MINERAL INDUSTRIES SURVEY OF THE UNITED STATES
CALIFORNIA
TUOLUMNE AND MARIPOSA COUNTIES
MOTHER LODE DISTRICT (SOUTH)
MINES OF THE SOUTHERN MOTHER LODE REGION
Part II—TUOLUMNE AND MARIPOSA COUNTIES

BY
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MINES OF THE SOUTHERN MOTHER LODE REGION

PART II—TUOLUMNE AND MARIPOSA COUNTIES

By C. E. Julian and F. W. Horton

INTRODUCTION

This bulletin, describing the mines of Tuolumne and Mariposa Counties of California, constitutes part II of Mines of the Southern Mother Lode Region, part I having already appeared in 1938 as Bulletin 413 of the Bureau of Mines.

The earlier bulletin, though chiefly concerned with Calaveras County, included also a general review applying to the Mother Lode region as a whole, which is not repeated here, although it was intended to serve as background for data contained in this bulletin as well as in the previous one. It described the Mother Lode, the California gold rush of 1849 and some of its important consequences, and the regional geology and ore deposition as presented by Knopf in the latest paper of the Federal Geological Survey on the subject. It also considered the three southern Mother Lode counties together with respect to their mineral production and the varied character of their mines.

In the present bulletin the account is continued to cover the mines of Tuolumne and Mariposa Counties in about the same degree of detail as in the account of Calaveras County. Chief emphasis is given to that which is typical so as to provide a general view of the circumstances applying to Mother Lode mining operations in the counties described. It is hoped that this will prove useful as a background for mining reports on individual properties by others.

A problem has arisen as to values of gold production because of the many changes in the price of the metal from $20.67 an ounce in March 1933 to $35 an ounce on February 1, 1934. In this bulletin the value of the product is given as it was when the product was mined unless conversion to the present price of $35 an ounce is expressly indicated.

FIELD WORK AND ACKNOWLEDGMENTS

This report is based on field work by the authors in October 1937 and from April to October 1938. During these 8 months all of the more

1 Work on manuscript completed May 1939.
2 Principal mining engineer, Mineral Industries Survey Section, Mining Division, Bureau of Mines.
3 Mining engineer, Mineral Industries Survey Section, Mining Division, Bureau of Mines.
important and many of the smaller mines and prospects of Tuolumne and Mariposa Counties were visited. Everywhere the operators co-operated cordially, for which appreciation is here expressed. Special acknowledgment for helpful assistance is due Chas. H. and Eric Segerstrom of Sonora, owners or part owners of the Malvina, Soulsby, Dutch-App, and other mines; Chas. E. Shafer, owner of the Crystalline-Alabama mines; Livingston Wernecke, president of the Pacific Mining Co.; John Mocine, general superintendent of the United States Lime Products Corporation; G. C. and L. J. Kane, operators of the Kane mine; C. A. Gillis, owner of the Gillis mine; Frank A. Notterman, president of the Car-Da Mining Co.; F. C. Innes, consulting mining engineer for the Harvard mine; Frank McGuire, resident manager of the Mariposa grant; John E. Steele, mine safety engineer of San Francisco; E. A. Kent, owner of the E. A. Kent placer operations; N. D. Madden, owner of the Gold Bug mine; Steven Corning and J. W. Warford, assayer and mining engineer of Mariposa; Walter McLean, owner of the Argo mine; Curtis Lindley, Jr., consulting engineer for the Rawhide mine; James Morrow, operator of the Kincaid Flat and Sullivan Creek placers; F. H. Mitchell, general manager of the Eagle-Shawmut mine; A. S. Wyner, manager of the San Juan-Ramsey Co.; Phil B. Dolman, manager of the Hickman mines; N. L. Wagner, manager, and L. G. Corwin, superintendent, of the Mount Gaines mine; A. E. Clark, owner of the Our Chance mine; A. F. Grant, vice president and manager of the Diltz mine; R. E. Jeffry, manager of the Silver Bar mine; E. H. Murchison, superintendent, and A. C. Harding, engineer, of the National Lead Co. barite mine.

Acknowledgments are also due Walter W. Bradley, State mineralogist of California, and the State Division of Mines for many data contained in their publications, which have been of great assistance in the preparation of this bulletin.

GENERAL REVIEW OF TUOLUMNE AND MARIPOSA COUNTIES

Tuolumne and Mariposa Counties, the two most southerly of the five counties traversed by the Mother Lode, resemble Calaveras County in the great extent of their mineralization. This includes countless gold-bearing quartz veins, numerous large, low-grade bodies of mineralized country rock containing only a little gold, and rich placers that have been derived from the erosion of several thousand feet of gold-bearing rocks.

Although gold mining is the major mining industry in both counties, Tuolumne County possesses large commercial deposits of marble and limestone, and Mariposa County has excellent deposits of granite, barite, and wetherite. All of these minerals have been mined extensively, and their production is keeping pace with the expanding market for them on the Pacific coast. Minor deposits of chromite and copper are present in both counties and have yielded small outputs when prices were high.

Figure 2 is a sketch map of the three southern Mother Lode counties showing the situation of the Mother Lode and the principal ancient river channels that formed rich placers during Tertiary time, many of which have been preserved beneath later volcanic extrusives or recentered by Quaternary erosion.
HISTORY

The histories of mining in Tuolumne and Mariposa Counties are so strikingly dissimilar that the fact warrants some explanation. Although the gold production of Tuolumne County greatly exceeds that of Mariposa, mining in the latter county began earlier and was at first deemed more promising. Only a few months after gold was first discovered in California, at Coloma near the northern end of the Mother Lode, it was also discovered in the placers of Mariposa Creek close to the southern end of the lode. A short trail of float led from the richest part of this placer up the hillside to a vein in which the Mariposa mine was soon opened. At first it proved very rich, and in July 1849, the first stamp mill in California was actually in operation at this mine.

Several thousand miners quickly arrived in the vicinity, from which they spread until placer claims had been staked on many creeks. Mexicans, of whom great numbers had come from beyond the Rio Grande, were especially active in prospecting for lodes, which they seem to have understood better than the Americans. Many lodes were discovered and worked superficially, arrastres being used to recover the gold.
It was then that the romantic episode of the Mariposa grant began, in which Gen. John C. Fremont claimed as his private property most of the Mariposa area within which valuable discoveries of gold had been made. In the section on Mariposa County an account of the Mariposa grant will be given. Here it is of chief interest that Fremont's claim to nearly 44,000 acres, covering 14 of the 24 miles along the Mother Lode within the county, caused uncertainty as to titles, bitter controversy, and even armed conflict from 1847 to 1859. Thereafter, miners who had located claims within the grant were dispossessed, and Mariposa County has never fully recovered from this early set-back to its mining. The handicap imposed upon it was maintained until recently by the administrative policy of the grant. Its land could not be bought, leases were granted for only a year at a time, and prospecting was forbidden except to those accorded permits applying to limited areas.

As a result, both mining and prospecting remained relatively neglected in Mariposa at a time when they were most active elsewhere in California. The widespread antagonism of miners to the grant tinged the reputation of the whole county, which was often represented by them to be virtually barren, and this tradition has survived until recently.

The history of Tuolumne County is strikingly different. It was partly settled by migration to the north from Mariposa. Every section of the county was explored by the free enterprise of miners who preempted the public domain at will, with only such restrictions as they themselves imposed. These restrictions took the form of definite rules adopted in meetings of the miners of a locality, their chief object being assurance of equal opportunity for all to obtain some share in discoveries made and prevention of individual holdings too large for prompt utilization. Occupancy and diligent working were the most effective title to possession. When a claim owner left his property idle it was soon regarded as abandoned and subject to relocation by another. On many properties there was a succession of owners, who demanded less and less return. In the placer mines most of the residual opportunities came at last into the hands of numerous Chinese, who had immigrated to the Pacific coast and were content to work harder and for far less return than their American predecessors would have deemed worth while.

The rich placers financed the prospecting and initial development of the gold veins and provided the capital required to equip the mines for production. With this assistance, and unhampered by restrictions, lode mining in Tuolumne County forged ahead. In general, its veins have been worked more persistently and to greater depth than those of Mariposa County and have produced nearly twice as much.

**PRODUCTION**

The output of gold in Tuolumne and Mariposa Counties is estimated at $251,000,000, or about one-eighth of the total gold production of California. Of this amount, $246,000,000 was produced prior to 1933, when gold was valued at $20.67 per fine ounce, so it corresponds to a weight of 11,900,200 ounces. From 1933 to 1937, inclusive, the gold production of the two counties was 146,853 ounces,
making a total yield of 12,047,053 ounces up to 1938, which at $35 an ounce, the present price of gold, would be worth $421,647,000.

About 84 percent of this combined production was provided by Tuolumne County and 16 percent by Mariposa County. The greater output of Tuolumne County is attributable chiefly to the remarkable richness of its placers, the production of which is estimated at $155,000,000, compared with $10,000,000, the estimated placer output of Mariposa County.

The values of the output of lode and placer gold in both counties are shown in the following table.

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<th>County</th>
<th>Placer mines</th>
<th>Lode mines</th>
<th>Total</th>
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<tr>
<td>Tuolumne</td>
<td>$155,000,000</td>
<td>$65,000,000</td>
<td>$220,000,000</td>
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<tr>
<td>Mariposa</td>
<td>10,000,000</td>
<td>30,000,000</td>
<td>40,000,000</td>
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<tr>
<td>Total</td>
<td>165,000,000</td>
<td>95,000,000</td>
<td>260,000,000</td>
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1 See p. 69.  2 See p. 16.  3 See p. 101.  4 See p. 109.

From 1850 to 1870 nearly all of the output was placer gold, which was mined in such quantities that the production from placers still constitutes 65 percent of the total yield, though it has formed only a very minor portion of the total output since 1870. Placer mining in both counties is rapidly approaching an end, as there are few remaining gravel deposits rich enough to be worked profitably even with the aid of extremely effective modern methods and equipment. The recent increase in the placer yield, which until 1935 had been only nominal for 65 years, has been due chiefly to the increase in the price of gold that has made it profitable to mine with draglines some low-grade deposits and even to rework some of the early diggings. When these few remaining deposits are worked out placer mining in these counties will end.

Lode mining in both counties seems to present an attractive future, as there are huge quantities of low-grade ore in their Mother Lode districts and ores of higher grade in the mines of the East belt of both counties, none of which has been explored to any considerable depth. In Mariposa County there is also a West belt of mines that promises increasing production, so, on the whole, it is believed that lode-gold mining in Tuolumne and Mariposa Counties will continue for many decades.

A factor of little-recognized importance that largely accounts for the preeminence of Tuolumne County as a gold producer is its Pocket belt—an area between the Mother Lode and the East belt that begins near the Stanislaus River and extends 6 miles south of it, with an average width of about 5 miles. Some minor outliers of the belt recur still farther south. Throughout this area there are widely separated very narrow seams containing coarse gold, which swell occasionally to form rich pockets. This type of ore deposition provides little opportunity for profitable mining because of its usual lack of continuity, but the discovery and mining of pockets have become highly specialized by the skillful pocket miners.
The total production from the pocket area has not been important, having been estimated at about $5,500,000. However, the mining of the area as a whole, which men would find unprofitable and therefore impossible, was accomplished in a vast period of time by natural erosion of perhaps 2,000 feet of rocks that contained an enormous treasure. All the coarse gold in the widely scattered veinlets of the Pocket belt was concentrated in nearby placers, where it remained, to be recovered easily by the early miners. Columbia Basin alone, whose placers were among those created by erosion of the area, contributed more than a third of the huge total of placer gold from Tuolumne County. Erosion of these rocks also appears to have been the source of the placers about Sonora, Gold Springs, Jamestown, Kincaid Flat, Sullivan Creek, Sawmill Flat, and several minor areas. The total value of placer gold that originated in the Pocket belt thus amounts to about two-thirds of the total placer production of the county.

In Tuolumne County the quarrying of marble near Columbia and limestone mining near Sonora have been important additions to the mineral industries of the county, but the value of their output has totaled only a few million dollars. In Mariposa County the mining of barite and witherite near El Portal ranks next to gold mining in importance, but production statistics cannot be disclosed because at present there is only one producer. The Foothill copper belt traverses both counties west of the Mother Lode. A few small copper mines in this belt have made nominal outputs of copper ores from time to time, being credited with a total production of about 1,000 tons of copper derived chiefly from deposits in Mariposa County. The value of all minerals and metals other than gold produced in both counties from 1880 to 1987, inclusive, has been nearly $10,000,000, which is less than 4 percent of the value of the total gold output.

MOTHER LODGE ROCKS, MINERALIZATION, AND STRUCTURE

The Mother Lode of California is a zone of rock fracture and mineralization ranging in width from several hundred feet to a mile or more. It is also often flanked on each side, at distances of several miles, by a similar zone of substantial but smaller width.

The lode is characterized by quartz that usually contains some gold, but only occasionally enough to constitute ore that is typically of low or medium grade. The quartz occurs predominantly in veins or lenticular masses of limited extent, which may be preceded, followed, or flanked by other similar occurrences. Often there are several parallel veins that may be nearly adjacent, or separated perhaps by hundreds of feet of highly altered country rock, through which may be scattered enough stringers and small lenses of quartz to make occasional bodies of low-grade ore.

The great point of interest in regard to such low-grade deposits is that, although their existence has been revealed occasionally in connection with vein mining, the possibility of mining them at any profit was formerly so slight that there has been as yet no systematic exploration for their discovery. It seems not only possible but very probable that suitable exploration for deposits of this kind would
reveal some large volumes of low-grade ore that could be mined profitably by modern mass-mining methods aided, also, by a gold price higher than that formerly prevailing.

The zones of fissuring occur in rocks that are predominantly folded sedimentaries of the Calaveras and Mariposa formations, the former being of Carboniferous, the latter of Upper Jurassic age. The Calaveras consists chiefly of phyllites, nearly approximating slates, with subordinate quartzite, limestone, and interbedded schists derived from augitic lavas and tuffs. The Mariposa consists predominantly of black slates interbedded with greenstone representing augitic tuffs and breccias.

After the Calaveras was formed, a period of metamorphism succeeded that was accompanied or closely followed by intrusions of diorite, which have since become either schistose or gneissic. The Mariposa rocks likewise were intruded and metamorphosed in late Jurassic or early Cretaceous time.

As a result of the revolution [the Cordilleran] the Mariposa rocks were folded, closely crowded together, and complexly infolded with Calaveras rocks. * * * After the rocks had been folded and given their steeply dipping attitude, great volumes of magma invaded the crust. Peridotite appeared first, gabbro and hornblendeite next, and granodiorite last. The granodiorite together with allied varieties—quartz monzonite, granite, and alaskite—vastly exceeds in volume the earlier rocks.6

It should be added that along the Mother Lode in both counties large areas of serpentinite derived from alteration of peridotite represent intrusions of this period. During and shortly after it the Mother Lode was formed, generally being considered of late Jurassic age, though it may have been later, as there is an unconformity between the Mariposa formation and the Chico, of Upper Cretaceous age. The rocks of later periods are therefore less important with respect to lode mining. They include rhyolitic lavas, tuffs, and breccias of late Eocene time, and still later rhyolitic and andesitic extrusive rocks in great quantity.

The fissuring of the Mother Lode is regarded as due to compressive stresses that usually caused reverse faulting. The fissures, striking north of west and dipping to the east, do not follow the bedding but in general cross it at acute angles. The stresses that caused them were related to the mountain building of the Sierra Nevadas, lying to the east, and it was the thrust from that direction that moved the hanging walls upward with respect to the foot walls.

The compressive stresses were so great that the rocks in their path yielded to the intense folding described by Knopf, with slight evidence of anything resembling cataclysmic episodes accompanying the process. The stresses, though resistless, must have been so slow that they attained their effects by persisting through a vast period of time.

The Mother Lode fissuring may logically be regarded as a very late manifestation of these stresses after their intensity had become greatly reduced and, in fact, had nearly ceased. Instead of effecting further folding of the rocks throughout great areas, as before, enough relief of the enfeebled stresses was afforded in general in the period of the lode’s formation by fissuring and slight movements chiefly

localized in the zone of weak rocks that became the Mother Lode.

The position of that zone of weakness and, hence, the general
course of the Mother Lode seems obviously to have been determined
by the winding course of the Mariposa formation that previously
had been infolded within the Calaveras. The mines of the lode
definitely follow this course of the Mariposa rocks, though not always
in them. The width of the Mariposa exposed along the lode is not
great, probably averaging less than a mile, including long distances
through which it is not half that width, yet the number of mines in
the Mariposa or very nearly adjacent to its contacts exceeds the
number of all other mines.

In the section from Plymouth south to the Mokelumne River
nearly all the mines are in the Mariposa formation, the exceptions
being only a very few in the older schists, greenstones, and Calaveras
rocks very close to the Mariposa contact. From the Mokelumne to
a few miles south of the Stanislaus River the mines are less numerous
but are situated east of the Mariposa contact, usually in the amphibolite
schist, beneath which the Mariposa contact probably often
extends in depth, as has been shown to be the case in some of the
mines. Thence to the Merced River most of the mines are in the
schist near its contact with the Mariposa or with intrusives now
represented by serpentinite. From the Merced River to the end of the
lode, at the granodiorite intrusion south of the town of Mariposa,
the mines of the lode are only a short distance east of the Mariposa
formation, usually in the amphibolite schist.

It is presumable, however, that the line of weakness that deter-
mined the course of the lode was not due wholly to weakness in the
Mariposa formation as such, but rather in part to structural weakness
developed at the bottom of sharp synclinal folding, with consequent
fracturing that may have extended to great depth in the plane of
the synclinal axis.

The veins of the Mother Lode may be classified in at least two
main groups embracing veins that differ in age, size, structure, and
degree of mineralization by gold. The earlier group is characterized
by the great size of its veins and their filling with massive bull
quartz or massive ankerite associated with mariposite, a green mica
that owes its color to chromium. These large veins contain little
gold except that easily recognized as due to mineralization of much
later age. The other more recent group includes veins less huge in
size that are characterized by banded or ribbon quartz almost always
containing some gold.

The massive veins of the first group are identified by Knopf with
a period in which the wall rock of the fissures was attacked by hot
carbon dioxide that broke down the rock silicates, released the silica
contained in them, and effected what he calls carbonization of the
wall rocks. The carbonate formed was ankerite, an iron-magnesium-
calcium carbonate (2CaCO₃·MgCO₃·FeCO₃). It may be regarded
simply as a dolomite containing iron.

The huge veins of ankerite thus represent replacement of the rock
minerals adjacent to fissures, together with silica freed to fill any
available openings. These veins are sometimes enormous, the anker-
rite-mariposite bodies attaining widths of several hundred feet.
There are also huge bodies of quartz of comparable width. Often the quartz is closely associated with the ankerite, occurring as veins within it or at its contacts.

The veins of the second or later group are entirely different in their general character, as they consist almost wholly of quartz and obviously have been built up by means of repeated fissuring that continued through a very long period. These veins usually are characterized through at least part of their width by alternate white and dark bands, the white ones consisting merely of quartz, while the dark bands consist of shattered wall rock cemented together chiefly by quartz. Numerous generations of quartz have been identified as entering into the composition of these banded veins, which are also referred to as ribbon veins when the banding has a characteristic width of about 2 to 3 inches. The usual explanation is that the white bands represent parallel fissures that were filled with the last generation of quartz, while the dark bands represent the previous state of the vein as a zone of wall rock that had already been intersected with quartz fissures of several generations.

It is suggested, however, that, in many instances at least, the dark bands may represent a depth within walls of fissures to which silica of the adjacent band of white quartz penetrated, with the result that a hard sheathing was formed on the walls and that the next fissure tended to follow the inner side of the siliceous sheathing. It is thought that this would explain the characteristic, fairly constant, narrow width of the dark bands in the veins of ribbon quartz and their unbroken persistence through long distances. It would also account for the pronounced tendency in many Mother Lode mines to have ore of higher grade on the hanging wall than on the foot wall. In many veins there is massive quartz on the foot wall that contains less gold than does the banded ore succeeding toward the hanging wall. It seems probable that this massive quartz represents the beginning of the vein while the banded ore is related to later periods when gold was being deposited in greater amount. Though both explanations doubtless are correct as applied to different exposures, the first is less satisfactory in accounting for the remarkable parallelism of the white quartz, of which there may be several or even numerous bands that persist through as much as 100 feet or more without intersecting, and, in fact, with the dark bands between them maintaining nearly constant width.

In the later period there seems to have been very little fissuring that effected large displacement in any single episode and its individual fissurings are only moderately persistent. This suggests that the stresses were relieved here and there from time to time and that siliceous solutions always were present to fill any openings made.

There is also abundant evidence of increasingly greater richness of ore in later and later periods while the fissuring grew less and less pronounced, until at the last it was faint indeed, with little or no movement, as if there had been only enough stress to effect a mere cracking of the rocks in place. Such is the general nature of the fissuring in the Gold Pocket belt of Tuolumne County, where these very late fissures are so faint, widely scattered, and lacking in
continuity as usually to provide no reliable basis for vein mining. Yet it is believed that they were the source of the enormous amount of gold that was recovered from placers in the near vicinity of the Pocket belt, including those of the remarkably rich Columbia Basin.

The age of fissures of the Mother Lode has therefore proved an important factor influencing the success or failure of many of the mines. Exploration of the great masses of quartz and ankerite, that were deposited during the early period of the lode’s formation, has generally resulted in disappointment, except where such masses have been fissured and further mineralized in some later period.

At the other extreme in the chronology of deposition are the pocket veins that have resulted from very late fissuring and have proved so alluring because of their rich ore, even though it is not persistent. Between these two, in probable age of their ores, are the mines with banded veins, which have definite structures that may be followed easily, and ores of only medium grades; but these also, like the large masses of quartz and ankerite, often have benefited by fissuring and richer mineralization subsequent to their original deposition.

The history of most of the mines that have been developed extensively records the discovery of occasional rich pockets, the descriptions of which closely coincide with those characteristic of discoveries in the Pocket belt. The usual story is that there was a tiny seam, very limited in extent, containing visible gold. It swelled to form a rich pocket and ended as it came—without leaving a trace. We have not heard of such a gold seam being faulted, although miners are always interested and long remember details in regard to them. It is concluded that many such showings probably were of the same late age as the tiny seams more common in the Pocket belt than elsewhere.

Besides these two or three main types of veins, in which the chief mineralization of the Mother Lode is found, and the gold placers created through erosion of several thousand feet of veins and rocks that originally contained the placer gold, there is one other important type of deposition—that in which large volumes of country rock contain only very small amounts of gold. Such deposits are always adjacent to veins and have usually been disturbed enough to contain some very narrow stringers and occasional small lenses of quartz. They occur in both the amphibolite schist, chiefly east of the lode, and which borders it through long distances, and the altered intrusive rocks, now referred to inclusively as greenstone, that lie chiefly to the west of the lode. The schist contains as much as a tenth of an ounce of gold in many places, though where mined the amount usually has been slightly less. Knopf indicates that more gold is likely to be present in the greenstone than in the schist, as shown by results of mining the two rocks, but it seems unlikely that this was because of the rocks themselves. More likely it was due to local variation in the intensity of their breaking and to the relative potency of the particular solutions from which the rocks received their gold. This also introduces, as a factor, the time at which the depositions occurred.
It is an outstanding fact that little prospecting has been done in the hanging walls of Mother Lode veins because diamond drilling was not practiced during the time when most of the mines were being operated. It is possible that much valuable ore might have been discovered in the hanging walls but for lack of this modern adjunct of mining, now so extensively used in underground exploration as, for example, in the very similar lode structures of the gold mines of Ontario. In the hanging-wall country of the Eagle-Shawmut vein in Tuolumne County, a mineralized zone 1,000 feet wide was discovered recently by surface pits and trenches. Presumably there are many other places where the hanging-wall region of the lode would prove equally interesting as a site for thoughtful exploration.

TUOLUMNE COUNTY

GENERAL REVIEW

Gold mining from both veins and placers is the oldest and by far the most important mineral industry of Tuolumne County, but there are others of considerable interest. Marble of excellent grade has long been quarried near Columbia, and limestone of high purity is mined and calcined on a large scale near Sonora. A score of small chromite deposits were operated from 1915 to 1919, and small quantities of copper, lead, manganese, magnesite, and granite have been produced from time to time. Deposits of diatomaceous earth, chrysotile asbestos, iron ocher, clay, and soapstone also are present in the county but are undeveloped.

The discovery of placer gold by John W. Marshall at Sutter’s Mill, near Coloma, Eldorado County, in 1848, caused the California gold rush of the following year, during which thousands of adventurers explored the stream beds of the Mother Lode country in search of rich placers. In Tuolumne County their dreams of abounding wealth to be had for the taking were more nearly fulfilled than elsewhere, for the placers of that county were richer than the now famous bonanza placers of the Klondike and Alaska, so remote from civilization that hundreds who sought them perished from hardships. Tuolumne County, on the contrary, gave its early settlers a mild climate, plenty of wood, water, and game, and the advantage of nearby supply points in San Francisco and Stockton and in the fertile San Joaquin Valley. In addition to these advantages, its placers probably were the richest ever known to man. Certainly they were the richest of all those whose production has been recorded, and nowhere in the world is more gold known to have been taken in so short a time from so small an area.

The richest of the placers were those derived from the veins of what later became known as the Pocket belt. These included the fabulously rich deposits in the vicinity of Columbia, Sonora, Gold Springs, Algerine, and other towns in the northwest part of the county. They are described later in detail in the discussion of placer mines.
Thousands of men soon were engaged in mining the richer gravels by hand methods. Camps and towns sprang up magically in dozens of localities. At Columbia, the chief camp of the remarkable Columbia Basin placers, over 10,000 people were at one time supported by the placer mines. It was even proposed that this colorful camp should be made the site of the State capital. From 1853 to 1870 many fortunes were won from the placer mines of the county. Express shipments of gold by Wells-Fargo & Co. from Columbia alone are reported to have totaled $55,000,000. By 1870, however, the placers had been fairly well depleted, and the veins from which they had been derived had begun to attract more serious attention.

By 1870 many lode deposits in Tuolumne County already had been known for 10 to 15 years, but for the most part they were of medium or low grade, and it was natural that their development should lag while gold more easily to be won was still available in the placers. Then too, the bonanza veins of the Comstock Lode at Virginia City, Nev., discovered in 1859, had attracted many mining men from California, and it was not until 1890, 5 years after mining on the Comstock had virtually ceased, that the lode mines of Tuolumne County entered their most productive period, which lasted for 25 years, or until 1915.

Then came the World War with its disastrous scarcity and greatly increased costs of labor and of steel, powder, and other mining supplies, which gradually forced numerous mines to close and prevented any further development of many others. Virtually all mines of Tuolumne County operating upon marginal or low-grade ore were closed, and development was curtailed in its mines that had richer ore. The gold-mining industry of the county had been dealt a staggering blow by these unusual circumstances, over which it had no control, and their effects proved cumulative because a low-grade mine once closed and allowed to fill with water offers no inducement for reopening. Lode mining remained virtually moribund in the county until the price of gold was increased in 1933. The final increase in price to $35 an ounce in 1934 assured such a revival of interest in the gold mines of the county that the value of production from its lode-gold mines in 1937 was approximately half a million dollars. Placer mining as well responded to the stimulus of the increased price of gold, but here the advance can be but temporary as the best placers of the county were exhausted prior to 1870. Recent placer production has been derived almost entirely from draglines and floating washing plants handling low-grade gravels that could not be worked profitably by older methods. The number of placer deposits remaining in the county that are suitable for mining with draglines is small, and all of them are likely to be exhausted within a few years.

The future of lode mining in the county presents a far different picture, as the low-grade ores of the Mother Lode within its boundaries exist in huge quantities and few of the mines of the East belt, with its richer ores, have been worked or explored to any considerable depth.

It should be realized that although almost no lode-gold mining was done in the county for nearly 20 years after the World War, great
technologic progress was made in mining and milling during that time. Improvements in methods together with the increased price of gold have almost certainly brought some of the large, low-grade gold deposits of the county into a class that might now be worked profitably. This assumption is borne out by the fact that several of the large deposits are being examined carefully at present by able mining concerns.

It is historically true that bonanza ores are worked out quickly but that marginal deposits are likely to form the basis of lasting mining industries. It is therefore probable that the large, low-grade gold deposits of the Mother Lode in Tuolumne County will continue to be mined for many decades.

The immense limestone and marble deposits of the county have formed the basis of small but prosperous industries for the past 30 years; with products of excellent grade and close proximity to markets, these industries also are likely to continue for many years.

PRODUCTION

The preeminence of gold mining in Tuolumne County is evidenced by a total yield of over $211,000,000 compared with less than $10,000,000 for silver, copper, chromite, marble, limestone, granite, and all other mineral products combined. This remarkable production represents one-tenth of California’s total yield of slightly more than $2,000,000,000 in gold since 1849. Immediately following the discovery of its rich placers in 1850, Tuolumne County became one of the leading gold-producing counties of the State and maintained its position until its rich gravel deposits were virtually worked out in 1870. Although lode mining had become firmly established in the county in the meantime, its production of gold has not ranked with that from the placers. After its rich gravel deposits were exhausted, the importance of the county as a gold producer diminished gradually, and in 1887 it ranked only seventeenth among the counties of the State in the annual value of its gold output.

Systematic compilation of statistics of the county’s gold production, as such, was delayed until 1880; but records of gold shipments by express companies and early production records of individual mines attest to the stated total output of over $211,000,000, of which $155,000,000 was placer gold while $56,000,000 was derived from ore. Virtually all of the huge output of placer gold was mined between 1850 and 1870 from shallow but extremely rich placers in and around Columbia, Sonora, Chinese Camp, Montezuma, Groveland, and dozens of other localities adjacent to the Pocket belt, the East belt, and the Mother Lode, from the veins of which the gold of the placers was derived. A table showing the allocation of this early placer production is given on page 69.

Figure 3 shows the annual production of gold and silver in Tuolumne County from 1880 to 1937, inclusive, with separate statistics for lode and placer gold since 1903. In this table, the figures representing total gold mined from 1880 to 1903 may be accepted as nearly representing the output of lode gold, as the amount of placer gold mined during these years was almost negligible. Further, it should
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1 Separate statistics for production of lode and placer gold prior to 1903 are not available.
be mentioned that the nominal silver production of the county is entirely incidental to gold mining.

A graph representing the value of the gold produced in the county from 1880 to 1937, inclusive, is shown in figure 4.

The production of lode gold in the county to January 1, 1938, is estimated at $56,453,253. The derivation of this estimate is shown in the table below.

![Graph](image)

**Figure 4.—Value of annual gold production of Tuolumne County, 1880-1937.**

**Approximate total production of lode gold in Tuolumne County to Jan. 1, 1938**

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<tr>
<td>1903 to 1937, inclusive 2</td>
<td>892,545</td>
<td>18,935,075</td>
</tr>
<tr>
<td>Total to Jan. 1, 1938</td>
<td>2,507,487</td>
<td>56,453,253</td>
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1 Summary of production of individual mines from California Miners' Association, California Mines and Minerals: Am. Inst. Min. Eng., California meeting, San Francisco, 1899, pp. 351-355. (See table, fig. 5.)

2 Total gold production during these years from Mineral Resources of the United States, Geological Survey, less 2,900 ounces estimated placer production known to have been only nominal during this period. (See fig. 3.)

3 Mineral Resources of the United States: Geological Survey and Bureau of Mines; Minerals Yearbook: Bureau of Mines. (See fig. 3.)

Accurate statistics of lode-gold production prior to 1903 are not available, but the annual output since that date is shown in figure 3. From the first lode-mining operations in 1853 to 1902, a period of 50 years, the estimated output of lode gold was $37,518,177—an average of about $750,000 a year. In 1903 the lode mines of the county, with a yield of 91,831 ounces of gold valued at $1,898,308, reached their maximum output since the statistical record was begun.
in 1880. The lode production of that year probably constitutes the high record for the county, as it is unlikely to have been exceeded prior to 1880.

The entry of United States into the World War in 1917 soon caused many lode mines to close because of labor shortage and increased cost of mining supplies. The yield of lode gold from the county accordingly decreased to a minimum of only 1,668 ounces, worth $34,376 in 1928. The total lode-gold production of the county from 1903 to 1916 was $14,978,081, an average of over a million dollars a year. During the next 17 years, 1917 to 1933, inclusive, the total output of the lode mines was $2,775,979, an average of less than $164,000 a year, or about 16 percent of the average annual yield for the 14 years prior to the war. Due to increase in the price of gold, beginning in 1933, the annual output of these lode mines had risen to approximately $500,000 in 1937. The higher price of gold also stimulated placer mining, which had been negligible in the county since 1870. Though only $1,511 of placer gold was produced in 1931, the output increased to over $200,000 in 1937.

Next to gold mining, marble and limestone quarrying and burning of lime form the second largest mineral industry of the county, with an estimated total output of over $5,000,000. The county has also produced 7,800 tons of low-grade chromite ore and about 100 tons of copper when prices were high, besides small amounts of magnesite, clay, silica, mineral paint, sandstone, and granite.

LODE-GOLD MINES

The sites of the principal and most of the smaller gold mines of Tuolumne County are shown in figure 5. Nearly all the individual mines and groups of mines mapped lie within a belt averaging 14 miles in width, which traverses the county from the northwest to southeast and has its northwest corner at Melones on the Stanislaus River. This broad major belt is bordered along its southwest side by the Mother Lode, and its northeast boundary is formed by the so-called East belt of mines. Between these two main belts of mines and centering around Sonora and Columbia is the Pocket belt, famous for its rich pocket mines. As may be seen in figure 5, there is also a second intermediate small group of mines around Groveland and Big Oak Flat, and a few mines lie to the east of the East belt proper near Confidence and Sugarpine.

Still farther east, near the summit of the Sierras, beyond the area shown in figure 5, is a belt of deposits carrying zinc, copper, and lead that also contains some silver and gold. This belt constitutes the Tioga district. Its deposits have been prospected only slightly, however, and little or no development work has been done on them because of their high altitude and the difficulty of access. They are deeply covered by snow through 6 or 7 months of the year. The following table shows the approximate outputs from lode mines of the Mother Lode, the East belt, and the Pocket belt prior to 1899. It is thought that this record is of such considerable value that it should be rendered more readily available by its inclusion here.
### Approximate production of lode mines in Tuolumne County before 1899

#### Mother Lode mines:
- **Heslep** .................................................. $1,000,000
- **Knox and Boyle** ......................................... 550,000
- **Mooney** .................................................. 400,000
- **Cardinelle** .............................................. 400,000
- **Golden Rule** ........................................... 350,000
- **Dutch** .................................................... 320,000
- **Triol** ..................................................... 250,000
- **Little Gem** ............................................. 200,000
- **Alabama** ................................................ 150,000
- **New Era** ................................................ 150,000
- **Orcutt** ................................................... 100,000
- **9 other mines with individual productions of less than $100,000** ............................................. 440,000

**Total for Mother Lode mines**: $4,310,000

#### East belt mines:
- **Soulsby** .................................................. 5,500,000
- **Confidence** ............................................... 3,250,000
- **Draper** ................................................... 2,500,000
- **Grizzly** .................................................... 1,500,000
- **Gilson** .................................................... 1,250,000
- **Buchanan** ................................................ 600,000
- **Longfellow** ............................................. 500,000
- **Mississippi** ............................................. 500,000
- **Excelsior** .............................................. 450,000
- **Hunter** ................................................... 300,000
- **Keltz** ..................................................... 300,000
- **Mount Jefferson** ......................................... 300,000
- **Spring Gulch** .......................................... 250,000
- **Star** ....................................................... 225,000
- **Bellevue** ................................................ 200,000
- **Green** ..................................................... 200,000
- **New Albany** ............................................ 200,000
- **Riverside** .............................................. 150,000
- **Basin Slope** ............................................ 100,000
- **Providence** ............................................ 100,000
- **Rhode Island and Philadelphia** .......................... 100,000
- **Starr King** ............................................. 100,000
- **16 other mines with individual production of less than $100,000** ............................................ 735,000

**Total for East belt mines**: 19,340,000

#### Pocket mines:
- **Bonanza** .................................................. 2,000,000
- **Jackass Hill** ............................................ 400,000
- **Sugarman claim** ........................................ 350,000
- **Colby** ..................................................... 200,000
- **Ford lead** ............................................... 190,000
- **Garrett claim** .......................................... 175,000
- **Simonich claim** ........................................ 165,000
- **Austrian lead** .......................................... 160,000
- **Sell lead** ............................................... 160,000
- **Norwegian** ............................................... 130,000
- **Arnold claim** .......................................... 110,000
- **Bald Mountain claim** ................................... 100,000
- **Fox claim** ............................................... 100,000
- **Magruder** ................................................ 100,000
- **Peterson claim** ......................................... 100,000
- **15 other mines with individual productions of less than $100,000** ............................................ 725,000

**Total for Pocket mines**: 5,165,000

#### Miscellaneous mines:
- **Golden Gate** ............................................ 1,400,000
- **Paterson** ................................................. 340,000
- **Valparaiso** ............................................. 320,000

**Total for Miscellaneous mines**: 2,060,000

**Grand total**: 30,875,000

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Prior to 1899 the mines of the East belt far surpassed those of the Mother Lode in their yield, as they provided about $19,340,000 compared with an output of $4,310,000 from the Mother Lode. This was because the ores of the East belt, although present in narrow veins, are in general much richer than those of the Mother Lode section of the county, and it was natural that the richer veins should at first receive greater attention. However, many mines of the East belt were forced to close at depths of a few hundred feet by inrushes of water, which could be handled only at great expense in those days when steam pumps were used and wood was the only fuel. Thus, it happened that the mines of the East belt reached their maximum production very shortly after their discovery and in general they have been worked to only slight depth. On the other hand, the mines of the Mother Lode, the total output of which prior to 1899 was exceeded by even that of the Pocket belt, were developed gradually and reached a depth of 1,800 feet, more or less, in the Rawhide, Harvard, Dutch-App, and Eagle-Shawmut, so that by 1915 their total output greatly exceeded the entire production of the East belt.

