DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MR-30

MERCURY IN THE UNITED STATES

(Exclusive of Alaska and Hawaii)

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INTRODUCTION

This map shows the location of mercury districts and deposits in the United States (exclusive of Alaska and Hawaii). The map was compiled from published reports and from data in the files of the Geological Survey. All map locations are numbered consecutively in each state and names, geographic coordinates, and selected references are given in the Index.

The estimated total quantity of mercury present before depletion by mining was used to assign districts to size categories; both production and reserves are included without distinction. Three sizes of mercury deposits are shown on the map: deposits of more than 100,000 flasks (76 pounds per flask); large deposits, but containing less than 100,000 flasks; and small deposits. Most mercury districts contain only one large deposit and many smaller deposits and occurrences, but a few districts contain several large deposits.

Geology

The mercury deposits of the World are confined, with a few minor exceptions, to a broad belt of late Tertiary orogeny and volcanism, a part of which extends through the Western United States. For many major deposits such as the New Idria mine in California, however, no close relation to a volcanic source can be demonstrated, and most deposits are at least a few miles from surface exposures of late Tertiary or Quaternary volcanic rocks. Most of the domestic mercury deposits are found in California and a few in Oregon and Nevada. Within this tectonic belt mercury deposits occur in rocks of all ages and of all common varieties. Structures responsible for ore localization are equally as varied. In some mines there are well-formed structural traps with "caps" of relatively impervious material, generally shale or gouge, but in some major deposits no structural control is obvious. In general, however, deposits in similar kinds of rocks exhibit similar structural environments, and an understanding of the geologic relations in one deposit can be of value in appraising or developing another deposit in the same kind of rock.

Mercury ores are formed relatively near the surface and appear to extend downward from the surface to a maximum depth of about 2,500 feet, reached at the New Almaden mine in California. The bulk of the ore that has been mined has come from depths of 1,000 feet or less. Because the deposits were formed near the surface in orogenic belts, it is likely that any geologically ancient deposits have been eroded away, and all deposits that can be accurately dated are Pliocene or younger in age.

The principal ore mineral in mercury deposits is cinnabar, HgS, but metacinnabar, native mercury, and several rare mercury minerals are found in some deposits. Because of their near-surface environment, mercury deposits exhibit great geologic variety, and even the major deposits have little in common other than their content of cinnabar and a gangue of silica or carbonate minerals. Pyrite, or more rarely marcasite, is a constituent of ores in rocks containing considerable iron, but in iron-poor rocks the iron sulfides are rare or absent. Stibnite accompanies the ore in some geologic provinces, and minor amounts of arsenic are not uncommon. Other metals, such as gold, silver, or base metals, are rarely present in more than trace amounts. In a few places a base-metal assemblage contains mercurial tetrahedrite, but these ores have not been a major source of mercury.

Production

The conterminous United States has produced a little more than 3,190,000 flasks of mercury, or nearly one-sixth of the World's supply. This has come principally from deposits in the Far Western States, but the deposits in Texas are notable exceptions and smaller deposits have been mined in Arkansas. The most productive mines, as well as the largest number, are in California. The Terlingua district in Texas makes that state second in order of production, closely followed by Nevada and Oregon. The total and relative production by state through 1960 is as follows:

State	Production (Thousands of flasks)	Percent of total
California	2,753.5	86.3
Texas	147.2	4.6
Nevada	127.1	4.0
Oregon	103.3	3.2
Idaho	30.5	1.0
Arkansas	11.4	.4
Arizona	7.0	.2
Washington	6.6	.2
Utah	3.4	.1

Within these states at least 350 mines have produced mercury, but about 90 percent of the total production has come from only 20 mines.

The following sections describe briefly the salient features of the regional and local geology of the more productive mines and districts of the conterminous United States. Similar brief accounts of these deposits, as well as other mercury deposits of the World, are given by Pennington (1959). For more detailed descriptions one may refer to the references cited.

