structures is also helpful. In general, the borders of the less steep parts of the dikes, and the places where dikes are cut off by faults or are overlain by shale or gouge, offer the most favorable places in which to search for ore.

In areas containing sedimentary rocks, ore is more likely to be found in limestone than in other kinds of sediments. Panning is often resorted to and many deposits have been found by panning up slope; however, it is equally advantageous to inspect the limestone outcrops, paying particular attention to fractured areas. If the latter method is resorted to, it is well to remember that cinnabar in limestone darkens appreciably on exposure to sunlight, and, as it is much more obvious when wet, the best time for such examination is after the rocks have been wetted by rain or snow. If a zone of closely spaced veinlets or a single vein of cinnabar is found, its surficial extent should be first determined; then, if it appears to have some continuity, it should be followed, however tortuous, in underground development. The practice of driving a long adit to intersect the vein at depth, although sometimes justified in the development of gold veins, is decidedly hazardous.

In areas underlain by other rocks the chances of finding a worthwhile deposit are rather poor. Although two moderately productive deposits have been found in metamorphic rocks in Nevada, rocks that would normally be recognized as metamorphic by the average miner or prospector are not believed to be really favorable for further prospecting. Likewise, a workable ore body has been found in granite, but, because the chances of finding a really good quicksilver deposit in granite are so small, prospecting for them is not recommended.

Hot-spring areas, despite popular beliefs, appear to be no more favorable for the occurrence of quicksilver deposits than are other places in the State more remote from hot springs. Small, or perhaps more precisely, relatively unproductive, deposits of the sulfurous type have been mined in hot-spring areas, but as most of these are of such low grade as to prohibit economic mining a specific search for deposits of this type seems inadvisable.

OUTLOOK

The outlook for quicksilver mining in Nevada is influenced by many factors, some of which are encouraging, whereas others are distinctly discouraging.

Probably the market price of the metal is the most important factor that must be considered, and certainly in the past it has largely controlled the amount of quicksilver produced. Even a hasty glance at Figure 6 showing the annual output and price reveals the fact that nearly all of the quicksilver mined in Nevada in the past 25 years has been recovered when the price was above $100 a flask.

The price of quicksilver is controlled by international conditions, and it is interesting to note that prices above $100 have prevailed only during the two World Wars and during the boom period between 1927 and 1930. Early in 1944 the price of quicksilver dropped from the abnormally high wartime level to about the equivalent of the pre-war price; only exceptional deposits in Nevada can be profitably mined at this low price.

The longer term outlook is much more encouraging. The writers have no doubt that additional prospecting in Nevada will result in the finding of new deposits at least as good as any that has been mined in the past. This belief is substantiated by Figure 7 which shows that many of the mines that have yielded considerable quicksilver in recent years were also only recently discovered and developed.

Another encouraging event is the discovery of ore at depths of as much as 600 feet at the Cordero mine in the Opalite district. It is the writers' belief that other "deep" quicksilver ore will be found in Nevada, but unless it is intelligently searched for, the cost of its discovery will be prohibitive. Deep exploration below flat opalite blankets is probably rarely justified; however, deeper ore bodies in deposits of the volcanic and limestone type may be expected where there are favorable structures at depth.

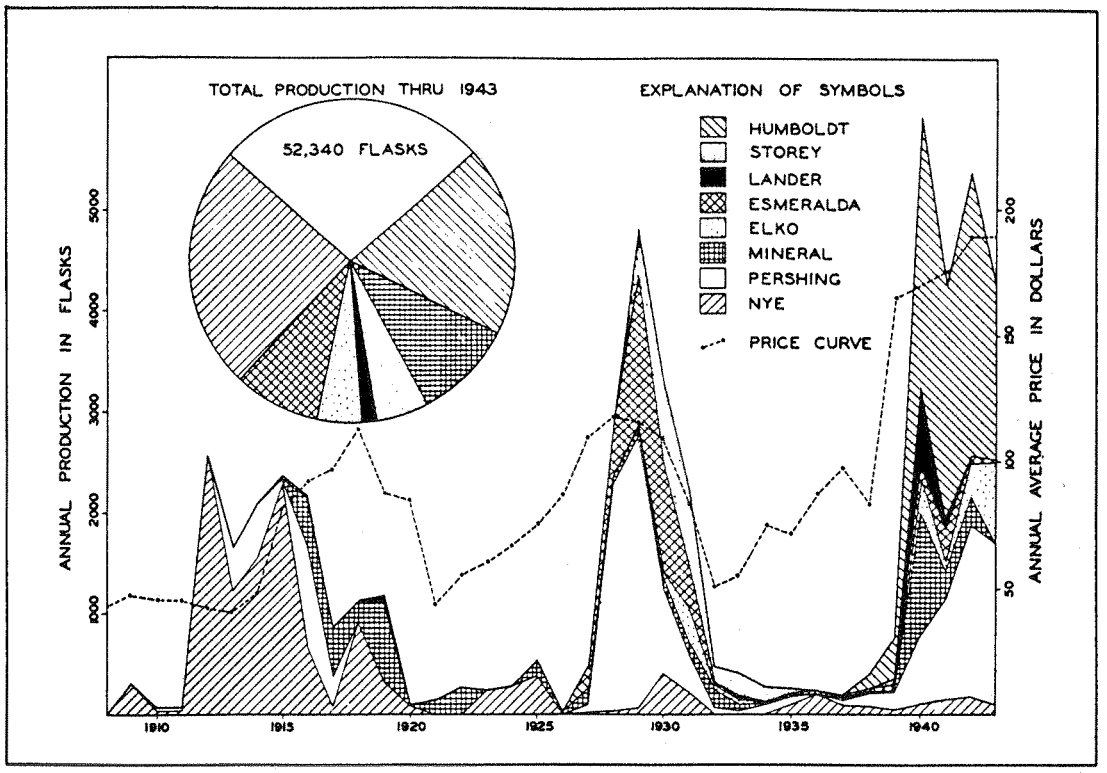

FIGURE 6. Graph Showing the Annual and Total Quicksilver Production in Nevada by Counties, and the Average Annual Price of Quicksilver. (Published with the permission of the mine owners and the Federal Bureau of Mines. Production records for 1943 subject to correction.)

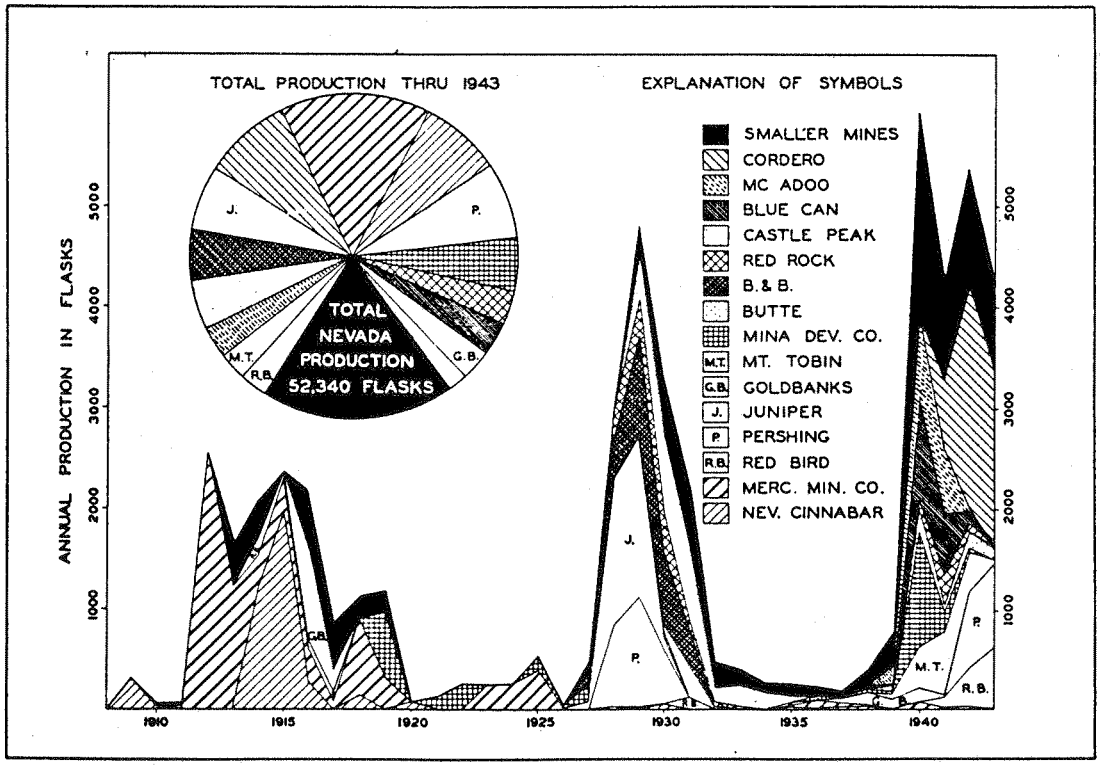

FIGURE 7. Graph Showing the Annual and Total Quicksilver Production in Nevada by Mines. (Published with the permission of the mine owners and the Federal Bureau of Mines. Production records for 1943 subject to correction.)

RECOVERY OF QUICKSILVER FROM ORES*

The recovery of quicksilver from its ores has always been a comparatively simple and inexpensive process, and, for this reason, the final product is recovered at the mine. The treatment now used is essentially that used during the past hundreds of years, but the equipment has been radically improved. The treatment involves heating the ore to 600°–700° C. to volatilize the quicksilver and then condensing the vapor. The quicksilver from the condenser is then cleaned, "bottled" in iron flasks containing 76 pounds of metal, and marketed.

Retorts and furnaces are the two general types of equipment used for the "burning" of the ore. They differ fundamentally in that retorts are fired externally, whereas furnaces are fired internally. A further difference is that retorts are generally small and comparatively inexpensive to install, but must be intermittently charged and fired; whereas furnaces are of larger capacity and more expensive to install, but are continuously operated. Consequently, retorts are used at mines having small, discontinuous but high-grade ore bodies, and furnaces with higher original costs but lower operational costs are used at mines having large, continuous, low-grade ore bodies.

In the following sections the more popular types of retorts and furnaces are sketchily described. For more detailed information on their construction and operation the reader is referred to the following:

> Von Bernewitz, M. W., Occurrence and treatment of mercury ore at small mines: U. S. Bur. Mines Inf. Circ. 6966, pp. 1–40, October 1937. Obtainable free of charge from the U. S. Dept. of the Interior, Bureau of Mines, Washington, D. C.
>
> Schuette, C. N., Quicksilver: U. S. Bur. Mines Bull. 335, pp. 1–168, 1931. Obtainable for 45 cents from the Superintendent of Documents, Washington, D. C.
>
> Schuette, C. N., Quicksilver in Oregon: Dept. Geol. and Min. Indust., State of Oregon, Bull. 4, pp. 3–172, 1938. Obtainable for $1.15 from the State Department of Geology and Mineral Industries, 702 Woodlark Building, Portland (5), Oregon.

*Included at the request of Jay A. Carpenter, Director of the Nevada State Bureau of Mines.

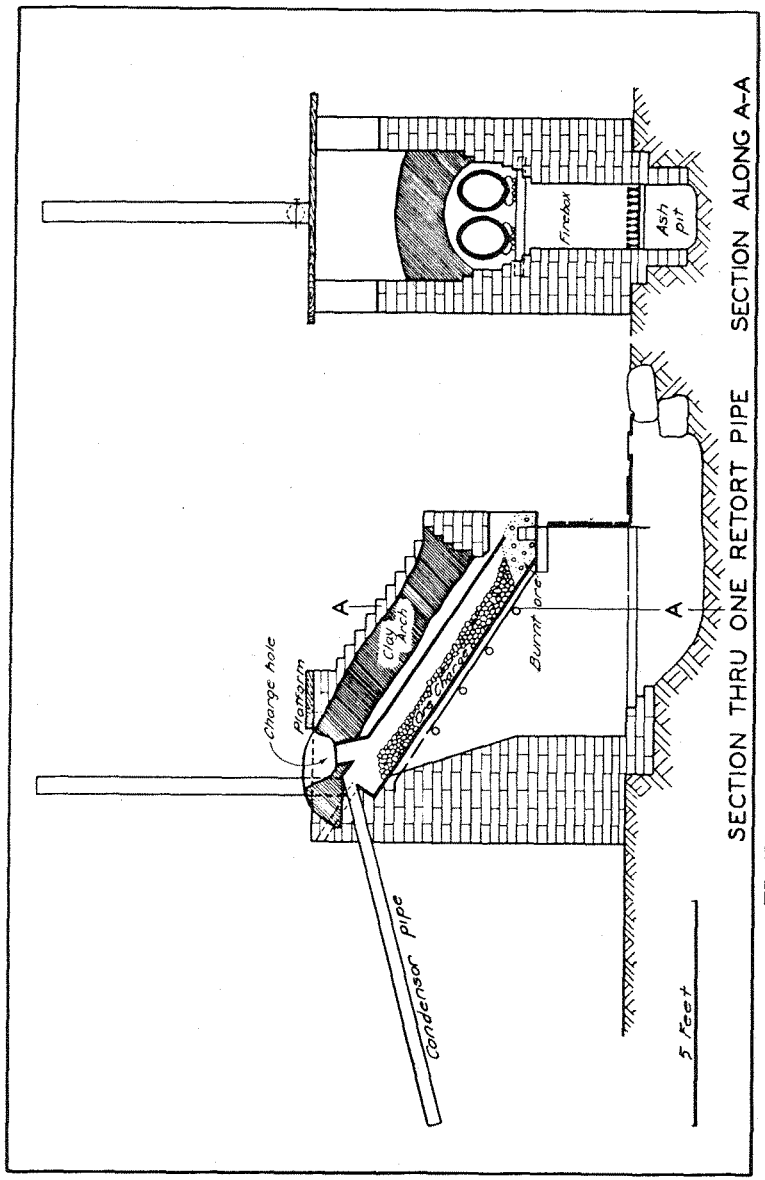

FIGURE 8. Cross Sections of a 2-Pipe Rossi-Type Retort.
(Reprinted, with omissions, from U. S. Bureau of Mines I. C. 6966)

The addresses of a few of the better known manufacturers of reduction equipment are given below; each of these manufacturers will supply, on request, detailed information on the equipment that they sell.

Cottrell Engineering Company, 322 South Avenue 17, Los Angeles, California.

H. W. Gould & Company, Mills Building, San Francisco, California.

Lacey Manufacturing Company, 601 Washington Building, Los Angeles, California.

Pacific Foundry Company, 3100 Nineteenth Street, San Francisco, California.

RETORTS

Most of the retorts that have been used in Nevada may be classified as belonging to one of four types—the D, Pan, Rossi, and Johnson-McKay types. Retorts of the Rossi and Johnson-McKay types, now most widely used, consist of iron pipes or "tubes," usually 10–12 inches in diameter and 7–9 feet long, erected above a combustion chamber and provided with a long pipe of smaller diameter which serves as the condenser. The Rossi type is installed at angles varying from 30°–45°, is charged at the top and unloaded at the bottom, and is "sealed" with ore or mud. (See Figure 8.) The Johnson-McKay type is installed in a horizontal position, is permanently sealed at one end, and is charged and discharged at the other end. Formerly, the Johnson-McKay retorts were installed in banks of 10–12 pipes above a single combustion chamber thus taking the place of a small furnace, but in recent years they have been used singly or in pairs. Probably the inclined type is somewhat superior, for it is more easily charged and discharged, and its inclination tends to create a natural draft.

The D and Pan retorts, which are not widely used in Nevada at the present, differ from the Rossi and Johnson-McKay retorts in that they have D-shaped cross section and are installed horizontally with the flat side of the D down. They differ in that the D retort is charged directly, whereas the ore is charged into the Pan retort chamber in flat pans.

Fuels used in heating are oil, coal, and wood; and each necessitates slight changes in the combustion chamber. The amount of ore retorted varies with the size of pipe and the kind of ore, but it is usually about 500 pounds in each pipe. The "burning time" likewise varies, but generally two or three charges are "burned"

every 24 hours. As no combustion product or dust is mixed with the quicksilver vapor, relatively clean quicksilver is recovered from the air-cooled condensing pipe.

FURNACES

Furnaces of different types used in Nevada include the formerly popular Scott furnace, the Herreshoff furnace, and several makes of rotary furnaces. In rated daily capacity they vary from less than 10 tons to 100 tons, but those most commonly used have a capacity of from 25 to 75 tons.

The Scott furnace was generally built of brick, and consisted of a series of inclined baffles upon which the ore migrated downward as the calcine was drawn off at the bottom. The furnace was fired with wood at its base and the heat circulated upward under the baffles. Air and water-cooled condensing pipes and chambers were used to collect the quicksilver. The Scott furnace, although fairly efficient, has not been erected in Nevada for over a decade as its initial cost is high, and before its recovery is good considerable ore must be treated in order to saturate the furnace. The only mines in the State at which large amounts of quicksilver were recovered in Scott furnaces are the Nevada Cinnabar and the Mercury Mining Company mines in the Union district.

The rotary furnace, of which there are several types, is the furnace most widely used in Nevada. A rotary furnace consists essentially of a gently inclined iron cylinder with a length of from 10 to 20 times its diameter. It is slowly rotated while crushed ore is fed into its upper end by an automatic feed, and heat is applied at its lower end by an oil burner. The gasses, which include dust and products of combustion as well as quicksilver, are drawn from the upper end of the cylinder through a dust collector and then passed through a system of condensers and released through a stack. (See Figure 9.) Furnaces of this type were being operated in 1943 in the Ivanhoe, Antelope Springs, and Fish Lake Valley districts.

The Herreshoff furnace has been successfully used at several of the larger mines in Nevada. Ransome[16] gives the following excellent description: "This type of furnace consists, essentially, of a series of superimposed circular hearths sealed fume-tight by an external drying hearth placed on top of the series. The ore is fed by a hopper to the drying hearth and thence into the subsequent hearths, being mechanically advanced through successive

[16]Ransome, A. L., Quicksilver metallurgy today: Eng. and Min. Jour., vol. 140, No. 4, pp. 47, 48, April 1939.

stages by a series of rabbles that revolve slowly about a central shaft. Firing is at any desired number of hearths, oil usually being burned for fuel through pressure burners. The heat and flame come into direct contact with the slowly moving ore. Calcine is discharged automatically into a burned ore bin * * * The gasses, including mercury vapor, dust, and the combustion by-products, are drawn off from the top (or any desired) internal hearth, and then pass through the dust collector. As in other processes, the fumes then pass through condensers, settling tanks,

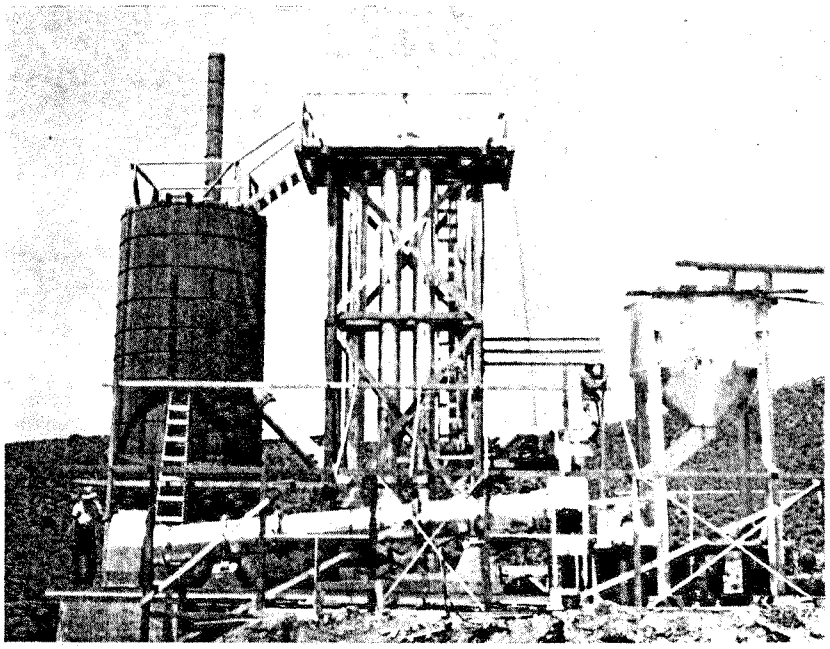

FIGURE 9. Rotary Furnace Used at the Mt. Tobin Mine, Pershing County, Nevada. (Courtesy of H. W. Gould & Co.)

and finally the stack." (See Figures 10 and 11.) Large Herreshoff furnaces were being operated in 1943 at the Cordero mine in the Opalite district and at the Pershing mine in the Antelope Springs district.

The product recovered from either type of furnace consists in part of free quicksilver and in part of a black "soot." This "soot," which is mostly finely divided quicksilver, is generally dried on steam tables and then mixed with a little lime and worked with a hoe. This "hoeing" causes the minute globules to coalesce, and the liquid metal is tapped from the table through a small pipe leading to a collecting tank. The residue, which still contains

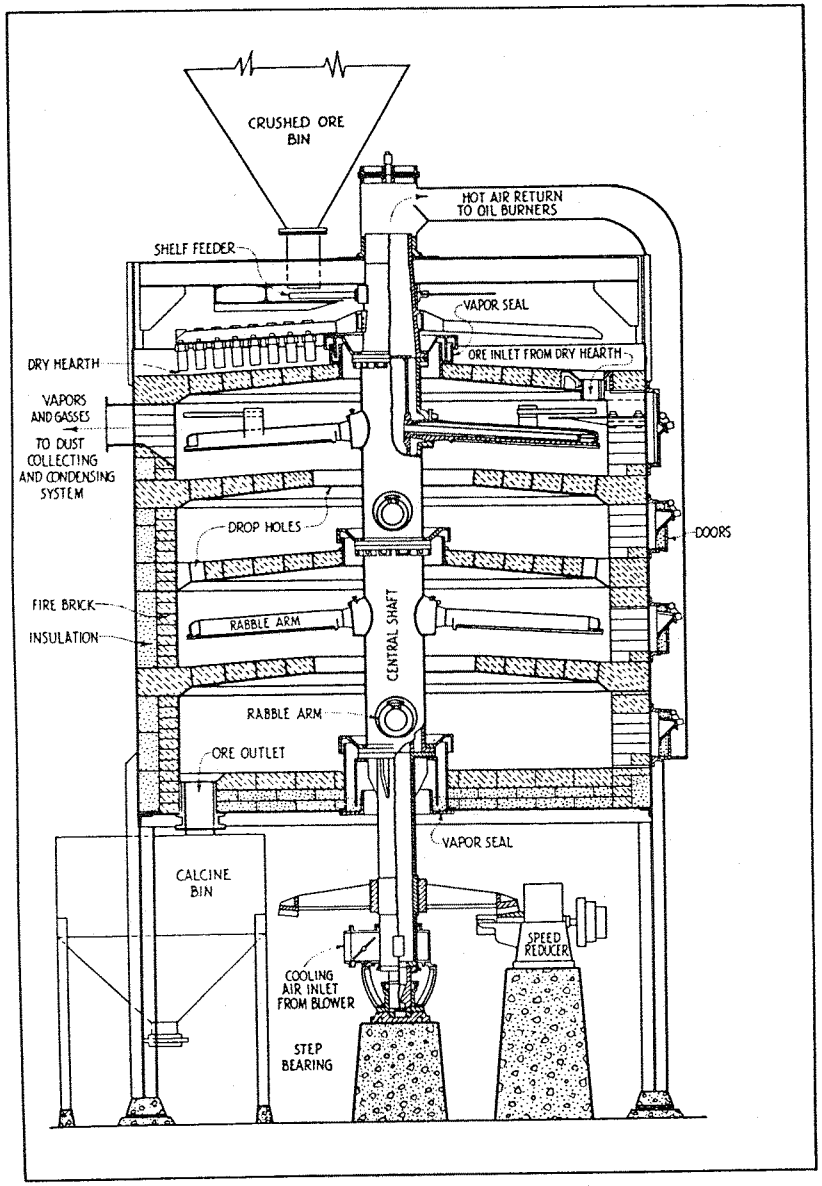

FIGURE 10. Cross Section of a Herreshoff Furnace.
(Courtesy of Pacific Foundry Co.)

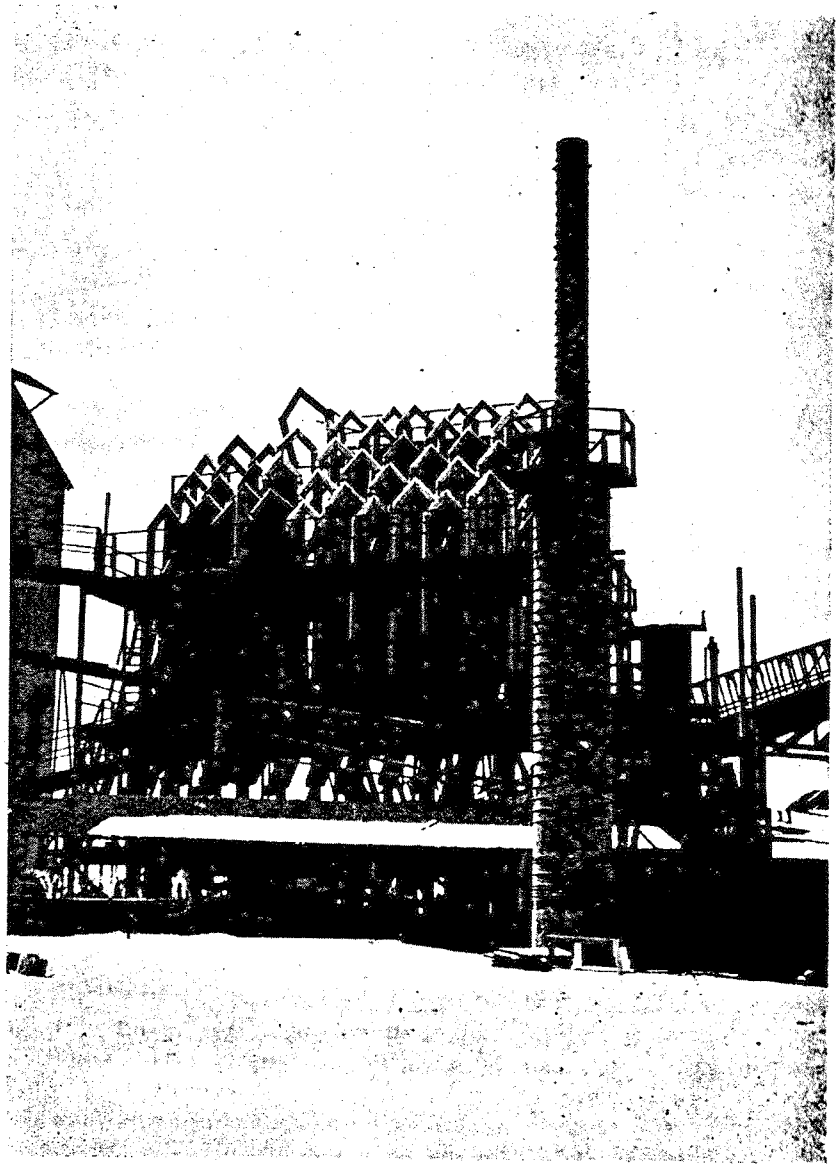

FIGURE 11. Condensing System Used at the Cordero Mine, Humboldt County, Nevada.

some mercury, is commonly returned to the furnace. In some plants the "soot" is treated directly in small retorts.

SPECIAL FURNACE TREATMENT REQUIRED BY SOME ORES

Various types of ore require somewhat different treatment, and a few types require exceptional precautions in furnacing.

The ore from some deposits of the opalite type requires careful treatment due to its dusty character and its water content. Where dust is abundant it is likely to accumulate in the condensing system and block the passage of vapors, but it can be effectively eliminated by the proper use of various kinds of dust collectors. If the ore is largely opal it yields considerable water even though it is apparently dry when fed into the furnace; this results in added fuel costs and lowered furnace capacity.

The ore from some of the deposits of the volcanic type contains considerable pyrite and must be cautiously treated. When furnaced the ore must be quite dry, for any water present will combine with the gases to form sulfuric acid which attacks the condenser pipes. Further, considerable care should be exercised to see that plenty of oxygen is provided, either from air or lime, to prevent the formation of sulfide instead of metal in the condensers.

Some of the ores of the limestone type of deposit contain as much as 10 percent lead and tend to slag in the furnace. The formation of this slag can be prevented by diluting the ore with limestone.

Other ores of the limestone type of deposit contain considerable antimony in the form of stibnite. As stibnite is converted to vapor at about the same temperature as cinnabar and likewise condenses at about the same temperature, unless the furnace is very carefully operated the condensing system will become clogged. Antimony oxide forms in the furnace condenser a little ahead of most of the quicksilver, but usually the "soot" must be reheated in a retort at a temperature low enough to revolatilize the mercury without affecting the antimony oxides. Another method for removing the antimony oxide consists of dumping the soot in water, for the antimony oxides float, whereas the quicksilver settles to the bottom.

WET METHOD

Attempts to recover quicksilver from ores by a chemical or wet method have been made at Steamboat Springs. This method

of recovery is based on the fact that solutions of sodium sulfide and sodium hydroxide readily dissolve cinnabar and, further, on the fact that quicksilver can be readily precipitated from such solutions by aluminum or copper. For more details on this method the reader is referred to a report by Bradley.[17]

If crushing and grinding are required before the ore can be treated by this method the costs will likely exceed normal furnace costs, but the wet method might be advantageously used on pulverulent or dusty ores.

BENEFICIATION OF QUICKSILVER ORES

Methods of beneficiation that have been applied to the ores of different Nevada quicksilver mines include hand-sorting, tabling, jigging, and flotation. Hand-sorting has been used to advantage in conjunction with both large furnaces and small retorts. For furnace operation, waste is generally sorted from the ore, whereas for retort operation the highest grade ore is generally sorted from the waste. Cinnabar is easily concentrated by tabling and jigging because of its heaviness, and it also can be successfully floated. However, as these methods of beneficiation generally require that the ore be crushed or ground, the beneficiation cost alone is high and for most ores exceeds the cost of direct furnacing.

[17] Bradley, Walter W., Quicksilver resources of California: Calif. State Min. Bur. Bull. 78, pp. 321–328 and 351, 1918.

RECOVERY OF QUICKSILVER FROM TAILINGS

In the early days of gold and silver mining in Nevada, particularly at Virginia City on the Comstock Lode, large amounts of quicksilver brought in from the New Almaden and other California mines were used in the now obsolete pan amalgamation or Washoe process for the recovery of gold and silver. Records of the amount of quicksilver used by the mines on the Comstock Lode are incomplete, but it is of interest to note that during a single year 300,000 pounds of quicksilver[18] were shipped to the Lode.

To effectively operate these pan amalgamators, about 50 pounds of quicksilver was used to every 300 pounds of pulp from the stamp mills. Considerable quicksilver was lost in this operation owing to the failure of the finely divided quicksilver or amalgam to settle from the pulp. Consequently, it has been estimated that for every ton of pulp treated in the pan amalgamators from half a pound to one and a half pounds of quicksilver was lost.

Few attempts were made in the early days of mining on the Comstock Lode to recover the lost quicksilver or the appreciable amounts of gold or silver remaining in the pulps. As a result, in the early part of the twentieth century with the advent of the cheaper cyaniding and flotation methods, the tailings from the amalgamation process received a good deal of attention. Many of these old dumps, including the Douglas tailings at the mouth of Six-mile Canyon below Virginia City, were then cyanided for their gold and silver content. To save the quicksilver, which would otherwise have been lost at the smelter, the gold and silver precipitates were retorted at the plant, and between 1906 and 1914 about 1,000 flasks of quicksilver were recovered by this method.

[18] Emmons, S. F. and Becker, G. F., Statistics and technology of the precious metals: Tenth Census of the United States, vol. 13, p. 173, 1880.

RECOVERY OF QUICKSILVER FROM DRY LAKE BEDS

Quicksilver, as well as other precious metals, has been said to be present in commercial quantities in many of the dry lakes or playas in Nevada. The most persistent rumors claim the quicksilver is present in such a form as to escape detection and analysis by ordinary chemical and assaying methods, but several types of metallurgical plants which supposedly can recover this fugitive quicksilver have been built. The writers are not aware of quicksilver having been recovered by any of these.

In an excellent article dealing with the presence and recovery of quicksilver and gold from these dry lakes, Jay A. Carpenter,[19] Director of the Nevada State Bureau of Mines, presents the following conclusions:

> The most likely explanation for the proven presence of gold and mercury in the lake bottoms of Nevada is that in the early days of mining in Nevada, gold and silver ore were hauled to a source of milling water which was most easily obtained from wells near the edge of the dry lakes. * * * the mills probably used the pan amalgamation process with the introduction and loss of much metallic mercury. * * * It is therefore conceivable that lake muds in a restricted area below old mills * * * might give assays for gold and mercury from a mixture of old tailings and lake mud.
>
> Gold almost always occurs in ores as metallic gold and mercury as cinnabar, both extremely resistant to change or to transportation from place of origin. * * * By all probabilities then the gold, and mercury as a sulfide, should be found on the slopes above the dry lakes, or at least as abundant along the old shore line as in the lake bottom. * * * It is conceivable that the detritus of a restricted rich area may have reached a dry lake through a gulch. If so, conventional panning and assaying should determine this conclusively.

The same article contains the following statement by Walter S. Palmer, Director of the State Analytical Laboratory:

[19] Carpenter, Jay A., An Investigation as to the presence of commercial quantities of mercury and gold in the dry lakes of Nevada: Univ. Nev. Bull., vol. 35, No. 4, pp. 5–20, 1941.

I believe that there is no evidence or records that an ounce of gold or a pound of mercury has ever been extracted from the dry lake material and sold. There are published statements that no gold, silver, etc., has ever been produced and sold. It is my opinion that no commercial production will ever be made from any dry lake material * * * unless that dry lake material will show the presence of gold, silver, mercury, platinum, etc., by properly conducted standard methods of analysis, to be in such amounts as to warrant the application of methods for its recovery.

DESCRIPTION OF INDIVIDUAL DISTRICTS, MINES, AND PROSPECTS

The following descriptions of individual districts, mines, and prospects include all of the localities in which, so far as the writers are aware, quicksilver minerals have been found in Nevada. They are arranged alphabetically by counties, districts, and by mines in each district. Where districts and mines have been given several names, they are herein designated by the name which seems most appropriate, even though it is not in every case the most popular name. Former names, however, are listed and are included in the index.

Most of the occurrences of quicksilver minerals have been verified in the field, but a very few were only reported either in technical journals or orally.

Historical sketches have been compiled from the recollections of operators, former operators, and from the technical press and newspapers. Many of the names of operators who only held a property have been omitted, but the names of individuals or companies who actually produced have, where known, been included. The date of discovery and the individual credited with the discovery is listed for most mines; these facts cannot in most cases be verified.

The listed production is, in nearly every case, the recorded production filed with the U. S. Geological Survey and, more recently, the U. S. Bureau of Mines; as these records are held in confidence, they are made public through the courtesy of the present mine owners. Admittedly, the recorded production is not always the actual production, and in the case of several of the smaller mines an estimate of unrecorded production has been made from the size of the calcine dump.

Many of the maps included with this bulletin were made by the writers, but some were made by other Survey geologists. The majority are of small areas and were made on a large scale for it seemed likely that such maps would prove to be of greatest value in future development and exploration. Most of the surface maps were made on a scale of 1 inch = 100 feet and can be enlarged to this scale without loss of necessary accuracy; none of the mine maps were made on a scale smaller than 1 inch = 50 feet.

CHURCHILL COUNTY

Six districts in Churchill County are known to contain cinnabar, but only in two mines—the Cinnabar Hill and Rosebud mines—has it been of sufficient abundance to have been exploited. The total recorded production of Churchill County through 1943 is eight flasks of quicksilver.

EASTGATE DISTRICT

About six miles southeast of Eastgate John Vargas and A. Basquez are reported to have located a cinnabar deposit of the opalite type in 1930.

FAIRVIEW DISTRICT

On the east slope of Fairview Mountain, 50 miles east of Fallon and one and a half miles east of the Hidden Treasure and Gold Bug properties, cinnabar is reported to occur in a gold vein.

HOLY CROSS DISTRICT

The Holy Cross district lies about 25 miles south-southeast of Fallon. Manganese ore has been the principal product from the district in the past, but in 1940 a small amount of quicksilver was produced.

CINNABAR HILL MINE

Former names....Robinson quicksilver.
Location.....Secs. 15, 16, 21, and 22, T. 15 N., R. 30 E.
Ownership.....A. L. Robinson, A. K. Dalby, C. M. Smith, H. C. Smith, and Mrs. Elsie Pierce of Fallon, and B. P. Hartman of Grass Valley, California.
Discovery.....1937 by A. L. Robinson.
Production.....Very small.
Geologic type.....Volcanic.

The Cinnabar Hill[20] mine is developed by an adit and crosscut with a total length of about 70 feet, and by a 65-foot inclined shaft with short crosscuts on two levels. A few other pits are scattered over six claims.

The rocks of the area are Tertiary volcanic flows and pyroclastics of andesitic and rhyolitic composition overlain by Pleistocene basalt flows. Granite of Jurassic age forms prominent peaks east of the mine, but it bears no genetic relation to the ore.

[20] Vanderburg, Wm. O., Reconnaissance of mining districts in Churchill County, Nevada: U. S. Bur. Mines Inf. Circ. 7093, pp. 31–32, 1940.

The workings explore altered andesite along a fault zone which strikes N. 80° W. and dips 40° north. This zone contains an irregular vein of calcite which locally attains a width of a foot. Cinnabar, pyrite, barite, gypsum, jarosite, and clays form narrow veinlets in places along the sheared footwall of the vein.

MOUNTAIN WELLS DISTRICT

In 1930 Jess Connell was reported to have discovered 35 feet of 8-pound ore 25 miles east of Fallon and within one-quarter of a mile of Mountain Wells. Apparently the property was never developed.

UNNAMED DISTRICT

ERWAY PROPERTY

Location.....Sec. 6 (?), T. 22 N., R. 27 E.
Ownership.....George W. Erway of Grass Valley, California.
Production.....None.
Geologic type.....Sulfurous.

The presence of cinnabar with sulfur in the vicinity of the Fernley Hot Springs, about 18 miles east of Fernley, has been known for many years. Several claims were staked by G. W. Erway in 1943 about one-quarter of a mile southeast of U. S. Highway 40 and half a mile east of the Hot Springs, and shallow pits were dug to explore silicified parts of the rhyolite tuffs in the area. The best showings of cinnabar seen by the writers were around an active hot springs vent that had apparently once been drilled. Here painty cinnabar occurred with sulfur, gypsum, and several other minerals in an argillized and silicified tuff.

UNNAMED DISTRICT

ROSEBUD PROSPECT

Former names....De Kinder property.
Location.....Sec. 20 (?), T. 24 N., R. 35 E.
Ownership.....Unknown.
Discovery.....Prior to 1940.
Production.....A few flasks.
Geologic type.....Interbedded sediments—sandstone and limestone.

The Rosebud prospect lies on a group of nine claims on the west slope of the Stillwater Range 28 miles east-southeast of Lovelock and close to the northern border of Churchill County. The property was worked in 1941 by Les Palmquist and William Bird who reported a recovery of six flasks from retort operations. In 1942, when the property was mapped, Mr. L. Swycaffer was

making test runs of ore in a small retort, and in 1943 the property was said to be active.

The principal workings consist of several adits, the total length of which is probably less than 700 feet, and two small open cuts. Two other adits lie about 500 feet to the northwest and perhaps 300 feet above the principal workings.

The rocks of the area are Mesozoic (?) sandstone, limestone, and shale unconformably overlain by Tertiary (?) pyroxene andesite. Cinnabar occurs in the southernmost open cut as disseminated crystals and scattered veinlets in iron-stained sandstone, and in the vicinity of the adits it is closely associated with small calcite veinlets in limestone and silicified limestone. Most of the ore is in small bodies of low grade and must be carefully sorted for retorting.

CLARK COUNTY

In Clark County cinnabar has long been known to occur in several gold and lead-zinc mines, but cinnabar deposits of possible commercial grade were not found until about 1941. A small amount of quicksilver has possibly been recovered from at least one mine, but if so it is unrecorded.

ELDORADO DISTRICT

The Eldorado district on the north end of the Opal Mountains about 20 miles south of Boulder City is primarily a gold district, but it contains at least one quicksilver prospect.

PATSY PROSPECT

The Patsy prospect has not been visited by the writers, and available information on it is meager. The property consists of eight claims located one and a half miles west of the schoolhouse at Nelson and owned by J. A. Thacke of Nelson and P. A. Simons of Jean. Development is reported to consist of a 165-foot shaft and a second shaft 45 feet deep as well as small open cuts. Ore minerals are said to be cinnabar and native mercury.

In 1942 one of the larger gold mining companies of the district was reported to be considering mining cinnabar ore from a large low-grade deposit and concentrating it by means of flotation, but development to the end of 1943 was reported to consist only of shafts and shallow pits.

GOODSPRINGS DISTRICT

In the Goodsprings district about 30 miles southwest of Las Vegas cinnabar occurred in the Kirby, Fredrickson, and Yellow Pine lead-zinc mines and in the Red Cloud gold mine.[21] [22] These deposits are in Paleozoic limestone and are possibly of late Mesozoic or early Tertiary age. The cinnabar occurs as coatings on oxidized lead minerals, and Hewett has suggested that it is derived from mercurial galena by oxidation and reprecipitation.

[21] Hewett, D. F., Geology and ore deposits of the Goodsprings quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 162, pp. 79, 81–82, 133, 1931.

[22] Lincoln, F. C., Mining districts and mineral resources of Nevada: pp. 31, 278, Reno, Nevada, 1923.

DOUGLAS COUNTY

No quicksilver properties or occurrences of quicksilver minerals in Douglas County are known to the writers.

ELKO COUNTY

All of the quicksilver mines in Elko County lie in the western half of the county. All of those with recorded production are in the Ivanhoe district about 25 miles northeast of Battle Mountain, but in the last few years several prospects have been developed farther to the north, in the Tuscarora and Rock Creek districts. Toward the recorded production of 2,136 flasks produced in the county, the Butte mine contributed 1,032 flasks and the Silver Cloud mine added an additional 866 flasks.

IVANHOE DISTRICT

The Ivanhoe district is in the Butte Creek Range, about 30 miles north-northeast of Battle Mountain and 10 miles southeast of Midas. The geology and ore deposits of the district were studied by J. M. Nelson and R. J. Roberts of the U. S. Geological Survey in parts of 1940, 1941, and 1942. To these men the writers are indebted not only for several maps included herein, but also for permission to use their unpublished report[23] as a basis for the discussion of the geology of the district and the individual mines.

The first discovery of quicksilver ore in the Ivanhoe district was made in 1915 by W. F. Roseberry and W. C. Davis. Mr. Roseberry, after locating over 100 claims, installed a 6-pipe Rocca retort and in 1916 and 1917 recovered 50 flasks of quicksilver. Thereafter until 1929 little quicksilver was produced in the district. Between 1929 and 1940 the principal production came from the Butte mine, also known at various times as the Rand mine and the Bowers mine, and during the same period the Governor mine on the Pangburn and Hunt properties had a substantial production. In 1942 the Silver Cloud deposit was taken over and operated by the New Verde Mining Company. This property through 1942 and 1943 yielded considerable quicksilver recovered by means of two rotary furnaces with a combined capacity of about 100 tons. The recorded production of the district through 1943 is 2,136 flasks of quicksilver.

Tertiary flows and pyroclastics that have been divided into two groups cover most of the district, but in a few places the underlying unconformable beds of pre-Tertiary quartzite and chert are exposed. (See Plate 2.) The older volcanic group is of Upper Miocene age and is tilted eastward from 10° to 30°. It includes

[23] Nelson, J. M., and Roberts, R. J., Quicksilver deposits in the Ivanhoe district, Elko County, Nevada: U. S. Geol. Survey, unpublished manuscript.

a basal member of rhyolite and rhyolitic pyroclastics, an upper member of rhyolitic pyroclastics and quartzitic fanglomerate, and intervening layers of more basic composition. The younger group, which overlies a nearly horizontal unconformity, is nearly flat-lying and consists of quartz-rich rhyolite, tuff, and ash.

The volcanic rocks are cut by two sets of normal faults. One set trends northerly and has displacements ranging up to 300 feet with the west block consistently downthrown; the second set trends easterly and either north or south block may be downthrown. Broad open folds are common, and near some faults the rocks are sharply folded.

All of the ore bodies of the district are of the opalite type and contain cinnabar disseminated in the opalite or coating fractures. Although the opalite is extensive and occurs in many of the rocks of both volcanic groups, ore bodies occur only in parts of the opalite that have formed from the more rhyolitic members of the older group. The ore bodies are localized either in favorable beds or along steep faults; consequently, they are either relatively flat blankets or steep tabular deposits. Only the blanket deposits have proven commercial, although some of the steep deposits have been extensively explored. Locally, small lenses and veinlets of ore occur on the periphery of bodies of the two commoner types, but unless the lenses are very closely spaced they cannot be profitably mined.

The ore is older than the oldest erosion surface in the district and was deposited in the late Miocene or early Pliocene period. In at least part of the district the ore was deposited at depths in excess of 500 feet below the oldest erosion surface.

BUTTE QUICKSILVER MINE

Former names....Rand, Bowers, Mayflower, Velvet, Ivanhoe.
Location.....Secs. 32 and 33, T. 38 N., R. 48 E., and secs. 4 and 5, T. 37 N., R. 48 E.
Ownership.....Butte Quicksilver Mining Company, Richard S. Eskridge, Winnemucca, General Manager.
Discovery.....Early 1920's.
Production.....1,032 flasks to the end of 1943.
Geologic type.....Opalite.

The Butte Quicksilver Mining Company's property contains several deposits explored by the Velvet, No. 1, No. 2, Mayflower, and Pit 3 workings. All, or part, of the ground explored by these workings is said to have been originally staked by F. R. Bowers

in the early 1920's. In December 1929 the property was purchased by George A. Newhall and associates who shortly thereafter installed a 20-ton Andrews-type rotary furnace. During 1930 the furnace failed to operate efficiently, but in 1931, after a new condensing system had been installed, several hundred flasks of quicksilver were recovered. Between 1932 and 1939 intermittent operation, probably by lessees, yielded only a few flasks. In November 1939 Lenox Rand and associates acquired the property and, following the installation of a 35-ton rotary furnace, recovered about 300 flasks of quicksilver. In June 1941 the Butte Quicksilver Mining Company bought the property, and in 1942 and 1943 intermittently operated the furnace, recovering 262 flasks of quicksilver.

Most of the rocks of the mine area belong to the upper part of the older group of volcanic flows and tuffs, but the quartz-rich rhyolite of the younger group crops out across the canyon to the east of the Velvet workings. The older beds are gently folded and cut by faults of small displacement. Nearly all of the ore has come from a single ash bed lying immediately above a quartzite fanglomerate. Its localization was largely controlled by the porosity and lithologic character of this favorable bed and by small faults and open folds.

The Velvet workings explore a gently inclined blanket deposit by a group of open cuts and short adits on one level; a haulage level 50 feet below cuts only a few veinlets of cinnabar. (See Plate 3.) The blanket deposit which ranges from 3 to 12 feet in thickness has been explored for a distance of 240 feet along its strike and for a distance of 125 feet into the hill. It has not been delimited, and probably a considerable tonnage of ore containing about 3.5 pounds of quicksilver to the ton could be developed.

The No. 1 workings, adjacent to the furnace, consist of an open pit and several shallow shafts. The ore that has been mined came from an opalized bed which lies stratigraphically higher than the blanket deposit of the Velvet workings. A more productive lower bed may lie 30-40 feet below the workings, and, although now unexplored, warrants further exploration.

The No. 2 workings, 1,800 feet southwest of the furnace, include a shallow pit and two adits. The best ore is at the surface in a few erosional remnants of the fanglomerate bed that underlies the Velvet ore body. In the opalized rock beneath the fanglomerate the grade of the ore decreases with increased depth, and deeper exploration is not advisable.

The Pit 3 workings, 600 feet north of the furnace, expose ore of good grade in the same favorable ash and fanglomerate beds as the Velvet ore body. The lateral extent of this deposit could be determined at low cost.

COLEMAN GROUP

Location.....Secs. 35 and 36, T. 38 N., R. 47 E.
Ownership.....Waddy Hunt.
Production.....A few flasks.
Geologic type.....Opalite.

The Coleman group adjoins the Governor property and is about a mile south of the old Governor camp. In 1942 it was under lease and option to the Ivanhoe Cinnabar Company.

The workings consist of a shallow shaft connected with a short drift, an open cut from which an inclined shaft has been sunk, and several pits and trenches. Cinnabar occurs in an opalite bed. Although this bed locally attains a thickness of four feet in the open cut, it is thinner and of lower grade where followed by the inclined shaft.

GOVERNOR MINE

Location.....Sec. 25, T. 38 N., R. 47 E.
Ownership.....L. V. Pangburn and Waddy Hunt.
Discovery.....1930.
Production.....107 flasks to the end of 1942.
Geologic type.....Opalite.

The Governor Mercury Mine, Inc., was organized early in 1940 by ex-Governor James M. Curley and others of Boston, Massachusetts, to exploit a large number of claims held under option from several owners. These claims included the Silver Fox group of nine claims owned by Mr. and Mrs. L. V. Pangburn, and the Combination, Florence, and Portland groups of 12 claims owned by Waddy Hunt. A 4- by 64-foot Gould rotary furnace installed in September 1940 was operated until early in 1941, and yielded 91 flasks of quicksilver. In 1942 the furnace was moved to the Silver Cloud mine. L. V. Pangburn continued exploration on the Silver Fox group in 1941, 1942, and 1943 and produced several flasks of quicksilver.

Pangburn property. The principal workings on the Pangburn property consist of three shafts and connecting drifts located on the Fox claim. These explore an opalite bed of cinnabar-bearing chalcedonized ash and tuff in which the ore ranges from four to eight feet in thickness. The cinnabar appears to have been introduced both with the silica and after the silica mineralization, for it is disseminated in the opalite and also crusts later openings and fractures. Other workings on the Pangburn property are about 1,800 feet west of the shafts and explore silicified and mineralized parts of the Stines fault zone more fully discussed in the following paragraph.

Hunt property. The Hunt property includes most of the ground actively developed by the Governor Mercury Mines Company. The principal workings consist of many closely spaced trenches and shallow adits which explore the silicified Stines fault zone along its strike for about 3,000 feet. (See Plate 4.) This fault zone strikes a little east of north and dips steeply westward; at most localities the hanging wall is ash and tuff, whereas the footwall is basalt. Opalite has been formed from the hanging wall rocks, and in the opalite some cinnabar is nearly everywhere present. However, the ore bodies that have been found were small, erratic in distribution, and of fairly low grade.

Sheep Corral workings. The Sheep Corral workings, a mile west of the site of the Governor mine furnace, consist of a 50-foot inclined shaft and a connecting drift that is about 150 feet in length. These workings explore a silicified fault zone trending northwesterly and separating obsidian on the hanging wall from silicified tuff on the footwall. Lenticular opalite ore bodies which locally attain a width of eight feet were mined from the drift and above.

JACKSON AND SURPRISE CLAIMS

Location.....Sec. 1, T. 37 N., R. 47 E.
Ownership.....E. J. Young.
Production.....A few flasks.
Geologic type.....Opalite.

The Jackson and Surprise claims, which are about two and a half miles west-southwest of the Butte mine, were leased by Lowell Thompson and Charles Johnson in 1940. These men are reported to have recovered several flasks of quicksilver from ore that averaged between five and ten pounds of quicksilver to the ton. The ore contains cinnabar disseminated as bunches and veinlets in porous ash and is most abundant along the hanging wall of a small fault.

HATTER PROPERTY

Location.....Secs. 34 and 35, T. 38 N., R. 48 E.
Ownership.....Mrs. M. Hatter.
Production.....None.
Geologic type.....Opalite.

The Hatter property is about two miles east of the Butte mine in the eastern edge of the district. The property has not been visited by the writers, but it is said to be explored by shallow shafts, pits, and short adits. Some cinnabar occurs in, and extends out from, joints in white opalized rhyolite.

LARK GROUP

Former names....Davis and Roseberry, Roseberry, Cinnabar group, Ivanhoe group, Rattlesnake, Lucky Boy.
Location.....Sec. 30, T. 38 N., R. 48 E.
Ownership.....L. B. and E. C. Wilkerson of Midas.
Discovery.....1915 by Davis and Roseberry.
Production.....Less than 100 flasks to the end of 1943.
Geologic type.....Opalite (?).

The Lark group consists of 10 claims about two miles northwest of the Butte mine. The property is said to cover the same ground as the original Davis and Roseberry claims located in 1915, and, in part, operated by the Ivanhoe Cinnabar Company. Available records credit the group with an early production of 50 flasks recovered in a 6-pipe D-type retort. In 1930 the property was leased to Ray and Reed who subleased it to Benjamin Harris in 1931. It was relocated a few years ago by the present owners, and in 1940 and 1941 was leased by J. D. and C. D. Edmondson who recovered several flasks of quicksilver.

Development consists of shallow workings which explore cinnabar-bearing fractures trending northerly through a glassy black tuff.

REDBOY GROUP

Location.....Sec. 34, T. 38 N., R. 48 E.
Ownership.....Mrs. William Geraghty.
Discovery.....Unknown.
Production.....A few flasks.
Geologic type.....Opalite.

The Redboy group of five claims is about one mile northeast of the Butte mine. The property is explored by only shallow workings lying in two opalite bodies along faults. The opalite body on the Redboy No. 1 claim covers an area of about 150 by 300 feet; cinnabar shows in several pits and trenches. The opalite body of the Redboy No. 4 claim is about 150 by 500 feet in extent and contains cinnabar in its northern end.

RIMROCK AND HOMESTAKE GROUPS

Former names....Wilburg, Ivanhoe Cinnabar.
Location.....Secs. 17 and 19, T. 38 N., R. 48 E.

Ownership.....Mrs. F. M. Williams of Winnemucca.
Discovery.....1932 by F. M. and H. E. Williams.
Production.....Small.
Geologic type.....Opalite.

The Williams property consists of six Homestake and four Rimrock claims which were located by the Williams brothers in 1932. In 1940 and 1941 a 2-pipe retort yielded a small production of quicksilver. During 1942 the property was leased to the Ivanhoe Cinnabar Company.

The workings consist of four adits aggregating about 400 feet in length, several shallow cuts, and two shafts. The upper workings are in opalized ash and tuff which contains irregularly distributed cinnabar and mercury chloride. The main pit of the upper workings, measuring about 20 by 50 feet in extent, yielded most of the ore from a bedded deposit.

SILVER CLOUD MINE

Location.....Secs. 25 and 26, T. 37 N., R. 47 E.
Ownership.....New Verde Mines Company.
Discovery.....1931 by J. T. Maddeford.
Production.....866 flasks by the end of 1943.
Geologic type.....Opalite.

The Silver Cloud mine lies in the southwestern part of the district about three miles north of Antelope Creek. Although the deposit was discovered in 1931, it remained little developed until 1940 when T. S. Smith and J. T. Maddeford installed a 2-pipe retort and recovered a few flasks of quicksilver. Early in 1942 the property was acquired by the New Verde Mines Company, a subsidiary of the Newmont Mining Company, and by the end of the year the company was producing with a 4- by 64-foot Gould rotary and a 3½- by 50-foot Cottrell rotary furnace. Late in 1943 the property was leased by R. O. Camozzi and associates.

The rocks of the area consist of rhyolitic obsidian overlain by ash and tuff; they are believed to lie near the base of the older group of Tertiary volcanics. Throughout much of the area the obsidian is hydrothermally altered to a dense white chalcedonic rock, and the overlying ash is largely opalized from the contact upward for about ten feet. Cinnabar impregnates the lower four feet of the opalized ash in sufficient abundance to form a blanket of mineable ore, and it locally occurs disseminated in lesser amounts in the overlying ash.

Structurally, the blanket occupies the warped trough of a northerly trending syncline about 1,500 feet in width. The borders of the syncline are interpreted as being either sharply folded or

FIGURE 12. Open Cut and Plant of the Silver Cloud Mine, Elko County, Nevada.

faulted along steep parallel faults which belong to the set that strikes northerly through the western part of the district.