Although lode mining in the county ceased for 15 years after the World War, the mines of all three belts have shared in the revived interest caused by the increased price of gold, and since 1934 each belt has shown a substantial increase in the output of its mines.

The principal characteristics of the Mother Lode district, the East belt, and the Pocket belt, together with some details regarding typical mines of each group, will be discussed separately.

MOTHER LODE DISTRICT

The general course of the Mother Lode, which extends 23 miles through Tuolumne County from the northwest to the southeast, is shown in figure 2, and in figure 5 it is outlined in greater detail by numbered dots that indicate the situation of more than 40 mines from the Bown property (No. 15), just south of the Stanislaus River, to the McAlpine (No. 139), at the head of Moccasin Creek. The lode crosses the Stanislaus River from Calaveras County at Melones and, running just west of Tuttletown, passes beneath Table Mountain 1 mile northeast of Jamestown. An airplane view of this portion of the lode is shown in figure 8. South of Table Mountain it is prominent at Whiskey Hill, its bold quartz outcrops being visible miles away. Veins of quartz and ankerite are also responsible for the elevations of Quartz Mountain and Golden Rule Hill. Passing thence about 2 miles west of Stent it continues down the east side of Woods Creek to its junction with the Tuolumne River just below the Eagle-Shawmut mine, where again its white bull quartz forms spectacular outcrops, shown in figure 18. Following now the Tuolumne River upstream to Moccasin Creek and the east bank of that creek to its headwaters, the lode crosses the divide into Mariposa County.

Along the course of the lode, as indicated, are numerous mines or groups of mines, including six with estimated individual outputs exceeding a million dollars, as follows:

*California State Division of Mines, Mining in California: Vol. 24, No. 1, January 1928, p. 9.*
Dutch-App group 9,500,000
Rawhide 6,000,000
Eagle-Shawmut 5,000,000
Jumper-Golden Rule group 5,000,000
Harvard 2,750,000
Santa Ysabel 1,500,000

Total 29,750,000

Since these estimates were made in 1928 additional gold has been produced at some of these mines.

The main fissuring of the Mother Lode in Tuolumne County is in the vicinity of the contact between the Mariposa formation on the west and the Calaveras formation on the east. The Calaveras is represented at the contact by the greenish amphibolite schists derived from andesitic tuff and breccia, diorite, and other igneous rocks, described by Knopf, that probably are of Carboniferous age. The contact has a general northwest-southeast course with gentle curving that causes wide local variations in its strike.

On the west side of the contact and following it for a considerable distance are serpentine dikes and masses derived from peridotite and other basic intrusives, and there are also several very minor areas, now greatly altered, that represent extrusive basalt, diabase, and andesite.

In the southern part of the county the contact has been intruded by a dike of syenite, extending 4 to 5 miles, whose usual width is several hundred feet. The mines of the lode are chiefly in the amphibolite schist or at its contact with Calaveras sedimentaries through the first 2 miles south of the Stanislaus River. In the next 3 miles the lode follows the contact between the Calaveras on the east and a large intrusion of serpentine on the west. Farther south the mines are either in the amphibolite schist or at its western contact with the Mariposa formation or with serpentine or syenite intruded at the contact.

This section of the lode, together with its southern extension in Mariposa County, is characterized by huge deposits of ankerite-marpisite laced through by networks of coarse veinlets of quartz and impregnated with auriferous pyrite of low grade. Ankerite is a chemical combination of the carbonates of calcium, magnesium, and iron, the symbol of which is usually expressed as $2\text{CaCO}_3\text{MgCO}_3\text{FeCO}_3$. Maripisite is a potash-magnesium mica with small amounts of chromium, which was probably derived from the neighboring serpentines and is peculiar to the gold deposits of California. On weathering, the ankerite-marpisite becomes rust-colored and finally crumbles away, leaving the veinlets of quartz that traverse it standing in relief. Its rusty outcrops, 10 to 100 feet wide, are characteristic of this section of the lode.

The Mother Lode ores of the county are usually of low or medium grade. They contain two or three times as much of sulfides as is usual in the lode ores of Calaveras, Amador, and Eldorado Counties. With a few exceptions, such as the ore shoots of the Rawhide and Jumper mines, they are likewise less free in milling, particularly at depth. Concentrates generally average from $40 to $60 a ton, which makes it almost mandatory that they shall be treated on the property to avoid shipping and smelting charges. Flotation methods em-
bodily the use of depressants, which virtually eliminate the troublesome carbon from the concentrates, recently have been applied successfully at the App and Eagle-Shawmut mines. Concentrates have always been shipped for treatment, however, either to smelters or to a custom cyanide plant in Amador County. It still remains for some company to take the initiative and extract the gold from its own concentrates, but it is realized that there are practical difficulties involved in cyaniding or otherwise treating these concentrates on a small scale.

Huge tonnages of low-grade ores are available in the Mother Lode district of Tuolumne County, and their successful mining appears to depend on the application of large-scale operations having a low unit cost. The recent profitable development of this section has been retarded seriously by many ill-advised attempts at inherently high-cost small-scale mining and milling, and often mills have been erected before any ore has been developed. In 1938, however, several low-grade mines in the district were being examined carefully by substantial mining people who were both financially and technically able to develop them on a sound basis.

RAWHIDE

Rawhide mine, which comprises one patented load claim and 260 acres of patented mill sites and agricultural ground, is 2 miles north of Jamestown. (See No. 68, fig. 5.) It is owned by the Central Land Co. of Patterson, Calif.

From 1894 to 1907 this mine was one of the most important producers of the Mother Lode, its output having increased from $39,000 in 1891 to about $500,000 in 1897, after which the annual yield declined gradually until the mine was closed in 1907. Total production may have amounted to as much as 6 million dollars, as quoted by Logan from an estimate of F. C. Cullers, mill foreman during the period of principal output. Only $2,524,000 is shown by mint records, however, from 1891 to 1907; but other shipments of bullion from the Rawhide are said to have been joined with those of the App mine by Capt. W. A. Nevills, who owned both mines and practiced a secretive policy regarding their production.

Previous to this period of operations there had been others. In 1867 there was a shaft 280 feet deep at the south end of the property; and in 1871 what later became the main shaft, about 200 feet north of the original shaft, had attained a depth of 310 feet on the vein. There is no record of the output from this early work, though the ore mined is said to have carried 0.35 ounce to 2.0 ounces of gold per ton.

Virtually the entire production of the mine is said to have come from an ore shoot south of the main shaft that was 160 feet long and extended to a depth of 1,800 feet along the dip, which was about 62° NE. This shoot, known as the south ore shoot, was near the hanging wall of a wide mineralized zone, but the width of ore mined is said to have averaged between 5 and 8 feet, though in some places it was stope for a width as great as 30 feet. The

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average grade was about 1 ounce of gold per ton, but ore containing from 2 to 4 ounces was not uncommon and there was occasional high-grade ore assaying many thousands of dollars per ton. One skipload of such ore is reported to have contained $80,000 in gold. Captain Nevills mined approximately 220,000 tons.

A report on this mine by Curtis Lindley, Jr., contains interesting details as to the nature of the Nevills operations. All drilling was done by hand, chiefly with double jacks. The stopes were square-set, and suitable timber was very expensive. The hanging wall of the stopes was completely lagged because of a heavy gouge. The hoisting equipment was underpowered for depths below 1,000 feet, a tradition surviving that a single man could hold back a loaded skip at the 1,800 level.

The ore was free-milling and yielded 85 percent of its gold by amalgamation in a 40-stamp mill. The discharge from the amalgamating plates was concentrated on 16 Frue vanners, the concentrates being roasted in a reverberatory furnace and treated by chlorination.

It is thought that mining and milling costs for ore taken above the 1,000 level were about $4.50 per ton, but for ore below that level they increased considerably. Traditionally, $7 ore was required to pay from the lowest level.

It is claimed that when the mine was closed, two bodies of ore had been found that would now be of considerable interest. One of these was near the end of a long drift to the north of the shaft on the 900 level. This ore, though of lower grade than that in the main ore shoot, nevertheless was being stope when the main shoot was bottomed against what is now presumed to have been a fault. (See fig. 6.)

The other ore body consisted of ankerite-mariposite 30 to 40 feet wide, averaging about $4.50 per ton, that had been found along the footwall back of the south ore shoot. An attempt to mine this ore on the 1,200 and 1,300 levels is reported to have been made, but it must have been a marginal operation at best and could have been maintained only with the aid of better ore from the main ore shoot. A recovery of $9.130, or $2.95 per ton, is reported from 3,100 tons of this ore, which is said to have been more difficult to mill than other ore of the mine, as only 35 percent of its gold was recoverable by amalgamation.

In 1915 the mine was unwatered by the Pittsburg Silver Peak Co. with the purpose of examining the south ore shoot. It was found that all ore exposures had caved to such an extent that systematic sampling was impossible, and as difficulty arose over an option on the Rawhide No. 2 claim, which adjoins the Rawhide on the south, the project of reopening the mine was abandoned.

In 1933 and 1934 lessees conducted pocket mining in the workings of the north shaft; and on expiration of their lease the present owner developed, under the immediate direction of Curtis Lindley, Jr., of Empire, Calif., a wide, low-grade ore body on the 200 level of this shaft and also crosscut the main ankerite-mariposite ore body by extending an old tunnel (A, fig. 6) situated about 700 feet south of the north shaft. This ore body was explored further for a distance of 850 feet by eight diamond-drill holes from the
surface. It was concluded that a large tonnage of low-grade ore existed near the surface, much of which can be mined by power shovels.

Geologically the Rawhide mine is fairly typical of other mines of the Mother Lode in this section. The mineralized zone consists of amphibolite schist and ankerite-marioposite 25 to 80 feet wide, containing quartz ore shoots and interspersed with quartz stringers. Its foot wall is chiefly serpentine but sometimes amphibolite schist, and the zone is separated from the hanging wall of Calaveras slate by a heavy gouge. The mineralized zone strikes N. 34° W. and dips about 62° NE.

![Diagram of Rawhide mine workings](image)

**Figure 6.**—Vertical projection of Rawhide mine workings showing ore shoots and supposed fault.

The areal geology of the section is shown in figure 7, which is based on a map of the Geological Survey appearing in Folio 63 of the Geologic Atlas of the United States, by F. L. Ransome. The block faulting, B–A–C, also shown in this figure, represents conclusions by Curtis Lindley, Jr., engineer in charge of development of the Rawhide mine, as a result of a study made while exploration was in progress.

A fault, which he considers the floor of the fault block, was discovered in the main crosscut on the 300 level from the north shaft of the Rawhide, its strike being N. 15° E. and its dip about 52° SE.
Figure 7.—Area geology of the district surrounding the Rawhide mine.
Figure 8.—Airplane view showing part of Table Mountain and nearby Mother Lode mines. 1 inch = 1,000 feet. (Courtesy Fairchild Aerial Surveys, Inc.)
On this fault the hanging wall had moved downward, though the displacement effected by this normal fault does not seem to be established very definitely. Lindley reached the conclusion that this fault should cut off the main ore shoot a little below the 1,800 level, where the ore of that shoot actually was bottomed. Further calculations have led him to conclude that the extension of the main ore shoot below the fault is represented by the ore shoot previously mentioned as found in the north drift of the 900 level, as shown in figure 6.

Though the block-faulting suggested cannot as a whole be checked from the surface, fault B is plainly evident in its crossing of the latite cap of Table Mountain. Here it is not a single fault but an easterly member of a series of step faults that are well shown in the aerial photograph reproduced in figure 8, the indicated strikes of which pass through the Rawhide property. This fault is present in the Omega mine also, immediately south of the Rawhide, where workings in a gravel channel beneath the lava cap showed the structure illustrated in figure 9, A. In the Alabama mine south of the Omega, a fault presumed to be an extension of fault B showed the relations illustrated in figure 9, B, according to Joseph Moyle of Rawhide, who was familiar with the Alabama before it closed.
Because of the interesting suggestion that the ore found on the 900 level may be the extension of the main south ore shoot, the following details are added in regard to it.

The exploratory drift on the 900 level was driven north 1,000 feet, having been carried partly in the gouge for easy going. Probably due to this, it was found to be completely caved when the mine was unwatered in 1915. It is recorded, however, that the drift entered ore about 750 feet north of the shaft and that it was of the same general grade and physical characteristics as the ore of the south shoot. It was stoped for a distance of 100 feet about 8 feet wide to a height of 150 feet above the level, where presumably the top of the stope must have reached the fault. The ore contained about 1 ounce of gold per ton.

No sinking was done on this shoot, as the ventilation at the end of the long drift was so poor that the men finally refused to work in it, and shortly thereafter the mine was closed by a labor strike. Prior to the strike, however, Captain Nevills had laid out a site for a shaft directly above the stope area on the 900-foot level, so it would appear that he had planned the development of this shoot in depth.

Recent developments.—In the fall of 1934 the owner of the property spent $15,000 in exploring and sampling the low-grade amphibolite schist and ankerite-marioposite ore body, which is represented on the surface by large outcrops extending virtually the full length of the Rawhide claim. During the early operation of the mine the existence of this ore body in the footwall back of the south ore shoot was well known, as it was frequently crosscut. Under Captain Nevills' ownership, several thousand tons of this ore had been stope from the 1,200- and 1,300-foot levels, where it was found to be 30 to 40 feet wide and to have an average gold content of about 0.22 ounce per ton; but with hand mining and inadequate ventilation and hoisting equipment this grade of ore could not then be mined at a profit. This low-grade ore body had also been found previously in a crosscut on the 200-foot level, where it is said to have been 30 feet wide and to have had an average gold content of 0.11 to 0.32 ounce per ton.

The sole object of the recent work was to prove large tonnages of low-grade ore. The four things done included (1) sampling of surface exposures, (2) development work on the 200- and 300-foot levels in the north shift, (3) crosscutting the low-grade ore body near the center of the claim by extending an old tunnel to the hanging wall of the Mother Lode, and (4) 864 feet of diamond drilling from the surface. The results of these developments are reported by Lindley as follows:

Five samples, covering a width of 31 feet of the outcrop 50 feet north of the main Rawhide shaft, showed a weighted average gold content of $4.08 per ton. In an open pit about 200 feet north of the main shaft and on the footwall side of the ore body, 5 samples, representing a width of 14 feet, yielded a weighted average of $6 per ton. Two samples from the vertical bank at the original shaft across 3 and 4 feet yielded $7.70 and $3.67, respectively.

The development on the 200-foot level of the north shaft exposed an ore body that has been crosscut in four places through a length of 185 feet. The average width of the ore is 25 feet, and its average
gold content is $3.92 per ton. Further development was done on the 300-foot level north of the development on the 200 level. Here the ore body showed comparable gold value, but owing to the proximity of the floor fault the ore body is badly shattered.

The tunnel (A, fig. 6) near the center of the claim was extended to the hanging wall of the lode, so that it completely crosscut the ankerite-mariposite ore. Thirteen car samples, taken by rounds and each representing approximately a 4-foot advance, showed an average of $3.15 per ton. Sixteen cut samples showed a weighted average of $2.78 per ton across a width of 50.7 feet.

Eight diamond-drill holes totaling 864 feet were drilled in the hanging wall at inclinations to cut the ore body at right angles. The position of these drill holes is shown in figure 6. Each hole was drilled completely through the ankerite-mariposite and into the footwall. The following table summarizes the results:

<table>
<thead>
<tr>
<th>Hole</th>
<th>Width of ore (feet)</th>
<th>Value (gold at $85 an ounce)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Below $1.00</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>1.95</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>3.07</td>
</tr>
<tr>
<td>4</td>
<td>48</td>
<td>2.69</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>2.51</td>
</tr>
<tr>
<td>6</td>
<td>43</td>
<td>2.72</td>
</tr>
<tr>
<td>7</td>
<td>78</td>
<td>2.39</td>
</tr>
<tr>
<td>8</td>
<td>65</td>
<td>2.30</td>
</tr>
</tbody>
</table>

The footwall was amphibolite schist that always carried less than $1 per ton in gold except in holes 7 and 8, where about 30 feet of the schist might be classed as low-grade ore.

It is claimed that these showings in outcrops, underground workings, and diamond-drill holes indicate about 400,000 tons of ore averaging about $2.50 that can be stripped and mined by power shovel at low cost.

Flotation tests on the low-grade ore by the Booth-Thompson Division of the Galigher Co. of Salt Lake City yielded excellent results. Ore containing 0.06 ounce of gold, 0.1 ounce of silver, 4.5 percent iron, and 0.35 percent sulfur was ground to 5 percent plus 65 mesh and 62 percent minus 200 mesh, and the pulp, at a density of 3 to 1, was treated by Agitair flotation. The reagents used and the results obtained were as follows:

- **Roughing reagents per ton**
  - 0.1 pound pentasol amyl xanthate (Z6)
  - 0.1 pound cresylic acid

- **Cleaning reagents per ton**
  - 0.05 pound starch in solution
  - 0.025 pound pentasol amyl xanthate
  - 0.05 pound cresylic acid

<table>
<thead>
<tr>
<th>Percent of total weight</th>
<th>Gold content per ton, ounces</th>
<th>Percent of total gold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaner concentrates</td>
<td>3.0</td>
<td>1.92</td>
</tr>
<tr>
<td>Final tailing</td>
<td>97.0</td>
<td>0.005</td>
</tr>
<tr>
<td>Heads</td>
<td>100.0</td>
<td>0.062</td>
</tr>
</tbody>
</table>

Ratio concentration—33.3:1.

The flotation concentrates were ground to 95 percent minus 200 mesh and agitated for 12 hours with a 5-pound KCN solution, and using 5 pounds CaO per ton of concentrates. The KCN consumption
was 8.2 pounds per ton of concentrates, or 0.25 pound per ton of original ore. The cyanide extraction was 1.85 ounces of gold per ton of cleaner concentrates, which is equivalent to 96.33 percent of the gold in the concentrates and to 88.86 percent of the total gold in the original ore.

The cost of flotation reagents per ton of ore is estimated as 5.5 cents and that of cyanide reagents as 5.2 cents. Amalgamation tests on pulp similar to that used for the flotation tests showed that 50 percent of the gold was recovered by amalgamation.

**CRYSTALLINE AND ALABAMA**

The Crystalline and Alabama group of mines, consisting of six contiguous patented claims and three patented mill sites embracing a total of 74 acres, is in sec. 9, T. 1 N., R. 14 E., 1 1/2 miles by road northwest of Jamestown. (See Nos. 75 and 74, fig. 5.) It is owned by Chas. E. Shafer of that town.

The claims comprising the group—the Alabama, Crystalline, Harris-Oliver, Junietta, and Shore—cover about 3,220 feet on the strike of the Mother Lode. The property was first actively mined in the 1880’s, and during early operations there was a 40-stamp mill on the Alabama, a 15-stamp mill on the Crystalline, and a 10-stamp mill on the Harris-Oliver. The ore for these mills was obtained principally from three glory holes through adits from the east side of the ridge, the backbone of which is formed by the vein system because it offers greater resistance to erosion than the rocks on each side. This ridge, known as Whiskey Hill, extends from the north end of the Alabama claim at Table Mountain through the Harvard mine, which adjoins the Crystalline-Alabama group on the south. The hill is a prominent feature of the landscape, rising 300 feet or more above the surrounding country. It is surmounted here and there by outcrops of massive white quartz visible miles away.

The vein system comprises three principal veins, roughly parallel, within a mineralized zone about 900 feet wide. The veins strike approximately N. 30° W. and dip about 65° NE. They are designated as the East, Central, and West veins. Of these, the Central vein forms the spectacular bull quartz outcrop along the ridge of the hill. About 320 feet east of it is the East vein and 400 to 500 feet west of it is the West vein. Both of these outlying veins are stringer leads consisting of quartz in schist heavily impregnated with low-grade auriferous pyrite and small quantities of free gold. About 65 percent of the gold recovered from the ore has been free.

The foot wall of the vein system is serpentine and the hanging wall is Calaveras slate. The intermediate zone consists of bands of slate and schist that have been highly altered, cut by veinlets of quartz, and impregnated with pyrite, with some zones showing alteration of the mariposite so characteristic of the south end of the Mother Lode. Throughout most of the property the mariposite lies near the extreme foot wall but it crosses to the hanging wall near the northern end. This intermediate zone has also been intruded by a gabbro dike.

With the exception of one adit, which taps the West vein on the Crystalline claim from the west side of the hill, the veins were worked originally by glory holes above adits from the east side of the hill.
There are also three shafts on the property. The main or Crystalline shaft on the Shore claim is vertical and attains a depth of 650 feet. It has double skip compartments to the 300-foot level, a single skip compartment and manway between the 300- and 600-foot levels, and a 50-foot sump. There are only these two levels from the shaft, the upper of which is connected with an inclined shaft on the Harris-Oliver claim, which provides a second exit from the mine workings. This shaft has one skipway and a manway and together with the main shaft gives access to about 9,000 feet of underground workings. As shown by old maps, a third shaft on the Alabama claim is about 300 feet deep and has a 260-foot east-west crosscut at the bottom. This shaft is not connected with the Crystalline workings, but by sinking it 300 feet deeper a short crosscut would connect it with the northerly workings of the Crystalline shaft on the 600-foot level.

In 1922 the Tonopah Mining Co. took an option on the property. This company watered the mine, built a new head frame, converted the steam hoist to the use of electric power, and drove a drift from the Crystalline shaft over 1,500 feet on the 600-foot level to a point beneath the old Alabama shaft. No crosscutting whatsoever from this drift was done in search of ore bodies, as the time agreed upon for prospecting did not permit it. The formations cut by this long drift are reported, in order, as the stringer lead accompanying the bull-quartz or Central vein, talcose schist, tafel mixed with quartz, and gray and black schist. The East and West veins were not explored to any extent, and the option was relinquished in 1923. The mine at this time made about 10,000 gallons of water per day, which was handled by bailing.

In 1936 the Crystalline workings were pumped out and sampled under the direction of E. A. S. Whittard of San Francisco, but as none of the ore bodies previously developed were accessible, owing to caving of all crosscuts where they entered the wall gouge, results were unsatisfactory. Although sampling underground was of necessity confined to areas too low in grade to have been of interest previously, three places on each level are reported to have been found, which, on development, would probably show a very considerable tonnage of good-grade mill ore. From 500 samples taken from the surface within an area 1,200 feet long on the strike of the vein and over widths of 150 to 250 feet, it is estimated that 425,000 tons of ore with an average value of $3.11 per ton is available above the adit levels or, by including much ore of lower grade, 1,200,000 tons averaging $2.04 per ton. This ore has average backs of 150 feet and can be mined by glory-holing into adits. The area, which was sampled systematically on the surface, represents only about one-third of the known surface ore, and a few random surface cuts over the remaining area showed as good average gold content as was obtained in the area thoroughly sampled. At one place within the sampled area a width of 20 feet averaged $6.56 per ton, and at another a 12-foot width averaged $9.62 per ton. These areas are apparently the outcrops of ore shoots that might be developed by short drifts from present adits.

The property is equipped with a double-drum electric hoist powered by a 100-horsepower motor, and it has a head frame, two cages, two water skips, and three hoisting cables, each 1,000 feet long, one
of which has never been used. There are also a Dunn-Gordon Laidlaw compressor, driven by a 100-horsepower motor having a capacity of 600 cubic feet of free air per minute, two large air receivers, three pumps, one 12-inch Root blower, blacksmith equipment, rail, steel, mine cars, etc., and a large frame residence. An electric power line from the trunk lines of the Pacific Gas & Electric Co. and transformers are installed at the mine.

The property is credited with a total production of about $250,000, and as very little underground stoping has been done it is almost virgin. The deepest workings are at 600 feet, compared with 1,800 feet in both the adjoining Harvard mine to the south and in the Rawhide mine to the north.

HARVARD

The Harvard mine is about 1 mile west of Jamestown on the southeast slope of Whiskey Hill adjacent to United States Highway 49. (See No. 79, fig. 5.) It is owned by the Harvard Gold Mining & Milling Co., of which Robert G. Hooker, Jr., Crocker-First National Bank Building, San Francisco, is president.

The property covers 4,800 feet along the Mother Lode, about 1,700 feet of which have been explored by workings in which a depth of 1,880 was attained. Supposed to have been discovered in 1850 and to have produced $400 to $500 ore in early days from shallow depths of the Trio and Mooney claims, its principal known production was made from 1906 to 1916, when ore valued at $1,883,674 was mined. The ore was low-grade, averaging $2.71, of which only $2.17 per ton was recovered. From a total of 849,508 tons of ore milled the yield was 98,534 ounces of gold, a little more than half of which was recovered by amalgamation, the balance being contained in concentrates. At $35 an ounce, the present price of gold, the value would be nearly $3,500,000. Only about 22,000 ounces of silver was recovered.

In spite of the low grade of its ore, this mine is interesting now because of credible reports that it still contains a very large tonnage of ore such as it formerly produced. With the higher price of gold and better recovery from milling than was obtainable formerly, such ore should now offer the possibility of substantial profits if worked on a large enough scale.

Fortunately the mine was examined and reported upon by Oscar H. Hershey in 1916, when it was still open to the 1,850-foot level, and in 1936 he revised his report in the light of results obtained by diamond drilling during the previous year. Fifteen holes totaling 5,500 feet had been drilled from the hanging wall through the mineralized zone into its foot wall, which gave a great deal of additional information as to the extensions and relations of ore bodies through a length of 2,500 feet along the lode. Hershey found that these drill holes supported the supposition that "the mine contains large tonnage of at least $5 ore."

These reports by Hershey were followed in 1937 by a report of Hamilton, Beauchamp, and Woodworth, who had made extensive

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8 The description and discussions of the property are based chiefly upon the Hershey report dated Oct. 19, 1936, and the Hamilton, Beauchamp, and Woodworth report dated Nov. 24, 1937, both being private reports addressed to Robert G. Hooker, Jr., president of the owning company. Abstracts and quotations from both reports have been used freely.
milling tests of the ore and determined a suitable method of milling it.

The Mother Lode here strikes N. 37° W., and its dip is about 60° NE. The zone of its shearing ranges in width from 100 to 300 feet. It extends chiefly through an amphibolite schist that is traversed by a large, low-grade quartz vein called the Central vein, above and below which ore bodies and other veins also are present in the schist. They are called foot-wall or hanging-wall veins and ore bodies, with reference to the walls of the Central vein. The Central vein is relatively barren, most of the ore produced from the mine having been derived from ore bodies near but not actually within it.

The foot wall of the Mother Lode is definite, being at the contact of a serpentine that lies south and west of the lode. The lode has no definite hanging wall, however, as quartz veinlets and irregular, low-grade masses of mineralized rock diminish gradually in frequency and value toward slates that gradually succeed the amphibolite schist.

At the foot-wall contact the serpentine usually is sheared through a width of 4 to 5 feet and altered in varying degrees to schistose serpentine or to gouge. Above this sheared serpentine there is usually a "more or less lensy sheet of hard, dark-green, partly sheared, granular rock" separating the serpentine from the thick mass of grayish-green amphibolite schist. (See fig. 10.) Hershey thinks the dark-green rock of the foot-wall contact represents an andesitic dike. It is seamed with quartz and has been mineralized by pyrite and gold.

The grayish-green amphibolite schist often begins with a narrow band of sericite schist at its contact with the dike. In places, also, narrow bands of talc schist are interbedded with the amphibolite schist. "All these rocks occur as a series of overlapping lenses, which make the structure exceedingly complex. They are more or less altered by vein action, fractured, quartz-seamed, and pyrite-impregnated. Those portions in which the mineralization is strongest constitute the commercial ore." No sharp walls divide ore from lower-grade mineralization.

Mine workings in these formations included six tunnels cross-cutting an ore zone near the surface. (See fig. 11.) Two vertical shafts were sunk to the 736-foot level, one being extended as an incline to the 1,850-foot level. There were working levels at depths of 182, 538, 736, and 800 feet, which were succeeded below the 800 by levels spaced 150 feet apart to the bottom. The average length of the levels was about 1,500 feet. (See fig. 12.)

The massive quartz of the Central vein persists throughout the length of the property and far beyond it in both directions, where its white outcrops frequently are prominent, and it is generally called the Bull vein. It is exposed in depth as far as the bottom of the mine. This vein holds to a certain horizon in the schists; other structural features in the mine are said to parallel it, but its content of gold is so low that very little of the vein has proved high enough in grade to be mined. It is thought that the nearly barren Bull vein represents deposition in an early stage of the lode's development and that the parallel fissuring is later in origin.
Figure 10.—Formations cut by drill hole L at the Harvard mine, showing low-grade ore bodies.
Figure 11.—Plan of tunnels, upper levels, and diamond-drill holes at the Harvard mine.
The most productive vein of the mine was in the schists beneath the Central vein. It was called the Footwall vein. From the surface to the 538-foot level the Footwall vein was mined continuously through a length of 160 feet to a width of about 20 feet. From the 538- to the 736-foot level it was mined with continuous stopes through a length of 800 feet. Above the 538, elsewhere than in the 160-foot section of the Dome stope, which was mined to the sur-

![Diagram of mine workings](image)

**Figure 12.—Longitudinal vertical projection of the Harvard mine workings.**

face, stopes were carried up from 50 to 200 feet. The range in width of stopes is given as 10 to 45 feet. It is said that these stopes still stand open and virtually uncaved because the ore contains a network of carbonate, chiefly ankerite, that is tough and resistant to caving.

Below the 736 level both the length and width of the ore body gradually diminish as far as the 1,700-foot level, but it is reported to have increased substantially in size on the 1,880-foot level. In the lower part of the mine the width was 5 to 7 feet.

In the schist above the Central vein there was another productive vein, called the Hanging-Wall vein, that was mined at the surface by an open pit 220 feet long. It was also exposed by crosscuts on
the 538-foot level and partly stope from the 800-foot to the 1,850-foot levels. The hardness of the rock in this vein is thought to have retarded its exploration. Its stopes were called the Hard-Rock stopes. Results from diamond drilling greatly increased interest in this ore shoot, which Hershey concludes to be 600 feet long and 20 feet wide and to average $6.50 per ton to a depth of 300 feet.

East of the Hanging-Wall vein other lenses of ore were mined by surface pits. They have been crosscut, also, on the 538-foot level and by diamond-drill holes. Though continuity was not established, it has been thought that there are several hundred thousand tons of low-grade ore in this section of the mine.

Hershey discusses the possibilities for ore in great detail, arriving at conclusions in two ways: First, he considers ores near the surface, about which there is most evidence, saying "They aggregate 1,115,000 tons that may contain $6,337,000, or an average of $5.68 a ton."

Second, he approaches the problem of total tonnage by estimating what he believes to have been the original total and subtracting from it the ore already mined. In doing this he has concluded that there was no fundamental change in ore deposition from the surface to the bottom of the workings, though the tonnage of ore on different levels varies, owing to the swell and pinch of various shots.

No place has been found in the mine where an ore shoot can be shown to clearly die out. They cannot all be traced from the surface to the bottom level, but I have no doubt that this is true merely because the necessary openings have not been made. Some of the shoots were largest near the surface, others at intermediate depths, and one near the bottom of the mine.

Accordingly he estimates the average tonnage of ore per foot of depth at 3,000 tons to a depth of 1,200 feet and thence to the 1,850-foot level at about 2,000 tons per foot. From surface to bottom he thus estimates an original ore content of 5,100,000 tons. From this he deducts 1,180,000 tons as mined from veins and the glory holes as well, leaving 3,920,000 tons as possibly remaining. "This is not ore in reserve, but is probable and possible ore." He states that in his estimates of value he has almost invariably gotten a higher figure than $5 per ton, and that there is every reasonable presumption that the ore will continue in depth below the exposures on the bottom level.

Hershey also estimated costs at $3.50 per ton at a production rate of 1,000 tons per day with $5.00 ore, from which $4.50 would be recoverable, leaving $1.50 as net operating profit.

In the Hamilton, Beauchamp, and Woodworth report other estimates are made of ore to the depth of the 736-foot level only, as follows:

<table>
<thead>
<tr>
<th>Surface to 538-foot level (probable ore)</th>
<th>Gross value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot-wall vein, 426,630 tons @ $5.12</td>
<td>$2,182,864</td>
</tr>
<tr>
<td>Hanging-wall vein, 811,660 tons @ $4.57</td>
<td>3,726,707</td>
</tr>
<tr>
<td>Total to 538-foot level, 1,238,290 tons @ $4.77</td>
<td>5,980,571</td>
</tr>
</tbody>
</table>

538 to 736 levels:

| Hanging-wall vein (prospective ore), 165,000 tons @ $4.00 | 660,000 |
| Ore reserves for surface mining (prospective) | |
| 1,000,000 tons; value, $2 to $3 | |

As to the last item, the report states:

It is conceivable that the entire outcrop ridge, that rises from 50 to 150 feet higher than the shaft collars, can be mined by power shovels for a low-grade
average value of $2 to $3 at costs of under $1.50. Selective open-pit mining along the principal vein concentrations and ore lenses, at slightly higher cost, should realize a higher-grade product. Values are generally distributed across widths of up to 250 feet, as shown by surface tunnel sampling, and the possibility of securing from 400,000 to 1,000,000 tons at low cost, with little preparation, deserves serious consideration.

The report by Hamilton and others also gives some estimates of costs in contemplation of operations on a basis of 500 tons per day, in substance as follows:

Preparation of mine and general overhead during preparatory period...$74,800
Cost of mine plant and mill...........................................318,000
Working capital................................................................................50,000
Capital requirement for operations..................................................442,800

Operating costs are estimated at about $2.92 per ton, including depreciation and taxation before depletion.

The metallurgical tests made by Hamilton, Beauchamp, and Woodworth indicated that cyanidation of the ore ground to 200 mesh, together with amalgamation and concentration, made possible a recovery of 95 percent of the value at an estimated cost of 85 cents per ton, if treated at a rate of 500 tons per day. When flotation is used, with cyaniding of the concentrates, the recovery is 5 to 10 percent lower.

In view of the emphasis laid upon the potentialities for large low-grade mining operations in the southern Mother Lode region in part I of this bulletin and in the introduction of part II, it is of special interest to note that the Alaska Juneau Gold Mining Co. had taken an option on this mine and was sampling it early in 1939.

**Dutch-App**

The Dutch-App group of mines is 2 miles southwest of Jamestown in secs. 22 and 23, T. 1 N., R. 14 E. It comprises the Sweeney, Dutch, App, Heslep, and Hitchcock mines, in the order named from north to south. (See Nos. 84 to 88, fig. 5.) These mines have a continuous length of 4,980 feet along the Mother Lode and, with four mill sites, embrace a total area of 102 acres, all of which is patented. The nearest railroad point is Jamestown, between which and the mines there is a paved road. These mines are now owned by the Sonora and Abstract & Title Co. of Sonora.

The App and Heslep claims are at the southern end of the area, the App covering the foot wall of the Mother Lode. (See fig. 15.) The Heslep lies east of the App and covers the hanging wall. Both are on the north side of a moderate eminence called Quartz Mountain, of which figure 18 is a view. The head frame of the App shaft may be seen on the right and the present mill on the left.

The Dutch lies adjacent to the north on a low ridge; beyond it is the Sweeney claim, which extends to the north boundary of the property. Between the Sweeney and the southern boundary of the Harvard is a gap of half a mile or more, through which the lode remains unexplored.

It is probable that the production of gold from the group as a whole exceeds 9 million dollars, 6½ millions being attributed to the App-Heslep group and 2½ to 3 millions to the Dutch-Sweeney. ⁹

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Figure 13.—Quartz Mountain, showing general view of the App mine.