Distribution of deposits

California

In California the principal deposits occur in the Coast Ranges in a belt about 350 miles long, extending from near Santa Barbara on the south to Clear Lake on the north. Along this belt, which has yielded more than 80 percent of the production of the United States, 18 districts are remarkably evenly spaced at intervals of about 25 miles.

The geology of the Coast Ranges is exceedingly complex. The oldest and most widely exposed rocks belong to the Franciscan formation of Jurassic and Cretaceous age, which consists of highly deformed, though not metamorphosed, graywacke, siltstone, and greenstone, with minor limestone and chert. This formation is intruded by tabular and plug-like masses of serpentine; locally their margins are hydrothermally altered to a rock consisting of silica minerals and magnesian carbonates, known as silica-carbonate rock, and many of the mercury ore bodies occur in this rock. Overlying this basement complex are thick sequences of sediments ranging in age from Cretaceous to Pliocene. Especially in the area between San Francisco and Clear Lake there are extensive flows of younger lavas ranging in composition from basalt to rhyolite.

Although 60 percent of the mercury produced in California has come from ore bodies in silica-carbonate rock, some large deposits are in younger sediments and volcanic rocks. Where mineralization can be dated it ranges from late Pliocene to Recent. Structurally the deposits show a variety of environments—some are along faults, though there are none along the great San Andreas rift; some are along margins of serpentine intrusives; some are in fractured sediments; and some are in relatively unbroken Recent volcanics. No close relationship to either granitic intrusives or younger volcanic rocks can be demonstrated for the majority of the deposits. Cinnabar is the common ore mineral, but in a few deposits metacinnabar is more abundant, and in at least two smaller deposits, native mercury is the predominant ore mineral.

Altoona district.—This district, in the northeastern part of Trinity County, contains the Altoona mine, which has produced about 35,000 flasks, and a few other mines with very small production. The mine is on the East Fork of the Trinity River in the southern part of the Klamath Mountains. The mine workings are in an area of porphyritic diorite and minor serpentine of Mesozoic age. Presumably the diorite intrudes the serpentine, although the relations are not clear in the mine. The rocks are cut by several faults; the ore minerals, cinnabar and some native mercury, occur in and near the fault gouge and are accompanied by considerable pyrite and a little ankerite, barite, and quartz.

Wilbur Springs district.—This district, in Lake and Colusa Counties, is about 15 miles east of Clear Lake. It contains a dozen mercury deposits, of which the largest, and only one producing in 1960, was the Abbott mine, with a production record of perhaps as much as 43,000 flasks

The Abbott mine is near the northwest end of a tabular mass of serpentine which is interlayered with shale and graywacke of Early Cretaceous age. The serpentine is believed to have been a flow that was deposited with the sediments. Parts of the serpentine are hydrothermally altered to form the opaline silica-carbonate rock that is the host for the ore. Cinnabar and minor metacinnabar are the ore minerals; gangue minerals are marcasite, calcite, and hydrocarbons with minor quartz. The cinnabar replaces the silica-carbonate rock along fractures and fills cracks to form relatively small, but often quite rich, ore bodies.

Clear Lake district.—This district, which is about 75 miles north of San Francisco, contains the Sulphur Bank mine, which has produced nearly 130,000 flasks, and a few other mines with very small production. Graywacke, siltstone, and greenstone of the Franciscan formation are overlain by late Tertiary and Quaternary continental sediments and volcanic rocks that range in composition from basalt to rhyolite. The ore deposits are Recent, and thermal waters are currently depositing some mercury and antimony.

Knoxville district.—This district, at the intersection of Napa, Yolo, and Lake Counties, contains the Knoxville mine, with a production of nearly 121,000 flasks, the Reed mine, with a production of over 26,000 flasks, and several less productive mines. The dominant geologic feature of the district is a large mass of serpentine, the eastern margin of which is separated from the sedimentary rocks of the Knoxville formation of Jurassic age by a fault. All the large ore bodies found in the district have been in sicila-carbonate rock formed from the sheared serpentine adjacent to this fault. Late Tertiary tuff and basalt blanket a small part of the area, and the ore of one of the smaller mines occurs in silicified tuff.