The mineralized blanket has been mined throughout the major part of an area 600 feet wide and 800 feet long. The central part of this area, measuring about 200 feet by 400 feet, was mined in an open pit, and the ore was followed under the deeper overburden by drifts and stopes. Underground, much of the ore was mined by slusher method.

ROCK CREEK DISTRICT

The Rock Creek district lying about ten miles west of Tuscarora is primarily a silver district, but it also contains two little-developed quicksilver prospects.

ROCK CREEK PROSPECT

Location.....T. 40 N., R. 48 E.
Ownership.....J. W. Gainey.
Production.....None.
Geologic type.....Volcanic (?).

The Rock Creek prospect, located a mile north of Rock Creek and about a mile above the corrals in the mouth of the canyon, was not visited. Only a small amount of development was said to have been done by August 1943. The ore contains crystalline cinnabar coating altered andesite and covered by quartz and pyrite; some stibnite is said to accompany the ore.

TEAPOT PROSPECT

Location.....Sec. 12 (?), T. 40 N., R. 49 E.
Ownership.....Louis Salet.
Production.....None.
Geologic type.....Volcanic.

Cinnabar was first discovered in the Rock Creek area at least as early as 1929 when J. W. Hall located a property just west of the old Falcon mine. It is suspected that the Teapot property is the same ground that was abandoned by Mr. Hall and relocated by Mr. Salet in 1942.

The rocks of the area are mostly andesitic flows which are locally cut by northerly trending faults and quartz veins. On the property a 55-foot shaft explores a shear zone that strikes N. 5° W. and dips about 80° to the east. In the shear zone cinnabar occurs as disseminated crystals with pyrite, and also occurs in narrow quartz veinlets that fill irregular cracks in the walls. The ore can be sorted to good retort grade.

TUSCARORA DISTRICT

The Tuscarora mining district lies on the east slope of the Tuscarora Range, near the town of Tuscarora, about 40 miles northwest of Elko. Late in the nineteenth century it was a placer gold camp and a lode silver-gold camp, and the presence of cinnabar in the district has been known since the early days. In 1940 several quicksilver claims were located, and, although very little quicksilver has yet been produced, it may become an important quicksilver district. All of the known deposits are of the volcanic type with cinnabar, pyrite or marcasite, and, to a lesser extent, native mercury filling steep fracture zones in altered andesite.

BERRY CREEK GROUP

Location.....Sec. 7, T. 39 N., R. 51 E.
Ownership.....J. W. Gainey.
Discovery.....1941 by Gainey.
Production.....None.
Geologic type.....Volcanic.

The Berry Creek group of seven claims is on Berry Creek one mile west of its junction with McCan Creek, about three miles southwest of Tuscarora. The property was developed by J. W. Gainey in 1942 and taken under lease and option by the Cordero Mining Company in July 1943. In the latter part of 1943 it was being actively developed by the Cordero Company.

The underground workings in August 1943 consisted of a single adit and drift a little over 100 feet long driven in altered andesite to explore a shear zone which strikes N. 32° E. and dips 70° southeasterly. On the surface about 40 feet above the adit the same shear zone is exposed by trenches for over 150 feet along its strike. In a broad valley about 400 feet to the west, along the strike of the shear zone, pannings from the surface and shallow pits indicate a continuation of the mineralized zone.

The only ore mineral seen was cinnabar which occurred along the shear zone in veins up to an inch in thickness and as disseminated crystals and small veinlets in the walls. Pyrite, and possibly marcasite, is fairly abundant in the ore, but it appears to be somewhat older than the cinnabar and accompanying chalcedony, quartz, and barite.

RED BIRD GROUP

Location.....Sec. 26, T. 40 N., R. 51 E.
Ownership.....Fred C. Bacon of Twin Falls, Idaho.
Discovery.....1940 by J. W. Gainey.

Production.....Very small.
Geologic type.....Volcanic.

The Red Bird group, consisting of 14 claims, is about a mile north of Tuscarora. The property was bought by M. H. Horn from the original locator in 1940. In 1941 it was leased to the Cardinal Mining Company who did development work, installed a 2-pipe retort, and probably produced a little quicksilver. In 1942 the property reverted to Mr. Horn and was later sold to the present owner.

The workings consist of two short adits, one about 18 feet above the other, and a shaft which was being driven in 1943 to a depth of 60–70 feet. These workings explore a sheared contact which strikes N. 78° W. and dips steeply southward; the footwall is an altered hornblende-biotite andesite whereas the hanging wall is a somewhat more acid tuff. All of the rocks are argillized and contain disseminated pyrite and possibly marcasite, but in the vicinity of the shear the mineralization has been the most intense.

The ore occurs in a zone along the footwall side of the shear where cinnabar, native mercury, and pyrite are disseminated through the altered andesite. Some cinnabar in more definite veinlets occurs in small fractures which lie in the footwall and strike at right angles to the main shear. Small amounts of quartz accompany and are later than the cinnabar. The width of the mineralized zone exposed in August 1943 was about five feet, but its lateral and downward extent had not been delimited.

ESMERALDA COUNTY

Most of the quicksilver mines in Esmeralda County lie in the Fish Lake Valley district on the north end of the White Mountains, but cinnabar ore bodies have been prospected in the Montezuma and Gilbert districts in the eastern part of the county. The two largest mines in the Fish Lake Valley district, the B. & B. and Red Rock mines, together yielded nearly 4,000 flasks between 1927 and 1931; since then the mines of the county have been relatively unproductive.

ALUM DISTRICT

The Alum district which lies about ten miles south of Blair Junction and just east of the road to Silver Peak contains a deposit of sulfur and alum that was known as early as 1868. In 1906 the deposit was visited by Spurr[24] who first described a red mineral that was believed to be cinnabar as occurring disseminated in the alum and associated with small amounts of gypsum and sulfur. The property was not visited by the writers, but it is probably similar to the sulfurous type of cinnabar deposit as explored at Sulfur and elsewhere.

FISH LAKE VALLEY DISTRICT

The Fish Lake Valley district lies about forty miles southwest of Coaldale on the northeast slope of the White Mountains. It is primarily a quicksilver district, and the quicksilver lodes extend northwestward beyond its limits into the Buena Vista district in Mineral County. However, as the quicksilver deposits are all closely spaced and probably genetically related, they will be grouped together as though they all lay within the Fish Lake Valley district.

The oldest mine in the district—the Wild Rose or Mt. Montgomery property—was located in 1916 and produced during the first World War. The period of greatest activity in the district started in 1927 with the development of the B. & B. and Red Rock mines and lasted until 1932; since 1932 mining has been done on a small scale. Although the district contains ten mines and prospects, the recorded production of 4,650 flasks came from only five of them, and two mines yielded all but about 300 flasks.

The district is for the most part underlain by Tertiary andesite and rhyolite flows and tuffs which are locally capped by younger

[24] Spurr, J. E., Ore deposits of the Silver Peak quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 55, pp. 157–158, 1906.

basalt flows. The southeastern part contains contorted and silicified Paleozoic limestone and phyllite that has been intruded by Jurassic "granite." In the central part of the district all of the rocks are flat-lying volcanics, with tuff and breccia more prevalent than flows, whereas farther west and higher on the slopes of the White Mountains the rocks consist of steeply inclined flow-banded rhyolite, rhyolite tuff, and spherulitic glassy flows.

The ore bodies are of three types and include disseminated bodies in opalite blankets, tabular bodies in silicified limestone and phyllite in a roof pendant, and smaller high-grade bunches of disseminated crystals and veinlets in silicified and brecciated rhyolite. The ore bodies of the first type are larger and more extensive than the bodies of the latter two types, but they also are of much lower grade.

B. & B. MINE

Former names....Chrysler.
Location.....Sec. 1, T. 1 S., R. 33 E.
Ownership.....State of Nevada, Bankrupt No. 475; E. S. Giles of Goldfield, trustee.
Discovery.....1925 (?) by George Chrysler.
Production.....2,659 flasks to the end of 1943.
Geologic type.....Opalite.

The B. & B. mine, on a group of nine claims, lies at an elevation of 7,700 feet on the west slope of the White Mountains about three miles east of Mustang Mountain. Early in 1927 the B. & B. Quicksilver Company was organized by Peter Buol and H. Bernie to develop a property that had been discovered a short time before by George Chrysler. Buol, after buying Bernie's interest and installing four D retorts, produced in 1927 over one hundred flasks of quicksilver. The following year a 50-ton rotary furnace was installed, and in 1929 a second rotary furnace of 60-tons capacity was added. However, the plant was closed down in June 1931 after having produced 2,467 flasks of quicksilver, and the company declared voluntary bankruptcy. Between 1932 and 1942 the property was leased several times, but no real attempt at large-scale mining was made. Late in 1942 the property was leased to Chicago interests who organized the Nevada Mineral Company and, after renovating the furnaces, recovered 28 flasks in 1943.

The principal workings consist of a glory hole about 350 feet by 150 feet and 35 feet deep, a branching haulage adit about 800 feet in length extending under the glory hole, a second open cut about 175 feet by 75 feet and 25 feet deep lying several hundred

FIGURE 13. Glory Hole and Plant of the B. & B. Mine, Esmeralda County, Nevada.

feet lower on the hill and below the furnace site, and two barren adits on the slope about midway between the two open cuts. (See Plate 5.)

All of the rocks in the area are late Tertiary volcanics with tuff and breccia more prevalent than flows. These rocks are gently folded and cut by a few steep faults. One of these faults of possible genetic significance is shown on Plate 5; it strikes northeasterly and dips steeply northwestward with tuffaceous rocks on its hanging wall and altered andesitic breccia on its footwall. North of the fault the more acid tuffs are altered to an extensive blanket of opalite, whereas to the south the andesite breccia is only locally opalized; only in the opalite bodies has ore been found.

The blanket opalite body on top of the main ridge and mined in the large glory hole has been the source of nearly all of the 2,659 flasks of quicksilver produced. The dominant unsilicified rock, exposed in only a few places, is a medium- to coarse-grained tuff which dips at low angles to the east. The silicified rock, or opalite, is distinctly but irregularly banded with silicified layers generally ranging from one to five inches in thickness separated by thinner bands containing a white chalky mineral, possibly finely divided opal, and abundant open spaces. Minor cross fractures and slumping tend to confuse the banding which is undoubtedly due to selective replacement of the original tuff beds.

Cinnabar is rather erratically distributed through the siliceous layers so that small samples may contain from traces to perhaps 20 pounds of quicksilver to the ton; however, the overall distribution of the cinnabar is such that a 5-foot cut across the bedded ore anywhere in the glory hole would probably contain between one and three pounds of quicksilver to the ton. Near the surface the ore body originally contained a thin blanket of crystal tuff largely composed of fragments and crystals of quartz thoroughly impregnated with cinnabar; all of this ore is said to have averaged more than 20 pounds of quicksilver to the ton.

The base of the opalite blanket is well exposed in the underground workings and in ore passes. In general, it is parallel to the bedding, but locally it cuts sharply across the beds for several feet. (See cross section that is a part of Plate 5.) Below the opalite the rocks are ashy tuffs which are in only a few places altered or argillized, and narrow irregular veinlets of crystalline cinnabar are widespread but not abundant. Nothing even remotely resembling a feeder or channelway for the mineralizing solutions has been cut in the workings below the opalite blanket.

The ore body has not been limited laterally, nor is it possible to estimate its extent from scattered pits and outcrops. At least 100,000 tons of ore averaging perhaps 1.5 pounds of quicksilver to the ton lie in and around the main glory hole, and possibly additional development would materially increase this tonnage estimate.

A second ore body, developed by the open cut below the campsite, lies in a post-mineral landslide block which before sliding probably lay adjacent to the fault. (See Section A – A′, Plate 5.) The ore is all opalized and locally is of good grade, but it seems doubtful that mineable ore will be found to have any continuity through the jumbled blocks of the slide.

CONTAINER MINE

Location.....Sec. 13, T. 1 S., R. 33 E.
Ownership.....L. E. Pitts, J. L. and C. A. McKinney of Dyer, and the A. N. Gibbs Estate of Ojai, Calif.
Discovery.....1927 (?).
Production.....65 flasks to the end of 1942.
Geologic type.....Metamorphic.

The Container mine is in the southern part of the district about a quarter of a mile west of the Red Rock mine. The property was apparently first located in 1927 by G. D. Mills who produced 32 flasks of quicksilver before selling it in 1928 to J. L. McKinney and associates. From 1928 to 1943 the present owners did some exploratory work, and in 1941 they produced 33 flasks of quicksilver from hand-sorted ore.

The principal underground workings, which total about 800 feet in length, consist of two adits connected by a combined ore chute and shaft that extends to the surface. A small glory hole connects with the upper level by a stope and ore-pass. Two open pits, the easternmost of which lies midway between the Red Rock and Container mines, and two adits, each about 300 feet long, complete the list of the workings.

The workings explore the same silicified rocks that are a part of a roof pendant and are productive in the Red Rock mine to the southeast.

Cinnabar, the only ore mineral, occurs with some quartz and barite as small crystalline veinlets and as painty coatings in brecciated zones in the silicified rocks. It seems to be locally concentrated along or near faults, but well-defined control for the ore deposition is lacking.

F. & L. MINE

Location.....Sec. 36, T. 1 N., R. 33 E.
Ownership.....Dr. Richardson.
Discovery.....1934 by Folwick and Lavender.
Production.....Small.
Geologic type.....Opalite.

The F. & L. mine about a mile northeast of the B. & B. quicksilver mine was being developed by H. B. Chester, lessee, in 1942 and 1943. Hand-sorted ore treated in a 2-pipe retort yielded several flasks in 1936 and a few flasks in 1941.

The rocks of the area are acid tuff, flow breccia, and andesite and rhyolite flows. Two opalite bodies have been explored by several shafts, adits, a small open cut, and many shallow pits. The upper or northern opalite body measures 60 feet by 20 feet in outcrop but may extend under cover further eastward; the lower opalite body measures about 80 feet by 100 feet, but its lower limit is poorly exposed. Cinnabar occurs disseminated in the most opalized rock, but because nearly all of the opalite is very blocky no real continuity for the ore could be demonstrated.

O. K. PROPERTY

Location.....Sec. 16, T. 1 N., R. 33 E.
Ownership.....Guy Tumblin and H. M. Brown.
Discovery.....1927 by R. D. Somerville.
Production.....Small, unrecorded.
Geologic type.....Volcanic.

The O. K. property is near the Gold Hit mine in the head of Pinchot Canyon in the northern part of the district. The property is said to have been first located by R. D. Somerville in July 1927, but it remained unworked until 1939 when the present owners relocated the ground and installed the 2-pipe retort that is still on the property. Messrs. McIntyre, Anise, and B. Mellas leased the ground in 1940, and in September 1943 were engaged in mining and erecting a single-pipe retort.

A single steep ore zone is explored by three short westerly trending adits which total approximately 100 feet in length. Additional exploratory work elsewhere on the property has not exposed any ore.

The rock is flow-banded rhyolite which strikes in an easterly direction and dips at moderately steep angles to the north. In the underground workings these rocks are cut by a zone of gouge and cemented fault breccia which strikes N. 70° W., dips from 50°

to 60° to the south, and varies in width from six inches to one foot.

Cinnabar occurs mostly as an earthy ocherous variety in the gouge zone of the fault and in nearly vertical joints trending S. 29° E. away from the fault, but the earthy cinnabar also fills small vugs in the cemented fault breccia. A few small veinlets of crystalline cinnabar, associated with chalcedony and some pyrite, were found in the fault breccia, and lesser amounts occur as isolated rhombohedral crystals.

The underground workings have not fully explored the ore zone, and further development along its strike and down its dip can be expected to yield additional ore.

RED CLOUD PROPERTY

Former names....World Exploration Company, Red Hope.
Location.....Sec. 2, T. 1 S., R. 33 E.
Ownership.....J. P. Cleary, Jack Chiatovich, L. H. Shirley.
Production.....None.
Geologic type.....Volcanic.

The Red Cloud property is at an altitude of 8,000 feet about two miles up Trail Canyon in the southwestern part of the district. The property was first located by the World Exploration Company in 1928 but was abandoned in 1929. In the latter part of 1929 it was restaked by J. P. Cleary and L. H. Shirley who did a little development and held the property until 1935. It was then abandoned until 1940 when it was relocated by the present owners.

Development work includes several trenches and a 15-foot shaft exploring a mineralized zone about 200 feet long. The rocks are flat-lying andesite agglomerate and tuff of Tertiary age. Cinnabar with chalcedony is exposed in a trench and shaft in a narrow veinlet that trends N. 5° E. and dips 65° to the east.

RED ROCK MINE

Former names....Chrysler.
Location.....Sec. 18, T. 1 S., R. 34 E.
Ownership.....Walter F. Dunnigan.
Discovery.....Located for silver, 1914; for quicksilver, 1927, by George Chrysler.
Production.....1,734 flasks to the end of 1943.
Geologic type.....Metamorphic.

The Red Rock mine lies on a group of four claims in the southern end of the district and about 11 miles west of the Chiatovitch ranch. In 1928 George Dunnigan acquired the property and leased it to E. F. Good and J. L. McKinney. Good, after buying out McKinney's interest, produced more than 1,000 flasks from retorts and a small rotary furnace between November 1928 and January 1931. In 1931 the mine was operated by several lessees who recovered two hundred flasks. The present owner took over the property in 1932 and by operating it at various times from 1932 to 1939 recovered about 130 flasks of quicksilver. In October 1939 Fred Vollmer, manager of the Calumet Gold Mines, obtained a five-year lease and by the winter of 1942 had recovered 435 flasks from ore treated in the 20-ton Cottrell furnace.

The Red Rock mine is developed by two main levels. The upper level is about 1,250 feet long and is connected by a stope with a 100-foot by 75-foot glory hole. The lower level, 80 feet below the upper one, is only about 480 feet long and is connected to the upper level by a raise. Additional workings in the area include two open pits and several short adits. (See Plate 6.)

The mine lies in a small roof pendant of Paleozoic metamorphic rocks consisting of interbedded phyllites and marble engulfed in a "granite" batholith; flows of basalt and dacite and some tuffs overlie both the intrusive and the pendant. Three subparallel zones of gouge and alteration striking N. 85° W. and dipping 45° to the south are cut off by a fault which strikes N. 60° E. and dips about 75° to the south. The intersection of the fault and the zones of gouge and alteration forms an "inverted trough" beneath which most of the mined ore was concentrated.

Cinnabar, the only quicksilver ore mineral found on the property, is associated with quartz, barite, stibnite, stibiconite, limonite, and clays. The stibnite appears to be genetically related to the cinnabar but is uncommon. The cinnabar occurs as crystalline seams filling cracks in the broken zone in the siliceous rock, and as coatings of "paint" on angular fragments of the same rock. High-grade lenses containing crystalline cinnabar occur locally within the fault zone.

RED ROSE PROSPECT

Location.....Secs. 34 and 35, T. 1 N., R. 33 E.
Ownership.....R. D. Somerville of Mt. Montgomery.
Discovery.....1934 by Mikerell and Somerville.
Production.....One flask to the end of 1942.
Geologic type.....Opalite.

The Red Rose prospect is in the northern part of the district about two miles south of the O. K. mine on a group of four claims

located in 1934 by R. D. Somerville and A. Mikerell. After the locators had done a small amount of development they leased the property in 1941 and the lessees are said to have recovered one flask of quicksilver from a D retort. When the property was visited in 1943 it was idle, and the retort had been removed.

An open cut 33 feet long explores a fault which trends easterly and dips 43° to the north. An inclined shaft in the cut goes down 30 feet on the hanging wall side of the fault, and at the base of the shaft a small drift explores the same fault for 15 feet to the east.

The rocks of the area consist of spherulitic glassy flows, tuffs, and some silicified and flow-banded rhyolite. The faulted easterly trending contact of a rib of flow-banded rhyolite is explored by the underground workings. Cinnabar occurs as painty films and encrustations in the clay gouge along the fault and as scant disseminations in the silicified rhyolite along its footwall.

WILD ROSE MINE

Former names....Mt. Montgomery, Red Rose, Starlight Group.
Location.....Secs. 16 and 21, T. 1 N., R. 33 E.
Ownership.....J. E. Renfro of Mt. Montgomery.
Discovery.....1916 by Morris brothers.
Production.....163 flasks to the end of 1943.
Geologic type.....Opalite.

The Wild Rose mine is in the northern end of the district on Sugarloaf Peak at an elevation of about 9,000 feet. This property, which is the oldest in the district, was discovered in 1916 and had been largely exhausted by 1918. It was first operated by Mr. Beedle who formed the Mt. Montgomery Mercury Company, installed a 2-pipe D retort, and recovered about 150 flasks of quicksilver during the first World War. Following this the property was abandoned until 1929 when it was relocated by J. E. Renfro and Charles Kenafake who, however, did no development work. In 1938 it was sold to W. H. Kirkbride who drove the lower 500-foot adit but, finding little ore, abandoned the ground in 1941. Late in 1941 the present owner relocated the property, but it was idle in 1943.

Two adits, amounting to about 1,100 feet of workings, explore an ore zone striking N. 50° E. The lower adit is connected with the upper adit by a 105-foot combined raise and stope; the upper adit connects with two glory holes by several raises and ore chutes.

The rocks in the area consist of Tertiary rhyolite flows trending about N. 60° E. and dipping 50° to 60° southward. The rhyolite has been locally silicified to opalite along the fault zone explored by the workings, and locally it is converted to a different more porcellaneous variety of opalite along favorable layers. Cinnabar is disseminated in the blocky opalized rib along the hanging wall of the fault and in lesser amounts is distributed erratically in the clay gouge of the fault. The porcellaneous opalite in the footwall is apparently barren.

GILBERT DISTRICT

The Gilbert district in the southeastern part of the Monte Cristo Range has been divided into two parts—Gilbert, and South Gilbert. The only quicksilver property in the district lies in the South Gilbert part about six miles north of Blair Junction. The rocks of the area consist of sediments and lavas of Middle to Late Tertiary age overlying a pre-Tertiary basement of chert, quartzite, siliceous slates, and some limestone.[25] The cinnabar deposits are of the volcanic type, occurring in fractures and shears in cemented breccia veins that cut Late Tertiary volcanic rocks.

CASTLE ROCK PROSPECT

Location.....Secs. 21 and 28, T. 3 N., R. 38 E.
Ownership.....F. O. and H. L. Gilbert of Luning, and C. A. Hendel and L. L. Sibley.
Discovery.....1928 (?).
Production.....Very small.
Geologic type.....Volcanic.

The Castle Rock quicksilver prospect is on what was formerly known as the Howard ground originally located for gold. In 1928 C. A. Herrold, E. H. Nelson, and P. Reuse having found veinlets of cinnabar on the property installed a small retort and produced one flask of quicksilver. However, the productive period was short-lived, and the only activity in 1943 consisted of rather erratic diamond drilling.

The underground workings consist of a 60-foot inclined shaft which has at its base a 33-foot drift along a breccia vein that trends N. 75° W. and dips 65° to the south. At the surface near the collar of the shaft the vein is further explored by a trench and 10-foot adit, and nearby several diamond-drill holes have been put down.

[25] Ferguson, H. G., The Gilbert District, Nevada: U. S. Geol. Survey Bull. 795, pp. 125–145, 1928.

The rocks in the vicinity of the mine consist of andesite tuffs which have been locally silicified and brecciated. The shaft and adjoining workings explore a chalcedony-cemented breccia vein which varies in width from one inch to one foot. Cinnabar occurs in the breccia vein in fractures and shears that cut the chalcedony; it is associated with jarosite, clays, and some pyrite.

A short trench and adit southwest of the shaft explores a locally silicified rib of andesite tuff which trends N. 65° W. and dips 70° to the northeast. Cinnabar here fills fractures and open spaces in the silicified andesite.

MONTEZUMA DISTRICT

The Montezuma mining district, which is chiefly a gold district, is on the west slope of Montezuma Peak in eastern Esmeralda County. A single nonproductive quicksilver prospect is known in the district.

MONTEZUMA PROSPECT

Location.....Sec. 17, T. 3 S., R. 41 E.
Ownership.....Frank McMillan of Goldfield and the Estate of J. P. Sweeney.
Discovery.....1928 by Sweeney and McMillan.
Production.....None.
Geologic type.....Opalite.

The Montezuma quicksilver property consists of six claims on the west side of Montezuma Peak about nine miles west of Goldfield. Since the deposit was discovered in 1928 it has been developed by Sweeney and McMillan and various lessees, but not enough ore has been found to justify the erection of reduction equipment.

Development consists of a 180-foot adit with about 175 feet of connecting drifts and crosscuts; above the adit are a few scattered cuts and a shaft.

The workings explore Miocene lake beds and tuffs faulted against the Cambrian Eldorado limestone. The faulted contact strikes N. 60° W. and dips 30° southward, locally nearly paralleling the inclination of the sediments; the tuffs and lake beds of the hanging wall are extensively silicified to form a rib of opalite. The rib is traceable on the surface for 450 feet and has a width of about 30 feet, although it is considerably wider underground.

Cinnabar is disseminated in the unsilicified tuff beds and in the opalized rib, but it is most concentrated in the opalite near the faulted contact with the limestone. No cinnabar was found in the limestone although the breccia zone between the two kinds of rocks contained some brecciated opalite ore.

UNNAMED DISTRICT

Small deposits of cinnabar ore have been found on the east side of Fish Lake Valley, but, as none of these has reached the productive stage, only one was examined.

RIEK PROPERTY

Location.....Sec. 11, T. 1 S., R. 35 E.
Ownership.....W. G. Weatherford and Carl Riek of Coaldale.
Discovery.....1916, relocated in 1937.
Production.....None.
Geologic type.....Sulfurous.

The Riek quicksilver property consists of a group of five claims lying three miles north-northeast of the Chiatovich ranch in Fish Lake Valley. In May 1940 the property was leased to the Western Mercury Company who did little work, and when the property was visited in 1943 it was idle.

Development consists of two 40-foot shafts, a short combined adit and stope, and several trenches scattered over an area of about two acres.

The rock is flat lying interbedded tuff and ash. The minerals encountered in the underground workings include chalcedony, sulfur, gypsum, and cinnabar. The sulfur occurs as small blebs, irregular stringers, and blankets filling open spaces and fractures in the tuff. Small amounts of cinnabar are disseminated in the tuff and fill tiny seams and fractures in the sulfur. No well-defined control for the deposition of either sulfur or cinnabar is apparent.

EUREKA COUNTY

Along the western edge of Eureka County cinnabar has been found in three districts, but the only production, about 100 flasks of quicksilver, came from the Beowawe mine.

BEOWAWE DISTRICT

The Beowawe district, just south of the town of Beowawe, contains a single productive mine and a few prospects which were not visited.

BEOWAWE MINE

Former names....Red Devil group, Nevada-Mexico.
Location.....Sec. 8, T. 31 N., R. 49 E.
Ownership.....Roy S. Harris and H. M. Grubaugh.
Discovery.....1924 by R. S. Harris and C. M. Wilkinson.
Production.....149 flasks by the end of 1943.
Geologic type.....Interbedded sediments—silicified limestone.

The Beowawe mine lies on the Red Devil group of three claims located in the hills about a mile south of Beowawe. It was first held by the Beowawe Quicksilver Mining Company which failed to produce. The major development of the property was done by the Nevada-Mexico Mining Corporation in 1928 and 1929. This company installed a 30-ton rotary furnace which was operated in 1929 and, according to Vanderburg,[26] recovered 132 flasks of quicksilver. In 1932 the Sacramento Gold and Quicksilver Mining Company produced a few flasks, but since then the mine has been idle.

The workings consist of a 150-foot shaft, about 2,000 feet of adits and crosscuts most of which are on two levels about 75 feet apart, and five small stopes which extend to a depth of only 60 feet below the surface.

The ore occurs in a silicified limestone conglomerate which strikes N. 25° E. and dips 25° eastward. This bed, which is prominently exposed on the top of the ridge for a distance of over half a mile, is underlain by shale exposed only in the workings. A prominent flat-lying flow of andesite that caps the ridge to the west of the mine may have extended over the limestone during the period of mineralization.

Cinnabar is concentrated along irregular vertical fractures and rubble zones that trend about N. 15° W. through the silicified

[26] Vanderburg, Wm. O., Reconnaissance of mining districts in Eureka County, Nevada: U. S. Bur. Mines Inf. Circ. 7022, p. 19, 1938.

limestone conglomerate. Most of the cinnabar forms thin coatings on the rubble, but the mined ore consisted of conglomerate containing cinnabar veinlets and disseminated crystals. Most of the conglomerate is essentially barren, and the exorbitant amount of development work done on the property was not justified by the surface showings.

CORTEZ DISTRICT

The Cortez district, on the west slope of the Cortez Range about 35 miles south of Beowawe, has been an important producer of silver, but recently a deposit of cinnabar was discovered on the east slope of the range. The quicksilver ore is reported to occur in early Paleozoic limestone.

ROSSI PROPERTY

Location.....Sec. 10 (?), T. 26 N., R. 48 E.
Ownership.....Toni Rossi.
Discovery.....About 1941 by the Rossi brothers.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Rossi property lies on the east slope of the Cortez Range near the head of Horse Canyon. The deposit is reported to have been discovered and developed by the Rossi brothers, but by the end of 1943 they had made no attempt to recover quicksilver from the ore.

The property is developed by three shafts, the deepest of which is reported to be 22 feet deep. The ore occurs in limestone.

LYNN DISTRICT

Cinnabar is reported to occur in the Lynn district[27] 20 miles northwest of Carlin, and, as the district contained only placer gold mines at the time of this report, it is probable that the cinnabar was found in the placer gravels.

[27] Schrader, F. C., Stone, R. W., and Sanford, Samuel, Useful minerals of the United States: U. S. Geol. Survey Bull. 624, p. 192, 1917.

HUMBOLDT COUNTY

Quicksilver deposits are widespread in Humboldt County, but all of the more productive districts lie in the eastern half of the county. None of the deposits were operated on a large scale until 1940, but by 1943 the county ranked third in total production and in a few years will probably attain first rank.

Nine districts are known to contain cinnabar, but of these only two have yielded over 1,000 flasks. The most productive, the Opalite district, lies west of McDermitt and partly in Oregon, but the Cordero mine, which had yielded 4,581 flasks to the end of 1943 and doubtless will yield much more quicksilver, is in Nevada. The next most productive district, the Bottle Creek district about 45 miles south of the Opalite district, contains three mines which together yielded nearly 4,000 flasks between 1939–1941; however, in 1943 it was comparatively inactive.

BOTTLE CREEK DISTRICT

The Bottle Creek quicksilver district lies about 55 miles northwest of Winnemucca in the foothills of the northeastern part of the Jackson Mountains. The geology and quicksilver deposits are discussed in a report by R. J. Roberts,[28] and a geologic map of the district is included in his report.

The rocks of the area include complexly folded and faulted sedimentary and volcanic rocks of pre-Tertiary age; conglomerate, pyroclastics, and basalt of Tertiary age; younger diabase dikes; and still younger rhyolite flows and intrusives. Most of the production has come from ore bodies lying in or along one of several northerly trending diabase dikes, but some production has come from ore localized along shear zones in rhyolite and rhyolitic tuff. The ore bodies in the diabase have been comparatively small but of such very high grade that, even after normal dilution due to mining, an exceptional day's run of 40 tons is reported to have yielded 63 flasks of quicksilver.

The presence of cinnabar float in the district was known at least as early as 1928, but the lodes were not discovered until September 1936. The production of the district through 1943 has been 4,544 flasks of quicksilver, and more than 3,000 flasks of this total came from the dike of the Blue Can-McAdoo mines. When the district was last visited in August 1943 only one property was active.

[28] Roberts, Ralph J., Quicksilver deposits of the Bottle Creek district, Humboldt County, Nevada: U. S. Geol. Survey, Bull. 922-A, pp. 1–29, 1940.

ANTHILL MINE

Location.....Sec. 7, T. 40 N., R. 33 E.
Ownership.....Mrs. Eva McAdoo Overholser.
Discovery.....1939 (?).
Production.....Small, recorded with McAdoo mine.
Geologic type.....Opalite.

The Anthill mine lies on top of a small knoll about 1,000 feet south-southwest of the McAdoo mine. The mine is on the property originally staked by Dr. W. C. McAdoo in 1936, and some ore from it was treated in the McAdoo furnace in 1941 or 1942. Since that time the property has not been further developed.

The workings consist of a 50-foot shaft, about 300 feet of drifts distributed on the 22-, 38-, and 50-foot levels, and a small stope connected with a glory hole.

The rocks are interbedded basalt, tuff, and agglomerate of Tertiary age. Cinnabar is locally disseminated through a rubbly silicified tuff or opalite and, in lesser amounts, occurs as narrow veinlets in clay seams.

B. & B. PROSPECT

Location.....Secs. 6 and 7, T. 40 N., R. 33 E.
Ownership.....Mrs. Eva McAdoo Overholser.
Discovery.....1940 (?).
Production.....Small.
Geologic type.....Opalite.

The B. & B. prospect is on a group of six claims about 1,000 feet north of the McAdoo mine. The small amount of ore that has been mined is believed to have been treated in the McAdoo furnace.

The workings consist of an inclined shaft extending to a depth of 50 feet, almost 100 feet of drifts from the base of the shaft, a small glory hole, and a second small glory hole connected to a stope. The workings explore tuffs of acid and intermediate composition. Some cinnabar was seen in the walls of the stope where it occurs as veinlets along a northwesterly trending fracture zone in a somewhat silicified tuff. Additional cinnabar is said to have been struck in churn drill holes northeast of the main workings.

BALDWIN MINE

Former names....Blue Bucket, Blue Bottle.
Location.....Sec. 8, T. 40 N., R. 33 E.
Ownership.....H. W. Baldwin of Winnemucca.
Discovery.....September 1936 by Baldwin.
Production.....141 flasks to the end of 1942.
Geologic type.....Opalite.

The Baldwin property consisting of eight claims and fractions lies in the eastern part of the district on the northeast slope of Halburg Mountain. During parts of 1937–1938 the property was optioned from H. W. Baldwin and the estate of John C. Duryea by the Fulton Quicksilver Company, but apparently their only development work consisted of sinking a 25-foot shaft. In December 1939 the property was optioned by Greenan Quicksilver, Inc., who drifted under the shaft and deepened it, but dropped the option in 1940 without recovering any quicksilver. In 1941 the property was leased by Melvin McCoy and John Hardin who deepened the shaft and recovered 47 flasks from retorts. In 1942 the same lessees recovered 94 flasks from ore that was trucked to the nearby McAdoo Herreshoff furnace. Early in 1943 the property was optioned by the Molybdenum Products Company of Tacoma, Washington, but by November 1943 they had done little development and treated no ore.

The workings are aligned along a northerly trending outcrop of silicified rhyolite about 800 feet long. The largest working lies near its north end and consists of a shaft 76 feet deep with small stopes and irregular short workings extending from the shaft at depths of 18, 31, 51, and 76 feet. About 300 feet to the south is a small glory hole and near-surface adit connected with 50 feet of underlying workings by a 25-foot shaft. Other workings still farther south include two shallow shafts, small open cuts, and extensive bulldozer cuts.

Bedrock, which is exposed in only a few places, includes pre-Tertiary sediments and both a flow and a dike of rhyolite. Where the sediments are silicified they crop out as low knobs; where not silicified they are exposed only in bulldozer cuts, but probably most of the covered area is underlain by these sediments. The rhyolite flow caps the hill to the north of the mine, and a more extensive flow lies to the south and west. The elongate body of rhyolite that is explored by the workings is steeply flow-banded, and because of the inclination of the banding and the shape of the mass it is believed to be a dike.

The ore deposits lie in the dike and are classed as being of the opalite type, but the ore does not resemble typical opalite ore for it occurs in silicified rhyolite rather than in the typical silicified rhyolitic tuff.

Cinnabar, which is the only ore mineral seen on the property, occurs in the silicified dike as veinlets, as small replacement crystals, and as the matrix in narrow breccia zones. A small lense of stibnite found in a quartz vein in the main workings is believed to antedate the cinnabar mineralization.

Most of the ore lined faults and was very narrow, but the ore body explored by the 76-foot shaft was in places 25 feet in diameter and lay in a wedge between a northwesterly trending vertical fault and a northeasterly trending fault which dips steeply to the southeast. The geology of the main workings does not suggest the ore is bottomed, but on the other hand there is no reason to suspect the grade of the ore will increase with depth.

BIRTHDAY MINE

Former names....Wootan, Wootan and McCown.
Location.....Sec. 18, T. 40 N., R. 33 E.
Ownership.....D. J. Wootan, Jerry Wootan, M. R. Wootan, and the estate of M. S. McCown.
Discovery.....October 1936 by D. J. Wootan.
Production.....220 flasks to the end of 1943.
Geologic type.....Basic dike.

The Birthday mine is in the southwest corner of the Bottle Creek district. Although the claims were located in 1936, apparently no mineable ore was discovered until June 1938. Shortly thereafter the north shaft was sunk and a 2-pipe retort installed and operated. In 1939 a second 2-pipe retort was built, and the major part of the total production of over 200 flasks was recovered during 1938–1939. Since 1939 the property has been held by several lessees who did little development, and it was idle and mostly caved in August 1943.

The property is developed by three inclined shafts, the northern two of which are slightly more than 50 feet deep, whereas the southern one reaches a depth of 100 feet. Drifts, crosscuts, and raises total somewhat more than 400 feet in length.

The workings explore a faulted diabase dike which cuts tuff and basalt of Tertiary (?) age. The dike is less than 10 feet wide and strikes northerly and dips 45°–50° to the west, but it is broken into many small segments by faults of small displacement. The ore bodies were confined to the dike and adjacent wall rocks and appear to have been most abundant where the dike was most faulted. Much of the ore mined was of high grade and is reported to have contained as much as 60 pounds of quicksilver to the ton.

BLUE CAN MINE

Former names....Bottle Creek Mercury mine, Tin Can.
Location.....Sec. 7, T. 40 N., R. 33 E.
Ownership.....C. P. Hoskins, C. T. Smith, and T. C. Niebuhr.
Discovery.....November 1936 by the present owners.
Production.....1,728 flasks to the end of 1943.
Geologic type.....Basic dike.

The Blue Can property, consisting of nine claims, is in the central part of the district, and the mine workings are connected with the workings of the McAdoo mine lying to the north. The property was developed by its present owners in 1937 and 1938, and by the middle of January 1939 they had recovered 40 flasks of quicksilver from a 2-pipe retort. In January 1939 the property was leased by James O. Greenan who, operating as Greenan Quicksilver, Inc., developed considerable ore in 1939 and, after installing a 50-ton Gould rotary furnace, in 1940 recovered 971 flasks of quicksilver. The lease was then given up by Greenan, and the furnace was moved to Santa Barbara, California. In May 1941 the mine was leased to C. N. Williamson, superintendent of the adjoining McAdoo mine, and during the remainder of the year he recovered 605 flasks from ore treated in the McAdoo Herreshoff furnace. Since 1941 the property has been leased to various individuals who have recovered some quicksilver from the margins of old stopes. In September 1943 J. E. Riley and H. H. Luce leased both the Blue Can and McAdoo mines.

The mine is developed by a 135-foot shaft and connecting drifts on the 32, 47, 86, 110, and 135-foot levels. The aggregate length of these workings is more than 2,000 feet, but about half of this work was done on the 86-foot level. All the stopes lay above the two lowest levels, and these and many of the other workings were either tightly timbered or caved when the mine was studied.

Because of the inaccessibility of many of the workings the geology of the mine is not entirely understood. The mine map included with this report was compiled from several existing surveys, and part of the geology shown thereon is based on the memories of the mine operators and miners. The ore bodies were localized in broken portions of a diabase dike which in most places strike northerly and dip westward. The wall rocks are greatly argillized, but appear to belong to both the pre-Tertiary and Tertiary sequences of sediments, tuffs, and flows. (See Plate 7.)

The ore bodies are conveniently divided into two groups. Those belonging to the eastern group were localized along a diabase dike which extends from the surface to a few feet below the 86-foot level. The dike varies from 3 to 15 feet in width and rolls considerably both in strike and dip. Cinnabar is confined to the dike and adjacent wall rocks, and it is most abundant along the hanging-wall side of particularly flat parts of the dike. Gangue minerals occurring with cinnabar in closely spaced vertical cracks include iron oxides, calcite, and chalcedony.

The western group of ore bodies was localized along an apex between a vertical dike and a heavy layer of clay or gouge which dips at a low angle to the east. The structural control is further complicated by large disconnected fragments of dike within the apex. The ore in these bodies was of very high grade and almost completely replaced the diabase. It consisted of cinnabar, clay minerals, and scant pyrite.

FRANKLIN-KEENEY PROPERTY

Location.....Sec. 29 (?), T. 41 N., R. 32 E.
Ownership.....Clyde Franklin of Sod House and Dr. Fred Keeney.
Discovery.....1940 by Franklin.
Production.....None.
Geologic type.....Opalite (?).

The Franklin-Keeney property of six claims is about two miles east of Happy Creek and about three miles northwest of the central part of Bottle Creek district. It is on the north slope of Buff Peak across the ridge west of most of the mines of the district, and it is accessible by road only from the Happy Creek ranch. The property has been intermittently developed since its discovery, and no attempt has been made to recover any quicksilver from the ore.

The principal work was done in a creek bottom and was caved when the property was visited in August 1943. Reportedly it consisted of a 50-foot shaft with a 25-foot drift to the east and a shorter drift to the west on the 30-foot level. The shaft is said to have followed a fault gouge which is vertical near the surface but dips at a low angle to the north near the base of the shaft. The country rocks are rhyolitic and andesitic tuffs and flows.

HAGAN-HEGAN PROPERTY

Location.....Sec. 1, T. 40 N., R. 32 E.
Ownership.....William J. Hagan and James Hegan.
Discovery.....1940 by Hagan and Hegan.
Production.....None.
Geologic type.....Opalite.

The Hagan-Hegan property is in the northwestern part of the district just southwest of the Niebuhr mine.

The principal working, a branching adit less than 400 feet long with several inclines and raises, explores altered and iron-stained pre-Tertiary flows and tuffs. No ore has been stoped from the workings, and they do not appear to contain more than a few scattered crystals of cinnabar.

McADOO MINE

Former names....Bluebird.
Location.....Sec. 7, T. 40 N., R. 33 E.
Ownership.....Mrs. W. McAdoo Overholser of Winnemucca.
Discovery.....September 1936 by Dr. W. C. McAdoo.
Production.....1,646 flasks to the end of 1942.
Geologic type.....Basic dike.

The McAdoo mine, on a block of 10 claims and fractions in the central part of the district, adjoins the Blue Can mine to the south. During part of 1937–1938 the property was leased by the Fulton Quicksilver Company who did little or no work on it. In May 1939 a 2-pipe retort was installed by H. Baldwin and Dr. W. C. McAdoo, four more pipes were added two months later, and late in the year an additional two pipes were added. Using these retorts, 161 flasks of quicksilver were recovered in 1939. By September 1940 a 30-ton Herreshoff furnace had been installed and production to the end of the year amounted to 838 flasks. During 1941 an additional 629 flasks were recovered from the furnace. Early in 1942 the property was closed down and, aside from a little mining by lessees, it remained idle until June 1943 when a small rotary furnace was installed to treat ore sorted from the dumps. In September 1943 J. E. Riley and H. H. Luce leased this property and the adjoining Blue Can property and started a drilling program.

The ground of the McAdoo mine is much less completely explored than that underlying the adjoining Blue Can property. The mine is developed by an inclined shaft extending to a depth of 107 feet and about 1,300 feet of drifts and stopes distributed on the 20-, 31-, 52-, 78-, and 107-foot levels.

The geology shown on the mine map is in part hearsay, as most of the stopes were either tightly timbered or caved when the mine was studied. (See Plate 7.) The ore bodies lie either in or adjacent to parts of a diabase dike which trends northerly and dips westerly through altered pre-Tertiary and Tertiary sediments and tuffs.

Nearly all of the ore was stoped from the eastern diabase dike which extends from the surface at least to the 78-foot level. The dike is irregular, with a variation in width of 3 to 15 feet, as well as considerable variation in strike and dip.

Cinnabar, the only ore mineral, occurred with iron oxides, calcite and chalcedony filling closely spaced steep fractures in the diabase dike. The fractures were most numerous along the hanging-wall side of flatter parts of the dike, but the ore body extending southward from the raise connecting the 78- and 107-foot levels lay in a nearly vertical but highly sheared part of the dike. The westernmost ore body, only the northern tip of which lies within the McAdoo property, is discussed under the description of the Blue Can mine on page 85.

The upper part of the dike followed by the 107-foot level north of the shafts should be further explored, for, where it is cut off by the easterly dipping fault that is exposed in the shaft, the structural conditions are similar to those responsible for the localization of the western group of ore bodies in the Blue Can mine. (See Section C-C′, Plate 7.)

NIEBUHR MINE

Former names....Sunset-Big Four group.
Location.....Sec. 36, T. 41 N., R. 32 E.
Ownership.....Thomas C. Niebuhr of Winnemucca.
Discovery.....March 1939 by Niebuhr.
Production.....19 flasks to the end of 1942.
Geologic type.....Opalite.

The Niebuhr property which consists of seven claims lies about a mile northwest of the central part of the district. The ground was originally staked by the Scossa brothers, but apparently the assessment work was not done as Niebuhr, after discovering some ore on the property in 1939, restaked the ground. In January 1940 a 2-pipe retort was built, and in that year and the following year 19 flasks of quicksilver were recovered. The property was idle when visited in August 1943.

The workings on the property consist of a 60-foot inclined shaft and several open cuts. The shaft is in broken and silicified rhyolite and follows a shear zone which strikes N. 70° E. and dips 70° to the southeast. Cinnabar coats the rhyolite fragments, impregnates the finely crushed material, and is said to have occurred as solid bunches weighing as much as two pounds.

An open cut 1,400 feet northwest of the shaft explores phyllite that is cut by a shear zone. Cinnabar and iron oxides occur along the shear and in fractures and cleavage planes. A diabase dike that crops out 100 feet east of the open cut warrants further exploration.

RED ORE MINE

Location.....Secs. 7 and 18, T. 40 N., R. 33 E.
Ownership.....James and Arnold Scossa.
Discovery.....1937 by the Scossa brothers.
Production.....Small, recorded with White Peaks mine.
Geologic type.....Basic dike.

The Red Ore group of eight claims and fractions is in the southwestern part of the district about a mile southwest of the McAdoo-Blue Can mines. Little is known of the history and development of this property which was jointly operated with the White Peaks mine by several lessees. In 1937 the Fulton Quicksilver Company did some development work, and in the following year the Scossa brothers further developed the claims. In 1942 the ground was held by Greenan Quicksilver, Inc., but their activity was confined to the White Peaks group. In August 1943 the property was idle.

The workings consist of shallow shafts, open cuts, and two short adits in Tertiary (?) diabase dikes and tuffs. Two different northerly trending dikes have been developed. The eastern one probably is the continuation of the dike explored by the Birthday mine to the south. Cinnabar occurs in the dike in narrow veinlets with calcite and limonite and in alluvium as nuggets.

ROGERS-BURNISON PROPERTY

Location.....Sec. 35, T. 41 N., R. 32 E.
Ownership.....S. W. Burnison and Ab Rogers.
Discovery.....1940 (?).
Production.....None.
Geologic type.....Opalite (?).

The Rogers-Burnison property is on the west slope of Buff Peak across the ridge from most of the mines of the Bottle Creek district. The property is still in the prospect stage and has not been examined by the writers.

The workings are said to consist of a 20-foot shaft with 30 feet of drifts, a 40-foot shaft, and several surface trenches. These workings explore rhyolite flows and tuffs. Cinnabar is reported to have been found in rich narrow stringers and as widespread disseminated crystals in the rhyolite.

WHITE PEAKS MINE

Former names....Scossa mine, Bottle Creek mine.
Location.....Sec. 7, T. 40 N., R. 33 E.
Ownership.....James Scossa and Arnold Scossa.
Discovery.....September 1936 by Scossa brothers.
Production.....773 flasks to the end of 1943.
Geologic type.....Basic dike.

The White Peaks group, consisting of three claims in the central part of the district, was first located in September 1936. In July 1937 the Fulton Quicksilver Mines, Inc., leased these claims and many others in the district. They developed some ore by

sinking a shaft to the 112-foot level and drifting on the 62-foot and 112-foot levels, but although they installed a 20-ton rotary furnace late in the year, apparently no ore was treated. In the following year, after a small production, the lease was dropped, and later in the same year some ore was treated by the Scossa brothers. In 1940 Eugene Franke and Anthony Lebechi leased the property, and operating as the White Peaks Mining Company produced 263 flasks without doing much development work. Early in 1942 J. O. Greenan optioned the property and, after striking rich ore on the previously little explored footwall side of a dike, recovered 343 flasks from ore treated in the 20-ton rotary furnace still on the property. Early in 1943 the White Peaks property was subleased, but in August of that year the property was idle.

Mining has followed a nearly vertical diabase dike. The workings consist of a 165-foot shaft, about 250 feet of drifts and crosscuts on the 62-foot level, about 300 feet of drifts and crosscuts on the 112-foot level, a short crosscut on the 165-foot level, and extensive stopes on each side of the dike above the 112-foot level. (See Plate 8.)

The oldest rocks are argillized tuffs, sandstones, and fine gravels of pre-Tertiary age. These rocks are cut by a northerly trending diabase dike which dips steeply to the east and either contains or borders all of the ore bodies. Uncomformably overlying the sediments and the diabase dike are extensive flows of rhyolite.

Cinnabar fills fractures in the dike, is disseminated in the dike and adjacent wall rocks, and has almost completely replaced parts of the dike to form pods and lenses of very high-grade ore. Small amounts of cinnabar occur as irregular veinlets in the overlying rhyolite. Pyrite, which is moderately abundant, appears to have been deposited at the same time as the cinnabar and small amounts of chalcedony; calcite veinlets are both younger and older.

The ore bodies have been stoped from along both walls of the dike and terminate sharply against the northerly dipping contact with the overlying rhyolite. The ore on the hanging-wall side was narrow, whereas the ore body mined from the footwall side tapered from 15 feet in width near the rhyolite to about 5 feet where mined above the 112-foot level. No ore has been mined from below the 112-foot level, although the dike contains some cinnabar at the base of the 165-foot shaft. The dike which averages nearly 20 feet in width is reported to contain about two

pounds of quicksilver to the ton, and it might be mined in its entirety at a time when the price of quicksilver is exceptionally high.

DUTCH FLAT DISTRICT

The Dutch Flat (Florence) district is on the western slope of the southern end of the Hot Springs Range about 18 miles northeast of Winnemucca and the same distance north of Golconda. Placer gold was discovered in the area by F. G. Wendell in 1893, and as cinnabar is distributed through the placer gravel, it was probably noted during the early placer-gold mining. Some cinnabar is said to have been saved from the more recent mining, and in 1940 the Dutch Flat Mines, Inc., developed quicksilver ore in place.

The rocks of the area consist of schists and phyllites intruded by granite with associated quartz veins, and overlain by erosional remnants of Tertiary volcanic flows and tuffs.

DUTCH FLAT MINE

Location.....Sec. 8, T. 38 N., R. 40 E.
Ownership.....Charles Osborne and Jacob A. Cowan.
Discovery.....1939.
Production.....70 flasks to the end of 1942.
Geologic type.....Metamorphic and volcanic.

The Dutch Flat Mining Company was organized by E. R. Rogers, Ed. Hazlett, and J. W. Tuft in September 1940, and during 1940–1941, following the installation of two Rossi-type 4-pipe retorts, 70 flasks of quicksilver were produced. Since then the property has apparently been idle.

Two areas, about 500 feet apart but probably both on the same structure, have been developed. The northern workings consist of an inclined shaft, following a fault that dips 35° to a depth of about 125 feet below the surface, with about 500 feet of short drifts and stopes extending from the shaft at short intervals. The southern workings are shorter and consist of a second inclined shaft about 75 feet long extending from a surface cut.

The workings explore a shear zone that strikes N. 45° E. and dips about 35° to the southeast. Below the shear zone in the northern workings the rocks are altered siliceous grits, whereas the hanging wall appears to be highly argillized andesite flows or tuffs. In the southern workings all of the rocks are greatly altered, but all are apparently of volcanic origin.

Cinnabar occurs as small disseminated crystals in the altered volcanic rock, as veinlets and veins along the shear zone, and as

painty films. Jarosite, pyrite, and quartz are minor associates of the cinnabar. The mined ore consisted mostly of a narrow vein along the shear zone, but locally also included mineralized wall rock. Because of the limited width of the ore zone, mining in even narrow stopes probably diluted the ore. A rough estimate based on production and the size of the calcine dump indicates the retorted ore, which may have been hand-sorted, averaged about 20 pounds of quicksilver to the ton.

The unexplored part of the shear zone between the two shafts probably contains several hundred flasks of quicksilver, but the amount of exploration necessary to find the local "hot spots" may be excessive.

LAST CHANCE PROSPECT

Location.....Sec. 21, T. 38 N., R. 40 E.
Ownership.....E. L., J. M., and L. M. Mullinix of Winnemucca.
Production.....About one flask.

The Last Chance prospect which lies on a group of three claims located two miles southeast of the Dutch Flat mine has not been visited. In 1940 the property was leased to the Dutch Flat Mining Company, but it reverted to the present owners in 1941. The only production was made in 1941 when one flask was recovered from ore treated in the retorts at the Dutch Flat mine.

The property is said to be developed by a shallow shaft and surface cuts. The local geology is not known.

RED DEVIL PROSPECT

Former names....Aurum Co., Golconda Quicksilver.
Location.....Sec. 5, T. 37 N., R. 40 E.
Ownership.....Mr. Garn and Mr. Rand of New York City.
Production.....Very small.

The Red Devil prospect which lies on the southern end of the Hot Springs Range about eight miles south of the Dutch Flat mine has not been visited. Early in 1940 the property was purchased by the Nevada Mines Corporation, and they laid plans to install a large furnace. However, by 1943 there was no reduction equipment on the property, and the only production consisted of one flask of quicksilver recovered from ore treated in the retorts of the Dutch Flat mine.

The workings are said to consist of a 20-foot shaft and scattered surface cuts. The ore is reported to occur in altered volcanic flows and tuffs.

NATIONAL DISTRICT

The National district, lying in the Santa Rosa Range about 12 miles south-southeast of McDermitt, was originally designated to include a gold-silver mining area which contained some cinnabar, but herein it is extended several miles southward to include three quicksilver deposits. Cinnabar was reported by Lindgren[29] in 1915 to occur in the veins at Auto Hill and in workings connected with the Blum shaft at the main National camp, but no attempt to mine the ores in the district for quicksilver was made until about 1930. The total recorded production of quicksilver is 103 flasks, but some production is known to be unrecorded.

The dominant rocks of the area are Triassic slates which are overlain by easterly tilted basalt and rhyolite flows and acid tuffs. The largest quicksilver deposits are in the rhyolite and tuffs, but a small deposit in a diabase dike has been mined.

BUCKSKIN PEAK MINE

Former names....McCormick, McCormick-Dermody.
Location.....Sec. 11, T. 45 N., R. 39 E.
Ownership.....Mrs. Chalmers McCormick, J. Dermody, and Mrs. Julia C. Ward.
Discovery.....1929 by John Dermody.
Production.....About 150 flasks to the end of 1943.
Geologic type.....Opalite.

The Buckskin Peak property, which consists of 18 claims and fractions originally located for gold and silver, is at the summit of Buckskin Peak, the northernmost peak of the Santa Rosa Range, at an elevation of about 8,600 feet. The presence of cinnabar on the peak has been known since as early as 1911,[30] but ore of commercial grade was first recognized in 1929. During parts of 1930 and 1931 the property was leased first to L. A. Friedman and J. H. Causten and later to the Bradley Mining Company, but neither operator did more than a small amount of development and failed to produce any quicksilver. In 1932, following the installation of a pan retort, the owners recovered several flasks of quicksilver; and in 1938 a single-pipe retort yielded 58 flasks from sorted ore. A serious attempt to develop the property was made in 1939 and 1940 by the Buckskin Quicksilver Corporation, controlled by Clarence H. Hall. After doing considerable development, a 64-foot rotary furnace was installed

[29] Lindgren, Waldemar, Geology and mineral deposits of the National mining district, Nevada: U. S. Geol. Survey Bull. 601, pp. 47, 48, 1915.