Figure 14.—Open pit in folded schists, Eagle-Shawmut mine.
The lode strikes about N. 40° W. and dips from 54° E. in the App to 64° in the Dutch. The country rock consists predominantly of black Calaveras slates with considerable amphibolite schist to the east of them, while serpentine and meta-andesite lie to the west of the slates. In this section the lode is characterized by a very large, strong vein of quartz and ankerite heavily stained by the chromium green of mariposite. It has been called the Great App vein. This vein attains a width of 200 feet in the App, but narrows toward the Dutch, where it is about 90 feet wide for the first 300 feet, then decreases in width, and swells again irregularly to the north.

Though so promising in appearance, the original massive vein is generally quite barren, except where it has been penetrated by quartz fissures of later generation. Hershey 10 concluded that the massive belts and lenses of carbonates—creamy white except as spotted with the green of mariposite—represent the first period of vein formation and that these masses were formed by replacement of the country rock, of which abundant remnants are found in the carbonates. They are, however, "traversed by an irregular network of white-quartz seams. In places, particularly along the borders, the quartz seams pass into large quartz veins, lenticular in cross section."

Some of this quartz contained enough gold to be mined as ore, but most of it was barren and is believed to have been older than the gold-bearing quartz.

Vertical and horizontal cross sections showing the general relations between the App and Heslep veins are shown in figures 16 and 17. The section between the veins, however, is often largely replaced by ankerite. Underground development of these properties is through two main shafts—the Dutch, 2,300 feet deep along the vein, and the App, extending directly to the 1,300 level with connections to lower depths. Figure 15 shows a plan of the mine workings with their several miles of drifts from the two shafts.

The structure, ore deposition, and history of these mines are fairly typical of many other mines of the Mother Lode. Details in regard to them have been preserved more fully than usual in a monographic report written by W. J. Loring 11 covering his own as well as previous operations.

The App "was worked almost continuously from the early days of quartz mining until 1911," by Capt. W. A. Nevills, its sole owner. At the same time he operated other mines, including the Rawhide. He would not disclose the production of any of them and even refused admission of Government geologists to his mines. Production from the App-Heslep is therefore understood to be merely a very uncertain estimate.

By the end of Captain Nevills' long administration he had worked the App vein north of the shaft to a depth of 1,300 feet. The Heslep ore body near the hanging wall of the lode, which was also called the Hanging-Wall vein, likewise had been mined extensively up to the end line of the Dutch.

The Dutch claim, though said to have been located in 1852, appears to have been relatively neglected in early days, having been mined

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11 An unpublished report dated 1921 and preserved in the records of Charles H. Segerstrom. This account is chiefly abstracted from it.
Figure 16.—Vertical cross section through the Dutch shaft, showing App and Heslep veins.
only by open-cuts and shallow pits, the production from which is unknown. In 1889, however, a shaft was sunk 225 feet, and a few hundred tons was mined from an ore body south of it.

More extensive operations were begun in 1893 and were continued by A. Trittenback until 1906, during which period the shaft was deepened to 1,800 feet on the incline.

An ore body 250 feet long, part of which was on one side of the shaft and part on the other side, was mined first. This ore body attained a depth of slightly more than 400 feet from the surface, but fingered out and bottomed below the 400 level. Other ore was found later extending almost continuously to the Sweeney claim, 700 feet north of the Dutch shaft. Below 400 feet, however, very little ore was found north of the shaft until the 1,650 level was reached, although it is reported that the intervening block of ground was not explored at all extensively. South of the shaft more ore was found, including an extension of the Heslep ore body that had been mined in the App-Heslep and crossed the end line into the Dutch claim.

The ore from the Dutch was treated in a mill that had 10 stamps at first, but 20 later. The value of production is reported to have been about 2 million dollars, from which a profit of $575,000 is said to have been made.

In 1909 operations were undertaken by Charles H. Segerstrom, the present owner, who combined the Dutch with the Sweeney. The latter had previously been developed only slightly by a 200-foot shaft and a little drifting. The claim was now partly explored on the 600 and 1,650 levels from corresponding levels of the Dutch mine.

The mill was enlarged to 40 stamps, and operations were largely a clean-up of old workings. Production of $500,000 is reported from 1909 to 1915, making a total of $2 ½ millions for the Dutch-Sweeney part of the group before its consolidation with the App-Heslep and the beginning of Loring’s administration.
From 1916 to 1920 W. J. Loring systematically explored and sampled all showings in these mines to determine tonnage, average grade, and a suitable milling process. Nearly 17,000 feet of development work was done, including 500 feet of shaft sinking, 4,000 feet of raising, and over 12,000 feet of drifting and crosscutting. About equal amounts of work were done in the Dutch and App ground. Loring states that on the 1,500 level the Heslep ore shoot was 555 feet in length, 380 feet remaining unmined. Its average width was 31 feet, and it represented 252,000 tons of unmined ore up to the 1,300 level, with an average value of $3.80 per ton ($6.46 at present price).

In all, he found nearly 1,500,000 tons of all classes of ore, nearly half of it in the Heslep vein below the 1,300 level; its average gold content was estimated to be between 0.15 and 0.18 ounce per ton.

Accordingly a new pilot mill was built and was operated through 1919 until April 1920. It treated 54,000 tons of ore averaging 0.17 ounce of gold per ton. Ninety percent of the gold was recovered, nearly one-fourth of it in bullion and the rest from concentrates. This extremely promising project was terminated by the rapid rise in costs following the World War and the difficulty experienced in obtaining suitably trained labor.

In the fall of 1935 the old Heslep shaft was reopened by Gold Diggers Syndicate, Inc., of Hollywood, Calif. Sidney Wood, Jr., 9172 Sunset Boulevard, Hollywood, Calif., is president, and K. C. Brown of Jamestown is superintendent. The shaft was retuberoed to the 100-foot level, and drifts were extended 200 feet south and 80 feet north, from whence stoping was carried upward for 40 feet, but the ore became too oxidized for flotation and stoping was discontinued.

In June 1936 the old App shaft was retuberoed to the second level, 280 feet below the collar. A crosscut was extended 200 feet east to cut the Heslep vein. Drifts were run south for 380 feet, and the vein was stoped to the 100-foot level of the old Heslep shaft. Directly east of the crosscut and extending from the App shaft to the Heslep vein, a crosscut was continued into the hanging wall for 40 feet in ore that was mined for 60 feet north and 20 feet south, at which points the values became too low for milling. This area was stoped to a height of 82 feet by shrinkage methods. About 29,000 tons of ore was extracted from the workings on the second level.

While this ore was being mined, the shaft was reconditioned to the third level, where a drift extended on a diagonal fracture to the Heslep vein. From this point it was necessary to spike through and retuberoer an old filled stope. At a point south, directly below a pillar on the second level, ore was found in place, and in June 1938, 12 chutes had been built and stoping operations had been begun. Toward the north end of this ore shoot were found slates that were greatly fractured but had been recemented with gold-bearing quartz. The best ore is found where the most fractures are present.

At the south end of the property graphitic slates occur and constitute soft, heavy ground, which must be square-set in mining. During the first quarter of 1938 mill heads averaged $7.05 per ton, and 85 percent of the ore milled came from development work.

The App shaft with three compartments was sunk in the hanging wall of the App vein at an inclination of 53°. The ore bin in the head frame has a capacity of 50 tons, and ore is transported from
it to the mill by cable haulage. The ore is crushed to minus 1½ inches in a jaw crusher and then ground in a 5- by 4-foot Straub ribbed-cone ball mill. A homemade trap that receives the discharge of the ball mill catches coarse free gold and discharges it to a Dorotype, single-rake classifier in closed circuit with the ball mill. The overflow from the classifier goes to a Wilfley table, the tailings from which go to flotation cells. A shipping concentrate is taken from No. 1 cell, and concentrates from the remaining three cells are returned for cleaning. Concentrates are shipped to the smelter at Selby, Calif., and the bullion to the mint. About 25 percent of the gold is free. No. 1 cell is a Fagergren, and a Kraut cell is used for cleaning. Flotation reagents are American Cyanamid 301 and pine oil. There is a small single-drum hoist, a small Ingersoll-Rand air compressor, and a blacksmith and machine shop. When the mine was visited, nine men were employed underground, two men on the surface, and seven men in the mill.

**SANTA YSABEL**

The Santa Ysabel mine is on the southeast slope of Quartz Mountain about 2½ miles south of Jamestown. It comprises the Knox & Boyle, Miller & Holmes, Gray Eagle, and Nyman claims, embracing 100 acres immediately south of the Hitchcock and Heslep claims of the Dutch-App group of mines. (See Nos. 91 and 92, fig. 5.)

The geology of the Mother Lode is here almost identical with that of the Dutch-App property already described. There are stringer veins of quartz in the Calaveras slates on both sides of a low-grade ankerite-marioposite zone of alteration, which at the Miller & Holmes claim is 170 feet wide. The stringer veins strike N. 16° W. and dip about 65° NE. They were developed by three shafts 830, 800, and 600 feet deep, respectively, and by several thousand feet of crosscuts and drifts. When the property was most active it was equipped with a 40-stamp mill, and concentrates were saved by four Frue vanners. Although it is credited with a total output of $1,500,000, this group of mines has been idle for many years.

**JUMPER AND GOLDEN RULE**

The Jumper and Golden Rule property is about 4 miles south of Jamestown in secs. 27 and 35, T. 1 N., R. 14 E. (See No. 95, fig. 5.) It is a consolidation of the Jumper, Golden Rule, and New Era properties, each of which was operated previously as a separate mine, with the Mark Bogan ranch, an agricultural patent on the east of the claims, which covers the dip of the vein system with increasing depth. The property is owned by J. W. Schiffman of Jamestown, Calif., and associates. The total production of the group is estimated at about $5,000,000.

In this property the Mother Lode is represented by three parallel veins striking about N. 16° W. and dipping 70° NE. Of these, the most easterly or hanging-wall vein is known as the Jumper. It is followed to the west by the Middle vein and the West or Footwall vein at intervals of 150 to 200 feet, the distance between the veins increasing slightly along their strike to the north. The hanging wall of the vein system is amphibolite schist and the foot wall is diorite.
The same pattern of primary mineralization characteristic of most of the Mother Lode properties in Tuolumne County exists here. The schist near the contact was dolomitized with the formation of ankerite and became veined or interlaminated with quartz and impregnated with pyrite. This mineralized zone was intruded subsequently by a diabase dike, and, still later, mineralization deposited silica, calcite, and gold in minor fissures opened by slight movements. This late mineralization seems responsible for the rich pockets of free gold for which the mines of the group, particularly the Jumper, are noted.

The main ore bodies, which range from 5 to 50 feet in width, are present in the schist on the hanging wall of the ankerite, although some large quartz lenses carrying a little free gold and auriferous pyrite are found in the ankerite. There is a narrow vein of quartz and calcite on the footwall of a silicified zone in the schist, and this vein has frequently been rich in free gold. The diabase dike also is often shattered, the resulting small fissures within it being filled with quartz and calcite, which carry enough gold in some places to convert the dike as a whole into ore. The rich pockets of free gold in the vein have always been found associated with the late seams of calcite, which cut through it and generally dip to the north; and, as in many of the pocket mines of the county, the free gold often is accompanied by petzite. Although famous for their rich pockets, the average ore taken from these mines has been low grade, average recovery for all years for which tonnage statistics are available being $5.25 per ton, corresponding to 0.245 ounce of gold.

The Golden Rule mine probably was the first of the group to be worked. Mining by means of open-cuts and a 200-foot vertical shaft was carried on in the 1860 decade, and the property is reported to have produced about $50,000 in 1870 and 1871. About 1895 a crosscut adit 528 feet long was driven from the west side of Golden Rule Hill or footwall side of the vein system, which intersected the Jumper vein at a depth of only 80 feet. From this intersection, the Jumper vein was drifted on for 800 feet north and about 100 feet south and was stopped to the surface throughout the entire length of the drift. The vein material here was schist impregnated with auriferous sulfides, and on its footwall were narrow veinlets of quartz and calcite that are said to have been rich in gold. The Golden Rule shaft was deepened subsequently to 530 feet, crosscuts having been driven east on the 300- and 400-foot levels and both east and west on the 500-foot level to cut all three veins. An inclined winze 800 feet deep was sunk on the Jumper vein from the 500-foot level. From 1899 to 1902 about $90,000 was produced from the Golden Rule, but there is no record of its total output before its consolidation with the Jumper.

The Jumper mine was developed originally by an inclined shaft 320 feet deep on the Jumper vein with drifts both north and south on the 100-, 200-, and 300-foot levels. In its lower levels, however, it was developed through the New Era shaft about 150 feet north of the Jumper shaft. The New Era shaft follows the inclination of the vein, and is 1,400 feet deep, with levels at 200, 400, 500, 600, 700, 800, 1,000, 1,100, 1,200, 1,300, and 1,400 feet. A winze north of the shaft, on the 1,400 level extends the workings 400 feet deeper,
FIGURE 18.—Massive quartz outcrop above pit in low-grade ore, Eagle-Shawmut mine. Men in foreground indicate size.
Figure 19.—Denuded limestone bedrock typical of the famous placer basin at Columbia.

Figure 20.—Eagle-Shawmut mill, with dragline and floating washing plant in foreground working a placer on Woods Creek.
with levels at 100-foot intervals, to 1,800 feet. Almost all stopes in
the mines are above the 800-foot level. The ground above this level
has been largely mined out through a length of 600 feet to within
100 feet of the surface. There are several miles of underground
workings in the group. The 500-foot level alone is 2,900 feet long
and connects the New Era workings with those of the Golden Rule.

In 1890 the Jumper mine had a 20-stamp mill, but this was
increased later to 40 stamps. No concentrators were used, as the
sulfides were considered to be too low grade to save. From 1896
to 1904, its most active period, the property was worked by the
Jumper Californian Gold Mines Co. Subsequent operations were
conducted by various lessees, all working above the 500-foot level.
Their maximum annual output is reported as $85,000. Milling at the
property ceased in 1919, and only a few thousand dollars worth of
gold has been produced since.

It is reported that when the mine was closed the existence of large
bodies of low-grade material in the West vein had been proved, but
these evidently did not contain enough gold to be classed as ore at
that time. However, at the present price of gold and with highly
developed flotation methods available for cheap concentration, it is
possible that much of the ore left in the mine is now better than
marginal in grade.

MAZEPPA

The Mazeppa mine is 1 mile southwest of Stent in sec. 35, T. 1 N., R.
14 E. (See No. 96, fig. 5.) It adjoins the Jumper mine on the south
and contains a continuation of the Jumper vein-system, which has
been described and which has been drifted on at the 700-foot level in
the Jumper ground to within 300 feet of the north endline of the
Mazeppa.

The vein on which the Mazeppa shaft is sunk is 5 to 20 feet wide,
strikes N. 16° W., and dips 65° NE. The vein material as a whole
is not ore, but the shoots seem to be confined to a 4- to 6-foot width
adjoining the hanging wall, which is Calaveras slate. The foot wall
is metadiorite and serpentine. No record of the total production of
this mine is available. The ore was treated in a 10-stamp mill at the
property. Operations were not profitable, however, and the mine
has not been worked for many years.

EAGLE-SHAWMUT

The Eagle-Shawmut mine is on the east side of Woods Creek,
2½ miles above its junction with the Tuolumne River and about 2
miles northwest of Jacksonville, in secs. 11 and 12, T. 1 S., R. 14 E.
(See No. 118, fig. 5.) It is owned and operated by a partnership
consisting of H. G. Miller and Geo. W. Clemson, both of Los Angeles.
F. H. Mitchell, of Eagle-Shawmut, is general manager.

This property includes 365 acres and represents a consolidation of
a number of mines that once were operated individually, some
of them a long time ago. The Eagle-Shawmut Gold Mining Co.
operated from 1896 to 1916. In the latter year the Belmont-Shaw-
mut Mining Co., a subsidiary of the Tonopah Belmont Development
Co., succeeded it and operated the property until 1923.
The total recorded production of these mines exceeds $5,000,000, as that amount had been produced by the end of 1924; there has been some additional output since then, probably amounting to several hundred thousand dollars. Virtually all of the output was derived from 1,750,000 tons of ore averaging $2.85 per ton at the old price of gold. The larger part of this tonnage was very low grade indeed, the rest being moderately higher.

The Mother Lode here strikes north 20° to 45° W. and dips 70° E. It follows a contact of the Mariposa formation on the west with the Calaveras on the east, which extends along the crest of a steep hill flanking the narrow valley of Woods Creek on the east. The mine workings, a longitudinal vertical section of which is shown in figure 21, include an inclined shaft about 1,800 feet deep on the dip of the vein with an offset winze from the twelfth level to the sixteenth level. Thence another offset winze bottoms the workings at a vertical depth of about 2,400 feet below the outcrop. In all, there are 7 miles of workings. In the upper part of the mine the levels are spaced irregularly, at an average of 180 feet, but in the lower portion they were driven every 200 feet.

The No. 2 level is an adit driven easterly into the hillside to the vein at a depth of about 500 feet below its outcrop. This adit is 1,100 feet long to its intersection with the shaft. The mine is filled
with water to the adit level, so that only the 500 feet above it is at present available for mining. The mine makes very little water, however, as the flow is only 60 gallons a minute, all of which is said to enter above the 1,200-foot level, the lower levels being dry.

The contact between the Mariposa and the Calaveras formations represents a discordance due to reverse faulting. West of the contact is the Mariposa formation, consisting of black slates that contain some thin bands of sandstone. It has been strongly folded and at the surface encloses a brecciated basalt flow that is amygdaloidal and has abundant augite phenocrysts. East of the fault is, first, a band of schists related to the Calaveras, and beyond that the Calaveras slate, also black but distinguishable from the Mariposa slates as it lacks the sandstone bands.

The fault between the two formations has been occupied by a dike, determined by Knopf to have been originally pyroxenite and called by him the pyroxenite dike. However, it has now become a narrow belt of sheared, silicified, glossy chlorite-schist. It is in this altered dike and in the schists between it and the Calaveras slate that the vein fissuring chiefly occurred. Both of these schists were heavily ankeritized, cut by quartz veins, and silicified. Much of the quartz makes low-grade ore, some of it being in itself fairly high grade. Knopf states that “the fractures are planes of little or no movement, as gouge is rare and brecciation is absent.”

Within a locus including the two schists, three fissurings have been recognized as veins. The first is the East vein. It was mined on the adit level for a length of 700 feet and to an average depth of 400 feet. It continued deeper, but evidently became marginal in grade and was not mined farther.

The second vein, at the contact of the pyroxenite dike and the Calaveras formation, is called the Middle or Shawmut, and from it the chief production of the mine has been derived. From the adit to the twelfth level, through a distance of about 1,200 feet, the average length of the ore shoot on this vein was about 400 feet. The mining of its low-grade quartz ore stopped at the twelfth level, although the vein continued. Farther to the north, however, there appeared in its footwall on the eleventh level a new shoot of ore containing a great deal of sulfide with gold values from $15 to $18 a ton. This became known as the sulfide shoot. It was mined to about 1,500 feet below the tenth level, with an average length of 300 feet. This shoot is a schist replaced by pyrite in overlapping lenses that attain a maximum thickness of 30 feet.

The third vein is known as the West vein. It is in the black slates of the footwall, and no attempt to mine it was made until recently, though its existence was known for years from showings found in crosscuts. However, in the early days it was impossible to make good recoveries from this ore because it contained a great deal of graphite, but with the recent developments in the flotation process of very effective depressants for carbon this difficulty has been overcome. The ore of the West vein has been exposed by crosscuts from the adit level for 850 feet, and prospecting indicates that it extends to the surface, about 500 feet above. From the adit level a raise has been carried up 135 feet, and a drift 300 feet long from the top of the raise is said to be in ore. Another raise in the center of
the ore body has been carried up 225 feet and is reported to be all in ore. This ore ranges from 20 to 32 feet in width, and the average recovery from all of it, as milled, is reported to have been 0.15 ounce of gold per ton. Behind the ore is black slate containing only small amounts of gold throughout a width of 5 feet, and this is succeeded by 8 feet of ankerite and then serpentine. It is believed by the management, from reports of showings in crosscuts, that the values continue to a depth of 2,000 feet. If this surmise proves even approximately correct, the future of this mine should be promising.

Some very interesting records remain of former operations, which may well be preserved here. Operations for 12 years after the consolidation—that is, from 1897 to 1908—resulted in the treatment of 1,060,443 tons of ore. From this ore $1.075 per ton was recovered in bullion by amalgamation, and in addition 37,264 tons of concentrates were made that contained $48.05 per ton, representing $1.71 per ton of ore. The total recovery per ton of ore was therefore $2.78. An additional 2 cents per ton was recovered from slags and general clean-ups, making $2.80 gross recovery. The bullion averaged 718 fine, most of the balance being silver.

In 1904 a chlorination plant was built to treat the concentrates, details as to which appear in a mine report for 1908. In that year 4,072 tons were treated at an average cost of $7.1453 per ton. The assay of tailings for the year is not given, but their nature is suggested by a sampling of 10,000 tons of tailings still remaining on the site of the old chlorination plant that showed $6.95 per ton. Some details of the cost of chlorination follow:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor (chlorinator, barrelmen, furnacemen, tram operator, machinists, smiths, carpenters)</td>
<td>$2.3884</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>2.1777</td>
</tr>
<tr>
<td>Chemicals (acid, salt, and lime)</td>
<td>1.1349</td>
</tr>
<tr>
<td>Overhead and sundry</td>
<td>0.9531</td>
</tr>
<tr>
<td>Depreciation</td>
<td>0.4912</td>
</tr>
<tr>
<td>Total</td>
<td>7.1453</td>
</tr>
</tbody>
</table>

Belmont-Shawmut operations were chiefly on heavy sulfide ore. Amalgamation was abandoned in favor of a combination of mechanical concentration and flotation, which was replaced later by cyaniding.

Present operations began in 1936 with mining from an open pit in the schist outcrops. A production of 114,000 tons from the south end of the pit averaged $2.98 a ton (old price). A strip of ore 30 feet in width in the north end of the pit averaged $4 per ton, but here the pit contained a quartz vein 2 to 3 feet wide that ran about $12 per ton. Views of the pit are shown in figures 14 and 18. In figure 18 the massive cliff is an outcrop of bull quartz that contains little gold and belongs to an earlier generation than the quartz that made ore, though most, even of that, is probably not very late in the sequence of depositions that formed the lode.

Metallurgical treatment.—The Eagle-Shawmut mill is on a steep east bank of Woods Creek about 200 yards south of the portal of the main haulage tunnel. (See fig. 20.) The mill building, 250 feet long, 125 feet wide, and 80 feet high, is a well-built wooden structure
with concrete floors running the full length of the building on three levels. At the time of the World War the mill was operated by the Tonopah Belmont Development Co. as a 60-stamp mill and cyanide plant, but later it was stripped of all equipment except the stamps and stamp-mill ore bins. In reequipping the mill, the present owners removed the stamps and installed a modern 300-ton cyanide plant, which was used to treat the ore mined with power shovels in the open-cuts on top of the hill. Recovery of gold by this process was not satisfactory, and, upon development of a large tonnage of $5 to $6 ore underground, it was abandoned in favor of the present flow sheet, which includes fine-grinding, jigging, tabling, and flotation. During June 1938, these methods recovered 92.53 percent of the gold, and the mill treated an average of 152 tons of ore per day.

Ore from the mine, in 4-ton cars, is hauled up a 12° incline by electric-trolley mine locomotives and dumped upon an 8-inch grizzly above a coarse-ore bin in the mill having a capacity of 110 tons. Large pieces of ore retained on this grizzly are slugged to pass the grizzly openings. The coarse-ore bin discharges to a 6-inch grizzly, the undersize from which falls into a 48-inch Symons cone crusher driven at 432 r. p. m. by a 100-horsepower motor. Oversize on the 6-inch grizzly is broken with sledges. The cone crusher makes a minus ½-inch product, which is elevated by an 18-inch belt conveyor 172.5 feet between pulley centers to the fine-ore bin. This conveyor has a belt speed of 225 feet per minute and is driven by V-belts from a 10-horsepower motor. The receiving end of the conveyor is inclined at 21°, but a 90-foot section at the discharge end is level. The fine-ore bin has a capacity of 300 tons and is discharged by a 24-inch belt feeder 14 feet between pulley centers and having a belt speed of 12.75 feet per minute. This feeder is driven by V-belts from an 8-horsepower motor.

The weight of ore milled is determined by taking a 2-foot sample from the feeder belt every hour. The speed of the belt is ascertained by a revolution counter attached to the driving pulley, so the total weight of ore fed can be calculated with reasonable accuracy. This weight is checked against that determined by the number of cars of ore delivered to the mill.

The feeder belt discharges to a feed hopper emptying into the scoop-box of a 5- by 10-foot Marcy rod mill driven at 26 revolutions per minute by a train of gears from a 100-horsepower motor. Enough water is added to the ore in the feed hopper to make the pulp discharge from the rod mill average 65 percent solids. About 15 tons of 3-inch steel rods are used in the mill. The mill discharges to a 24- by 24-inch Pan-American jig, which carries a 2-inch bed of ½-inch steel shot and makes 250 pulsations per minute. The pulp from the jig, consisting principally of pyrite mixed with flattened pieces of free gold, tramp iron, and copper, flows to a 4- by 8-foot Straub table driven by a 3-horsepower motor and making 240 strokes per minute. This table yields about 300 pounds of concentrates per day, which average between $1,000 and $1,500 per ton in gold, depending on the amount of coarse gold in the ore, and approximately 13½ tons of middlings per day containing about 2.8 ounces of gold per ton. The rich concentrate is screened on 10 mesh, and the oversize, consisting of flattened pieces of gold, copper, and
iron, is cleaned by hand and melted with a high-niter flux to produce gold bars averaging about 880 fine in gold and 110 fine in silver, which are shipped to the United States mint at San Francisco. The undersize of the rich concentrate is shipped in sealed drums to the smelter at Selby, Calif. The middling product is discharged to a 30-ton concentrate bin, which also receives the flotation concentrates. These mixed concentrates are hauled by truck to the Selby smelter. Tailings from the Straub table amount to only about 1/2 ton per day and usually average $7 to $9 per ton. At present these tailings are wasted, but arrangements are being made to return them to the mill circuit.

The overflow from the jig goes to an 8- by 24-foot duplex Dorrco classifier in closed circuit with the rod mill. This classifier is operated by a 7½-horsepower motor and makes 25 strokes per minute. About 80 percent of the rod-mill discharge is returned to the mill as plus 35-mesh pulp by a 10-inch helicoid at the upper end of the classifier. The classifier overflow averages about 30 percent solids and usually contains 5 percent of plus 65-mesh, 10 percent of plus 100-mesh, 25 percent of plus 200-mesh, and 60 percent of minus 200-mesh material. This overflow is discharged into an 8- by 8-foot circular steel Dorrco-type conditioner, where it is diluted to 20 to 22 percent solids and mixed with 0.30 pound of pentasol xanthate (Z6) and 0.51 pound of pine oil per ton of solids. The pulp in this conditioner is stirred by 2-foot blades, which are revolved 145 times per minute by a 3-horsepower motor. The conditioned pulp flows to an 8-foot Southwestern primary rougher cell, where it receives 0.15 pound of Z6 and 0.40 pound of American Cyanamid reagent 639 per ton. This last reagent is one of a group of carbon depressants in which the active wetting ingredient is Aerosol, an ester of a sulfonated bicarboxylic acid (U. S. Patent 2,028,091). The flotation pulp normally has a natural alkalinity of \( pH \) 8.2 to 8.4, which is ideal for the reagents used. Very occasionally, however, the alkalinity will fall below \( pH \) 8, and it is then raised within the desired limits by the addition of soda ash.

The concentrates from the primary rougher cell go to a 6-foot cleaner cell of similar make, and the tailings from the rougher are retreated in a 16-foot secondary rougher cell also made by the Southwestern Engineering Co. No reagents are added in the cleaner cell except sometimes a small quantity of the 639 carbon depressant. The secondary rougher receives 0.15 pound of Z6, 0.20 pound of 639, and 0.10 pound of pine oil per ton of solids. The concentrates from this rougher go to the cleaning cell, and the tailings are wasted after being sampled by a Southwestern automatic sampler, which cuts a 1/2-liter sample every 12 minutes. A 1-inch stream of these tailings is treated on a 5- by 2-foot Straub pilot table to show visually the proportion of sulfides that is being wasted.

A 2- by 3-foot Southwestern blower driven by V-belts from a 30-horsepower motor at 125 r.p.m. and having an air displacement of 1,250 cubic feet per minute supplies air at a pressure of 7 pounds per square inch to the three flotation cells. Flotation reagents are supplied to the conditioner and flotation cells by four Southwestern reagent feeders, two of which have two compartments each and the other two, three compartments each.
The concentrates from the cleaner cell are discharged to a 6- by 6-foot Dorrico filter, which is driven at 2 r. p. m. by a 1½-horsepower motor. The filter is operated with a 25-inch partial vacuum supplied by a vacuum pump driven by a 15-horsepower motor. The filtered concentrate, which contains about 10 percent moisture, is discharged into the 30-ton concentrate bin that receives the middlings from the Straub table.

The following table lists the principal milling data for June 1938:

<table>
<thead>
<tr>
<th>Mill heads</th>
<th>Weight, tons</th>
<th>Assay value per ton</th>
<th>Total value</th>
<th>Percent of total gold in mill heads</th>
<th>Percent of total recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table concentrates</td>
<td>4,455</td>
<td>$5.20</td>
<td>$22,166</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>Table middlings</td>
<td>4</td>
<td>1,274.00</td>
<td>5,096</td>
<td>22.00</td>
<td>23.78</td>
</tr>
<tr>
<td>Table tails</td>
<td>56</td>
<td>163.00</td>
<td>5,768</td>
<td>24.90</td>
<td>26.91</td>
</tr>
<tr>
<td>Flotation heads</td>
<td>15</td>
<td>8.00</td>
<td>120</td>
<td>32.00</td>
<td></td>
</tr>
<tr>
<td>Flotation concentrates</td>
<td>4,390</td>
<td>2.75</td>
<td>12,182</td>
<td>62.28</td>
<td>49.31</td>
</tr>
<tr>
<td>Flotation tails</td>
<td>110</td>
<td>96.10</td>
<td>10,571</td>
<td>45.63</td>
<td>49.31</td>
</tr>
<tr>
<td>Recovery</td>
<td>4,270</td>
<td>377</td>
<td>1,611</td>
<td>4.95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>170</td>
<td>126.98</td>
<td>21,435</td>
<td>92.53</td>
<td>100.00</td>
</tr>
</tbody>
</table>

It will be noted that mill heads during the month averaged $5.20 per ton and that recovery was 92.53 percent, which is equivalent to $4.8115 per ton. Recovery was divided almost equally between the products obtained by tabling the jig hutch and the flotation concentrates.

At present the cost of milling is high, due primarily to the lack of a coarse-crushing unit, which necessitates the employment of two men per shift to sledge ore through the grizzlies and which likewise throws a heavy load on the cone crusher, causing excessive wear and frequent replacement of its wearing parts.

Water for the mill is brought 5 miles to the property by the Algerine ditch of the Pacific Gas & Electric Co. and is delivered to a reservoir holding 600,000 gallons and 525 feet above the mill.

Enlargement of the milling capacity to 350 tons per day is already under way. A 164 Telsmith primary crusher is being installed, and ore from the mine will be delivered to it over a new low-line track with a 0.5-percent grade instead of being pulled up an incline by the mine locomotives as at present. A 12- by 12- by 24-foot Stephens Adamson all-steel bucket elevator will carry the coarsely crushed ore to an 8- by 8- by 8-foot surge bin above the cone crusher. Grinding capacity is being increased by the installation of a 5- by 10-foot Marcy rod mill.

J. W. Garlinghouse, of Chinese Camp, Calif., is mill superintendent. Eleven men are employed in the mill per 24 hours.

Clio

The Clio mine is on the north bank of the Tuolumne River, ¼ mile southeast of Jacksonville, in sec. 18, T. 1 S., R. 15 E. (See No. 128, fig. 5.) The mine is said to have been opened in 1862; and, equipped with a 10-stamp mill, it was worked steadily for about 5 years. Then it closed and has since operated only spasmodically up to 1926. Two patented claims, the Clio and Kershaw, and three unpatented claims
formed the original holdings. They covered 3,000 feet along the strike of the Lode. During late operations the property was expanded to over 630 acres by purchase of the West Clio, Bell Boy, and Imperial claims and of land from E. R. Bolton. Its production has been estimated at $140,000.

The mine was last reopened in November 1919, but the mill and surface plant were destroyed by fire late in 1922. However, a new head frame and 10-stamp mill were erected in 1924, and three Wilfley tables and a 50-ton Vandercook mercuric cyanide plant were installed. This operation proved unprofitable; and 2 years later, in 1926, the mine was closed and has not since been reopened.

The vein in the Clio property has a maximum width of 40 feet, the average being 8 to 10 feet. It strikes N. 40° W. and dips 65° to 69° NE. The vein material consists of quartz stringers in an amphibolite schist that has been dolomitized and impregnated with pyrite, which forms 3 to 5 percent of the ore. The gold content of the vein is small, running from 0.05 to 0.25 ounce per ton. The average yield during the last period of operation is reported as slightly more than 0.1 ounce, or a little over $2 per ton at the price of gold then current, and this would not meet the cost. At the present price of gold the same recovery, which is said to have ranged from 90 to 94 percent, would have yielded about $8.50 per ton, with the possibility of some profit.

The footwall of the vein is serpentine, which carries a heavy gouge and is swelling ground that causes trouble in mining. The hanging wall is an altered amphibolite schist. It appears evident that the structurally weak contact zone between the serpentine and schist afforded a channel for the mineralizing solutions.

Initial development was by a 600-foot adit, which cuts the vein at a depth of 218 feet. There are over 1,100 feet of drifts on this level. Later, a three-compartment shaft was sunk on the vein at an incline of 67° to a depth of 930 feet, and seven levels were run below the adit at depths of 306, 361, 473, 565, 700, 800, and 900 feet. Principal development below the adit level consists of 350 feet of drifts on the 473-foot level, 480 feet on the 565 level, 300 feet on the 700 level, 225 feet on the 800 level, and a 313-foot crosscut into the hanging wall on the 900 level. A stope above the 800 level, which is 160 feet long and 8 feet wide, is the deepest one in the mine. Above the adit, or 218-foot level, most of the vein has been stope to the surface. It is reported that the mine contains plentiful supplies of ore carrying 0.1 ounce gold or slightly more per ton. This grade of rock was unquestionably submarginal prior to the increase in the price of gold, but it might now be classed as ore if it could be mined and milled on a scale large enough to permit low operating costs.

**McALPINE**

The McAlpine mine is situated at an altitude of 2,200 feet on the divide between Tuolumne and Mariposa Counties at the head of Moccasin Creek, just east of United States Highway 49 and about 2 miles from the Mariposa County line in sec. 18, T. 2 S., R. 16 E. (See No. 139, fig. 5.) It is the most southerly mine on the Mother Lode in Tuolumne County that has an appreciable amount of
development work. Its outcrop of massive white quartz forms the backbone of the ridge on which it is situated and is a prominent feature of the landscape that can be seen from the highway for several miles. The Mother Lode fissuring in the McAlpine ground is 100 feet wide and occurs in a belt of amphibolite schist that runs northwesterly to beyond Jamestown and southeasterly into Mariposa County beyond Bagby.

Large masses of quartz fill the major fissuring, but in general these are too low grade to constitute ore. The best pay is said to be found in a narrow, green, talcose vein near the hanging wall. The property was developed first by an adit from the west side of the ridge, which cut the vein at a depth of about 150 feet. The ground above the adit is stope and is said to have yielded a net profit of $75,000. After this early work, the mine was idle until about 1911, when a vertical shaft was sunk near the mouth of the adit to 455 feet with crosscuts east to the vein at the 200- and 375-foot levels. In 1914 the McAlpine Mines Co. acquired the property, the shaft was deepened to 670 feet, and three additional crosscuts were driven to the vein at levels lower than the earlier ones. The results of this development presumably were disappointing, as work was discontinued in 1928.

EAST BELT

In Tuolumne County the East belt parallels the Mother Lode about 10 miles to the east and forms a southerly continuation of the belt of mines that traverses Calaveras County through Glencoe, Sheep- ranch, and Murphy. Figure 5 shows its general course through Tuolumne County, as indicated by more than 30 mines extending from the Snell property (see No. 1, fig. 5) southeast of Stanislaus through Pooleys Ranch, Soulsbyville, and Tuolumne to the Kanaka mine (see No. 114, fig. 5) on the Tuolumne River. These mines, in granite, granodiorite, and various rocks of the Calaveras formation, are characterized by their narrow quartz veins, often with ribbon structure, containing small shoots of high-grade ore, which generally shows along contacts or at intersections of the veins with igneous dikes.