Mayacmas district.—This district, in parts of Sonoma, Lake, and Napa Counties, is the third most productive district in California. Unlike most districts, it contains several mines with large production as well as dozens of smaller ones. The more productive mines and approximate production are Oat Hill (162,000 flasks), Great Western (105,000 flasks), Aetna (66,000 flasks), and Mirabel (42,000 flasks).

The rocks of the district are mostly graywacke, shale, and greenstone of the Franciscan formation, which are mildly to intensely folded and cut by many faults and wide shear zones. The axes of the folds, and the faults and shear zones, trend west-northwest; large sill-like masses of serpentine intruded along the shear zones have a similar trend. Parts of the area are overlain by flat or gently inclined silicic flows and tuffs of Pliocene and Pleistocene age, and younger basalt flows locally cap some of the lower hills in the eastern part of the district.

The mineralized area is about 25 miles long and 7 miles wide, but the more productive deposits lie within half a mile of a straight line drawn through the length of the district. Most of the ore bodies occur in silica-carbonate rock formed by hydrothermal alteration of marginal parts of the serpentine; but ore bodies of the highly productive Oat Hill mine are along faults in graywacke of the Franciscan formation, and at the less productive Cloverdale mine the ore is in chert of the Franciscan formation. Cinnabar is the usual ore mineral, but native mercury is abundant.

Guerneville district.—This district, two miles north of the

Russian River in central Sonoma County, contains the Sonoma (Great Eastern-Mt. Jackson) mine, which has produced about 85,000 flasks.

The rocks of the area are chiefly graywacke and shale of the Franciscan formation, serpentine, and silica-carbonate rock.

The mine is at the intersection of a major fault traceable northwestward for at least 20 miles and a secondary fault that trends eastward. A tabular mass of serpentine that extends northwest and east from the fault intersection is extensively altered along its southwesterly margin to silica-carbonate rock, and other silica-carbonate rock has formed within the serpentine along secondary shear zones. Thick breccia composed of shale and graywacke borders the serpentine and also occurs along shears that separate faulted portions of the serpentine; much of it is altered to a dense hard rock that cannot be distinguished easily from the silica-carbonate rock.

Cinnabar, the only important ore mineral, occurs with small amounts of pyrite and hydrocarbons disseminated in favorable parts of the silica-carbonate rock. Ore bodies are both tabular and pipelike in form.

New Almaden district.—This district, about 50 miles southeast of San Francisco, has yielded about 40 percent of the domestic mercury. The New Almaden mine, with a record of more than 1,000,000 flasks, the Guadalupe mine, with more than 100,000 flasks, and several other mines with relatively small production lie within a belt about 5 miles long and a mile wide. The deposits in this area were the first discovered in the United States, and between 1850 and 1900 they yielded enormous quantities of mercury. During the World War II years these mines produced about 10,000 flasks, but in subsequent years they have been worked chiefly by small groups of lessees.

The deposits of the New Almaden mine were first recognized to contain mercury ores in 1845, and, except for very brief periods of inactivity in recent years, have been mined ever since.

The ore bodies formed in silica-carbonate rocks near contacts with rocks of the Franciscan formation. Where these contacts are relatively flat, the ore lies in structural highs such as apices of domes or anticlines; where contacts are steep the ore appears to be localized by the presence of fractures. Cinnabar, the only important ore mineral, replaces the silica-carbonate rock that was formed by hydrothermal alteration of serpentine. Although replacement extended only a few inches away from the fractures, it was so complete that commonly over 50 percent of the rock was cinnabar. In the major ore bodies, steep fractures occur as swarms so closely spaced that much of the intervening rock is rich ore.

Small amounts of sulfides such as pyrite, stibnite, chalcopyrite, bornite, galena, and sphalerite, plus native mercury accompany the cinnabar. Introduced gangue minerals include quartz, dolomite, and hydrocarbons.