[30] Lindgren, Waldemar, Geology and mineral deposits of the National mining district, Nevada: U. S. Geol. Survey Bull. 601, p. 51, 1915.

and operated, but in 1941, after producing only 70 flasks of quicksilver, the plant was removed from the property. From 1941 to 1943 the property remained idle.

The principal workings consist of a 560-foot tunnel, two adits that lie above the tunnel and aggregate 420 feet in length, and a short sublevel reached by shafts from the surface and a raise from the tunnel.

The geology and ore deposits are discussed in a bulletin by R. J. Roberts,[31] and the reader is referred to this bulletin for maps of the district. The rocks on Buckskin Peak are Tertiary acidic tuffs and flows which in the vicinity of the mine have been locally converted to several types of opalite. The oldest rocks are rhyolitic tuff and rhyolite, with an aggregate thickness of about 1,000 feet. A blanket of silicified ash and tuff, or opalite, about 50 feet thick overlies the rhyolite and contains all the known ore bodies. The opalite is of variable appearance. Where porous it can be seen to consist of stratified layers of fragments which range in size from coarse ash to coarse pebbles, but finer interstitial ash has apparently been leached out. Where the rock is completely silicified it is massive and nonfragmental in appearance. Interbedded with the silicified tuffs are thin layers of chalcedonic rock whose upper surfaces are in many places cracked. These cracks resemble dehydration cracks, and suggest the thin layers may have had an origin similar to that of some chert or sinter. Much of the cinnabar occurs in, and on, these layers.

The richest ore occurs in widespread nearly flat bedding layers which vary from a fraction of an inch to several inches in thickness. Some cinnabar occurs scattered along fractures and filling openings in the more porous opalite, but in most places this ore is not as rich, nor can it be expected to be as continuous, as are the thinner blankets. Much of the ore as exposed in the underground workings is estimated to contain about two pounds of quicksilver to the ton over a mineable width of five feet. However, as the individual ore layers are relatively thin, hand sorting should yield ore averaging at least 15 pounds of quicksilver to the ton.

CANYON CREEK PROSPECT

Location.....Sec. 13, T. 45 N., R. 38 E.
Ownership.....Unknown.

[31] Roberts, R. J., Quicksilver deposit at Buckskin Peak, National mining district, Humboldt County, Nevada: U. S. Geol. Survey Bull. 922-E, pp. 115–132, 1940.

Production.....Very small.
Geologic type.....Basic dike.

The Canyon Creek deposit is about 13 miles south of McDermitt and just south of the road at the mouth of Canyon Creek. In 1929 it was owned by J. P. Atkinson, H. Bretchel, and C. V. Gutches and leased to Dr. Brooks and E. D. Hicks, but it was idle and apparently abandoned when visited in 1943. The remains of a retort and a small calcine dump indicate a few flasks were recovered from the deposit.

The workings, which consist of two 70-foot adits connected by a 20-foot raise, explore a highly altered diabase dike which strikes N. 15° E. and dips steeply eastward. The walls are fine-grained altered and silicified sedimentary rocks with apparently about the same altitude as the dike. Crystalline cinnabar and chalcedony coat pyrite in a narrow brecciated zone in the dike.

STALL QUICKSILVER PROSPECT

Location.....Sec. 31, T. 45 N., R. 39 E.
Ownership.....F. W. Stall of Sacramento, California.
Discovery.....1913.
Production.....A few flasks.
Geologic type.....Volcanic. (?).

The Stall quicksilver prospect is about seven miles southwest of Buckskin Peak in a canyon that branches southward from Canyon Creek. Soon after the discovery of placer cinnabar in stream gravel in 1913, a shallow shaft was put down in the stream bed. Although the shaft is said to have encountered ore, there is no record of any quicksilver having been recovered at that time. The property was little developed because of its inaccessibility until shortly before 1941 when the Bradley Mining Company took an option, built a good access road, did some exploratory work with a power shovel, but produced no quicksilver. In 1941 the property was leased to H. O. Harris and a Mr. Kissack who installed a 4-pipe retort and produced some quicksilver from sorted ore. The property was idle when visited in August 1943.

The principal underground workings consist of two shafts, said to be 50 feet deep and to connect with short drifts, but these were inaccessible when the property was examined. In the vicinity of the shafts are several surface cuts and short near-surface adits, and high on the ridge about 2,000 feet to the south are two other adits. Because of the alluvial cover these workings offer the only exposures of mineralized rock.

The rocks of the area are silicified and altered rhyolite flows and rhyolitic and glassy tuffs which strike northerly and dip gently eastward. A small steeply inclined fault exposed in one of the cuts strikes N. 15° E. and nearly parallels a buried fault zone which is believed to lie several hundred feet to the east along a line of springs and a topographic swale.

The deposit is tentatively classed as being of the volcanic type, even though most of the rocks are rhyolitic, because of widespread clay alteration and because much of the ore is found along steep fractures. The only ore mineral seen was cinnabar, but native mercury is said to have been panned from the soil. In the workings cinnabar occurs as fracture fillings and as disseminated crystals in rhyolite and altered tuff. The soil in the broad canyon floor pans considerable cinnabar for several hundred yards up canyon from the principal workings. This zone could be further explored most economically by bulldozer cuts trending easterly across the fault zone that is believed to lie to the east of the present workings.

OPALITE DISTRICT

The Opalite quicksilver district begins a few miles west of McDermitt and extends westward along the Oregon - Nevada boundary for about 20 miles. Cinnabar was first discovered in the district by William Bretz in 1917, and his continued prospecting led to the discovery of the ore bodies that were developed into the well-known Bretz and Opalite mines. The total production of these mines is about 25,000 flasks of quicksilver, but as both lie in the Oregon half of the Opalite district they will not be further discussed in this bulletin. In the southeastern, or Nevada, part of the district quicksilver ore was discovered by Tomas Alcorta in 1924, and the Cordero mine, developed on his discovery, may be expected to yield more quicksilver than has any other mine in Nevada. By the end of 1943 it had yielded over 4,500 flasks, and in 1941, 1942, and 1943 it was the largest quicksilver producer in the State.

The geology of the district has been summarized in a bulletin by R. G. Yates[32] as follows:

> The rocks of the district are flat-lying Miocene lavas, ranging from basalt to rhyolite in composition, and overlain by late Miocene tuffaceous lake beds. All these rocks are cut by steep normal faults, which locally have acted as channelways for rising hydrothermal solutions.

[32] Yates, R. G., Quicksilver deposits of the Opalite district, Malheur County, Oregon, and Humboldt County, Nevada: U. S. Geol. Survey Bull. 931-N, p. 319, 1942.

FIGURE 14. One of the Open Cuts of the Cordero Mine, Humboldt County, Nevada.

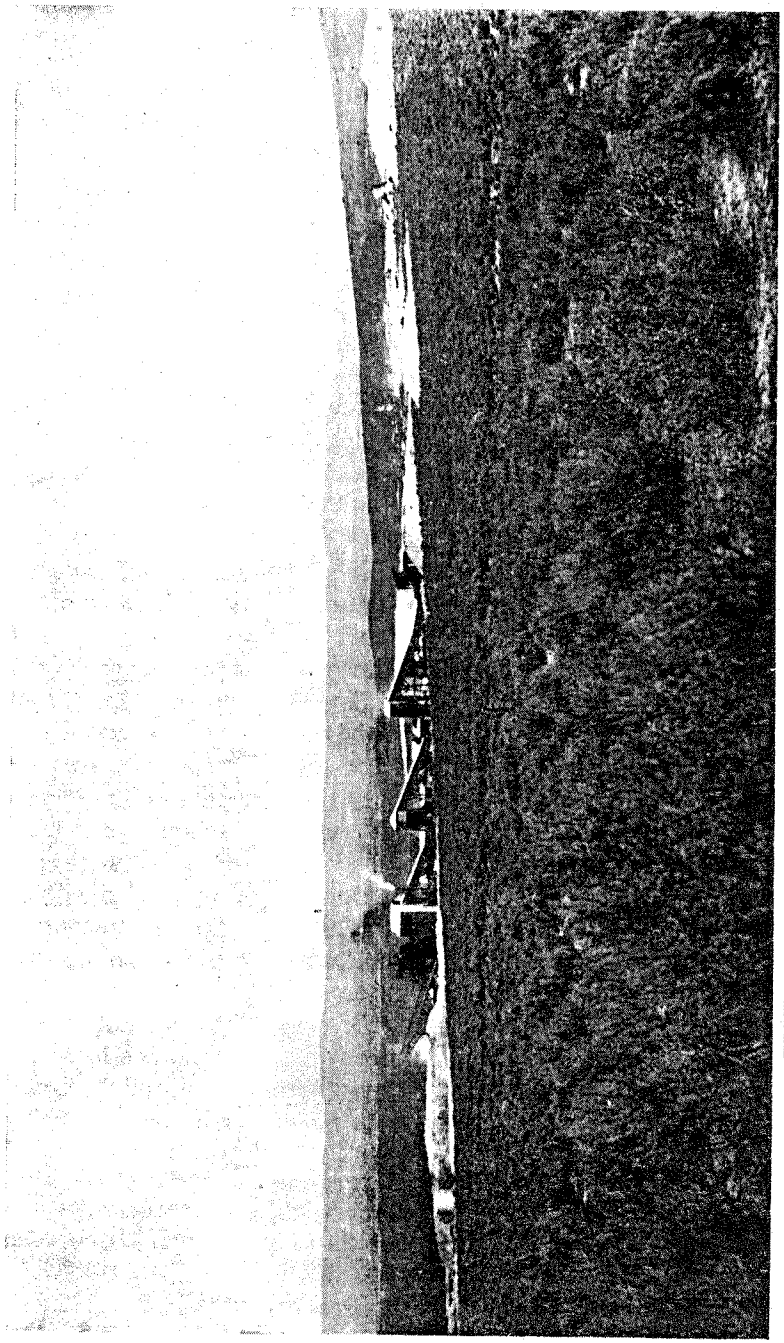

FIGURE 15. Plant of the Cordero Mine, Humboldt County, Nevada.

The tuffs and lake beds were silicified in places by these solutions into lenticular masses of chalcedony, producing a rock locally called "opalite." The ore mineral, cinnabar, occurs partly in these chalcedony zones and partly in unsilicified rocks immediately adjacent to them. All of the ore bodies mined were within 100 feet of the surface.

Since the publication of the report by Yates, deep drilling at the Cordero mine has disclosed ore to depths of about 600 feet in altered felsitic rocks lying beneath irregular masses of opalite.

CORDERO MINE

Former names....McDermitt.
Location.....Secs. 27, 28, 33, and 34, T. 47 N., R. 37 E.
Ownership.....E. Aznarez, T. Alcorta, and J. Ondarez.
Discovery.....1924 by T. Alcorta.
Production.....4,569 flasks to the end of 1943.
Geologic type.....Volcanic and opalite.

The Cordero mine is about 13 miles southwest of McDermitt on the north end of a low range of hills which lie on the east side of the Quinn River Valley. The original locators did only scattered surface exploration, but in 1935 the property was leased by the Bradley Mining Company who sank a 50-foot shaft and drove several hundred feet of underground workings. However, this company recovered only 45 flasks of quicksilver from scattered pockets of rich ore and soon gave up their lease. Following this activity the property remained idle until 1940 when it was leased by the Cordero Mining Company, a subsidiary of the Sun Oil Company of Pennsylvania. The Cordero company installed a 14-foot 12-hearth Herreshoff furnace in 1941, and under the able management of D. Ford McCormick was the largest quicksilver producer in Nevada in 1941, 1942, and 1943.

The mine workings consist of six open pits and about 3,000 feet of underground workings. Most of the ore bodies have been first found by surface drilling, then further explored by underground workings, and finally mined by open-pit methods. Deep drilling has revealed ore to depths of 600 feet, and much of the future mining will be done by underground methods. In January 1944 a proposed 600-foot shaft had reached a depth of 385 feet and levels had been started at depths of 75 and 175 feet. (See Plate 9.)

The rocks of the Cordero mine area comprise a thick heterogeneous section of Tertiary volcanics, but because of the thick alluvial mantle their sequence has not yet been worked out in detail. The younger volcanic rocks exposed in the workings are glassy tuffs and flows, whereas the older rocks are mostly felsite agglomerates with a few interlayered rhyolite flows. These volcanics strike northeasterly and are inclined from 20° to 60° to the northwest. They are unconformably overlain by post-mineral Pleistocene (?) alluvium and Recent alluvium and slope wash.

The only outcrops in the area are knobs of opalite formed from the more acid of the volcanic rocks lying near the top of the exposed sequence. The opalite, which is predominantly quartz and chalcedony, is most abundant along and above the ore-bearing zones and dies out laterally and in depth. Locally it contains enough cinnabar to be mineable ore.

Nearly all of the felsitic rocks have been extensively converted to clay minerals, and in places some of the rhyolitic rocks are similarly altered. Spherules, which are quite generally the sole textural feature visible in the more altered rocks, are of importance in their correlation. They are as yet incompletely studied, but appear to be of two kinds. Those of one kind range in size from half an inch to one inch in diameter, are somewhat oblate, and doubtless represent spherulites that were present in the unaltered rock. Those of the second kind are generally slightly smaller and in most places are confined to heavy clays along fault zones. They appear to be secondary growths in the clay and as such are induced rather than original features which might otherwise be used in correlating the altered volcanic rocks.

Two significant structural features are exposed in the pits and the underground workings. One, a well-defined system of northeasterly trending steep faults, has perhaps served as throughgoing channelways for the mineralizing solutions. The second structure, a combination of favorable beds and minor faults, has likewise guided the rising solutions, for it is characterized by abundant iron oxides, other alteration products, and spherulitic textures.

Cinnabar is the only commercially important ore mineral, but native mercury and oxychlorides of mercury are locally abundant. For the most part the cinnabar occurs as disseminated crystals in altered volcanic rocks or in opalite, but a small amount is found as veinlets or solid masses. The associated minerals are quartz, chalcedony, opal, pyrite, hematite and other iron oxides, jarosite, alunite, and clays. Flourite and heulandite have been found in some of the more altered rocks.

Three kinds of ore have been mined. These kinds, which are

all gradational, may be separated as follows: first, small high-grade bodies in or below fault zones and below opalite masses; second, large ore bodies containing disseminated cinnabar in altered volcanic rocks; and, third, large but low-grade bodies in opalite. Of these, the opalite ore has probably been of the least commercial importance. The new ore body explored by drilling has not been studied, but specimens showing clots of finely crystalline pyrite surrounded by rims of slightly larger cinnabar crystals suggest it is fairly typical of ores from deposits of the volcanic type.

The control for the deposition of the cinnabar is obscure. In general, the majority of the ore has come from areas lying below opalite masses or from the base of the opalite itself. Seemingly, the early mineralization consisted mostly of silicification and formed opalite bodies which later acted as partial "cap rocks"[33] for the rising quicksilver solutions.

The ore bodies mined in the past have come from shallow depths, but the discovery of ore to depths of 600 feet is encouraging to those who believe that a quicksilver ore body is not necessarily shallow just because it occurs in Nevada. Although the drilling program is not completed, the new ore body appears to be of sufficient grade and extent to be profitably mined even at expectable postwar quicksilver prices.

DISASTER PEAK PROPERTY

Former names....Nevada Cinnabar Group.
Location.....Sec. 10, T. 47 N., R. 34 E.
Ownership.....Harry Bretchel and G. F. Schaefer.
Discovery.....1939.
Production.....None.
Geologic type.....Opalite.

The Disaster Peak property is a group of nine claims located about 22 miles west of McDermitt near the base of Disaster Peak. Apparently the prospect was originally developed in 1940 and 1941 by Stive Crutcharray and P. Apesteguy. Development in 1942 consisted of a northeasterly trending 95-foot adit and a second 32-foot adit lying about 25 feet above. The workings explore silicified volcanic rocks which contain some cinnabar.

POTOSI DISTRICT

GETCHELL GOLD MINE

The Potosi gold-tungsten district, which contains the well-known Getchell mine, lies about 30 miles north of Golconda on

[33] Schuette, C. N., Occurrence of quicksilver ore bodies: Amer. Inst. Min. and Met. Eng., Tech. Pub. No. 335, pp. 5–88, 1930.

the east flank of the Osgood Range. No quicksilver has as yet been recovered in the district, but the association of minor amounts of cinnabar with the ore of the Getchell mine is of interest.

The Getchell mine area contains metamorphosed Paleozoic sediments invaded by a granitic batholith of supposed Jurassic age; Tertiary igneous rocks in the area consist of andesitic, and possibly also rhyolitic, flows and dikes. The gold ores occur in an erratically silicified shale and gouge zone overlying a bed of metamorphosed limestone. The mineralization is believed by Hardy[34] to have occurred during two periods. The first period of mineralization, which introduced silica, pyrite, arsenopyrite, and gold, is believed to be of early Tertiary age; whereas the second period, which formed gold-free arsenic ores containing minor quantities of antimony, has been dated as late Tertiary. The cinnabar specimens that have been seen contain only thin films and inclusions of cinnabar in coarse calcite crystals; presumedly the cinnabar was deposited during the later arsenic and antimony mineralization.

POVERTY PEAK DISTRICT

The Poverty Peak district, as used herein to designate an area including several quicksilver deposits, is in the northern part of the Hot Springs (Paradise) Range about 12 miles south-southeast of Paradise Valley. The rocks of the district are dominantly interbedded Triassic (?) limestone and quartzite which are locally folded, faulted, and cut by many quartz and calcite veins. The ore is usually high grade and is localized in limestone and calcareous quartzite along poorly developed bedding plane faults and satellitic transverse fractures. The production of the district, from its discovery in 1936 through 1943, is about 700 flasks of quicksilver. This production came mostly from the Cahill mine, but other deposits were being actively developed in 1943.

CAHILL MINE

Location.....Sec. 14 (?), T. 40 N., R. 40 E.
Ownership.....Mrs. Dorothy Cahill of Reno.
Discovery.....1936 by Jack Cahill.
Production.....545 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone.

The Cahill property, consisting of six unpatented claims lying a few hundred feet above the valley on the west slope of the Hot

[34] Hardy, Roy A., Geology of the Getchell mine: Min. Tech. (A. I. M. E.) Tech. Pub. 1240, pp. 1–4, 1940.

FIGURE 16. Plant of the Cahill Mine, Humboldt County, Nevada.

Creek Range, was developed between 1936 and 1940 by Jack Cahill, but for a part of 1938 was under lease to J. O. Greenan and T. L. Oddie. A 10-ton Gould rotary furnace installed in November 1939 yielded during the following year 490 flasks of quicksilver. E. T. Fischer and T. L. Chapman took a lease and option early in 1941 and, in spite of a costly fire which necessitated extensive repairs to the furnace and building, recovered 55 flasks of quicksilver. The property reverting to its owner in the latter part of the year, remained inactive until the fall of 1943 when the Cordero Mining Company working under a lease and option did some development work. Early in 1944 the property was leased to J. W. Hicks and George Johnson who mined ore from the deeper levels. The furnace on the property is still in good condition, and a study of the geology does not indicate the mine is exhausted.

The mine contains about 2,000 feet of workings, most of which are on two levels about 50 feet apart. (See Plate 10.) A fairly continuous ore body has been stoped from above the upper level to below the haulage level, a vertical distance of nearly 100 feet. Because of the relatively flat inclination of the stope, however, its pitch length is nearly 200 feet, whereas the stope width averages about 40 feet.

Cinnabar was localized beneath a narrow gouge zone lying along a fault which for the most part is parallel to beds of limy quartzite and recrystallized sandy dolomite. The fault is locally multiple and in places dies out only to reappear a few feet above or below; the displacement is obviously small. The plan of the fault is arcuate, and ore bodies were localized where it rolls in strike toward its footwall forming an "inverted trough" which would be effective in guiding and concentrating rising solutions. The ore in part occurred as nearly pure cinnabar veinlets filling openings along, and close beneath, the fault; but the richest ore occurred as pods resulting from replacement of highly fractured silicified dolomite and extended several feet into the footwall. Locally, minor quantities of stibnite accompany the ore.

Exploration following the "inverted trough" portion of the fault at greater depth would offer the best chance for finding new ore bodies.

HAPGOOD MINE

Former names....Grayson Group.
Location.....Sec. 11 (?), T. 40 N., R. 40 E.
Ownership.....T. C. Hapgood, F. T. Johnson, and O. L. Cash.
Discovery.....1937 by T. C. Hapgood.

Production.....104 flasks to the end of 1942.
Geologic type.....Interbedded sediments—limestone.

The Hapgood mine on the Grayson group of six unpatented claims is about two miles southwest of Poverty Peak and a mile northeast of the Cahill mine. In 1937, soon after discovering the property, T. C. Hapgood formed a partnership with the other two owners, and, following the erection of a 2-pipe inclined retort, 66 flasks of quicksilver were recovered in 1939–1940. In 1941 the property was leased to E. T. Fischer and T. L. Chapman who did further development and produced 38 flasks. Early in 1942 the lessees turned the property back to the present owners.

The principal working is a haulage level which with its two branches totals about 500 feet in length. A mineralized fault cut about 120 feet from the portal has been followed below the haulage level to a depth of 34 feet, and above this level to the surface, a distance of 75 feet. In 1943 an adit was being run to intersect the ore 30 feet below the haulage level.

The rocks consist of half-a-foot to two-foot beds of sandy limestone with thin interbeds of shale; they strike N. 45° E. and dip about 45° to the northwest. Cinnabar occurs along several closely spaced parallel bedding plane shears as veinlets, and locally forms isolated bunches in the limestone away from the shears. Associated minerals include calcite, quartz, gypsum, and some clay.

HOLT PROPERTY

Location.....Sec. 24, T. 41 N., R. 40 E.
Ownership.....Ralph Holt of Paradise.
Discovery.....Unknown.
Production.....None.
Geologic type.....Interbedded sediments.

The Holt property consists of four claims, the Red Hope, Bronco, XX, and XXX claims, located five miles north and a little east of the Cahill mine. It has no recorded production and was not visited by the writers.

Development is reported to consist of a 70-foot adit and two shallow shafts. The cinnabar is said to be disseminated in soft sedimentary rock, and, although the property may possibly contain a large low-grade deposit, no ore of retort grade has been found.

PRENTISS PROPERTY

Location.....Sec. 11, T. 40 N., R. 40 E.
Ownership.....Mr. and Mrs. C. R. Prentiss of Paradise.
Discovery.....1940.

Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Prentiss property consisting of nine claims is on the west slope of Poverty Peak a little more than a mile north of the Cahill mine. It is developed by several trenches and two shafts about 30 feet deep.

Cinnabar forms crystalline veinlets with calcite and some quartz, and occurs also as scattered isolated crystals in limestone and calcareous quartzite. The best ore, which can be sorted to retort grade, was found along bedding shears striking N. 10° W. and dipping steeply eastward.

SNOWDRIFT PROPERTY

Location.....Sec. 1, T. 40 N., R. 40 E.
Ownership.....W. O. and Robert Zilkey, and Joe Legarza.
Discovery.....1940.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Snowdrift property lies on the northeast slope of Poverty Peak with the principal development about 100 feet below the summit. A few months after the discovery of the property in February 1940 it was leased by N. H. Getchell who built a steep road to the main adit. This adit extends 73 feet into the hill exploring sandy limestone and shale which strike northeasterly and dip 45° to the northwest. Small amounts of cinnabar occur as crystalline bunches in calcite veinlets, but no real ore body had been exposed by 1943. A second adit 23 feet long, said to lie on the west side of the Peak, was not examined.

TURILLAS PROPERTY

Location.....Sec. 11 (?), T. 40 N., R. 40 E.
Ownership.....Frank Turillas of Paradise.
Production.....None.
Geologic type.....Interbedded sediments—sandstone.

The Turillas property, consisting of seven claims and fractions, lies north and west of the adjoining Cahill property. It has been held for several years, but not until after the claims were purchased by F. Turillas in 1940 were they developed. Development has exposed ore in several places on the property, but work in August 1943 was confined to an area on the northwest side of the Cahill mine spur. Here four shallow trenches explore a mineralized zone about 100 feet long and perhaps 20 feet wide, and two adits were being driven to intersect the zone at a depth of about 75 feet.

The rocks consist of silicified limestone, quartzite, and phyllite trending northeasterly and dipping steeply both to the northwest and southeast. The more limy sediments are cut by numerous irregular veinlets of calcite and quartz.

Cinnabar in the surface workings occurs as large isolated crystals, as narrow veinlets, and in lesser amounts as small disseminated crystals. Most of the ore is confined to brecciated bedding shears and crush zones, but some good ore also fills cross fractures. The ore is easily sorted to good retort grade.

WHOLEY'S QUICKSILVER MINE

Former names....Long Horn Group.
Location.....Sec. 11 (?), T. 40 N., R. 40 E.
Ownership.....J. C. Wholey of Winnemucca and partner.
Discovery.....1939 by J. C. Wholey.
Production.....14 flasks to the end of 1942.
Geologic type.....Interbedded sediments—limestone.

The Wholey quicksilver mine lies north of the Turillas property and west of the Hapgood property, about a mile north of the Cahill mine. A 4-pipe retort was installed in 1941 and during the same year 14 flasks were recovered from ore mined in a small open cut and stope. An adit driven from the retort site extended southward about 160 feet, and irregular workings containing a small stope extend up from it to the open cut.

Cinnabar occurs as veinlets and crystals along bedding faults that strike northerly and dip to the west in the surface workings. The ore lends itself to sorting to retort grade.

RED BUTTE DISTRICT

The Red Butte copper-antimony district lies about 25 miles northwest of Jungo on the west flank of the southern part of the Jackson Mountains. A small cinnabar deposit lying a few miles southwest of the district was known as early as 1909,[35] but development work in 1941 and 1942 failed to expose other than scattered pockets of ore.

RATTLESNAKE CANYON PROSPECT

Location.....Sec. 34, T. 38 N., R. 30 E.
Ownership.....Unknown.
Discovery.....Prior to 1909.

[35]Ransome, F. L., Notes on some mining districts in Humboldt County, Nevada: U. S. Geol. Survey Bull. 414, p. 30, 1909.

Production.....Very small.
Geologic type.....Interbedded sediments—limestone.

The Rattlesnake Canyon prospect is in a canyon of the same name on the west flank of the southern end of the Jackson Mountains about 20 miles northwest of Jungo and 20 miles north-northeast of Sulphur. The property was apparently abandoned when it was visited in August 1943, and little is known of its past history. In 1941 and 1942 it was owned by Walter L. Low who installed a small retort and recovered several flasks of quicksilver. Mr. Low reports that the property was developed before he owned it.

The workings lie on two hills that are about 200 yards apart. On the eastern hill a 50-foot shaft, a 20-foot shaft, and three trenches explore different shear zones. On the western hill the workings consist of a 50-foot shaft and two small trenches.

Most of the area is covered by a mantle of alluvium. The workings on the western hill explore thin andesite breccia dikes that transect gray, thin-bedded limestone. The workings on the eastern hill appear to lie wholly within an igneous breccia which contains fragments and boulders of limestone.

The only ore mineral observed was cinnabar, but native mercury is reliably reported to have been found. The cinnabar fills fractures in the igneous rocks adjacent to small shear zones, is disseminated in the shear zones, and forms rounded "strawberries" in the open cracks. Associated minerals include pyrite, hematite, calcite, dolomite, various clays, and several copper minerals.

SULPHUR DISTRICT

The Sulphur district lies on the northwest slope of the Kamma Mountains about two miles southeast of Sulphur station on the Western Pacific Railroad. The district is noteworthy for having produced considerable sulfur from deposits shown to white men by Indians in the 1870's. In 1882 the deposit is reported by Russell[36] to have been producing six tons of sulfur a day, and it seems likely that the closely associated cinnabar was recognized at that time. The occurrence of cinnabar with sulfur and alum was recorded by Adams[37] in 1904, but no attempt was made to recover quicksilver until 1941. The quicksilver production of the district is very small.

[36]Russell, I. C., Sulphur deposits in Utah and Nevada: N. Y. Acad. Sci. Trans. 1, pp. 168–175, 1882.
[37]Adams, G. I., The Rabbit Hole sulphur mines near Humboldt House, Nevada: U. S. Geol. Survey Bull. 225, pp. 497–502, 1904.

NEVADA SULPHUR COMPANY MINE

Location.....Sec. 36, T. 35 N., R. 29 E.
Ownership.....Nevada Sulphur Company, S. H. Beetem principal stockholder.
Discovery.....Sulfur in the 1870's; cinnabar prior to 1904.
Production.....25 flasks to the end of 1943.
Geologic type.....Sulfurous.

Although sulfur has been recovered at the mine of the Nevada Sulphur Company since the late 1870's and the presence of cinnabar was early noted, no attempt was made to mine the ore for quicksilver until 1941. In that year Messrs. Hansen, Reed, and Otto C. Miller erected a small 2-pipe retort but failed to produce any quicksilver. Late in 1942 George Kellogg, Barnes, and S. H. Beetem bought the property, and early in 1943 the ground was leased to C. D. and J. D. Edmondson who, after recovering several flasks in the retort, were installing a 15-ton furnace in August 1943.

The old sulfur mine consisted of several large glory holes and extensive underground workings driven for haulage and to explore the rock beneath the glory holes. Only a few crosscuts and shallow trenches were made by the quicksilver miners in order to better expose the cinnabar ore encountered during the sulfur mining.

The rocks consist of Tertiary interbedded rhyolite agglomerates and tuffs which are locally silicified and impregnated with sulfur and some alum, and still more locally coated and filled with cinnabar. The beds are nearly flat, but a short distance north of the mine they dip gently to the south. In the area containing the principal workings considerable alluvium mantles the "incipient opalite."

Finely crystalline cinnabar occurs as sugary coatings around fragments of both unsilicified and silicified tuff and agglomerate in several places. Only in a few small areas was the cinnabar seen to be disseminated through the silicified tuffs forming typical opalite ore. That the cinnabar is later than the sulfur is indicated by thin coatings of cinnabar in small vertical tubules in the sulfur.

WINNEMUCCA DISTRICT

The Winnemucca district lies on Winnemucca Mountain about five miles northwest of Winnemucca. Various gold-silver-copper-lead mines in the district have been intermittently active since the early 1870's, and Lindgren in 1915 reported the occurrence of cinnabar in one of the veins.[38] The cinnabar was found on the west side of the mountain at an elevation of about 6,000 feet in irregular stockworks of calcite veins cutting Triassic slates, and an assay of the cinnabar-bearing rock yielded a trace of gold and one-third of an ounce of silver to the ton. In 1942 Paul Langworthy was reported to hold 13 claims of cinnabar ground in the Winnemucca district.

UNNAMED DISTRICT

In the northern end of the Sonoma Range about five miles southeast of Winnemucca are two small cinnabar prospects which have never been developed to the producing stage.

GAYER-MOO PROPERTY

Location.....Sec. 1, T. 35 N., R. 38 E.
Ownership.....Unknown.
Production.....None.
Geologic type.....(?).

The Gayer-Moo quicksilver property is about one mile southwest of the Harmony mine and about five miles southeast of Winnemucca; it adjoins the Plymouth claims. The property reportedly is little developed and has not been visited. In 1941 it was owned by James Gayer and R. W. Moo of Oakland, California, and was leased to the Greenan Quicksilver Company.

The ore is said to occur in a wide dike of rhyolite which cuts sandstone, grit, and quartzite breccia.

PLYMOUTH PROPERTY

Former names....O'Leary Quicksilver.
Location.....Sec. 1, T. 35 N., R. 38 E.
Ownership.....F. R. O'Leary of Winnemucca.
Discovery.....1929 by Bob Beko (?).
Production.....None.
Geologic type.....(?).

The Plymouth property consists of two claims which lie in a small canyon between Harmony and Water Canyons about five miles southeast of Winnemucca. It was originally purchased by F. R. O'Leary in 1940 from the Southern Pacific Railroad, but the only systematic exploration was done in 1941 when the Greenan Quicksilver Company held an option on the property. In 1942 R. H. Williams, T. C. Hapgood, and Andrew Blair were reported to have built a road to the property.

[38] Lindgren, Waldemar, Geology and mineral deposits of the National Mining district, Nevada: U. S. Geol. Survey Bull. 601, p. 15, 1915.

Scattered short adits explore mildly metamorphosed sandstone, grits, and easterly trending silicified and altered dikes of rhyolite. Cinnabar is said to occur as scattered pods and veinlets in the altered dikes, and Mr. O'Leary reports that 600 pounds of ore from the property yielded six pounds of quicksilver when treated in a small retort.

LANDER COUNTY

Lander County contains the Wild Horse district, which has yielded 992 flasks of quicksilver, and at least two other small quicksilver deposits. In the Wild Horse district quicksilver was first recovered in small amounts in 1919–1920 at the McCoy mine, but most of the production has come from the nearby Wild Horse deposit discovered in 1939 and worked in 1940–1941 by H. W. Gould & Co. In 1943 all of the mines were essentially idle.

WILD HORSE DISTRICT

The Wild Horse district is in the western part of Lander County, a few miles southeast of the common corner of that county with Pershing and Churchill Counties. The district is accessible only by unimproved roads. The presence of cinnabar ore in the district has been known since about 1916, but little ore was treated until 1940. In that year and in 1941, deposits discovered in 1939 and mined to apparent exhaustion by the Wild Horse Quicksilver Mining Co., yielded 883 flasks, but since then only a small amount of mining has been done.

The geology and ore deposits of the district are discussed in a report by C. H. Dane and C. P. Ross, and the reader is referred to this report for geologic maps and a more complete description of the deposits.[39] In brief, the district is underlain by moderately deformed sandstone, shale, and limestone of Lower and Middle Triassic age locally covered by remnants of a mantle of Tertiary fanglomerate, tuff, and lava. The Triassic rocks are partly silicified, and cinnabar has been found in and near silicified rock, particularly the silicified limestone at the base of the Middle Triassic. The ore bodies so far discovered were individually small and ill-defined, and had an average tenor of less than 0.5 percent of quicksilver. Other similar ore bodies doubtless exist at moderate depths, but the cost of finding them may, perhaps, prove excessive.

McCOY MINE

Former names....Ruby Group, Quicksilver Mines Co., Liquid Metal.
Location.....Sec. 15, T. 23 N., R. 40 E.
Ownership.....R. and F. Quicksilver Corporation.
Discovery.....1916 (?).
Production.....109 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone.

[39] Dane, C. H., and Ross, C. P., The Wild Horse quicksilver district, Lander County, Nevada: U. S. Geol. Survey Bull. 931-K, pp. 259–278, 1942.

The McCoy property, consisting of a group of 17 claims, is in the northern end of the Wild Horse district about a mile north of the Wild Horse quicksilver mine. Early records report cinnabar to have been treated in a retort on the Ruby group in 1918 by the Quicksilver Mines Company; production for 1919 to 1920 was recorded at 78 flasks recovered from 12 Johnson-McKay retorts, and small amounts of quicksilver were produced by this company until the end of 1925. In 1929 the Imperial Development Company took over the property but produced no quicksilver. In 1931 T. A. Ray and B. McCoy renamed the property the Liquid Metal mine, and operating until 1934 they produced about 31 flasks of quicksilver. In 1936 the Quicksilver Corporation of America acquired the property, and although they did some development work produced no quicksilver and finally went bankrupt. The property was reportedly idle in 1943.

The development consists of about 1,000 feet of scattered adits and drifts, a vertical shaft near the top of the ridge southwest of the camp, a 65-foot inclined shaft close to a gulch near the upper camp buildings, and several small scattered excavations.

The rocks of the area consist of Lower and Middle Triassic sandstone and shale. Cinnabar occurs as fracture fillings and as crystals in calcite veins in the sandstone and in sandy interbeds in the shale. Moderately rich ore is said to have been taken from some of the workings, but most of the material that remains in sight is of low grade.

WILD HORSE MINE

Location.....Sec. 20, T. 23 N., R. 40 E.
Ownership.....Wild Horse Quicksilver Mining Company, a subsidiary of H. W. Gould & Co.
Discovery.....1939 by Clyde Garrett.
Production.....883 flasks to the end of 1943.
Geologic type.....Interbedded sediments—silicfied limestone.

The Wild Horse property consists of 14 claims in the southern part of the Wild Horse district. In the latter part of the year of discovery the property was sold to the Wild Horse Quicksilver Mining Company. In 1940 a 30-ton rotary furnace was installed, and during this year and in 1941 it yielded 883 flasks of quicksilver. Following this brief period of activity the furnace was removed, and the property has remained idle through 1943.

The principal workings consist of four small glory holes and about 2,000 feet of underground workings, most of which served as haulageways for ore mined in the glory holes.

Nearly all of the ore mined to date has come from silicified Middle Triassic limestone varying from 20–30 feet in thickness and overlain by a reddish shale, but some cinnabar is sparsely scattered through Lower Triassic sandstone beneath the limestone. The local structure is a southward plunging anticline that is cut along its crest by small northerly trending faults and fractures which have apparently formed the locus for ore deposition.

Cinnabar occurs in limestone as scattered coarsely crystalline aggregates, and in silicified sandstone as crusts in fractures and between original clastic grains. Some has filled cavities in the silicified limestone and in many places, particularly the richer spots, part of the cinnabar is pulverulent. The minerals associated with the cinnabar are calomel, pyrite, quartz, calcite, barite, and small amounts of stibnite.

UNNAMED DISTRICT

RAST PROPERTY

Former names....Valley View (?).
Location.....Sec. 27 (?), T. 21 N., R. 45 E.
Ownership.....H. W. Rast of Austin.
Discovery.....1932 by Gus Laurent (?).
Production.....None.
Geologic type.....Interbedded sediments—limestone and quartzite.

The Rast property, a group of six claims, is half a mile south of the Callahan Ranch, 18 miles northeast of Austin, and on the east slope of the Toyabe Range. An early attempt to open up a cinnabar deposit in this area was made in 1932 by Gus Laurent who located the nine Valley View claims. This early discovery, made near an unsuccessful gold camp called "Burro," is believed to be the same as the deposit later located by Rast.

Reportedly, Rast has sunk a 50-foot shaft in quartzite and limestone, although the workings on the property located by Laurent in 1932 consisted only of scattered trenches and pits, none greater than five feet deep.

Placer cinnabar has been found in the soil around the underground workings and small amounts have been found as detrital grains in joints in the underlying bedrock. Laurent is reported, however, to have found rich specimens of cinnabar containing abundant native mercury in rock he believed to be in place.

UNNAMED DISTRICT

WARM SPRINGS PROSPECT

Location.....Sec. 24 (?), T. 27 N., R. 43 E.
Ownership.....1939–1941 by Ben Payne and John Laborde.

Discovery.....Unknown.
Production.....Very small.
Geologic type.....Volcanic.

The Warm Springs prospect is a few hundred yards west of the Nevada Highway 8A about 33 miles south of Battle Mountain. It is believed that a few flasks of quicksilver were produced from ore treated in a now abandoned 2-pipe Rossi-type retort, but the property was idle when visited in 1943.

The workings consist of a 20-foot shaft and connecting 50-foot drift and several shallow trenches.

The deposit is on an isolated hill on the edge of a broad valley filled with alluvium. The hill consists of locally fractured and altered rhyolite and rhyolitic tuff, and it is bordered by several hot springs.

The largest amount of cinnabar seen on the property was that which formed a narrow vein developed by the shaft. It occurs along a fault of small displacement which strikes N. 85° E. and dips 85° south. The associated minerals are pyrite, barite, chalcedony, jarosite, and a yellow mineral which is believed to be eglestonite, for it darkens rapidly on exposure to sunlight.

LINCOLN COUNTY

No quicksilver has been recovered from Lincoln County, but in the Tem Piute district several cinnabar claims have been located.

TEM PIUTE DISTRICT

The Cammon Mining Company is said to have located five cinnabar claims in the Timpahute Range in 1941. Reportedly the underground workings consist of an 80-foot shaft and a 60-foot adit.

LYON COUNTY

No quicksilver properties or occurrences of quicksilver minerals in Lyon County are known to the writers.

MINERAL COUNTY

The most productive quicksilver area in Mineral County is the Pilot Mountains district just east of Mina. This district includes at least 16 mines and prospects with the Mina Development Company and Drew mines as the large producers. Several small mines have been developed in other parts of Mineral County, but by 1943 they had yielded only small amounts of quicksilver. Of the more than 5,000 flasks produced in the county, all but 200 flasks came from the mines in the Pilot Mountains district.

CEDAR MOUNTAIN DISTRICT

The Cedar Mountains district is 22 miles northeast of Mina and has been important in the past as a silver-lead district containing small amounts of gold, zinc, and quicksilver ores. The quicksilver ore has been found in greatest abundance in altered Tertiary volcanic flows at the Lou prospect in the central part of the district, but it is also reported to have been found in the northern part of the district.

LOU PROSPECT

Former names....Murphy Lease, Costa, Red Cap (?).
Location.....Sec. 6 (?), T. 8 N., R. 36 E.
Ownership.....J. Costa of Simon.
Discovery.....1939 (?) by J. Costa.
Production.....Very small.
Geologic type.....Volcanic.

The Lou property consists of a group of four claims in the north end of the Cedar Mountains about three miles north of Simon. Little is known of its past history, but the cinnabar is said to have been first discovered by Costa while panning for gold. In 1942 J. D. Murphy held a three-year lease on the property and produced several flasks of quicksilver from a 2-pipe Rossi retort.

Development consists mostly of about 150 feet of underground workings including a short adit, a winze, and a sublevel. In addition, five scattered open cuts are above these workings.

The country rock consists of argillized andesite overlain by silicified rhyolite. Pyrite-bearing quartz veins that cut the altered volcanic rocks have been mined for gold in the past, but the discovery of cinnabar along a vertical northerly trending fault led the owners to renewed exploration which resulted in the finding of local high-grade lenses of cinnabar. Other small faults

exposed in the pits above the workings contain small quantities of cinnabar.

PILOT MOUNTAINS DISTRICT

The Pilot Mountains district is in the southeastern part of Mineral County, and all of the mines are readily accessible by road from Mina. Cinnabar was first discovered in mineable amounts in 1913 at the Lost Steer mine, and intermittent production to the end of 1943 has yielded about 5,000 flasks of quicksilver.

Sedimentary and volcanic rocks of Mesozoic age which underlie most of the area are in places overlain and intruded by Tertiary volcanic rocks. The sedimentary formations include the Middle Triassic Excelsior formation, the Upper Triassic Luning formation, and the Lower Jurassic Dunlap formation.[40] Early Jurassic thrust faulting and Tertiary (?) normal faulting produced moderately complicated structures in the district.

Cinnabar, the only important ore mineral, has been found in rocks belonging to each of the sedimentary formations. The most productive mine in the district—the Mina Development Company mine—lies in a thick bed of limestone and is classed as belonging to the limestone type of deposit. Most of the other mines of the district, which together have not equalled the production from the Mina Development Company mine, are classed as belonging to the interbedded sediments type of deposit. Their ore bodies are smaller, but are generally rich enough to be treated in retorts; they are mostly localized beneath, or along, small normal faults.

Some of the mines have small amounts of high-grade ore in sight, and development work along the controlling structures may be expected to lead to the discovery of other small, but rich, ore bodies.

The deposits of the Pilot Mountains have been described by various writers including Knopf,[41] Ransome,[42] Foshag,[43] and Phoenix and Cathcart.[44] The general stratigraphy of the area has been described by Muller and Ferguson.[45]

[40] Muller, S. W., and Ferguson, H. G., Mesozoic stratigraphy of the Hawthorne and Tonopah quadrangles, Nevada: Geol. Soc. America Bull., vol. 50, pp. 1573–1624, 1939.

[41] Knopf, Adolph, Some cinnabar deposits in western Nevada: U. S. Geol. Survey Bull. 620, pp. 59–62, 1916.

[42] Ransome, F. L., Quicksilver: U. S. Geol. Survey Mineral Resources, 1917, pt. 1: pp. 417, 418, 1921.

[43] Foshag, W. F., Quicksilver deposits of the Pilot Mountains, Mineral County, Nevada: U. S. Geol. Survey Bull. 795, pp. 113–123, 1927.

[44] Phoenix, D. A., and Cathcart, J. B., Quicksilver deposits of the Pilot Mountains, Mineral County, Nevada: U. S. Geol. Survey Bull. (in preparation).

[45] Muller, S. W., and Ferguson, H. G., *op. cit.*

ALLEN MINE

Former names....Spring.
Location.....Sec. 20, T. 6 N., R. 36 E.
Ownership.....The estate of E. Allen, Mina, Nevada.
Discovery.....1929.
Production.....48 flasks to the end of 1943.
Geologic type.....Interbedded sediments—sandstone.

The Allen mine is about half a mile south of the Hitt mine in a small canyon that branches west from Dunlap Canyon. Since its discovery in 1929 the ground has been worked intermittently by Allen and others who have retorted ore in a small D retort.

The mine workings consist of two adits, one of which is about 150 feet west of the other and on about the same level, and 510 feet of drifts, crosscuts, and stopes.

The workings have been driven in sandstone and conglomerate of the Dunlap formation. The easterly adit explored a steep northwesterly trending fault zone, and a stope extends up to the surface along this fault. The ore bodies are localized at the intersection of two normal faults and also occur as smaller bodies in the main fault. They consist mostly of small bunches of crystalline cinnabar with which is associated calcite, pyrite, barite, and clay.

BETTY MINE

Former names....Betty and Messenger, Red Wing.
Location.....Sec. 23, T. 6 N., R. 36 E.
Ownership.....H. Betty and E. Messenger of Mina.
Discovery.....Prior to 1918.
Production.....109 flasks to the end of 1943.
Geologic type.....Interbedded sediments—chert.

The Betty property on the south flank of the Pilot Mountains at an elevation of about 8,500 feet is believed to have been first located by H. Betty and E. Messenger some time prior to 1918. Little is known about the subsequent history of the mine, although it is reported to have been leased at various times since its discovery. Aside from a production of 29 flasks for the years 1926–1927 and 46 flasks for 1940–1941, the property has had a small annual output.

The underground workings consist of about 570 feet of drifts and crosscuts on two levels that are connected with a stope to the surface.

The rocks in the vicinity consist of folded chert and chert conglomerate of the Excelsior formation. Above the mine workings thick beds of hornblende andesite and other altered volcanic rocks

overlie these cherts. Two nearly vertical normal faults with northerly trend cut the chert and have formed breccia zones of from half a foot to two feet in width.

Crystalline cinnabar forms high-grade lenses in the porous breccia of the faults and fills small fractures in the more broken chert. Locally, mineralizing solutions have migrated out from the fault and deposited cinnabar along bedding shears in the chert.

BLACK LIZARD PROSPECT

Former names....Sullivan's property, Sullivan and Cornelius.
Location.....Sec. 34, T. 6 N., R. 36 E.
Ownership.....C. E. Sullivan and L. E. Cornelius of Mina.
Discovery.....1940 by Sullivan.
Production.....Small.
Geologic type.....Interbedded sediments—chert.

The Sullivan property consisting of two claims is located at the head of Dunlap Canyon about two and a half miles south of the Reward mine. The claims were located in 1940 and several flasks of quicksilver were produced from a 2-pipe D retort in 1941. The prospect was being worked on a small scale in 1943.

The workings, consisting of a series of trenches and pits, explore a northwesterly trending zone about 135 feet long.

The rocks of the area are bedded chert and chert conglomerate of the Excelsior formation; they strike northwest and dip at low angles to the northeast. The loci for ore deposition are the intersections of small steep normal faults and relatively flat bedding shears. Crystalline cinnabar occurs in the clays along the flat bedding shears and in cracks and fissures in the chert. It is associated with quartz, calcite, pyrite, and manganese oxides.

CARDINAL MINE

Former names....Towner and Ott, Harris.
Location.....Sec. 14, T. 6 N., R. 36 E.
Ownership.....L. E. Cornelius and son of Mina.
Discovery.....1929 by J. C. Ott and J. Towner.
Production.....133 flasks to the end of 1943.
Geologic type.....Interbedded sediments—chert.

The Cardinal property is on the southeast slope of the Pilot Mountains at an altitude of about 8,000 feet. In 1929 J. C. Ott, one of the original locators, optioned his interest to J. C. Ray of Stanford University, California, and in the following year 65 flasks were produced from an ore body said to have averaged

12 percent cinnabar. In 1931 the property was taken over by the Cardinal Mining Company which produced about 60 flasks during a two-year period. Since that time the property was acquired by the present owners, and they have leased it to various individuals who have as yet done little development.

The major development work has been confined to the vicinity of a steep fault that cuts transversely across a northerly trending ridge of Excelsior chert. A small open pit which explored the main ore zone at the surface is connected by a stope to a drift run about 150 feet lower on the hillside to cut the fault at depth. Other exploration has been done along the east slope of the ridge, and therein minor faults containing some cinnabar have been found. In all, there are about 650 feet of drifts and crosscuts.

Cinnabar, the only ore mineral, occurs with quartz and calcite, filling cracks and fissures in the chert, and in the gouge and breccia along the fault. The ore bodies, which were small and high grade, were localized as lenses along the major fault. The junctions of the major fault with the bedding shears in the chert seem to be the most favorable places for ore bodies.

DREW MINE

Former names....Bugg and Drew, Farnham and Drew, Red Devils.
Location.....Sec. 14, T. 6 N., R. 36 E.
Ownership.....Mrs. Emily Phillips of Reno.
Discovery.....1914 by H. Farnham and Al Drew.
Production.....916 flasks to the end of 1943.
Geologic type.....Limestone.

The Drew property, consisting of eight unpatented claims, lies at an altitude of nearly 8,000 feet about one mile east of the Mina Development Company mine. The property was discovered sometime prior to 1915, and by 1916 H. Farnham and Al Drew had produced 280 flasks. In 1917 the property was leased by the Mina Quicksilver Company who produced 444 flasks of quicksilver from ore retorted in 12 Johnson-McKay retorts; early in 1918 they exhausted the ore in sight and abandoned operations. In 1919 Mr. Bugg and Al Drew resumed work, and during the year produced 136 flasks. From 1920 to 1943 the property was worked sporadically by various lessees, but only in 1942 did it yield as much as 20 flasks of quicksilver in one year. In 1943 the Mina Development Company attempted to reopen an inclined shaft which had caved sometime prior to 1940.

The open underground workings in 1943 consisted of an inclined shaft extending to a depth of 100 feet and about 120 feet of drifts and crosscuts on the 55-foot level. Two other levels at 150 feet and 200 feet have been inaccessible for many years.

The country rock is a yellow limy shale with lenses of limestone and is a part of the Dunlap formation. The rocks are crushed and sheared because of their proximity to the Dunlap Canyon thrust fault and a later normal fault, but most of the shears strike easterly and dip at 40° to the north, thus paralleling the bedding.

Crystalline cinnabar has been found, but a scarlet earthy variety of cinnabar is apparently much more abundant. The cinnabar is associated with stibiconite, valentinite, quartz, calcite, and, according to Foshag,[46] sphalerite, calamine, and bindheimite—the antimonate of lead. Various copper minerals including azurite, malachite, and olivenite also occur on the property. The powdery nature of many of the minerals, and the fact that they fill cavities, suggests they are of supergene origin.

The ore bodies were formed by the replacement of the limestone lenses in the shale, and some ore also occurred along favorable fault zones in the shale. Mining followed small stringers of cinnabar which paralleled the bedding and which, when they encountered limestone lenses or favorable fault zones, opened out into bodies of high-grade ore. The largest ore shoot reportedly plunged westerly, passing from the east side of the shaft on the 55-foot level to the west side of the shaft on the 200-foot level. Unmined portions of another parallel shoot are reported to lie farther west between the 55- and 200-foot levels.

FAULT LINE PROSPECT

Former names....Coveney.
Location.....Sec. 15, T. 6 N., R. 36 E.
Ownership.....Clay Coveney and Herbert Pickle of Mina.
Production.....6 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone and shale.

The Fault Line prospect lies between the Mina Development Company mine and the Drew mine. Nothing is known of its early history.

Less than 100 feet of workings have explored a steep normal fault in crushed and sheared yellow shale of the Dunlap formation lying beneath the Dunlap Canyon thrust fault. Cinnabar

[46] Foshag, W. F., Quicksilver deposits of the Pilot Mountains, Mineral County, Nevada: U. S. Geol. Survey Bull. 795, pp. 116, 117, 1927.

was observed in only small amounts in the gouge along the small normal fault.

HASBROUCK PROPERTY

Former names....B. & B.
Location.....Sec. 16, T. 6 N., R. 36 E.
Ownership.....Unknown.
Discovery.....1929.
Production.....None.
Geologic type.....Interbedded sediments—sandstone.

The Hasbrouck property is located in a side canyon just west of the Reward mine. Nothing is known of the early history or present ownership of the property.

The development work consists of a 40-foot inclined shaft and a few scattered pits. The rocks explored belong to the Dunlap formation and consist of sandstone and conglomerate which strike westerly and dip 20°–25° southward. The workings explore bedding shears and a small normal fault in conglomerate. Cinnabar occurs in a barite gangue and is also associated with quartz, calcite, azurite, and malachite.

HITT MINE

Location.....Sec. 20, T. 6 N., R. 36 E.
Ownership.....Bert Hitt of Mina.
Discovery.....1929 by Bert Hitt.
Production.....46 flasks to the end of 1943.
Geologic type.....Interbedded sediments—sandstone.

The Hitt mine is at an elevation of about 7,100 feet in a small canyon which branches west from Dunlap Canyon. It remained undeveloped for ten years after its location, but in 1940 the Hitt Mercury Mines, Inc., with Walter F. King of Los Angeles as president, installed a 40-ton furnace, and during 1940–1941 produced 46 flasks of quicksilver. Late in 1941 the lease and option of this company expired, and the property, which reverted back to the owner, remained idle in 1943.

The underground workings consist of two adits, one about 150 feet above and 450 feet southwest of the other, totalling about 500 feet in length.

The rocks of the area consist of interbedded red and brown quartzitic sandstones and red conglomerates of the Dunlap formation. They strike N. 10°–20° E. and dip 35° west. A vertical northwesterly trending fault cutting these sediments has been explored by the workings. Cinnabar is associated with calcite and various manganese and clay minerals in the gouge of the

fault, and also occurs in cracks and fissures, along bedding planes, and locally disseminated in the sandstone. Ore bodies were small but of high grade; they were localized on the upthrown side of the fault where dragfolded bedding planes allowed the solutions to migrate out into the sandstone.

INMAN MINE

Former names....Summit Springs, Crystal Quick, Red Wing Group.
Location.....Sec. 23, T. 6 N., R. 36 E.
Ownership.....Frank Inman and Jack Inman of Tonopah.
Discovery.....1915 by Carl Riek and Ed Messenger.
Production.....76 flasks to the end of 1943.
Geologic type.....Interbedded sediments—chert.

The Inman mine lies about a quarter of a mile east of the Betty mine and at an elevation of about 8,500 feet. The property as originally located in 1915 included 16 claims known as the Red Wing group, but it has since been divided into two groups—the present Inman and Betty properties. No records of production from the property prior to 1928 are available, but in that year the present owners acquired the mine and produced 15 flasks from retorts. In 1930 George Chrysler worked a placer deposit on the property, and during 1931 Inman and Chrysler averaged 3–4 flasks a month. Since 1931 various operators have produced only a few flasks a year.

The underground workings, which consist of 750 feet of drifts, crosscuts, and stopes on three levels, have followed a fault which trends northeast and dips about 70° to the southeast. Pockets of high-grade ore have been stoped from along this fault for a distance of about 120 feet.

The country rock is iron-stained broken chert and chert conglomerate which strikes northeast and dips 40° to the southeast. The bedding planes between chert layers are locally sheared and contain gouge, and where these sheared bedding planes are cut by the steep fault they contain ore. The ore consists of crystalline cinnabar which forms high-grade lenses along the fault and fills fractures in the chert in either wall.