The geology of the belt as a whole is typified by that of its principal district about Soulsbyville. There the highly metamorphosed Calaveras formation has been intruded by a semicircular area of granodiorite 9 miles in diameter. As is usual in masses of this size, the granodiorite presents several different facies such as quartz-gabbro, pyroxene-diorite, and also granite. The granodiorite has been decomposed to depths of 25 feet or more. In common with the Calaveras formation, it is cut by pegmatite dikes. The gold-bearing quartz of the veins generally appears to have been introduced into the fissures after the formation of the pegmatites. The veins, though usually in the granodiorite, also often follow its contacts with rocks of the Calaveras formation. Considerable areas of the granodiorite and of Calaveras rock are capped by volcanic agglomerates, including tuffs and andesitic lavas, but these rocks are all of later age than the formations containing the veins. The ore in the veins carries free gold and is rich in sulfides,
including pyrite, pyrrhotite, chalcopyrite, galena, and sphalerite, and sometimes complex sulfides of lead and antimony.

Although the veins are ordinarily narrow, there are some notable exceptions. At the Black Oak mine, the vein where mined was commonly 8 to 10 feet wide, and at the Columbia mine there are impressive exposures of quartz in which one of the veins attains a width of 22 feet; but such widths are exceptional. Most of the veins range from only a few inches to 2 feet in width and constantly swell or pinch to form lenses. Yet these veins are remarkably persistent and probably extend to considerable depths, as few if any of them have been bottomed.

Because of the richness of their ore, the veins of the East belt were prospected and developed to shallow depths very soon after their discovery, and in the past their output far exceeded that of the Mother Lode in the county. The East belt mines are credited with a total output of $19,340,000 prior to 1899 (see table, p. 18), and six of them individually produced a million dollars or more. Their output is shown in the following table:

<table>
<thead>
<tr>
<th>Mine</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soulsby</td>
<td>$5,500,000</td>
</tr>
<tr>
<td>Black Oak</td>
<td>3,500,000</td>
</tr>
<tr>
<td>Confidence</td>
<td>3,250,000</td>
</tr>
<tr>
<td>Grizzly</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Gilson</td>
<td>1,250,000</td>
</tr>
<tr>
<td>Draper</td>
<td>1,000,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16,000,000</strong></td>
</tr>
</tbody>
</table>


² Now consolidated with others as the Soulsby.

The output of the Draper mine has been quoted elsewhere as much more than a million dollars, but it is thought that the lower figure represents more accurate information than was previously available.

In general, the mines of this belt have been worked to depths of only a few hundred feet, although at some properties depths between 1,000 and 1,800 feet have been attained. The Dead Horse shaft of the Grizzly mines is 2,100 feet deep on a 50° incline, and the Black Oak shaft is bottomed at 1,700 feet. These are the two deepest mines in the East belt.

The narrow veins of the East belt are unsuited for large-scale mining and their complex sulfides have made cyaniding difficult. There was also a difficult pumping problem in the Soulsbyville area, where there is a great deal of ground water. It proved so costly to handle with steam pumps and boilers fired with wood that this caused the closing of some of the mines. Further, as the sulfides in the ore were not saved customarily, operating income was limited to that derived from the free gold.

In view of the impressive records of production from many of the East belt mines, the usual high grade of their ores, cheaper pumping costs, recent improvements in milling methods by which the sulfides can be saved cheaply, and more especially because of
the substantial increase in the price of gold, it is apparent that mining in the belt should now be more attractive than formerly.

SOULSBY

The Soulsby mine is at Soulsbyville, 6½ miles due east of Sonora in sec. 31, T. 2 N., R. 14 E., at an altitude of 2,850 feet. (See No. 52, fig. 5.) The property now consists of the Soulsby, Johnson and Bradbury, Platt, Gilson, and Churchill quartz claims and three mill sites extending for half a mile both north and south of Soulsbyville. It is owned by J. Alden Armstrong of New York City. The Soulsby claim was located by Benjamin Soulsby in 1856 and was operated at various times by many different owners and lessees up to 1911. It will be referred to hereafter as the Old Soulsby to distinguish it from the group of mines that now bears its name.

The Old Soulsby, credited with a total output of $5,500,000, has been the largest producer in the East belt, and the Gilson, now consolidated with it, has made the fifth largest yield with an approximate output of $1,250,000; so, as now consolidated, the property has yielded at least $6,750,000, which makes it second only to the Dutch-App group of the Mother Lode as the largest producing mine in the county.

The Soulsby vein ranges in strike from N. 10° to N. 20° E. and has an average dip of about 80° E., although in some places it stands vertically or may even dip slightly to the west. The average thickness of the vein where mined was about 18 inches.

Beginning about 600 feet south of the north end line of the Soulsby claim, the vein follows the contact between diorite and a quartzite roof pendant of the Calaveras formation S. 10° W. for about 1,200 feet. It then turns slightly westward into a granodiorite and about 400 feet beyond splits into two nearly parallel branches 40 to 60 feet apart, which continue into the Johnson and Bradbury claim to the south. The easterly branch has been followed on the second level of the mine for 550 feet and the westerly branch 250 feet from their junction. The easterly branch and the main vein make a continuous fissure for 2,100 feet.

The vein is developed by the Davidson, Flat Rod, and Central shafts, in the order named, from north to south. All three shafts are now caved at their collars, and the mine workings are filled with water. The Davidson shaft is reported to have followed the vein on an incline to a vertical depth of 550 feet and to have had seven levels. The Flat Rod, whose collar is higher on the hill, is said to be 450 feet deep. The Central shaft extends below the ninth level on the inclination of the vein and probably reached a vertical depth of about 750 feet.

Old mine maps indicate that the most extensive stope was between the Flat Rod and Central shafts and that the ore bodies raked decidedly northward. All mining was confined to the Soulsby vein, and only one crosscut was run; this extended 375 feet west from the fifth level near the Davidson shaft to the Wheal-Perran vein, which was drifted on for about 250 feet without disclosing ore bodies.
Although its mineralization was erratic, the Soulsby vein has yielded about $1,000,000 per 100 feet of depth from an average width of only about 18 inches.

The Platt claim and the Gilson adjoining the Soulsby on the south were formerly worked as one mine and were credited with a total output of $1,250,000. The principal workings are on two nearly parallel veins called the East and West veins, whose general strike is about N. 20° W. Both are in the granodiorite from 60 to 100 feet apart. The East vein has an average dip of 85° E. and has been developed for about 900 feet along its strike, a third of which distance is in the Johnson and Bradbury ground to the north of the Platt claim. Its northern extremity extends nearly to the south end of the Soulsby’s east branch, situated a few hundred feet to the northwest of it. The West vein has been traced for only about 300 or 400 feet opposite the central section of the East vein. Its position is such that it could be an extension of the Soulsby east branch.

The East vein is developed by the Pennsylvania shaft, which is almost in the center of Soulsbyville, and by the Spider shaft, about 375 feet south. The Pennsylvania shaft is vertical and is reported to be 520 feet deep with eight levels. Ore bodies were mined on this vein for about 350 feet north and 400 feet south of the shaft and to a depth of 500 feet. The West vein was mined through crosscuts from the Pennsylvania shaft and is said to have had a rich ore body on the 500-foot level, which pinched to an unprofitable stringer on the level above. No ore of consequence is said to have been discovered below the 500-foot level in either vein. The ore shoots in both veins raked northward, as in the Soulsby and Black Oak veins. A fault striking about N. 40° E. and dipping about 70° SE. cuts the West vein on the 300-foot level near the Pennsylvania shaft and the East vein at a depth of about 550 feet. The fault is reported to be minor and to have caused slight displacement of the vein.

East crosscuts, one 300 feet long from the 800-foot level at the Pennsylvania shaft and another 200 feet long from the 200-foot level 400 feet north of the shaft, failed to disclose commercial ore bodies in the hanging wall. The Spider shaft at the south end of the workings on the East vein was an air shaft extending to the surface from the 200-foot level. Although the Pennsylvania workings are reported to have yielded much coarse gold in high-grade ore, it seems probable that most of the output was from fine gold contained in the sulfides.

About 800 feet south of the Spider shaft is the Platt shaft, now choked with debris and probably caved. It is reported that this shaft was sunk to about 300 feet on a 2-foot vein on which there are drifts of 100 feet or so in each direction. As this vein strikes nearly due north and directly toward the Spider shaft, it may be a continuation of the East vein. The Platt vein was mined as a separate operation, and its workings have no connection with those of the Pennsylvania shaft. Ore from the Platt workings was treated in a little mill on the hillside below the shaft, but it was presumably of low grade, as no records concerning it are now available.

Southwest of the Platt shaft a crosscut adit 719 feet long was driven southeasterly into the hill to prospect the north end of the
Gilson claim. This adit, called the water tunnel because it now furnishes water for domestic use in Soulsbyville, is almost entirely in granodiorite but intersects a few basic dikes and an occasional narrow pegmatite. A 4-inch quartz vein carrying $5 to $6 in gold per ton is reported to have been found in the face of this adit, but no commercial ore bodies were found.

On the Churchill claim to the west of the Johnson and Bradbury ground, a vein parallel to the Soulsby has been traced for 600 feet and opened by crosscut adits into the hill at both extremities. Where prospected, its gold content was not large enough to warrant mining.

**BLACK OAK**

The Black Oak mine, located in 1878, is 1 mile west of Soulsbyville in sec. 36, T. 2 N., R. 15 E., at an elevation of 2,750 feet. (See No. 51, fig. 5.) It comprises the Black Oak, Live Oak, White Oak, and Carra claims and the Carra fraction. It is credited with a total output of approximately $3,500,000 and is the second largest producer of the mines of the East belt.

The Black Oak vein strikes N. 15° E. and dips 60° to 70° W. It ranges in width from 2 to 20 feet and has several branches into the hanging wall. It occurs in granodiorite and is developed by a shaft following the inclination of the vein to the 18th level, where a 150-foot winze connects with the 19th level having a vertical depth of approximately 1,700 feet. The vein is commonly 6 to 8 feet wide, and the ore consists of ribbon quartz containing about 0.75 ounce gold per ton associated with pyrite, pyrrhotite, galena, sphalerite, and a little chalcopyrite. These sulfides usually constitute 3 to 4 percent of the ore and yield a concentrate containing about 7 ounces of gold per ton.

The ore shoot is approximately 800 feet long on all levels and is remarkably uniform even to the depth of the 19th level, where it pinches and becomes too narrow to be mined, although the gold content of the ore is said to remain quite constant. It rakes north similar to the ore shoots of the Soulsby mine. At the surface most of the shoot is south of the shaft but, due to its rake, the entire shoot is north of the shaft on the 18th level. Stopes maps indicate that about three-fourths of the developed area on this shoot has been mined.

A fault striking N. 55° E. and dipping about 75° N. cuts the vein north of the shaft, and the north segment of the vein has moved west relative to the south segment. On the 1,300-foot level 385 feet north of the shaft the fault displaces the vein 110 feet to the west, but on the surface the horizontal component of the displacement is about 200 feet. The fault is reported to show a moderately heavy gouge in the mine workings. The best ore is said to have been found in lenses at the intersections of diorite dikes with the vein in the vicinity of the fault. These dikes are 1 to 2 feet wide, strike N. 55° E., and have vertical dips. In the recent operation of the mine the ore was treated in a 20-stamp mill, and the pulp from the amalgamation plates was cyanided.
The Draper mine is a mile west of Soulsbyville in secs. 35 and 36, T. 2 N., R. 15 E., and adjoins the Black Oak mine on the northeast. (See No. 50, fig. 5.) It is credited with a total output of about $1,000,000.

There are four parallel veins on the property striking from N. 10° to N. 20° E. and with dips ranging from 80° E. to 80° W. Of these veins the Draper is the only one on which any considerable development work has been done. It has been mined for 600 feet along its strike and is opened by an inclined shaft 630 feet deep with levels every 100 feet to the 600-foot level. The vein has an average width of about 18 inches but swells to 2 feet or pinches to a mere stringer of an inch or less. The ore contains gold associated with pyrite, pyrrhotite, sphalerite, and galena. The upper levels of the mine were operated profitably, and recently a high-grade ore shoot was discovered and mined in a winze below the 600-foot level.

Both walls of the vein are granodiorite, which is cut at frequent intervals by narrow diabase and pegmatite dikes, none of which seem to have affected ore values. In some instances the diabase dikes are later than the vein and intersect it. The walls of the vein show alteration, and in places the fissure is not completely filled with quartz. It has been noticed in mining that the westerly dipping and vertical portions of the vein are likely to be barren and that the best ore is found in the easterly dipping sections. The mine was not in operation when visited in the summer of 1938.

The United Mines comprise nine patented claims, including the Grizzly, Lady Washington, Dead Horse, Eureka, New Albany, North Albany, and Side Wiper, on the North Fork of the Tuolumne River in secs. 4 and 9, T. 1 N., R. 16 E., about 1 mile east of Tuolumne. (See Nos. 101–104, fig. 5.) Of these claims, the Grizzly and New Albany have been the largest producers and are credited with outputs of $1,500,000 and $200,000, respectively.

The principal veins—the Dead Horse and New Albany—are roughly parallel and strike N. 35° to N. 40° W. The New Albany vein lies east of the Dead Horse and dips 55° to 60° NE. It has an average width of from 3 to 5 feet and lies along the contact of granodiorite on the east or hanging-wall side and black carbonaceous slate of the Calaveras formation on the west or foot wall. The chief development of the mine is by the New Albany inclined shaft, 6 by 10 feet in the clear and 1,050 feet deep, and by several adits on the vein. Two principal ore shoots, 120 and 200 feet long, respectively, and raking to the south, have been stopped from the 700-foot level to the surface. These shoots are said to have been present at the intersection of the vein with diorite dikes. The walls of the vein stand well, and little timbering is required. The ore carries about 1 percent pyrite and galena. When the mine was last operated in 1914 the ore was treated in a 10-stamp mill. It was reported that two-thirds of the gold was recovered in the stamp batteries and one-third on the plates. The sulfides are said to contain 2 ounces of gold per ton but were not saved, as they would not pay for concentration, shipment, and treatment at the old price of gold.
The Dead Horse vein in its southeast section lies along the contact of the granodiorite and the Calaveras formation, but to the northwest it passes into the granodiorite. It has been worked extensively through two adits on the Lady Washington claim and by two inclined shafts on the Grizzly and Dead Horse claims, which are 1,000 and 2,100 feet deep, respectively. For the first 2,400 feet the main adit on the Lady Washington claim is a crosscut to the vein, which it intersects at an inclined depth of 1,160 feet. Thence it becomes a drift on the vein for 900 feet to the northwest. The vein ranges in width from 1 to 5 feet. Three principal ore shoots, two of which were 300 feet in length and 3 feet in average width, are reported to have been stoped from the surface to the 1,400-foot level. The best ore in these shoots is said to have been that along the granodiorite contacts with the vein, which seldom persisted for horizontal distances of more than 60 feet. The ore is quite similar to that of the New Albany vein, containing 1 or 2 percent pyrite and a little galena. It was treated in a 20-stamp mill, the pulp from which was concentrated on Frue vanners. The concentrates are said to have contained about 3½ ounces of gold per ton. Later a 50-ton cyanide plant was erected, but it was not effective. From 1919 to 1921 the Grizzly Mining Co. deepened the Dead Horse shaft 300 feet and did over 1,000 feet of underground development on the vein without discovering commercially important ore bodies.

BUCHANON

The Buchanon mine is about 4 miles, in an airline, southeast of Tuolumne between Hunter Creek and the Tuolumne River, in secs. 26 and 27, T. 1 N., R. 16 E. (See No. 110, fig. 5.) The mine was located in 1856 and is credited with a production of $600,000. The vein strikes NE. and dips about 45° SE. It is in Calaveras slate and is made up of three main bands of quartz separated by layers of black slate, the whole having an average width of 20 feet. The ore is ribbon quartz and contains about 1½ percent sulfides, consisting largely of pyrite but carrying a little galena and chalcopyrite. It is reported to contain 0.25 to 0.75 ounce of gold per ton, and the sulfide concentrates range in gold content from 3 to 10 ounces per ton. The quartz band on the hanging wall is said to contain the best ore. Three ore shoots have been developed, the largest being about 200 feet long. Principal development is by an inclined shaft to the 500-foot level where, 300 feet from the shaft, a winze paralleling it is sunk to the 700-foot level. In the early days the property was equipped with a 20-stamp mill having Frue vanners for concentration of the sulfides, which were roasted and chlorinated locally.

PROVIDENCE

The Providence mine is in the canyon on the south side of the North Fork of the Tuolumne River, 2 miles southeast of Tuolumne in sec. 9, T. 1 N., R. 16 E. (See No. 106, fig. 5.) The mine comprises the Providence, East Providence, Consuello, East Consuello, and Good Enough claims, with a total of 90 acres. It was worked in a small way before 1897, but its principal period of production was from that year to 1908, and it has been idle since 1917. The total yield from the property is said to approximate $700,000.
The vein really consists of two parallel veins a few feet apart and is a continuation of the Eureka-Dead Horse lode. It strikes N. 8° E. and dips 45° E. Near the surface the veins are in black slate of the Calaveras formation, but at depth the hanging wall becomes limestone and granodiorite.

The mine is developed by a 1,300-foot inclined shaft on the foot-wall vein with levels at 100-foot intervals, most of the workings being north of the shaft. There are drifts on the veins with a maximum length of 1,050 feet. From the surface to the 700-foot level the ore shoots were in the foot-wall vein, but between that level and the 1,100-foot level they were in the hanging-wall vein and have been stoped from that level to the surface.

The ore contains about 1½ percent sulfides consisting principally of pyrite and a little galena. During late operations it is said to have averaged from 0.5 to 0.75 ounce of gold per ton. The ore was treated in a 10-stamp mill, and two Wilfley tables were used to recover concentrates said to contain 4.5 to 5 ounces of gold per ton.

CONFIDENCE

The Confidence mine, consisting of the Confidence, Independence, Little Jesse, and Plow Boy claims, is situated at Confidence, 13 miles northeast of Sonora, in sec. 10, T. 2 N., R. 16 E. (See No. 13, fig. 5.) It is in the granite area east of the Calaveras formation at an altitude of about 4,000 feet. The mine has been one of the largest producers in the county and is credited with a total yield of approximately $3,250,000.

The Confidence vein strikes N. 14° W., dips about 25° E., and ranges in width from a few inches to 15 feet. It usually is accompanied by a light-colored dike rock, sometimes pale green due to chlorite. The walls of the vein are decayed to a depth of nearly 300 feet along its dip but then become normal granodiorite. The ore extracted early in the history of the mine is said to have averaged better than 0.5 ounce of gold per ton, and as shipments of concentrates were made to Swansea, Wales, for treatment they must have been of excellent grade. The vein is developed by an inclined shaft 810 feet deep, below which is a 265-foot winze following the vein and situated about 600 feet north of the shaft station on the 800-foot level. It is reported that all high-grade ore above this level has been stoped but that there are large reserves of ore in the mine containing 0.2 to 0.3 ounce of gold per ton, which, though formerly marginal, might now be mined at a profit. In the expectation of utilizing these low-grade reserves and developing new ore at depth, the property was re-equipped with a mining and cyanide plant in 1938; but unforeseen difficulties experienced in supporting the mine workings delayed resumption of full-time operations.

DENSMORE

The Densmore mine is 2½ miles northwest of Columbia on the south bank of the Stanislaus River in sec. 4, T. 2 N., R. 14 E. (See No. 9, fig. 5.) It is owned by Densmore Gold Mines, Inc., of which Dr. E. A. Julien of Turlock, Calif., is president and Thomas Bains of Columbia is manager.
The vein is in granodiorite and ranges from 1 to 25 feet in width but averages about 5 feet. It strikes N. 40° W., dips 38° SW., and extends south from the Stanislaus River for over a mile. Apparently it occupies a normal fault fissure, which became filled with quartz that enclosed large horses of granodiorite. Subsequent fissuring and movement resulted in another deposition of quartz accompanied by auriferous pyrite, pyrrhotite, marcasite, and occasional sphalerite and galena. Although there is little free gold and it is very fine, much of the ore mined during early operations averaged 0.8 ounce of gold per ton, the concentrates containing 7 to 12 ounces of gold per ton.

This vein was worked before 1900 by Lane and Hayward. It is developed by five adits, from No. 1 adit near the river to No. 5 adit high on the hill, and by a 500-foot shaft, which connects with No. 3 adit. The ore is in large lenses, which rake toward the river. The largest stopes are between the No. 5 and No. 3 adits, through which the ore was mined. No. 3 was the main working adit during early operations but is now closed by a cave. A second shaft, 125 feet deep, whose collar is 400 feet above No. 5 adit, is connected with that adit by a 1,200-foot diagonal raise. All ore mined recently has been hoisted through this shaft and hauled by truck about 1,800 feet to the mill, which is situated on the side hill just below the portal of the No. 5 adit.

The mill has a capacity of 50 tons per day and is equipped to save the sulfides by flotation. Its machines are operated electrically. In September 1938 the mill heads averaged about $10 per ton. Ore from the trucks is dumped into a 100-ton coarse-ore bin, which feeds an 8-by 10-inch jaw crusher that discharges a minus ¾-inch product to a 100-ton fine-ore bin. Ore from this bin is conveyed by a belt feeder to a ball mill 64 inches in inside diameter by 4 feet in length, driven by a 40-horsepower motor. The pulp from the mill is discharged to a Bendelari jig with a screen having ¾-inch slots. The hutch from the jig is concentrated on a high-speed (Rawhide) table, and the concentrates, containing about 16 ounces of gold per ton, are delivered to a concentrate storage bin.

The overflow from the jig goes to a Dorr-type classifier in closed circuit with the ball mill, and the overflow from the classifier goes to a 44-inch Fagergren cleaner cell, which makes a concentrate that flows to settling boxes and thence to a Dorroco filter; this reduces their moisture content to about 6 percent, in which condition they are discharged to the concentrate storage bin for shipment to the smelter at Selby, Calif. The tailings from the cleaner cell are treated in four 28-inch Fagergren rougher cells, the concentrates from which are discharged to a sump and returned to the classifier by a sand pump. The tailings from the rougher cells are delivered to a Diester table, which is used to check the extraction made by flotation, and any concentrates obtained are returned to the classifier by the same sand pump that handles the rougher concentrates. Very little free gold is found in the ore. Tailings usually contain $2.00 to $2.50 a ton, indicating extractions of 75 to 80 percent. Enough water is obtained from the mine to supply the mill.
Tuolumne County is famous for the number and richness of its pocket mines, which are in what is known as the Pocket belt, which lies in slates and schists between the Mother Lode and the East belt. This area is 5 to 6 miles wide and extends southeast from the Stanislaus River to beyond Jamestown and Sonora, where it gradually becomes less pronounced. Bald Mountain, 2 miles north of Sonora, is approximately in the southeast corner of the richest pocket area, Columbia being situated in its northeast corner.

Though it is not generally recognized, the Pocket belt appears to have been chiefly responsible for the preeminence of the county as a gold producer, because much of the placer gold must have originated in it. Throughout its area are widely separated, very narrow seams of quartz and calcite containing coarse gold that swell occasionally to form rich pockets. These seams do not persist individually but usually appear to have been made by very minor, almost insignificant fissuring in a period of mineral deposition favored by the presence of rich gold-bearing solutions. The pocket gold often is beautifully crystallized (see fig. 23) and frequently is associated with petzite, calaverite, and other tellurides.

The pockets almost invariably occur in very minor fissures that seldom have been at all disturbed by others, so that their origin is presumed to have been very late in the sequence of mineralization. Reports as to many of them indicate that they showed slight evidence of displacement or even of movement, and those actually seen suggest no more than a merely feeble fracturing in place.

In other respects, the nature of the Pocket belt is not noticeably different from that of the relatively barren areas to the north and south of it that also lie between the heavier fissurings of the Mother Lode and the East belt. The Pocket belt seems no more fractured or altered than these other intermediate areas. The circumstances seem to suggest a highly localized source of enrichment that was active very near the end of the long period during which the Mother Lode was being mineralized.

This type of ore deposition offers only occasional opportunity for profitable mining because of its usual lack of continuity. A rich seam may persist only a few feet and then fade out without leaving anything at all definite to follow. Although aimless exploration in the area usually proves futile, there are a few mines where the presence of some definite structure provides a basis for exploration, and the frequent discovery of pockets at or near the surface in the area has caused the development of a special class of pocket miners, who have become notably skillful in finding them. Their success has often been spectacular and has attracted much romantic interest. Some pocket mining persists and is likely to continue indefinitely.

There is striking contrast between the relatively small amount of gold mined by man from the uncertain veins of the Pocket belt, which is estimated at about $3,500,000, and the enormous treasure it contributed to nearby placers through erosion of perhaps 2,000 feet of rocks that overlaid its present surface, in which this placer gold was originally contained.
The Columbia Basin alone, whose placers were created by erosion of the pocket area, contributed more than a third of the huge total production of placer gold from the county. Erosion of the Pocket belt also appears to have caused the placers about Sonora, Gold Springs, Jamestown, Kineaid Flat, Sullivan Creek, Sawmill Flat, and several minor areas. The total value of placer gold that probably originated in the Pocket belt thus amounts to about two-thirds of the total placer production of the county.

The Bonanza pocket mine, on the north slope of Piety Hill within the city limits of Sonora, is credited with an output of over $2,000,000 and has been the richest pocket mine in California. Jackass Hill, the one-time home of Mark Twain and site of the cabin in which he lived in the late 50's, has produced more than $500,000 from the Atlas, Carrington, Chileno, Gillis, Norwegian, Santissima, Wilson and Means, and other pocket mines. Bald Mountain has yielded a million from pockets, and a score or so of smaller pocket mines throughout the belt are credited with about 2 million dollars more.

Many of these pocket mines have yielded small fortunes because of the small cost of extracting ore. Although their successful development requires special aptitude in recognizing the conditions under which the pockets occur, they are not without possibilities of profit, which should make them of interest to the experienced small operator.

Descriptions of some of the more important and typical pocket mines follow.

**BONANZA**

The Bonanza mine, situated on the north slope of Piety Hill within the city limits of Sonora (see No. 47, fig. 5), is probably the most famous pocket mine in the United States. It is said to have been discovered in 1851 by several Chileans, who in a few years took out substantial fortunes from surface workings. In the early 70's J. G. Divoll, Joseph Bray, and Charles Clark purchased the property and sank an inclined shaft in the ore zone, which they then followed down for 1,500 feet. The first big strike made by the new owners, after a few months' work, occasioned great excitement throughout central California, and the mine was named Bonanza. Its most productive period was from 1878 to 1880; and it is said that in one week during 1879, 990 pounds of gold, valued at that time at over $300,000 but now worth about $500,000, was taken out.

It is not surprising that the name Bonanza became popular in the vicinity of Sonora. There were Bonanza saloons, stores, and restaurants; James Divoll, one of the owners, was henceforth known as Bonanza Divoll; and not a few babies born at this time were likewise named Bonanza. Clark and Bray, the other two partners, died, and other local men became interested in the property. Among them were J. B. Bacon, Alonzo Colby, M. B. Harriman, Albert Johnson, Edward Kiel, and D. R. Oliver, all of whom made fortunes. The total production of the mine is said to have been more than $2,000,000.

The rich pockets of the Bonanza were found along a narrow quartz seam in a diorite dike 10 to 16 feet thick and in quartz sheatings on each wall of the dike, which strikes N. 30° E. and dips 20° to 35°
to the northwest. This dike was intruded along a contact between Calaveras mica schist on the west and limestone on the east. It is cut frequently by narrow quartz stringers and nearly horizontal small seams heavily stained with iron oxide. Generally, the pockets are found where an iron seam and a quartz crossing meet in the quartz sheathings on the walls of the dike or in its central vein. In the pockets, the native gold is associated with petzite and other tellurides and with pyrite. The mine workings are said to have been bottomed in granodiorite at an inclined depth of 2,700 feet. The pockets apparently were formed by a rich gold solution ascending in fissures that were opened along the walls and in the dike itself by slight movements subsequent to its cooling.

The assumption that the richest gold deposition of the Mother Lode came last is supported by the fact that the opening and filling of the small fissures of the pocket belt appear to be the latest geologic phenomena recorded by the local rocks.

**SUGARMAN**

The Sugarmann mine is situated on the west slope of Bald Mountain 2 miles north of Sonora in secs. 19 and 30, T. 2 N., R. 14 E. (See No. 48, fig. 5.) It is owned by Ralph H. Butler of Sonora and consists of the Sugarmann and Nigger patented claims aggregating 25.6 acres and extending nearly 2,000 feet along the Sugarmann vein. It is a pocket mine typical of those on Bald Mountain and is credited with the production of over $725,000, largely in beautifully crystallized gold associated with petzite and other tellurides. It is said to have been worked first prior to 1870 by a group of Chileans, who took out about $200,000 within a depth of 70 feet on the north end of the Sugarmann claim from the workings of the Moreles tunnel. (See fig. 22, which shows a section of the Sugarmann and Nigger workings in the plane of the vein.)

About 1875, Reeb, Suderman, and associates opened a series of ore shoots near the center of the Sugarmann claim, first with a series of inclines but later by the 800-foot Reeb tunnel driven on the vein from the west side of the mountain. (See fig. 22.) This tunnel gave access to about 150 feet of back of the central ore shoots, and $225,000 is said to have been taken from the workings. Other operators later drove the Neale, Smith, and Herold tunnels, the last 1,800 feet long and extending almost to the north end of the claim, and sank a winze on the Calico ore shoot.

The Nigger claim was first developed by a tunnel from Portuguese Gulch about 50 feet lower than the Herold tunnel, and $120,000 is reported to have been taken from backs above the tunnel in six ore shoots within a length of 240 feet on the vein. In 1928, Sugarmann Mines, Inc., of Los Angeles, sank the Nigger shaft, which inclines 62° and is 450 feet deep, and ran drifts south to cut the Nigger series of shoots on the 250- and 380-foot levels. In 18 months this company made a total production of $64,651, but in September 1929 the mine flooded and the lease was abandoned.

In 1930 the mine was unwatered and reequipped by the present owner, who took out $35,523 without further development work. Owing to failure of pumping equipment, water again flooded the
FIGURE 22.—Section of the Sugarman mine in the plane of the vein.
mine in March 1934, and it has since been worked only above the 250-foot level. Inadequate pumping equipment has been responsible for water trouble at this property, as the mine makes an average of only 180 gallons of water a minute.

The mine lies in the Calaveras formation of slates, schists, and limestone, which here strikes N. 16° W. and dips about 80° E. and is intruded by granodiorite and porphyritic dikes. The vein, which is about 30 inches wide, strikes N. 37° E., cutting the country rocks at about 70°. It is nearly vertical, dipping slightly to the west on this property but in certain other places dipping a little to the east.

The ore shoots are said to have been present only where the vein intersected a band of slate, but the vein filling in the shoots consists almost equally of shattered porphyry and quartz. There is no consistent enrichment in the shoots, all the free gold occurring in pockets.

The Herold tunnel on the Sugarman claim intersects six bands of mineralized slate, and six other slate bands have been cut similarly by the Nigger workings. Three more slate bands outcrop in Portuguese Gulch, but their contacts with the vein have been covered by a slide and consequently have not been prospected.

A fault in evidence on the Lewis claim adjoining the Sugarman on the north dips about 50° S. and is thought to bottom the early Moreles workings on the north end of the Sugarman claim, which possibly accounts for their abandonment at a depth of only 70 feet. If this fault persists with the same dip, it is estimated that it will intersect a continuation of the Nigger shaft at a depth of 1,200 to 1,300 feet, allowing a further depth of 750 to 950 feet on the Nigger slates in which ore may exist.

It is reported that otherwise the rich seams of ore do not appear to have been interrupted by later fissuring. They thus probably represent a very late epoch of mineralization, as has been observed to be the case generally where very rich ores of the Mother Lode are concerned.

NORWEGIAN

The Norwegian mine is in sec. 30, T. 2 N., R. 14 E., on the north slope of Jackass Hill just east of the Mother Lode. (See No. 16, fig. 5.) Two parallel quartz veins about 12 feet apart strike N. 12° W. and dip 55° E. Of these, the Norwegian or hanging-wall vein is 6 to 18 inches wide and the foot-wall vein is 4 to 6 inches wide. They are in a band of highly altered amphibolite schist rich in pyrite and carbonates, which is about 50 feet wide and occur near its contact on the west with Calaveras black slates, which show fluting. The veins converge at an angle of 15° or 20° with a large, barren, bull-quartz vein in their hanging-wall schist. The ore is in pockets containing native gold, petzite, and other tellurides associated with pyrite and smaller quantities of chalcopyrite and galena.

The Norwegian mine has been operated only sporadically and on a small scale since its discovery in 1851. Through development by successive operators the shaft on the Norwegian vein has been deepened to 350 feet. At one time it was hoped that enough ore, aside from pocket material, could be developed on this vein to supply
Figure 23.—Crystallized gold from Nigger Hill near Jamestown (actual size).

Figure 24.—Gold nuggets from Tuolumne River (actual size).
**Figure 25.**—Home-made chaser mill at the Gillis pocket mine on Jackass Hill.

**Figure 26.**—Hand sluicing for gold on Woods Creek near Sonora.

**Figure 27.**—Shaft through open pit, United States Lime Products Corporation, Sonora.
a small stamp mill, but this hope never was realized and the latest development work has been done in a search for pockets on the foot-wall vein.

GILLIS

The Gillis mine is on the southeast slope of Jackass Hill in sec. 30, T. 2 N., R. 14 E. (See No. 28, fig. 5.) It comprises 130 acres originally located as a homestead, but that portion of it near the summit of the hill is being prospected actively for pockets by four sets of lessees. The owner is C. A. Gillis. The principal operation is being conducted by him at the south end of the pocket zone in partnership with G. W. Holmes, W. E. Gillis, and W. E. Lilly.

Gillis formerly had taken out approximately 1,300 ounces of gold within 90 feet of the surface in this section of his ground. An additional 600 ounces of gold has been recovered by the partnership operations. One pocket, discovered in October 1937, yielded about one-fourth of this amount.

The gold shows characteristically as thin veinlets of the native metal in white calcite associated with a white talcose schist containing about 5 percent pyrite. It forms specimens of unusual beauty. Tuolumne County recently purchased about $6,000 of pocket gold from this mine for its collection of gold specimens now on exhibition at the 1939 Golden Gate Exposition.

The pockets are present along the intersections of calcite stringers with a band of talcose schist 2 or 3 feet wide, which is highly mineralized with pyrite and strikes N. 10° W. with a dip 75° E. The calcite seams or veinlets strike nearly east and west and dip 45° to 60° N., their width being usually 3 inches or less. They extend into the schist from within its diorite footwall. This diorite has a width of 200 to 300 feet. The hanging wall of the schist is a narrow porphyry dike not penetrated by the calcite fissures. A band of black Calaveras slate about 100 feet wide lies beyond the dike.

The principal workings at the Gillis mine comprise a vertical shaft 110 feet deep with a drift 80 feet south on the 75-foot level and a 150-foot drift north on the 90-foot level. There is a 32-foot winze below the latter level 110 feet from the shaft. From its bottom there is a drift 20 feet north and the same distance south. The ground above the 75-foot level south of the shaft has been stope to the surface, as has also about half the ground above the 90-foot level to the north. The yield of gold, valued at $65,000, has involved the mining of a tonnage of rock surprisingly small. During the summer it is necessary to pump about 3,000 gallons of water per day to keep the workings unwafered, but in winter two or three times this quantity must be pumped.

The richer ore from the pockets, when not retained as specimen ore, is crushed in a hand mortar and panned. The poorer ore is ground in an ingenious home-made chaser mill, shown in figure 25. In this mill the grinding is done by two steel balls about 10 inches in diameter, which are propelled around the periphery of the mill by two arms from a revolving central spindle. Quicksilver is added in the mill, and the pulp discharges through a 30-mesh screen at one side to an amalgamating plate about 4 feet long. An excellent recovery of the free gold in the ore is made by this method.
At this property the rich pockets unquestionably have been formed by deposition of gold-bearing solutions subsequent to a very minor fissuring that is the latest breaking observable.

CHILENO

The Chileno mine on Jackass Hill is in sec. 27, T. 2 N., R. 14 E., and belongs to the Sharon Estate, Palace Hotel, San Francisco. (See No. 27, fig. 5.) The vein is a stringer lead of quartz and calcite in a wide band of highly silicified amphibolite schist just east of the Mother Lode. Besides occasional pockets containing native gold and tellurides, commonly valued up to $1,000, it carries much coarsely crystallized pyrite that occasionally makes ore, although the pyrite itself contains only $18 to $22 a ton in gold and is therefore too low in grade to be shipped even as a concentrate.

In 1922 the Chileno mine and eight other neighboring properties on Jackass Hill were taken under option by the Nevada Wonder Mining Co., and a shaft was sunk on the Chileno vein, with an inclination ranging from 45° to 70°, to a depth of 450 feet. At a depth of 230 feet, the north end of a lens of ore 175 feet long and having a maximum width of 15 feet near its center was cut. This lens lay south of the shaft and was staked virtually to the surface. It averaged 0.27 ounce of gold per ton contained almost wholly in pyrite, which constituted about one-fifth the weight of the ore.