The Guadaulpe mine, about 4 miles west of the New Almaden mine has the same geologic setting.

New Idria district.—This district is in northeastern San Benito County, about 140 miles southeast of San Francisco. In 1960 the New Idria mine was one of the leading producers in the United States, having produced about 500,000 flasks.

The mine is on the northern margin of the large pluglike mass of serpentine and Franciscan rock which intrudes the shales of the Panoche formation of Late Cretaceous age. Near the plug the shales are warped upward, and in the mine area they are overturned so that they dip steeply southward toward the plug. In most of the mine area the rocks above the inward-dipping margin of the plug are sedimentary rocks of the Franciscan formation, which form a thin selvage around the serpentine. Most of the ore occurs beneath a thrust fault near the margin of the plug. In addition to the marginal fault, there are other faults, some of which offset the main thrust and are important because they create structures favorable for ore deposition.

Cinnabar is the chief mineral, but in some ore bodies metacinnabar is an important constituent. Pyrite and marcasite are abundant in places, but generally are minor constituents of the ore. Carbonate minerals and quartz are also locally common, but much of the ore contains no obvious nonmetallic gangue.

San Luis Obispo district.—In northwestern San Luis Obispo County an elongate area of about 75 square miles contains several dozen relatively small mines with an aggregate production of over 80,000 flasks of mercury. About 80 percent of the production came from the Oceanic mine (41,000 flasks) and the Klau mine (26,000 flasks).

Much of the area is underlain by sedimentary rocks of the Franciscan formation and serpentine intrusive into them. These rocks are unconformably overlain by Cretaceous sedimentary rocks in the eastern part of the area and Miocene sediments and diabase sills in the western part. Folds axes trend northwest, and the area is broken into slivers by a series of faults trending roughly parallel to the folds. Rhyolite stocks and dikes were intruded in late Tertiary or Quaternary time.

Oregon

Mercury mines in Oregon have yielded about 100,000 flasks, of which about 90 percent has come from five mines—Bonanza (35,000 flasks), Black Butte (17,000 flasks), Horse Heaven (17,000 flasks), Opalite (15,000 flasks) and Bretz (10,000 flasks). Although occurrences of mercury ores are widely distributed throughout the state, the productive deposits are in restricted areas in the central, southwest, and southeastern parts. Most of the deposits are in Tertiary rocks of pre-Miocene age, but in the Opalite district in southeastern Oregon large ore bodies occurred in tuffs and lake beds of late Miocene age. The widespread Columbia River basalt of Miocene and Pliocene(?) age, andesite of Pliocene age in the high Cascades, and younger intrusives are remarkably unmineralized.

Southwestern Oregon.—A mineralized belt, extending from Medford to Cottage Grove, includes the two most productive mines in the State, the Bonanza and Black Butte, as well as a dozen other small mines and prospects. Most of the deposits are in sedimentary rocks and lavas of Eocene age, but some small ore bodies have been found in the underlying schists of Devonian(?) age. Most of the ore bodies formed along normal faults and are accompanied by widespread veinlets of quartz and carbonates. As cinnabar is generally disseminated in the country rock beyond the limits of ore shoots, the ore bodies are bordered by unmined mineralized rock that provides a sizable reserve of low-grade ore.

The Bonanza mine workings are in a sequence of arkosic and tuffaceous sandstones, shales, and tuffs assigned to the Umpqua formation of Eocene age. The ore occurs along a zone of fractures which parallels the bedding and is developed in tuffaceous sandstone near its contact with overlying shale. In the ore zone the tuffaceous sandstone is extensively altered to clay and contains small disseminated crystals of cinnabar along with rare metacinnabar and native mercury. Other introduced minerals are quartz, chalcedony, various carbonates, and minor, through widespread, realgar and orpiment.