About 250 feet east, and below the main workings, a small adit and stope explore a gravel bed which contains small nuggets of cinnabar concentrated on the chert bedrock.

KEG PROSPECT

Location.....Sec. 15, T. 6 N., R. 36 E.
Ownership.....L. B. Spencer and A. J. Anderson of Mina.

Discovery.....Prior to 1917.
Production.....A few flasks.
Geologic type.....Interbedded sediments—limestone and shale.

The Keg prospect, on a group of five claims, is at the head of Cinnabar Canyon adjacent to, and north of, the Mina Development Company mine. Since its discovery it has been little worked, and, although part of a retort and a small calcine dump is on the ground, the production is unrecorded. Development work consists of an inclined shaft about 75 feet long and 40–50 feet of adits.

The country rock is yellow limy shale belonging to the Dunlap formation, and, as the deposit is directly under the Dunlap Canyon thrust fault, the rocks are highly contorted and sheared. Ore minerals, powdery cinnabar and possibly also metacinnabar, occur with calcite and wad in and near a small flat fault.

LAKEVIEW MINE

Former names....Jong Wong, Chinaman's property.
Location.....Sec. 12, T. 6 N., R. 36 E.
Ownership.....H. W. Bell of Reno.
Discovery.....1919 by Jong Shore Wong.
Production.....Small.
Geologic type.....Interbedded sediments—limestone.

The Lakeview property consisting of five claims lies at an elevation of about 7,800 feet and about one mile northeast of the Drew mine. The property was first worked by J. S. Wong, and he is said to have recovered several flasks of quicksilver. It was subsequently operated by unknown lessees who also are believed to have produced a few flasks from retorts. The property was acquired by Bell in 1942, and in 1943 he was erecting a retort to burn sorted ore.

An adit, which with connecting workings is about 200 feet long, was driven in limestone to explore a nearly vertical fault that trends N. 60° W. Three pits above the underground workings are in alluvium containing local bunches of detrital cinnabar. A 200-foot adit, 280 feet south of the main workings, and a few scattered trenches also are on the property.

The ore bodies are localized where the coarsely crystalline limestone of the Luning formation is cut by steep normal faults. They have been small but of high grade, and were formed by the concentration of cinnabar in the gouge zones, in small irregular calcite veinlets, and in the limestone as disseminated crystals. Gangue minerals include calcite, barite, and pyrite.

LOST STEER MINE

Location.....Sec. 15, T. 6 N., R. 36 E.
Ownership.....L. B. Spencer and A. J. Anderson of Mina.
Discovery.....1913 by Thomas Pepper and Charles Keough.
Production.....397 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone.

The Lost Steer mine is on the same group of claims as the Mina Development Company mine, but lies to the south near the top of Cinnabar Hill. The discovery of the Lost Steer deposit in 1913 caused considerable excitement in the area, but small amounts of cinnabar are said to have been previously found in the district. Following its discovery the property was worked more or less continuously by lessees until 1918, and during this period a production of 344 flasks was recorded. After this initial period of activity the property remained idle for about 20 years. In 1939 it was taken over by the present owners who in 1941–1942 trucked ore from the Lost Steer mine, treated it in the Mina Development Company's rotary furnace, and recovered about 53 flasks of quicksilver. From the early part of 1942 through 1943 the property was idle.

Most of the ore has come from a small—40 feet by 25 feet and 30 feet deep—glory hole and several short adjoining crosscuts. These workings explore a jointed and broken limestone bed belonging to the Dunlap formation, but a lower haulage level has been driven in a brown sandy limestone and shale lying conformably beneath the broken limestone. Several small faults seen only underground and a more conspicuous vertical northerly trending fault a few feet east of the main workings localized the ore.

Cinnabar is the only ore mineral seen on the property, but Foshag[47] reports the occurrence of calomel. Most of the cinnabar is crystalline, but some is earthy and fills cracks and small cavities in the limestone. Associated with the cinnabar are stibnite and its oxidation products, stibiconite and valentinite, with calcite, quartz, and probably some barite.

The ore body was formed by scattered small discontinuous veinlets of cinnabar in the broken limestone. It was apparently localized in the most broken area and is bottomed by a shale contact at the base of the limestone. Near the main workings many cinnabar-bearing calcite stringers cut the limestone, but they do not appear to be sufficiently numerous to form ore.

[47] Foshag, W. F., Quicksilver deposits of the Pilot Mountains, Mineral County, Nevada: U. S. Geol. Survey Bull. 795, pp. 113–123, 1927.

MAMMOTH MINE

Former names....Easter.
Location.....Sec. 17, T. 6 N., R. 36 E.
Ownership.....Mammoth Quicksilver Corp., Noble Smith of Fresno, California, President.
Discovery.....1929 (?) by Ed Mace.
Production.....52 flasks to the end of 1942.
Geologic type.....Interbedded sediments—sandstone.

The Mammoth mine is in the central part of the district in Dunlap Canyon at an elevation of about 7,000 feet. Soon after the property was located in 1929 it was purchased by the Mammoth Quicksilver Corporation which did some development work and produced a small amount of quicksilver. However, no large ore bodies were encountered and the property reverted to the Fresno Branch of the Bank of America. Since that time lessees have retorted small amounts of quicksilver. In 1943 Mr. Elko Zerado held a 10-year lease on the property and was doing development work.

The workings consist of two adits connected by a 77-foot stope and raise, a glory hole above the main workings, and a second glory hole about 180 feet west of the main workings. The total length of the drifts and crosscuts is about 380 feet. (See Plate 11.)

The main workings explore a northeasterly trending fault which dips 55° to the southeast, whereas the glory hole to the west lies on a second nearly parallel fault. These faults are apparently of small displacement and cut interbedded conglomerate, sandstone, and shale belonging to the Dunlap formation.

The only visible quicksilver mineral is cinnabar which occurs with clays in the gouge of the faults and with calcite in veinlets in the country rock adjacent to the faults. The ore bodies are small and of high grade; they are localized beneath rolls in the faults.

MINA DEVELOPMENT CO. MINE

Former names....Cinnabar King, Booth-Wardell, Seitz, Mina Mercury, Mina Merc.
Location.....Sec. 13, T. 6 N., R. 36 E.
Ownership.....A. J. Anderson and L. B. Spencer of Mina.
Discovery.....1913 by T. Pepper and C. Keough.
Production.....2,766 flasks to the end of 1943.
Geologic type.....Limestone.

The Mina Development Company property consists of a group of 13 claims which lie in the central part of the district at an elevation of about 7,400 feet in the upper part of Cinnabar Canyon.

From the mine's discovery until 1918 only small amounts of ore were mined and treated in a D retort, but in 1919 the property was taken over by Booth and Wardell who produced 628 flasks from a 2-pipe D retort. During 1920–1928 various owners and lessees recovered from retorts an average of about 80 flasks a year. In 1929 the property was bonded to B. F. Miller, A. H. Gunnell, and E. H. Bedford who installed a 30-ton Cottrell furnace, and in 1930–1931 B. F. Miller and W. G. Fairbanks (Southern Mines, Inc.) held an option and produced about 34 flasks. From 1931 to 1938 the property was idle except for sporadic lessee activity which resulted in only small amounts of quicksilver being produced. In 1939 the property was purchased by the present owners, and in 1940 they encountered a high-grade ore body which during 1940–1941 yielded about 1,300 flasks of quicksilver. In 1942–1943 the mine was idle.

The workings consist of about 5,000 feet of drifts and crosscuts on seven levels, the lowest of which is 210 feet below the rim of a small glory hole. (See Plate 12.) The two lowest levels were flooded when the property was mapped in the fall of 1942.

The rocks of the area consist of interbedded limestones and shales of the Dunlap formation which strike northeasterly and dip at moderate angles to the northwest. Faults of three different ages displace the rocks explored by the mine workings. (See Plates 12 and 13.) The oldest of these faults is a small thrust fault which is probably subsidiary to the Dunlap Canyon thrust fault and bears no close relation to the ore deposits.

Pre-mineral normal faults which strike easterly have probably been active several times and are younger than the thrust fault. They are in turn offset by several parallel tranverse normal faults collectively known as the "Keough fault." At least part of the movement along the Keough fault is believed to be post-mineral. Measurement of displacement was only attempted for the normal faults, and it is nowhere greater than 80 feet including both pre- and post-mineral movement. A few small bedding plane faults diverge from the normal faults.

The only ore mineral of quicksilver seen on the property is cinnabar. It is associated with stibnite, and the antimony oxides, stibiconite and valentinite, along with pyrite, barite, and quartz. It occurs as high-grade masses replacing the broken limestone, as crystals in calcite veinlets cutting the limestone, as painty films on slickensided faults, and as disseminated grains in fault gouge.

The ore bodies were localized in limestone at the intersections of the steep pre-mineral normal faults with the relatively flat bedding faults that are probably genetically related to the steep faults. They were of three closely related types. In the first type cinnabar partly filled cracks but mostly replaced the limestone; this type of ore body was exceptionally rich and has yielded most of the quicksilver. In the second type, which was of lower grade, the cinnabar only filled cracks in the limestone. In the third type the cinnabar was concentrated in the gouge of the normal faults.

REDWING PROSPECT

Former names....Seitz property.
Location.....Secs. 17 and 20, T. 6. N., R. 36 E.
Ownership.....George J. Barry of Los Angeles, California.
Discovery.....1935 by Yaunkin and Seitz.
Production.....Very small.
Geologic type.....Interbedded sediments—limestone.

The Redwing prospect lies adjacent to, and west of, the Mammoth mine on the west end of Tent Hill. The property was under lease to several individuals before being sold to Barry in 1942, and reportedly a small amount of quicksilver has been produced in the 2-pipe D retort on the property.

The underground workings consist of a single adit 60 feet long trending N. 60° W. and containing a 12-foot winze and a 12-foot raise to the surface. Two 25-foot shafts and five trenches explore the hillside above the main workings.

The rocks are part of the Dunlap formation and consist of red and brown sandstone and conglomerate overlying a partly silicified fine-grained white limestone. The workings explore a steep normal fault which cuts the limestone and strikes N. 65° W. and dips 65° to the south. Cinnabar is associated with quartz and calcite in the fault gouge and occurs in minor amount as fillings of cracks and fissures in the silicified limestone. On the hillside above the workings the trenches and shafts explore a fault cutting brown sandstone and conglomerate. This fault strikes N. 45° W. and dips 72° to the east, and cinnabar occurs along it as a veinlet varying from one-fourth to half an inch in width.

REWARD MINE

Former names....Kane, Leighton Cinnabar, Sommerfield and Thompson.
Location.....Sec. 16, T. 6 N., R. 36 E.
Ownership.....D. H. Grey, Jr., and C. A. Bonner Estate of San Francisco, California.
Discovery.....1928 by H. H. Leighton and J. T. Kane.
Production.....536 flasks to the end of 1942.
Geologic type.....Interbedded sediments—sandstone.

The Reward property consisting of nine claims is in Dunlap Canyon at an elevation of about 7,000 feet. Since the property was first located in 1928 it has been held by at least 13 different owners and lessees who in the aggregate have recovered 536 flasks of quicksilver from several types of retorts and furnaces. A rather unsuccessful attempt at concentrating the ore was made by W. T. Childers in 1931. In 1942 the property and 50-foot Cottrell furnace were under lease to the Pacific Placers Company, a partnership of D. Grey, J. Enberg, and a Mr. Gleason.

The mine workings consist of two adits which are on about the same level. The southern one has about 350 feet of drifts and crosscuts and connects with a large stope that extends to the surface. The northern adit contains only about 50 feet of workings connected with a small inclined winze 20 feet deep. Another adit farther to the south was not examined.

The country rock belongs to the Dunlap formation and consists of brown quartzitic sandstone overlain by sandy limestone and red conglomerate. Where explored by the mine workings the sandy limestone and sandstone strike N. 50° E. and dip 55° to the northwest. A northerly trending fault which dips about 45° to the west cuts these beds and formed the principal channel for the ore solutions.

Cinnabar occurs with stibnite and calcite as disseminated grains in a sandy limestone lens on the hanging-wall side of the fault, with calcite as veinlets in the sandstone, and in the gouge of the fault as disseminated grains. The ore bodies were localized by a roll in the fault and lay principally on the footwall side.

RAWHIDE DISTRICT

The Rawhide district is in the northeastern part of Mineral County bordering Churchill County. The district was first located in 1906, and from 1908 to 1929 it produced very notable amounts of silver, gold, and other metals. Although the presence of cinnabar was known as early as 1908, no attempt to mine this mineral was made until 1929.

Tertiary volcanic rocks underlie the area. Cinnabar occurs in small amounts in rhyolitic tuff and in local parts of the tuff that have been silicified to typical opalite.

STOCKTON PROPERTY

Location.....Secs. 3 and 10, T. 13 N., R. 31 E.
Ownership.....W. W. Stockton.
Discovery.....1929.

Production.....None.
Geologic type.....Opalite.

The Stockton property is on Black Eagle Hill about 400 yards west of the Black Eagle mine and about four miles west of Rawhide. Reportedly, soon after its discovery in 1929 the property was developed for a short time by the Bob O. Lee Mining Company of San Francisco. Since then little work has been done, and in 1943 the property was idle.

Development work consists of a single 165-foot adit trending S. 30° E. into the hill.

The rocks in the immediate vicinity consist of horizontal beds of Tertiary rhyolitic tuff which over several acres are spottily altered to opalite. The adit was begun in hard but rubbly opalite, but after 70 feet it passed into fresh ashy tuff which contained only small isolated patches of opalite.

Near the portal of the adit some of the ore contains enough disseminated cinnabar to average a few pounds of quicksilver to the ton. Near the face cinnabar forms very narrow veinlets and clots in the fresh tuff, but not enough of this low-grade material is present to be commercial.

UNNAMED DISTRICT

NOGUEZ PROSPECT

Location.....Secs. 25 and 36 (?), T. 3 N., R. 31 E.
Ownership.....Joseph Gabriel Henri Noguez of Mt. Montgomery.
Discovery.....1940 by Noguez.
Production.....A few flasks.
Geologic type.....Sulfurous.

The Noguez property consists of a group of 16 claims on the north end of the White Mountains about eight miles north of the Highway Maintenance Station at Basalt. The property is said to have been discovered by Noguez about 1940, and it has been worked by him and lessees since that time. A small retort is on the property and some quicksilver has probably been recovered from hand-sorted ore.

Development work consists of three adits totaling about 500 feet in length, a glory hole, and several shallow pits and trenches.

The workings are in Tertiary tuffs which have been completely silicified over an extensive area. Several faults and zones of broken rock with variable trends have been followed in the search for ore. The ore that was retorted was formed by concentrations

of cinnabar as veinlets and coatings on boulders in the crush zones. Much gypsum accompanies the ore, and sulfur occurs locally in moderate amounts.

MONTGOMERY SUMMIT PROPERTY

Former names....Summit Mountain Mercury.
Location.....One and a half miles west-northwest of Montgomery Pass.
Ownership.....James Houghton and J. L. Newsom.
Production.....None.
Geologic type.....Volcanic (?).

The Montgomery Summit property one and a half miles west-northwest of Montgomery Pass has not been visited. Small amounts of cinnabar are reported to have been found at this locality in 1940 in a gold prospect that was discovered about 30 years before. Cinnabar is said to occur as a one-inch veinlet along a northerly trending shear in rhyolite and tuff, and is associated with pyrite, quartz, and chalcedony.

UNNAMED DISTRICT

POINSETTIA PROPERTY

Location.....Sec. 34, T. 11 N., R. 33 E.
Ownership.....V. S. Baxter of Fallon.
Discovery.....1929 (?).
Production.....None.
Geologic type.....Volcanic.

The Poinsettia property is about six and a half miles southeast of Dead Horse Wells in the northeast end of the Gabbs Valley Range. The property has been intermittently developed by Baxter since its discovery. Apparently no reduction equipment has ever been installed and no quicksilver has been recovered, although several hundred tons of retort ore have been stockpiled.

The underground workings explore a nearly vertical vein and consist of a 175-foot shaft and workings on two levels. A 67-foot level extends easterly for about 250 feet from the shaft, and a crosscut 70 feet long extends northerly to a 110-foot easterly trending drift. A 160-foot level 200 feet long extends easterly below the workings of the 67-foot level.

The rocks in the area consist of altered andesitic tuffs and flows which dip at variable low angles to the northeast. A fault that trends N. 63° W. and dips 85° to the north cuts these rocks and has formed the locus for ore deposition. Cinnabar is confined to the fault and occurs as small high-grade lenses and veinlets associated with abundant pyrite and possibly marcasite, chalcedony, sulfur, gypsum, and clays.

UNNAMED DISTRICT

SOUTHVIEW PROPERTY

The Southview property is two miles south of Pactolus in the northern end of the Cedar Mountains. C. Garrett is reported to have found cinnabar in andesite in this area in 1932, and in 1941 he optioned the property to A. H. Leach. The property has not been visited, and apparently it has not produced any quicksilver.

NYE COUNTY

Quicksilver deposits have been found throughout the length of Nye County, but most of them lie in the western half of the county. This county, with a production of almost 13,000 flasks, holds second rank among the quicksilver producing counties in the State, but in 1943 it contained no large producers and most of the mines were idle.

Cinnabar has been found in thirteen districts, but only one of these—the Union district south of Ione—has yielded notable amounts of quicksilver. This district contains the Mercury Mining Company mine which produced over 6,000 flasks during 1912–1919 and, although now inactive, retains first place among the mines of the State in quantity of quicksilver produced. A second very productive mine, the Nevada Cinnabar mine with an early production of over 4,000 flasks, is also in the Union district.

BELMONT DISTRICT

The Belmont district lies west of the old mining town of Belmont on the east flank of the Toquima Range. This district has been known as an important silver-gold producer since 1865, but the several quicksilver mines in the area have yielded a total of 756 flasks.

As early as 1876 A. R. Whitehill[48] reported the occurrence of cinnabar in the district; later, in 1888, Becker[49] noted the occurrence of cinnabar along a vein of argentiferous ore in the Barcelona silver mine.

The country rocks of the Belmont district are Ordovician (?) phyllites and limestones cut by the intrusive granite and locally overlain by Tertiary volcanic rocks. The quicksilver ore bodies occur in quartz-barite veins in the granite or as tabular bodies in roof pendants of metamorphic rock embedded in the granite. Some of the ores owe their value to metacinnabar, but all of the mines contain deep purple cinnabar.

FLOWER QUICKSILVER MINE

Former names....Duane Group, Kernick Divide Mining Co., Kernick - Duane, Flower - Kernick, Fiorite Group.
Location.....Sec. 33, T. 10 N., R. 45 E.

[48]Whitehill, H. R., Sixth biennial report of the State Mineralogist of the State of Nevada for the years 1875 and 1876.

[49]Becker, G. F., Geology of the quicksilver deposits of the Pacific slope: U. S. Geol. Survey Mon. 13, p. 385, 1888.

Ownership.....W. S. Flower and W. F. Logan.
Discovery.....1908 by Mrs. Flower.
Production.....About 50 flasks to the end of 1943.
Geologic type.....Metamorphic.

The Flower quicksilver mine is in Antone Canyon, a tributary to Meadow Canyon, on the east slope of the Toquima Range. Although cinnabar was discovered on the property by Mrs. Flower in 1908, it has been only intermittently mined. The mine was originally known as the Wm. Duane mine, and as such had a small production prior to 1928. In 1928 the Kernick Divide Mining Co. bought the property, but after several years abandoned it without producing. Flower and Logan relocated the ground, and in 1936 leased it to Walter Low who produced some quicksilver from cinnabar concentrated on tables. In 1937 Lee Wagoner leased part of the property and planned to build a 100-ton concentrating plant, but this was never done. In 1938 the property was leased to Fred Volmar who, although he did considerable development work, failed to produce. In 1942 Mr. V. B. Dewey leased the property but made no attempt to produce more than one flask of quicksilver. Mr. Flower was working the property in 1943 and retorting ore in a 2-pipe oil-fired Rossi-type retort.

Two areas have been developed. The mining in September 1943 was confined to about 300 feet of drifts and shafts which explore a small silicified rib on several levels. The other area that has been developed, referred to locally as the "placer ground," is about a quarter of a mile south of the camp on a rather gentle hillside which has been extensively explored with bulldozer cuts. On the hill above the placer ground several shafts have been sunk searching for the parent lode.

The rocks of the area consist of mildly metamorphosed sediments—quartzite, phyllite, and limestone—that are intruded by granite and overlain by rhyolitic tuff and agglomerate. The active workings explore a 30-foot rib of silicified limy phyllite which stands nearly vertical and strikes N. 30° E.; cinnabar is disseminated along a sheared contact on each side of the rib. Sorted ore of good retort grade has been taken from these workings, but it has been found only in small quantities.

The placer ground extends over an area measuring about 400 feet by 200 feet. The surface soil or rubble within this area pans cinnabar and probably averages a few pounds of quicksilver to the ton; however, its average depth is only about one foot. The cinnabar is believed to be nearly in place and to occur as

small veinlets in the underlying shaly phyllite, but attempts to mine several of these veinlets indicate the ore is probably too low grade to be commercial.

MARIPOSA CANYON PROSPECT

Location.....Sec. 15 (?), T. 9 N., R. 44 E.
Ownership.....C. A. Readle of Round Mountain.
Discovery.....Unknown.
Production.....Small.
Geologic type.....Granite.

The Mariposa Canyon prospect is about six miles southeast of Round Mountain near the mouth of Mariposa Canyon, on the west flank of the Toquima Range. Nothing is known about the past history of this property, and although it was idle in 1943, an abandoned retort and small calcine dump indicates a small amount of activity in the past.

The principal working is a 45-foot adit with a short raise to the surface, but several other shallow workings are in the vicinity.

The mine lies in an area of jointed granite and explores a three-foot composite vein which strikes N. 39° E. and dips 71° to the southeast. A fairly continuous sheared quartz vein with lenticular inclusions of somewhat reconstituted granite follows the footwall side. Metacinnabar occurs as scattered crystals in the quartz vein, and cinnabar is disseminated in the sheared micaceous footwall. Small amounts of barite accompany the ore, and clays are abundantly developed in the granite on the hanging wall side of the vein. Some good retort ore could be hand-sorted, but it is not of sufficient abundance to make mining economic.

SENATOR MINE

Former names....Zero.
Location.....Sec. 2, T. 9 N., R. 44 E.
Ownership.....George J. Barry of Los Angeles, California.
Discovery.....1925 (?) by Charles and Jack Humphrey.
Production.....About 100 flasks to the end of 1943.
Geologic type.....Granite.

The Senator mine lies at an elevation of 8,800 feet at the head of the north fork of Mariposa Canyon on the west slope of the Toquima Range. It is reached only by three miles of pack trail starting from the end of the Shoshone Canyon road. The history of the property is confused by the fact that the claims have been jumped, and several of the operators turned in no production reports. The property was apparently discovered and first worked

by Charles and Jack Humphrey between 1925 and 1928. Late in 1928 Albert Walters, Irwin Carpenter, Charles Bradley, and Joe Francisco held the ground and produced considerable quicksilver from retorts. In 1937 and 1938 A. W. Peterson owned the property, and Jack Stevens leased it and recovered at least 16 flasks. The present owners, who acquired the property in 1941, had not attempted to operate the mine by the fall of 1943.

The principal workings are two veins about 200 feet apart and will be referred to as the "west" and "east" workings. The west workings consist of two adits, one about 50 feet above the other, and a small interconnecting stope. The east workings include an upper adit about 90 feet long with narrow stopes extending upward to the surface and downward to a partly caved lower adit about 65 feet below. About 50 feet from the portal of the lower adit are two small stopes which extend nearly to the surface, and beyond these stopes the adit is inaccessible but is said to extend about 70 feet farther to join the stope from the upper level.

The rocks of the vicinity are granite cut by small quartz veins which parallel its steep sheeting. The mine workings explore two of the larger veins, but other smaller veins in the area also contain quicksilver minerals.

The ore minerals are cinnabar and metacinnabar; gangue minerals are barite, quartz, chalcedony, pyrite, muscovite, jarosite (?), and, along the walls of the veins, clays. The metacinnabar occurs as coarse crystals in a barite-quartz gangue. Cinnabar occurs as coatings on the metacinnabar, as small veinlets in barite and quartz, and as painty clouds in the kaolinized wall rocks.

The ore in the east workings occurs in two shoots along a composite vein which strikes N. 29° E. and dips to the southeast. The stope width of about three feet includes several barite veins and lenses that are from two to four inches in width and locally contain perhaps 15 percent of metacinnabar and more than 1 percent of cinnabar. Sheared and kaolinized granite along the footwall side contains cinnabar and is said to average about four pounds of quicksilver to the ton. The ore appears to be quite discontinuous along the strike of the vein.

The ore in the west workings is of considerably lower grade and more painty than that in the east workings, but the occurrence is similar. The ore minerals are confined to a narrow vein that strikes N. 14° E. and dips 70° to the east.

None of the ore shoots have been explored below the haulage levels, but it seems likely that they contain more ore at depth.

VAN NESS MINE

Location.....T. 9 N., R. 44 E.
Ownership.....Homer Williams and John Connolly of Tonopah.
Discovery.....1928 by J. Humphrey.
Production.....728 flasks to the end of 1943.
Geologic type.....Metamorphic.

The Van Ness mine, on a group of six patented claims, is at an elevation of 8,600 feet on the east slope of the Toquima Range and about six miles northwest of Belmont. In the year of its discovery the property was sold to Raymond Van Ness. He produced a small amount of quicksilver in 1928–1929, and after installing a 30-ton Cottrell furnace he recovered about 500 flasks of quicksilver in 1930–1931. This operation was apparently unprofitable, for in the latter part of 1931 the property was sold under judgment to Homer Williams and John Connolly. Since 1931 the owners have leased the property to various men who have annually produced from retorts about 25 flasks of quicksilver. The property was idle when visited in 1943, but the rotary furnace appears usable.

The underground workings explore parts of a single easterly trending zone for a distance of 800 feet, and to a depth of 145 feet; however, the productive workings all lie in the western end of the zone. These workings consist of two glory holes tapped by a haulage adit, and several stopes from which ore was raised up a 135-foot inclined shaft. A 900-foot adit was driven to explore the ore zone at depth, but little ore has been removed from it. (See Plate 14.)

The rocks of the area are slightly metamorphosed sedimentary rocks of Ordovician (?) age occurring as a roof pendant in granite. Most of the metamorphosed sediments are phyllites, but one 15-foot bed of mildly metamorphosed chert contains all the ore.

The ore bodies are tabular and contain irregular veinlets of purplish-red cinnabar locally as much as a quarter of an inch thick. They occur adjacent to dike-like bodies of granite and also in the more broken parts of the meta-chert. The ore bodies in the chert were narrow and elongate parallel to the bedding which strikes N. 70° W. and dips about 45° southward.

WILDCAT PROSPECT

Location.....Sec. 1, T. 9 N., R. 44 E. (?).
Ownership.....E. A. Michal.
Discovery.....1939 by Michal.

Production.....Very small.
Geologic type.....Granite.

The Wildcat prospect is near the head of Shoshone Creek on the west slope of the Toquima Range about two and a half miles east of Round Mountain. A single-pipe retort and small calcine dump indicate that the property has produced some quicksilver.

Development work consists of a deep trench about 50 feet long in granite and following several parallel one-inch quartz-barite veins that strike east and dip 60° south. Cinnabar occurs in small amounts in the vuggy parts of these veins.

CUPRITE DISTRICT

The Cuprite district lies in a group of low hills 12 miles south of Goldfield and a mile east of U. S. Highway No. 95. The hills consist mostly of horizontal Tertiary Siebert lake beds and younger rhyolite tuff, dacite, and basalt, but in places the underlying Cambrian limestone is exposed. Cinnabar occurs in opalized and alunitized tuffs which have been prospected in several places, but only one deposit—the Ralston prospect—was active in 1943, and the other properties were not visited.

RALSTON PROSPECT

Location.....Sec. 28, T. 4 S., R. 43 E.
Ownership.....E. A. Moross, Goldfield, Nevada.
Discovery.....1930 (?).
Production.....Very small.
Geologic type.....Opalite.

The Ralston prospect consists of two claims one mile due west of the Ralston water tank, on the east edge of the Cuprite district about 15 miles south of Goldfield. The earliest exploratory work on the Ralston property was done by J. Fuetsck, G. Smith, and Wm. Buers in 1930. The property was then abandoned until 1939 when A. Nagdboort relocated it. After this it was again abandoned until relocated in 1941 by E. A. Moross who had by 1943 driven about 200 feet of drifts and crosscuts and installed a 1-pipe retort on the property.

Development work consists of a westerly trending adit 100 feet long connected with 140 feet of crosscuts and a 30-foot shaft; 500 feet to the south of these workings is a 120-foot adit and a 30-foot trench.

The rock explored by the underground workings consists of rhyolite tuff and agglomerate. Local parts of these rocks have been silicified to hard resistant stringers and blocky bunches of

opal and chalcedony, and other parts have been altered to a white "flour" of silica and alunite.

Cinnabar mineralization accompanied and followed the silicification as is shown by the presence of cinnabar cutting the chalcedony veinlets and by the occurrence of detached spherulitic aggregates of cinnabar crystals within the "flour."

The control for the deposition of the cinnabar is obscure. Where most abundant the cinnabar is concentrated along poorly defined fault zones within the silicified parts of the rock.

FAIRPLAY DISTRICT

The Fairplay district is in the south end of the Paradise Range east of Gabbs, and northeast of Goldyke. It was established in 1905 and since that time has produced small amounts of gold, silver, tungsten, and copper and, from a single deposit, a little quicksilver. The rocks in the district consist of limestone and shale of Triassic and Jurassic age intruded by granodiorite.

SCHEEBAR MINE

Former names....North Star.
Location.....Secs. 15 and 16 (?), T. 11 N., R. 37 E.
Ownership.....James O'Brien of Luning and Fred Wallace of Hawthorne.
Discovery.....1929 by J. O'Brien.
Production.....9 flasks recorded to the end of 1943. Possibly about 50 flasks.
Geologic type.....Metamorphic—limestone.

The Scheebar mine lies on the northeast slope of Paradise Peak at an elevation of about 8,000 feet. During the 1930's the property was sporadically developed, with the principal production being made in 1936 when it was operated by the Mercury Mines of Nevada. Early in 1943 Benjamin J. Parker and Julius Redelius (Scheebar Syndicate) obtained a lease on the property. Scheelite was discovered in the burnt ore dump by Parker and was later found associated with cinnabar in recrystallized limestone. In the fall and winter of 1943 development work was being done by Parker and Redelius, and they planned to concentrate cinnabar and scheelite at the recently leased Desert Scheelite mill east of Mina and to retort the cinnabar in a 2-pipe D retort installed at Mr. Parker's assay laboratory in Reno.

The workings consist of four adits ranging from 50 feet to 250 feet in length, a 110-foot raise from the lowest adit to the surface, two shafts 10 feet deep, and a number of small cuts.

Mildly metamorphosed Mesozoic sedimentary rocks that in general strike northwest and dip at moderate angles to the northeast underlie the property. A bed of marble which contains the ore is overlain by impure blue limestone and underlain by quartzite, phyllite, and greenstone. These rocks are gently folded and locally sharply contorted. Several northerly trending shear zones cross the area and along one of these the stratigraphic displacement is in excess of 120 feet.

Cinnabar occurs in the upper 40 feet of the marble and reportedly in the overlying limestone. The three localities that have been explored include a small glory hole and underhand stope measuring 30 feet by 60 feet by 10 feet deep, a small trench and adit 150 feet east of the glory hole, and a third ore occurrence explored by two shallow shafts about 200 feet northeast of the glory hole.

The largest ore body was mined in the glory hole and underhand stope. It was formed by a concentration of disseminated one-quarter inch crystals of cinnabar along the crest of a gentle arch in a six-inch to three-foot layer of white coarsely crystalline calcite which is presumably a recrystallized bed. A second ore body lying 150 feet east of the glory hole is likewise formed by disseminated crystals of cinnabar in coarsely crystalline calcite, but locally a vein of cinnabar about half an inch wide is exposed along a bedding plane fracture. In the third occurrence the character and distribution of the ore is similar to that in the glory hole, but the ore is of lower grade.

Scheelite occurs at three or four scattered places on the property and is of particular interest because in about half of its occurrences it is associated with cinnabar. The most striking association of cinnabar and scheelite is found in the glory hole where clouds of scheelite crystals occur in and near the cinnabar ore. Elsewhere the scheelite is concentrated in small lenticular bodies of coarsely crystalline white calcite which are probably recrystallized parts of limestone beds, but some scheelite occurs in small pods along fractures. A few specimens of the scheelite ore contain appreciable amounts of fluorite.

FLUORINE DISTRICT

The Fluorine (Bare Mountain) district occupies the northern part of the Bare Mountains and the western end of the Yucca Mountains. The presence of cinnabar in the district was discovered in 1908 by J. B. Kiernan and A. A. Turner on what is now known as the Harvey mine property. Just prior to the first

World War there was considerable activity in the district when several deposits were exploited and retorts and a 10-ton Scott furnace were installed. However, the mines never came up to expectations and the recorded production for the district is less than 200 flasks.

The cinnabar deposits are of two types. Those in the Bare Mountains occur in early Paleozoic limestone and in peculiar lenses of silica lying along a fault zone, whereas the deposits in the Yucca Mountains are typical opalite deposits occurring in silicified Tertiary tuffs.

HARVEY MINE

Former names....Denver Cooperative Mining Corp., Telluride Group.
Location.....Sec. 18 (?), T. 12 S., R. 48 E.
Ownership.....Mrs. Emily F. Harvey of Beatty and Dr. A. Blenstrub of New York City.
Discovery.....1908 by J. B. Kiernan and A. A. Turner.
Production.....72 flasks recorded to the end of 1943.
Geologic type.....Interbedded sediments—limestone.

The Harvey mine is on the summit of Meiklejohn Mountain eight miles east of Beatty. The property consists of ten unpatented claims first located for gold and quicksilver in 1908 by Mr. J. B. Kiernan who later formed the Denver Cooperative Mining Corp. During the period from 1912 to 1916 the property was leased by the Telluride Consolidated Company, and ore was trucked three miles from the mine to their 10-ton Scott furnace in the north end of the Yucca Mountains.[50] A total of 49 flasks of quicksilver was recorded from these operations. In 1916 the Telluride Consolidated Company gave up its lease, the Denver Cooperative Mining Corporation was dissolved, and Mr. Kiernan became the sole owner. For 14 years the property remained idle, but in 1930 the mine was reopened by Mr. Harvey. Since 1930 various lessees, including Dr. A. Blenstrub, obtained small amounts of quicksilver by retorting. When the property was last visited in the fall of 1943 it was idle.

The workings of the mine consist of a main adit with two short sublevels and an overlying open pit from which extends a northerly trending 50-foot adit. The total length of these workings is about 550 feet.

The rock in the vicinity of the mine is an early Paleozoic dark

[50] Knopf, A., Some cinnabar deposits in western Nevada: U. S. Geol. Survey Bull. 620-D, pp. 62-67, 1915.

gray limestone which strikes northeasterly and dips northwestward. An elongate "pod" of white to gray chalcedony and opal parallels the bedding of the limestone, and at its northern end pinches and splits to form two narrow veins that are traceable on the surface for only a short distance. At its southern end it appears to pinch out south of the edge of the open pit.

Cinnabar forms minute disseminated crystals in scattered places in the siliceous "pod" and is somewhat concentrated beneath the limestone hanging wall between the main level and the pit at the surface. Traces of painty cinnabar also line faulted zones in the limestone. The mined ore body was small, probably of low grade, and was confined to the silicified "pod."

THOMPSON PROPERTY

Location.....Sec. 29 (?), T. 11 S., R. 48 E.
Ownership.....G. B. Thompson of Beatty.
Discovery.....1929 by Thompson.
Production.....Very small.
Geologic type.....Opalite.

The Thompson property is a group of 26 claims located in the northern end of the Yucca Mountains and reached from Beatty by traveling eastward 11 miles over dirt roads. Since the discovery of the ore in 1929 the property has been extensively explored by the owner and outside interests working under lease and option. In 1943 no mining or reduction equipment was on the property.

The principal underground workings on the property consist of an upper level 285 feet in length and a lower level that is 600 feet in length and connected to the surface by a 100-foot shaft. Above these workings is an open cut about 15 feet wide and 200 feet long, and scattered over the rest of the claims are many other pits and bulldozer cuts.

The rocks in the vicinity of the mine consist of nearly horizontal Tertiary rhyolite flows, tuffs, and obsidian. Local parts of the volcanic rocks have been silicified to opal and chalcedony, and elsewhere the rocks are leached and alunitized.

Cinnabar on the upper level occurs as small concentric spheres replacing the silicified rhyolite and as veinlets and painty coatings in sheared and brecciated zones in the silicified rocks. On the 100-foot level small quantities of cinnabar were found in veinlets of soft waxy clay.

Control for the localization of the cinnabar is obscure. Where

most abundant this mineral occurs along shear zones in silicified areas near the surface. As the nearly barren 100-foot level has explored an area lying beneath the cinnabar-bearing rocks in the upper level, the deposit is probably shallow.

TIP TOP MINE

Location.....Sec. 7 (?), T. 12 S., R. 48 E.
Ownership.....Mrs. Emily F. Harvey of Beatty, and Dr. A. Blenstrub of New York City.
Discovery.....Unknown.
Production.....None recorded, possibly about 100 flasks.
Geologic type.....Interbedded sediments—limestone.

The Tip Top mine is about nine miles east of Beatty on the north slope of Meiklejohn Mountain, and about 600 feet northeast of the upper workings of the Harvey mine. Little is known of the past history of the property, but it is reported that Joe Murphy and J. B. Kiernan produced about 100 flasks of quicksilver from a now inaccessible winze.

The underground workings, which explore a southwest trending nearly vertical fault zone in limestone, consist of an adit not more than 100 feet in length with an inclined winze which is blocked at a depth of 40 feet.

The rocks of the area are early Paleozoic limestones which strike N. 50° E. and dip about 20° northward. Cinnabar is disseminated in the fault gouge and fills a one- to two-inch vein along the plane of the fault.

GOLDFIELD DISTRICT

The Goldfield district was first discovered in 1902 and from 1904 to 1918 was the most important gold-producing district in the State. Cinnabar was discovered in small amounts on the eastern edge of the district in 1907, but no attempt has been made to mine the ore. The older rocks of the district consist of Cambrian shales intruded by alaskite that is probably of Cretaceous age. Resting unconformably on these rocks are Tertiary lake deposits and volcanics, and it is in these volcanics that the cinnabar has been found.

DIAMONDFIELD PROPERTY

Location.....Sec. 21, T. 2 S., R. 43 E.
Ownership.....Joe Murphy and Mrs. Lee Brotherton of Manhattan.

Discovery.....1907.
Production.....None.
Geologic type.....Volcanic.

The Diamondfield property is about two miles east of the abandoned mining camp of Diamondfield on the eastern edge of the Goldfield district. The occurrence of cinnabar at this locality was first described by Ransome[51] in 1908, and since that time sporadic exploratory work has been done without finding commercial quantities of ore.

The area has been explored by scattered pits and trenches and two shafts which were not examined. The rocks consist of altered and locally silicified andesites that are part of the Tertiary Milltown andesites described by F. L. Ransome.[52] Cinnabar occurs as isolated crystals along a poorly defined shear zone in one of the pits and as isolated crystal aggregates in boulders of silicified and alunitized andesite.

KAWICH DISTRICT

The Kawich district is on the southeastern end of the Kawich Range and includes a group of gold mines located in 1904 near the now abandoned station of Gold Reed. Small amounts of cinnabar associated with gold and silver in monzonite are said to have been found on the Bristol group of claims owned by W. H. Brunton of Grantsville, Utah.

MANHATTAN DISTRICT

WHITE CAPS GOLD MINE

The Manhattan district is in Manhattan Canyon on the west side of the Toquima Range about 45 miles north of Tonopah. The district was discovered in 1905 and considerable quantities of gold, silver, and arsenic have subsequently been recovered from lodes and placers. The best known lode mine is the White Caps gold mine which is of considerable interest because of the mineral association and the depth of occurrence of the fairly large amounts of cinnabar that it contained.

The White Caps ore bodies lay in Cambrian (?) limestone and were replacement deposits of pyrite, stibnite, realgar, orpiment, and arsenopyrite in a gangue of calcite, quartz, dolomite, fluorite, and sericite or leverrierite. Cinnabar was fairly widespread

[51] Ransome, F. L., Geology and ore deposits of Goldfield, Nevada: U. S. Geol. Survey Prof. Paper 66, p. 113, 1909.
[52] Ransome, F. L., *op. cit.*, *pp.* 47–54.

above the 200-foot level.[53 54] In 1929 a sizable shoot reported to contain 30 percent cinnabar and $20 a ton in gold was encountered 1,100 feet below the surface. A part of the quicksilver ore from this shoot is rumored to have been hauled to Horse Canyon and there treated in retorts. A specimen of ore containing cinnabar with stibnite and realgar in calcite from a still lower level was given the writers by James W. Berg of Round Mountain.

TONOPAH DISTRICT

WEST END SILVER-GOLD MINE

The Tonopah district is well known as a silver-gold district which has yielded precious metals valued at over $150,000,000. The ores occur in typical epithermal veins that intersect Tertiary lavas and pyroclastics of acid and intermediate composition. No cinnabar has been mined in the district, but in the West End mine, according to Burgess,[55] "fissures are coated successively with botryoidal pyrite or marcasite, and afterwards with botryoidal cinnabar."

TYBO DISTRICT

The Tybo (Hot Creek) district is in the central part of the Hot Creek Range about 45 miles east of Tonopah. The district was discovered in 1865 and has been a notable producer of silver and lead. Cinnabar was discovered on the crest of the Hot Creek Range in argillized rhyolite in 1929, and in 1934 J. Y. Anderson and H. Buckley discovered cinnabar float midway between Warm Springs and Tybo on the western side of the Hot Creek Range. Since that time two properties, the A. & B. and M. & M. mines, have been intermittent producers in the area.

The rocks in the quicksilver-producing area consist of interbedded, flat-lying tuffs and flows of Tertiary age.

A. & B. MINE

Former names....Lydia.
Location.....Sec. 23 (?), T. 5. N., R. 49 E.
Ownership.....J. H. Smith of Tonopah.
Discovery.....1934 by J. Y. Anderson and H. Buckley.
Production.....189 flasks to the end of 1943.
Geologic type.....Volcanic (?).

[53] Dynan, J. L., The White Caps mine, Manhattan, Nevada: Min. and Sci. Press, vol. 113, No. 25, pp. 884, 885, 1916.

[54] Ferguson, H. G., Geology and ore deposits of the Manhattan district, Nevada: U. S. Geol. Survey Bull. 723, pp. 83-94, 1924.

[55] Burgess, J. A., The Halogen salts of silver and associated minerals at Tonopah, Nevada: Econ. Geology, vol. 6, p. 21, 1911.

The A. & B. property consisting of four claims is on the west slope of the Hot Creek Range. In 1934 Jack Anderson and Homer Buckley discovered float in the area, and in two months were producing quicksilver from retorts for the mills at Manhattan and Round Mountain. Anderson and Buckley leased the property to E. W. Fiddler in 1937, and later it was sold to J. H. Smith. In 1938 the property was idle, but in 1939 Smith produced 23 flasks from retorts, and started installation of a small Cottrell furnace. Early in 1940 the furnace was completed and the property was under lease and option to J. Beetles, Howard Callendar, and F. Enos, who produced 15 flasks. In September the Freeport Sulphur Company is reported to have taken a lease and option, but the following year, after failing to find ore by diamond drilling, they let their option lapse. Late in 1941 C. M. Cotton of Long Beach, California, leased both the A. & B. and the Mercury Mountain (M. & M.) properties and by using the rotary furnace and four retorts had recovered 100 flasks by the end of 1942. In 1943 the property was being operated by the owner who was recovering some quicksilver and doing exploratory work with a bulldozer.

The underground workings total 700 feet in length. They consist of two adits connected by small stopes and a sublevel that is connected to the lower of the two adits by inclined winzes. The depth of the ore is about 60 feet and it is apparently not bottomed. About 1,000 feet of power-shovel cuts have explored the surface near the underground workings.

The rocks of the area are all Tertiary rhyolitic tuffs and flows, and the mine is in argillized tuff which is overlain by a flat-lying fresh rhyolite flow. The ore has apparently been localized in the tuff by a poorly defined fault which strikes easterly and dips about 25° southward.

Cinnabar is associated with abundant jarosite and clays, and it forms narrow veins along the plane of the fault and disseminated crystals and veinlets in the clayey tuff. The largest of the stopes is perhaps 20 feet by 30 feet by 20 feet in maximum dimensions; its walls are economic. Much of the ore has been of retort grade, and mining costs have been relatively low because of the softness of the ore.

M. & M. MINE

Former names....Mercury Mountain.
Location.....Sec. 23 (?), T. 5 N., R. 49 E.
Ownership.....J. Y. Anderson and Estate of H. Buckley.
Discovery..... .1929 (?) by Anderson and Buckley.

Production.....59 flasks to the end of 1943.
Geologic type.....Volcanic (?).

The Mercury Mountain quicksilver property consisting of a group of four claims is about one and a half miles by road east of the A. & B. property and is reached by travelling over 48 miles of paved highway and dirt road east of Tonopah. Prior to 1943 the property was intermittently worked by various lessees. In 1943 it was under lease to J. H. Smith who reportedly recovered about $15,000 worth of quicksilver from ore hauled to the A. & B. property and there treated in a Cottrell furnace.

The underground workings consist of an upper and lower adit containing about 450 feet of drifts and crosscuts. The upper adit contains a stope which measures 130 feet by 50 feet by 25 feet high; the lower adit contains a small irregular stope. Trenches and pits explore the surface near the underground workings.

The rocks in the area consist of rhyolite tuff that underlies a thick flat-lying flow of rhyolite. The rhyolite tuff is sheared and argillized and locally contains veinlets of jarosite and cinnabar. The cinnabar in the upper adit occurs as disseminated crystals along steep southeasterly trending joints; locally, small veinlets of cinnabar cut surface rubble. In the lower adit the cinnabar is concentrated as disseminated crystals and veinlets beneath and in a low-angle westerly dipping clay zone in rhyolite tuff. The mined ore bodies, although small, are said to have averaged about 20 pounds of quicksilver to a ton.

UNION DISTRICT

The Union district is on the west flank of the Shoshone Mountains and extends a few miles southward from Ione. The district was first located for gold and silver in 1863, and until 1907 had produced little else. In 1907 cinnabar was discovered at the Shoshone Quicksilver property—now known as the Nevada Cinnabar property—at the head of Sheep Canyon, and in the same year J. L. Workman and Lew Davis located the present Mercury Mining Company ore deposit in the adjacent Shamrock Canyon. Following the discovery of these two deposits the district was a steady producer of mercury until 1920, yielding up to that time some 10,000 flasks from two Scott furnaces. After 1920 production, which has averaged about 50 flasks yearly, came from retort operations. Most of the production has come from two large mines, but the district contains many small mines and prospects.

The rocks in the district consist of Tertiary volcanics that are in fault contact with Triassic (?) sediments including slates, sandstones, shales, limestones, and intrusive greenstones. Cinnabar occurs in both the Tertiary and Triassic (?) rocks as replacement bodies, fracture fillings, painty films, and disseminated crystals.

HUMPHREY PROPERTY

Near Grantsville, about one mile from the San Pedro mine, cinnabar is reported to have been found in alluvium, and F. Humphrey is said to have sunk a 30-foot shaft into the underlying rhyolite in search for the lode.

INDIAN JOHNNIE DICK PROPERTY

Location.....Sec. 2, T. 12 N., R. 39 E.
Ownership.....Johnnie and Willie Dick of Ione.
Discovery.....1939 by the Dick brothers.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Indian Johnnie Dick property consists of four claims located in a saddle about a mile west of the Mercury Mining Company mine. Assessment work that has been done consists of several scattered pits and trenches. Cinnabar in small amounts fills seams and fractures in interbedded silicified limestone and conglomerate; however, no equipment for treating the ore was on the property in 1943.

Reportedly Johnnie Dick had located a cinnabar prospect in the area in 1929, and in 1931 he produced some quicksilver from a small retort. The writers were not able to ascertain whether or not the present Johnnie Dick property is the same as the older property of the same name.

MERCURY MINING CO. MINE

Location.....Sec. 1, T. 12 N., R. 39 E.
Ownership.....J. C. Bradley Mining Co., 425 Crocker Building, San Francisco, Calif.
Discovery.....1907 by J. L. Workman.
Production.....7,290 flasks to the end of 1943.
Geologic type.....Volcanic and interbedded sediments.

The Mercury Mining Company property consists of a group of 10 patented claims at the head of Shamrock Canyon. The mine is at an altitude of 8,000 feet and is reached from Ione over two and a half miles of graveled road which, because of heavy snowfall, is not passable during the winter months. Although discovered in 1907, the property remained little developed until 1909, when Workman and Davis erected a bank of retorts and started operations. In 1912 the installation and use of a 25-ton Scott

furnace materially increased production, which from 1912 to 1919 amounted to 6,114 flasks of quicksilver. From 1919 to 1922 the property was idle, but in 1923 the Bradley Mining Company bought the property and to the end of 1925 produced 891 flasks of quicksilver. Since 1925 intermittent retorting by various lessees has yielded annually 40 to 50 flasks of quicksilver.

The accessible workings include about 3,400 feet of adits and crosscuts and four large glory holes the largest of which measures 150 feet by 50 feet by 70 feet deep. Reportedly most of the ore came from the glory holes, and the underground workings were driven to draw ore from them and to explore the intervening ground. As only three small stopes were encountered, it seems unlikely that the underground exploration was profitable.

Slightly metamorphosed sediments of Triassic (?) age are intruded by and faulted against Tertiary volcanic rock. (See Plate 15.) They consist of altered limy shale and a gray limestone which is locally leached and cut by numerous stringers of calcite. The altered limestone grades into the hard silicified limestone that crops out as prominent ridges.

The Tertiary volcanic rocks are divided into two units: one, a coarse bouldery andesite agglomerate, may be vent debris; the other, a series of overlying rhyolitic tuffs and rhyolite may be in part intrusive into the metamorphics. The andesite agglomerate that possibly accumulated in a volcanic vent is believed to be the older of the Tertiary units. It contains large boulders of andesite porphyry, rhyolite, silicified limestone, and angular fragments of shale in a matrix of soft, argillized tuff and small fragments of the same rocks. The vent debris is highly altered and is separated from the Triassic (?) sediments by a zone of black pyrite-bearing and iron-stained gouge varying from 15 to 20 feet in thickness. The contact between the agglomerate and the widespread overlying rhyolite tuffs and flows was traced by float, but as exposed in one of the pits it appears to be a fault contact. The limy shale where in contact with the rhyolite is broken, argillized, and iron-stained; but the limestone close to the rhyolite is blocky, highly silicified, and locally contains considerable psilomelane, wad, pyrite, drusy calcite, and some cinnabar. These alteration products may be due either to intrusive or to later hydrothermal effects.

The principal ore mineral is cinnabar, but small amounts of native mercury are reported to have been found. The cinnabar occurs in limy shales as veinlets and stringers along bedding planes and fractures close to a nearly vertical fault, and in the highly silicified portions of the limestone as disseminated crystals associated with psilomelane, wad, pyrite, and drusy calcite. In the agglomerate the cinnabar forms disseminated crystals in the boulders and films and veinlets in the matrix; and in the altered rhyolite tuff it occurs as "painty" films along thin irregular fractures and as abundant scattered nodules which form fairly high-grade ore.

The only ore bodies of appreciable size were mined from the glory holes and occurred in the folded and faulted limy shales close to a pair of parallel nearly vertical faults. These ore bodies are apparently bottomed in the large glory holes, and underground exploration suggests no others will be found at depth. A second type of ore body has been sporadically mined from the altered andesite agglomerate on the edges of two of the glory holes and in one small underground stope. This type of ore was probably localized by irregularities of the intrusive contact of the agglomerate with the shales, and by the "capping" of the overlying rhyolite tuffs.

NEVADA CINNABAR MINE

Former names....Shoshone Quicksilver.
Location.....Sec. 12, T. 12 N., R. 39 E.
Ownership.....Mrs. B. Cislini of Ione and the estates of S. Lompa and J. M. Doonan.
Discovery.....1907.
Production.....4,136 flasks to the end of 1942.
Geologic type.....Volcanic.

The Nevada Cinnabar mine is about three miles southeast of Ione in the head of Sheep Canyon near the crest of the Shoshone Range. From the time of its discovery until 1911 it was known as the Shoshone Quicksilver mine, and as such had a recorded production from retorts of 341 flasks. In 1912 the property was acquired by the Nevada Cinnabar Company of Salt Lake City, Utah, who did development work on the property until 1914 and then erected a 50-ton Scott furnace from which 1,180 flasks of quicksilver were recovered during the first year. From 1914 to 1918 the property produced continuously, and during that period yielded 3,462 flasks of quicksilver. Following this activity the mine was idle and, except for minor activity by lessees, has remained dormant. In 1943 the property was leased to J. L. Corlett and Les Palmquist who treated hand-sorted ore in a 2-pipe retort.

The ore was mined from two adjoining glory holes with dimensions of 275 feet by 60 feet by 40 feet deep and 115 feet by 40

feet by 20 feet deep. The glory holes are tapped by two adits having a combined length of 750 feet. More than 20 shallow prospect pits have been dug along a fault which extends northwesterly from the glory holes, and two short adits were driven across the canyon from the main deposit in search for additional ore. (See Plate 16.)

The area is underlain by Tertiary volcanic rocks that are divided into three units. The two older units are acid tuffs and flows, whereas the youngest is a fairly thick flow of dacite. The oldest beds strike N. 85° W. and dip 10° to the north. Where not silicified they crop out in few places, but they are well exposed in parts of the glory holes and in crosscuts and drifts. A silicified part of this unit contains the ore that has been mined in the two glory holes. The younger unit of pyroclastic rocks consists of vitrophyric tuff and agglomerate; the presence of black glass distinguishes it from the older unit, but the contact is everywhere gradational. The youngest lithologic unit, a thick flow of hornblende dacite, is faulted against the ore-bearing tuff and agglomerate. In the western part of the mapped area the dacite forms a prominent dark-colored hogback which trends northwesterly and dips toward the canyon.

The ore bodies show some of the characteristics of both the opalite and volcanic types of deposits. They have, however, been classed as being of the volcanic type because of the prevalence of clay alteration and because of the localization of the ore along steep fractures. Cinnabar occurs in silicified tuff and agglomerate as narrow veins, the central parts of which are fracture fillings while the borders are narrow bands of disseminated cinnabar crystals. Cinnabar is also present as random disseminated crystals in unaltered tuff. Locally the cinnabar is found as abundant "painty" films in the fault gouge which separates the dacite and pyroclastic rocks, and in places it occurs in broken vitrophyre as narrow veinlets filling short irregular fractures.

The only known ore body on the property is that which was mined in the two glory holes. Apparently it was localized beneath the fault that separates the dacite from the pyroclastic rocks where the cinnabar occurred along a series of fractures which, although dipping at various steep angles, strike nearly parallel to the major fault. The southeastern extension of the fault does not appear to have been adequately explored.

SAN PEDRO MINE

Location.....Sec. 31, T. 12 N., R. 40 E.
Ownership.....H. R. and Ella M. Humphrey, S. Chiatovich, and E. J. Shirley.

Discovery.....1941 by the owners.
Production.....42 flasks to the end of 1942.
Geologic type.....Volcanic.

The San Pedro property consists of a group of three claims located at an elevation of 7,200 feet at the Reese River-Grantsville summit and five miles south of the Nevada Cinnabar mine. After a small amount of exploratory work by the owners, the property was leased in 1942 to Fred Vollmer who shipped a small amount of ore to the Red Rock furnace in Fish Lake Valley. In 1943 Frank Irving leased the property, and later in the same year subleased it to R. B. Dickey who produced a small amount of quicksilver.

Exploratory and development work consists of a 50-foot vertical shaft and a short intermediate level. In addition more than 800 feet of power shovel cuts have been dug near the portal of the shaft and elsewhere over an area of about two acres.