From the bottom of the shaft a crosscut was run to the west for 110 feet, and a drift to the north from its face entered a second lens of ore at 120 feet. This lens was drifted on for 150 feet and staked up for 40 feet. The ore in the lens is said to have averaged 0.25 ounce of gold; but, as in the south lens, very little of the gold was free. As a mill run on 600 tons yielded only $1.03 per ton the option on the mine was abandoned.

In 1924 the Mark Twain Mining Co. leased the property and continued development and mining, but the recovery from 3,000 tons of ore treated in a 5-stamp mill was too small to pay expenses, and a few years later the lease was abandoned.

Excepting in the pockets, the gold is contained almost wholly in pyrite, which, when concentrated, contains only about $20 per ton and is far too low in value to stand shipping and smelting charges. Accordingly, if the property is to be developed other than as a pocket mine, provision must be made to cyanide at the mine either the ore itself or the pyritic concentrate.

ATLAS

The Atlas mine on Jackass Hill, a mile north of Tuttletown, is in sec. 25, T. 2 N., R. 14 E. (see No. 25, fig. 5), and belongs to Bert Stoner of Sonora. It adjoins the Chileno property previously described and presents identical conditions as to the occurrence of rich pockets and low-grade pyritic ore. In the early days the surface was worked for pockets for a length of 1,000 feet along the vein—a stringer lead in highly silicified amphibolite schist. The vein ranges from 10 to 30 feet in width and contains 5 to 10 percent pyrite. It is developed by an inclined shaft 450 feet deep. From
time to time the property has been credited with a substantial production, but it was not in operation when visited in the summer of 1938.

From 1913 to 1916 a few hundred tons of carefully selected ore is said to have yielded from $13 to $55 per ton. It was treated in a 10-stamp mill and the pulp from the amalgamation plates was concentrated, but the concentrate obtained was of very low grade, as usual in all mines of Jackass Hill. The rich seams making gold pockets probably are of a much later generation than the fair-size shoots of low-grade ore whose gold is contained in pyrite.

In 1928 the Atlas was among the group of mines with the Chileno worked by the Mark Twain Mining Co. and is said to have produced about $10,000 from pockets during the tenure of this company. From 1929 to 1931 the mine was worked by F. H. Bernard, who reported a substantial production in 1931.

**SHORE**

The Shore mine is 1 mile west of Jamestown on the south slope of Table Mountain in the northwest quarter of sec. 10, T. 1 N., R. 14 E. (See No. 73, fig. 5.) It consists of about 31/3 acres of patented ground and is owned by the estate of the late J. B. Shore of Jamestown. It is not to be confused with a mine of the same name lying about 1 mile west and adjoining the Crystalline mine. Shore is said to have recovered about $25,000 in gold from numerous pockets within a few feet of the surface, these discoveries having yielded from a few hundred to several thousand dollars each. After his father's death, Frank Shore continued mining for pockets and has taken out $17,000 more, one pocket, discovered in 1933, having yielded $11,000. Much of this pocket gold has been beautifully crystallized, and splendid specimens, some in the form of ribbons up to 3 inches wide and 1 1/2 feet long, have been obtained. A natural-size photograph of one of these unusual pieces of ribbon gold is shown as the frontispiece of this bulletin. All these pockets have been found in the oxidized zone along the foot and hanging walls of a zone of highly altered gray slate and ankerite-marioposite, both containing much pyrite and interlaced in every direction with quartz veinlets that clearly are of two different ages. The older quartz is intimately associated with ankerite, and although it carries considerable pyrite and a little gold the content of the latter generally is not large enough to make ore. The more recent quartz, which characteristically is present as veins up to 2 feet in width along the walls and as cross veins through the mineralized zone, is the source of the commercial ore and of the beautiful specimens of gold found in pockets along the walls.

As exposed in the underground workings, the mineralized zone is 50 to 60 feet wide and is bounded on both foot and hanging walls by black slates of the Calaveras formation. This zone strikes to the northwest and dips 70° to the northeast. On the foot wall is a well-defined gouge along which veins of the more recent quartz attain a width of 2 feet in places. The black slate of both the foot and hanging walls also is sometimes penetrated by veinlets of this same quartz. The gold content of the mineralized zone is seemingly.
proportionate to the number of veinlets of the more recent quartz in the rock. Samples of the mariposite-ankerite rock well seamed with the late quartz contained from 0.1 to 0.2 ounce of gold per ton.

A highly acid dike 6 feet wide, which can be traced on the surface for three-quarters of a mile, follows the mineralized zone and seemingly conforms with it both in strike and dip. It intruded the zone after the formation of the mariposite-ankerite rock, and several smaller dikes 4 to 10 inches wide, which may be offshoots, have been cut in the foot wall by the mine adit. There is also a second dike 2 to 3 feet wide paralleling the larger dike about 60 feet east of it in the hanging wall. The larger dike, in common with the mineralized zone it traverses, has been shattered by earth movements, and the countless fissures that were formed have been filled with quartz. This fracturing was so intense that the dike was broken into small fragments, the whole mineralized zone having been converted into a stockwork.

In his search for pockets, the present operator is keeping in view the ultimate development of milling ore, and the mine now has about 700 feet of underground workings, consisting of a 300-foot adit and several crosscuts and raises. The adit has its portal in the foot wall and runs about 150 feet N. 15° W. until it intersects the mineralized zone. It then turns west and follows along the foot wall. The face of the adit is as yet, however, only about 90 feet below the surface, and the workings are almost wholly within the oxidized zone. The carbonates that impregnated the mineralized zone have, in large part, been leached in the horizon of the workings, and the shells of quartz and mariposite that remain form a soft and easily minable material. The face of the adit is in or near the unoxidized zone, and it is interesting to note that small quantities of native copper can be obtained by panning the foot-wall gouge and ore in this vicinity, showing that acid copper solutions presumably derived from oxidation of a little chalcopyrite in the ore above were reduced here at the top of the oxidized zone.

Frank Shore and his brother work the property alone. Air for drilling is supplied by a small compressor run by a gasoline engine.

PLACER MINES

GENERAL REVIEW

The placers of Tuolumne County were the richest in California, and probably nowhere in the entire world has so much placer gold been derived from an equal area. The following table, showing the value of gold shipped from the principal placer localities of the county by express companies prior to 1899, is but a partial statement of the yield, as other unrecorded millions were taken from the placers.

This table is abstracted from a book prepared for the San Francisco meeting of the American Institute of Mining and Metallurgical Engineers in 1899, at which time records of gold shipments by Wells Fargo & Co., later destroyed in the San Francisco fire, were still available.
Express shipments of gold from principal placer localities in Tuolumne County

Columbia and Springfield ........................................... $ 55,000,000
Groveland, Deer Flat, and Big Oak Flat .......................... 25,000,000
Sonora ................................................................. 11,000,000
Don Pedro Bar, Jacksonville, and Stevens Bar .................. 9,000,000
Gold Springs and Nigger Gulch ................................... 7,500,000
Shaws Flat ............................................................ 6,000,000
Campo Seco ................................................................ 5,500,000
Browns Flat .............................................................. 4,500,000
Poverty Hill and Chili Camp ....................................... 4,000,000
Pine Log, Experimental Gulch, and Italian Bar ................. 3,500,000
Yankee Hill and Knickerbocker Flat ................................ 3,500,000
Jamestown ................................................................ 3,500,000
Sullivan Creek ............................................................ 3,000,000
Kincaid Flat .............................................................. 3,000,000
Chinese Camp ............................................................ 2,500,000
Sawmill Flat ............................................................... 2,500,000
Algerine .................................................................. 2,500,000
Mormon Creek ........................................................... 2,225,000
Montezuma and Precipice Gulch ................................... 1,500,000
Table Mountain Humbug ............................................. 500,000
Horseshoe Bend ........................................................ 300,000
Moccasin Creek .......................................................... 150,000

Total allocated output .................................................. 151,175,000


Other prominent producing localities were Six-Mile Bar, Willow Bar, Green Spring Run, Byrnes Ferry, Central Ferry, Peoria Flat, Morehouse Bar, Confidence and Davis Flats, Blanket Creek, Turnback Creek, Cherokee, and Rough & Ready.

All of the allocated output of $151,175,000 listed above was made prior to 1899. Taking into account the additional production of the camps for which the output is not specified and also the known placer production of the county from 1903 to 1937, which amounted alone to about $800,000, the total placer-gold production of the county might reasonably be estimated as approximately $155,000,000.

In the early days the streams and gulches in and adjacent to the Mother Lode district were very rich in gold, but the gravels in the limestone area at Columbia and Springfield surpassed them all and carried gold in fabulous quantities. Here, in a flat basin less than 2 miles in diameter, over $55,000,000 was recovered between 1853 and 1870 largely by hand methods from shallow gravels that filled potholes and crevices in the eroded limestone bedrock. The placer deposits of the Columbia Basin and the method of their formation will be discussed later. It suffices here to state that probably nowhere in the world, not excepting the famous Eldorado and Bonanza Creeks of the Klondike or the Third Beach Line at Nome, were the deposits so rich.

It may be of interest to draw a few comparisons between the yield of the placers of Tuolumne County and those of famous placer districts elsewhere. According to the Federal Geological Survey, the whole Seward Peninsula of Alaska, embracing the Nome district

and eight other principal placer regions with a total area approximately as large as all the placer districts of California combined, produced $104,825,000 in gold from the first output in 1897 to 1936, inclusive. This is less than 70 percent of the production of Tuolumne County alone. The rich Fairbanks-Richardson district, outranking all other individual districts of Alaska in its output of placer gold and closely approximating the placer districts of Tuolumne County in size, has yielded $105,741,500 from the time of its discovery in 1903 to 1936, inclusive. This, again, is far surpassed by the production of Tuolumne County.

The gold in the placers of Tuolumne County was very coarse, and it is unlikely that any other area of comparable size ever yielded so many large nuggets. The following table lists a few of them:

<table>
<thead>
<tr>
<th>Weight, Troy Pounds</th>
<th>Locality</th>
<th>Date Found</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown Quartz Boulder with 135 Pounds of Gold:</td>
<td>Holden's Garden</td>
<td></td>
<td>Sold for $30,000.</td>
</tr>
<tr>
<td>75</td>
<td>Woods Creek</td>
<td>1848</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>Columbia</td>
<td>1854</td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>¾ mile east of Columbia</td>
<td>1848</td>
<td>Valued at $5,500, so evidently contained 4 or 5 pounds of quartz. Worth $5,750; evidently contained some quartz.</td>
</tr>
<tr>
<td>50</td>
<td>Columbia</td>
<td>1854</td>
<td></td>
</tr>
<tr>
<td>37½</td>
<td>Sonora</td>
<td>1850</td>
<td>Worth $7,000.</td>
</tr>
<tr>
<td>35</td>
<td>Columbia</td>
<td>1854</td>
<td></td>
</tr>
<tr>
<td>33½</td>
<td>Gold Hill</td>
<td>1859</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Sonora</td>
<td>1850</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Pine Gulch</td>
<td>1854</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Wood's Diggings</td>
<td>1851</td>
<td>Worth $5,000.</td>
</tr>
<tr>
<td>22½</td>
<td>Holden's Garden</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Nuggets up to a pound in weight were very common, and even today some of fair size are found occasionally. Figure 24 shows the actual size of three nuggets, with a total weight of 14½ ounces, recently found in the county. The two larger nuggets came from Stevens Bar in the Tuolumne River—the smaller one from Woods Creek, almost within the city limits of Sonora.

Over 95 percent of the huge yield of placer gold from Tuolumne County was obtained from Quaternary gravels, the gold content of which was derived in considerable part from erosion and reconcentration of gravels of the earlier Tertiary streams. However, the total production of gold from original Tertiary gravels within the county probably has not exceeded 5 or 6 million dollars, derived chiefly from surface placers at Chinese Camp and Montezuma and from drift mines on the Table Mountain channel.

Today the placer deposits of the county rapidly are approaching exhaustion. Although thousands of men were engaged in mining the richer gravel by hand methods from 1853 to 1870, the depletion of the richer deposits led to a gradual desertion of the placers, until in the late 70's the output of placer gold had dwindled to a few hundred ounces a year. Accurate statistics of the placer-gold production before 1903 are not available, but as far as known it was not until 1932 that the annual placer output of the county again
became as great as 1,000 ounces. Since then, however, under the stimulus of the higher price of gold, the output has risen steadily, until in 1937 it was 5,720 ounces valued at $200,285. (See fig. 4.)

Virtually all of this recent production has been derived from power-shovel or dragline operations on gravel too low in grade to have been worked profitably at the old price of gold. In the summer of 1938, five draglines with floating washing plants were operating in the county. Of these, two were working on Woods Creek above the Eagle-Shawmut mine, one on Woods Creek at Jamestown, one on Moccasin Creek, and one at the Mencke-Hess placer near Chinese Camp. In the early fall a small experimental plant in the nature of a floating power shovel was installed on the Tuolumne River near Jacksonville. There are few gravel areas remaining within the county, however, that are suitable for dragline operations and their exhaustion apparently is a matter of only a few years.

Areas suitable for dredging are likewise lacking, though Quaternary gravels are being dredged successfully just beyond the western boundary of the county at La Grange in the alluvial fan of the Tuolumne River where it issues from the mountains. Though some small areas of rich gravel that were overlooked probably will yet be discovered within the county, and other small areas, which formerly were unworkable because of water conditions, may perhaps now be worked at a profit, the remaining placer-gold resources of the county are very limited and their virtual exhaustion within a few years may be expected.

“Sniping” for gold along the creeks and rivers of the county was done by several hundred itinerant prospectors during the year, and a few of the more fortunate or more skillful among them made fair wages, although in general the average recovery of gold probably amounted to less than 75 cents per day per person. Figure 26 shows a hand-sluicing operation on Woods Creek just north of Jamestown that was better organized than the average. A small gasoline pump was utilized to keep seepage water from the creek out of the pit, and the two partners reported that they recovered over $400 in gold in less than two weeks from a small bank of gravel that had been overlooked by early miners. Such incidents, however, are infrequent.

COLUMBIA BASIN

Nowhere in the world has so much gold been taken from so small an area of placer ground as in the Columbia Basin of Tuolumne County. There, on an open flat, within a radius of a single mile, $55,000,000 in nuggets and gold dust was panned, rocked, or sluiced by miners from 1853 to 1870 and shipped by the Wells Fargo and local express companies. At the present price of gold, recorded shipments from this basin thus represent more than 93 millions of dollars, but gold unaccounted for in the records of express shipments, which was produced before express service began or was carried away in the pokes of miners, probably would raise this total to 100 millions.

Today, however, there is no active mining within the basin, where only the white pinnacles of the deeply eroded limestone bedrock serve as monuments to the once thriving placer industry and to the eager horde of anonymous adventurers who hopefully toiled on the bedrock
between them. The town of Columbia, once proposed as the site for the State capital, an honor said to have been lost by a single vote, is today a somnolent village claiming interest only by its few relics of a romantic past. The smaller placer camps at Gold Spring and Springfield on the circumference of the basin have virtually vanished.

This richest of the world's known placers resulted from a fortunate combination of geologic causes. Natural riffles of irregularly eroded white, crystalline, limestone bedrock about 1½ miles wide lay in the path of a stream that carried the debris of gold-bearing rocks. The source of the alluvial debris was near-by in slates such as are seen on both sides of the limestone. These slates contained and still exhibit numerous narrow seams and stringers of gold-bearing quartz with occasional small pockets of exceedingly rich ore. Erosion of the slates, then standing at a considerably higher elevation than at present, by tributaries of the main stream finally brought down to it the gold and quartz together with the softer slates of the hills, which distegrated more readily. Much of the gold was retained on the limestone riffles of the Columbia Basin, and the larger fragments of quartz sank into pot holes, to mill about until worn away by attrition.

It is possible, of course, that besides the quartz stringers and occasional rich pockets such as are still found in the slates, some large, rich ore shoot may have been eroded away, contributing some of the many large nuggets found in the placers of Columbia Basin; yet in a region of such rich pockets as have been found in the vicinity of the Columbia Channel they alone could account for the coarse gold and large nuggets so abundant in its placers.

Incidentally, it may be mentioned that many bones of the mastodon and of early forms of the elephant and horse were found by the miners in the gravels of the basin, as well as stone and bone implements of some prehistoric race.

The erosion tributary to the Columbia Basin occurred in two periods. The first was in the prevolcanic Tertiary time, when, according to Lindgren, "The drainage was evidently northward by Gold Spring toward some point of the deep channel of the Tertiary Calaveras River near Douglas Flat."

This early stream bed, known as the Columbia Channel, has been traced from a source with a present elevation of 2,060 feet at Yankee Hill, south along Woods Creek, then west across the low divide southwest of Columbia to Mormon Creek, and thence north to Gold Spring, where its elevation is 2,150 feet. Beyond there the channel has been cut away by the canyon of the Stanislaus River, but on the opposite side of the river, near the junction of the Moaning Cave road with the Parrott Ferry-Vallecito highway, at an elevation of about 2,000 feet, there is a remnant of an ancient channel exposed by erosion and filled with gravel composed largely of quartz. It was mined in the past with a reported yield of nearly a million dollars. The altitude and direction of this channel remnant correlate it almost exactly with the Columbia Channel, supporting Lindgren's conclusion that in early Tertiary time the drainage of the Columbia Basin was to the north through a tributary of the Tertiary Calaveras River.

During the andesitic epoch of the late Tertiary the Columbia Basin, in common with the rest of the countryside, was deeply blanketed by tuffs. When a new drainage of the region was developing, the stream that flowed through Table Mountain Channel stole the drainage of the Columbia Basin (see p. 74).

Erosion of the andesitic tuffs during Pliocene and Quaternary time removed most of them. As soon as bedrock was reached, erosion of the gold-bearing veins and concentration of their gold were renewed; but as weathering progressed and the Table Mountain Channel, with its protective capping of lava, was converted into a divide, the drainage of the Columbia Basin was diverted again and today flows into the Stanislaus River through Mormon Creek. Except in minor features, however, the present land surface of the Columbia Basin probably is about as it was in Eocene time.

As the gravels of the basin have been formed locally, they consist largely of subangular and little-worn fragments of quartz. These gravels with their accompanying gold found ideal lodgment in the crevices and potholes of the eroded limestone bedrock and there remained until discovered in 1853.

The early miners excavated the gravel by hand from between the limestone pinnacles of the bedrock and hoisted it in buckets by derricks to raised platforms at the head of sluice boxes. Thousands of men worked in the diggings, and the yield per cubic yard of clay and gravel they handled was enormous. The gold was very coarse, and the finding of a nugget weighing a pound or so was so usual as to attract little attention. The table on page 70 lists five nuggets weighing from 33 1/2 to 72 pounds found at Columbia during the early days. However, the early miners were handicapped by lack of drainage for their workings in the flat basin, and as they were unable to mine much below the water level there are probably many deep pockets and holes in the limestone that have never been bottomed.

One such hole, to the east of Columbia, was cleaned out to a depth of over 200 feet, only to disclose an underground torrent at its bottom. Large springs thought to be outlets of subterranean streams flowing through fissures in the limestone gave names to the early placer camps at Gold Spring and Springfield on the rim of the basin.

Figure 19 (p. 43) is a photograph of a typical section of the limestone bedrock of the Columbia Basin as it appears today. This picture was taken from United States Highway 49, looking northeast toward Columbia, with the spire of St. Anne's Church in the background. The land on which this church stands and the little cemetery that adjoins it today constitute the only tract of unmined ground in the whole basin.

**TABLE MOUNTAIN CHANNEL**

Drift mining of gravels from the buried channels of ancient rivers, as described in Bulletin 418, has been much more important in Calaveras County than in Tuolumne. There are only two such channels in the latter—the Tertiary Tuolumne River and Table Mountain Channel.

Table Mountain Channel, also called, as to its upper reaches, the Cataract Channel, was part of a new drainage system developed in
the debris from andesitic eruptions of the early Neocene period that had filled the valleys of previously existing streams. It begins near the headwaters of the Middle Fork of the Stanislaus River. Cutting through the easily eroded tufts and breccias, it took the general southwesterly course shown in figure 2, crossing the westerly course of the earlier Tertiary drainage.

Rising in Tuolumne County, Table Mountain Channel crosses the North Fork of the Stanislaus River into Calaveras County 2 miles southeast of Big Trees. There it swings to the southwest and continues down the west bank of the Stanislaus River to Parrott Ferry, intersecting on its way the older Tertiary Calaveras River at nearly a right angle a few miles east of Vallecito. Recrossing the canyon of the Stanislaus into Tuolumne County at Parrott Ferry, the channel runs southeasterly toward Sonora for about 3 miles and then swings almost at a right angle to the southwest to cross the Stanislaus again about 5 miles above Knight's Ferry. Thence it follows the west bank for 2 or 3 miles and again recrosses the river into Tuolumne County; but its course cannot be followed farther downstream, though it probably emptied into the Ione Sea a short distance below Knight's Ferry. Its course in the lower section, where it cannot be followed, is below the level of the present river.

This channel provided drainage for a long time as, in its lower reaches particularly, it not only cut through the earlier volcanic rocks but in some places eroded the underlying Bedrock series to depths of 200 to 300 feet. For example, a few miles above Knights Ferry the channel bottom is level with the bed of the Stanislaus River, the canyon of which here cuts quite deeply into granitic rocks and greenstones. In the course of its formation, the channel accumulated shallow deposits of gravel that, downstream from where it crosses the Tertiary Calaveras River, contains enough gold to have invited many mining ventures, although in only a few instances were gravels found that were rich enough to pay. Some of the gold in this channel undoubtedly was derived from veins of the Mother Lode and vicinity by direct erosion of the stream; but as this erosion was comparatively slight, it is believed that the greater part of the gold was taken from the rich gravels of the Tertiary Calaveras River and its intersected tributaries, which in general had north-south courses. In this connection it is of interest to note that the Table Mountain Channel apparently stole the drainage of the Columbia Basin from the Tertiary Calaveras River by cutting such a tributary (see p. 73), so that some of the gold in the Table Mountain Channel probably was derived from the immensely rich gravels of this basin.

Another place where the Table Mountain Channel intersected the prevolcanic drainage is just north of Jamestown where the adits of the New York and Humbug mines followed a north-south Eocene Channel from opposite sides of Table Mountain until their workings intersected beneath the mountain, with the result that there was an underground battle for possession of the rich gravel followed by prolonged litigation.

The formation of placer deposits by the Table Mountain Channel was stopped abruptly by renewed volcanic eruptions, which filled
the valley of the stream with andesitic muds and tuffs and later, probably in the Pliocene epoch, covered them with a flow of lava 50 to 250 feet thick. This lava is a black latite that is very resistant to weathering. It is characterized by abundant porphyritic crystals of labradorite in a fine-grained ground mass that is largely augite, but it contains a little olivene and vesicular obsidian with magnetite and apatite as accessory minerals.

The andesitic cobbles and other volcanic debris that formed the sides of the valley down which the lava flowed were much more easily eroded than the lava, and they have been worn away almost completely, leaving the flow as a capping perched high on top of the ancient stream bed. Because it is protected from erosion by this capping, most of this ancient stream bed on its course south of Parrott Ferry is well above the general level of the surrounding country. The lava flow now appears as a gigantic black wall with nearly perpendicular sides several hundred feet high topping a ridge and extending almost continuously for 20 miles, from a few miles north of Jamestown to a short distance above the bridge at Knights Ferry. This immense wall with its nearly flat top, ranging in width from 500 to 1,500 feet, is one of the most striking topographic features of the county. This portion of it, known as Tuolumne Table Mountain, is mentioned frequently in the writings of Bret Harte and Mark Twain.

The top of Table Mountain ranges from 300 to 500 feet above the general level of the country on the southeast side, but on the northwest side the erosion has been greater, and the valley is 500 to 800 feet below the upper edges of the lava cliffs. Upstream from this mountain, the continuity of the lava flow has been broken by erosion so that it is now represented only by a series of islandlike patches. However, for 8 miles above Parrott Ferry these remnants of the lava stream lie close together and form imposing columnar cliffs 200 to 300 feet high facing the Stanislaus River.

As a rule, the gravel deposits of the Table Mountain Channel are both narrow and shallow, rarely exceeding 100 feet in width or 15 feet in thickness. Further, they have been disturbed by frequent faulting. For example, at the Omega drift mine near where the channel crosses the Mother Lode there is a series of step faults that strike about N. 30° W., one of which has lifted the downstream portion of the channel approximately 60 feet above the upstream section. Several of these faults can be seen clearly in figure 8.

As in most stream valleys of considerable age, in some places there are several channels at varying levels between the main rims. In these channels the auriferous gravel normally is covered with 3 to 30 feet of clay, then with 50 to 75 feet of unconsolidated volcanic sand, next by a compact andesitic tuff, and finally by the heavy capping of latite. However, in some instances the layers of clay and sand are missing and the andesitic tuff is in direct contact with the gravel.

The gravel itself is composed of a heterogeneous assortment of rocks not only derived from the primary erosion of the many different rocks cut by the 50-mile channel but containing Eocene gravels robbed from the older drainage. The gold is coarse, but the "pay" areas are extremely spotty. This fact, together with the shallowness

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of the gravels, their small width, their disturbance by faults, and the normal presence of heavy clay and unconsolidated sands above them, making the mine workings difficult to support, all have contributed to the many failures that have attended attempts to mine this channel.

Most of the mines are confined to a 10-mile stretch under Table Mountain, extending from near Columbia south to Montezuma. Gold is said to have been discovered in the channel in 1854 at a point near its south rim in the vicinity of Shaws Flat, where the lava has been denuded. During the next 10 years more than 40,000 feet of drifts were run to gain access to the channel, and active mining was carried on at 20 or more properties, prominent among which were the App, Boston, Buckeye, Duchow, Eureka, Hunter, Jefferson, Leap Year, Maine Boys, McKinley, Montezuma, Punchbowl, Omega, Ophir, Ranch, Richards, Rosedale, and Springfield. The situation of 16 of these old mines is shown in figure 5. By 1870, however, drift mining here had virtually ceased, although some little work has been done almost every year since. It is estimated that slightly more than $1,000,000 in gold was recovered from Table Mountain Channel. Only one or two of the mines were profitable and it is doubtful if the total recovery equaled the total cost.

When the Table Mountain area was visited in the summer of 1938 work was being carried on at only one drift mine—the Punchbowl—which is described briefly.

**Punchbowl**

The Punchbowl mine, comprising about 200 acres, is situated in sec. 20, T. 1 N., R. 14 E., and extends completely across Table Mountain about 2½ miles south of the Rawhide mine. (See No. 89, fig. 5.) It was one of the early drift mines beneath Table Mountain and is being reopened by G. B. Miller, 1825 Highland Place, Berkeley, Calif., and associates.

An adit 1,800 feet long runs east into the west side of Table Mountain to tap the auriferous gravels of the old Neocene streams. About 1,450 feet from its portal a 28-foot raise has tapped an ancient channel that has been drifted upon upstream to the north for about 800 feet. The gravel extracted from the drifts is reported to have averaged $2 per cubic yard and was uncemented. The gold was coarse and well worn, and nuggets weighing ¼ to ½ ounce each are said to have been found frequently. The gravel, consisting largely of well-rounded porphyry, granite, and schist but containing very little quartz, was washed in a plant on the hillside just below the mouth of the adit, but the plant has long since disappeared. It is evident from the small quantity of tailings that very little gravel was breasted in the workings. North of the adit is an old shaft 420 feet deep and sloping about 18° almost due south. A survey has shown that if this shaft were extended 240 feet its bottom would be on the same level and within 100 feet of the north end of the old drift. If a connection were made between the shaft and drift it would provide good ventilation for the workings. At the time the property was visited in the fall of 1938
two men were engaged in removing caved material from near the end of the adit in preparation for making the connection referred to as a means to resume exploratory work.

**TERTIARY TUOLUMNE RIVER**

In Tuolumne County evidences of only one large prevolcanic Tertiary river comparable to the Tertiary Calaveras, Mokelumne, and American Rivers in the Mother Lode counties to the north have been preserved. This ancient stream, the course of which is shown in figure 2, is known as the Tertiary Tuolumne River. It is the most southern of the Tertiary rivers that drained the Mother Lode region, of which enough evidence remains to allow its general course to be traced with a fair degree of accuracy. Doubtless there were other prevolcanic streams in Tuolumne County and also to the south in Mariposa County that had their sources near the crest of the Sierras and emptied into the Ione Sea. However, the great flows of lava and volcanic mud that filled the valleys of the early Tertiary rivers to the north extended only over the northern portion of Tuolumne County, and in consequence the ancient rivers to the south, lacking this cause of deflection and protective covering against erosion, simply deepened their channels during Quaternary time with little alteration of their courses and have not, therefore, been preserved as distinct streams.

The Tertiary Tuolumne River rose near Mount Dana in the High Sierras in the southeastern corner of Tuolumne County and flowed in a general westerly direction through Hetch Hetchy Valley and on to the north of Groveland and Shawmut through Chinese Camp to empty into the Ione Sea, probably in the vicinity of Knights Ferry. As it was near the southern edge of the area covered by the andesitic eruptions of the late Tertiary in a region blanketed by a relatively thin covering of volcanic ejecta, its valley was not filled completely by the ashes, mud, and lava that flowed into it, and in consequence its course was little altered by the eruptive material. Hence, the later drainage followed the course of the prevolcanic stream closely throughout most of its length. However, during the late Pliocene and early Quaternary, when erosion was speeded by torrential grades resulting from the westerly tilting of the region, the stream was deflected considerably in its lower reaches, where it occupied a wide and open valley. There, just downstream from the confluence of the North Fork of the present river and a few miles east of Chinese camp, the old stream was turned from its general westerly course. It cut a new channel to the south, which has since been deepened until, at the confluence of Woods Creek near Jacksonville, the nearest point of the present river to Chinese Camp, it is about 700 feet below the old stream bed at Chinese Camp. Farther upstream the difference in elevation between the present and prevolcanic stream beds is even greater, reaching 1,500 feet or more, showing the great influence that the tilting of the region has had on canyon cutting by the river during Pliocene and Quaternary time. The relative positions of the present and Tertiary Tuolumne Rivers are shown in figure 2.
The geologic history of the Tertiary and present Tuolumne Rivers has an important economic bearing on their placer deposits. Those of the ancient stream consists of patches of gravel remaining here and there between Piute Canyon near the headwaters of the river and Big Humbug Creek, 33 miles farther downstream. These gravels occasionally have been productive, but as in its upper reaches the ancient river traversed granitic rocks that contained few auriferous veins, the Tertiary gravel deposits in this section are relatively unimportant. However, 2 or 3 miles above Big Humbug Creek the old river cut the auriferous veins of the East belt, and 13 miles farther downstream, about 2 miles east of Chinese Camp, it cut the Mother Lode itself and the gold-bearing Mariposa slates that flanked it on both sides.

The gravels resulting from this erosion were unquestionably rich in gold, but they have been almost wholly swept away by more recent erosion, only one considerable area of the ancient gravel remaining at Chinese Camp. Here, within an area of less than 1 square mile, shallow patches of gravel composed largely of quartz, filling the depressions of a rather flat bedrock, are credibly reported to have yielded $2,000,000 to the early miners; and later, after the best of the gravel had been worked, this same area supported several thousand Chinese miners for a number of years, the Chinese having been engaged in cleaning bedrock and working by hand the poorer gravels left by the white miners.

Much of the gravel of the Tertiary Tuolumne River and its tributaries has been eroded and reconstituted by the present river system and enriched further by Quaternary erosion of the gold-bearing areas. Hence, the placers of the present river within and downstream from the area of gold-bearing rocks were rich and were mined with surprising thoroughness by the old-timers. By building wing dams when the water was low during the late summer and fall, they were even able to work gravels well out in the main river; and the placers of the main stream and such tributaries as Woods, Sullivan, Curtis, Rough & Ready, Blanket, Turnback, Moccasin, Deer, and Big Humbug Creeks and the North Fork were rapidly worked out and yielded millions of dollars.

There were gravel areas, of course, that contained too little gold to be worked profitably by the old-timers, and some of these, in conjunction with tailings from the past workings, now furnish profitable ground for dragline operations. During the summer of 1938 there were four such areas on tributaries of the Tuolumne River, all of which had been mined before, that were being reworked by draglines. Three of these were on Woods Creek and one on Moccasin Creek. Descriptions of the operations follow.

**DRAGLINE OPERATIONS**

**SHAWMUT PLACER**

In the summer of 1938 two draglines and floating washing plants were being operated by E. A. Kent, 149 California Street, San Francisco, at the Shawmut placer on Woods Creek about half a mile above the bridge that crosses it on United States Highway 49. (See No. 117, fig. 5.) Plant 1 was at work in the valley of the
creek just above the Eagle-Shawmut mill, and plant 2 was operating about a quarter of a mile farther upstream, both on claims leased from the Woods Creek Placer Co. in sec. 11, T. 1 S., R. 14 E. J. V. Rice of Sonora was general superintendent.

Plant 1 was one of the first draglines and floating washing plants built by the Bodinson Manufacturing Co. and began mining near Oroville, Calif., in January 1936. It was moved to Tuolumne County in October of that year and, after working out about 50 acres of placer at Montezuma Flat, was transferred to the lower end of Woods Creek, where it began operations in June 1937. Here it mined about 600,000 cubic yards of gravel below the highway bridge and was then completely rebuilt and put in operation again above the bridge in May 1938.

Plant 2 was erected on the Tuolumne River just above the mouth of Woods Creek on November 20, 1937, but was completely demolished 20 days later by a flood of unusual severity, which not only wrecked the washing plant, dragline, and bulldozer but carried away the first clean-up. However, the plant was rebuilt, and mining in the river was resumed on February 20 and continued until April 8, when the plant was moved to Woods Creek, beginning work only 9 days later.

Both washing plants are of steel construction throughout. No. 1 plant has a capacity of 2,000 cubic yards of gravel per day and No. 2 plant handles 3,000 to 3,500 cubic yards daily. No. 1 boat is 40 by 40 by $2\frac{1}{2}$ feet and is made up of five steel pontoons each 8 by 40 feet. This boat carries a trommel 24 feet long and 52 inches in diameter, with a scrubbing section 5 feet long followed by a 4-foot section of screen with $\frac{3}{8}$-inch holes and 1$\frac{1}{2}$-inch bridges; a 4-foot section with $\frac{5}{8}$-inch holes and 1-inch bridges; a 6-foot section with $\frac{3}{8}$-inch holes and $\frac{3}{4}$-inch bridges; and a 5-foot discharge section.

The stacker is 35 feet long and has a 24-inch, 6-ply rubber belt driven at 275 feet a minute. A 7-inch Eclipse centrifugal pump supplies 1,000 gallons of wash water per minute. Power is provided by an 80-horsepower Diesel engine, which drives a main shaft by V-belts. This shaft, in turn, drives two countershafts through a gear box. One countershaft operates the trommel by means of a chain drive, and the other runs the stacker. The pump is driven at 900 r. p. m. by V-belts from the main shaft.

The gold tables, of which there are six on each side of the boat, are cleaned up twice a week. A 156-horsepower Marion model 371 dragline serves the washing plant. It has a 50-foot boom and a 1$\frac{1}{2}$-cubic yard bucket.

No. 2 boat is 50 by 50 by $2\frac{1}{2}$ feet and consists of four pontoons 50 by 8 feet and a pontoon at each end, one of which is 40 by 10 feet and the other 40 by 8 feet. All the machinery on this boat is operated electrically. The trommel, 40 feet long and 5 feet in diameter, is driven at 15 r. p. m. by a chain drive from a 40-horsepower motor. It has a 10-foot scrubbing section followed by 20 feet of screen sections having $\frac{3}{8}$-inch holes, except for 2 feet, which has $\frac{3}{4}$-inch holes. The stacker is 70 feet between centers and has a special 30-inch Hewitt rubber belt driven at 275 feet per minute by a 15-horsepower motor. A 10-inch Byron Jackson pump driven directly by a 100-horsepower motor supplies 3,000 gallons of wash water per minute. There are 10 gold-saving tables on each side of
this boat. The tables on each side are cleaned up alternately once a week. Electric power is purchased from the Pacific Gas & Electric Co. A general view of boat 2 is shown in figure 28, and details showing the bucket, bin, trommel, gold-saving tables, and jig are illustrated in figure 29.

An installation of two Pan-American jigs is being tested with feed from one 3½-inch screen section. A roughing jig makes a hutch that is delivered by a jet pump to a cleaning jig. Results indicate that the small additional recovery made by the jigs is not enough to justify their installation in this instance. Gravel for this No. 2 plant is excavated by a 182-horsepower 39A Marion dragline having a 65-foot boom and using either a 2½- or 2½-cubic yard Page bucket. The dragline is powered with a Waukesha Hesselman Diesel engine. Brush and large boulders are removed from the surface and the ground is leveled with two 60-horsepower caterpillar bulldozers. The wash is heavy and well rounded. It contains many cobbles 18 inches to 2 feet in diameter and rests on a slate or schist bedrock. The gravel ranges from 3 to 20 feet in depth, averaging about 10 feet. Two feet of the bedrock is mined where possible.