The Black Butte mine is in flows and beds of Eocene andesitic lavas, tuffs, and breccias that dip to the northeast and are intruded by irregular masses of basalt and andesite. The volcanic rocks are hydrothermally altered over a wide area and silicified more locally. Calcite veins and veinlets are abundant, and opal, chlorite, sericite, pyrite, and marcasite occur in minor amounts. Small crystals of cinnabar are scattered through much of the rock within and below the fault, but only in the richer parts of the shoots does it occur in distinct veinlets.

Southeastern Oregon.—In southeastern Oregon two districts contain ore bodies distinctly different from those of the rest of the state. The highly productive Opalite district, which lies in southern Malheur County and extends into Nevada, contains the Opalite and Bretz mines. Deposits in the Steens Pueblo Mountains area in southern Harney County have yielded very little mercury but are notable because of the abundance of mercurial tetrahedrite (schwatzite) that occurs in quartz veins with cinnabar, pyrite, chalcopyrite, galena, magnetite, and barite. Some of the cinnabar in the oxidized zone is clearly secondary, but some of the more crystalline cinnabar is believed to be primary.

The Opalite mine is in an area of nearly flat lying lake beds and tuffs of Miocene age. The ore occurs in a lenticular blanket of chalcedony, commonly referred to as opalite, formed by silicification of the beds. Cinnabar is scattered through much of the upper half of the opalite blanket, but the best ore is in and adjacent to steep fractures and breccia zones. Minor amounts of native mercury and mercury oxychloride (terlinguaite) accompany the ore; pyrite is present in very minor amounts. The rocks beneath the opalite blanket have been extensively altered to clay, and locally a little cinnabar occurs in the argillized lake beds.

The Bretz mine, which has yielded more than 10,000 flasks of mercury, is in Miocene tuffs and lake beds adjacent to a fault bounded on the north by andesitic and rhyolitic pyroclastic rocks. In contrast to the ore bodies formed in a similar geologic setting in the Opalite mine area, the ore bodies of the Bretz mine are largely in unaltered lake beds or argillized tuffs layered along fault zones. The cinnabar occurs disseminated in the lake beds and as thin films along the bedding planes, but locally the beds contain high-grade bunches and nodules.

Central Oregon.—An area in eastern Jefferson County and Crook County contains the Horse Heaven mine, with a production of about 17,000 flasks, and nearly a score of small mines and prospects. Ore bodies are in andesite and basalt flows and tuffs of Eocene age or in younger intrusive plugs of andesite or rhyolite, but nearly all the more productive ore bodies are in brecciated marginal parts of a rhyolite plug.

The most abundant ore mineral is cinnabar, which generally fills openings but locally replaces the host rock. Native mercury is locally abundant, and metacinnabar, though scarce, is widely distributed. The principal gangue minerals are marcasite, carbonates, and silica minerals. The wall rocks are extensively altered to clays.

Washington

Although mercury minerals have been found at several places in Washington, the only production has been from the Morton district in Lewis County. The district is unusual because some of the best ore occurs in seams of coal.

The mineralized area extends northeasterly about two miles and has a width of about half a mile. The rocks are shale, tuffaceous sandstone, and coal assigned to the Puget group of Eocene age, and basic sills and dikes that have intruded them. Several faults, formed at different times and having different kinds of displacement, appear to have localized the ore. Most of the cinnabar produced comes from brecciated sediments along a steep fault, but two of the richest ore bodies are in relatively unbroken sandstone beneath a clay gouge developed along a gently dipping thrust fault.

Idaho

Idaho contains two mercury mines with significant production—the Cinnabar (Hermes) mine near Yellow Pine, with a production of about 15,000 flasks, and the Idaho-Almaden mine near Weiser with a production of nearly the same amount.

The Cinnabar mine is in limestone and shale strata of Paleozoic(?) age that are a part of a series of metamorphosed sedimentary rocks forming a roof pendant in the granite of the Idaho batholith. Dikes of aplite and granite that cut the sedimentary rocks and are exposed in the underground workings do not appear to be genetically related to the ore. The host rocks were argillized, sericitized, and silicified along a broad fault zone prior to mineralization. Cinnabar, the only ore mineral, ocurs as fracture fillings and disseminations chiefly in the altered limestone; associated with it are pyrite, stibnite, realgar, and orpiment.