The rock explored by the shaft is a bouldery tuff which is interbedded with ash and tuff beds and is overlain by later rhyolite and andesite flows. The bouldery tuff has a fine-textured matrix, possibly of ash and clay, and contains boulders of rhyolite, conglomerate, argillite, and other rock types whose size ranges from less than an inch to more than five feet in diameter.

The cinnabar for the most part replaces boulders or fills fractures in boulders in the bouldery tuff; locally it occurs in bunches and veinlets in the tuffaceous matrix. The bouldery tuff layer is apparently lenticular or faulted off, as more than half a dozen shovel cuts in the vicinity of the main shaft fail to expose this bed.

The ore deposit explored by the vertical shaft appears to be the only one known on the property. Ore at the bottom of the shaft is reported to have averaged less than four pounds to the ton, whereas the surface and near-surface ore averaged about 12 pounds to the ton. No local control for the ore body is known, but the small dimensions suggest it is possibly an old fumarolic vent.

TWO INJUN PROPERTY

Location.....Sec. 11, T. 12 N., R. 39 E.
Ownership.....Ben and Trueman Collins.
Discovery.....1940 by Collins brothers.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Two Injun property is about one mile west of the Mercury Mining Company mine in a small canyon tributary to Sheep Canyon, and it is adjacent to the Indian Johnnie Dick property.

Since locating the property in 1940 the owners have done a small amount of development and erected a single-pipe retort.

Development work consists of several scattered trenches which explore silicified limestone and conglomerate. Cinnabar occurs as disseminated crystals in the gouge of a northerly trending fault zone.

WAR CLOUD PROPERTY

The War Cloud property is in Boneta Canyon about 10 miles north of Ione; it has not been visited. The owners, Obie La Favor and J. F. Schweble, have reportedly found small amounts of cinnabar in rhyolite and obsidian, and are said to have recovered small amounts of quicksilver from a single-pipe retort.

YELLOW CAT MINE

Former names....Golden Fleece.
Location.....Sec. 1, T. 12 N., R. 39 E.
Ownership.....John Connelly of Tonopah.
Production.....Small.
Geologic type.....Interbedded sediments—limestone.

The Yellow Cat mine is at the head of Shamrock Canyon about a half a mile north of the Mercury Mining Company mine. Reportedly, in 1930, the property was leased to Glenn Mills who recovered quicksilver from retorts. In 1942 James Corlett did some development work, but in 1943 the property was idle.

The mine is developed by a shallow shaft connected with about 150 feet of drifts extending southward from the bottom of the shaft. The rocks of the area consist of interbedded shales and limestones of Triassic (?) age, and cinnabar occurs as high-grade veinlets and lenses in an irregular northerly trending shear zone.

UNNAMED DISTRICT

BLACK HAWK MINE

Former names....Mellan, Mellan and Reid.
Location.....Sec. 13 (?), T. 2 S., R. 53 E.
Ownership.....Mrs. Hazel Mellan of Tonopah.
Discovery.....1929.
Production.....68 flasks to the end of 1943.
Geologic type.....Interbedded sediments.

The Black Hawk property, consisting of seven claims, is in the south end of the Quinn Valley Range and lies within the limits of the Tonopah Bombing and Gunnery Range. The property is on the west side of the summit about one mile north of the Pioche road. It has been worked intermittently in the past by J. Mellan and several lessees, and the production recorded for the property in 1930 and 1935 is believed to have come from ore treated in a 2-pipe D retort. The property was idle in 1943 and has not been examined.

The underground workings consist of a vertical shaft about 100 feet deep, with adits on two levels and several connecting stopes and raises.

The rocks in the area are sandstone and limestone cut by quartz veins. The cinnabar is reported to occur as botryoidal masses along the contact of the sandstone and limestone. Ore of retort grade is said to remain on the dump.

FALLINI PROPERTY

The Fallini property consists of two claims, Mercury No. 1 and No. 2, located a short distance north of the Black Hawk property. Development work is said to have exposed scattered showings of cinnabar in limestone.

OSWELL PROPERTY

About five miles east and a short distance south of the water tank at Cedar Springs in the north end of the Belted Range showings of cinnabar are reported to have been found by Mr. Oswell of Tonopah.

UNNAMED DISTRICT

HORSE CANYON MINE

Former names....Magee Mercury, Inc.
Location.....Secs. 8 and 9, T. 9 N., R. 42 E.
Ownership.....Charles J. Pearce of Oakland, California.
Discovery.....1937 by C. J. Pearce, C. A. and J. C. Humphrey, and E. E. Seyler.
Production.....46 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone and shale.

The Horse Canyon mine is near the head of Horse Canyon which is a tributary to Peavine Canyon in the southern part of the Toyabe Range; the mine is about 14 miles northwest of Manhattan. The present Horse Canyon property consists of a group of eleven claims that were originally divided into two groups—the Lida and Lucile groups. The seven claims making up the Lida group were originally located by C. A. and J. C. Humphrey and E. E. Seyler in 1937, and the Lucile group of four claims was located by C. J. Pearce and H. H. Magee the following year. Prior to 1941 the two groups produced a total of 23 flasks of quicksilver from retorts. In 1941 the Lida group was sold to Magee Mercury, Inc., and in 1942 a 20-ton rotary furnace installed

on the property yielded 23 flasks. Early in 1943 Magee stopped mining and removed all the equipment. Later in the year Pearce bought Magee's interest and was planning to resume mining in 1944.

Two areas have been developed. The east workings on the Lucile claims are about 200 feet above, and east of, the main canyon. They include a 325-foot adit with a raise to a surface pit and a second steep inclined raise from the face. The west workings on the Lida group of claims lie west of the main canyon and are more extensive but scattered and partly caved.

The oldest rocks of the area are Paleozoic (?) thin-bedded contorted and broken beds of limestone, shale, and chert conglomerate. These rocks contain all of the known ore bodies. Unconformably overlying the sediments is a 75-foot bed of andesitic tuff which is altered and poorly exposed; overlying the tuff is a thick flow of glassy rhyolite which strikes west and dips steeply southward.

Apparently no large ore bodies have been found. Cinnabar occurs in poorly developed shear zones in shale and leached sandy limestone partly as veinlets up to three-eights of an inch in thickness but more abundantly as disseminated crystals and thin films. The small stope in the west workings was mined over a width of two to six feet and to a depth of twenty feet, but, judging from walls and pillars, most of the cinnabar was confined to narrow-sheared zones only a few inches wide.

UNNAMED DISTRICT

FINGER ROCK PROSPECT

Location.....Sec. 29, T. 11 N., R. 36 E.
Ownership.....Unknown.
Discovery.....1934 by Clyde Garrett.
Production.....A few flasks.
Geologic type.....Volcanic.

The Finger Rock prospect is on a group of three claims in the northwestern tip of Nye County and about six miles south of Brucite. The property was largely developed by the Finger Rock Quicksilver Company in 1935–1936. Late in 1936 H. E. Grohs purchased the property, and by treating ore in a 20-ton portable rotary furnace he recovered a small amount of quicksilver. In 1942 the property was reported to be leased by a Mr. Hanley, but in 1943 it was apparently idle.

The workings consist of a small glory hole tapped by a short

adit, a second adit about 250 feet long, and several shorter adits.

The rocks exposed in the underground workings consist of locally silicified and iron-stained breccia and tuff whose poorly defined bedding indicates variable low-angle dips. The most favorable site for ore deposition appears to have been a 3-foot fracture zone which trends northwesterly and is nearly vertical. Cinnabar occurs with jarosite as small disseminated crystals in the broken zone.

ORMSBY COUNTY

No quicksilver has been produced in Ormsby County. However, small amounts of cinnabar have been panned from the Carson River, and one prospect has been located on the northwest flank of McTarnahan hill overlooking the river.

UNNAMED DISTRICT

VALLEY VIEW PROPERTY

Location.....Sec. 15, T. 15 N., R. 20 E.
Ownership.....J. S. Jewett and V. Cunningham.
Production.....None.
Discovery.....1942 by the owners.
Geologic type.....Metamorphic.

The Valley View prospect is on a group of five claims, six miles southeast of Carson City on the northwest flank of McTarnahan Hill. The property was first located in the 1870's for lead and silver and at that time a small amount of development work was done. Little is known of subsequent operations, however, until 1942 when the owners further explored the area for silver, lead, and tungsten. During this later exploration a small amount of cinnabar was discovered.

The rocks of the area are mildly metamorphosed slates and locally silicified and iron-stained breccia and tuff whose poorly defined bedding indicates variable low-angle dips. The most favorable site for ore deposition appears to have been a 3-foot fracture zone which trends northwesterly and is nearly vertical. Cinnabar occurs with jarosite as small disseminated crystals in the broken zone.

PERSHING COUNTY

Pershing County with a production of over 14,000 flasks ranks first among the quicksilver producing counties in the State. At least nine districts in the eastern half of the county are known to contain cinnabar, but only three of them have yielded more than 1,000 flasks of quicksilver.

The most productive district is the Antelope Springs (Relief) district which has yielded almost 10,000 flasks of quicksilver. It contains the well-known Pershing and Red Bird mines which were major producers in 1943 and also contains the very productive, but now inactive, Juniper (Nevada Quicksilver) mine. Other notably productive districts, which were comparatively inactive in 1943, are the Goldbanks and Mt. Tobin districts.

ANTELOPE SPRINGS DISTRICT

The Antelope Springs (Relief) district which is on the southern end of the Black Range about 16 miles east of Lovelock is primarily a quicksilver district. Cinnabar was discovered in the area at least as early as 1907, and during 1914–1917 several hundred flasks were recovered from two banks of retorts. Thereafter the district was comparatively inactive until 1928–1929 when production from the Juniper and Pershing mines made it one of the most productive quicksilver districts in the United States. For the following ten years most of the mines were inactive, but, in response to rising quicksilver prices, the Pershing and Red Bird mines were reopened in 1941 and have since produced substantial amounts of quicksilver. The total production of the district to the end of 1943 is nearly 10,000 flasks.

The district has been examined by several men since it became an important producer in 1928, and the reader is referred to articles by Tyler,[56] Gould,[57] and Schuette[58] for additional information. In preparation for a U. S. Geological Survey strategic mineral bulletin, in 1941, the district was mapped by Carle Dane and the geology of the mines was mapped by Robert Yates. The writers were greatly aided by Dane's manuscript report and the accompanying maps.

The rocks of the area comprise a very thick sequence of Upper

[56] Tyler, Paul, Mineral resources U. S., 1928, pt. 1, pp. 270–273, 1929.
[57] Gould, H. W., Nevada Quicksilver Mines, Inc., operates new plant: Eng. and Min. Jour., vol. 127, pp. 7–9, 1929.
[58] Schuette, C. N., Occurrence of quicksilver ore bodies: Am. Inst. Min. and Met. Eng., Tech. Pub. 335, pp. 40, 41, 1930.

Triassic and Lower Jurassic sediments which includes thick beds of shale, limestone, sandstone, and a curious conglomeratic dolomite. Locally these rocks are intruded by small sills and dikes of diabase that are believed to be Jurassic in age. These rocks are folded and complexly faulted into a series of northwesterly trending ridges which normally have a resistant core of either limestone or dolomite. Slightly tilted flows of Pleistocene (?) basalt mantel the northern part, and in the southern part there are deposits of Pliocene (?) fanglomerate.

The ore bodies have been found only in limestone or dolomite near faults with comparatively small displacement. The richer ore bodies, such as those of the Juniper and Red Bird mines, are due largely to the replacement of limestone by cinnabar and are classed as belonging to the limestone type of deposit; whereas the lower grade but more extensive ore bodies of the Pershing and Montgomery mines are largely due to the filling of fractures in dolomite and sandstone by cinnabar and are classed as belonging to the sedimentary type of deposit.

BUNKER HILL GROUP

Former names....Henry-Olesen Lease.
Location.....Cor. Secs. 29, 30, 31, and 32, T. 27 N., R. 34 E.
Ownership.....O. H. Olesen and C. E. Grella of Lovelock.
Discovery.....1928 (?).
Production.....Small.
Geologic type.....Interbedded sediments—limestone.

The Bunker Hill group of six claims and two fractions is less than a mile northwest of the Juniper mine. The property was first developed in 1932 by Henry and Olesen, and in 1936–1939 was operated by O. H. Olesen and C. E. Grella who reported producing six flasks of quicksilver.

The upper workings consist of scattered pits and a 75-foot shaft, and a long tunnel driven about 100 feet below these workings explores the ore zone at depth. The workings are in gray to black limestone with some interbedded shale. Crystalline cinnabar occurs with small calcite veinlets in the limestone, is locally disseminated in the limestone, and forms crusts along fractures in some of the more broken rock.

CRAWFORD PROSPECT

Location.....Sec. 15, T. 26 N., R. 34 E.
Ownership.....Unknown.
Production.....Very small.

Geologic type.....Interbedded sediments—dolomite and sandstone.

The Crawford prospect is about one-quarter of a mile east of the main workings of the Montgomery mine. The majority of the development work was apparently done in 1940 by G. W. Crawford who operated under a lease from O. H. Olesen and is reported to have recovered one flask of quicksilver.

The workings consist of a short inclined adit that extends to a depth of 25 feet and connects with a drift which trends northwesterly along a faulted contact for about 400 feet. These workings explore a sharply downfolded, and locally faulted, bed of buff sandstone which is overlain and underlain by conglomeratic dolomite. The ore is in both the sandstone and overlying dolomite and is similar in character to the ore of the Montgomery mine which explores the same "horizon" farther to the west.

GOOD SPOT PROSPECT

Location.....Sec. 30, T. 27 N., R. 34 E.
Ownership.....Harold's Club Mining Company, Raymond I. Smith of Reno, Manager.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Good Spot prospect is about a mile northwest of the Juniper mine on a group of three claims. The presence of cinnabar on the property has been known for many years, but little development work was done until 1941, when Albert Smith, finding the claims abandoned, restaked the ground and exposed better showings. In 1941 and 1942 the property was leased by several individuals who did little work. Late in 1942 the property was taken over by the present owners who leased it to Homer Barnes and M. E. Fayhe. Although there is a 2-pipe retort on the ground, apparently no quicksilver had been recovered by the end of 1943.

The property is explored by two shafts, a short drift, and erratic bulldozer cuts. Small amounts of cinnabar have been found in a fault zone and in veinlets in black limestone of Upper Triassic age.

JUNIPER MINE

Former names....Benedict Mine, Nevada Quicksilver, Nevada Quick.
Location.....Sec. 32, T. 27 N., R. 34 E.
Ownership.....Harold's Club Mining Co., Raymond I. Smith of Reno, Manager.
Discovery.....1923 by E. M. Benedict.

Production.....3,259 flasks to the end of 1943.
Geologic type.....Limestone.

The Juniper property was first located in 1923 by E. M. Benedict who shortly thereafter put down an inclined shaft which passed within a few feet of the rich ore body he struck by lateral exploration several years later. In 1927 the property was bought by L. A. Friedman who organized the Nevada Quicksilver Company and developed the property to such an extent that it became one of the leading producers in the country during 1928–1929. A 40-ton rotary furnace, installed in September 1928 and operated until 1930 on ore from the Juniper mine, yielded nearly 3,000 flasks of quicksilver. In 1931 Joe Huntley and Joe Forbes leased the property and recovered small amounts of quicksilver from the margin of the old stopes, but the property remained essentially inactive until Basil Prescott obtained a lease in 1941 and, after unwatering the mine, did extensive diamond drilling. However, he apparently found no ore for the lease was dropped in 1942. Late in the same year the present owners acquired the property and installed a 20-ton rotary furnace, but they made no effort to develop the mine in 1943.

The principal workings of the mine connect with a two-compartment 45° inclined shaft with a reported vertical depth of about 335 feet, but all workings below 250 feet were flooded when the mine was examined. Levels extend from the shaft at vertical depths of 95, 161, 193, and 229 feet, and published maps indicate other levels at depths of approximately 260, 300, and 330 feet. The total length of drifts and crosscuts is reportedly more than a mile, but only about 2,500 feet were accessible in 1943. The ore came mostly from two stopes now considerably caved. The larger stope nearly reached the surface north of the collar of the northeasterly trending shaft and from there pitched easterly at about 45°, crossing the shaft just above the 95-foot level, and tapering out above the 161-foot level east of the shaft. A smaller horizontal stope lies approximately normal to the shaft between the 161- and 193-foot levels. (See Plates 17 and 18.)

The workings are in beds of Upper Triassic limestone conglomerate and overlying shale which strike approximately N. 35° W. and dip about 45° northeastward. The limestone-shale contact that was followed in the search for ore is in most places more or less faulted, but locally it is apparently a normal contact. A prominent easterly trending vertical fault which has offset the limestone shale contact was of importance in the localization of the major ore body, and other diverging steep faults aided in forming openings for the deposition of cinnabar.

Cinnabar, the only quicksilver mineral seen in the mine, occurred in limestone as very rich bunches and pods and also formed disseminated crystals in white calcite veinlets cutting the limestone. Some of the ore from the upper parts of the mine contained considerable stibnite, and in the lower levels scattered pods of ore are reported to have contained an even higher percentage of stibnite.

Both of the ore bodies lay in the limestone conglomerate close beneath the contact with the overlying black shale, but in few places does the ore actually extend upward far enough to be in direct contact with the shale. The largest ore body was localized between two intersecting oblique steep faults, into whose common crush zone the ore-forming solutions were guided by an inverted trough of shale formed by drag along the larger fault. The smaller ore body was localized in the limestone conglomerate beneath a flat segment of the shale-limestone contact, and probably was also partly controlled by a branch fault, but caving in the stope prohibited detailed study.

The average grade of all of the ore removed from the mine is about 20 pounds of quicksilver to the ton, but much of the ore was richer than this. A single day's run of 40 tons of ore from the large stope is said to have yielded 44 flasks of quicksilver.

MONTGOMERY MINE

Location.....Sec. 16, T. 26 N., R. 34 E.
Ownership.....O. H. Olesen of Lovelock.
Discovery.....1924 by N. Adamson (?).
Production.....About 500 flasks; production recorded with Juniper mine.
Geologic type.....Interbedded sediments—dolomite and sandstone.

The Montgomery mine is about 1,500 feet southeast of the Pershing mine on the continuation of the same ridge. (See Plate 17.) In 1929 the property was sold by W. A. Montgomery to the Nevada Quicksilver Company which was then operating the Juniper mine and furnace. This company developed the Montgomery mine and trucked ore to its furnace until the Juniper mine was closed down in 1931. The production record is confused, but probably most of the 300 flasks of quicksilver recovered in the Juniper furnace in 1930–1931 came from ore from the Montgomery mine. In 1933–1935 the property was leased by C. W.

Cramer who recovered some quicksilver. In 1939 Ben Jackson had a lease and installed the 6-pipe retort still on the property in 1943. Since 1939 it has been worked by various lessees who have recovered a few dozen flasks of quicksilver each year.

Most of the workings lie on four levels closely following a single contact which is a part of a gently plunging anticline. These workings total nearly 3,000 feet in length and attain a depth of over 100 feet, but all of them below a depth of 80 feet were flooded when the mine was examined in 1942.

The rocks explored by the mine consist of a thin layer of buff or yellowish sandstone overlain and underlain by beds of conglomeratic dolomite. The thick upper dolomite is normally overlain by red shale, but in the vicinity of the Montgomery mine the only observable contacts between these rocks are faulted. The hill that contains the mine is dominantly a broad asymmetrical anticline whose axis trends about N. 60° W. Within the anticline, and exposed in the workings, are several broken zones and faults of small displacement.

The ore mineral is cinnabar which is mostly of the orange-red pulverulent variety that is often suspected of being of supergene origin. Stibnite, antimony oxides, barite, ankerite, and quartz accompany the ore in small amounts.

The ore has been localized along the upper contact of the buff sandstone and in the overlying dolomite. The crest of the anticline is not as highly mineralized as is the northeastern limb, and the ore appears to be the richest where the anticline is crossed by numerous fractures. Probably most of the mined ore was of low grade, but in 1942 hand-sorted ore treated in retorts was said to have averaged better than six pounds of quicksilver to the ton.

It is quite probable that elsewhere in the anticline along the same contact are other ore bodies similar to those that have been mined. Another place which should be equally as favorable for ore deposition is the intersection at depth of the fault exposed in the northeasternmost workings with the top of the buff sandstone.

PERSHING MINE

Former names....Lovelock Quicksilver, Adamson property.
Location.....Secs. 8, 9, 16, and 17, T. 26 N., R. 34 E.
Ownership.....Pershing Quicksilver Company, H. B. Chessher, President.
Discovery.....1912 by Chris Mattevich.
Production.....4,173 flasks to the end of 1943.
Geologic type.....Interbedded sediments—dolomite and sandstone.

Although the ore of the Pershing mine was discovered in 1912 there is no record of its having been mined prior to 1916 when the property was acquired by the Lovelock Quicksilver Mining Company. This company installed a bank of twelve 12-inch retorts and during 1916–1917 recovered about 150 flasks of quicksilver. Following this early period of activity the claims were abandoned, but in 1922 the ground was relocated by C. H. Baker and E. P. Walker who, in 1926, sold the property to the individuals who organized the Pershing Quicksilver Company. In the following year extensive development work was done under the direction of W. D. Adamson, and in 1928 a 60-foot Gould rotary furnace was installed and operated. Early in 1929 the capacity of the plant was increased by the addition of an 8-hearth (80-ton) Herreshoff furnace. From 1928 until May 1930, when the plant was shut down because of the low price of quicksilver, 2,396 flasks were recovered. The mine again remained idle until late in 1941, but during 1942–1943 under the able management of L. R. Messer it produced an additional 1,646 flasks of quicksilver. Late in 1943 the present owners obtained control of the Pershing Quicksilver Company, but they operated the mine for only a few months in 1944.

The mine explores parts of two narrow northwesterly trending eschalon ridges about two miles long. (See Plates 19, 20, and 21.) The principal workings consist of several long adits connected by raises to underground stopes which in several places extend upward to large glory holes. Several shafts have been sunk to a depth of nearly 100 feet below the haulage levels, but little ore has been recovered from these. The total length of the seven longest adits is in excess of 7,000 feet.

The rocks that are explored by the workings are Upper Triassic sediments which are cut by a few small diabasic dikes and sills. The strike of the beds is northwesterly, parallel to the length of the ridges, and in most places they dip at moderate angles to the northeast. Regional stratigraphic studies in progress suggest the entire sequence may be overturned, but for ease of visualization the units will be treated herein as though they lay in their normal order.

The lowest unit, exposed on the southwest side of the ridges is a variegated shale which has a thickness of more than 150 feet. It is overlain by about 75 feet of gray to black sandstone, but the intervening contact appears to be everywhere somewhat faulted. The steep cliffs and ragged knobs along the crest of the ridge are formed in overlying conglomeratic dolomite which has a

variable thickness of from 10 to more than 100 feet. A thin layer of buff-colored sandstone lies between the sandstone and dolomite in most places and is followed as a "key bed" in the underground mining. However, along the southern part of the ridge, because of differences in sedimentation, a thick sequence of the conglomeratic dolomite lies below the buff sandstone "key bed." The dolomite is overlain by a red shale which covers the more rounded northeast-facing slopes.

The area has been affected by a long succession of folding and faulting, but only the structures which played a part in the localization of the larger ore bodies lying between the furnace and the camp will be discussed. Along this part of the ridge the sediments are sharply folded, and a steep fault which dips southwesterly nearly parallels the steep limb of the fold. The fault is a reverse fault with considerable displacement in the southeastern part of the ridge, but it appears to become a normal fault in the northwestern part of the ridge. (See Plate 20.)

The commercially important ore mineral is cinnabar, but quite possibly small amounts of other mercury minerals are present. Other sulfide minerals occurring only locally include stibnite, pyrite, sphalerite, and galena. Gangue minerals are nowhere prominent; probably the most abundant is microcrystalline quartz which replaces the dolomite along faults, but more obvious minerals occurring in veinlets or small vugs include ankerite, dolomite, calcite, barite, and quartz.

Ore bodies occur where cinnabar fills numerous irregular fractures or, as is less common, is disseminated as crystals in the unbroken rock. Most of the ore bodies lay in the conglomeratic dolomite just above the buff sandstone; some formed in the buff sandstone; and a few have been found in the underlying black sandstone and at the top of the dolomite close beneath the overlying red shale.

The largest ore body lay in the footwall side of the main fault near the haulage level, but along the crest of the ridge it lay in the hanging-wall side. The better ore was probably localized, but, as is often the case where several ore bodies lie along the same zone, most of the rock in the zone has been stoped. The length of the zone of nearly connected stopes lying above the main level is more than 1,000 feet; the average stope width perhaps 15 feet; and the average height perhaps 40–50 feet. (See Plate 21.)

Probably not all of the ore bodies in the vicinity of the mine have yet been found; the best places for exploration are the intersections of the northwesterly trending steep faults with the dolomite just above the buff sandstone.

RED BIRD MINE

Former names....Dolbear, Antelope Springs, Rowland-Young, Newton-Burney, Berg-Chapman.
Location.....Secs. 28 and 33, T. 27 N., R. 34 E.
Ownership.....P. Rowland and the Estate of R. S. Young.
Discovery.....1907.
Production.....1,463 flasks to the end of 1943.
Geologic type.....Limestone.

The Red Bird mine is in the northern part of the district about one mile northeast of the Juniper mine. Although the deposit was discovered in 1907 there is no record of production prior to 1914 when it was operated as the Dolbear mine and yielded about 200 flasks from a bank of twelve pipe retorts. The following year the name was changed to the Antelope Springs mine by its owner, J. F. Sweet, and a small amount of quicksilver was recovered. After 1918 G. H. McCormick owned the ground and packed ore on burros down from the mine to the retort site, but his production is not on record. The property then remained idle until about 1927 when it was leased from Rowland and Young to L. C. Newton and E. N. Burney who operated for several years as the Antelope Springs Mercury Mines, Inc. In 1929 they installed retorts near the mine and in 1930 put up a peculiar 20-ton conical rotary furnace, but they ceased operating in 1931 after recovering less than 200 flasks of quicksilver. Following this period of activity the Red Bird mine was operated only intermittently until it was optioned from P. Rowland and R. S. Young by the Harold's Club Mining Company in 1941. Since 1941 the mine has been actively exploited and considerable amounts of quicksilver have been recovered from retorts and from the 20-ton rotary furnace moved from the Mt. Tobin mine to the furnace building of the old Nevada Quicksilver mine.

The workings consist of about 2,000 feet of adits and other workings most of which are on a main haulage level and an adit 70 feet above. The stopes and an intermediate level on which most of the mining was being done in 1943 lie between these levels. Another short adit with two drifts and a caved stope lie higher up the slope 150 feet above the haulage level. (See Plate 22.)

The workings lie in Upper Triassic limestone conglomerate and shale folded into a syncline which strikes about N. 70° W. Several normal faults, none of which have more than 20 feet of displacement, strike nearly parallel to the syncline and in places have localized the deposition of cinnabar.

The dominant quicksilver mineral is cinnabar which occurs in

both crystalline and earthy forms, but the ore is reliably reported to contain some native mercury. Several of the larger ore bodies contained considerable amounts of bindheimite—a hydrous lead antimonate—which, according to Mr. J. J. Fahey* of the Geological Survey, is probably mercurial. Primary sulfides present in only small amounts are pyrite, sphalerite, zinkenite (?), and stibnite; oxidation products include limonite, cerussite, hemimorphite, and various antimony oxides. Gangue minerals are quartz, calcite, and tarnowitzite—a plumbian aragonite.

The ore bodies which were localized in the limestone and limestone conglomerate close beneath the relatively flat-lying shale along the trough of the syncline were of two types. One type, mined in the old northern stope, was about 8 feet wide, 75 feet long, and extended about 70 feet up the slope from the intermediate level. Most of the ore was formed by veinlets and disseminated crystals of cinnabar in a body of crushed limestone lying between two faults. The second type, mined in the larger new stope in the western part of the workings, lay in a pipe-like body extending from just below the intermediate level to the shale capping. Most of this ore was vuggy and contained much pulverulent cinnabar together with bindheimite and the other oxidation products listed above. Its localization was possibly controlled by a pre-existent lead-zinc ore body.

S. & J. MINE

Location.....Sec. 32, T. 27 N., R. 34 E.
Ownership.....Ira Stanley and J. A. Jurgenson of Lovelock.
Discovery.....About 1931.
Production.....Small.
Geologic type.....Interbedded sediments—limestone.

The S. & J. mine lies on 160 acres of patented ground about a quarter of a mile to the southeast of the Juniper mine. Little early history of the property is definitely known, but probably the mine was first developed by Joe Huntley and Joe Forbes in 1932. In the summer of 1943 a 2-pipe retort was being operated, but the mine was reported to be idle late in the year.

The main workings consist of a long adit and crosscut exploring limestone conglomerate close to the contact with the overlying shale that "capped" the ore at the nearby Juniper mine. Some cinnabar was seen occurring as disseminated crystals in the limestone conglomerate and in bunches in the coarsely crystalline white calcite veins that cut the limestone in the underground workings.

*Personal communication.

BLACK KNOB DISTRICT

The Black Knob district about 12 miles east-northeast of Lovelock is best known as containing the formerly productive Sutherland antimony mine. However, a small amount of quicksilver is said to have been recovered in 1914–1918 from a deposit lying near the antimony mine. In 1929 a second occurrence of cinnabar was discovered.

PAYMASTER PROSPECT

Location.....Sec. 14, T. 27 N., R. 33 E.
Ownership.....Unknown.
Discovery.....1929 by Ben Dewitz and E. W. Dingee.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Paymaster prospect is about two miles by road east of the Sutherland antimony mine. The property was developed by E. W. Dingee, Ben Dewitz, and J. C. Foster in 1929–1932, but apparently it never reached the productive stage.

The main workings consist of a 50-foot inclined shaft and several small trenches along a single zone. A few hundred feet south of these workings are other trenches which explore limestone overlain by a gently inclined basalt flow.

The rocks in the vicinity of the workings consist of beds of limestone, limestone breccia, and conglomerate; they are somewhat contorted, but in general strike N. 25°–45° W. and dip steeply northeastward. The main workings follow a bedding plane shear that dips about 65° to the northeast. Cinnabar occurs as disseminated crystals in the limestone close to the shear plane and with dolomite and ankerite in small cross fractures. No workable ore bodies have been found, but selected specimens are of good retort grade.

GOLDBANKS DISTRICT

The Goldbanks district, which is in a group of low hills 34 miles south of Winnemucca, was first exploited for gold ores discovered in 1907. About 1912 quicksilver ore was discovered a few miles west of the gold deposits, and during the first World War the Goldbanks quicksilver mine yielded over 1,000 flasks of quicksilver. Since then, although a few other deposits have been prospected, only small amounts of quicksilver have come from the district.

The rocks in the district are late Paleozoic sediments intruded by Jurassic (?) granite and overlain by Tertiary volcanic rocks. The larger ore bodies occur in the volcanics and are of the opalite

type, but in the southern part of the district cinnabar has been found in the Paleozoic sediments.

GOLDBANKS QUICKSILVER MINE

Location.....Sec. 14, T. 30 N., R. 38 E.
Ownership.....Bradley Mining Company.
Discovery.....1912 (?).
Production.....1,563 flasks to the end of 1943.
Geologic type.....Opalite.

The Goldbanks quicksilver mine lies 34 miles south of Winnemucca in the group of low hills that separates Grass Valley from Pleasant Valley. The deposit was first developed in 1913 by the Nevada Quicksilver Company, and in the following year the same individuals operating as the Goldbanks Quicksilver Company produced nearly 400 flasks from a bank of 15 inclined pipe retorts and a large D retort. During 1915 the company's efforts were confined to development and the installation of a 50-ton 6-hearth Herreshoff furnace which was successfully operated in 1916 and until July 10, 1917, when it was partly destroyed by fire. Although more than 1,100 flasks were recovered from the furnace apparently no effort was made to rebuild it, and the property remained virtually idle until 1937. From 1937 to 1941 Melvin McCoy leased the ground and retorted about 300 flasks of quicksilver. In June 1941 the property was taken over by the Bradley Mining Company and, although considerable development, diamond drilling, and surface stripping had been done by the end of 1943, only small amounts of quicksilver had been recovered from ore hauled to the company's plant at the Opalite mine near McDermitt. In February 1944 the company was reported to have ceased mining and development work.

The Goldbanks deposit was recently studied by Dreyer,[59] and the reader is referred to his report for maps showing the extent of the workings and the local geology. Briefly, the workings consist of an open cut 275 feet long, about 50 feet wide, and averaging perhaps 20 feet in depth, from which short drifts and rooms extend 75 feet to the west and 50 feet to the south. In addition, the area underneath the open cut has been explored by several hundred feet of drifts and crosscuts.

The rocks in the vicinity of the mine are all nearly flat-lying Tertiary and Pleistocene volcanics ranging in composition from rhyolite to basalt. The ore bodies occur in opalite formed by

[59] Dreyer, R. M., Goldbanks mining district, Pershing County, Nevada: Univ. Nevada Bull., vol. 34, No. 1, pp. 7–36, 1940.

silicification of the more acid fragmental rocks lying at the base of the volcanic sequence. Most of the cinnabar is confined to two tabular zones lying parallel to the bedding in the immediate vicinity of the open pit; the upper zone ranges from two to seven feet in thickness, whereas the lower zone lying only a few feet below averages only about two feet in thickness.

Cinnabar in these zones is disseminated through the more opalitic rock and coats fragments and lines fractures in the brecciated chalcedonic rock. Some of the ore is reported to have averaged several percent of quicksilver, but most of it must have contained less than one percent.

OLDTIMER PROPERTY

Location.....Sec. 22, T. 29 N., R. 38 E.
Ownership.....A. J. Coss and Vernon Bell of Winnemucca.
Discovery.....1941 by A. J. Coss and Dan Wootan.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Oldtimer quicksilver property is located about seven miles south of the Goldbanks quicksilver mine near the valley on the east slope of the East Humboldt Range. Apparently most of the development work was done in 1942 by A. J. Coss and Vernon Bell.

Exploratory work has been done at two localities about one-quarter of a mile apart. The northern workings consist of a 50-foot adit trending N. 50° W. and containing a 20-foot inclined winze; about 40 feet south of the portal is a vertical shaft which was not examined. The southern workings consist of a 30-foot open cut and a short adit.

The rocks of the area are dark gray limestone and interbedded quartzite striking N. 30° E. and dipping at low angles eastward. Calcite veinlets, faults of small displacement, and breccia zones formed the sites for ore deposition.

The northern workings explore a small shear zone which trends N. 45° W. and dips 55° to the north; ore on the dump contains cinnabar in fractures in a quartzite breccia and a few pieces contained botryoidal coatings of cinnabar. The southern workings explore a wide brecciated zone containing large irregular masses of calcite and veinlets and disseminated crystals of cinnabar. Some of this ore can be sorted to good retort grade.

PRONTO PLATA PROPERTY

Location.....Sec. 6, T. 30 N., R. 38 E.
Ownership.....H. W. Baldwin of Winnemucca.

Discovery.....1939 by Bob Beko and H. W. Baldwin.
Production.....Very small.
Geologic type.....Opalite.

The Pronto Plata property lies on the summit of the East Humboldt Range just north of Table Mountain, and about four miles west-northwest of the Goldbanks quicksilver mine. The property was first located in 1940, but it has been developed mostly by the Bradley Mining Company who held a lease in 1942. The only production came from test runs of ore hauled to the Bradley plant, and in August 1943 the property was idle.

The workings consist mostly of about 20 bulldozer cuts spaced over an area half a mile square, but a few short adits explore the more favorable places exposed by the bulldozer cuts.

The rocks are nearly horizontal flows and tuffs of Tertiary and Pleistocene age. Cinnabar occurs disseminated in parts of scattered irregular opalite blankets formed by the silicification of rhyolitic ash and breccia. Beneath the opalite is a somewhat more basic tuff and clay that locally contains considerable pyrite, and above the opalite is a flat basalt flow from which Table Mountain takes its name. All ore found by the extensive exploration has been of low grade and erratic distribution.

IMLAY DISTRICT

The Imlay district lies on the west flank of the Humboldt Range near its northern end. It is primarily a gold-silver district, but it contains a single, formerly quite productive, quicksilver mine.

ELDORADO MINE

Former names....Ruby.
Location.....Sec. 25, T. 31 N., R. 33 E.
Ownership.....T. W. Hebbard.
Discovery.....1906.
Production.....971 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone and shale.

The Eldorado mine is at an elevation of about 6,500 feet on the west slope of Star Peak in the northern part of the Humboldt Range. The property is accessible only by about two miles of trail leading from the mouth of Eldorado Canyon. The Eldorado deposit was discovered in 1906 and has the distinction of being the oldest known cinnabar deposit of consequence in the State. However, it did not reach the producing stage until 1913 when it was operated as the Ruby mine and yielded 425 flasks from a 12-pipe retort built in the canyon a mile by trail below the mine. In the following year 347 flasks were recovered, but after the

exhaustion of the rich ore the property remained idle for over 25 years. In 1939 T. W. Hebbard and H. E. Lufek relocated the property and changed its name to the Eldorado mine. In 1941 and 1942 Mr. Hebbard and others produced 199 flasks of quicksilver from ore sorted at the mine and sledded to the retort site.

The workings consist of about 1,000 feet of adits and interconnecting stopes from which all of the ore was mined, two other adits driven to explore beneath the stopes at depths of 80 and 122 feet, and several short exploratory adits above the main stope.

The geology of the deposit was first described by Ransome[60] in 1909. The rocks of the area consist of gray unfossiliferous limestone with thin black shale interbeds; they are presumedly a part of the Star Peak formation of Triassic age. In the vicinity of the stoped area the beds appear to form a shallow northerly trending syncline which has two gentle anticlinal rolls along its trough. No faults of large displacement were observed, but low-angle shears which branch upward from the shale-limestone contact are fairly common. The lower surface of the massive limestone bed lying just above the main stope is deeply pitted by pipe-like holes, which resemble overturned pot holes, into which black shale has flowed and in a few of which cinnabar is concentrated. It has been suggested that the lower surface of the limestone bed formed the back of a solution cave which has subsequently collapsed.

The only ore mineral recognized is cinnabar, but it is quite possible that native mercury or other quicksilver minerals are contained in the fine-grained jet-black shale which has been the principal ore-bearing rock. Visible cinnabar occurs as veinlets, as crystalline coatings on limestone nodules, as painty films, and as disseminated crystals in the black shale and limestone. Mineral associates include calcite, quartz, jarosite, pyrite, and some clays.

The concentration of cinnabar was primarily controlled by a rolling nearly flat contact between shale and overlying massive limestone; low-angle splits from this contact also contained some ore. Most of the ore came from a shaly zone about one foot thick that yielded about 2 percent of quicksilver, but the ore was probably rather carefully sorted to reach this grade. The ore retorted in 1941–1942 was largely recovered from dumps and from robbed pillars.

[60] Ransome, F. L., Notes on some mining districts in Humboldt County, Nevada: U. S. Geol. Survey Bull. 414, pp. 45, 46, 1909.

MOUNT TOBIN DISTRICT

The Mount Tobin district is about 50 miles south of Winnemucca on the west side of Pleasant Valley in the central part of the Tobin Range. Cinnabar was first discovered in the district prior to 1918, but the only large ore body—the Mt. Tobin mine ore body—discovered by J. D. and V. A. Thornton in 1929 was not worked on a large scale until the mine was taken over by H. W. Gould & Co., in 1940. The total production of this mine is 1,491 flasks of quicksilver.

The country rocks are pre-Tertiary sediments capped by Tertiary (?) volcanics and mantled by Quaternary terrace gravels and recent alluvium. The ore deposits are of the sedimentary type and are localized in the pre-Tertiary sediments by faults, fractures, and bedding planes.

LAST CHANCE PROSPECT

Location.....Sec. 36 (?), T. 29 N., R. 39 E.
Ownership.....W. L. Low.
Discovery.....1938 by J. D. and V. A. Thornton.
Production.....Small.
Geologic type.....Interbedded sediments—sandstone and shale.

The Last Chance prospect is a mile northwest of the Mount Tobin mine on the west slope of the Tobin Range. Two years after the discovery of this property it was sold to H. W. Gould & Co. About 100 tons of ore were mined, sorted, and treated in the Mount Tobin furnace, but according to reports the grade was low. In 1942 the property was sold to Mr. Low, and in 1943 he had mined and sorted a small amount of ore.

The underground workings trend N. 80° W. and consist of 225 feet of drifts and crosscuts which tap two small glory holes measuring 130 feet by 40 feet by 30 feet deep and 20 feet by 20 feet by 40 feet deep.

Cinnabar occurs as painty films and veinlets associated with small amounts of pyrite in pebbly shale and sandstone which strikes westerly and dips 20° S. The cinnabar is associated with fractures striking N. 30° E. and dipping steeply to the northeast. Most of the cinnabar occurs in the fractures, but locally it extends out along bedding planes.

MOUNT TOBIN MINE

Former names....Miners' Dream.
Location.....Sec. 6, T. 28 N., R. 40 E.
Ownership.....Walter L. Low.
Discovery.....1929 by J. D. and V. A. Thornton.

Production.....1,491 flasks to end of 1943.
Geologic type.....Interbedded sediments—conglomerate.

The Mount Tobin mine is at an elevation of about 6,500 feet at the head of Golconda Canyon on the west slope of the Mount Tobin Range. The property was discovered by J. D. Thornton and son Victor in 1929. Five claims were located, and for the next ten years exploratory work was carried on intermittently. In 1938 they installed a 4-pipe retort and subsequently recovered about 45 flasks of quicksilver. In 1940, H. W. Gould & Co. purchased the property and installed a 20-ton rotary furnace which was operated until the summer of 1942, producing 1,410 flasks of quicksilver. The furnace was then sold and the buildings removed from the property. Mr. Low, the present owner, purchased the claims in December 1942, and in 1943 after doing development and exploratory work he recovered 36 flasks of quicksilver.

The property was mapped by R. J. Roberts and A. E. Granger of the Geological Survey in 1940 and was revisited in the fall of 1942. The writers are indebted to these men for the use of their maps and for permission to abstract their manuscript report.

The underground workings are divided into two groups designated "east workings" and "west workings." The east workings consist of a glory hole and connecting stope about 120 feet long, 40 feet wide, and 45 feet deep, and a 600-foot haulage level about 40 feet below the base of the glory hole. The west workings consist of a shallow glory hole about 100 feet long and 40 feet wide, and a haulage level about 20 feet below. Several bulldozer cuts in the area are too shallow to adequately explore the ground.

The rocks of the area consist of interlayered beds of pre-Tertiary conglomerate and shale, Tertiary (?) rhyolite and tuff, and detrital cover of two ages. Locally the chert conglomerate is leached, and the rhyolite and shale in the vicinity of the west glory hole is highly argillized. The important structures are northerly trending faults of small displacement.

The only ore mineral observed was cinnabar. In the conglomerate it fills fractures and cavities due to leaching and, to a lesser extent, replaces both the pebbles and matrix. In shale and in argillized rhyolite it occurs only as painty films and small disseminated crystals. In old alluvium above the richest ore body cinnabar occurs as angular fragments of botryoidal coatings as much as one-eighth of an inch thick. Chalcedony locally accompanies the cinnabar, and scant pyrite was seen on one of the dumps.

The ore body of the east workings was localized by a northerly

trending fault which dips about 50° to the east. The hanging wall of the fault is weakly mineralized rhyolite and agglomerate; the footwall is altered shale and chert conglomerate. Most of the production of the mine came from the small glory hole and stope on the footwall side of this fault. The ore body appears to be worked out and adequately explored on all sides; it averaged about seven pounds of quicksilver to the ton. The overlying old alluvium on the west end of the glory hole contains enough cinnabar to constitute furnace ore, but this ore probably is not of great extent.

The ore body of the west workings was localized by a series of fractures that trend northeast and dip northwestward at moderately steep angles. Some rich ore was taken from this area, but it appears to have been of narrow width and discontinuous. The average grade of this ore body is reported to have been about 12.5 pounds of quicksilver to the ton.

The extension of the ore-controlling fault of the east workings is very inadequately explored, and, according to Mr. Low, good surface pannings can be obtained to the south of the glory hole.

NORTH FORK PROPERTY

Location.....Sec. 25 (?), T. 29 N., R. 39 E.
Ownership.....J. B. Davis.
Discovery.....1941 by Davis.
Production.....Very small.
Geologic type.....Interbedded sediments—conglomerate.

The North Fork property consists of two claims located two miles northwest of the Mount Tobin mine. A small amount of development work was done by the owner for a short time after its discovery, but in 1942 and 1943 the property was leased to W. L. Low of Winnemucca who did exploratory work and recovered a small quantity of quicksilver from ore retorted at the Mt. Tobin mine. Development work consists of about 120 feet of adits and drifts connected to a 13-foot shaft.

The rocks in the underground workings are sandstone, grit, and conglomerate beds similar to the "pre-Tertiary" beds at the Mt. Tobin mine. The main drift explores a poorly developed fault trending N. 77° E. and dipping 47° to the north. Painty films of cinnabar impart a pink tinge to gouge zones, and locally narrow veinlets and crusts of cinnabar line fractures in the broken area. No ore of retort grade was seen.

PLACERITAS DISTRICT

The placer gravels at Rabbit Hole in the Placeritas district nine miles south of Sulphur are reported to contain small amounts of cinnabar.

ROSEBUD DISTRICT

Near Barrel Springs, in the Rosebud district three miles south of Sulphur, cinnabar is reported by M. R. Klepper[61] of the Geological Survey to occur in placer gravel which also contains small amounts of cassiterite, hubnerite, and gold. In 1943 the placer ground was owned by the Monkota Trust Syndicate, O. Wadell, and Mr. Jensen.

SPRING VALLEY DISTRICT

The Spring Valley district lies on the east slope of the Humboldt Range and includes Spring Valley and American Canyon. The district contains one lode gold mine and numerous placer diggings worked between 1881 and 1895. The abundance of cinnabar in the placer gravels in American Canyon doubtless led to prospecting for quicksilver lodes, and in 1906 several cinnabar deposits were discovered. These yielded a small production in 1910–1911, but the largest mine—the King George or Cinnabar King mine—was most productive in 1930–1931 when about 250 flasks of quicksilver were recovered.

The more productive lodes and best prospects lie in Triassic limestone, but a deposit in altered felsite was the first quicksilver producer in the district.

ALPINE PROSPECT

Location.....Sec. 5, T. 27 N., R. 35 E.
Ownership.....H. E. Simpson and Jack Omar.
Discovery.....1924 by Mr. Lawrence.
Production.....1 flask to the end of 1943.
Geologic type.....Interbedded sediments—limestone.

The Alpine prospect is six miles south of Fitting on the southeast slope of the Humboldt Range just north of Buffalo Peak. It lies a few hundred feet above the floor of the south branch of Troy (Fisher) Canyon and is accessible only by trail. The property was developed by Mr. Lawrence in 1924, Mr. Wiley in 1926, Bert Downing in 1928, and Frank Tessier and O. E. Swan in 1930. About 1940 the present owners restaked the ground, but they have done little development work. It is reported locally that a small amount of quicksilver was recovered from hand-sorted ore treated at Fitting.

The workings consist of a 25-foot inclined shaft and a few open cuts lying in Triassic limestone striking N. 10° E. and dipping

[61] Oral communication.

55° eastward. They explore a coarsely crystalline calcite vein that strikes N. 40° E. and dips 50° to the southeast.

Cinnabar forms crystalline bunches in the iron and manganese-stained calcite vein, and small isolated lenses along the contact of the vein and the limestone. No real ore bodies have been found, but the ore in the small scattered lenses is easily sorted to retort grade.

HILLSIDE MERCURY PROSPECT

Location.....Sec. 6, T. 28 N., R. 35 E.
Ownership.....Earl Simpson and Jack Omar.
Discovery.....1941 (?).
Production.....1 flask to the end of 1943.
Geologic type.....Volcanic.

The Hillside Mercury property lies at an altitude of about 5,500 feet one mile south-southeast of Fitting. Reportedly the property was first located in 1941 by the present owners, and when it was visited in the summer of 1943 they were actively developing the mine.

The underground workings consist of an inclined shaft about 30 feet deep and connected at its base with about 75 feet of drifts which trend in a northerly direction.

The rocks are Triassic limestone dipping about 25° eastward and unconformably overlain by a flow of Pleistocene basalt and interbedded ash and tuff dipping gently eastward. The underground workings are in the volcanic rocks just above the contact with the underlying limestone.

The ore body explored by the workings consists of scattered stringers and disseminated crystals of cinnabar lying along an irregular shear zone which dips 60°–70° to the west; and, although the present ore body is poorly defined, the geologic possibility of finding a larger ore body in the limestone below the volcanic rock is good.

KING GEORGE MINE

Former names....Harris, Cinnabar King, Cinnabar City.
Location.....Sec. 1, T. 28 N., R. 34 E.
Ownership.....Mrs. Peggy Hamilton Clack of Reno.
Discovery.....1926 by Matt Music.
Production.....322 flasks to the end of 1943.
Geologic type.....Limestone.

The King George mine, better known perhaps as the Cinnabar King mine, lies about two miles south of Fitting on the divide between Spring Valley and American Canyon. The property was

first developed by W. H. Harris in 1926 and was reportedly sold to George S. Clack in 1927. In 1928 Mr. Clack organized the Cinnabar King Mining Company which operated the property until 1931, producing about 250 flasks of quicksilver in retorts and the 15-ton rotary furnace still on the ground. After 1931 the mine was idle except for sporadic lessee activity until 1943 when it was leased by Harold F. Honn who did development but failed to get into production before the end of the year.

The main workings consist of a 440-foot haulage level which connects with an inclined stope extending to the surface about 100 feet above. Other workings in the vicinity have been unproductive.

The country rock consists of a thick easterly dipping bed of Triassic limestone nearly conformably overlain by basic tuffs which are in turn overlain by the basalt flows that form prominent Louderbacks on the east slope of the Humboldt Range. The upper surface of the limestone is irregular, broken, and coated with more than ten feet of limestone boulders; between the boulders and extending downward in fractures and open cracks is altered tuff. Presumedly the tuff accumulated on an erosional surface of limestone nearly devoid of soil.

An irregular vein of coarsely crystalline white calcite of the replacement type extends at an acute angle to the bedding through the limestone, but does not penetrate into the tuff. Several faults of small displacement cut the limestone, and one of these that locally coincides with the limestone-tuff contact is partly responsible for the localization of the ore.

The principal ore mineral is cinnabar which forms striking coarsely crystalline replacements in the white calcite vein and smaller crystals and veinlets in the limestone beyond the vein. Minor amounts of native mercury, calomel, stibnite, and quartz accompany the ore. The ore body was localized at the intersection of the calcite vein and the fault or contact; scattered cinnabar occurs in places away from the vein but close beneath the overlying tuff. The ore mined from the single stope must have been of high grade and very amenable to sorting. The main shoot does not appear to be bottomed.

Minor amounts of cinnabar were found in the tuffs, indicating the mineralization is of Pleistocene or later age and, further, indicating the close association of the white calcite and the cinnabar is due to ease of replacement rather than to contemporaneous deposition of cinnabar and calcite. Other coarsely crystalline veins of white calcite which are fairly common in the district

must be considered to be the most favorable places for ore, but not all such veins can be expected to contain cinnabar.

WALKER MINE

Former names....Dixie, Claybanks, Duplex.
Location.....Sec. 10 (?), T. 28 N., R. 34 E.
Ownership.....Unknown.
Discovery.....Prior to 1908.
Production.....85 flasks (?) to the end of 1943.
Geologic type.....Volcanic.

The Walker mine is near the head of American Canyon about three miles southwest of Fitting. The property is one of the oldest in the State and was examined by Ransome[62] in 1908. Between 1910 and 1916 it was operated by E. P. Walker and yielded 85 flasks of quicksilver from concentrated ore. It is reported that in 1917[63] an attempt was made to mine the deposit for ceramic clay, but impurities made this operation unsuccessful. In 1930 the Claybanks Quicksilver Company operated the mine but apparently failed to produce. In 1943 the property appeared to be abandoned.

The workings consist of several hundred feet of near-surface stopes and connecting drifts, a 700-foot haulage drift more than 100 feet below, and several inclined interconnecting passageways.

The rocks consist of highly sericitized felsite, probably equivalent to the Rochester trachyte, cut by quartz-pyrite-tourmaline veins. A prominent slickensided shear zone that dips north at about 25° is explored by the near-surface workings.

Cinnabar occurs as very small disseminated crystals and painty films close beneath the shear plane and related branching shears. Scant amounts of cinnabar coat quartz crystals in small vugs in the altered felsite. All of the ore was probably of low grade, averaging perhaps a pound of quicksilver to the ton, and apparently all the ore was concentrated before retorting.

The ore is definitely localized by the shear zone, and as the shearing is post-sericitization, the cinnabar cannot be genetically related to the late Jurassic sericitization and silver mineralization as is suggested by Knopf.

UNNAMED DISTRICT

On the west slope of the Stillwater Range between Fencemaker

[62] Ransome, F. L., Notes on some mining districts in Humboldt County, Nevada: U. S. Geol. Survey Bull. 414, p. 37, 1909.

[63] Knopf, A., Geology and ore deposits of the Rochester district, Nevada: U. S. Geol. Survey Bull. 762, pp. 53, 54, 1924.

Canyon on the north and Copper Kettle Canyon in Churchill County on the south are several small quicksilver mines and prospects. One of these, the Rosebud mine, is described under Churchill County; the others lie in Pershing County.

BLACK DYKE PROPERTY

Location.....Secs. 11 and 14, T. 25 N., R. 35 E.
Ownership.....Unknown.
Production.....None.
Geologic type.....Sulfurous.

The Black Dyke property consists of seven claims located about 26 miles east-southeast of Lovelock on the west slope of the Stillwater Range close to Buena Vista Valley. The workings are reached by walking three-quarters of a mile south from the end of the road in the mouth of New York Canyon. There is no record of any quicksilver having been produced at the property, and it was idle when visited late in 1942.

The property is developed by three short adits spaced at about 500-foot intervals along a northeasterly trending zone of shearing and alteration. This shear zone is bordered on the east by granite and on the west by metamorphic rocks, and it is quite possibly one of the main range faults for the Stillwater Range. Locally parts of the rock along the zone are silicified to form resistant ridges. Cinnabar is disseminated in small amounts in both granulated quartz and kaolinized granite; locally it is accompanied by irregular masses of sulfur.

ROMAN MINE

Former names....Williamson and Gartiez.
Location.....Secs. 27 and 34, T. 26 N., R. 36 E.
Ownership.....C. N. Williamson and Charles Gartiez.
Discovery.....1940 by Joe Chabagno.
Production.....162 flasks to the end of 1943.
Geologic type.....Interbedded sediments—limestone.

The Roman mine is on the east edge of Buena Vista Valley south of Fencemaker Canyon and about 30 miles east of Lovelock. In 1941 it was leased from J. Chabagno by C. Baker and R. Jevning who for a few months worked the mine and hauled ore to the retorts of the Montgomery mine in the Antelope Springs district. In 1942 the property was relocated by the present owners who installed a vertical automatic-feed 2-pipe retort and recovered about 100 flasks of quicksilver.

The workings consist of a vertical shaft more than 50 feet deep connected with several hundred feet of short adits and small

stopes. In addition, several drill holes have been sunk in the vicinity of the main shaft.

The property is on a dissected pediment largely covered by alluvium so that little can be seen of the local geology except in the main workings. The rocks consist of interbedded limestone and shale of Mesozoic age. The ore was formed by concentrations of veinlets of cinnabar in limestone beneath a flat-lying bed of shale, but apparently irregular faults of small displacement have offset the shale-limestone contact for the ore bodies were not quite continuous. The ore being treated in October 1942 averaged about 12 pounds of quicksilver to the ton; however, ore obtained earlier in the year was said to have been richer.

STORM PROPERTY

Location.....Sec. 36, T. 26 N., R. 36 E.
Ownership.....Tim Smith, Rene Amat, and Bob Beko.
Discovery.....1941 by Smith, Amat, and Beko.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Storm group of claims is about 30 miles east of Lovelock on the west slope of the Stillwater Range and one-quarter of a mile south of the road through Fencemaker Canyon. The claims were first located late in 1941, and by the end of 1943 development consisted of a 25-foot shaft and three shallow trenches.