Woods Creek has been a prolific producer of placer gold, and although the claims under lease have been worked and reworked by hand methods many times the average yield of the ground is large enough to justify the present operation. In June 1938, 600,000 cubic yards of gravel was still available for mining on these claims. Both plants are operated three 8-hour shifts. Forty men are employed, six of whom are engaged in testing a placer 1½ miles upstream, to which one of the plants may be moved later.

RIMM-CAM DREDGING CO.

In June 1938 the Rimm-Cam Dredging Co., of which Albert and Cedric Rimmer and Jack Cameron, all of Jamestown, Calif., are the active partners, was mining a 6-acre tract of gravel on Woods Creek at Jamestown (see No. 72, fig. 5) with a ¾-cubic-yard dragline and floating washing plant. The washer, which is supported on two wooden pontoons each 22 by 11 by 3 feet, is designed so that it may be dismantled easily and moved, as it was planned for mining areas of rich gravel too small to be handled profitably by a larger plant. Three other small tracts of gravel on Woods Creek between Jamestown and Sonora, totaling 16 acres, have been obtained by the company already, and it is expected that the plant will be busy for several years in mining these and other small areas of workable gravel that are available in the county.

A Northwest dragline operated by a Twin City gasoline engine and having a 50-foot boom normally delivers 75 cubic yards of gravel per hour to the hopper of the washing plant, which discharges it to a trommel 21 feet long and 46 inches in diameter. This trommel has a slope 1½ inches to the foot and has three sections with 3½-, ½-, and 3½-inch holes, respectively. It is chain-driven by a Fordson tractor engine at 12 r. p. m. This engine also operates the stacker, which is 38 feet long and has a 20-inch belt driven at 180 feet per minute. A 5-inch centrifugal pump operated by a Chevrolet engine supplies wash water. There are seven gold-saving tables on each side of the washer, each set discharging
Figure 28.—Gold-washing plant of E. A. Kent on Woods Creek.

Figure 29.—Details of above plant, showing bucket, bin, trommel, gold-saving tables, and jig.
FIGURE 30.—Water-filled pit, tailings dump, and incline of Mencke-Hess power-shovel placer operations.

FIGURE 31.—Gold washing at the Mencke-Hess placer near Chinese Camp.
into a tailing sluice. Quicksilver is used in the riffles. Although the area being mined was worked in the past, considerable coarse gold and occasionally nuggets weighing up to ¼ ounce are recovered. The gold is 850 fine. The gravel deposit, which is situated largely on the north bank of Woods Creek, ranges from 3 to 6 feet in depth and contains only a few boulders too large to be handled by the stacker. The bedrock is schist. The brush and the few trees growing on the tract are cleared before the gravel is excavated. The stumps are handled by the dragline.

The average yield in gold is reported as 68 cents per cubic yard. Three men are employed, and the plant is operated during an 8-hour day shift only. The dragline is said to consume an average of 3½ gallons of gasoline per hour and uses 3 pints of lubricating oil per shift.

The entire plant cost approximately $20,000, the largest item being $11,000 for the second-hand dragline and bucket. The pontoons, trommel, and superstructure of the washer were constructed by the operators. The frame supporting the trommel and gold-saving tables is made from 4-inch steel tubing electrically welded, and the trommel likewise is welded throughout. This home-made washing plant cost less than $9,000 and is giving excellent service.

MOCASIN CREEK PLACER

Larsen & Harms, of Sacramento, Calif., are operating a dragline and floating washing plant near the mouth of Mocassin Creek, about 2 miles southeast of Jacksonville, in sec. 20, T. 1 S., R. 15 E. (See No. 129, fig. 5.) Mocassin Creek has its source near the top of the divide between Tuolumne and Mariposa Counties, where it is crossed by United States Highway 49. The creek is about 7 miles long and flows northwesterly. Near its headwaters it cuts the Mother Lode and then courses along the northeast side of the Lode for 4 miles to its confluence with the Tuolumne River. The creek has eroded a deep V-shaped valley through the Mother Lode and adjacent rocks, and the gold in its placers was derived from this source. In the past, when its more accessible gravels were mined and washed by hand, it is said to have yielded about 7,500 ounces of gold. The floor of the creek valley for 2 miles above its mouth averages about 350 feet in width and is covered with approximately 10 feet of coarse gravel containing many large cobbles and boulders, the latter often being 3 feet or more in diameter. All this material is well-rounded, and the wash contains little clay, as the grade of the creek is steep enough to keep fine sand and mud in suspension. The bedrock in this portion of the creek is serpentine and slate.

Larsen and Harms began mining about three-fourths mile above the mouth of the creek in November 1937. A strip of ground about 175 feet wide between the center line of the valley and the north bank and extending to the mouth of the creek was first excavated and washed. When the plant was visited in June 1938 mining upstream along the south bank was well under way, the mouth of the creek having been mined completely across.

Digging equipment consists of a Northwest Engineering Co. dragline driven by a 150-horsepower Murphy Diesel engine and
equipped with a 50-foot boom and a 2-cubic-yard Esco bucket. The washing plant, built by the Bodinson Manufacturing Co. of San Francisco, comprises a floating hull 40 by 40 by 2½ feet, consisting of five steel pontoons and an all-steel superstructure carrying the washing and gold-saving equipment. The trommel, 32 feet long and 4½ feet in diameter, is chain-driven at 14 revolutions per minute by a 120-horsepower caterpillar Diesel engine, which also operates the stacker and runs a 10-inch centrifugal pump that supplies about 675 gallons of wash water per minute. The trommel has ¾-inch holes in its upper screen sections and ½-inch holes in one section at its discharge end. The oversize from the trommel is piled by a 50-foot stacker having a 24-inch belt that travels 300 feet per minute. The undersize from the trommel flows over five gold-saving tables on each side of the boat. Quicksilver is used in the riffles of these tables, and they are cleaned up once a week. The gold is 820 to 845 fine and of medium size, with occasional nuggets weighing 1 or 2 pennyweight. A nugget worth $5 is the largest that has been recovered.

About 2,000 cubic yards of gravel is excavated and washed daily, with a recovery of about 20 cents per cubic yard. An RD7 gasoline caterpillar rated at 62 horsepower and equipped with a LeTourneau bulldozer is used for clearing brush and leveling the ground before excavation. All repairs that do not involve lathe work are made locally with electric welding equipment. A set of six bucket teeth lasts 2 days on an average. The teeth are purchased in lots of 500. The plant is operated with three 8-hour shifts of four men each. In June 1938 enough gravel was still available to supply the plant for a year.

MENCKE-HESS PLACER

The Mencke-Hess placer is about 2 miles south of Chinese Camp in secs. 15 and 22, T. 1 S., R. 14 E. (see No. 119, fig. 5), at the head of Sixbit Gulch, which drains into the Tuolumne River 2 miles farther south. Although this valley was formed during Quaternary time, much of the gravel in it probably was derived from the erosion of older placers deposited by the Tertiary Tuolumne River in the vicinity of Chinese Camp, and much of the gold in the present deposit is thought to have come from this source. The gravel is fairly coarse and uncedmented and it contains many cobbles weighing from 25 to 100 pounds each; these are not only too well worn to be of local origin, but many are composed of rocks found far up the canyon of the Tuolumne. Near the head of the valley the gravel is from 50 to 75 feet deep and is reported to average more than 50 cents a cubic yard. The gold is largely concentrated, however, on and near the bedrock. It is said that in the early days about $40,000 was recovered along the bedrock by drift mining.

In 1935 and 1936 Mencke-Hess Gravels, Inc., under the direction of Lloyd Root, former State mineralogist of California, worked the upper end of the deposit by open-pit methods. A power shovel loaded cars into the pit, and these were hauled by a gasoline locomotive and dumped over a heavy grizzly above a loading platform in the pit. The grizzly removed the larger boulders, and the undersize fell
into 13-cubic-yard cars, which were drawn by cable up an incline to a washing plant on the hillside southwest of the pit. Here the gravel was dumped into a bin, from which it was hosed into a large cylindrical trommel, the oversize from which was stacked while the undersize passed over riffled tables and sluices. It is reported that $92,820 was recovered from 160,000 cubic yards of gravel excavated from the pit, an average of 58 cents a cubic yard; but costs and royalties together exceeded the recovery, and when in the winter of 1937 one of the banks of the pit caved, mining was abandoned.

Figure 30 shows the pond that now fills the pit and the hoisting incline, with coarse-tailings pile in the background.

The next attempt at mining was about 1/2 mile farther down the valley, where a floating washing plant and dragline were installed in 1937 by Chinese Gravels, Inc. Here drilling is reported to have disclosed a body of gravel 250 feet wide and about 30 feet deep, averaging over 50 cents per cubic yard, but again with most of the gold on bedrock. The washing plant, mounted on a 50- by 35-foot hull, comprised a cylindrical trommel 35 feet long and 5 feet in diameter with a 20-foot scrubbing section, a 10-foot screen section with 3/4-inch holes, and a 5-foot screen section with 1/2- and 5/8-inch holes. This trommel was gear-driven by a 30-horsepower electric motor, and its oversize was stacked by a 50-foot conveyor with a 24-inch belt driven by a 5-horsepower motor. The undersize from the trommel passed over five gold-saving tables equipped with rubber-shot riffles and two tail sluices on each side of the boat. As the gold was chiefly coarse, no quicksilver was used in the riffles. Wash water was supplied by a 50-horsepower, 8-inch centrifugal pump, and a 2 1/2-inch pump driven by a 5-horsepower motor was used in cleaning up. The gravel was excavated by a Link-Belt electric dragline with a 75-foot boom and a 1 1/2-cubic-yard bucket. A second dragline, with a 63-foot boom and operated by an 80-horsepower gasoline engine, constituted a reserve excavating unit. Other equipment consisted of a 50-horsepower caterpillar bulldozer, electric welding apparatus, blacksmith shop, etc.

A cut 85 by 90 feet wide was mined upstream for a few hundred feet, but the serpentine bedrock proved much too hard to be dug, and its surface was so uneven that very little of the rich gravel on it could be scraped into the dragline bucket. In fact, it is reported that only 5 or 6 cents per cubic yard, or about 10 percent of the gold content shown by sampling, was recovered. After several disappointing clean-ups the pond was pumped down, and an attempt was made to clean bedrock with a suction hose from the intake of a 6-inch sand pump installed on the bank of the dragline pit just above water level. Figure 31 shows this pump discharging gravel over a sluice near the edge of the pit, and the washing plant can be seen in the background. Although some gold was recovered by this method, the immobility of the arrangement foredoomed it to failure, and mining again was abandoned in the summer of 1938.

The failure of a well-equipped dragline plant on this ground emphasizes the fact that a diggable bedrock is a primary requisite for a successful dragline operation where the gold is concentrated on or near it.
MISCELLANEOUS PLACER OPERATIONS

KINCAID FLAT AND SULLIVAN MINES

The Kincaid Flat and Sullivan placers are 2 miles southeast of Sonora in sec. 7, T. 1 N., R. 15 E. (See Nos. 99 and 100, fig. 5.) They are owned by the M. McCormick Co. of Stockton, Calif., and are under lease to James Morrow of Sonora.

Kincaid Flat lies between Sullivan and Curtis Creeks and is the site of an ancient stream whose gravels were rich in gold. The average elevation of the flat is 100 feet or more above the creeks on each side. In the past a tunnel 1,200 feet long was driven from the southeast bank of Sullivan Creek through the limestone rim of this old stream valley and entered the gravels at a depth of about 60 feet and about 90 feet above the lowest point in the bedrock reached by an exploratory shaft. The tunnel was equipped with a sluice 4 feet wide, and after the gravel above the tunnel level was washed, some of the deeper gravels near by were hoisted into the sluice, but much of the deeper ground remains unworked. This early operation is said to have yielded most of the $3,000,000 output with which Kincaid Flat is credited.

Sullivan Creek, a southwesterly tributary of Woods Creek, is reported to have produced an equal amount of gold, but the early miners were unable to work the deep gravels in a bar covering 3 or 4 acres just below Arroyo Seco. These deeper gravels rest on a stratum of limestone, which crosses the creek here and has been eroded far below the level of the harder rocks downstream, which dam the subsurface water so that the gravels in the limestone pocket are flooded to a depth of 40 to 50 feet.

In March 1936 Morrow leased this bar and the Kincaid Flat property and proceeded to test the gravel of the bar by sinking five shafts with the aid of a ½-cubic-yard clamshell dipper. In general, pay gravel was reached at a depth of 12 feet, and from this level to a depth of 25 feet the gravel contained $2 to $10 per cubic yard. Bedrock was not reached in any of the shafts, as the available pumping facilities could not handle the water at greater depth. On the strength of this sampling Morrow subleased the bar to Larsen & Harms of Sacramento in November 1937. In January 1938 this company installed a washing plant on the southeast bank of Sullivan Creek capable of handling 30 cubic yards of gravel per hour and began stripping with a ¾-cubic-yard electric dragline. After the overburden had been removed from about 1½ acres on the bar, the pay gravel was excavated with the dragline and dumped into 12-cubic-yard LeClair carry-alls, which were hauled to the washing plant on the hillside by Diesel and gasoline caterpillar tractors. Unusually heavy winter rains made operations difficult, and continuous work was impossible. Water was pumped from the pit by a 10-inch centrifugal pump mounted on a float and driven by a 50-horsepower electric motor. This pump was unable to lower the water beyond 35 feet, and pay dirt was dug almost continuously through 6 or 8 feet of water. As the underlying limestone has been eroded very irregularly, with the formation of deep crevices and potholes with pinnacles between them and residual boulders of limestone where the pinnacles
had been cut through underneath, it was impossible to excavate the
gravel with the dragline, particularly as the operator could not see
where he was digging beneath the muddy water. Consequently, the
sublease was abandoned in May 1938 after $8,000 had been recovered
from about 4,000 cubic yards of gravel, which included much over-
burden dug from the banks of the pit in filling the dragline bucket.
The gold recovered was coarse, ranging in size from a pinhead to
nuggets weighing half an ounce. It averaged 910 fine.
Morrow plans to work the bar by fluming those sections of the
creek that apparently are supplying most of the seepage into the pit,
and then pumping out the water with an electric pump and exca-
vating the gravel by hand methods. If this operation is successful,
plans will be outlined for working Kincaid Flat.

COPPER MINES

The Foothill copper belt, which extends through all five of the
Mother Lode counties between their western boundaries and the
Lode, enters Tuolumne County at Byrnes Ferry on the Stanislaus
River and crosses the county in a southeasterly direction into Mari-
posa County just beyond Blanchard. An eastern branch of this
belt parallels the Mother Lode 2 or 3 miles to the west of it, enter-
ing the county 2 miles west of Tuttletown and passing through
Chinese Camp to Moccasin Creek. This east belt has developed
only a few minor copper prospects. The more westerly main belt
has two mines, described hereafter, which have made some small
production. However, nowhere in Tuolumne County have copper
deposits been found comparable in commercial importance with
those in this same belt north of the Stanislaus River at Copper-
opolis and Campo Seco in Calaveras County. These were described
on pages 112–116 of Bulletin 413. In fact, the total copper output
of Tuolumne County since accurate annual records first became
available in 1902 has been less than 200 tons.

OAK HILL

The Oak Hill mine is in sec. 23, T. 2 S., R. 14 E., about 1 mile
northwest of the Don Pedro Reservoir. The vein, which is in green-
stone (augite-porphyrite), strikes northwest and dips slightly south-
west. Its outcrop can be traced for 350 feet.

The property was first worked as a gold mine and is said to
have paid well until sulfides came in at a depth of about 100 feet.
Below this depth an irregular zone of secondary enrichment was
found, in which semioxidized ore was interspersed with chalcopyrite
and pyrite, and at still greater depth chalcopyrite is present. After
the early gold-mining operation was completed the property re-
mained idle until 1901, when a 150-foot shaft was sunk a little
north of the original shaft, drifts were run on the 100- and 150-foot
levels of the new shaft, and the ore between them was stope out.
Shipments of ore made to the smelter contained 0.22, 0.71, and
0.62 ounce of gold, 2.38, 7.11, and 6.16 ounces of silver, and 4.9,
10.5, and 20.9 percent of copper, respectively. After 2 or 3 years’
operation, the mine was closed for several years but was then
reopened and the shaft was deepened to 350 feet and 350 feet of
drifts were run on the 350-foot level.

Above this level are 400 feet of drifts on the 150-foot level and
300 feet of drifts on the 100-foot level. In all there is about 2,000
feet of underground development work. There are two known ore
shoots, which are generally 4 to 6 feet wide, but stopes in the old
workings near the surface are up to 30 feet wide. Six feet of chal-
copyrite is said to have been struck on the 350-foot level, and in
1908, 1,000 tons of ore containing 7 percent copper and several
dollars a ton in gold are reported to have been shipped to a smelter.

SALAMBO

The Salambo mine, formerly known as the Washington, is in
secs. 30, 31, and 32 of T. 2 S., R. 15 E., about 3 miles northwest
of Blanchard. It consists of a group of unpatented claims along
the contact of a greenstone lens and the Mariposa slate in which it
occurs. At one time this mine is said to have supported a village
of 400 people, which was destroyed by fire. As the price of copper
had fallen sharply at that time the mine remained closed and has
never been reopened. The ores are reported to have been of good
grade and chiefly sulfides.

CHROMITE MINES

Nearly a score of small chromite mines in Tuolumne County were
operated during the World War from 1915 to 1918 and are cred-
ited with an output of 7,586 tons during that period. Of this out-
put, 2,680 tons was produced in 1917 and 4,269 tons in 1918. Prior
to 1915 there were shipments of 197 tons in 1906 and 30 tons in
1909, making a total recorded output of 7,813 tons in the county
to the end of the World War. Since then there has been little if
any production.

The chromite deposits occur in the serpentine formations in the
vicinity of the Mother Lode or adjacent to it, but most of the
production came from properties in the broad belt of serpentine
that parallels the Mother Lode on the west, extending from the
Stanislaus River to the west of Montezuma and Chinese Camp
and across the Tuolumne River north of Red Mountain Bar. In
general, the chromite deposits are small and erratic, the ore occur-
rning in narrow veins and lenses within the serpentine. Some ore
containing as much as 45 percent Cr₂O₃ has been shipped, but most
of it has been of much lower grade, containing 25 to 35 percent
Cr₂O₃.

MISCELLANEOUS PROPERTIES

The following notes on various chromite properties show the
sites of the mines and the typical occurrence of small lenticular
masses of low-grade chromite ore widely scattered over a large area
of serpentine.¹⁵

¹⁵ Bradley, W. W., Huguenin, Emile, Logan, C. A., Tucker, W. B., and Waring, C. A.,
Manganese and Chromium in California: California State Mining Bureau Bull. 70, 1918,
pp. 213–214.
ROUGH & READY

The Rough & Ready mine is in sec. 25, T. 1 N., R. 13 E., near the north end of the Don Pedro Reservoir. This property was operated during the World War by its owners, Thomas and George A. Richards of Oakdale, Calif., who produced several hundred tons of low-grade chromite ore from occasional small lenses in the serpentine. These lenses have a general east-west strike and dip about 80° N. The largest one, uncovered by an open-cut, was 50 feet long and had a maximum width of 10 feet. Two analyses of ore from it showed 26.3 and 29.9 percent Cr₂O₃ and 12.6 and 18 percent SiO₂, respectively.

About one-fourth mile west of this lens a 25-foot inclined shaft struck a lens of ore 6 feet long and 4 feet wide, which yielded a few tons of ore averaging 36.7 percent Cr₂O₃ and 8.8 percent Si₂.

PEREIRA

The Pereira claims in the SW¹/₄ of sec. 25, T. 1 N., R. 13 E., are about one-half mile south of the Rough & Ready mine. The ore is of the same general type as at the latter property, the chromite being in small lenticular masses widely scattered in the serpentine. The lenses are exposed by trenching and have been mined by open-cuts and shallow shafts. About 55 tons of ore containing approximately 24 percent Cr₂O₃ was taken from an open-cut 100 feet long and from 2 to 8 feet deep, following the ore in a N. 80° E. direction. About 500 feet south of this open-cut other narrow lenses are reported to have yielded about 15 tons of ore containing 35 percent Cr₂O₃.

DON PEDRO

The Don Pedro property in sec. 6, T. 2 S., R. 14 E., 4 miles southeast of Keystone, was leased by the Levensuler-Speir Corporation during the World War. Some ore from the property was hauled to Keystone in 1916. Development consists of two shafts 90 and 70 feet deep, respectively.

KAHL

The Kahl mine is in the SE¹/₄ of sec. 6, T. 1 N., R. 14 E., about 2 miles southwest of Tuttletown on 40 acres of patented ground. In 1915 several carloads of ore was taken from a lenticular body of chromite striking N. 40° W. and dipping 80° S., which was exposed in a pit 50 feet long, 30 feet wide, and 16 feet deep.

MACKEY

The Mackey property is in the SE¹/₄ of sec. 21, T. 1 N., R. 14 E., 3 miles southwest of Jamestown and within 50 yards of Woods Creek. Old workings indicate that an ore body 40 feet long, 14 feet wide, and 14 feet deep was taken out. Seventy tons of ore was taken from three small open-cuts and sold by the owner in 1916.

SIMS

The Sims mine is in the NE¹/₄ of sec. 5, T. 1 S., R. 14 E., about 2 miles southeast of Yosemite Junction. This property, owned by Henry Sims, of Chinese Camp, was worked on a royalty basis by Eglin & Gouge, of Jamestown, Calif., in 1917. Lenticular bodies
of chromite were followed to a depth of 25 feet in the serpentine by an inclined shaft. The ore at the bottom of the shaft was 6 feet wide and had an east-west strike. A carload of ore reputed to average about 40 percent Cr₂O₃ was shipped.

TERRY & SELL

The Terry & Sell mine is in sec. 2, T. 1 S., R. 13 E., about 2 miles west of Yosemite Junction on property leased from the McCormick Cattle Co. of Sonora. A 14-foot shaft was sunk on a lens of chromite 8 feet long and 4 feet wide striking N. 35° W. In May 1917, 20 tons had been mined, and the bottom of the shaft was all in ore. About 10 feet northwest of this shaft another lens of chromite 30 feet long and 3 feet wide had been worked out from a 65-foot shaft sunk several years previously.

LIMESTONE AND MARBLE

Tuolumne County has large commercial deposits of limestone contained within the slates and schists of the Calaveras formation. The metamorphism this formation has undergone has caused crystallization of much of the enclosed limestone and its alteration to marble. The limestone, or marble, as the case may be, is in two main areas, one of which, about 9 miles in length and ½ mile in average width, extends westerly from opposite the mouth of Big Humbug Creek on the Tuolumne River to Curtis Creek, almost due south of Sonora. The east end of this belt is split into 5 roughly parallel fingers ranging from 1 to 4 miles in length, with a dozen or more small outlying lenses to the north and east. Formerly, marble was quarried near the west end of this belt at the Maine and Mississippi properties, but no recent developments of consequence have been undertaken in this area.

The other main limestone belt begins about 3 miles south of Sonora and, extending north through Columbia, crosses the Stanislaus River into Calaveras County. In the canyon of the Stanislaus the limestone is exposed to a depth of 1,100 feet below its outcrops at Columbia. On the south side of the river this limestone belt attains its greatest width in the Columbia Basin where it is 2 to 4 miles across. Here the limestone has been altered to marble, which generally ranges in color from white to dark gray and commonly has bluish veining. This marble is reported to contain 16 to 27 percent magnesium carbonate and is especially fine grained for a dolomitic variety. It has high compressive strength—10 to 12½ tons per square inch—and takes a brilliant polish. There are half a dozen marble quarries in the vicinity of Columbia, including the Bell quarry just east of the town, the Columbia quarry 2¾ miles northeast, the Warren quarry 3½ miles northwest, and the Bordoli or Sonora quarry 2½ miles south on the road to Sonora. Of these, the Columbia quarry, described later, is by far the largest and the only one that has been operated recently.

South of Sonora, near the southern end of this belt, the magnesium content of the limestone virtually disappears, except in certain horizons, and the limestone is nearly pure calcium carbonate commercially valuable for calcining and other purposes. About a mile south of Sonora a large limestone mine with milling and calcining
plants is operated by the United States Lime Products Corporation of San Francisco. This mine is described later.

LIMESTONE MINE OF THE UNITED STATES LIME PRODUCTS CORPORATION

The United States Lime Products Corporation of San Francisco is operating a limestone mine and calcining plant 1 mile southeast of Sonora. R. E. Tremoureaux is general manager and John Mocine of Sonora general superintendent.

The property consists of over 160 acres and extends about 4,000 feet along a belt of limestone that strikes N. 17° W. and extends in this general direction for several miles both north and south of Sonora. The limestone occurs in four similar parallel bands each about 200 to 275 feet wide and standing vertically within heavily folded Calaveras slates and schists, so they may represent a single formation. The band being worked is 3 miles long, and at the mine is 250 feet wide. The limestone is white, coarsely crystalline, and of remarkable purity throughout most of its width. It is said to average 99.2 percent calcium carbonate, about 0.6 percent magnesium carbonate, and 0.12 percent silica, iron oxides, and alumina. For about 10 feet along the west wall the limestone has been changed to dolomite, which is mined separately for making special products.

Early work at this property was done in an open quarry, but because the broken stone is contaminated by impurities from the surface an underground mine has been opened beneath the floor of the old quarry and has reached a depth of 300 feet with no sign of change in the physical characteristics of the deposit. The mine shaft rises through the floor of the old quarry, as shown in figures 27 and 32. A striking feature of this mine is the remarkable firmness of the limestone, which stands perfectly. This fortunate characteristic has largely determined the method of mining and is chiefly responsible for the exceedingly low costs possible. The limestone is not at all shattered. In the area worked it is interrupted only by one small mud seam and several thin basic dikes, probably diabase, that cross the formation at right angles without any shattering effects. It is as if the dike rock had quietly filled open preexisting jointing planes rather than actual fissures, and there is no evidence of movement along the dikes.

Figure 32 shows vertical longitudinal and cross sections of the mine and illustrates the method of mining. Levels are about 60 feet apart and are extended only about 800 feet from the shaft in both directions along the strike. They are driven with headings 60 feet wide, which form the beginning of a combination of a modified shrinkage stoping and room-and-pillar system of mining that is made possible only by the great standing ability of the rock. Although the limestone is strong it is not hard to drill. The roof is said never to have caved, though in places it is unsupported for a width of considerably more than 60 feet. Neither does the limestone spall after it has been exposed to the air for a few months.

Backs are drilled with long flat holes and blasted down to form a pile on the floor of the level. From the inner face of this pile additional cuts are made in the backs up as far as the floor pillar of the level above in the general manner of shrinkage stoping. However, instead of proceeding to the end of the level in this way, with a resultant tying up of considerable capital in an immense reserve of
Figure 32.—Vertical sections of mine of United States Lime Products Corporation at Sonora, showing method of mining.
broken rock, the pile is drawn upon steadily from the side toward the shaft as it is built up by blasting down upon its other side. Thus, a pile of broken rock of only moderate and relatively constant size is maintained, the outer face of which constitutes a slowly advancing platform from which the drilling is done. Stopping thus advances to the end of the drift. By this method only about 8 percent of the broken stone is held in the pile compared with at least 60 percent that would be held in a full stope.

Only under the exceptional circumstances described would this method of mining be possible, but in this instance the simplicity of the method could hardly be increased. There are no chutes or tim-bering whatever. The rock is shoveled into the mine cars from the pile. This method of mining, some details of which are thought to be original with the management, has possibilities even where the roof might be less dependable, though still very strong, of course, as the system might be applied in retreat from a mining limit. Under those circumstances the cars would have to pass the rock pile and take the rock from its far, instead of near, side. Narrower stopping might be required to leave a protected passageway at one side for cars, but some arrangement undoubtedly could be worked out that would make it unnecessary for men to pass under the high backs after stopping had been completed.

Figure 33 shows the method of driving headings and the lay-out or drift and pillar-cut rounds. The headings are 60 feet wide by 10 feet high. They are advanced by drilling and blasting in three sections, each extending 20 feet along the breast. The first section is at one side, where long holes are drilled fanwise. After the first section is broken and mucked out the middle section is drilled, as shown, from the side of the first section with holes parallel to the face, which provides good breaking. The third section is broken in the same manner with holes drilled from the side of the middle section.

An average of thirty 2-inch holes 18 feet long serve for drilling all three sections to advance the heading about 11 feet. The volume of rock broken is thus 6,600 cubic feet (500 tons), 13 cubic feet in place weighing a ton. Thus, only 1.08 linear feet is drilled per ton of rock broken. Blasting is done with a 25-percent dynamite made especially for quarry work, the average consumption of which is \( \frac{1}{8} \) pound per ton of rock broken. Wall pillars are cut through, usually on 40-foot centers, by the same general method used in advancing the drift. (See fig 33.)

Three parallel longitudinal drifts of the character described are spaced across the deposit as shown by the cross section in figure 32. The pillars left between them are so situated as to include the igneous dikes that dip nearly vertically. The pillars between drifts are cut through by laterals, and these are extended to the walls of the deposit.

As a variation of the mining method, in some places the floor pillars of the levels have been broken through to form what amount to underground glory holes. The purpose of this is not apparent, except that it supplies a means for a general clean-up of pillars before abandonment of a section of the workings.

An interesting feature of this mine is the liberal use of flood-lights for illuminating the face of the rock piles being loaded out.
The limestone is delivered directly from the stopes to the calcination and crushing plants without further handling.

_Calcining and milling plants:_—The limestone is calcined in 10 vertical steel kilns 9.5 feet in diameter and 30 feet in height and a rotary kiln 6 feet in diameter and 120 feet in length, all oil-fired. The rotary kiln is fired at a temperature of 2,650° F. and the vertical kilns at 2,300° F. Temperatures are held within close limits by recording pyrometers and automatic draft and oil-feed devices. The rotary kiln produces 48 tons of lime per day, and the vertical kilns make 8 tons each, a total daily capacity of 128 tons. The burned lime is either shipped as kiln-run or crushed and ground to meet trade requirements, principally in glass-making. Roughly, 2 tons of

![Diagram](image_url)

**Figure 33.—Plan and elevation of typical drift in mine of United States Lime Products Corporation at Sonora, showing drill rounds.**

limestone is required to produce 1 ton of lime. About one-third of the calcined product, after crushing to suitable size, is converted into calcium hydroxide in a modern hydrating machine, then cooled, ground, sized, and bagged by automatic machines.

Part of the crude limestone is treated in a milling plant where crushers, hammer mills, vibrating screens, and air separators convert it into products ranging from coarsely crushed limestone to powder that will pass a 200-mesh screen, the size depending on the requirements of the various consuming industries.
A research and control laboratory is maintained in which the grade of all products is checked carefully. All equipment is driven by electric motors, which consume an average of about 400 kilowatts of electricity purchased from the Pacific Gas & Electric Co.

About 100 men are employed in the mine and surface plants, the annual capacity of which is 250,000 tons of limestone, from which 40,000 tons of lime, 50,000 tons ofhydrate, and 30,000 tons of milled products are manufactured, leaving a balance of 130,000 tons of crude stone for direct shipment. The plant is served by the Sierra Railway. The health and safety of employees are carefully guarded, and the company has made an enviable record in respect to lost-time accidents.

**COLUMBIA MARBLE QUARRY**

The Columbia Quarry, 23/4 miles northeast of Columbia, has operated almost continuously since 1891 and has produced a great deal of handsome and durable dolomite limestone that has been used extensively in many of the finest buildings on the Pacific coast. The quarry is reported to have been purchased in 1938 by R. E. Tremoureux of San Francisco for the United States Lime Products Corporation, of which he is general manager.

The quarry comprises 160 acres, in which there is a belt of marble 1 mile long and 200 feet wide that has been proved to a depth of 500 feet. This block of ground is estimated to contain over 200,000,000 cubic feet of merchantable marble. Some of the stone is pure white, but more of it is white with bluish veining. Sometimes the marble is an attractive blue; and a handsome buff marble with red veining, known at Portola marble, also has been produced.

The method usually employed in quarrying is to channel out 16-by 12-foot blocks in horizontal section. These are then drilled horizontally at the depth of the channel cut, which usually is 10 feet, and broken off with wedges and feathers. In normal procedure the blocks are then subdivided into sections weighing about 7 tons, each of which is hoisted by derrick, placed on cars, and transported to the gangsaws.

All quarry equipment, including channeling machines, derricks, and air compressors, is operated electrically. In the marble-cutting shop are eight gangsaws, which use steel shot as the cutting medium. The saws cut at the rate of about 0.3 to 0.4 inch per hour, and it takes about a week to slab a block. After being trimmed with an air chisel, the slabs from the saws go to a cast-iron rubbing bed 12 feet in diameter and weighing about 10 tons. A fine quartz beach sand mixed with water is fed onto this rubbing bed, which revolves about 50 times per minute beneath the slabs resting upon it. The slabs are rubbed down in this way to the desired thickness, which is usually 1 1/4 inches, and the finish obtained is suitable for flooring, steps, and similar uses. The marble is hauled by truck to Sonora and shipped via the Sierra Ry. Twenty-five men are employed.
MARIPOSA COUNTY

GENERAL REVIEW

Gold mining was the earliest and chief mineral industry of Mariposa County, and the gold was derived both from lodes and placers. In recent years two other mineral industries have come to be of comparable importance in the value of their joint outputs—that producing barite and that producing limestone for making cement. In addition there are several small deposits of chromite, one of which yielded a few tons during the World War; there is also some copper-bearing ore and a considerable amount was once mined, though now only a small tonnage is produced occasionally.

Gold was found in the gravels of Mariposa Creek a few months after the first discovery of gold in California at Coloma in Eldorado County, near the other end of the Mother Lode. The placers of Mariposa Creek proved so rich and easily worked that they attracted much attention at first. Many people stampeded to them and quickly extended their discoveries to Agua Fria and other nearby creeks, where several thousand people were soon at work.

Lode mining also was begun early and with outstanding success because of the discovery of a trail of rich float leading up the hillside from Mariposa Creek to a vein in which the Mariposa mine was soon opened. By July 1849 a stamp mill was operating on the property, its power being derived from a 30-foot water wheel, a sketch of which has been preserved. This was probably the first stamp mill in California, though it was extremely primitive, being used only for crushing the ore to be washed in rockers for recovering the gold, as was customary with placer gravel. Mexicans appear to have been especially active in lode mining, as the histories of many mines of the county begin with accounts of Mexican operations to shallow depths. Some evidences of their arrastres can still be seen.

In this county the Mother Lode extends only about 24 miles from its northern boundary near Coulterville to the margin of a granodiorite batholith a little southwest of the town of Mariposa, where the sedimentary formations cease. The part of the lode characterized by wide veins of quartz and ankerite that is usually called the Mother Lode is flanked for miles on both sides by other well-mineralized fissuring less definitely localized in belts than it is in Tuolumne County.

The geologic formations of Mariposa County are not shown on the Mother Lode map of the Federal Geological Survey farther south than the Merced River. They are of the same general pattern, however, as in Tuolumne County, with the lode closely following the contact of Mariposa slate on the west and the earlier
amphibolite schists on the east, which are succeeded farther eastward by the Calaveras formation. There are also considerable areas of greenstones representing altered extrusive rocks and minor areas of intrusive rocks, predominantly granodiorite, aside from many dikes.

On the whole, the mineralization of Mariposa County is no less promising in appearance than that of Tuolumne County, but it has been far less productive, as previously shown. This may be due partly to a set-back received by mining in Mariposa County from the amazing claim of Gen. John C. Fremont to ownership of a huge tract of land covering 14 of the 24 miles of the lode within the county.

In 1847 Fremont had bought for $3,000 a Mexican land grant of 44,000 acres called Las Mariposas, whose boundaries had never been surveyed, though its location was described generally. Gold had not then been discovered in California, and Fremont left for the East without visiting his property.

In the following year he was once more leading an exploration party in search of a route to the West suitable for a railroad, this being the last of the several expeditions that had won him the sobriquet “the Pathfinder.” His course led him south to the Rio Grande, where he was astonished to see a horde of Mexicans crossing the river, from whom he first learned of the discovery of gold in California. They were headed for Mariposa Creek, from which the name of his grant had been derived. Fremont promptly abandoned his expedition, arrived at Mariposa early in 1849, and soon learned that his grant covered the richest area claimed by those who were mining gold.

Unfortunately for Fremont and all others concerned, his title to the property could not be established without protracted litigation. It was not officially accepted until 1852, and even then the recognition was canceled by order of a court.