The main ore body of the Idaho-Almaden mine is of the opalite type and occurs as a blanket above beds of feldspathic sandstone which are part of the Payette formation of Miocene and Pliocene age. In the mineralized area an anticline is crossed by a pronounced northwest-trending sag, the margins of which are in part flexures and in part faults of small displacements. Fractures with little or no offset are developed both parallel to the anticline and to the transverse downwarp, forming a series of blocks; much of the best ore is in places where these fractures are closely spaced. The dominant silica mineral is opal, but chalcedony also is common; clay minerals are abundant in places but are inconspicuous in much of the opalite. Cinnabar, the only ore mineral, is disseminated as minute crystals in the opalite and also occurs in steep opal veins that fill fracture zones. A very small amount of pyrite accompanies the ore.

Nevada

Nevada contains more than 100 mines that have produced some mercury, distributed among about 30 districts, most of which are confined to a northerly trending belt in the central third of the State. Ore bodies are unusually diverse; they in-

clude small deposits containing some of the richest ores ever mined in the United States as well as large bodies of low-grade ore. Host rocks are equally varied as they include sandstone, limestone, sinter, opalite, rhyolite, andesite, and granitic rocks. The mines in andesitic flows and breccias, however, have yielded two-thirds of the total production. By the end of 1959 the State had produced about 120,000 flasks of mercury of which more than half came from the Cordero mine. The mine is in an extension of the opalite district of southeastern Oregon.

The rocks in the mine area are andesitic flows, breccias, and tuffs of Tertiary age. Near the surface, parts of these rocks were silicified to form opalite, but the rocks below the shallow opalite are largely argillized rather than silicified. The chief ore mineral is cinnabar, although native mercury and mercury oxychlorides were found in small amounts in the near-surface workings. Cinnabar occurs disseminated in the porous altered volcanic rocks, accompanied in many places by microcrystalline hematite, and in veins with silica minerals and abundant pyrite and some marcasite. The opalite, consisting of both chalcedony and opal, contains cinnabar disseminated through the rock in an irregular fashion; however, the major ore bodies are stratigraphically below the opalite in a mineralized zone about 500 feet long and 100 feet wide.

Utah

Nearly all the 4,000 flasks of mercury recovered in Utah has come from three mines, and all but 110 flasks was produced prior to 1910. Most of the production came from the Sacramento gold mine, in the Mercur district in Tooele County. Here earthy cinnabar occurs in bands in altered limestone of Late Mississippian age adjacent to a dike and fracture zone. The Lucky Boy mine near Marysvale in Piute County yielded in the 1880's about 250 flasks from tiemannite (mercury selenide) ore occurring in limestone.

Arizona

Southern Arizona contains more than twenty small mercury mines and prospects with an aggregate production of 5,000 flasks. The larger mines are the Ord in the Mazatzal Mountains in western Gila County and the Sunflower and Pine Mountain mines lying a few miles west of the Ord mine in eastern Maricopa County.

Most of the deposits in Arizona occur along fault zones in Precambrian schists. The mineralogy of some of the ores is unusual; in the Dome Rock Mountains cinnabar occurs with gold, wulfenite, and copper minerals, and in the Mazatzal Mountains the lodes contain tourmaline, mercurial tetrahedrite, and other copper minerals. Although the ore bodies occur along well-defined structures and contain some rich ores, the overall grade has been too low to permit sustained mining.

Texas

Texas is in second rank among mercury-producing states because of the large output from the Terlingua district. The district has yielded more than 140,000 flasks of mercury since production began in 1895, and over 90 percent came from the Chisos-Rainbow mine (100,000 flasks), the Maricopa mine (20,000 flasks), and the Study Butte mine (10,000 flasks).