The workings explore a zone of alteration and shearing cutting limestone and shale of Mesozoic age. No quicksilver ore was seen on the property.

VICTORY PROPERTY

Location.....Sec. 25, T. 26 N., R. 36 E.
Ownership.....Lewis Dingy and Charles Hauskins.
Discovery.....1943 by Dingy and Hauskins.
Production.....None.
Geologic type.....Interbedded sediments—limestone.

The Victory property is just north of the road through Fencemaker Canyon on the east side of Buena Vista Valley about 30 miles east of Lovelock. It was apparently first located in June 1943 and by the end of the year was still in the prospect stage.

The workings consist of three 10-foot shafts each of which explores a different structure. The rocks of the area are thinly bedded limestones and gray to brown shales of Triassic (?) age. The principal development has been along a sheared limestone-shale contact which strikes N. 18° W. and dips 74° eastward. Coarsely crystalline cinnabar is irregularly disseminated through

the limestone bordering the contact, and, although no ore bodies have been developed, some of the rock removed from the shafts is of good retort grade.

UNNAMED DISTRICT

Half a mile south of Humboldt on the west side of the Southern Pacific railroad is a group of siliceous sinter deposits which have been described by Russel.[64] Specimens of the associated gypsum and sulfur in the Museum of the Mackay School of Mines showed detectable amounts of quicksilver, but no cinnabar was definitely identified.

[64] Russel, I. C., Geological history of Lake Lahontan: U. S. Geol. Survey Mon. 11, pp. 54, 55, 1885.

STOREY COUNTY

Storey County contains a single quite productive mine and several small quicksilver prospects. Virtually all of the quicksilver produced in the county has come from the Castle Peak mine in the Castle Peak district ten miles north of Virginia City. This mine yielded 2,576 flasks of quicksilver, most of which was recovered during 1929–1934. In 1943 the deposits in the county were not being worked.

CASTLE PEAK DISTRICT

The Castle Peak district is about ten miles north of Virginia City in the Flowery Mountain Range. Cinnabar, the most important mineral mined in the district, was discovered in 1927 at the site of the Castle Peak mine. Over 2,500 flasks of quicksilver have been recovered from this deposit, but when the district was last visited late in 1943 the Castle Peak mine and the nearby Washington Hill prospect were idle.

The rocks in the district include pre-Tertiary sediments, Tertiary andesitic volcantic rocks, and late Tertiary or Pleistocene basalt which forms broad mesas and flat-topped ridges. The largest deposits of cinnabar are of the volcanic type and occur in the altered facies of the volcanic rocks, but a small amount of cinnabar has been found disseminated in opalite.

CASTLE PEAK MINE

Location.....Sec. 20, T. 18 N., R. 21 E.
Ownership.....R. Nenzel of Babbit, Nevada.
Discovery.....1927 by H. E. Lufek.
Production.....2,576 flasks to the end of 1943.
Geologic type.....Volcanic.

The Castle Peak mine lies at an elevation of about 5,800 feet on the west fork of Lousetown Creek in the Paradise Range. The deposit was discovered by Hank Lufek in 1927, and in the following year he did development that lead to the blocking out of considerable ore. By September 1929 he had organized the Castle Peak Quicksilver Company and installed a 30-ton rotary furnace. By the end of the year 461 flasks of quicksilver had been recovered from 3,641 tons of ore, averaging 9.6 pounds of quicksilver to the ton. During the following two years 1,480 flasks were recovered from ore mined from above the haulage level. In 1931 and 1932 somewhat richer ore encountered below the haulage level yielded 865 flasks. During 1933, 1934, and 1935 considerable development was done on the lower levels, and ore averaging

about six pounds of quicksilver to the ton yielded 407 flasks. In 1937 the property was leased to Brechtel and Hann, and in 1938 to the Moro Bay Copper Company, but neither of these lessees produced. In 1939 it was leased to the American Quicksilver Company which recovered 66 flasks. Since 1939 the property has been leased to several individuals who produced only small amounts of quicksilver, and in 1943 the furnace was removed. The total production from the mine has been 2,576 flasks of quicksilver recovered from about 23,500 tons of ore averaging 8.7 pounds of quicksilver to the ton.

The underground workings consist of over 3,000 feet of drifts and crosscuts and small stopes on three main levels and several sublevels. Surface workings consist of a glory hole which measures about 100 feet by 60 feet by 35 feet, several small trenches, and three shafts about 45 feet deep. (See Plate 23.)

The rocks of the area consist of pre-Tertiary limy shales, Tertiary undifferentiated volcanic rocks and gray hornblende andesite, and a late Tertiary or Pleistocene flow of olivine basalt.

The pre-Tertiary sediments which strike northerly and stand nearly vertical crop out only in the area to the south of the mine.

The oldest Tertiary rocks are undifferentiated volcanics that include hornblende andesite, andesite agglomerate, olivine basalt, and rhyolite. The hornblende andesite and the agglomerate have been extensively argillized and locally alunitized. Lenticular bodies of olivine basalt interbedded with the altered andesitic rocks are remarkably free from alteration. Rhyolite is not abundant, but one small outcrop lies just north of the furnace. Unaltered gray andesite porphyry overlies the afore-mentioned rocks and apparently is not penetrated by the underground workings.

The only fault of economic importance is the northerly trending fault explored by drifts and the main inclined winze. No offset along this fault could be measured, but the displacement is believed to be small. Near the surface two sets of intersecting joints which trend N. 55° W. and N. 65° E. through the altered volcanic rocks were of importance in localizing ore minerals. These mineralized joints have been followed by the glory hole, the connecting or "dome" stope, the main haulage level, and a stope below the main haulage level.

The principal ore mineral is cinnabar, but considerable native mercury, and less calomel, contribute to the value of the ore. Gangue minerals include clays, barite, several carbonates, pyrite, and possibly marcasite, and gypsum.

Crystalline cinnabar fills fractures as veinlets and fills small

openings due to leaching of the volcanic rocks; the wider cinnabar veinlets in many places contain crystal-lined vugs which locally contain native mercury. In some specimens cinnabar clearly replaces selectively the clay-like alteration products of hornblende and plagioclase phenocrysts, and in some fine breccias it replaces selectively some of the smaller angular fragments. However, most of the cinnabar not in distinct veinlets is disseminated as very small crystals or crystalline aggregates through the altered rock. It seems probable that this cinnabar began to form in minute openings, but increased its size by replacing the surrounding rock.

The ore bodies may be classified on the basis of occurrence into two kinds. One kind includes the ore bodies of greatest value mined in the glory hole, connecting "dome" stope, and a stope immediately below the haulage level. They were localized along two sets of nearly vertical nonpersistent joints intersecting at angles of 60–80 degrees. The joint intersections seem to have been the most favorable loci for ore deposition, but cinnabar also occurred in mineable quantities along individual joints, and locally was disseminated for several feet into the wall rocks. As the ore bodies follow the joint planes they are in part tabular, but at joint intersections they are more pipe-like. The rock mined in the glory hole and upper stopes probably contained sufficient cinnabar disseminated away from the joints so that it all was furnace ore.

The ore bodies of the second kind were of lesser value and were mined from the levels below the haulage level. They were localized by the northerly trending fault which dips 55° to the east, but lenses of ore lay not only in the fault gouge but also in places beneath the gouge and elsewhere along parallel faults in the hanging wall. In contrast to the disseminated type of ore in the upper workings, this ore occurred as small rich pods and veins with sharply defined walls.

Rarely have character changes with increasing depth in quicksilver ore bodies been noted; however, some changes are conspicuous within a vertical interval of 250 feet at the Castle Peak mine. These changes in going from surface to depth consist of an increase in the amount of silicification, native mercury, pyrite, calcite, barite, ankerite, and dolomite (?), and a decrease in rock alteration, and the amount of gypsum, calomel, and disseminated cinnabar.

WASHINGTON HILL PROSPECT

Location.....Sec. 5, T. 18 N., R. 21 E.
Ownership.....Estate of H. E. Lufek of Reno.

Discovery.....1941 (?) by Lufek.
Production.....Very small.
Geologic type.....Volcanic.

The Washington Hill property is in the northern part of the Flowery Mountain Range about three miles north of the Castle Peak quicksilver mine. In 1942 the property was under lease to Dave Livisohn who, in an experimental way, mined ore from an open pit and trucked it to the Southern Comstock Mill at Silver City for concentrating. Although production records are not available, it is safe to assume that no more than a few flasks of quicksilver were recovered.

The workings consist of a small open pit and a 200-foot adit extending directly below the pit. Many shallow bulldozer cuts have been made in the vicinity of the pit and on a hill to the east.

Volcanic rocks and a near-surface intrusive exposed in the area are believed to be of Tertiary age. The oldest of these rocks are fine-grained andesite flows, tuffs, and agglomerates that are cut by the andesitic intrusive; a younger andesite flow unconformably overlies these older rocks. Silicified rocks of two types were formed from the pyroclastics; their differences are believed to be due to differences in the original rocks. One type, a red to purple silicified agglomerate, consists mostly of chalcedony and crops out as prominent lenticular ribs which strike northwesterly. The second type, a white to brown opalite, is in most places confined to the base of the youngest andesite flow.

The rocks are mildly folded and faulted, but the most significant structural feature is the apparent conformity of the silicified ridges and the ore-bearing faults seen in the excavations. The conformity suggests the ore bodies and the generally barren opalite pods were both deposited along northerly trending fractures but not contemporaneously.

Cinnabar occurs as minute disseminated crystals and as small irregular veinlets in altered tuff and agglomerate. A large fractured area in the open cut contains a slight local concentration of cinnabar, and scattered crystals of cinnabar were observed in a resin-colored opalite exposed in the bottom of the open cut. Probably all of the ore mined in the past was of submarginal grade.

UNNAMED DISTRICT

TAYLOR-BRANCH PROSPECT

Location.....Sec. 35, T. 20 N., R. 22 E.
Ownership.....Unknown.
Discovery.....1931 by Clyde Taylor and Fred Branch.

Production.....Very small.
Geologic type.....Volcanic.

The Taylor-Branch prospect lies one mile south of Clark Station, a station on the Southern Pacific railroad in Truckee Canyon, about 36 miles east of Reno. The property was discovered in 1931 by Fred Branch and Clyde Taylor who did little development work until 1940–1941 when they installed a 2-pipe retort and recovered a small amount of quicksilver.

The underground workings consist of a 54-foot inclined shaft and 200 feet of northeasterly trending drifts on the 32-foot level. The surface above the workings has been explored by several open cuts and pits.

The rocks in the area are argillized and locally silicified andesite tuff and breccia overlain by younger unaltered flows of andesite. Cinnabar occurs as scattered crystals in the tuff and fills incipient fractures in the silicified rock. Pyrite occurs as veinlets in scattered chalcedony nodules in the breccia; gypsum and jarosite are fairly abundant in the surface workings.

WASHOE COUNTY

In Washoe County cinnabar has been discovered in small amounts from the southern edge of the county at Steamboat Springs to the northern edge on the Sheldon National Game Refuge. Quicksilver was first mined in Nevada from the Steamboat Springs deposit in the late 1870's, but because of the low grade of the ore repeated efforts to mine the deposit have been unsuccessful. The total production of the county is not definitely known, but it is probably only about 100 flasks of quicksilver.

LONE PINE DISTRICT

The Lone Pine district is in northwestern Washoe County in the southern part of the Sheldon National Game Refuge. Early prospecting for gold disclosed very little of that metal, but the more recent discovery of cinnabar led to the location of a block of 18 claims by Curtes Mathews and W. A. Miller in December 1929.

The geology and ore deposits are discussed in a recent bulletin by Ross.[65] Briefly, the rocks in the district consist of andesitic lava flows and associated tuffs that appear to belong to two lithologic units, both of which are probably of Tertiary age. The only quicksilver deposit is of the volcanic type, as the cinnabar occurs along steep fractures in argillized and iron-stained andesite. When the district was last visited in 1942 inadequate exploratory work had failed to develop other than submarginal ore bodies.

ANTELOPE PROSPECT

Location.....Center of T. 45 N., R. 21 E.
Ownership.....W. A. Miller and Curtes Mathews.
Discovery.....1929 by Mathews and Miller.
Production.....Very small.
Geologic type.....Volcanic.

The Antelope prospect consists of a group of 18 patented claims lying on the top of a block-faulted plateau at an altitude of 6,700 feet. The workings are within the confines of the Sheldon National Game Refuge about six miles south of the refuge headquarters. From the time of the discovery of the property until 1939 little exploratory work was done, but in 1939 the Colton Log and Lumber Company took a bond on the property, did some development work, and reportedly produced a small amount of

[65] Ross, C. P., Some quicksilver prospects in adjacent parts of Nevada, California, and Oregon: U. S. Geol. Survey Bull. 931-B, pp. 24, 25, 1941.

quicksilver from a 10-pipe retort. In 1942 when the property was visited by the writers it was said to be owned by Andy Duke, W. B. Meyer, Walker Borden, Jerry Eisenhauser, Herbert Smith, and Jess Evans of Reno; however, in 1943 it was reported to be owned by W. A. Miller and Curtes Mathews.

The principal workings consist of a 43-foot inclined shaft, two small pits close to the shaft, several pits 525 feet southeast of the shaft, and several bulldozer cuts which only locally penetrate through the overburden to bedrock.

The area is underlain by nearly flat, probably not greatly faulted, lava flows with associated tuffs and agglomerates adequately described by Ross. Cinnabar occurs in greatest abundance along shear zones in somewhat argillized andesitic agglomerate, and one of these shears is explored by the inclined shaft. Development in 1942 was inadequate to reveal the presence or absence of ore bodies of any considerable size that may be concealed beneath the alluvium.

PEAVINE DISTRICT

The Peavine district lying just northwest of Reno has yielded small amounts of precious and base metals in the past 80 years. In 1941 a cinnabar deposit was discovered and worked by three Reno youths, but there is no record of their having recovered any quicksilver. Probably the cinnabar occurred in the Tertiary andesite flows that cover most of the southern part of the district.

STEAMBOAT SPRINGS DISTRICT

The Steamboat Springs district, encompassing the well known hot springs a few miles south of Reno, contains a few occurrences of cinnabar which, although widely known, have yielded little quicksilver. In addition to cinnabar, silica and refractory clays have been mined in the district.

STEAMBOAT SPRINGS MINE

Location.....Sec. 32, T. 18 N., R. 20 E.
Ownership.....Unknown.
Discovery.....1875 by Thomas Wheeler.
Production.....Small.
Geologic type.....Sulfurous.

Steamboat Springs lies between the Sierra Nevada and the Virginia Range, eleven miles south of Reno on the west side of U. S. Highway No. 395. The hot springs area was first located by Felix Monet in 1860. In 1875 the quicksilver and sulfur

deposit about 3,000 feet west of the active hot spring belt was discovered by Thomas Wheeler who sold it to the Nevada Quicksilver Company in 1877. This company erected a furnace and worked the mine for several years, producing sulfur as well as quicksilver. From the time of this early attempt at mining until 1929 little is known of further activity. In 1929 the Steamboat Springs Mining Company headed by D. F. Meikeljohn planned to recover the quicksilver by a flotation process. However, little success was realized, and in 1930 the property was leased to Balfour & Co. of Liverpool, England, who worked the ground mainly for silica, but attempted to recover quicksilver and clays as by-products. In 1938 John Keeler, George Blackmore, and associates obtained a five-year lease on the property and planned to install a rotary furnace. In 1940 the property was leased by W. D. Swallow who planned to recover the quicksilver by a vibratory precipitation process involving the use of sodium sulphate. However, when the property was last visited in February 1944 no mining was being carried on.

Steamboat Springs is a locality which is world famous among geologists because of the importance of the studies made there by G. F. Becker[66] in 1883–1886. The name specifically applies to the active hot springs and sinter mound just west of U. S. Highway No. 395, but it is also used as the name of an area of three-quarters of a square mile that contains many extinct and flowing hot springs and steam vents. Within this area Becker found gold, silver, and the sulfides of mercury, lead, copper, arsenic, antimony, and iron in the spring deposits and, realizing that here was a nearly unique locality in which it was possible to study the formation of an ore deposit, made an extensive study of the mineralized solutions and the conditions favoring ore deposition. In his work he showed that all of the above elements and compounds except lead and silver are soluble in Na_2S as well as a mixture of Na_2S and NaOH and NaHS; furthermore, he proved that the waters of the hot springs contained sodium and sulfur and would therefore form a suitable solvent. This work has been recognized by geologists as an important step towards the understanding of the origin and deposition of mineral deposits.

Mining has been carried on in the area at two of the several localities containing cinnabar. At the first locality, about 3,000 feet west of the active hot spring belt, the workings consist of a large open pit and several caved adits. At the second locality,

[66] Becker, G. F., Geology of the quicksilver deposits of the Pacific slope: U. S. Geol. Survey Mon. 13, pp. 331–353, 1888.

about a quarter of a mile further west the rocks have been explored by an open pit and several trenches. In other localities in the area small pits and short adits explore the rocks for possible cinnabar content.

In the sinter, cinnabar has been found in several places in the hot spring area. The sinter seen from the highway and deposited by the active springs has no visible content of cinnabar at the surface, but a short adit driven into this blanket about 40 feet below its crest disclosed small amounts of cinnabar. About a quarter of a mile to the west, two blankets of sinter formed by now extinct hot springs contain cinnabar as bands and clouds of disseminated crystals.

In hydrothermally altered rock, cinnabar has been found in two localities in sufficient quantity to have stimulated several attempts to mine it. The first of these localities is about 3,000 feet west of the active hot spring belt at the site of the old workings described by Becker,[67] and the second is about a quarter of a mile still farther west at the site of an open pit excavated for clay within the last few years. In the first locality cinnabar fills incipient fractures in decomposed granite, is disseminated in veins of opal cutting the granite, and is found as painty films and encrustations in the altered andesite breccia and basalt. In the second locality cinnabar coats fractures and is disseminated in altered andesite breccia.

As is pointed out by Becker,[68] the waters of the active hot springs possibly contain detectable amounts of mercury, although no evidence found by the writers points to it being actively precipitated at the surface. According to V. P. Gianella,[69] drill holes near the area of hot spring activity encountered cinnabar-bearing sinter at depths of 20 to 30 feet below the surface, and it is his belief that cinnabar is being deposited at this depth.

WHITE HORSE DISTRICT

The White Horse or Olinghouse gold district lies on the east flank of the Pah-Rah Range in the southeastern part of Washoe County. The rocks of the district are Tertiary and Quaternary volcanics; the ore deposits are apparently typical epithermal gold veins. No mining for quicksilver has been done in the district, but a few specimens sent to the Mackay School of Mines contained considerable cinnabar.

[67] Becker, G. F., *op. cit.*, p. 350.
[68] Becker, G. F., *op. cit.*, pp. 346, 347.
[69] Gianella, V. P., oral communication.

UNNAMED DISTRICT

WHEELER RANCH PROSPECT

Location.....Cor. secs. 33 and 34, T. 19 N., R. 19 E., and secs. 3 and 4, T. 18 N., R. 19 E.
Ownership.....Unknown.
Discovery.....1875 by John Poe.
Production.....Very small.
Geologic type.....Volcanic.

The Wheeler Ranch prospect is on Evans Creek about seven miles south of Reno and three miles west of U. S. Highway No. 395. The deposit was discovered in 1875 and is one of the earliest known occurrences of cinnabar in the State. Soon after 1875 it was acquired by the Nevada State Quicksilver Mining Company which explored the ground with approximately 260 feet of drifts. Since that time the deposit has been worked only intermittently, but in 1940 a small amount of development was done and a retort was operated for a short time. When the property was visited late in 1943 it was idle and apparently abandoned.

Most of the underground workings were caved in 1943, but are reported[70] to consist of a 164-foot drift trending N. 19° W. along a zone of faulting. In the adit 108 feet from the portal a winze has been sunk 45 feet, and from its base levels extend along the fault. The total length of the workings is about 260 feet.

Cinnabar occurs as veinlets along northerly trending faults which also contain discontinuous and irregular quartz veins. It is also found in fractures in the quartz and as disseminated crystals in the altered wall rocks. The associated minerals are pyrite, jarosite, gypsum, chalcedony, and reportedly native mercury.

[70] Whitehill, H. R., Sixth Biennial Report of the State Mineralogist for the State of Nevada for the Years 1875 and 1876: pp. 157 (not dated).

WHITE PINE COUNTY

No quicksilver properties or occurrences of quicksilver minerals in White Pine County are known to the writers.

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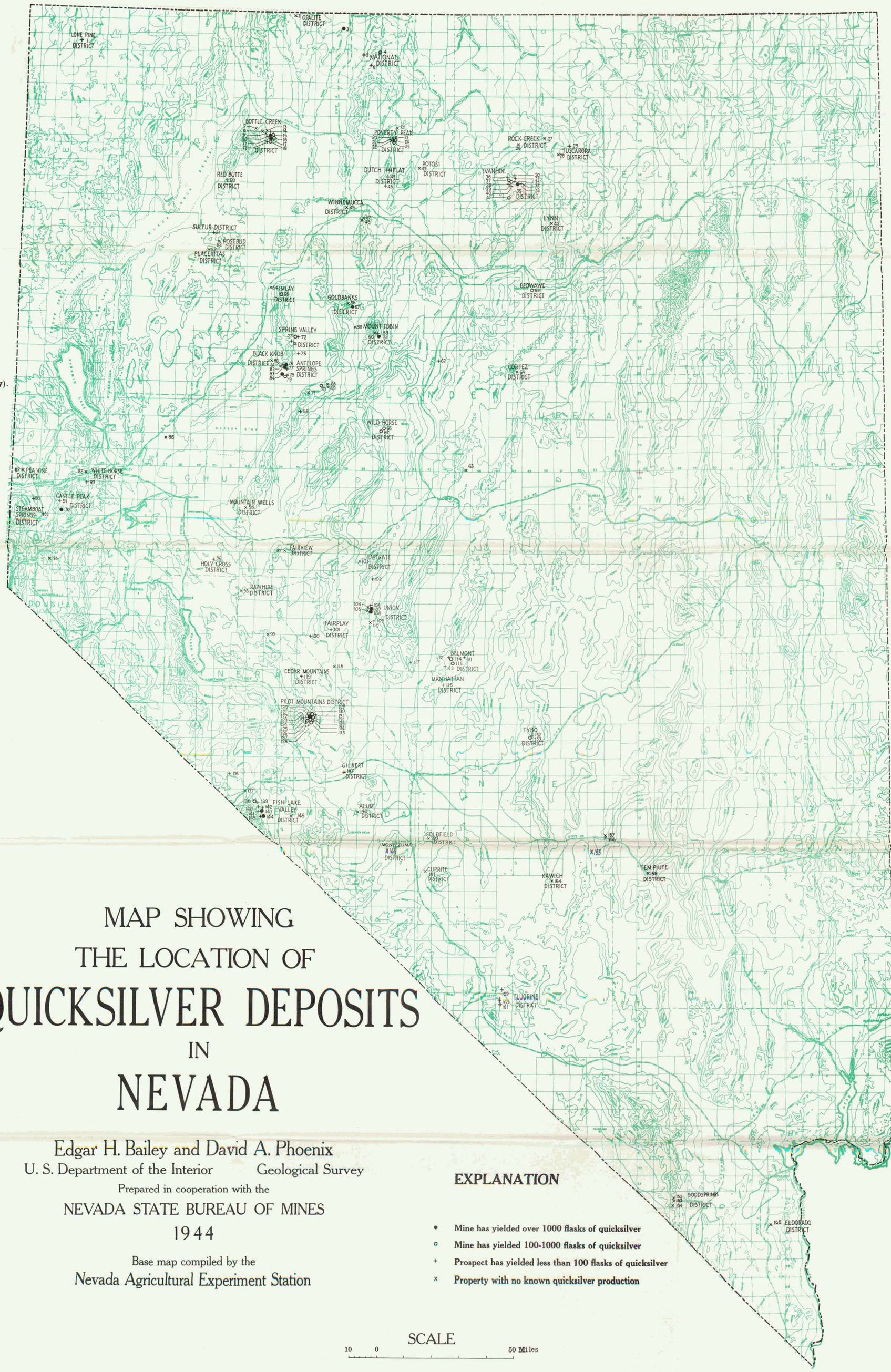

MAP SHOWING THE LOCATION OF QUICKSILVER DEPOSITS IN NEVADA

Edgar H. Bailey and David A. Phoenix

U. S. Department of the Interior Geological Survey

Prepared in cooperation with the

NEVADA STATE BUREAU OF MINES

1944

Base map compiled by the

Nevada Agricultural Experiment Station

EXPLANATION

- • Mine has yielded over 1000 flasks of quicksilver
- ○ Mine has yielded 100-1000 flasks of quicksilver
- + Prospect has yielded less than 100 flasks of quicksilver
- × Property with no known quicksilver production

SCALE

10 0 50 Miles

Contour Interval 1000 Feet

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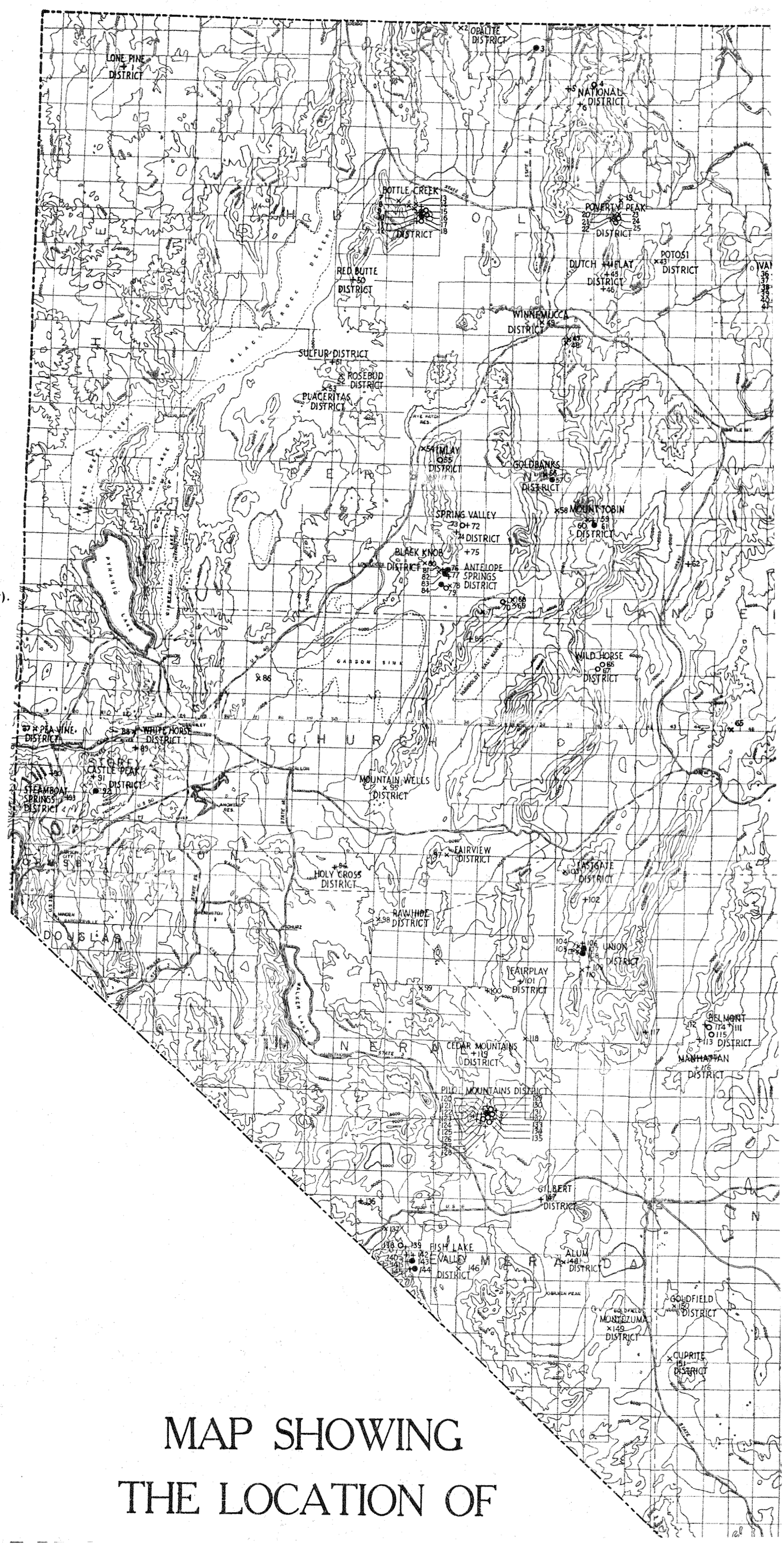

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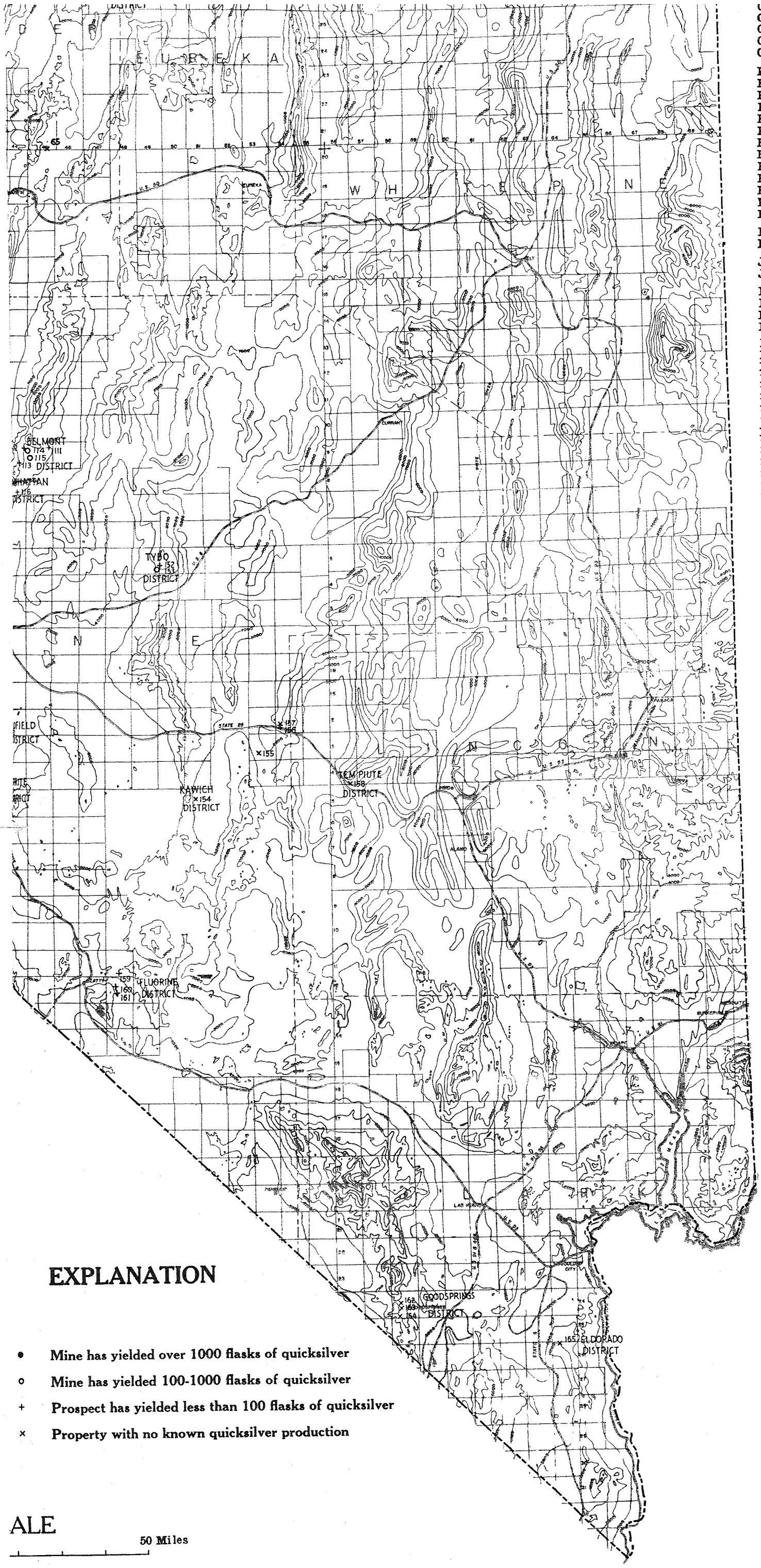

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Storm Property 69

Taylor-Branch Prospect 89
Teapot Prospect 27
Tem Piute District 158
Thompson Property 159
Tip Top Mine 160
Turillas Property 22
Two Injun Property 105

Valley View Property 94
Van Ness Mine 115
Victory Property 68

Walker Mine 74
War Cloud Property 102
Warm Springs Prospect 62
Washington Hill Prospect 91
Wheeler Ranch Prospect 90
White Caps Gold Mine 116
White Peaks Mine 15
White Horse District 88
Wholey's Quicksilver Mine 21
Wild Cat Prospect 112
Wild Horse Mine 67
Wild Rose Mine 138
Winnemucca District 49

Yellow Cat Mine 106
Yellow Pine Lead-Zinc Mine 163

44. Dutch Flat Mine.
45. Last Chance Prospect (Humboldt County).
46. Red Devil Prospect.
47. Gayer-Moo Property.
48. Plymouth Property.
49. Winnemucca District.

50. Rattlesnake Canyon Prospect.
51. Nevada Sulphur Company Mine.
52. Rosebud District.
53. Placeritas District.
54. Humboldt Hot Springs Deposit.
55. Eldorado Mine.
56. Pronto Plata Property.
57. Goldbanks Quicksilver Mine.
58. Oldtimer Property.
59. Last Chance Prospect.

60. North Fork Property.
61. Mount Tobin.
62. Warm Springs Prospect.
63. Beowawe Mine.
64. Rossi Property.
65. Rast Property.
66. McCoy Mine.
67. Wild Horse Mine.
68. Victory Property.
69. Storm Property.

70. Roman Mine.
71. Black Dyke Property.
72. Hillside Mercury Prospect.
73. King George Mine.
74. Walker Mine.
75. Alpine Prospect.
76. Red Bird Mine.
77. S. & J. Mine.
78. Crawford Prospect.
79. Montgomery Mine.

80. Paymaster Prospect.
81. Bunker Hill Group.
82. Good Spot Prospect.
83. Juniper Mine.
84. Pershing Mine.
85. Rosebud Prospect.
86. Erway Property.
87. Peavine District.
88. White Horse District.
89. Taylor-Branch Prospect.

90. Wheeler Ranch Prospect.
91. Washington Hill Prospect.
92. Castle Peak Mine.
93. Steamboat Springs Mine.
94. Valley View Property.
95. Mountain Wells District.
96. Cinnabar Hill Mine.
97. Fairview District.
98. Stockton Property.
99. Poinsettia Property.

100. Finger Rock Prospect.
101. Scheebar Mine.
102. War Cloud Property.
103. Eastgate District.
104. Indian Johnnie Dick Property.
105. Two Injun Property.
106. Yellow Cat Mine.
107. Mercury Mining Company Mine.
108. Nevada Cinnabar Mine.
109. San Pedro Mine.

110. Humphrey Property.
111. Flower Quicksilver Mine.
112. Wild Cat Prospect.
113. Mariposa Canyon Prospect.
114. Senator Mine.
115. Van Ness Mine.
116. White Caps Gold Mine.
117. Horse Canyon Mine.
118. Southview Property.
119. Lou Prospect.

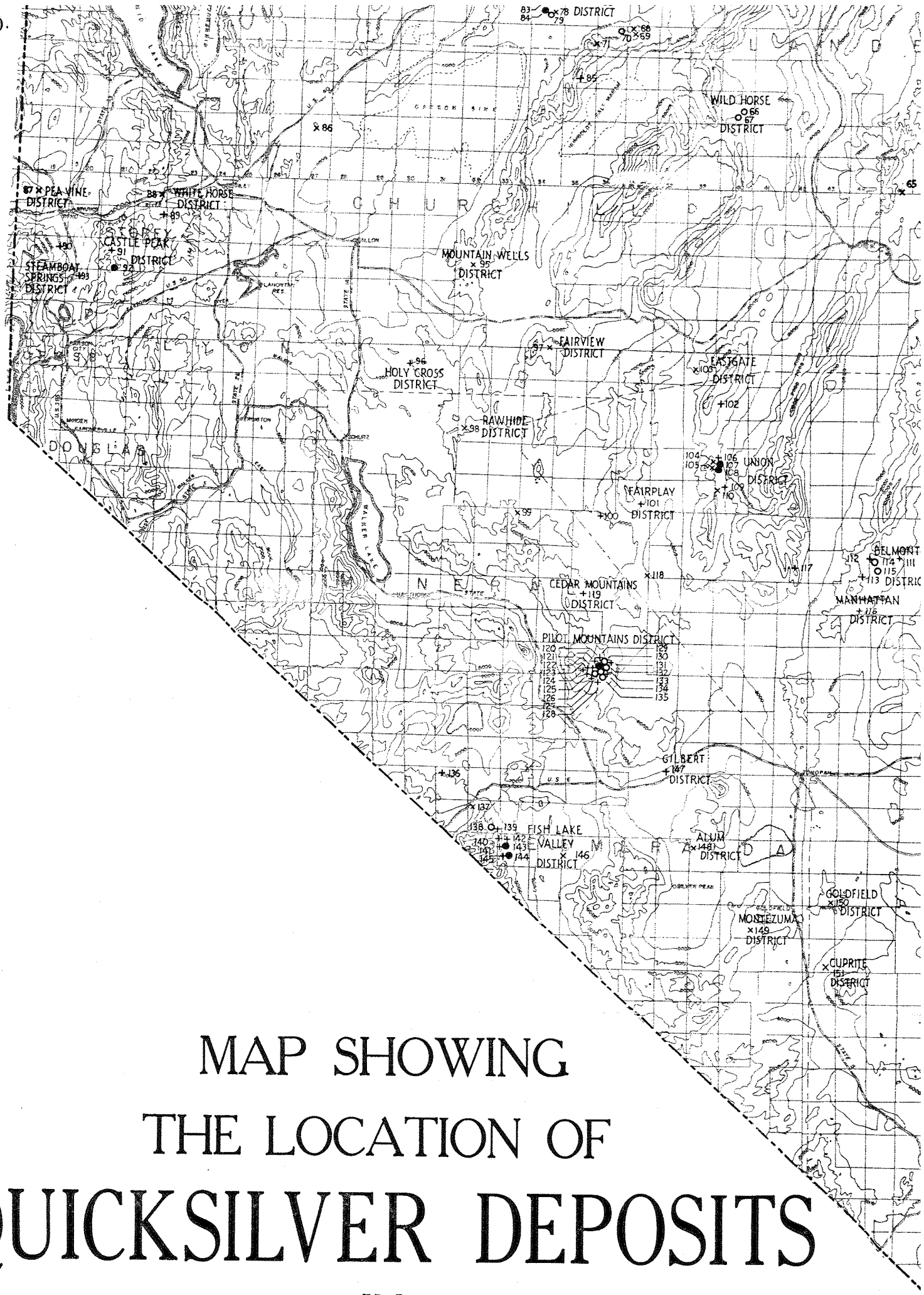
120. Fault Line Prospect.
121. Keg Prospect.
122. Mammoth Mine.
123. Redwing Prospect.
124. Hitt Mine.
125. Allen Mine.
126. Hasbrouck Property.
127. Reward Mine.
128. Black Lizard Prospect.
129. Mina Development Company Mine.

130. Drew Mine.
131. Lakeview Mine.
132. Cardinal Mine.
133. Lost Steer Mine.
134. Inman Mine.
135. Betty Mine.
136. Noguez Prospect.
137. Montgomery Summit Property.
138. Wild Rose Mine.
139. O. K. Property.

140. Red Rose Prospect.
141. Red Cloud Property.
142. F. & L. Mine.
143. B. & B. Mine.
144. Red Rock Mine.
145. Container Mine.
146. Riek Property.
147. Castle Rock Prospect.
148. Alum District.
149. Montezuma Prospect.

150. Diamonfield Property.
151. Ralston Prospect.
152. M. & M. Mine.
153. A. & B. Mine.
154. Kawich District.
155. Oswell Property.
156. Black Hawk Mine.
157. Fallini Property.
158. Tem Piute District.
159. Thompson Property.

160. Tip Top Mine.
161. Harvey Mine.
162. Red Cloud Gold Mine.
163. Yellow Pine Lead-Zinc Mine.
164. Kirby Lead-Zinc Mine.
165. Patsy Prospect.



MAP SHOWING THE LOCATION OF QUICKSILVER DEPOSITS IN NEVADA

Edgar H. Bailey and David A. Phoenix

U. S. Department of the Interior Geological Survey

Prepared in cooperation with the

NEVADA STATE BUREAU OF MINES

1944

Base map compiled by the

Nevada Agricultural Experiment Station

EX

• Mine

○ Mine

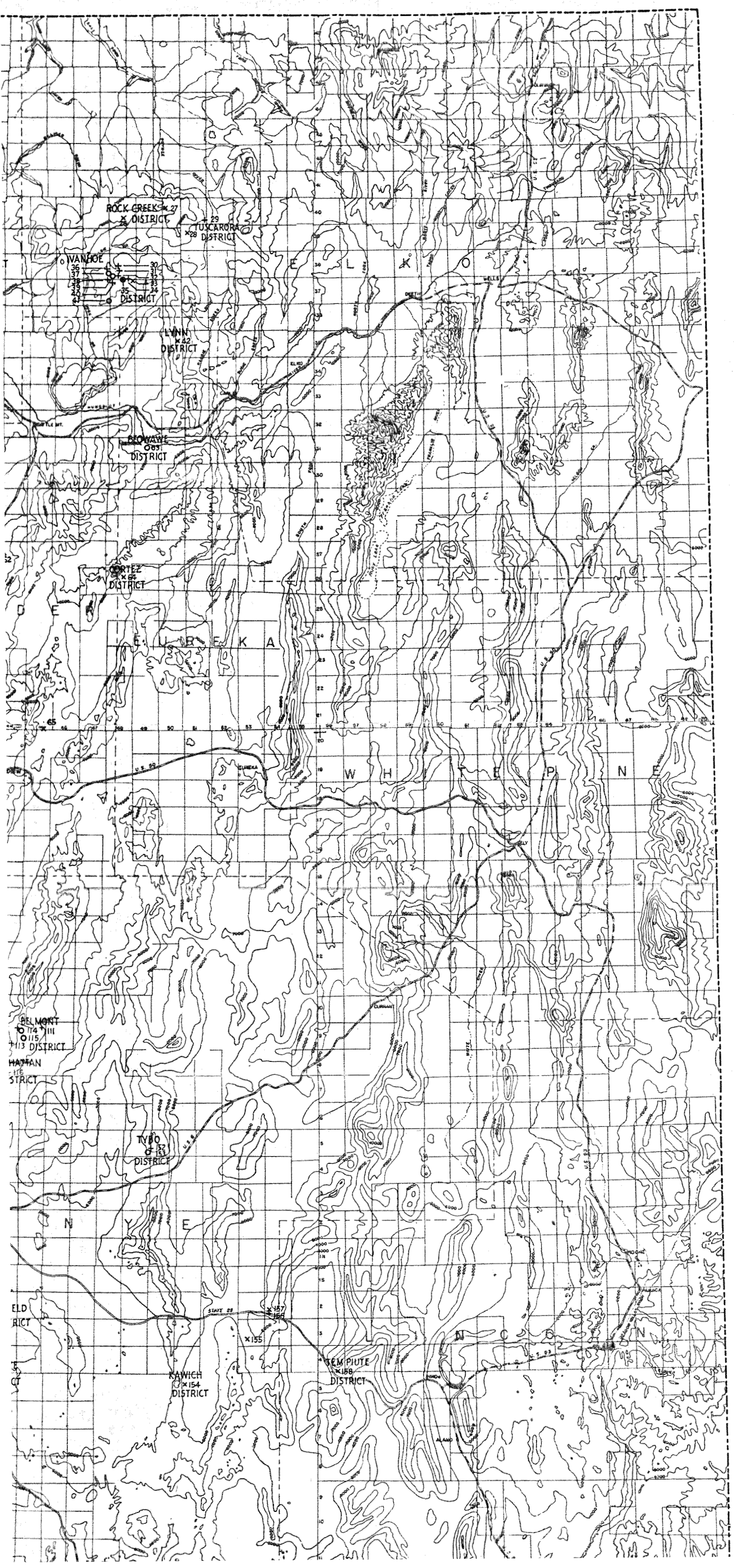
+ Prosp

× Prop

SCALE

10 0

Contour Interval 100



ALPHABETICAL KEY

A. & B. Mine 153
Allen Mine 125
Alpine Prospect 75
Alum District 148
Antelope Prospect 1
Anthill Mine 10

Baldwin Mine 16
B. & B. Prospect 14
B. & B. Mine 143
Berry Creek Group 28
Betty Mine 135
Beowawe Mine 63
Birthday Mine 18
Black Dyke Property 71
Black Hawk Mine 156
Black Lizard Prospect 128
Blue Can Mine 17
Buckskin Peak Mine 4
Bunker Hill Group 81
Butte Quicksilver Mine 35

Cahill Mine 25
Canyon Creek Prospect 5
Cardinal Mine 132
Castle Peak Mine 92
Castle Rock Prospect 147
Cinnabar Hill Mine 96
Coleman Group 38
Container Mine 145
Cordero Mine 3
Crawford Prospect 78

Diamondfield Property 150
Disaster Peak Property 2
Drew Mine 130
Dutch Flat Mine 44

Eastgate District 103
Eldorado Mine 55
Erway Property 86

Fairview District 97
Fallini Property 157
F. & L. Mine 142
Fault Line Prospect 120
Finger Rock Prospect 100
Flower Quicksilver Mine 111
Franklin-Keeney Property 7

Gayer-Moo Property 47
Getchell Gold Mine 43
Goldbanks Quicksilver Mine 57
Good Spot Prospect 82
Governor Mine 37–39

Hagan-Hegan Property 9
Hapgood Mine 24
Hasbrouck Property 126
Hatter Property 33
Harvey Mine 161
Hillside Mercury Prospect 72
Hitt Mine 124
Holt Property 19
Homestake Group 31
Horse Canyon Mine 117
Humboldt Hot Springs Deposit 54
Humphrey Property 110
Hunt Property 37

Indian Johnnie Dick Property 104
Inman Mine 134

Jackson and Surprise Claims 40
Juniper Mine 83

Kawich District 154
Keg Prospect 121
King George Mine 73
Kirby Lead-Zinc Mine 164

Lakeview Mine 131
Lark Group 32
Last Chance Prospect (Humboldt County) 45
Last Chance Prospect (Pershing County) 59
Lost Steer Mine 133
Lou Prospect 119
Lynn District 42

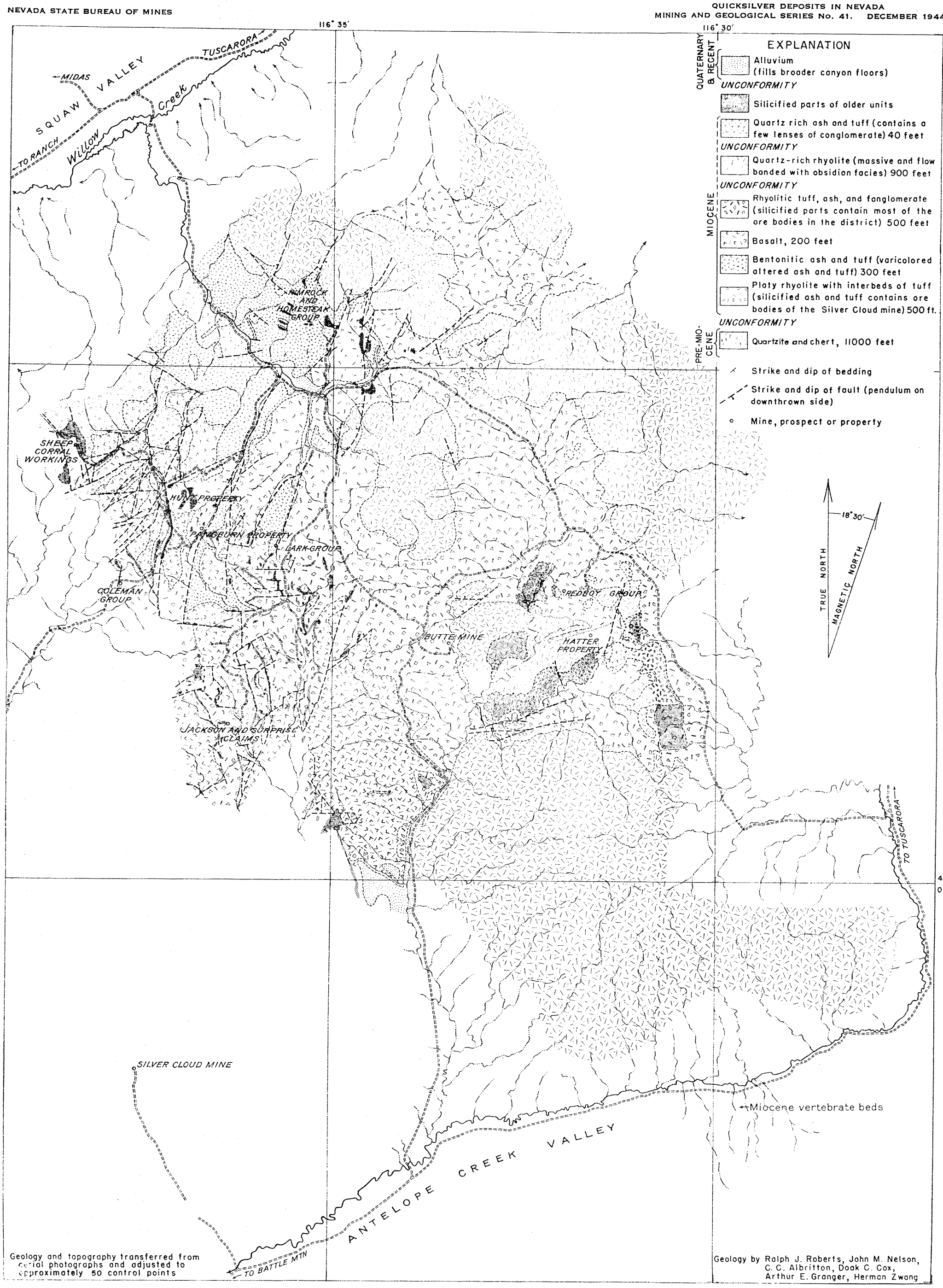
Mammoth Mine 122
M. & M. Mine 152
Mariposa Canyon Prospect 113
McAdoo Mine 11
McCoy Mine 66
Mercury Mining Company Mine 107
Mina Development Company Mine 129
Montezuma Prospect 149
Montgomery Mine 79
Montgomery Summit Property 137
Mountain Wells District 95
Mount Tobin Mine 61

Nevada Cinnabar Mine 108
Nevada Sulphur Company Mine 51
Niebuhr Mine 13
Noguez Prospect 136
North Fork Property 60

O. K. Property 139
Oldtimer Property 58
Oswell Property 155

Pangburn Property 39
Patsy Prospect 165
Paymaster Prospect 80
Peavine District 87
Pershing Mine 84
Placeritas District 53
Plymouth Property 48
Poinsettia Property 99
Prentiss Property 20
Pronto Plata Property 56

Ralston Prospect 151
Rast Property 65
Rattlesnake Canyon Prospect 50
Red Bird Group 29
Red Bird Mine 76
Red Boy Group 34
Red Cloud Gold Mine 162
Red Cloud Property 141
Red Devil Prospect 46
Red Ore Mine 12
Red Rock Mine 144
Red Rose Prospect 140
Redwing Prospect 123



GEOLOGIC MAP OF THE IVANHOE DISTRICT
ELKO COUNTY, NEVADA

PLATE 2

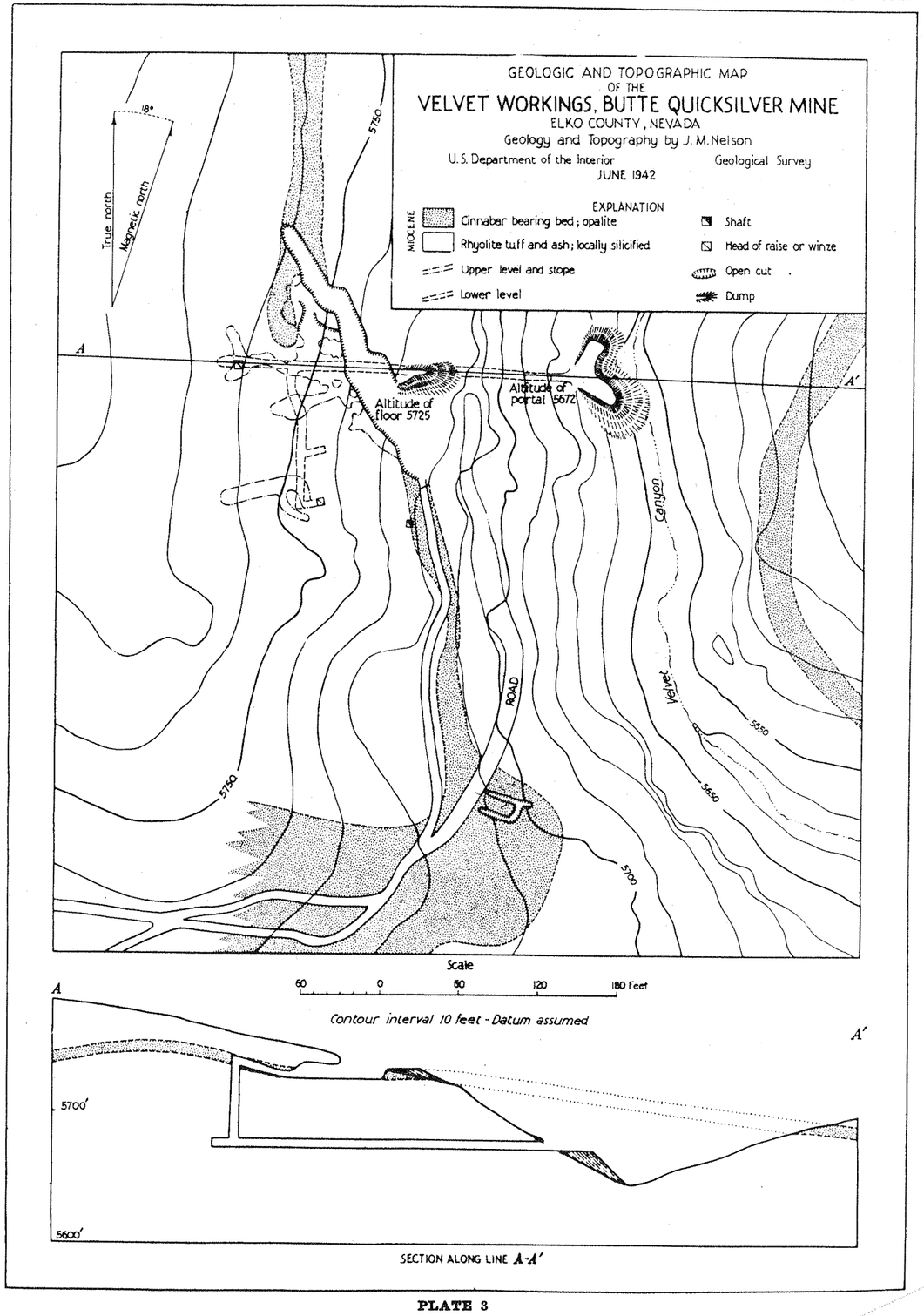
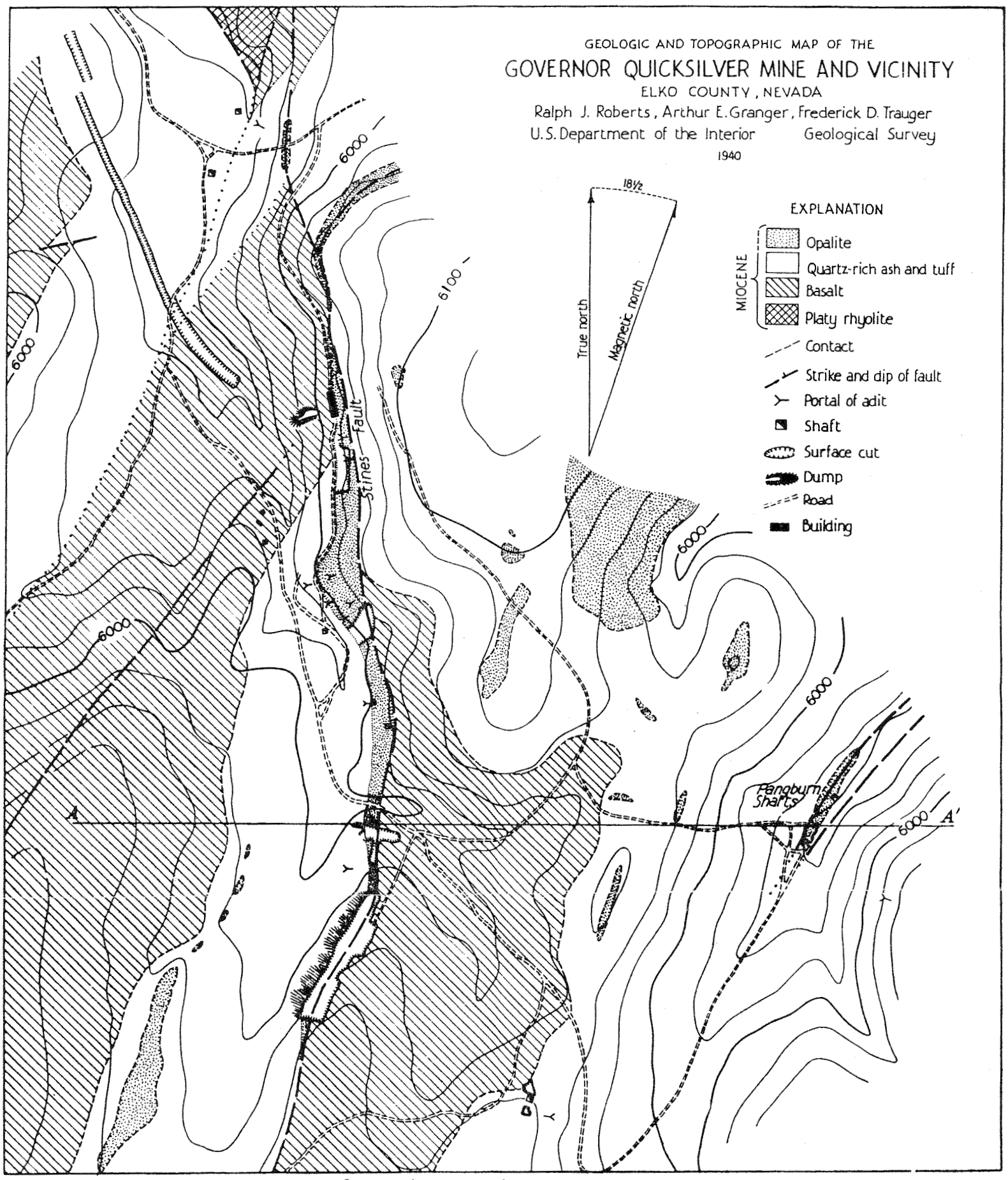