As yet, the titles to mining land had been based merely upon staking the boundaries of claims and maintaining possession by occupancy under local rules adopted in meetings of the people immediately concerned; but the American Government, in acquiring California, had undertaken to respect previously existing titles to property. Fremont’s claim ultimately was confirmed by the courts, but only after litigation that lasted until October 1859, more than 11 years after the first discovery of gold in Mariposa County.

Meanwhile those mining within the boundaries of the Mariposa grant, finding themselves threatened with the status of mere squatters without legal rights, had fought General Fremont’s claims to the utmost, especially the individuals and companies with producing mines. Even after the final award to Fremont their sullen resist-
ance culminated in an armed attack upon the Josephine and Pine Tree mines, of which he had taken possession. The former actually was seized by malcontents, though the Pine Tree was defended successfully by means of stone fortifications Fremont had erected.

In 1863, Fremont sold the Mariposa grant, subject to $1,500,000 indebtedness, to a banker of New York City and received a like sum in cash. Ultimately he is said to have received a total of $2,000,000 from his original investment of $3,000.

This purchase price, regarded at that time as enormous, seems to have been justified by the apparent richness of the grant, as J. Ross Browne \(^{19}\) records that the production of bullion from its mines during the first 5 months of 1863 preceding the sale averaged $77,000 a month and rose to $101,000 in May, the last month of that period.

The expectations of vast riches from the grant that had been encouraged by studies and reports of the most eminent authorities of the time were not fulfilled. A scandal followed when the highly capitalized company that bought the property became bankrupt and was compelled to surrender it to creditors.

The truth is that the shallow placers had soon become virtually exhausted and the ores first mined at a profit were considerably richer near the surface than at slight depth beneath it. Undoubtedly a great deal of gold was lost through crude milling processes, and still more was lost with the increase of sulfides as the depth of mining increased. Other difficulties lay in a seasonal shortage of water that greatly reduced mill capacity in the dry months of the year. Spring floods, on the contrary, annually threatened and often damaged the dams used to impound water for the mills. Broadly speaking, mining and milling technology, communications, and sources of supply were as yet inadequate to permit much profit from such ores as were available.

Subsequent managements of the grant persisted long in a policy that precluded all likelihood of bringing about its exploration and development by enlisting the individual enterprise of venturesome miners. They required permission to prospect on the grant and issued only annual leases, a system that guaranteed only a minimum benefit to the discoverer of a workable deposit. The limitation of prospecting by permits was unsuited to the nature of such work as it was then conducted; prospectors would go only where they were free to hunt for ore wherever they pleased with an assured right of holding what they found.

These circumstances caused prospectors to avoid the 14 miles of the Mother Lode covered by the grant. Another 2 miles was included in the 20,000 acres of the Cook estate, leaving only 8 of the

24 miles of the Lode within the county as a possible site for mining enterprise of the kind freely practiced in counties to the north.

There is little wonder, then, that Mariposa County, blighted in its early period of promise and posted with warnings against trespass, remained dormant for decades and generally was reputed to be barren. Recently, with former restrictions relaxed, the interest of prospectors in veins of the Mother Lode within this county has been revived, with the result that its outlook for the future has improved greatly.

Despite all the unfavorable circumstances recited, the gold production of the county has been substantial, as will be shown before its source in individual mines is discussed.

**Production**

The total gold production of Mariposa County through 1937 is estimated at approximately $40,000,000, three-quarters of which was supplied by lode mines and one-quarter by placers. The value of this output far exceeds that of all other minerals and metals combined. In 1937 over a million dollars worth of gold was mined. However, during the last few years the output of barite has attained sizable proportions in both tonnage and value and is now second only to gold in the value of annual production. The mining of limestone for use in cement making ranks next in importance.

A few thousand dollars worth of silver is produced annually, chiefly as a byproduct of gold mining, and there is a nominal production of copper from the smelting of auriferous concentrates containing chalcopyrite. From 1860 to 1870 thousands of tons of high-grade copper ore were mined and shipped from zones of secondary enrichment near the surface in mines of the Foothill copper belt in the southwest corner of the county, but there are only fragmentary records of this early copper production. Copper was mined sporadically in small amounts between 1900 and 1915, but since then all copper produced has been a byproduct of gold mining.

Figure 34 shows the annual output of gold, silver, and copper in the county from 1880 to 1937, inclusive. In addition, small quantities of chromite, granite, marble, slate, mica schist, and silica have been mined from time to time.

The total value of the lode gold produced in Mariposa County before 1880 is uncertain, and the only basis of estimating it is records of production of some of the more important mines during these early years. These records, though scarce and largely fragmentary, apparently are authentic and are summarized as follows:
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<th>Placer gold ¹</th>
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<th>Silver</th>
<th>Copper</th>
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<td>Value</td>
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</table>

Fig. 34.—Annual production of gold, silver, and copper in Mariposa County, 1880-1937, inclusive.
<table>
<thead>
<tr>
<th>Year</th>
<th>Gold Production (troy ounces)</th>
<th>Silver Production (troy ounces)</th>
<th>Copper Production (troy ounces)</th>
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<tr>
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<td>1924</td>
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<td>1925</td>
<td>170,330</td>
<td>2,769</td>
<td>8,809</td>
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<tr>
<td>1926</td>
<td>179,573</td>
<td>2,627</td>
<td>9,327</td>
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<tr>
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<td>172,852</td>
<td>2,461</td>
<td>8,119</td>
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<td>1928</td>
<td>170,215</td>
<td>2,500</td>
<td>8,892</td>
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<tr>
<td>1929</td>
<td>118,472</td>
<td>2,096</td>
<td>5,832</td>
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<tr>
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<td>186,711</td>
<td>2,391</td>
<td>91,052</td>
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<td>826</td>
</tr>
<tr>
<td>1933</td>
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<td>2,000</td>
<td>58,985</td>
</tr>
<tr>
<td>1934</td>
<td>478,985</td>
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<td>38,488</td>
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<tr>
<td>1935</td>
<td>477,125</td>
<td>1,069</td>
<td>37,419</td>
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<tr>
<td>1936</td>
<td>741,090</td>
<td>1,397</td>
<td>122,395</td>
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<tr>
<td>1937</td>
<td>775,215</td>
<td>7,137</td>
<td>240,795</td>
</tr>
<tr>
<td>Total</td>
<td>458,182</td>
<td>10,483,218</td>
<td>17,643</td>
</tr>
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</table>

1 Separate production figures for lode and placer gold are not available prior to 1903.
Princeton (1859 to 1867) ........................................... $3,000,000
Hite (1863 to 1882) ........................................... $3,000,000
Mariposa (1849 to Oct. 1870) .................................. $1,500,000
Pine Tree and Josephine (June 1860 to May 1863, $350,000, and
Pine Tree, 1864, $67,940) .................................. $417,940
Oaks and Reese (1869) .......................................... $360,000
Badger (prior to 1880) .......................................... $60,000

Total ............................................................................... $8,357,940


The six mines listed probably include all of the production prior to 1880 of the three largest mines of the county—the Princeton, Hite, and Mariposa. The records of the three smaller properties are incomplete. The recorded output of these six properties is more than $8,000,000, and at least 35 other mines in the county produced considerable gold before 1880. These included the Adelaide, Bandarita, Bunker Hill, Comptononica, Cranberry, Crown Lead, Doss, Eureka, Feliciana, Ferguson, Francis, Green Gulch, Hasloe, Louisiana, Malvina, Marble Springs, Mary Harrison, Mexican, Mount Gaines, Mount Ophir, Number 9, Ortega, Oso, Queen Specimen, Rutherford, and Washington, all of which were in operation prior to 1875 and most of them prior to 1870.

Considering all that is known of the production of these miscellaneous mines, which evidently was substantial in many cases, an average annual production from them of about $200,000, totaling about $6,000,000 for the 30-year period beginning with 1850, appears to be a reasonable estimate. This, together with the $8,000,000 for the six producers previously listed, indicates $14,000,000 as the approximate total lode production of the county before 1880.

More accurate estimation of lode output of gold since 1879 is possible as there is a statistical record of the yield that accounts for $16,690,664 of both lode and placer gold for the period 1880–1937, inclusive. From this there must be deducted $548,152 for placer production after 1902. The lode production indicated is thus $16,142,512. Placer production was not segregated before 1903 but is known to have been minor from 1880 to 1902, having been about $2,000 to $3,000 a year. This may be covered suitably by rounding the figure of lode production to $16,000,000, which, when added to the production before 1880, indicates a total of about $30,000,000 as the approximate lode production of the county through 1937.

Statistical segregation of placer gold was begun in 1903, long after active placer operations had ended. Hence, the total amount of gold mined from the placers of Mariposa County can only be estimated from known circumstances and some scant data.

By far the greater proportion of the placer product was mined before 1860, in the first decade after placer mining began in Mariposa. The gravel deposits were fairly rich but were shallow and did not
cover as large areas as did those of Tuolumne County, which accounts for their rapid depletion. Probably $7,000,000 to $8,000,000 of gold was taken from the placers before 1860, and about $2,000,000 more from 1860 to 1870, a round estimated total being about $9,500,000. By then the placer output had dwindled to only a few thousand dollars a year, and it remained nominal for over 60 years until 1934.

Stimulated by the higher price of gold, $38,458 was mined in 1934, since when production has grown rapidly, to $249,795 in 1937, the recent increase having been derived almost wholly from several drag-

![Figure 35.—Value of annual gold production of Mariposa County, 1880–1937.](image)

...line operations on shallow creek placers that were submarginal at the old price of gold.

Placer gold mined in the county from 1903 to 1937 amounted to 17,648 ounces valued at $548,152 (see fig. 34), so that the approximate total output from Mariposa County through 1937 is estimated at $10,000,000. Adding this to the estimated lode-gold production of $30,000,000, brings the estimated total gold output of the county to $40,000,000.

Figure 35 shows the value of the annual gold production of the county from 1880 to 1937, inclusive. A further increase in the gold output of the county probably was made in 1938, though official statistics are not yet available. That the lode mines of the county will continue to be worked may reasonably be expected; but the placer
output inevitably will decline and again become nominal as the few remaining deposits of medium- and low-grade gravel suitable for dragline operations are exhausted.

LODE-GOLD MINES

The Mother Lode enters Mariposa County about 3 miles northwest of Coulterville and extends 24 miles southeast at an average distance of about 13 miles from the western boundary of the county. The sedimentary rocks in which the lode occurs cease in the region of Mariposa Creek, where it flows southwest from Mormon bar (see fig. 36). South of the creek is a batholithic mass of granodiorite that continues far to the south. The reputation of this granodiorite area as barren is unwarranted with respect at least to the marginal part of the batholith exposed in Mariposa County. Though most of the mines are north of its contact with the sedimentaries, there are many quartz veins and several mines south of it in the granodiorite. Moreover, it can hardly be doubted that the veins in the granodiorite are similar in origin to some of those found in the region north of them.

The lode proper, identified by huge veins of quartz and marmor-posite-ankerite, is flanked on both sides for a width of several miles by smaller veins, on many of which are mines. The belt west of the lode has a width of about 9 miles, and that to the east is 15 miles wide, with a few scattered mines still farther east to a distance as great as 20 miles. Generalizing, the belts on both sides of the axial lode may be said to be similar, except that the sedimentaries on the west are of Mariposa formation and those on the east are Calaveras formation. To the east, also, are the amphibolite schists. In both belts, however, are greenstones, generally representing early lavas, tuffs, and breccias, and areas of intrusive rocks, including a wide range from basic to acid. The massive intrusives generally are granitic, but some of them are gneissic or otherwise highly altered, as in the case of peridotites now transformed to serpentine. There are also numerous dikes of porphyritic or felsitic texture and very late aplite dikes with complementary dikes of basic composition.

The combined production of the East and West belts of the county has considerably exceeded that of the Mother Lode proper. A few outstanding mines on the lode itself, such as the Princeton, Mt. Ophir, Pine Tree and Josephine, Virginia, Louisa, and Mary Harrison, have produced its total yield, their outputs having been derived from fairly large tonnages of medium- and low-grade ore. On the other hand, the yield from the East and West belts has come from a hundred or more properties with richer ore. Of these, the Hite, Mariposa, Bondurant, Bandarita, Hasloe, Mount Gaines, Oaks and Reese, and Original have been among the largest producers.

The productive veins in both the East and West belts are fairly narrow, usually averaging less than 4 feet in width, and there is much to suggest that many of them derived their minerals to a surprising extent from still narrower seams of rich, high-grade ore
contained in them. This explains the fact that the county is identified with very rich specimen ore, some of which has been found in most of its mines. Nevertheless, such ore usually is so narrow and unevenly distributed that it becomes mixed with much lower-grade material while being mined, so that run-of-mine ore proves to be only medium in grade. It is believed that in many of these mines, as in the case of the mines of the Pocket belt in Tuolumne County, there was a late episode in which the fissures reopened slightly at a time when circumstances were favorable for rich gold deposition.

MOTHER LODE DISTRICT

For 13 miles or more—from north of Coulterville to south of Bear Valley—the veins of the Mother Lode are enormous. They consist predominantly of mariposite-ankerite and quartz. Of veins of this type, supposed to represent an early phase of the lode's mineralization, this part of the lode presents the most striking examples to be found anywhere along its entire course. The large quartz outcrops of the Mary Harrison mine may be seen on Maxwell Creek close to Coulterville. Crossing the divide and thence to the Merced River at Bagby are prominent massive exposures of mariposite-ankerite oxidized to a rust color. Similar outcrops appear south of the river in the vicinity of the Pine Tree and Josephine mines. Two miles south of Bear Valley is a huge quartz outcrop of the Mother Lode at May Rock, which rises 80 feet above the plain. (See fig. 42.) It is said to contain a little gold throughout and as much as $5 per ton where the quartz is much shattered. There is reason for assuming, however, that both the mariposite-ankerite and the huge quartz bodies accompanying it were virtually barren when they were deposited, and the larger part of their gold content was introduced by later fissuring accompanied by some deposition of gold. Narrow veins of very rich ore have been found in or at the margins of these massive deposits or in their vicinity, but it is usually obvious that the high-grade ore is of relatively late origin.

Beginning at the north and proceeding south some of the more important mines in the Mother Lode belt are the Champion, Black Hill or Pumpkin, Louisa, Mary Harrison, Virginia, Red Bank, Crown Peak, Pine Tree and Josephine, Mount Ophir, Louis, Green Gulch, Princeton, and New Princeton. Of these, the Princeton has been by far the largest producer, being credited with a total output of more than $4,000,000. It is noteworthy that the Mount Ophir mine supplied much of the gold for the first mint in California, which was built on the property in the early 1850's, and that it coined $50 gold slugs.

Of the high-grade ore for which the county is noted, a surprisingly small amount has been derived from the mines on the Mother Lode, the ores of which are generally low grade. It is believed that successful future developments on the lode itself must be predicated on large-tonnage operations with low unit costs.
MALVINA

The Malvina is one of a large group of mines near Coulterville formerly owned by the Merced Gold Mining Co. but now belonging to the Boston-California Mining Co., a syndicate headed by Charles H. and Eric Segerstrom of Sonora, Calif. It is situated about 1 1/2 miles southwest of Coulterville in sec. 4, T. 3 S., R. 16 E. (See 24, fig. 36.) A general view of the mine and mill is shown in figure 37.

The Malvina vein strikes N. 45° W. and dips 65° E. Although nominally in the West belt, the vein system of which the Malvina is a part unquestionably was supplementary to the main fissuring of the Mother Lode, which it parallels about 1 1/4 miles to the west, and for this reason it is treated here as a Mother Lode mine. From northwest to southeast the Malvina vein system is covered by the Boston, Mahoney, Glendive, G. Douglas, Miles, D. Cook, Helena, Potosi, Ninety-Four, Malvina, Bozeman, Regina, Malvina No. 2, and Rittershoffen claims.

In the early days these claims belonged to the extensive Cook estate, but they were acquired later by the Merced Gold Mining Co., which drove a long tunnel to the vein in the Potosi claim and at one time operated four mills. The Malvina is said to have been worked from a main tunnel level connecting through other properties with the tunnel and mill of the Potosi mine. From this level ore was mined to the surface, a distance of several hundred feet, and a winze was sunk 400 feet below the tunnel to the 600-foot level. The grade of ore and the yield from these operations are not known, but it is said that when mining ceased the ore was averaging only about $4.00 per ton. From 1895 to the fall of 1897 the property was bonded to Montana operators, who sank a two-compartment vertical shaft in the hanging wall, which intersected the vein at a depth of about 1,000 feet. From this shaft crosscuts were driven to the vein on the 200-, 400-, 600-, 900-, and 1,000-foot levels, and a substantial amount of exploring was done. Figure 43 shows a plan of the mine.

The present owners began unwatering the Malvina in the fall of 1933 to sample approximately 250,000 tons of 0.2-ounce ore shown by records to exist in the mine. In fact, some ore of similar grade had been mined and was available at the surface in a dump. Electric power was installed, and by November 1934 the 1,000-foot shaft had been reconditioned to the bottom. Exploration soon revealed ore of higher grade than was anticipated, and a considerable quantity containing $10 per ton or better was found, some of which was very rich, as indicated by the specimen shown in figure 39.

The Malvina vein ranges from 6 to 15 feet in width and is especially interesting because of its pronounced banding, which is well shown in figure 38. The illustration is fairly typical of the banding throughout the mine, though in the back of levels it is more even, as if the component of stresses had been much less in the
Figure 37.—Malvina mine and mill near Coulterville.

Figure 38.—An ore face in the Malvina mine showing typical ribbon vein structure.
Figure 39.—Rich gold ore from the Malvina mine.

Figure 40.—Typical ore from Mount Gaines mine (actual size).
Figure 41.—Pine Tree mine and mill near Bear Valley.

Figure 42.—May Rock, quartz outcrop of the Mother Lode near Bear Valley.
Figure 43.—Plan of Malvina mine.
direction of the strike in the vein than that on its dip. It is thought that each dark band represents what was once the slate hanging wall of a fissure; that it was transformed into a hard sheathing through silification to a relatively constant depth; that subsequent breaking in the hanging wall incorporated the sheathing in the vein; and that repetitions of this process gradually built up the vein from the foot wall to hanging wall. This method of vein formation, resulting in a banded structure, is discussed in detail on page 9.

The shaft house of the Malvina consists of a large, steel-framed, galvanized-iron structure that completely houses the head frame; a double-drum hoist operated by a 75-horsepower motor; a two-stage, Imperial, type 10, Ingersoll-Rand compressor; and tool and blacksmith shop.

Milling was begun in September 1938 and has progressed steadily ever since. Loaded mine cars are trammed from the shaft collar, across a trestle, over a tributary of Maxwell Creek, to a 65-ton mill erected early in 1938, where the ore is dumped into a 40-ton bin. Thence it is discharged over a 1-inch grizzly to a 9- by 24-inch Cedar Rapids crushe driven by V-belts from a 40-horsepower motor and broken to minus 1-inch size. The discharge from the crushe and undersize from the grizzly are elevated by a belt conveyor 62 feet between centers and having an 18 degree rise and a 16-inch five-ply belt to a 130-ton mill bin. A 16-inch belt feeder traveling 54 inches per minute delivers ore from this bin to an Eimco ball mill charged with 7 tons of 4-inch steel balls and driven at 25 r. p. m. by V-belts from a 100-horsepower motor. The mill heads contain $7.50 to $8.00 per ton in gold. The discharge from the ball mill, having about 80 percent solids, goes to a 26-inch Bendelari jig, which makes 133 3/4-inch oscillations per minute and carries a 2-inch bed of 1/4-inch steel shot. The hutch from the jig, containing coarse gold and heavy sulfides, discharges continually through a launder to a half-size Wilfley table making 278 3/4-inch strokes per minute and driven by a 1-horsepower motor. The concentrates from the table were treated with quicksilver and a little sodium cyanide in a 22- by 36-inch amalgamation barrel, the discharge from which is cleaned in a Galigher mechanical batea driven by V-belts from a 3-horsepower motor. About 62 percent of the total gold recovered is saved here. A middling product from the Wilfley table, assaying about $5.00 per ton, is shipped to the smelter at Selby, Calif., and comprises 22 percent of the total gold recovered. The table tailings are conveyed by a 11/2-inch Kimball-Crowe sand pump to a duplex Dorr classifier in closed circuit with the ball mill. This classifier is 6 by 22 feet, makes 211/2 strokes per minute, and is driven by a 5-horsepower motor. Its overflow has 22 percent of solids that contain 1 percent minus 100-mesh size, 24 percent plus-100- and minus-200-mesh, 25 percent plus-200- and minus-325-mesh, and 50 percent minus-325-mesh. The overflow from the classifier runs over a 4- by 4-foot amalgamation plate with drops at 1-foot intervals and thence to a steel sump, from which a 2-inch Wilfley pump discharges it to an 8- by 8-foot conditioner tank having a 24-inch Devereaux blade driven at 135 r. p. m. by a 3-horsepower motor.
About 0.025 pound of pine oil per ton of ore is added to the conditioner and the pulp is discharged to six Agitair cells, which act as roughers. An Adams siphon reagent feeder supplies 0.15 pound of American Cyanamide Z6 and 0.20 pound of American Cyanamide 697 to these cells per ton of ore for depressing carbon. Air is supplied by a Roots blower at a pressure of 2 pounds per square inch. A 24-inch Fagergren cell, which acts as a cleaner, follows the roughing cells. Flotation concentrates, assaying about $160 per ton and 16 percent of the total gold recovered, are sun-dried and shipped to the Selby smelter. Flotation tailings go to a 22-foot thickener, the underflow from which, containing about 50 percent solids, is discharged to waste after being sampled by a Galigher automatic sampler that takes a sample every 15 minutes. The overflow from the thickener is pumped by a 2-inch Myers pump, driven by a 2-horsepower motor, to an 8- by 8-foot steel mill-supply tank. Additional water for milling is pumped from Maxwell Creek against a static head of 250 feet through a 7,200-foot pipe line and discharged into a 22,000-gallon mill tank.

PINE TREE AND JOSEPHINE

The Pine Tree and Josephine mines, in secs. 9 and 16, T. 4 S., R. 17 E., are situated about 2 miles south of the Merced River at Bagby. (See No. 83, fig. 36.) They are included within an area of 5 1/3 square miles at the northern end of the grant recently purchased by the Pacific Mining Co., Crocker Building, San Francisco, whose president is Livingston Wernecke. A general view of the Pine Tree mine and mill is shown in figure 41.

The two mines are joined almost inseparably, not only by proximity and their close relation to the same geological structure, but by historical associations that began in the earliest period of Mother Lode discoveries. Rich ore was found in them in 1849, and they are supposed to have been highly productive in the years before the validity of the grant and ownership of the mines were settled by a court decision in 1859. After this decision was rendered, a struggle for possession of the mines began nevertheless and Fremont was actually besieged at the Pine Tree property by an armed band of miners, who had already seized the Josephine. He had fortified the Pine Tree, however, with rock walls and a tower at the tunnel portal and thus managed to defend the property; eventually he recovered the Josephine as well.

In spite of extravagant estimates of the wealth contained in these mines, as reported by Browne,27 who quotes the opinions of a number of early authorities, their known production is only about $2,000,000, though actual production probably exceeds this considerably. There is no record of production during the period of litigation previous to 1860, when there were obviously good reasons for concealing it. Browne records, however, that from the two mines $350,000

in bullion was produced from May 1860 to May 1863, derived from 45,000 tons of ore, and that $67,940 was produced in 1864. The total of $417,940 really covers only 3 years' operation, as nothing was produced in 1862, when a dam supplying power was carried away by a flood.

As to the grade and recovery from this ore, Browne states: "In December 1863, when the ore paid $29 to the ton, the refuse tailings assayed $16 a ton." He also quotes a report that "70 percent of the gold in the Benton mills was lost *. * *. This fact was ascertained by a series of assays upon the tailings which have been allowed to run to waste." The Benton mills were those at which the ore of the Pine Tree-Josephine mines was treated at the Merced River, where there was water power.

Logan 38 indicates that active production was continued to 1870. In a later period, 1900 to 1915, production of $371,748 from 20,968 tons (an average of $12.40 per ton) was recorded.

From 1933 through 1937, 170,943 tons, averaging 0.194 ounce of gold, was produced, the recovery from which was valued at $989,174. Recovery from 1938 was $267,434.

The Pine Tree is a hanging-wall vein and the Josephine a foot-wall vein of a sheared and mineralized zone on the course of the Mother Lode, averaging about 170 to 180 feet in width. The Pine Tree vein is about 20 feet wide, the Josephine 10 to 15 feet wide. In schists, carbonates, and mariposite, between the two veins, is considerable mineralization with an appreciable amount of gold for a width of about 140 feet. This low-grade material between the veins is known as the intervein carbonate ore body.

The strike of the lode is northwest and its dip about 60° NE. The two mines are included in a section about 3,000 feet long, where the lode is roughly lenticular in plan, swelling to somewhat greater width in the middle of the section and tapering toward its ends. The-workings of the Josephine mine are at the southern end of this section, those of the Pine Tree being at its northern end. They are not connected, but both veins have been exposed in each of the mines.

The veins are of quartz that is chiefly or nearly barren but includes shoots of quartz of a later generation containing enough gold to make milling ore, of which the Pine Tree has been more productive than the Josephine. A geologic section of the Pine Tree mine, taken from the fifth annual report of the Pacific Mining Co., is shown in figure 45.

The main ore shoot of the Pine Tree is 150 to 200 feet long and of substantial width within the bull quartz that surrounds it. It is said to yield about 18,000 tons per level, averaging 0.20 to 0.25 ounce of gold per ton with a value of $7 to $9. This ore shoot is not continuous but comprises a succession of curved lenses having cross sections shaped like an elongated or flattened $ that begin and end sharply but swell to a fairly constant thickness in the middle. They are 25 to 40 feet long and tend to overlap. Their vertical section is characterized in the same way. Some hold that these peculiar-

Figure 45.—Vertical geologic section of Pine Tree mine, 680 feet south of McKenzie shaft.

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shaped lenses were formed by breaking of a pay shoot originally continuous and the bending of its segments by intrusion of the surrounding bull quartz. Otherwise, it may be supposed that the continuity of an original ore shoot was broken by the flat faults shown in the section. In either instance the bull quartz probably was older than the ore shoots, as there is much evidence throughout the Mother Lode that the bull quartz is identified with a period before that in which deposition of gold was most active. Likewise, it has been noted in this mine that gold is in brecciations of the bull quartz and especially in seams marginal to it.

The Intervein carbonate ore is well exposed by five tunnels across it that are said to have yielded an average sampling of 0.08 ounce of gold, or $2.80 per ton, applying to a width of about 100 feet and a length of 800 feet estimated to include 12,000,000 tons from the surface down to the level of the Steampipe tunnel. It is said that excavation of only 1 ton of waste to 4 tons of ore would be necessary to mine this ore body by open-cut methods.

There is a striking similarity in the occurrence of the Intervein ore body of the Pine Tree vein to that of the large, low-grade ore body at the Carson Hill mine described in Bulletin 413 on Calaveras County (p. 102).

At the Carson Hill mine it seems probable not only that the thick inclined quartz of the Bull vein acted as a dam against which mineralizing fluids were held in their ascent but that the curved course of the hanging-wall vein provided a structure like an inverted funnel that acted as a trap for the fluids. At the Pine Tree mine there is also such a curvature of the quartz vein, although it is less pronounced. In both instances, also, the richer ore bodies exist where the veins at the lode margins are drawing closer together. At Carson Hill the best ore near the surface was found in the Morgan workings, where the width of the lode between the Bull vein and the Calaveras vein was least. It is understood that the narrowest part of the lode north of the Pine Tree has not been much explored; but still farther north, where the lode widens again, ore has been worked in what is known as the Queen Specimen mine. No positive conclusion is drawn from these facts, but it seems that they should be stated for further consideration in the study of Mother Lode ore occurrences.

Much of the work in these veins has been done from tunnels, but the Pine Tree mine has been opened by a shaft from its Pine Tree adit to a depth of about 1,150 feet, measured along the incline.

Figure 44 is a plan and elevation of the Pine Tree and Josephine, Queen Specimen, and Succeedo mines showing their interrelat,ion, and also the river adit, begun many years ago, which is again being driven forward to link all of the properties.

**Pine Tree mill.**—Ore from the mine cars is dumped into a 300-ton ore bin, which feeds a Pacific crusher having a 10- by 20-inch opening and making 325 r. p. m. The crusher, driven by a 30-horsepower motor, breaks about 25 tons of ore per hour to minus 1⅜ inches. Its discharge is elevated to a 200-ton mill bin by an 18-inch belt conveyor 126 feet between centers and having a 15° slope and a belt speed of 500 feet per minute. From the mill bin the ore is fed by a 16-inch pan conveyor with a Reeves variable-speed
transmission driven by a 3-horsepower motor to an 8- by 3-foot Harding mill. Two pans of ore are taken from this feeder every 30 minutes and weighed to determine the tonnage going to the mill, and the sample so obtained is crushed and split to supply a ball-mill heads sample. The Harding mill is driven by a 150-horsepower motor and is operated with a 14-ton load of 5-inch iron balls weighing 18 pounds each when new. The pulp in the ball mill contains twice as much water as ore and discharges to a single-cell Harz jig making 250 quarter-inch strokes per minute. The jig hutch is treated in an amalgamation barrel and yields about 10 percent of the total gold recovered. The overflow from the jig goes to a 16-foot duplex Dorroco classifier driven by a 5-horsepower motor and making 25 strokes per minute. The oversize from the classifier is returned to the ball mill, and the overflow is delivered by a 2-inch conditioning pump to the flotation unit. Characteristic screen analyses of the classifier products are as follows. Overflow: 12.2 percent plus 60 mesh, 24.8 percent minus 60 plus 80 mesh, 11.6 percent minus 80 plus 100 mesh, and 51.4 percent minus 100 mesh. Return: 23.8 percent plus 20 mesh, 47 percent minus 20 plus 40 mesh, 18.7 percent minus 40 plus 60 mesh, 7.6 percent minus 60 plus 80 mesh, 2.2 percent minus 80 plus 100 mesh, 0.7 percent minus 100 mesh.

A total of 0.16 pound of amyl xanthate Z8, a total of 0.05 pound of pine oil, and starch solution as required are added by Kraut reagent feeders to the flotation circuit, but none of these reagents is added in the ball-mill circuit. The flotation circuit has 12 Kraut cells with impellers making 1,100 r. p. m. Four rougher cells receive the pulp from the conditioner and deliver a concentrate to two cleaner cells and tailings to six scavenger cells, which return their concentrate to the rougher cells and discharge their tailings to waste. Samples of the flotation heads and tails are taken every 12 minutes. The tailings from the cleaner cells are returned to the roughers. The cleaner concentrates are delivered by a chain-type dewaterer to a heated screw conveyor, in which they are dried. The concentrates are shipped in bulk by truck or train to the smelter at Selby, Calif. They consist principally of pyrite and arsenopyrite, with smaller quantities of chalcopyrite, sphalerite, and galena in about equal amounts and 2 or 3 percent niccolite and millerite. It is interesting to note that the nickel content of the concentrates ranges from 0.35 to 1.35 percent and that during 1936 it averaged 0.77 percent.

Mill tailings flow to a dam in Queen Specimen Canyon, the clear overflow from which runs into the Merced River. Mill heads average about 0.152 ounce of gold and tailings 0.0228 ounce, indicating a recovery of 85 percent, which is excellent when it is considered that several radically different kinds of ore from different parts of the mine are treated.

CHAMPION

The Champion mine, owned by the Car Da Mining Co., of which Frank A. Noterman of Sonora is president and general manager, is 2 miles north of Coulterville on Blacks Creek in sec. 28, T. 2 S., R. 16 E. (See No. 2, fig. 36.) It consists of three claims—the Cham-
pion, Car Da Do, and Noipmahc, and covers 2,200 feet along the vein, which strikes N. 17° E. and dips 45° SE. between slate walls. It ranges in width from 2 to 10 feet. The ore consists of a quartz gangue containing gold, pyrite, galena, tetrahedrite, and sphalerite.

The vein is developed by a 440-foot single-compartment shaft with levels at depths of 140, 240, 340, and 440 feet and a 200-foot exit shaft. It contains about 2,000 feet of drifts, crosscuts, and raises. The ore shoots are nearly vertical. The mine makes about 40,000 gallons of water per day during the summer and 60,000 gallons per day during the winter. Water from the 440-foot level is lifted by an air pump to the 340-foot level; it is served by a 5-horsepower electric pump, which lifts the water to the 240-foot level, where a 10-horsepower pump forces it to the surface. The drainage from the 140-foot level is handled by a 5-horsepower electric pump. Air for drilling is supplied by a 250-cubic foot Ingersoll-Rand compressor driven by a 30-horsepower motor, and a 10-inch Buffalo blower run by a 3-horsepower motor furnishes ventilation. Drilling is done with two automatic drifters and automatic rotating stopers. Drill steel is sharpened by machine. The shaft is served by a single-drum hoist driven by a 30-horsepower motor. The head frame is 32 feet high and contains a 65-ton bin, into which the ore is delivered by a 1-ton skip. From this bin it is transported by an autotruck to the mill, about 125 feet away, where it is broken into minus 1½-inch in an 8-by 10-inch Blake-type jaw crusher with a Tex-rope drive from a 15-horsepower motor. This crushed ore is delivered to a 10-ton fine-ore bin, which is discharged by a Challenge feeder to a 5-stamp mill operated by a Tex-rope drive from a 15-horsepower motor. The stamps weigh 10,050 pounds each and drop through a height of 6 inches 107 times per minute. The stamp-mill pulp is crushed through a 40-mesh punched screen and flows over a 5-by 10-inch amalgamation plate. Approximately 15 tons of ore is crushed by the mill in 24 hours. Of the total free gold, 60 percent is recovered inside the battery and 40 percent on the plate. The pulp from the plate goes to a Wilfley table, the concentrates from which are hauled by autotruck to the smelter at Selby, Calif. These concentrates comprise about one-quarter of the total gold recovery. The concentration ratio is 30 to 1. The contents of the battery and high-grade ore from the mine, the latter comprising about 10 percent of the total gold output, are treated in an 18-by 24-inch amalgamation barrel, run from a jack shaft on the stamp mill. With mill heads averaging $10 a ton, the tailings contain about 70 cents per ton. The present mill was begun in June 1936, and the total production to August 1938 was approximately $60,000.

Twelve men are employed in the mine and four men in the mill in 24 hours. The mine is operated one shift for ore extraction and two shifts for development. The property is equipped with a bunkhouse, office, cook house, hoist and compressor house, blacksmith shop, and change house.

MOUNT OPHIR

The Mount Ophir mine, situated northwest of the Princeton and about a mile west of Mount Bullion in sec. 12, T. 5 S., R. 17 E., is a property of the Mariposa grant. (See No. 129, fig. 36.) It
includes nearly 3,000 feet along the Mother Lode, and its huge outcrops of quartz are prominent features of the landscape.

The production of this mine has not been large, and little is known of its early operations when the ore was milled in arrastres, some remains of which still existed until recently. Although Fremont dispossessed miners who were conducting operations on the property after his title to the grant was confirmed, little further work appears to have been done until the mine closed in 1864. However, the company records show a production of $43,000 from 1,845 tons, an average of $23.20 a ton, from less than 3 months' operations in 1860.

In 1868 Browne reported that the mine had been "worked extensively," that it produced $12,000 in 1864, and that its mill of 28 stamps was then idle. Apparently the property remained idle thereafter until 1900.

From 1901 to 1905, 1,523 tons was mined and was treated at the Princeton mill with an average recovery of $15.50 per ton. Less than 1,000 tons was mined by leasers from 1906 to 1914, with an average recovery of $7.40 per ton. The recorded production is thus 4,221 tons yielding $72,966, an average of $17.30 per ton; but total production from earliest operations has been estimated as $250,000 to $300,000.

The vein here is between a slate hanging wall and a serpentine foot wall. Occasionally a dike intrudes along the slate contact. The strike of the vein is N. 47° W., its dip 55° NE. The quartz averages about 15 feet in thickness, ranging from 3 to 30 feet. Ore was stoped for a width of about 5 feet, only the relatively high-grade material having been selected, according to reports of those who worked there.

The workings include two tunnels that follow the course of the vein. The lower, 700 feet long, gains a vertical depth of 250 feet, equivalent to about 300 feet on the dip of the vein. The other is 320 feet long 115 feet above the lower tunnel. Several shafts connect through workings to the upper tunnel, and there is a connection between the tunnels.

The upper tunnel and the first 250 feet of the lower one are reported to have been driven before 1860.

In the vein, minor step-faulting rarely exceeded 10 feet or so; it was not difficult to follow the vein. It is said that the main body of quartz was barren but was fractured and recemented with gold-bearing quartz that was mined selectively.