The Terlingua district, which is mainly in Brewster County in the southern part of the Big Bend region, is a narrow east-trending area about 20 miles long. The layered rocks of the district consist of about 5,000 feet of Cretaceous limestone and shale overlain by early Tertiary volcanic rocks. These are intruded by dikes, sills, and laccoliths that have compositions ranging from basaltic to rhyolitic, with a widespread phase characterized by analcite. The district is dominated by an east-trending monocline, which is broken in places by northwest-trending graben. Small faults of northeasterly trend are abundant, and many of these are mineralized. Other structural features that have localized important ore bodies are collapse breccias in pipelike and tabular bodies.

The Chisos-Rainbow mine lies immediately north of a prominent graben in gently folded and strongly faulted Cretaceous shale and limestone. Here three types of ore bodies have been mined: (1) deposits in calcite veins, (2) deposits near the contact of the Devils River limestone with the overlying Grayson formation of Late Cretaceous age, and (3) deposits in brecciated rocks. The vein deposits are in calcite-filled fissures along steep normal faults. Only parts of the veins are mineralized with cinnabar, and few ore shoots are over 100 feet long or as much as 100 feet deep. The deposits along the contact in limestone beneath the Grayson formation are in flat troughlike zones of altered rock localized by faults of small displacement in the underlying limestone. In these zones cinnabar generally occurs only within 50 feet of the contact. The breccia deposits, richest and most productive in the mine, occur in fault breccia zones in limestone and in a pipelike body of breccia in the Grayson formation. The pipe ore body is a vertical cylinder of breccia composed of jumbled blocks and fragments of limestone with cinnabar enclosed in a matrix of clay in the Grayson formation.

At the Mariposa mine erosion has stripped the Grayson formation from all but the central part of the deposit; most ore bodies are therefore exposed at the surface. Along northeast-trending faults of small displacement the limestone just below the clay was dissolved by hydrothermal solutions, producing elongate zones of altered clay that sagged and collapsed into the limestone. These altered zones, which are locally 100 feet wide, are termed "cave fill zones" and are locally mineralized with cinnabar. Near the surface, parts of the zones also contained notable amounts of calomel, mercury oxychlorides, native mercury, montroydite, and rarer mercury minerals.

The Study Butte mine workings are mainly in a wedge-shaped sill of fine-grained quartz syenite intruded into calcareous shales of Late Cretaceous age. Cinnabar occurs principally in the intrusive rock but also forms ore in the shale. Seams of cinnabar and pyrite ranging from a film to an inch in thickness were deposited along steep northeast-trending fractures in the intrusive rock. The ore in the shale occurs as irregular impregnations and veinlets of pyrite, cinnabar, and calcite.

Arkansas

About 10,000 flasks of mercury have been recovered from a single district in the southwestern part of Arkansas. More than two dozen mines and prospects occur in the district along an east northeast-trending belt over 30 miles long and less than a mile wide. Small ore bodies occur in sandstone of late Paleozoic age; some are pipe-like and formed at fault intersections, and others are tabular parallel to the bedding. The ore consists of cinnabar disseminated in sandstone. Minor amounts of several rarer mercury minerals have been

found, and a little pyrite and stibnite accompany the ore. Gangue minerals are quartz and dickite.