GEOLOGIC AND TOPOGRAPHIC MAP
OF THE
VELVET WORKINGS, BUTTE QUICKSILVER MINE
ELKO COUNTY, NEVADA
Geology and Topography by J. M. Nelson
U. S. Department of the Interior
Geological Survey
JUNE 1942
EXPLANATION
MIOCENE
Cinnabar bearing bed; opalite
Rhyolite tuff and ash; locally silicified
Upper level and stope
Lower level
Shaft
Head of raise or winze
Open cut
Dump
18°
True north
Magnetic north
5750
A
A'
Altitude of floor 5725
Altitude of portal 5672
ROAD
Velvet Canyon
5650
5700
Scale
60 0 60 120 180 Feet
Contour interval 10 feet - Datum assumed
5700'
5600'
SECTION ALONG LINE A-A'

PLATE 3


GEOLOGIC AND TOPOGRAPHIC MAP OF THE
GOVERNOR QUICKSILVER MINE AND VICINITY
ELKO COUNTY, NEVADA
Ralph J. Roberts, Arthur E. Granger, Frederick D. Trauger
U.S. Department of the Interior Geological Survey
1940
18½
True north
Magnetic north
EXPLANATION
MIOCENE
Opalite
Quartz-rich ash and tuff
Basalt
Platy rhyolite
Contact
Strike and dip of fault
Portal of adit
Shaft
Surface cut
Dump
Road
Building
6000
6100
Stines Fault
Pangburn Shafts
A
A'
Contour interval 20 feet - Datum assumed
Scale
400 0 400 800 1200 feet

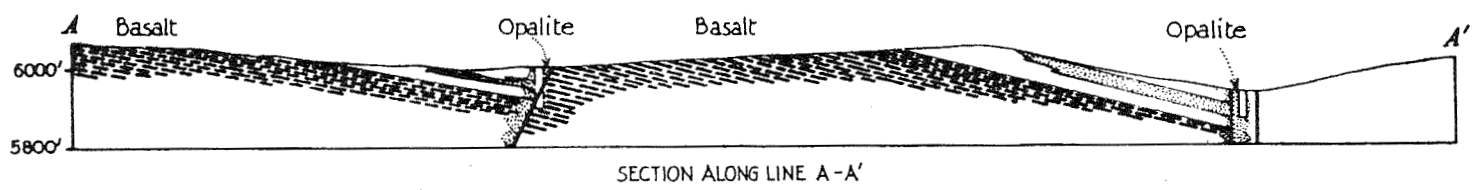

A
Basalt
Opalite
Basalt
Opalite
A'
6000'
5800'
SECTION ALONG LINE A-A'

PLATE 4

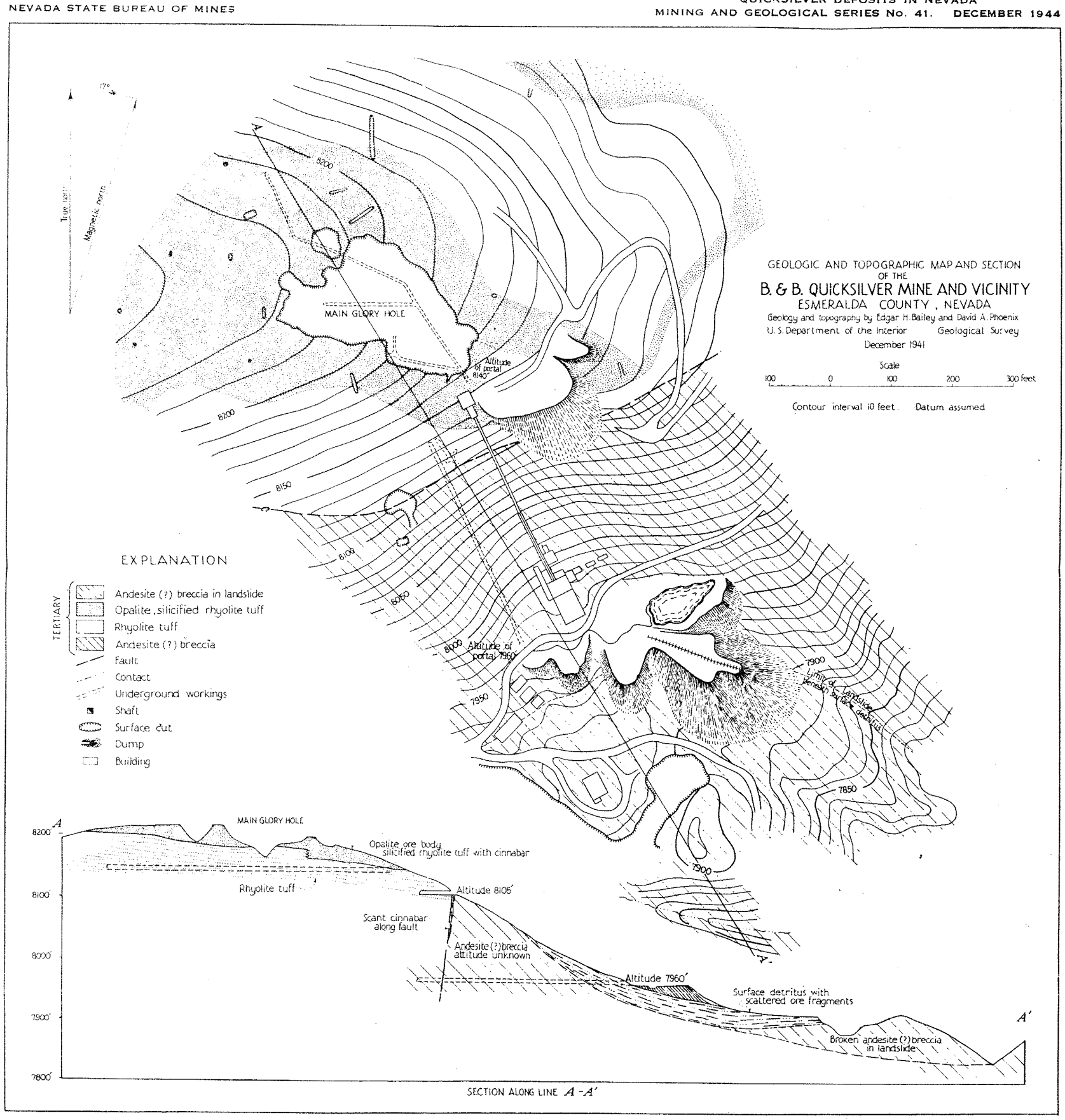

GEOLOGIC AND TOPOGRAPHIC MAP AND SECTION
OF THE
B. & B. QUICKSILVER MINE AND VICINITY
ESMERALDA COUNTY, NEVADA
Geology and topography by Edgar H. Bailey and David A. Phoenix
U. S. Department of the Interior Geological Survey
December 1941
Scale
100 0 100 200 300 feet
Contour interval 10 feet. Datum assumed
True north
Magnetic north
17°
MAIN GLORY HOLE
Altitude of portal 8140'
Altitude of portal 7960'
Limit of landslide beneath surface detritus
8200
8150
8100
8050
8000
7950
7900
7850
EXPLANATION
TERTIARY
Andesite (?) breccia in landslide
Opalite, silicified rhyolite tuff
Rhyolite tuff
Andesite (?) breccia
Fault
Contact
Underground workings
Shaft
Surface cut
Dump
Building
A
A'
MAIN GLORY HOLE
Opalite ore body silicified rhyolite tuff with cinnabar
Rhyolite tuff
Altitude 8105'
Scant cinnabar along fault
Andesite (?) breccia attitude unknown
Altitude 7960'
Surface detritus with scattered ore fragments
Broken andesite (?) breccia in landslide
8200'
8100'
8000'
7900'
7800'
SECTION ALONG LINE A-A'

PLATE 5

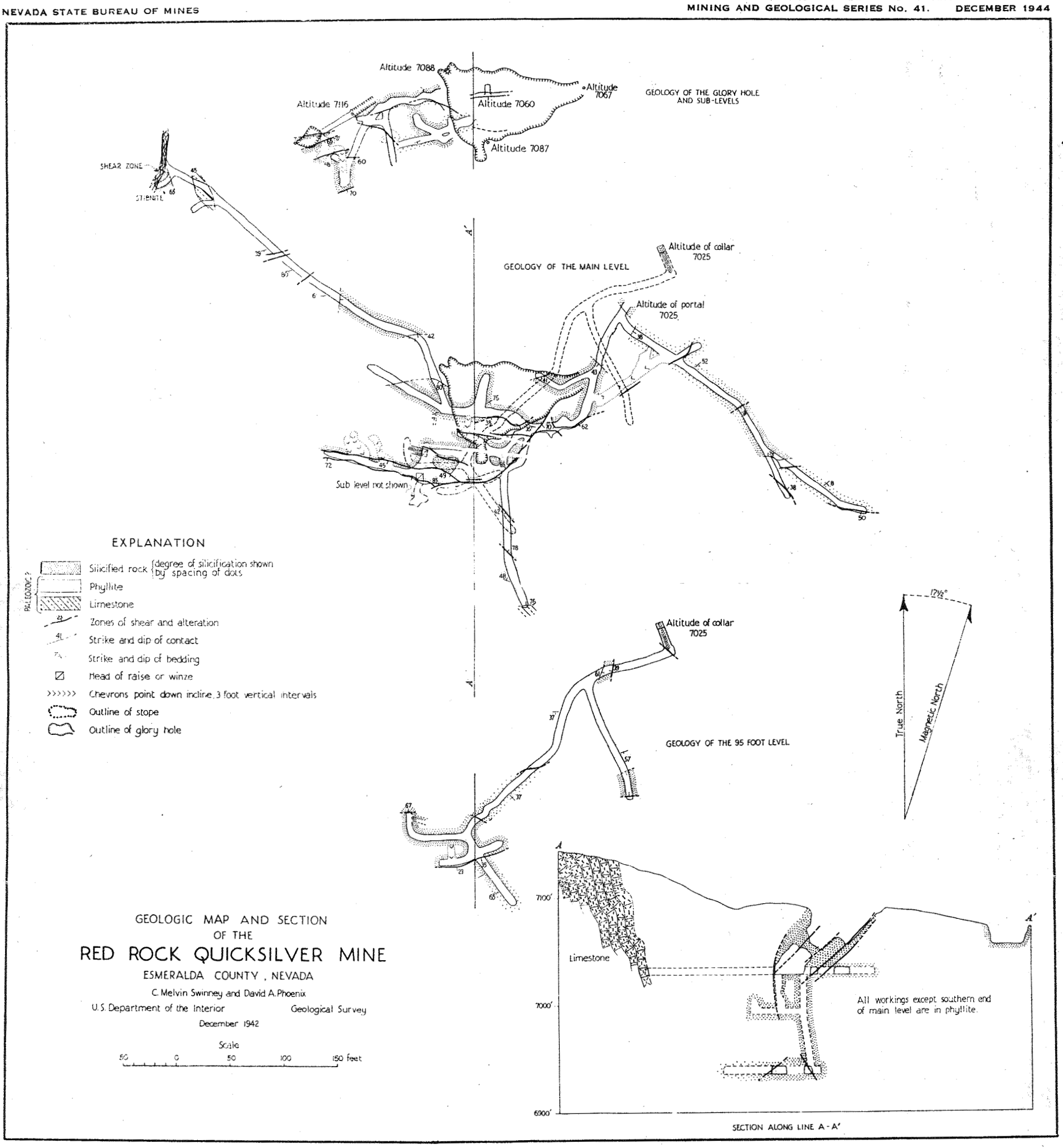
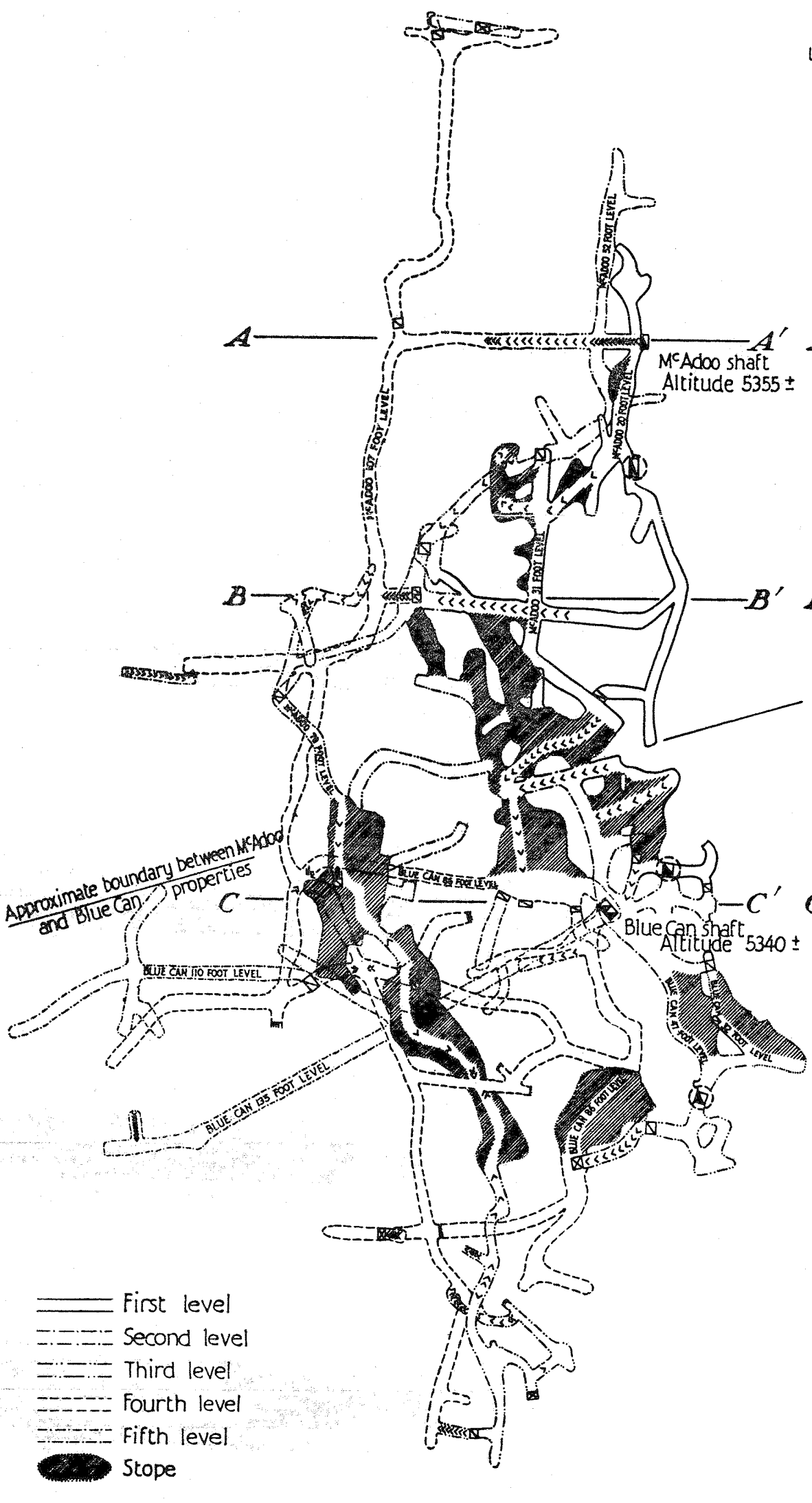

GEOLOGY OF THE GLORY HOLE AND SUB-LEVELS
Altitude 7088
Altitude 7116
Altitude 7060
Altitude 7067
Altitude 7087
SHEAR ZONE
SYENITE
GEOLOGY OF THE MAIN LEVEL
Altitude of collar 7025
Altitude of portal 7025
Sub level not shown
EXPLANATION
PALEOZOIC ?
Silicified rock {degree of silicification shown by spacing of dots
Phyllite
Limestone
Zones of shear and alteration
Strike and dip of contact
Strike and dip of bedding
Head of raise or winze
Chevrons point down incline, 3 foot vertical intervals
Outline of stope
Outline of glory hole
GEOLOGY OF THE 95 FOOT LEVEL
Altitude of collar 7025
True North
Magnetic North
17½°
Limestone
All workings except southern end of main level are in phyllite.
7100'
7000'
6900'
SECTION ALONG LINE A-A'
GEOLOGIC MAP AND SECTION
OF THE
RED ROCK QUICKSILVER MINE
ESMERALDA COUNTY, NEVADA
C. Melvin Swinney and David A. Phoenix
U.S. Department of the Interior Geological Survey
December 1942
Scale
50 0 50 100 150 feet

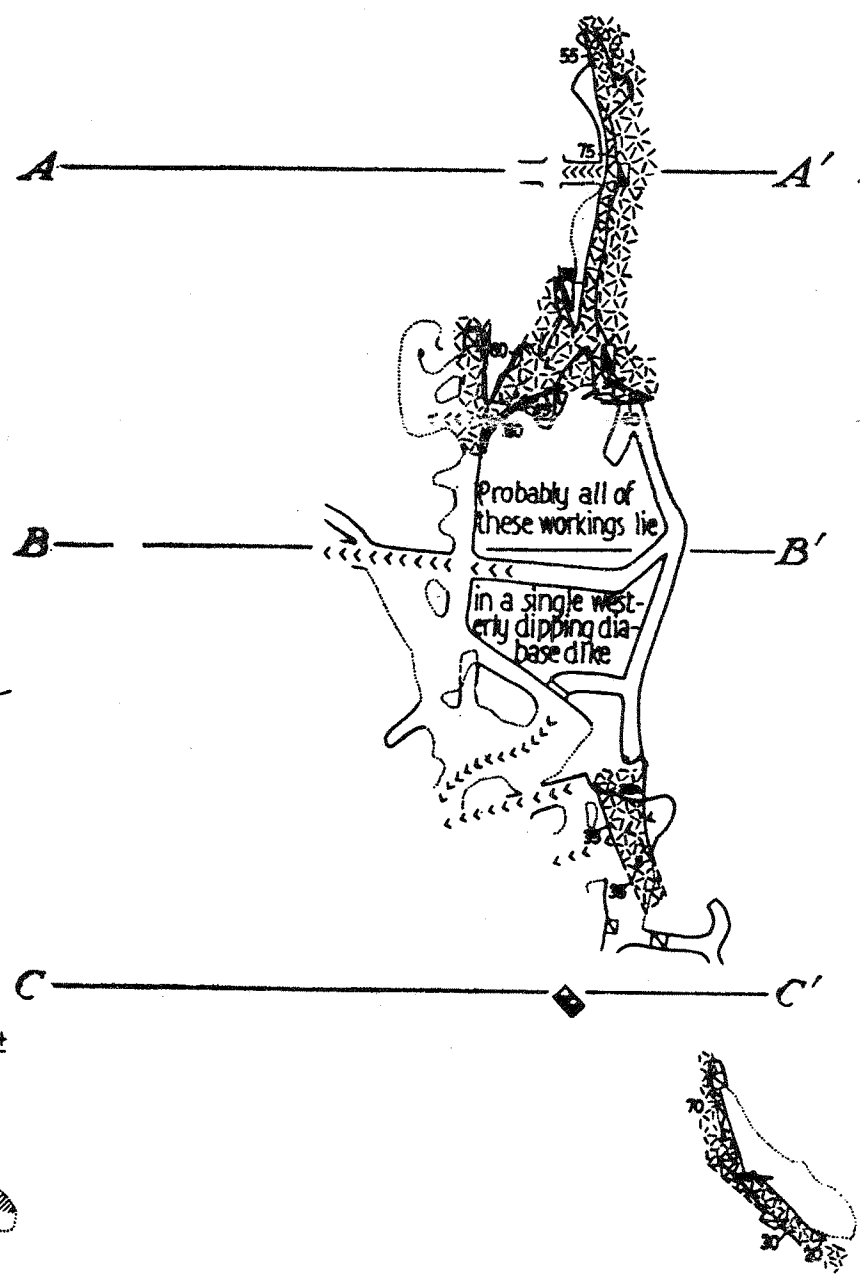
PLATE 6

EXPLANATION

- Diabase dike
- Tertiary and Pre-tertiary sedimentary and pyroclastic rocks
- 60 Strike and dip of contact
- 75 Strike and dip of fault
- Shaft
- Caved or filled shaft
- Head of raise or winze
- Foot of raise or winze
- Chevrons point down incline, 4 foot vertical intervals



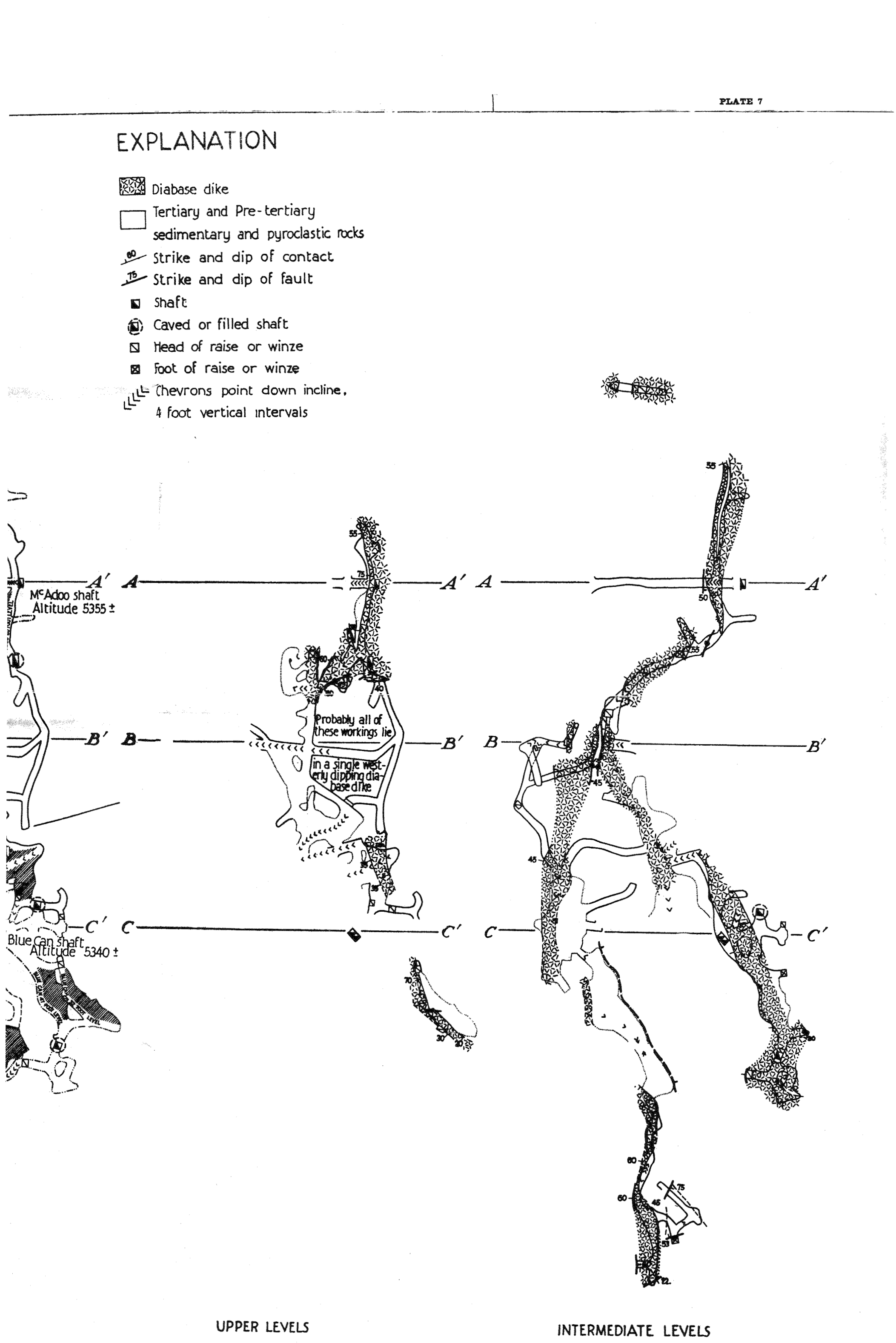
COMPOSITE PLAN



UPPER LEVELS

EXPLANATION

- Diabase dike
- Tertiary and Pre-tertiary sedimentary and pyroclastic rocks
- 60 Strike and dip of contact
- 75 Strike and dip of fault
- Shaft
- Caved or filled shaft
- Head of raise or winze
- Foot of raise or winze
- Chevrons point down incline, 4 foot vertical intervals



UPPER LEVELS

INTERMEDIATE LEVELS

GEOLOGIC MAP AND SECTIONS OF THE

BLUE CAN AND McADOO QUICKSILVER MINES

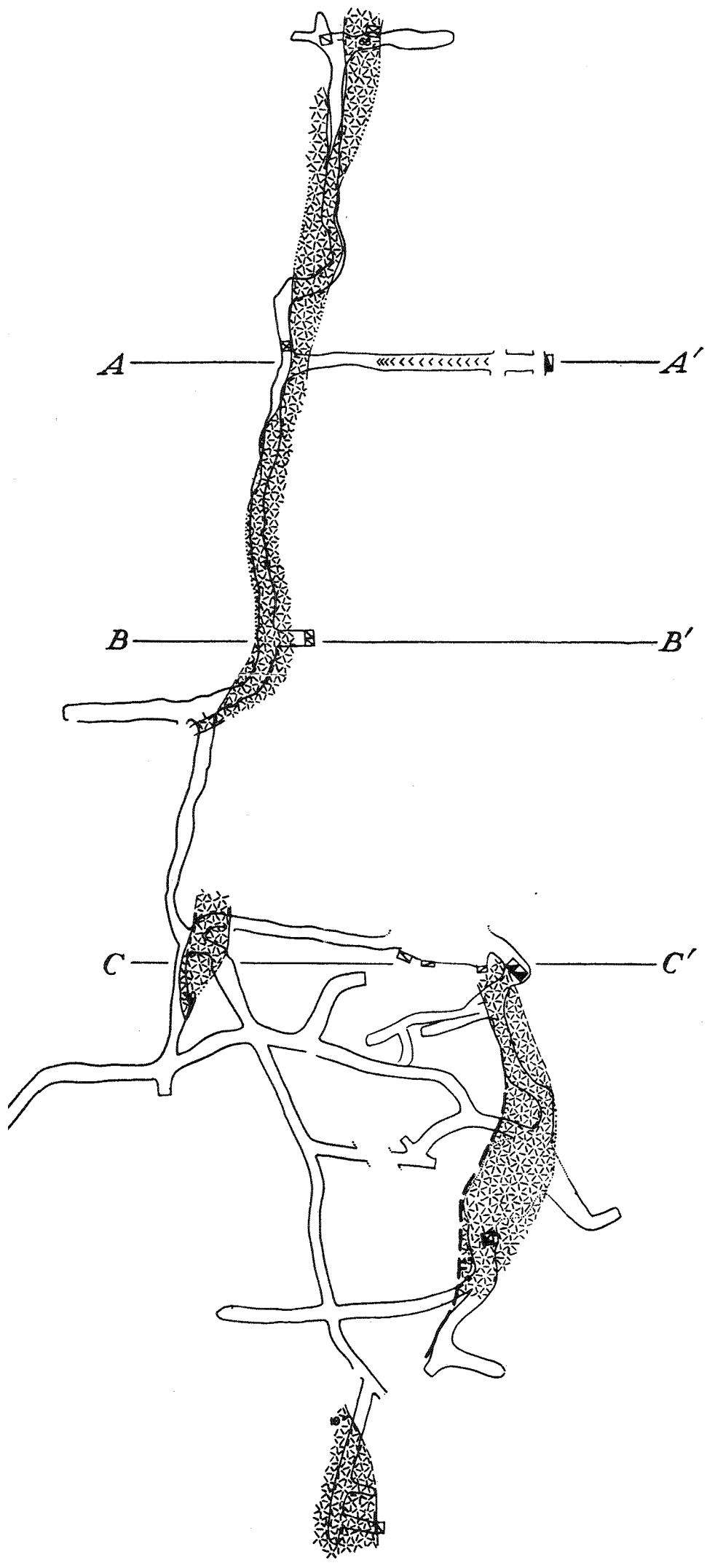
HUMBOLDT COUNTY, NEVADA

Compiled from maps by R. J. Roberts, J. O. Greenan
J. B. Cathcart, C. M. Swinney, and E. H. Bailey
U. S. Department of the Interior Geological Survey

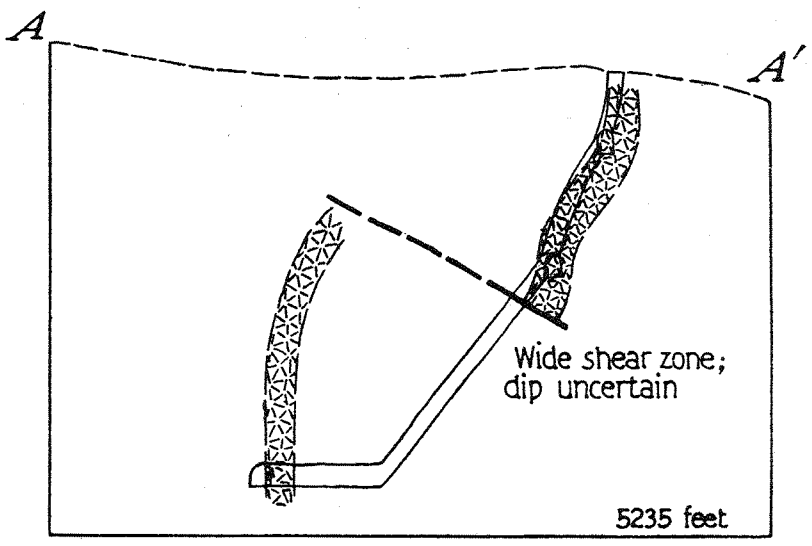
1943

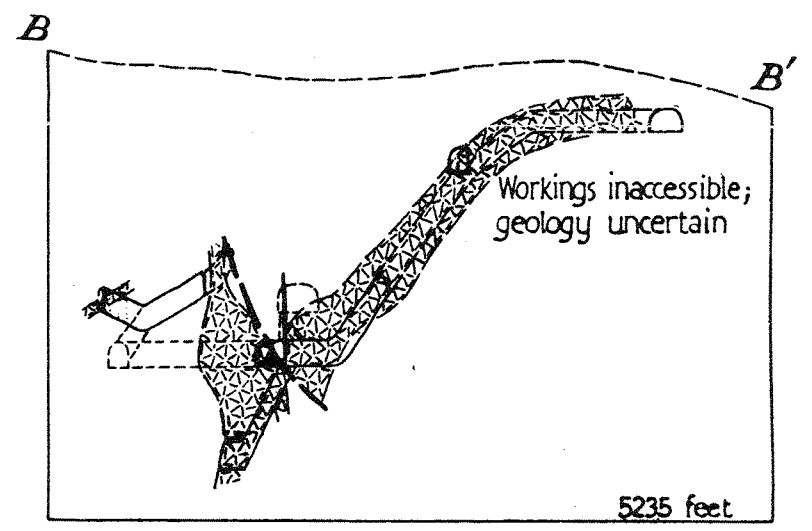
Scale

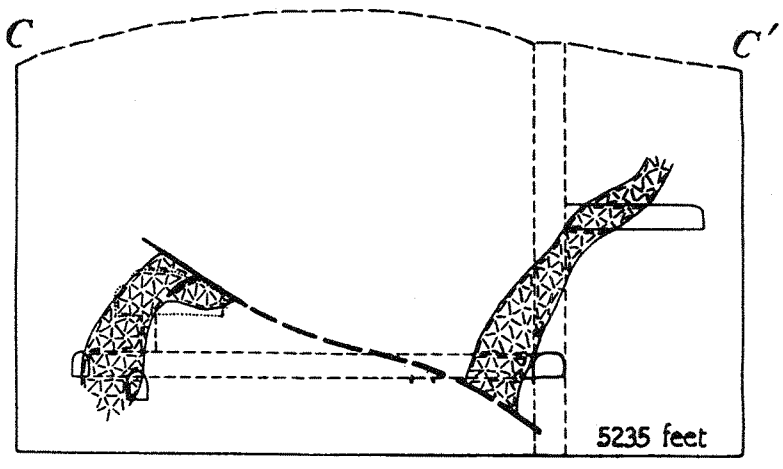
50 0 50 100 150 feet



LOWER LEVELS







SECTIONS ALONG LINES *A-A′*, *B-B′*, AND *C-C′*

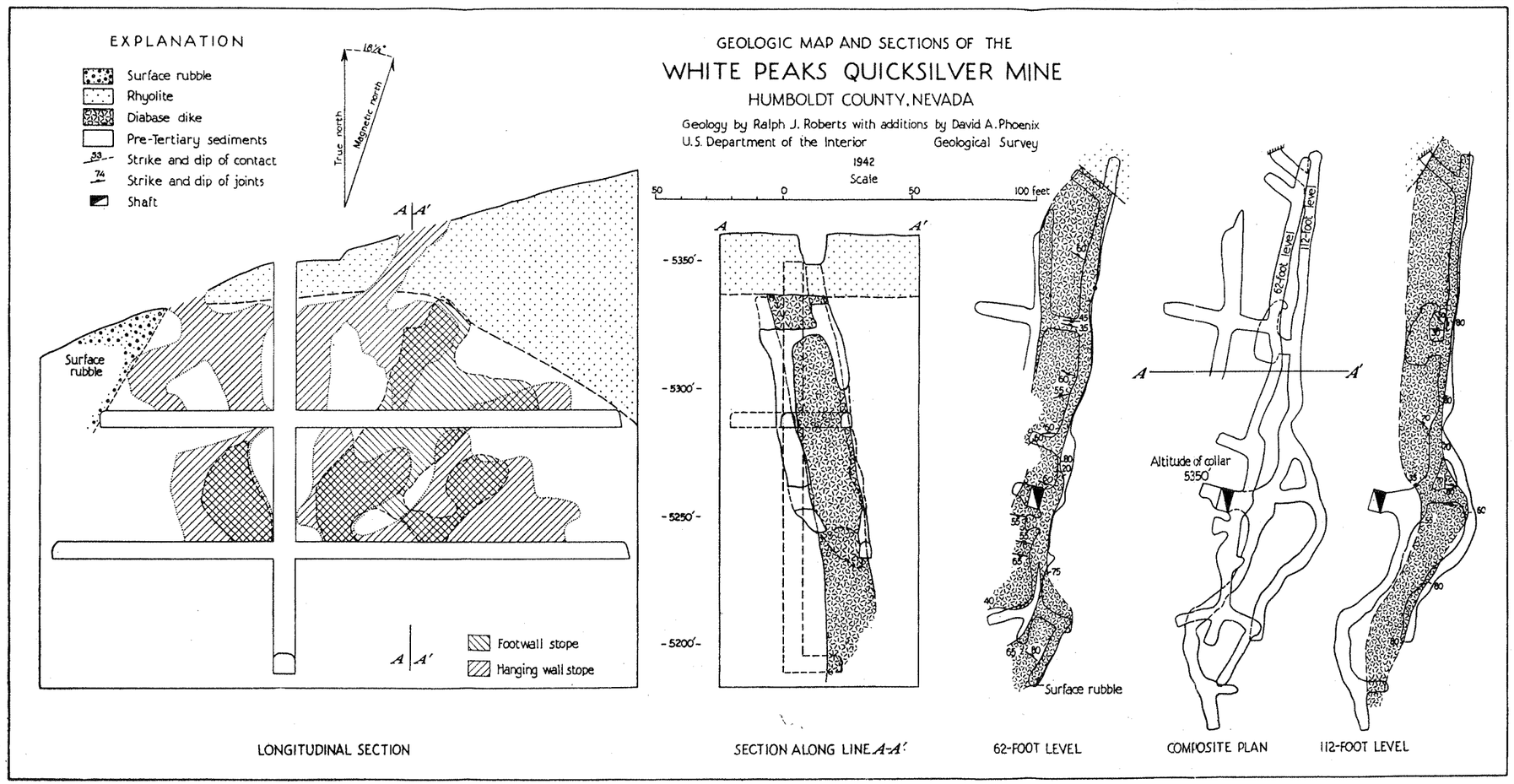

EXPLANATION
Surface rubble
Rhyolite
Diabase dike
Pre-Tertiary sediments
Strike and dip of contact
Strike and dip of joints
Shaft
18½°
True north
Magnetic north
GEOLOGIC MAP AND SECTIONS OF THE
WHITE PEAKS QUICKSILVER MINE
HUMBOLDT COUNTY, NEVADA
Geology by Ralph J. Roberts with additions by David A. Phoenix
U.S. Department of the Interior Geological Survey
1942
Scale
50 0 50 100 feet
Surface rubble
Footwall stope
Hanging wall stope
-5350'-
-5300'-
-5250'-
-5200'-
62-foot level
112-foot level
Altitude of collar 5350'
Surface rubble
LONGITUDINAL SECTION
SECTION ALONG LINE A-A'
62-FOOT LEVEL
COMPOSITE PLAN
112-FOOT LEVEL

PLATE 8

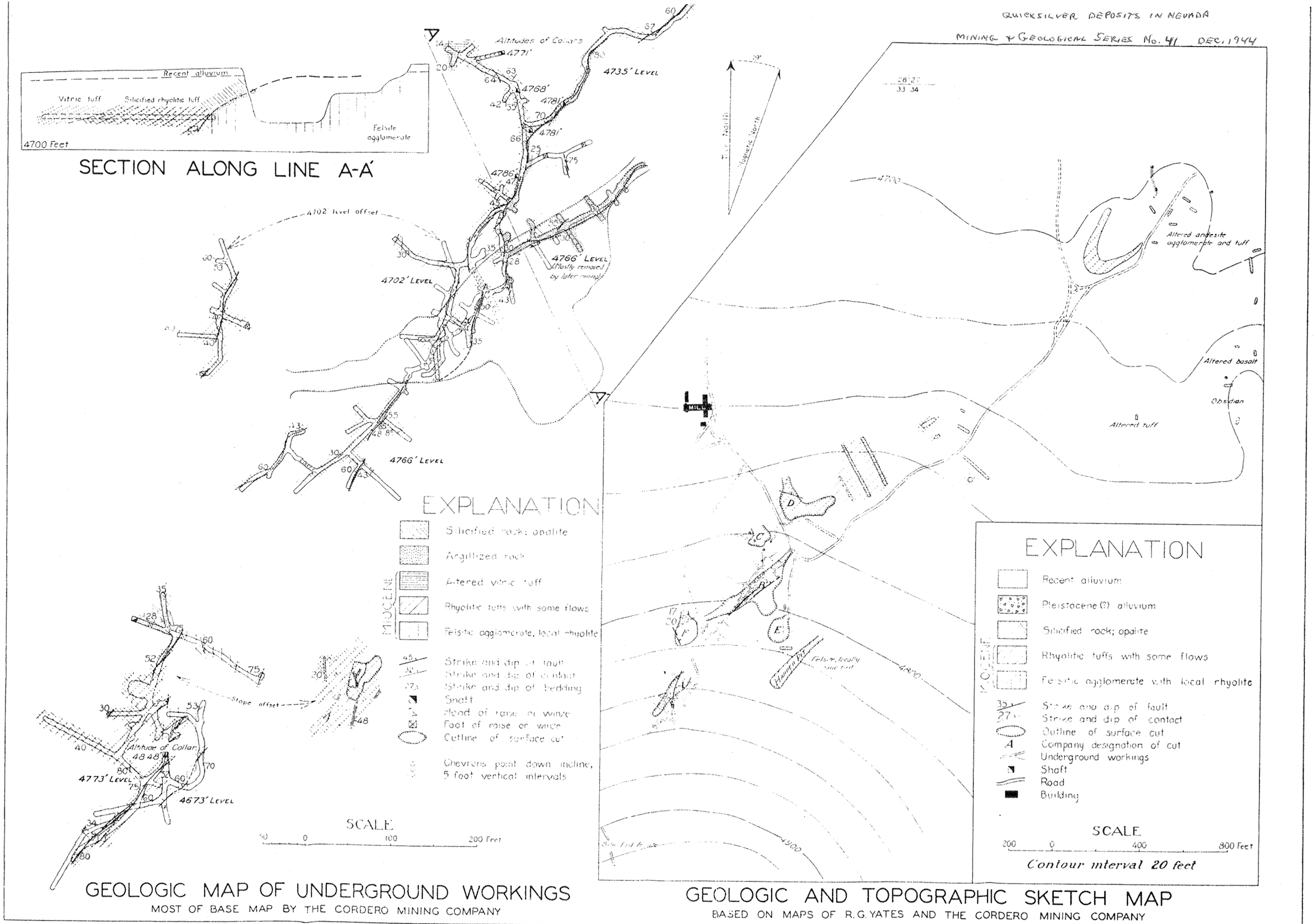


PLATE 9. GEOLOGIC MAPS AND SECTION OF THE CORDERO QUICKSILVER MINE, HUMBOLDT COUNTY, NEVADA. U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY. EDGAR H. BAILEY AND DAVID A. PHOENIX. JANUARY 1944.

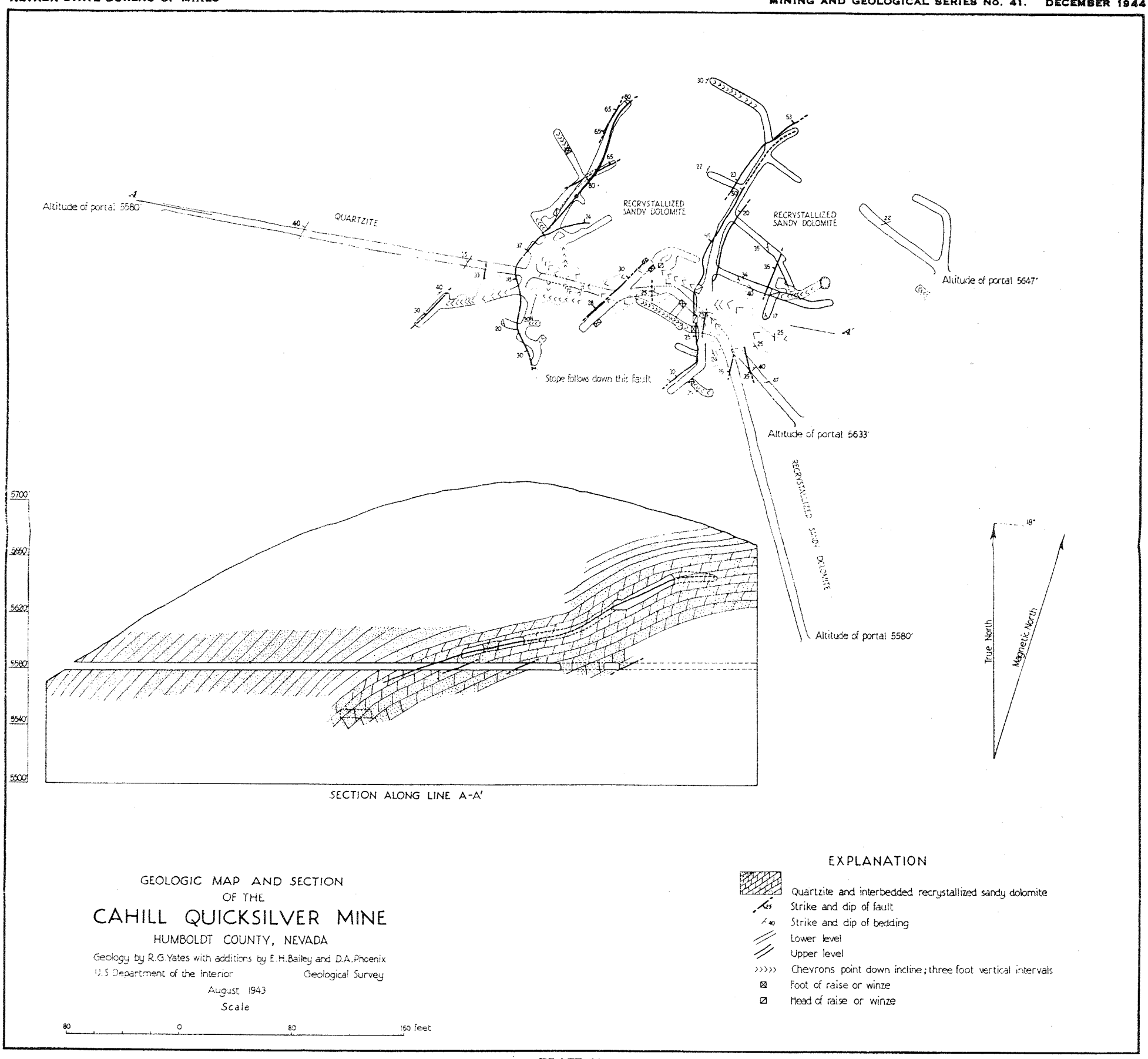

Altitude of portal 5580'
QUARTZITE
RECRYSTALLIZED SANDY DOLOMITE
RECRYSTALLIZED SANDY DOLOMITE
Altitude of portal 5647'
Stope follows down this fault
Altitude of portal 5633'
RECRYSTALLIZED SANDY DOLOMITE
Altitude of portal 5580'
5700'
5660'
5620'
5580'
5540'
5500'
SECTION ALONG LINE A-A'
18°
True North
Magnetic North
EXPLANATION
Quartzite and interbedded recrystallized sandy dolomite
Strike and dip of fault
Strike and dip of bedding
Lower level
Upper level
Chevrons point down incline; three foot vertical intervals
Foot of raise or winze
Head of raise or winze
GEOLOGIC MAP AND SECTION
OF THE
CAHILL QUICKSILVER MINE
HUMBOLDT COUNTY, NEVADA
Geology by R.G.Yates with additions by E.H.Bailey and D.A.Phoenix
U.S. Department of the Interior Geological Survey
August 1943
Scale
80 0 80 160 feet

PLATE 10

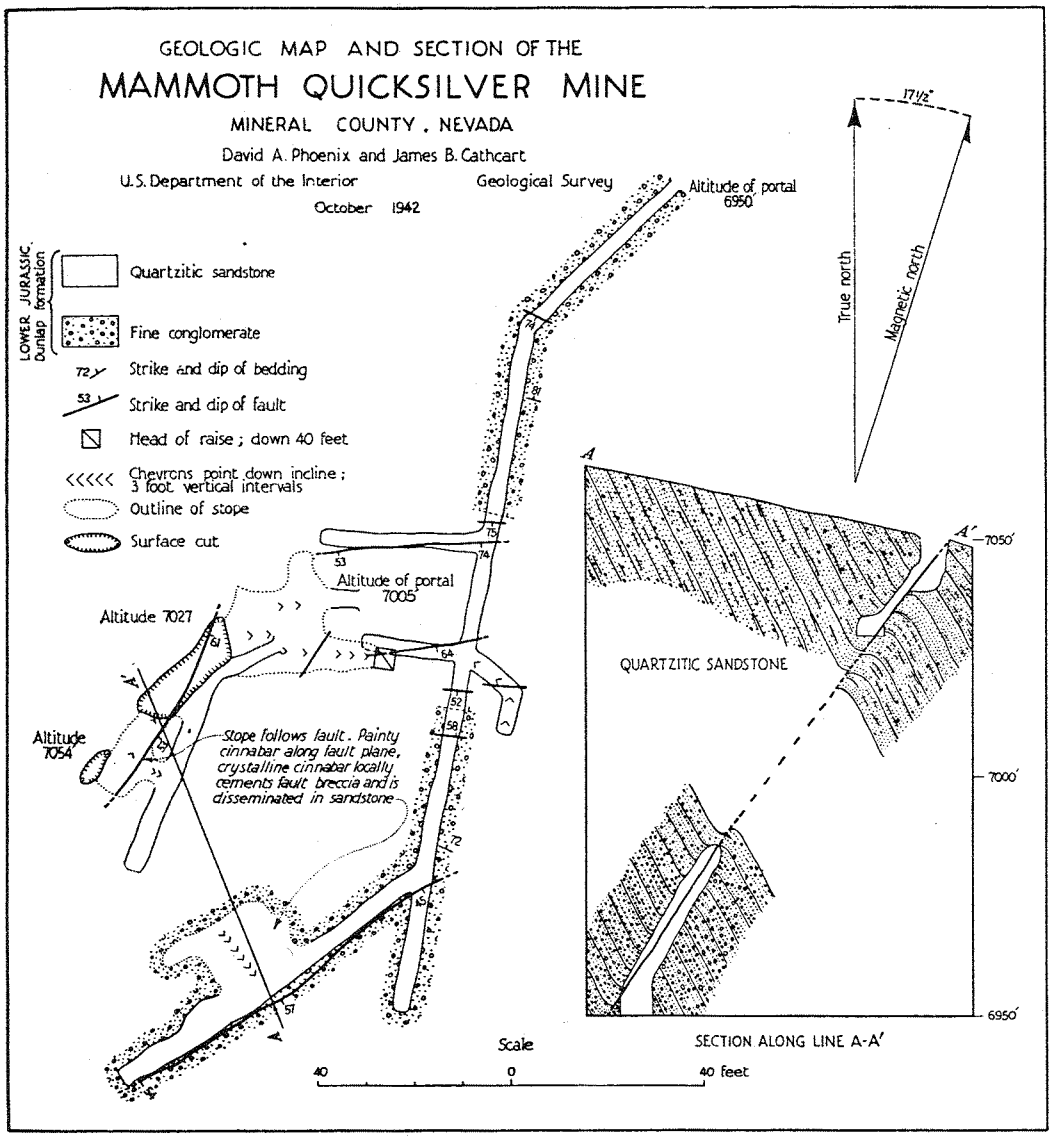

GEOLOGIC MAP AND SECTION OF THE
MAMMOTH QUICKSILVER MINE
MINERAL COUNTY, NEVADA
David A. Phoenix and James B. Cathcart
U.S. Department of the Interior Geological Survey
October 1942
LOWER JURASSIC
Dunlap formation
Quartzitic sandstone
Fine conglomerate
Strike and dip of bedding
Strike and dip of fault
Head of raise; down 40 feet
Chevrons point down incline; 3 foot vertical intervals
Outline of stope
Surface cut
Altitude of portal 6950'
Altitude of portal 7005'
Altitude 7027
Altitude 7054
Stope follows fault. Painty cinnabar along fault plane, crystalline cinnabar locally cements fault breccia and is disseminated in sandstone
Scale
40 0 40 feet
17½°
True north
Magnetic north
A
A'
7050'
7000'
6950'
QUARTZITIC SANDSTONE
SECTION ALONG LINE A-A'

PLATE 11

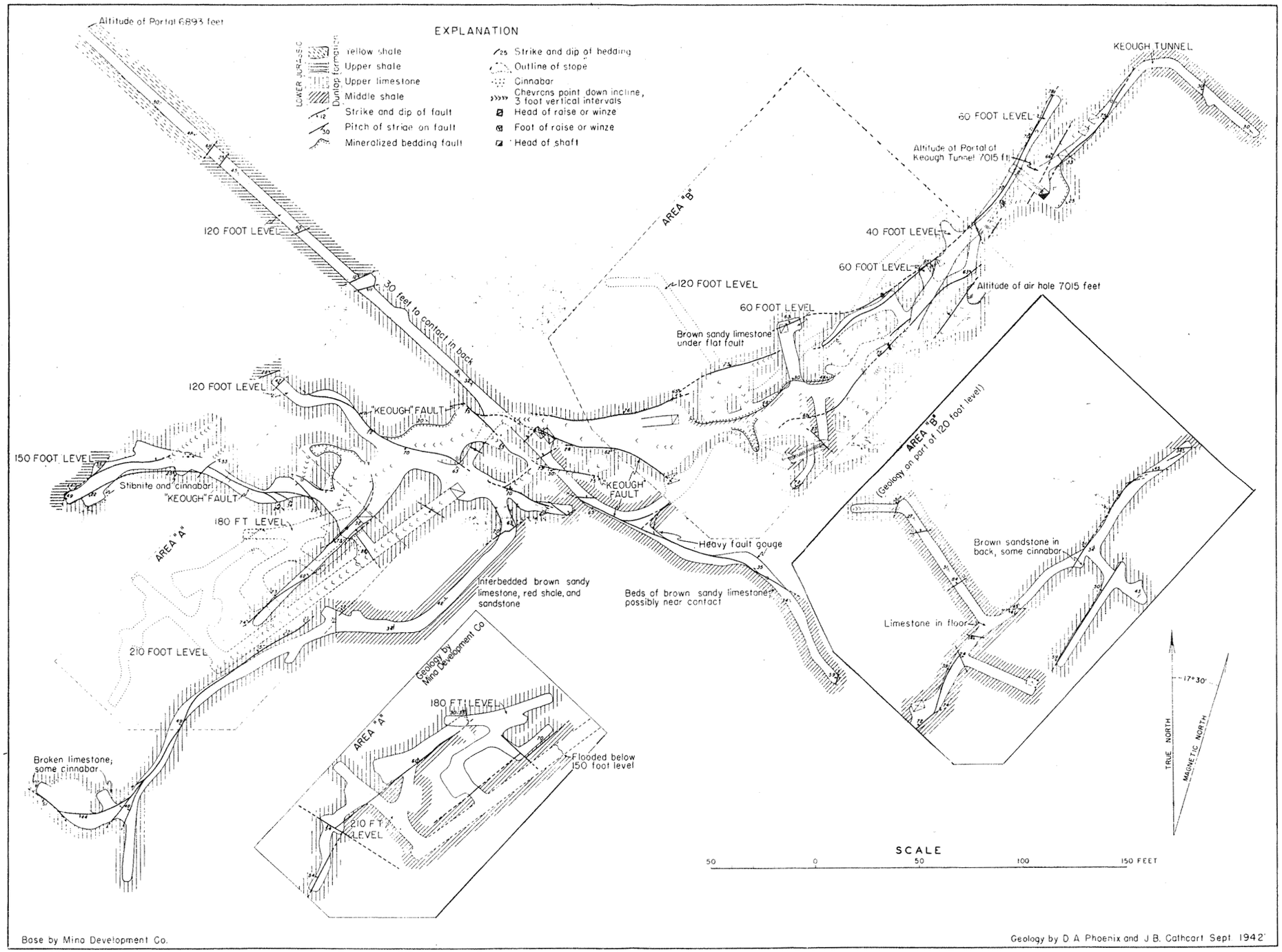


PLATE 12. GEOLOGIC MAP OF THE MINA DEVELOPMENT COMPANY QUICKSILVER MINE, MINERAL COUNTY, NEVADA. U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY.