Mercury Index

District or region	Lat. N.	Long. W.
Arizona		
1. Mazatal Mountains Faick, 1958	33°58′	111°28′
2. Dome Rock Mountains Lausen and Gardner, 1927	33°32′	114°19′
Arkansas		
1. Pike County Gallagher, 1942	34°10′	93°35′
California		
1. Patrick Creek	41°58′	123°54′
2. Beaver Creek	41°57′	122°50′
3. Altoona Swinney, 1950	41°08′	122°33′
4. Wilbur Springs	39°04′	122°26′
5. Clear Lake Everhart, 1946	39°00′	122°41′
6. Knoxville Averitt, 1945	38°51	122°22′
7. Mayacmas Yates and Hilpert, 1948	38°45′	122°42′
8. Guerneville Myers and Everhart, 1948	38°34′	122°59′
9. Oakville Fix and Swinney, 1949	38°27′	122°26′
10. Vallejo	38°07′	122°11′
11. Mt. Diablo Ross, 1940	37°54′	121°53′
12. New Almaden Bailey, 1951	37°14′	121°51′
13. Phoenix Hawkes and others, 1942	37°24′	121°23′
14. Stayton Bailey and Myers, 1942	36°57′	121°13′
15. Central San Benito Yates and Hilpert, 1945	36°37′	121°00′
16. New Idria Eckel and Myers, 1946	36°21′	120°38′
17. Parkfield Bailey, 1942	35°55′	120°19′
18. San Luis Obispo Eckel and others, 1941	35°41′	121°03′
19. Rinconada Eckel and others, 1941	35°11′	120°22′
20. Cachuma Everhart, 1950	34°43′	119°53′
21. Los Prietos	34°33′	119°40′
22. Tehachapi Bailey and Swinney, 1947	35°13′	118°32′
23. Coso Ross and Yates, 1943	36°01′	117°47′
Idaho		
1. Yellow Pine Schrader and Ross, 1926	44°55′	115°18′
2. Weiser Ross, 1956	44°15′	116°41′
Nevada		
1. Opalite Yates, 1942	42°00′	117°55′
2. National Roberts, 1940a	41°45′	117°35′
3. Bottle Creek Roberts, 1940b	41°23′	118°17′
4. Poverty Peak Bailey and Phoenix, 1944	41°22′	117°25′
5. Tuscarora Bailey and Phoenix, 1944	41°20′	116°13′
6. Ivanhoe Bailey and Phoenix, 1944	41°07′	116°35′
7. Dutch Flat Bailey and Phoenix, 1944	41°08′	117°28′
8. Imlay Bailey and Phoenix, 1944	40°31′	118°10′
9. Goldbanks Dreyer, 1940	40°30′	117°41′
10. Mt. Tobin Bailey and Phoenix, 1944	40°21′	117°32′
11. Spring Valley Bailey and Phoenix, 1944	40°17′	118°06′
12. Antelope Springs Bailey and Phoenix, 1944	40°08′	118°05′
13. Wild Horse Dane and Ross, 1942	39°51′	117°28′
14. Castle Peak Bailey and Phoenix, 1944	39°28′	119°37′
15. Union Bailey and Phoenix, 1944	38°54′	117°31′
16. Belmont Bailey and Phoenix, 1944	38°38′	116°58′
17. Pilot Mountains Phoenix and Cathcart, 1952	38°22′	117°55′
18. Fish Lake Valley Bailey and Phoenix, 1944	37°53′	118°18′
19. Fluorine Bailey and Phoenix, 1944	36°53′	116°38′
Oregon		
1. Oak Grove	45°04′	121°58′

	Schuette, 1938		
2.	Horse Heaven Waters and others, 1951	44°40′	120°35′
3.	Ochoco Schuette, 1938	44°24′	120°30′
4.	Maury Mountain Schuette, 1938	44°05′	120°25′
5.	Bear Creek Schuette, 1938	44°01′	120°43′
6.	Black Butte Wells and Waters, 1934	43°33′	123°08′
7.	Bonanza-Nonpareil Brown and Waters, 1951	43°23′	123°10′
8.	Tiller Schuette, 1938	43°02′	122°56′
9.	Trail Schuette, 1938	42°38′	122°58′
10.	Steens-Pueblo Mountains Williams and Compton, 1953	42°35′	118°32′
11.	Opalite Yates, 1942	42°00′	117°55′
	Texas		
1.	Terlingua Yates and Thompson, 1959	29°19′	103°40′
2.	Mariscal	29°07′	103°12′
	Utah		
1.	Mercur Gilluly, 1932	40°19′	112°12′
2.	Mt. Baldy (Lucky Boy mine)	38°24′	112°16′
	Washington		
1.	Morton Mackin, 1944	46°35′	122°18′

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