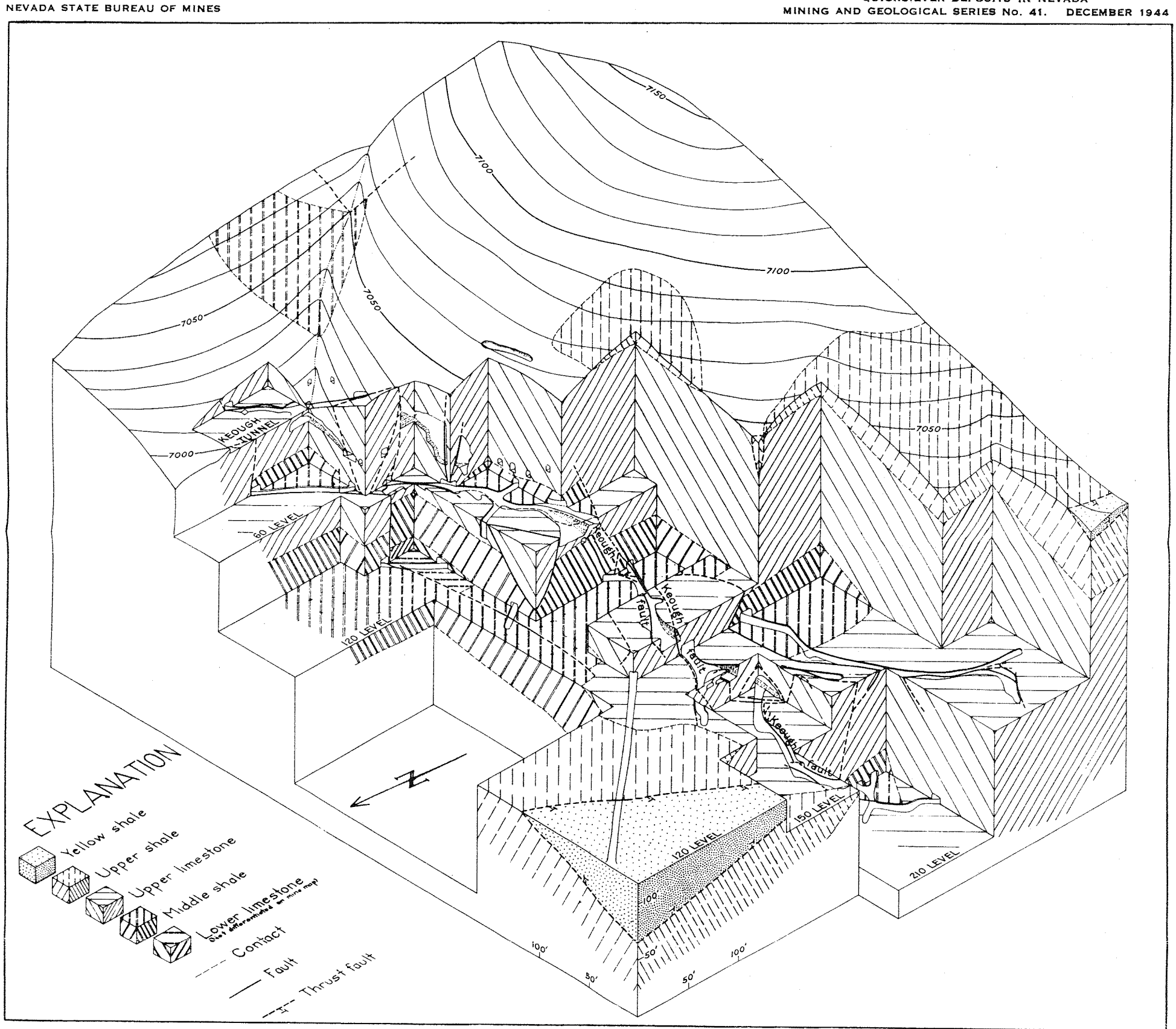
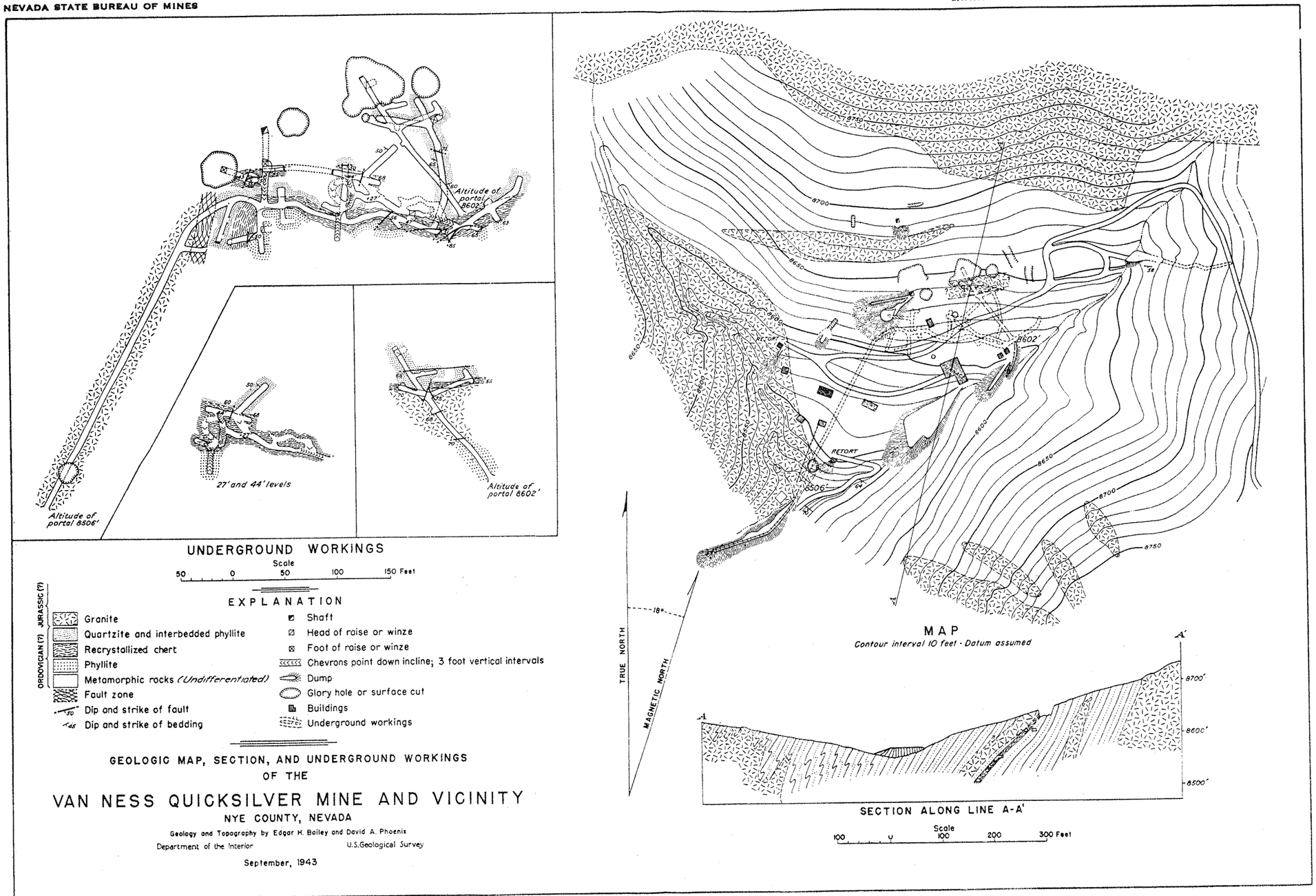


PLATE 13. BLOCK DIAGRAM OF THE MINA DEVELOPMENT COMPANY QUICKSILVER MINE, MINERAL COUNTY, NEVADA.
U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY. DAVID A. PHOENIX. 1944.


Altitude of portal 8602'
27' and 44' levels
Altitude of portal 8506'
Altitude of portal 8602'
UNDERGROUND WORKINGS
Scale
50 0 50 100 150 Feet
EXPLANATION
ORDOVICIAN (?) JURASSIC (?)
Granite
Quartzite and interbedded phyllite
Recrystallized chert
Phyllite
Metamorphic rocks (Undifferentiated)
Fault zone
Dip and strike of fault
Dip and strike of bedding
Shaft
Head of raise or winze
Foot of raise or winze
Chevrons point down incline; 3 foot vertical intervals
Dump
Glory hole or surface cut
Buildings
Underground workings
GEOLOGIC MAP, SECTION, AND UNDERGROUND WORKINGS
OF THE
VAN NESS QUICKSILVER MINE AND VICINITY
NYE COUNTY, NEVADA
Geology and Topography by Edgar H. Bailey and David A. Phoenix
Department of the Interior
U.S. Geological Survey
September, 1943
8750
8700
8650
8600
8506'
RETORT
8602'
A
A'
TRUE NORTH
MAGNETIC NORTH
18°
MAP
Contour interval 10 feet - Datum assumed
8700'
8600'
8500'
SECTION ALONG LINE A-A'
Scale
100 0 100 200 300 Feet

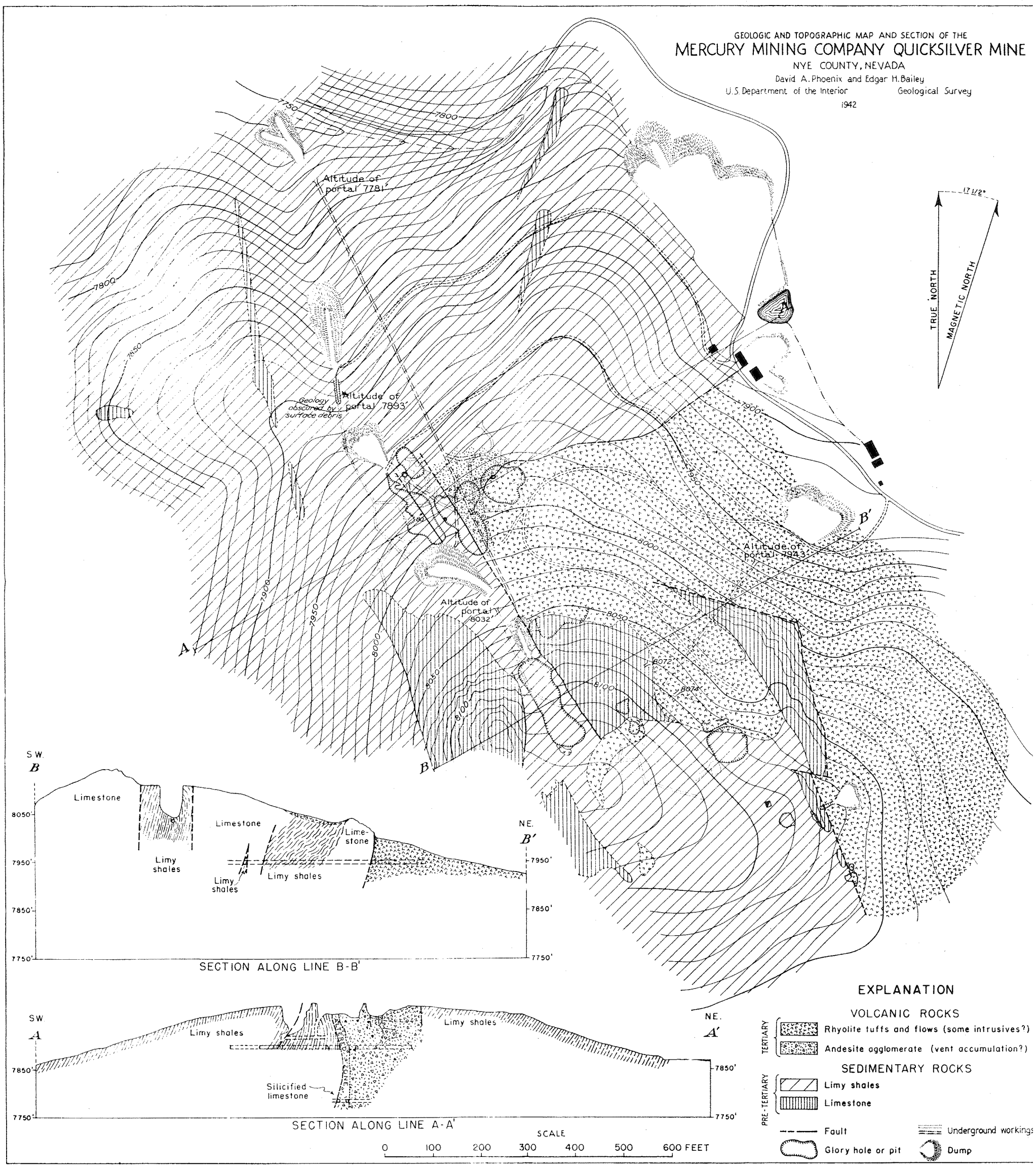

GEOLOGIC AND TOPOGRAPHIC MAP AND SECTION OF THE
MERCURY MINING COMPANY QUICKSILVER MINE
NYE COUNTY, NEVADA
David A. Phoenix and Edgar H. Bailey
U.S. Department of the Interior Geological Survey
1942
TRUE NORTH
MAGNETIC NORTH
17 1/2°
Altitude of portal 7781'
Altitude of portal 7893'
Geology obscured by surface debris
Altitude of portal 7943'
Altitude of portal 8032'
A
A'
B
B'
SW
NE.
Limestone
Limy shales
Limestone
Lime-stone
Limy shales
Limy shales
SECTION ALONG LINE B-B'
Limy shales
Limy shales
Silicified limestone
SECTION ALONG LINE A-A'
SCALE
0 100 200 300 400 500 600 FEET
EXPLANATION
VOLCANIC ROCKS
TERTIARY
Rhyolite tuffs and flows (some intrusives?)
Andesite agglomerate (vent accumulation?)
SEDIMENTARY ROCKS
PRE-TERTIARY
Limy shales
Limestone
Fault
Glory hole or pit
Underground workings
Dump

PLATE 15

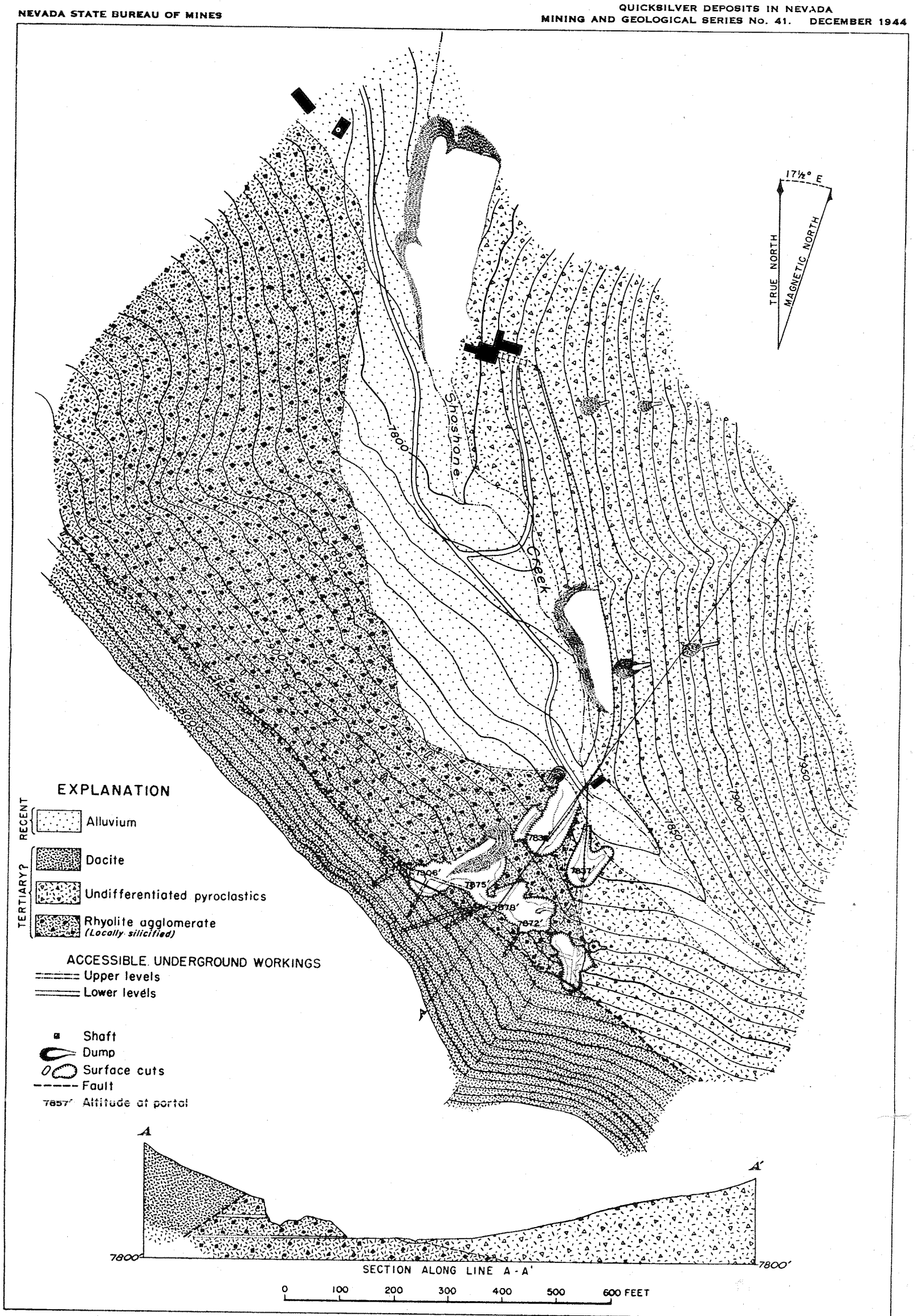


PLATE 16. GEOLOGIC AND TOPOGRAPHIC MAP AND SECTION OF THE NEVADA CINNABAR MINE AREA, NYE COUNTY, NEVADA.
U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY. DAVID A. PHOENIX AND EDGAR H. BAILEY. 1943.

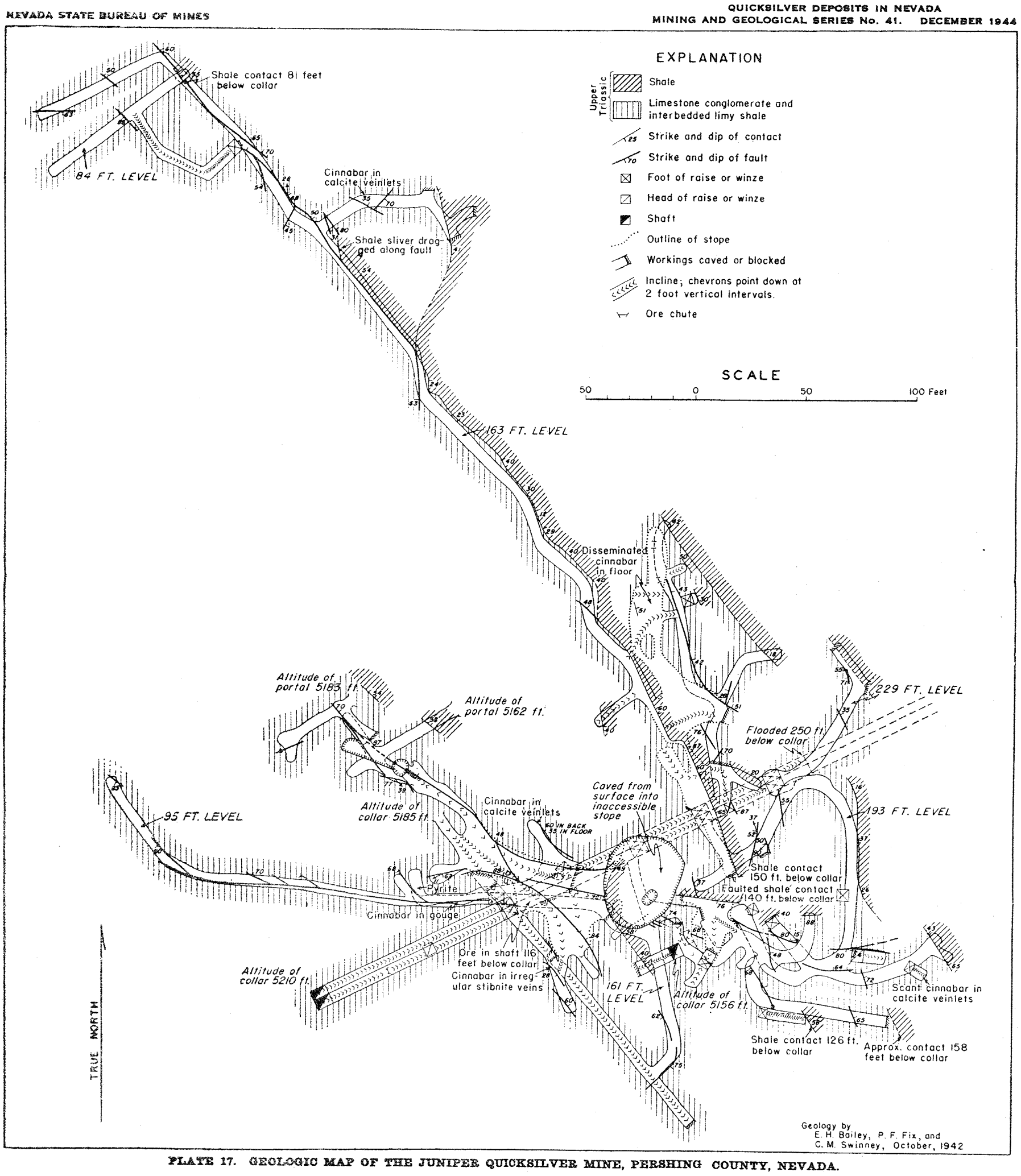


PLATE 17. GEOLOGIC MAP OF THE JUNIPER QUICKSILVER MINE, PERSHING COUNTY, NEVADA.

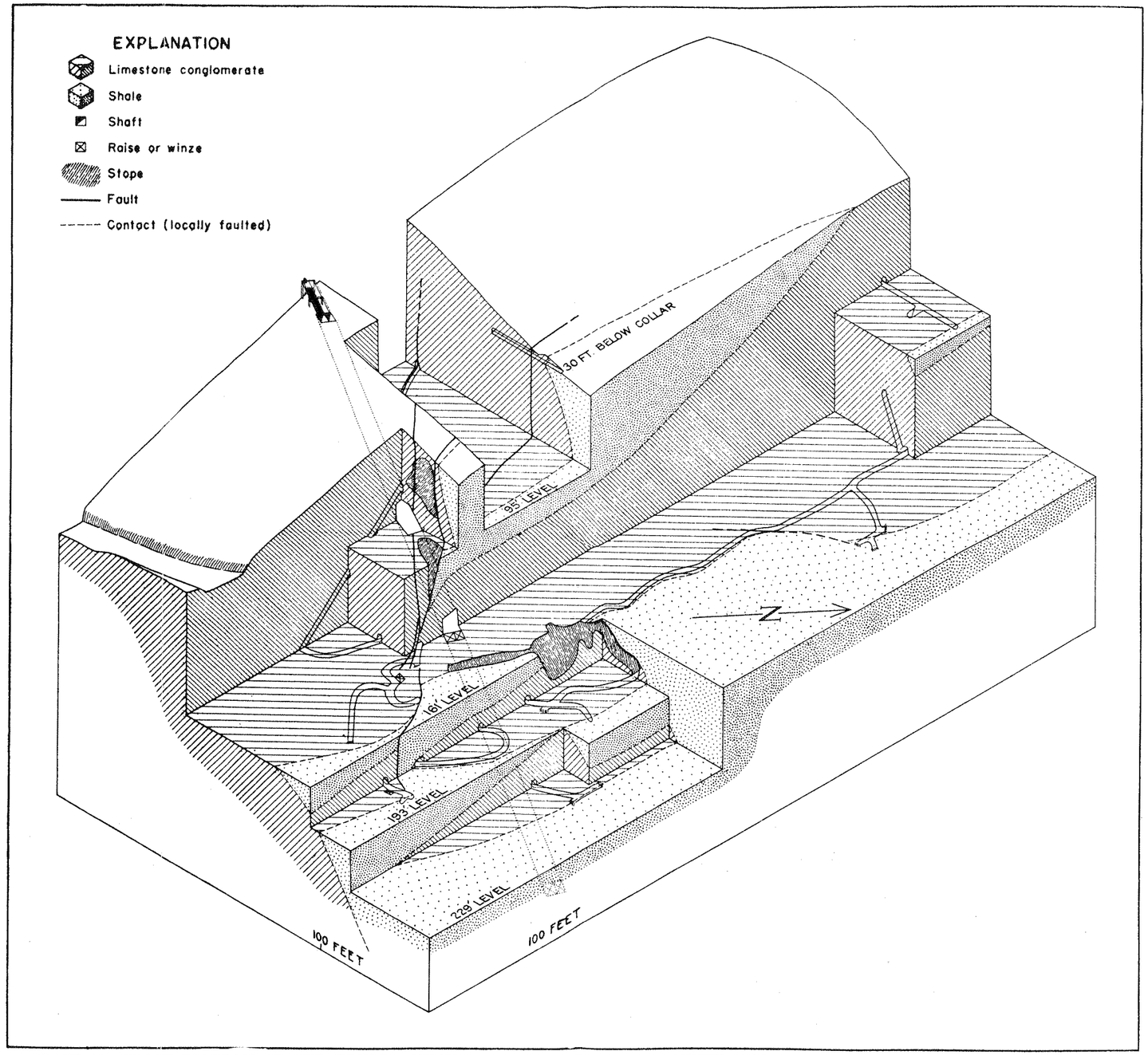


PLATE 18. BLOCK DIAGRAM OF THE JUNIPER QUICKSILVER MINE, PERSHING COUNTY, NEVADA. U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY. EDGAR H. BAILEY. 1943.

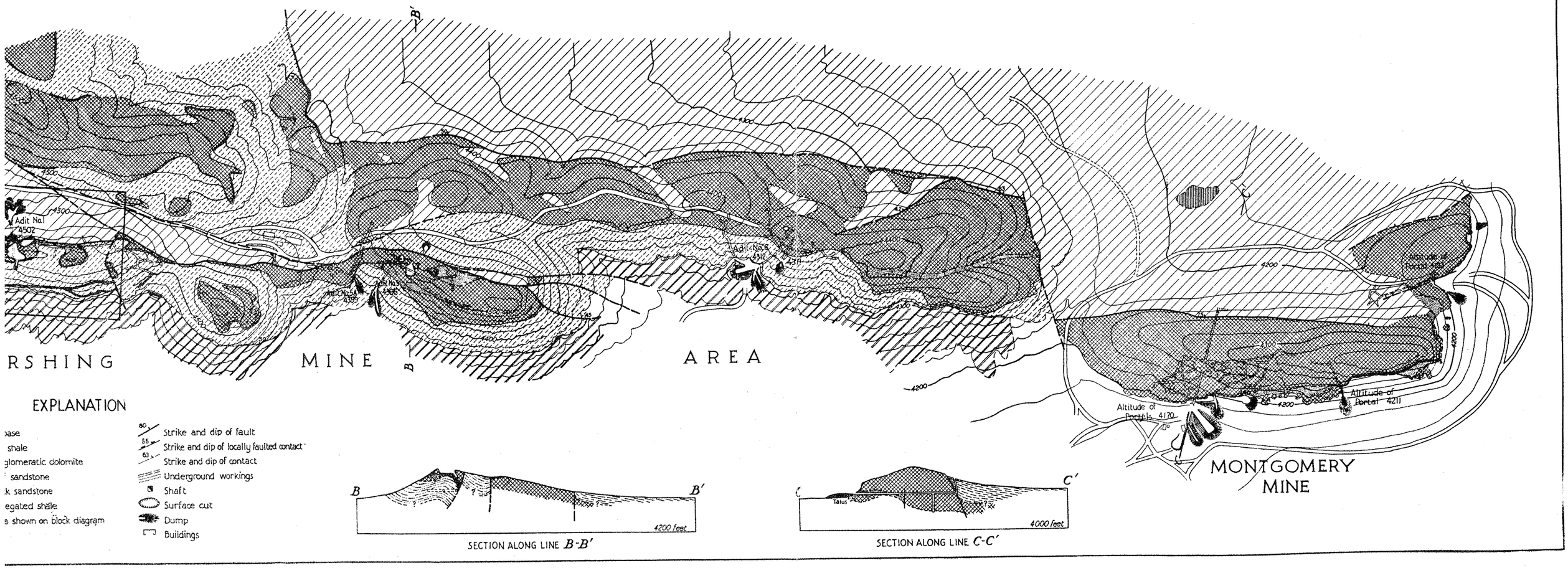
GEOLOGIC AND TOPOGRAPHIC MAP AND SECTIONS OF THE

PERSHING AND MONTGOMERY QUICKSILVER MINE AREA

PERSHING COUNTY NEVADA

Geology and topography by E. H. Bailey, P. F. Fix, D. A. Phoenix, and C. M. Swinney

U. S. Department of the Interior Geological Survey

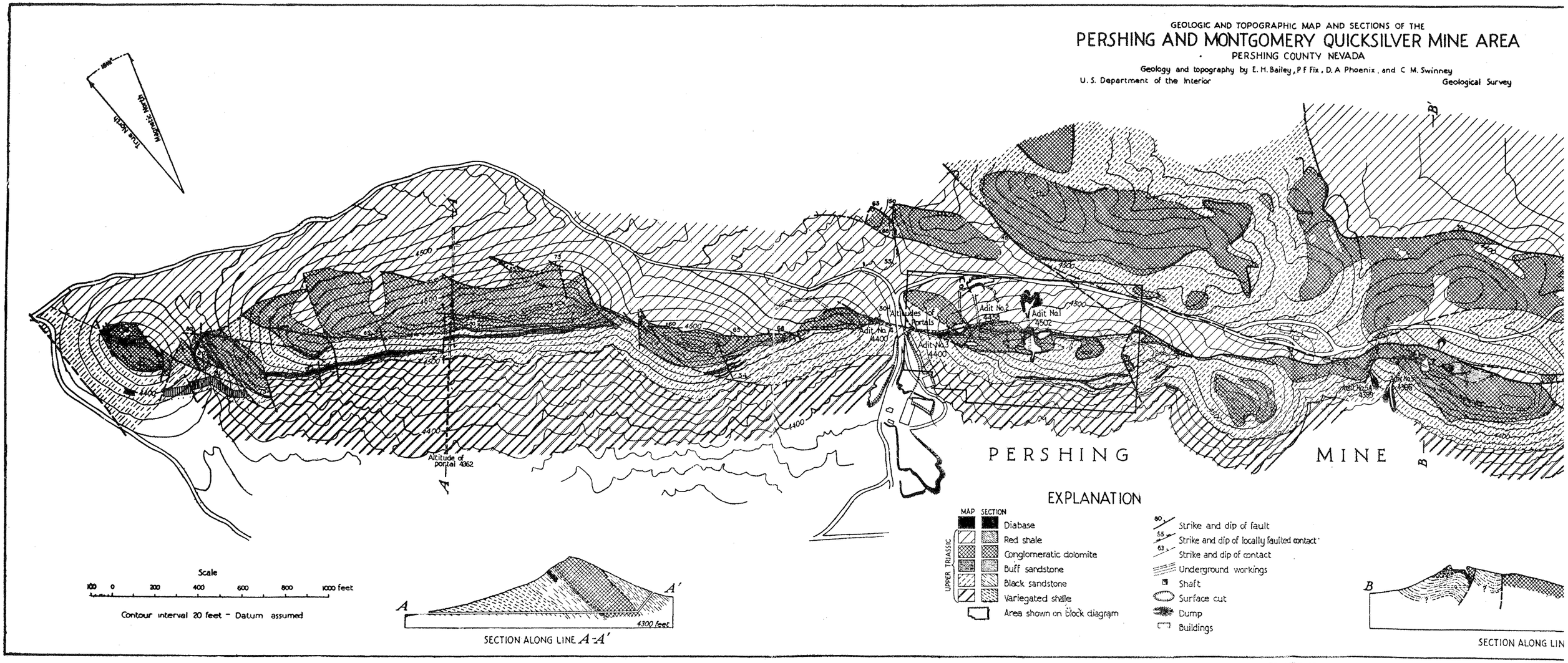


GEOLOGIC AND TOPOGRAPHIC MAP AND SECTIONS OF THE

PERSHING AND MONTGOMERY QUICKSILVER MINE AREA

PERSHING COUNTY NEVADA

Geology and topography by E. H. Bailey, P F Fix, D. A Phoenix, and C M. Swinney
U. S. Department of the Interior Geological Survey



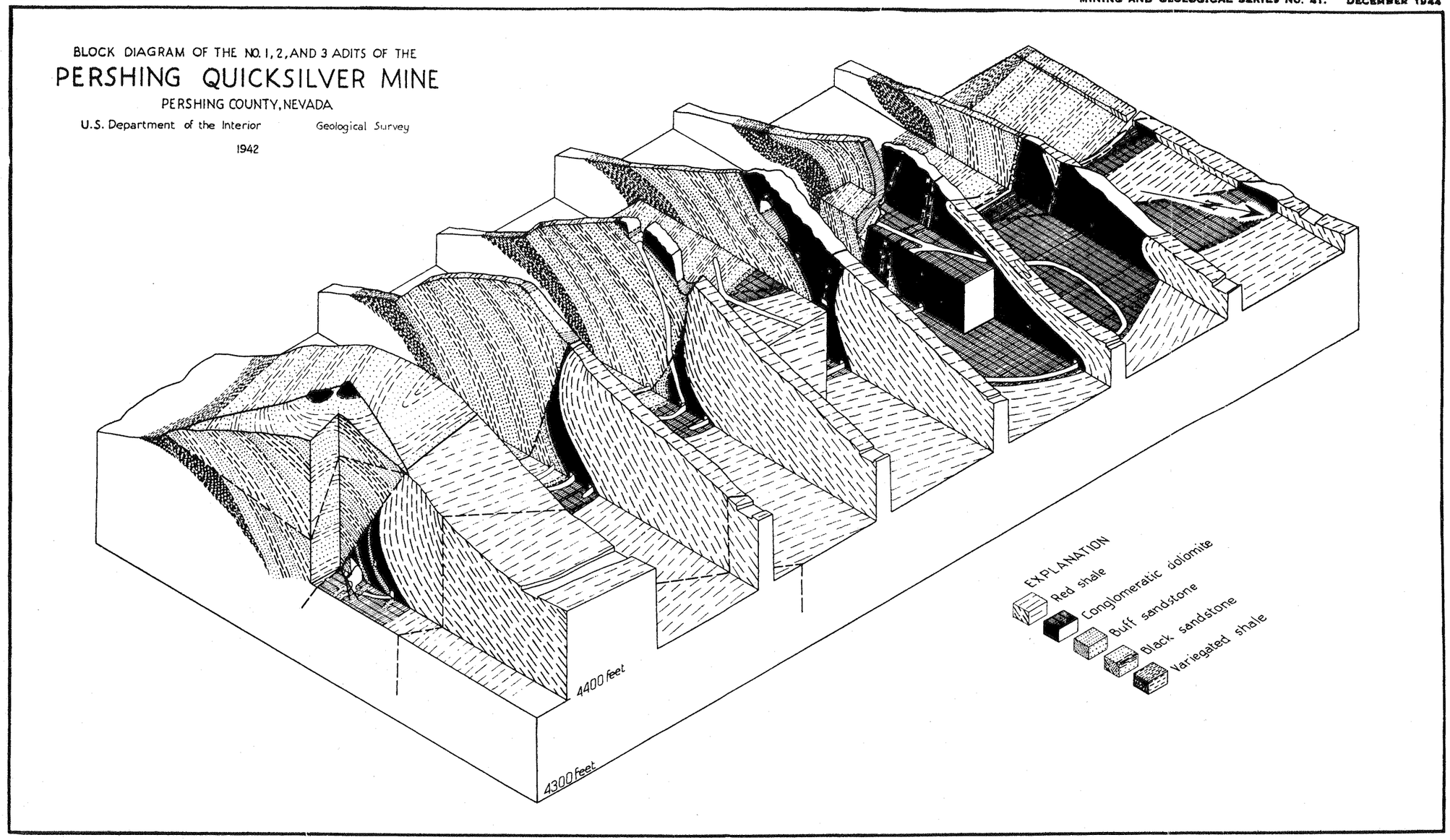
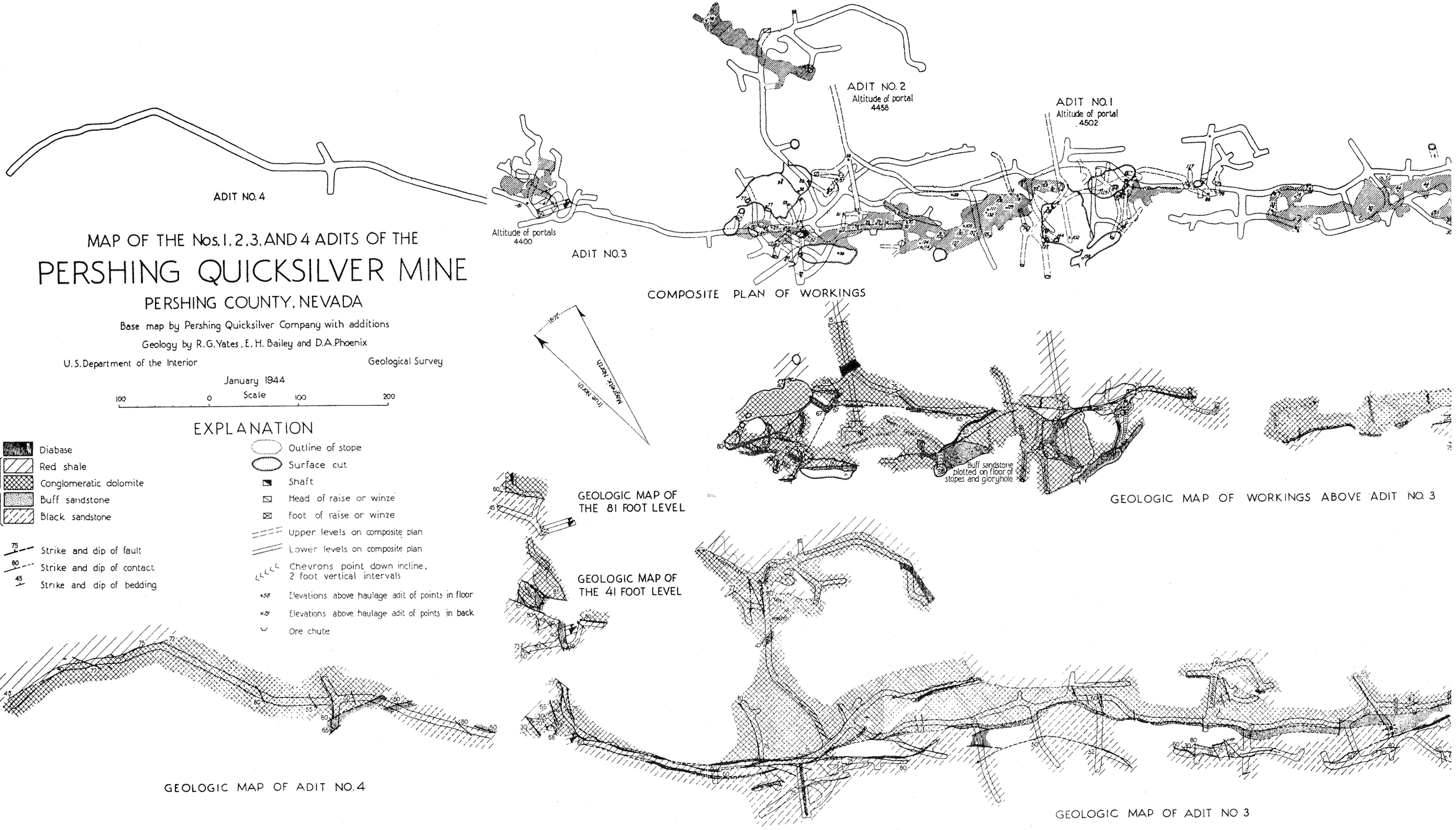
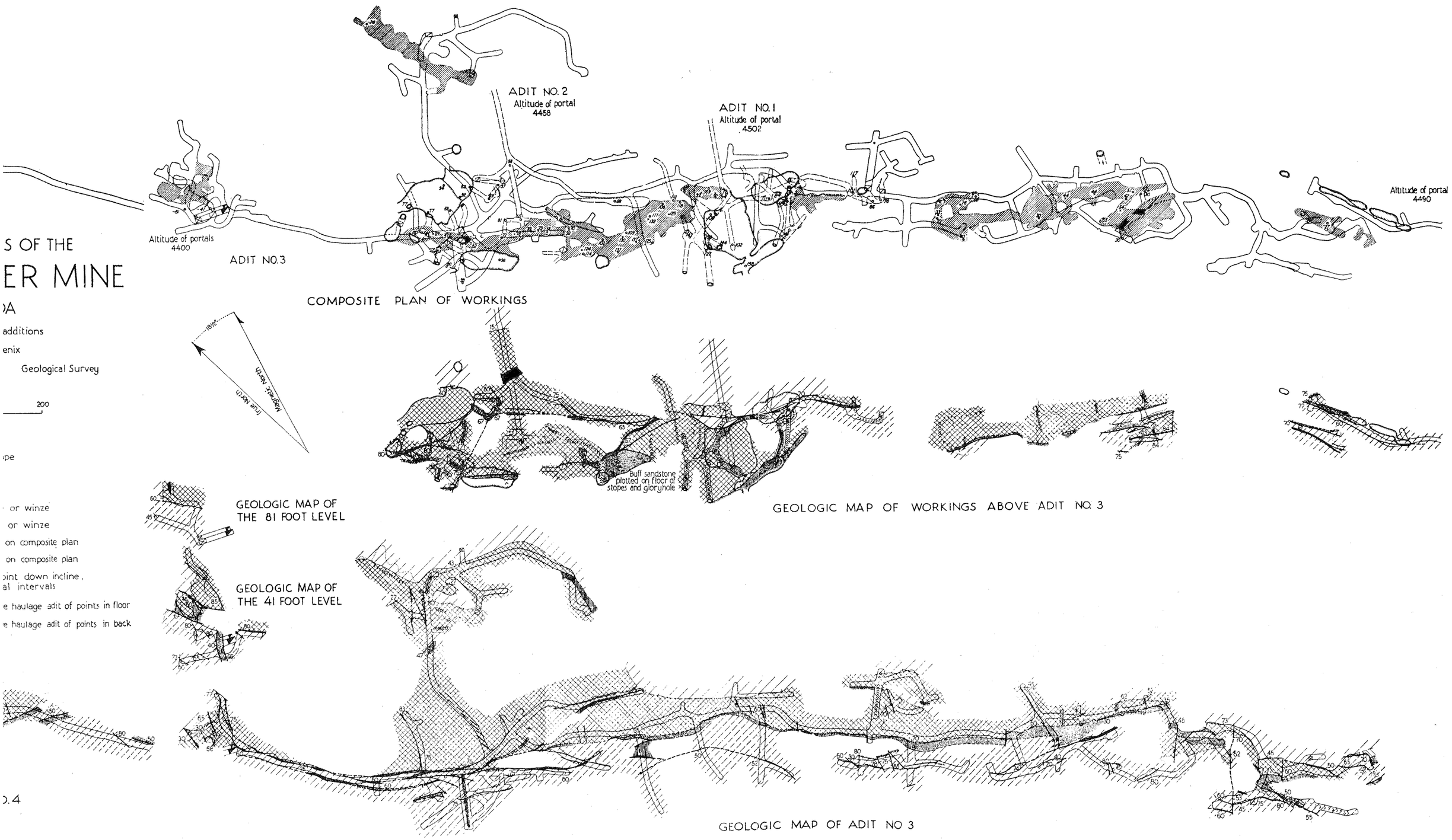

BLOCK DIAGRAM OF THE NO. 1, 2, AND 3 ADITS OF THE
PERSHING QUICKSILVER MINE
PERSHING COUNTY, NEVADA
U.S. Department of the Interior Geological Survey
1942
4400 feet
4300 feet
EXPLANATION
Red shale
Conglomeratic dolomite
Buff sandstone
Black sandstone
Variegated shale

PLATE 20


ADIT NO. 4
Altitude of portals
4400
ADIT NO. 3
ADIT NO. 2
Altitude of portal
4458
ADIT NO. 1
Altitude of portal
4502
COMPOSITE PLAN OF WORKINGS
MAP OF THE Nos. 1, 2, 3, AND 4 ADITS OF THE
PERSHING QUICKSILVER MINE
PERSHING COUNTY, NEVADA
Base map by Pershing Quicksilver Company with additions
Geology by R. G. Yates, E. H. Bailey and D. A. Phoenix
U. S. Department of the Interior
Geological Survey
January 1944
Scale
100
0
100
200
EXPLANATION
UPPER TRIASSIC
Diabase
Red shale
Conglomeratic dolomite
Buff sandstone
Black sandstone
Strike and dip of fault
Strike and dip of contact
Strike and dip of bedding
Outline of stope
Surface cut
Shaft
Head of raise or winze
Foot of raise or winze
Upper levels on composite plan
Lower levels on composite plan
Chevrons point down incline, 2 foot vertical intervals
Elevations above haulage adit of points in floor
Elevations above haulage adit of points in back
Ore chute
Magnetic North
True North
Buff sandstone plotted on floor of stopes and gloryhole
GEOLOGIC MAP OF WORKINGS ABOVE ADIT NO. 3
GEOLOGIC MAP OF THE 81 FOOT LEVEL
GEOLOGIC MAP OF THE 41 FOOT LEVEL
GEOLOGIC MAP OF ADIT NO. 4
GEOLOGIC MAP OF ADIT NO 3


S OF THE
ER MINE
)A
additions
enix
Geological Survey
200
ype
or winze
or winze
on composite plan
on composite plan
oint down incline,
al intervals
e haulage adit of points in floor
e haulage adit of points in back
).4
ADIT NO. 2
Altitude of portal
4458
ADIT NO. 1
Altitude of portal
4502
Altitude of portal
4490
Altitude of portals
4400
ADIT NO.3
COMPOSITE PLAN OF WORKINGS
True North
Magnetic North
Buff sandstone
plotted on floor of
stopes and gloryhole
GEOLOGIC MAP OF WORKINGS ABOVE ADIT NO. 3
GEOLOGIC MAP OF
THE 81 FOOT LEVEL
GEOLOGIC MAP OF
THE 41 FOOT LEVEL
GEOLOGIC MAP OF ADIT NO 3

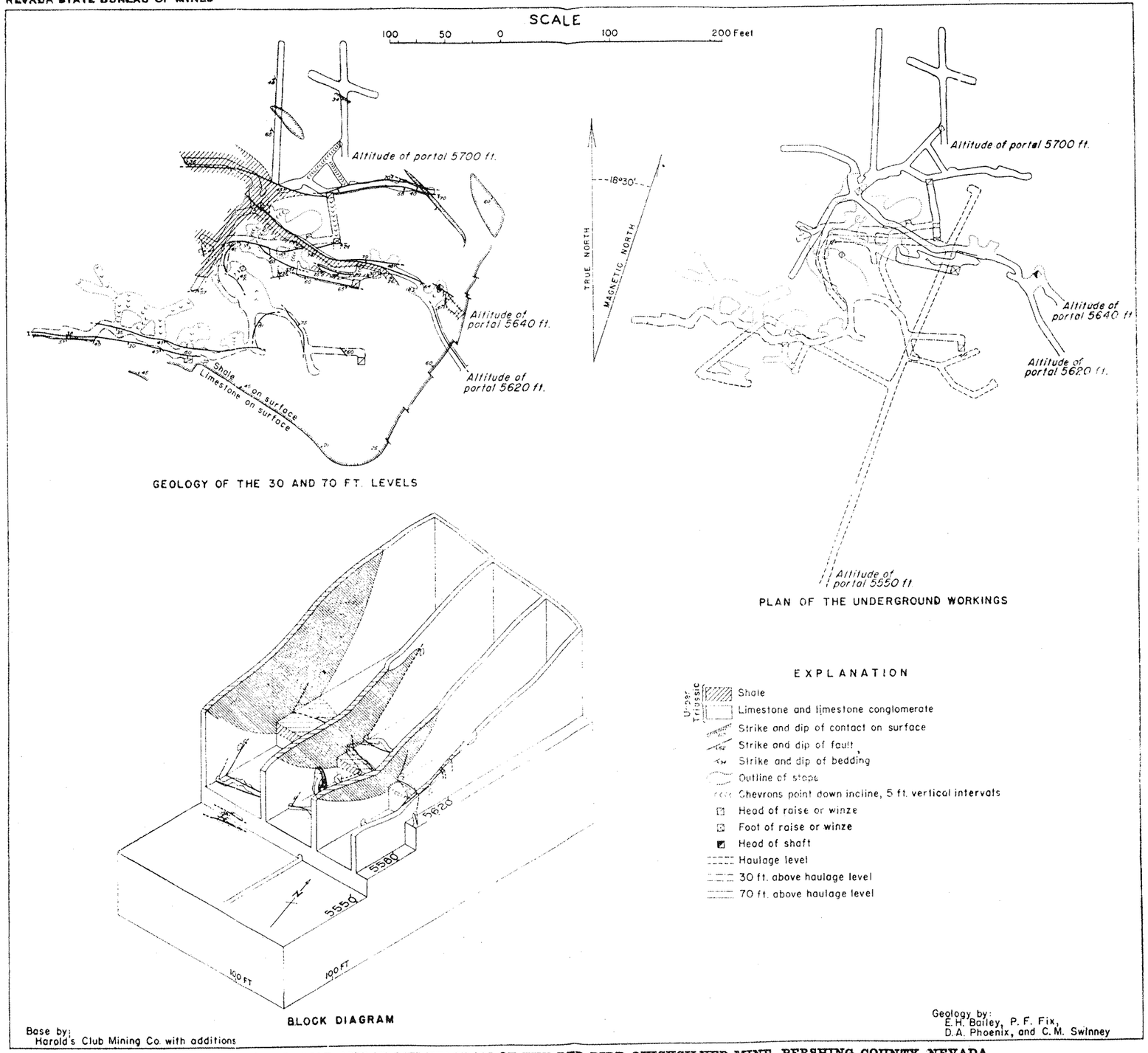


PLATE 22. GEOLOGIC MAP AND BLOCK DIAGRAM OF THE RED BIRD QUICKSILVER MINE, PERSHING COUNTY, NEVADA.
U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY. 1944.

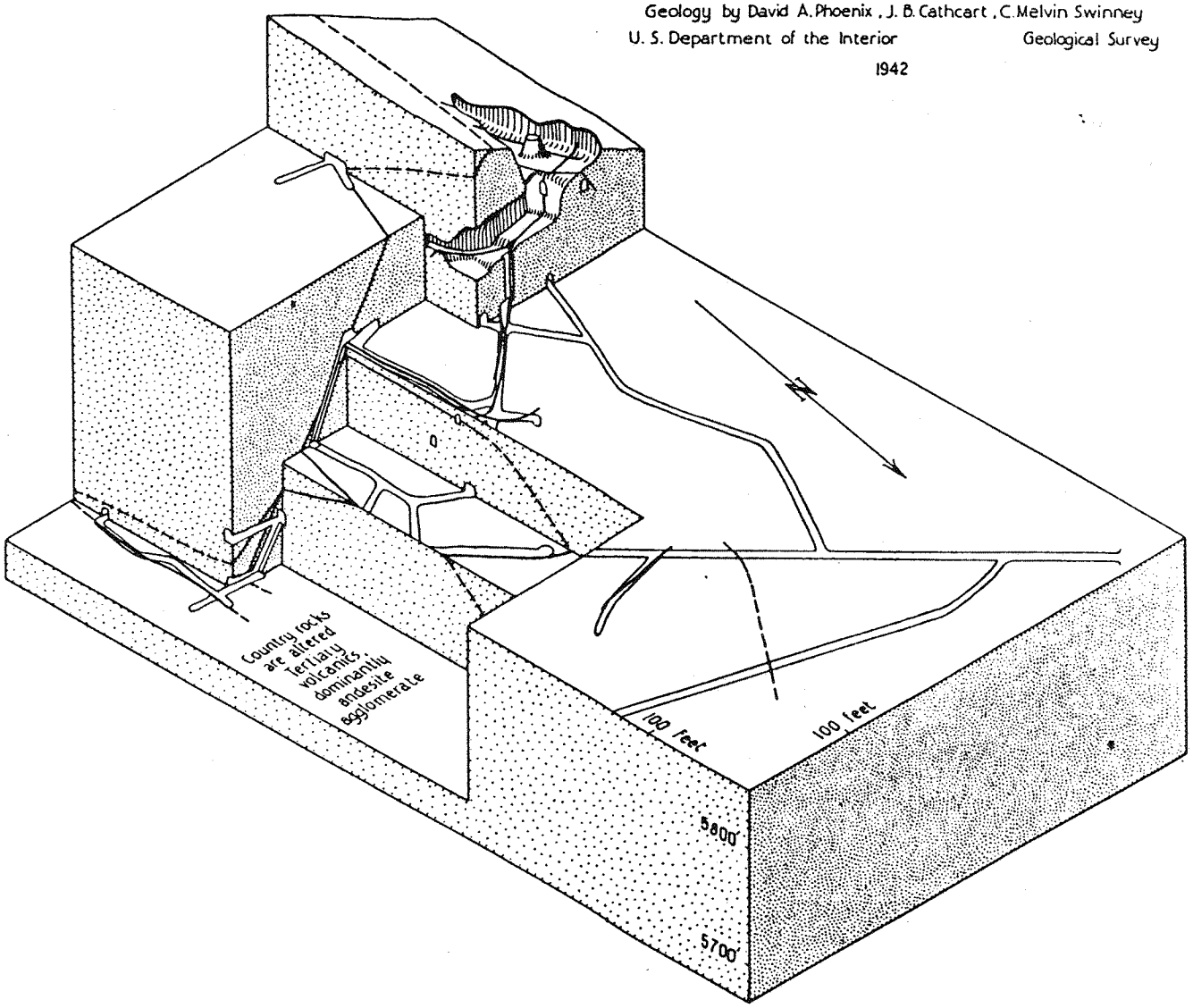

BLOCK DIAGRAM OF THE
CASTLE PEAK QUICKSILVER MINE
STOREY COUNTY, NEVADA
Geology by David A. Phoenix, J. B. Cathcart, C. Melvin Swinney
U. S. Department of the Interior Geological Survey
1942
N
Country rocks are altered Tertiary volcanics, dominantly andesite agglomerate
100 feet
100 feet
5800'
5700'

PLATE 23