The failure of this property to make a mine of some importance does not seem conclusive, especially in view of the fact that it was worked chiefly very early when only relatively high-grade ore was sought. Subsequent operations were sporadic and minor.

It was claimed in a report of 1922 by Frank Eichelberger that the workings contained 4,000 to 5,000 tons of ore averaging 4 feet in width that would mill $5 to $6 (old price of gold), as indicated by sampling done at that time. The writer of the report thought new developments would disclose better-grade ore. He stated that all drifting had merely followed the footwall and indicated that the large bodies of massive quartz had not been crosscut.

It is hardly to be doubted that such a vein will receive further attention ultimately.
The Princeton mine is near the center of the Mariposa grant, about a mile west of the town of Mount Bullion, in sec. 18, T. 5 S., R. 18 E., at an elevation of 2,200 feet. (See No. 133, fig. 36.) It is one of the properties belonging to the grant.

It has produced more than 4 million dollars in gold but has been idle since 1915. At the present price of gold the value of its output would be about 7 millions.

The vein is in the black Mariposa slates that have generally proved to be the most favorable country rock in the northern Mother Lode counties. It strikes N. 50° W., dips about 55° SE., and averages about 5 feet in width. It consists chiefly of a white friable quartz with fine-grained pyrite and occasional small amounts of galena, and it usually is ribboned with narrow bands of silicified slate. Most of the ore mined has averaged between 0.2 to 0.3 ounce of gold, but all of the vein contains an appreciable amount of gold, as indicated by assay maps.

The vein was opened by an inclined shaft 1,660 feet deep, with nine levels. Development includes about 12,000 feet of drifts, 1,800 feet of raises, and 1,800 feet of crosscuts, totaling about 15,000 feet. A section of the mine workings in the plane of the vein is shown in figure 46.

This mine was discovered and first opened in 1852, according to Logan, its ore then averaging about $70 a ton to a depth of about 100 feet. It is further stated in a report by an engineer named Brumagin, filed as a record of the Mariposa grant, that $100,000 in rich specimens was taken from a place only 100 feet deep. However, there is no detailed record of production in this early period.

Large-scale operations were begun in 1859, by a company that leased the property from General Fremont as soon as his title to the grant had been confirmed by the courts. For a time the mine attracted much attention by production that averaged a million dollars a year in 1862 and 1863.

Browne records a total production of $2,563,633 during the 4-year period 1859 to 1863. That amount was derived from 147,000 tons of ore from which an average of $17.44 per ton was recovered. The losses incurred in the primitive milling were very great, however. The ore as mined in this period probably averaged more than $25 per ton.

This relatively high grade ore having been bottomed at the 600 level, an additional $243,700 was produced in 1864 by drawing the pillars, bringing the total recorded production to $2,807,333 for the 5 years of operation. Unfortunately, waste was dumped into the shaft during the last phase of operations, and that may have contributed to rendering the mine idle for a long term of years.

When the grant was bought by a British firm in 1899, a new shaft was sunk in the vein; and, below a brief nearly barren zone in which the early workings had been bottomed, ore of fair milling grade was found as far as the 1,200 level. In the 12-year period 1899–1911, 350,214 tons of ore was mined, from which $1,375,300

Figure 46.—Section of the Princeton mine in the plane of the vein.
was recovered, an average of $3.92 a ton, bringing the total recorded production to $4,182,693. Careful sampling of the tailings later showed 58 cents per ton, so that the gross value had been about $4.50 per ton, equivalent to $7.65 at the present price of gold. From assay charts of levels and stopes much of this tonnage appears to have averaged $6 to $7 a ton, but that average was reduced in the latter part of the period by the mining of very low grade pillars; and all rock from driving the levels, including much waste as well as ore, was milled.

The lowering effect of this upon the average grade must have been especially pronounced with respect to rock from the lower levels, where the gold content had fallen materially.

Calculation from an assay chart of the 1,100 level north of the shaft shows an average value of $4.43 a ton, 4.87 feet wide for the first 299 feet back from the face. This would be equivalent to $7.53 at the present price of gold, but this grade evidently was lower than that prevailing in the upper stopes. Continuing southward, the average grade drops to $4.02 for an average width of only 3.53 feet through the next 552 feet. The average through a total of 851 feet was thus $4.18 with an average width of 4 feet. The equivalent at the present price of gold would be $7.10.

On the two lowest levels—at 1,400 and 1,600 feet—the ore proved too low-grade to be mined, except in one stope above the 1,400 level. Brumagin states that 1,500 feet opened on the 1,600 level averaged $1.54 ($2.62 at present price of gold) through an average width of 4.89 feet and that 185 samples taken from muck piles during the driving of the level averaged $2.41 per ton. It is evident, therefore, that appreciable amounts of gold continued as deep as the 1,600 level, though not in sufficient quantity to warrant its mining. Brumagin also states that "quite a shoot of $6 ore was encountered in the south drive." Failure to explore such a shoot would not be improbable, as closing of the mine was brought about in part by an inadequate water supply over several seasons for generating power at the Merced River. It is recorded that just before operations ceased the water had barely been pumped below the 1,600 level when the power gave out and the pumps had to be withdrawn pending the next season of high water.

Further light is thrown upon the question of values on the 1,600 level by computations from the sample chart of the level. North of the shaft it shows appreciable values in three sections separated by barren intervals. The first section includes the first 81 feet from the north face. It shows a weighted average of $2.39 a ton through an average width of 6.34 feet. The second section is 53 feet long with an average value of $2.66 over an average width of 4.13 feet. The third section is 269 feet long with average value of $3.05 through an average width of 4.33 feet. These three sections together average $2.83, with a width of 4.72 feet, through a combined length of 403 feet. This value at the present price of gold would be $4.81 a ton.

In most of the deep mines of the northern Mother Lode counties, lean zones have been found that subsequently were passed, with the result that new commercial ore bodies were found in depth. Several able engineers, well-acquainted with this characteristic of Mother
Lode mining, have therefore expressed belief that the Princeton vein would likewise probably have shown lower horizons of pay ore below the 1,600 had exploration been continued in depth.

Hennen Jennings, who presumably was well informed as to showings in other deep mines of the Mother Lode and had become part owner of the grant, is of record as having advocated the sinking of a new vertical shaft to intersect the vein 400 feet below the 1,600 level. After the death of Jennings, G. D. B. Turner, another engineer of recognized ability who had extensive knowledge of lode operations, proposed that a new shaft, instead of being made vertical, should be inclined to explore, during its sinking, a new section of the vein where the Princeton was intersected by another vein, the Ludwig, and had produced 736 tons of quartz at the surface that averaged $13.37 a ton. In 1917, however, Turner assumed that mining costs on the Princeton should be comparable to those of the Plymouth, which then averaged $3.40 a ton with a daily production of about 400 tons.

The Princeton mine made little water—about 30 gallons per minute—and it was necessary for milling operations to pump water several miles from Agua Fria creek. The flooded workings are supposed to contain about 40 million gallons.

WEST BELT

In Mariposa County there has been much fissuring to the west of the main Mother Lode, with subsequent intrusion of dikes along the fissures, accompanied or succeeded by mineralization from gold-bearing solutions. This has resulted in a nearly continuous belt of gold mines to the west of the lode extending from the north boundary of the county to the Francis mine (see No. 151, fig. 36) on Mariposa Creek, a distance of 22 miles, and to as far west as the Doss mine near Hornitos (see No. 123, fig. 36), 9 miles from the lode. The western portion of this belt of gold mines overlaps the Foothill copper belt. It seems probable that these copper deposits were approximately contemporaneous with the gold deposits of the West belt and that the two are closely related in origin. The copper ores always contained some gold and occasionally, as at La Victoria mine in Hunter Valley, fairly high gold values.

The gold mines of the West belt are far more numerous in this county than in either Tuolumne County (where they are almost lacking) or Calaveras County (where there are only a few producing gold mines to the west of the lode).

Beginning at the north and proceeding south, some of the better-known mines of the West belt in Mariposa County are as follows: The Potosi and Malvina, which, though close to the Mother Lode, are actually in the West belt; the Live Oak and Governor, Oaks and Reese, Iron Duke, Cotton Creek, Pyramid, Mount Gaines, Hickman, Elizabeth, No. 9, Long Mary, Alice, Ruth Pierce, Doss, Ortega, and Francis.

The veins are in a wide variety of formations, which may be broadly generalized as chiefly of upper Jurassic age, including the Mariposa formation and rocks of related marine deposition, also a series of intrusives ranging from peridotite (now altered to serpen-
tine), pyroxenite, basic intrusives represented by hornblende schists, and acid intrusives including granite and much granodiorite. There are also several formations consisting of early volcanic rocks interbedded with the sedimentaries and numerous late dikes, which have generally intruded along contacts and are nearly always to be found in close proximity to the veins. It is also characteristic of virtually all of the mines that the ore deposits are on contacts of some sort, one of the walls usually being an intrusive that is most frequently a dike.

Detailed descriptions of the principal producing mines of this belt follow:

OAKS AND REESE

The Oaks and Reese mine in Hunter Valley is 9 miles north of Hornitos and 2 miles east of the Exchequer Reservoir in sec. 32, T. 3 S., R. 16 E. (See No. 48, fig. 36.) It comprises two patented claims—the Grand Prize and Badger—and covers 26 acres. When visited in July 1938, it was operated by W. A. Hayes, 156 Montgomery Street, San Francisco; Thomas Henry of Hornitos was mine superintendent.

This mine was discovered in 1863 and was one of the important early producers of the county. It is credited with a total production of $500,000 to $600,000 and was characterized by very rich ore, first worked in arrastres that were succeeded in 1866 by a 10-stamp mill. Two years later there were 28 stamps, and Raymond\(^{22}\) reports that $50,000 per month was produced throughout 1869. Apparently, however, the mine was closed soon thereafter, and except for the desultory operations of a few leasers it remained closed until June 1937.

The ore in this property is in the footwall region of a strong, quartz vein called the Blue Lead, which is 5 feet in average width, strikes northwest, and dips at about 75° NE. In the footwall of the lead, which is a chert, are four lateral veins 1 to 2 feet wide and several hundred feet long in a distance of 1,200 feet along its strike. The best ore is in these narrow veins, being richest at their junctions with the Blue Lead. The chief ore body was in the nature of a pipe at the junction of the Potts lateral with the Blue Lead, the high-grade passing into lower-grade ore in both directions along the footwall of the larger vein. The ore from this shoot averaged about 2.5 ounces of gold per ton, though the best of it ran 5 ounces per ton or more.

The main shaft was sunk to 450 feet at the junction of the Potts lateral and the lead, and there are two other shafts 160 and 70 feet deep, respectively, on other laterals. The ore in the laterals averaged about 16 inches in width. In the main shaft there are levels at depths of 130, 200, 300, and 450 feet. The vein is stoped for 60 feet north on the 200-foot level nearly to the surface and was mined on the lateral 282 feet from the shaft on the 130-foot level and 147 feet on the 300-foot level. In all, there are only about 800 feet of drifts from this shaft, and this small footage may indicate that the ore became two low-grade for profitable mining a short distance from the intersection of the lateral and the lead. In July 1938, the Blue Lead was being drifted on from the 200-foot level to pick up its junction with the next lateral 300 feet south.

An interesting statement by William Irwin of San Francisco, who was formerly superintendent at this mine, is quoted from a report by an unknown writer dated 1904.

The principal workings were upon the small (No. 1) lateral vein and the stopes or area of ore extracted along the course of the vein extended about 200 feet toward the creek or to the south. Beyond this 200 feet there is still in place good average ore which would not pay in those days, probably averaging about $15 per ton. In the main workings the best ore was confined to a space of about 70 feet near its junction with the Big Blue vein, and this portion of the vein was extremely rich all the way from the surface to below the 500 level. In fact, it was a succession of pockets all the way down, the ore averaging easily over $100 per ton.

After reaching below the 500 level, this shoot of ore did not keep its average up, but still was of such a grade as to be considered high-grade ore. The rest of the ore extracted beyond this rich shoot was of a profitable grade for those days, averaging from $20 to $35 per ton and the general average of the entire mine ore, as returned for in the mill, was about $40 per ton. This did not include milling losses, which were undoubtedly large with the slipshod amalgamation methods of those days, nor did it include the concentrates. * * *

A large quantity of waste was put through with the quartz, as the large capacity of the mill and the smallness of the vein necessitated some waste being milled with the quartz. The daily tailings averaged $8 per ton and over.

The mine paid dividends nearly every month besides paying the cost of the new mill additions, hoist, and various buildings. The vein varied in width from 10 inches to 2 1/2 feet, averaging throughout 16 inches. In the large vein were occasional bunches of very fair ore but it would not pay as a whole, on account of the high costs at that time. It was frequently crosscutted its entire width of 30 feet, but a profitable shoot of ore (with the current expenses) was not found. However, the footwall streak of this vein was of a higher grade than the rest of the width, and at the present cost of operations it can be classed as pay ore. The vein (the large one) was never prospected to the southeast, beyond the diverting influence of the rich cross veins, and here is excellent ground for finding higher-grade ore.

In the spring of 1870 the main body of quartz diminished in size and grade, and work was stopped as soon as it ceased to pay. Irwin states that there was still a good strong vein in the bottom, although smaller than usual, and that ore of average grade remained in the south faces of the small vein. The 160-foot shaft was sunk on another lateral somewhat wider than the Potts. The operation was known as the Floyd mine. It showed a rich pocket at the surface containing $5,000. Irwin and another bonded it and took out $67,000, but it was then consolidated with the Oaks and Reese and remained undeveloped when that mine closed.

The main shaft, 5 by 12 feet in section, is equipped with a 52-foot head frame. A 17 1/4-ton skip, operated by a 50-horsepower electric single-drum hoist, dumps ore into a 25-ton bin and waste into a similar bin, both in the head frame. From these bins waste is taken by truck and distributed along the circumference of the mine dump and ore is hauled to the mill on the hillside about 100 yards from the shaft. Here the ore is dumped over a 1 1/2-inch grizzly, the oversize from which goes to a 15-horsepower Pacific jaw crusher set to break to minus 3/4-inch size and having a capacity of 40 tons per 24 hours. The discharge from this crusher and the undersize from the grizzly fall into a 100-ton mill bin, from which the ore is conveyed by a belt-feeder operated by a variable-speed motor to a 40-ton Marcy ball mill charged with 5,600 pounds of 4-inch steel balls and belt-driven at 31 r. p. m. by a 35-horsepower motor. The pulp in this mill contains 33 to 50 percent solids and is discharged
to a Bendelari jig operated by a 2-horsepower motor. The hutch from the jig discharges continually to a 4- by 10-foot amalgamation plate and thence to an Economy concentrating table. As most of the gold in the ore is free, the concentrates recovered on this table are low-grade and generally contain only about 1/2 ounce gold per ton. They are cleaned up in an amalgamation barrel. Tailings from the table flow over a corduroy table 14 feet long and 18 inches wide and thence to waste. The corduroy is washed out periodically, and the material caught by it is panned. The overflow from the jig goes to a duplex Dorr classifier in closed circuit with the ball mill. The classifier overflow is discharged over amalgamation plates to an Economy concentrating table. The sulfides recovered on this table are cleaned up in the amalgamation barrel and the tailings are wasted. Much of the old dump at the mine has been milled and is reported to have yielded $6 per ton. Eight men are employed.

IRON DUKE

The Iron Duke mine, adjoining the well-known Oaks and Reese property on the southeast, is situated in sec. 4, T. 4 S., R. 16 E. (See No. 75, fig. 36.) It includes the Iron Duke, Commercial, and Petro claims situated on the same Blue Lead that traverses the Oaks and Reese claims. Many years ago a 100-foot shaft was sunk on the property at the junction of the Blue Lead and a cutter vein, and in sinking it ore was found from which 190 ounces of gold are said to have been mortared. However, with the exception of sporadic leasing, there was little further work on the property until July 1934, when E. F. McTarnahan and associates began development, hauling ore from the mine to a 5-stamp mill at Hornitos. Their operations proved short-lived; and on January 1, 1938, the mine was taken over by J. O. Gillice, 156 Montgomery Street, San Francisco, acting as trustee.

In this property the Blue Lead averages about 4 feet in width, strikes N. 37° W., and dips 70° NE. Its hanging wall is greenstone and its foot wall a carbonaceous slate with a belt of chert about 10 feet back of it. A porphyry dike occasionally contacts the vein from the foot-wall side. Ore is present at the junction of narrow cross veins, referred to as cutters, which intersect the Blue Lead at intervals of about 250 feet and at angles of 45° to 90°. The ore extends out from the Blue Lead on the cutter veins.

The property is developed by a 200-foot inclined shaft, with a 500-foot drift south on its 185-foot level. This drift intersects two cutters, which have been drifted on for 75 and 100 feet, respectively. Their gold content is spotty, and because the veins range from only a few inches to 3 feet in width there is a considerable dilution of the broken ore by wall rock. A powder box full of ore from a high-grade pocket in one of the cutters yielded $524, but it is difficult to keep the grade of average mill heads much above $10 a ton. Sulfides in proximity to high-grade ore are rich but elsewhere rarely contain more than $50 a ton. They consist chiefly of marcasite and arsenopyrite and constitute 1 1/2 to 2 percent of the ore.

A two-stage Gardner-Denver compressor supplies air for drilling at 100 pounds pressure. The ore is crushed in a No. 2 Hadsell pendulum mill driven by an 18-horsepower gasoline engine and having a maxi-
mum swing of 16 inches. With automatic feed this mill crushes 10 tons of ore per day through 40 mesh. The pulp flows over two 4- by 6-foot amalgamation plates with a 1½-inch drop between them and a slope of 1½ inches to the foot, and then is subjected to countercurrent flotation in four Kraut cells. Ninety percent of the total recovery of gold is by amalgamation, and a total extraction of 95 percent or more usually is obtained. Five or six men are employed.

COTTON CREEK

In July 1937 the Cotton Creek Mining Co. began development of a prospect in Hunter Valley in sec. 22, T. 4 S., R. 16 E. (See No. 78, fig. 36.) W. H. Hauser, Richmond, Calif., is manager of the company, and Thomas Atalic, Hornitos, is mine superintendent.

The vein, which is in greenstone, strikes northwest and dips 18° to 20° S. It has an average width of about 2½ feet and a maximum width of 5 feet. The ore consists of ribbon quartz containing auriferous pyrite and free gold. It is said to average about $15 a ton. When the property was visited in August 1938 the vein had been opened by a 175-foot inclined shaft and a drift running about 75 feet both north and south on the 100-foot level. Figure 53 (p. 148) shows a general view of the mine and mill.

Ore from the mine skip is dumped into a 40-ton bin, from which it is fed to a 10- by 20-inch Blake-type jaw crusher, which reduces it to minus 1½-inch size. The discharge from the crusher is reduced further in an 8- by 10-inch Straub crusher with a ¾-inch discharge opening which delivers it to a Leahy vibrating screen with punched holes 1 inch in diameter. The crushers and screen are driven by a 40-horsepower motor. The undersize from the screen is delivered by a 24-inch belt conveyor, 75 feet between centers, to a 100-ton fine-ore bin, from which it is discharged by two swing feeders to a 3- by 4-foot Marcy mill and a 2½- by 3-foot Straub mill driven by 75- and 40-horsepower motors, respectively. The discharge from the Marcy mill goes to a Pan-American jig and that from the Straub mill to a home-made two-compartment pulsator jig. The hatch from the jigs is concentrated on a 5- by 8-foot Straub table, and the concentrates are treated in a Gibson impact amalgamator. The tailings from both jigs go to a Dorr classifier in closed circuit with the Marcy mill. The classifier overflow is delivered to a 40- by 40-inch Groch flotation cell, which yields a shipping concentrate and tailings that are re-treated in four Kraut cells. The first of the Kraut cells makes a shipping concentrate, and the concentrates from the other three cells are returned to it. Flotation tailings are treated on an Overstrom table, the tailings from which are wasted. The tailings from the Straub table, which concentrates the jig hutchers, are pumped back to the classifier. Three-quarters of the total gold recovered is contained in the hutchers of the jigs. The concentrates are shipped to the smelter at Selby, Calif., and usually contain about 14.5 ounces of gold and 10 to 11 ounces of silver per ton.

PYRAMID

The Pyramid mine comprises 200 acres of an agricultural patent in secs. 4, 5, and 23, T. 4 S., R. 16 E. (See No. 79, fig. 36.) It is
owned and operated by Pyramid Gold, Inc., of which Eugene B. Gratton, Grant Building, San Jose, Calif., is president, and Lloyd A. Mason, Hornitos, is general manager.

A quartz vein with an average width of 5 feet strikes N. 65° W. and at the surface dips south at about 45° but steepens to 80° within a depth of 190 feet. Grayish slate and a porphyritic rock form the foot wall and diorite the hanging wall. The quartz ore contains gold associated with about 1½ percent sulfides, consisting chiefly of pyrite, galena, and sphalerite. The ore averages 0.3 to 0.6 ounce of gold per ton. Ninety-five percent of the gold is free and the concentrates are of good shipping grade, containing 5 to 6 ounces of gold per ton.

The vein is developed by a 6- by 10-foot inclined shaft 190 feet deep, which has three levels. On the 65-foot level drifts extend 90 feet north and 240 feet south of the shaft; on the 105-foot level drifts extend 238 feet north and 85 feet south, and there is a 215-foot north drift on the 176-foot level. The best ore is found where the footwall is porphyry, and sometimes it is very rich. Five hundred tons averaging over $100 a ton were stope above the 65-foot level. About 600 feet south of the shaft, in section 23, there is a parallel vein 6 to 8 inches in average width that in one place shows ore of $100 grade. This vein was opened in early days by a 165-foot shaft, but it is now half filled with debris.

A single-drum Alamo hoist is operated by a 15-horsepower gasoline engine, and a 130-cubic-foot Chicago Pneumatic compressor driven by a semi-Diesel hoist head engine supplies air at 100 pounds pressure for drilling. Ore from a 37-ton bin in the head frame is trammed to a 5-stamp mill where it is reduced to minus 1½-inch size by a 6- by 8-inch Blake-type jaw crusher and delivered to a 22-ton mill bin. From this bin it is discharged by a Challenge feeder to the stamps, each of which weighs 1,000 pounds and drops 105 times per minute through a height of 6½ inches, crushing the ore through a 20-mesh punched screen. The stamp-mill pulp flows over a 4- by 16-foot amalgamation plate and thence through a mercury trap to a Wilfley table. The table concentrates are shipped to the smelter at Selby, Calif., and the amalgam is retorted, the sponge gold being sold to the San Francisco Mint. The mine makes about 15,000 gallons of water per day, which is used in the mill. Six to eight men are employed.

MOUNT GAINES

The Mount Gaines mine is an old one with a record of substantial production that is now being revived with apparent success. It is situated 6 miles northeast of Hornitos in secs. 25, 26, 35, and 36, T. 4 S., R. 16 E. (See No. 81, fig. 36.) Merced Falls, the nearest point on the railroad, is 12 miles west by road. The mine is owned by the Mount Gaines Mining Co., of which Nielson L. Wagner, Hornitos, Calif., is general manager. L. G. Corwin is mine superintendent.

The property includes 593 acres, 320 of which are patented. Within this area the main vein system is said to extend nearly 9,000 feet. The property represents a consolidation of several early
mines, including most notably the Mount Gaines, Bearfield, and Frenchman. A general view of the mine and mill is shown in figure 47.

Nearby placers on Eldorado and Burns Creeks are said to have been worked from 1853 to 1873 and to have produced a large amount of gold. In 1868, lode mining was begun at many places on the property with shallow workings of rich but narrow stringers, the ore from which was milled in arrastres. A few years later a nearly vertical shaft was sunk about 400 feet on the Frenchman, about 2,000 feet northeast of the present Mount Gaines shaft. Selected high-grade ore from very narrow workings at this shaft is reported to have yielded about $100,000. Beginning in 1880, three successive mills were built on the Mount Gaines, two having been destroyed by fire and the third by flood. They are said to have operated chiefly upon ore from narrow surface workings in the Mount Gaines and also to have recovered $150,000 from ore from the Bearfield. In 1908 the Mount Gaines was equipped for operating the consolidated properties, but mining to the 500-foot level resulted in a net loss.

The Mount Gaines shaft varies in dip but averages about 30°. It is 1,322 feet deep, measured along the slope, and has two compartments. It lies beneath a dike regarded as the hanging wall of the vein, against which the best ore in the mine usually has been found, and the only ore in persistent shoots. Beneath the dike are slates, heavily shattered through a zone said to range from 15 to 75 feet in width to what is referred to as the footwall. However, little exploring has been done that far to the west of the dike, and the footwall is probably an irregular boundary of crushing and fissuring. No ore has been found above the dike, so the mineralization may have been related to the damming of solutions beneath it as they rose through the shattered ground, forming irregular deposits in it as well as against the dike itself.

In 1909 a new management proved more successful, deepening the shaft and drifting as much as 1,000 feet north of it and 750 feet south, so that the workings extended over 1,700 feet along the vein. Production from 1900 to 1911 is reputed to have totaled nearly $1,000,000. The average gold content of the ore mined during that period was between 0.48 to 0.53 ounce per ton, and the average recovery was 0.455 ounce per ton, with mill losses estimated at about 10 percent. Approximately 100 tons per day was treated, and total operating costs were $5.40 per ton. It is assumed, therefore, that the above cost represented the lower limit in value of the ore mined, an assumption that is partly supported by recent sampling. All drifts follow the hanging wall, though several veins at varying distances to the west of it were worked from the surface. Most of the ore was mined from shoots in the hanging-wall vein beneath the dike, but some of it came from overlapping lenses, irregular quartz masses, and cross veins through the slates that ended at the dike.

Between the 350- and 900-foot levels were four ore shoots, succeeded by irregular quartz masses. Three of these were 55 to 120 feet long; the fourth was about 400 feet long. On the 1,200-foot
Figure 47.—Mount Gaines mine and mill near Hornitos.

Figure 48.—Quartz vein in the Mount Gaines mine.
level away from the foot wall was a quartz mass 12 feet wide containing 0.7 ounce of gold per ton. Mining north of the shaft began in a narrow rich streak west of the foot wall. On the 350-foot level the hanging-wall fissure was discovered and mined. It was explored down to the 900-foot level and largely mined out, though a considerable tonnage of low-grade ore is said to remain. On this level ore with an average gold content of about 0.3 ounce per ton is reported in the floor over a distance of 360 feet. South of the shaft, between the 400- and 700-foot levels, the old stopes range from 3 to 6 feet in width for 450 feet. The best ore now exposed in the mine is just above the 400-foot level south of the shaft, and there are 400 feet of backs above it. Just before the property was closed in 1911 a drift on the 500-foot level is said to have passed through heavy ground of a fault 500 feet south of the shaft and to have found the vein beyond it showing a good thickness of ore and carrying a very rich pay streak on the hanging wall. Above the 700- and 900-foot levels south of the shaft are only two stopes but much ore that was formerly submarginal. As far as known no workings below the 900-foot level reach the hanging wall. From 1905 to 1911 mining was highly profitable, but it was stopped by a lawsuit that ended operations until August 22, 1934, when the present management took charge.

Figure 49 is a plan of the Mount Gaines workings showing development to the end of August 1938. There are over 2 miles of drifts and approximately 1,200 feet of raises in the mine, and it will be noted that the principal development is to the north. Under the present management most of the development has been beyond the north end of the 500-foot level, where a raise has been driven along the slope of the vein, and five other levels (500B to 500G) have been run a considerable distance to the north. Mining costs in this area are high because the slight dip of the vein requires that ore in the stopes be moved by scrapers, and more particularly because the ore has to be trammed over a circuitous route for more than a quarter of a mile to the shaft station on the 500-foot level with several transfers en route. However, by raising through to the surface above this area, a new hoisting shaft could easily be established, which would do away with the long transfer of ore underground.

The main or hanging-wall vein averages 5 to 7 feet in width but occasionally swells to 15 feet or more. In general, mineralization by sulfides is more pronounced near the hanging wall. Figure 48 is a characteristic view of the vein as it appears in one of the sublevels above the 500-foot level about 1,200 feet north of the shaft.

The ore averages from 3 to 4 percent sulfides, principal among which are pyrite, chalcopyrite, sphalerite, and galena. The ore also contains free gold, arsenopyrite, bornite, and occasionally other sulfides, including proustite and argentite. Figure 40 (p. 105) is a photograph of a piece of typical ore showing the association of the component minerals. Microscopic examination shows free gold in cracks in the pyrite, indicating that the gold was deposited after the pyrite and probably at the time the galena and sphalerite were formed, since both these minerals are also later than the pyrite.

Surface equipment at the shaft consists of a hoist and compressor house, blacksmith and machine shops, and others. A 2-ton skip
is handled by a single-drum Allis-Chalmers hoist operated by a 75-horsepower motor. Air is supplied by a 640-cubic-foot Ingersoll-Rand two-stage compressor. Two Worthington pumps, each operated by a 50-horsepower motor, keep the mine watered. About 600 gallons of water per minute is pumped during the summer and twice that quantity in the winter.

Ore from the mine is crushed to minus 2-inch size by a Wheeling jaw crusher and trammed from a 200-ton bin in the head frame to a 600-ton bin in the mill. From this bin it is fed by four Challenge feeders to the same number of 5-stamp batteries having 1,050-pound stamps that drop 110 times per minute from a height of 5 1/2 inches. The stamp-mill pulp is discharged through 40-mesh punched screens to 4- by 8-foot amalgamation plates. Quicksilver is added in the batteries, and the gold recovered by amalgamation is derived about equally from the batteries and plates. The pulp from each 10 stamps is treated in a series of two especially deep circular flotation cells and two Groch cells, the tailing from each cell being re-treated by the next and the concentrates from each cell going to a settling box. Pine oil, creosote, American Cyanamide Z6, and Tarol No. 2 are used as flotation reagents. The tailings from the last cell in each series are treated on a Wilfley table, the concentrates from which go to the concentrate settling box. The combined flotation and table concentrates are sun-dried and shipped to the smelter at Selby, Calif. They generally assay about $220 per ton, and their gold-silver ratio is approximately 1 to 2. About 85 tons of ore per day is treated. Mill heads average $8.50 per ton and yield about $8, indicating a recovery of approximately 94 percent. From 65 to 70 percent of the gold is recovered by amalgamation.

Both mine and mill are operated on three shifts. Sixty men are employed.

CAMPO

The Campo mine consists of two claims in sec. 16, T. 5 S., R. 16 E., 2 miles east of Hornitos. (See No. 120, fig. 36.) It is an old property formerly known as the Campodonica, which was one of the well-known producers in the past when Hornitos was a boom mining camp. The vein, averaging 4 to 5 feet in width, lies between a schist foot wall and a porphyry hanging wall. It strikes nearly due north and dips 40° E. It was developed by a 230-foot inclined shaft, and the size of the mine dump indicates that the drifts must have been extensive. Careful sampling of the old dump showed a gold content of $8.42 per ton. The property is being reopened by N. L. Wagner, general manager, and L. G. Corwin, superintendent, of the Mount Gaines mine, and Claude Shafer of Hornitos. When the property was visited in September 1938 the shaft, which had caved for 40 or 50 feet below the collar, was being cleared and retimbered. A 14- by 21-inch Gardner-Denver compressor driven by a four-cylinder Case semi-Diesel engine, a 6-horsepower Fairbanks-Morse single-drum hoist, and a 750-pound skip had been installed.

NELLIE KAHO

The Nellie Kaho prospect consists of a 20-acre claim about 3 miles south of Bear Valley and just west of Cow and Calf road in sec. 32, T. 4 S., R. 17 E. (See No. 125, fig. 36.) The property is leased
from the Mariposa grant by four working partners—D. A. Johns, Harold Hansen, Ben Hayes, and Joe Hicks of Bear Valley. Mining was begun in June 1937, and about $1,400 is reported to have been taken from the surface, where the vein has been traced for about 100 feet. The vein averages about 18 inches in width, strikes northwest, and dips about 80° SW.

The foot wall is greenstone and the hanging wall slate. When the property was visited in October 1938 a vertical shaft had been sunk to a depth of 100 feet. A drift extends about 50 feet south on the 50-foot level, and a 50-foot crosscut has been driven eastward from the bottom of the shaft. The ore is said to average $10 to $20 per ton, but some very rich rock has been mined.

Ore is hoisted by a drum fastened to the rear axle of an automobile and dumped into a 10-ton bin, from which it goes to a 6- by 8-inch Dodge-type crusher, which reduces it to minus 1-inch size. The discharge from the crusher drops into a 4-ton mill bin that feeds an Ellis mill, in which the ore is ground to pass a 80-mesh punched screen. The mill crushes about 800 pounds of ore per hour and is driven by a 6-horsepower Sampson gasoline engine. The pulp from the mill is amalgamated on a 4- by 5-foot plate and on curved plates inserted in the discharge of the mill. After passing over the plates the pulp flows to a home-made bumper-type concentrating table, which yields ¼ to ⅔ percent of concentrates containing 6 to 7 ounces of gold per ton. These are hauled to the Pine Tree mine and sold to the Pacific Mining Co. The mine workings make about 8,000 gallons of water per day, which is used in milling.

**Ruth Pierce**

The Ruth Pierce mine is situated about 4 miles east of Hornitos in sec. 13, T. 5 S., R. 16 E. (See No. 122, fig. 36.) This property is on patented agricultural land and contains three quartz veins, 3 to 5 feet in width, that strike in a general east-west direction and dip about 65° N. The wall rocks are slate and diorite. A shaft 600 feet deep serves six levels, having a total of about 4,000 feet of drifts, but the mine has not been operated since 1927, when the surface plant and mill were destroyed by fire, and the workings are now inaccessible. The property had been taken over in 1916 by the Hornitos Gold Mining Co. and was equipped with a 10-stamp mill, amalgamation plates, and Frue vanners. At the time of the fire, about 400 tons of ore averaging $10 per ton was being milled per month.

When visited in the summer of 1938, a small cyanide plant was being operated on the mill tailings by E. L. Buerke, Martin Risch, and S. S. Correa of Hornitos, who held a lease on 38 acres, on which about 30,000 tons of tailings averaging $2.50 a ton in gold remained, other tonnage having been washed away.

The procedure followed in treating these tailings was both simple and effective. They were shoveled by hand into a ½-ton truck and hauled a few hundred yards to an elevated platform on the side hill adjacent to the cyanide plant. Here they were screened through ½- to ¾-inch mesh to remove sticks, stones, roots, etc., but more particularly to get rid of the slimes, which have hardened on weathering so that most of them can be screened out as lumps. The
screened material falls into a car that is trammed by hand and emptied into one of four elevated 15-ton leaching tanks with a tramway beneath them for disposing of the leached tailings. One tank is charged and one tank emptied every 24 hours, providing a leaching period of 60 to 72 hours. A charged tank is percolated with 45 tons of solution containing 2 to 2½ pounds of NaCN per ton and then drained for 1 to 3 hours before washing. Pregnant solution is precipitated on zinc shavings, and the precipitate is treated with sulfuric acid and dried. It is then melted with a flux of borax glass and soda and cast into a brick, which is shipped to the mint. Two or 3 pounds of lime is used per ton of tailings to neutralize any acids present. From 90 to 95 percent extraction is obtained. The three partners do all the manual work, and as the cost of chemicals and gasoline is not more than $2.50 to $3.00 per day the profit yielded is far greater than normal wages. In August 1938 enough tailings remained to keep the plant in operation for 2 years.

GOLD COIN

The Gold Coin mine, comprising nine claims containing 160 acres, is situated 2½ miles west by road from United States Highway 49 at a point just south of the Mary Harrison mine in sec. 14, T. 3 S., R. 16 E. (See No. 43, fig. 36.) The property was purchased by Gordon and Charles Greenamyer of Mariposa in May 1937 and is reported to have produced $40,000 to $50,000 in free gold from stringers prior to November of that year when it was sold to J. K. Wadley of Texarkana, Ark. Charles Greenamyer is mine superintendent.

A large quartz vein striking nearly due north through slate country rock and dipping 68° to 70° E. is cut by 18 or 20 parallel quartz stringers ½ to 18 inches wide and 1 to 20 feet apart. These stringers strike northwesterly and here and there contain very rich high-grade ore. A road and power line to the property were put in, and a shaft about 70 feet deep was sunk by the present owner. It is reported that $17,500 was mined early in 1938, but in October of that year the property was closed.

LIVE OAK AND GOVERNOR

The Live Oak and Governor mines, owned by J. P. and E. A. Carroll of Bagby, Calif., are situated in the Hunter Valley district at an altitude of about 1,500 feet in sec. 35, T. 3 S., R. 16 E. (See Nos. 50 and 51, fig. 36.) The property is reached over a 1½-mile trail from Kittridge Station on the Yosemite Valley R. R. or from the Mascus Ranch in Hunter Valley over a 3½-mile road that in places is washed out and badly in need of repair.

The Live Oak mine comprises five claims—the Grand View, Henrietta, Live Oak, Lincoln, and Roosevelt—and two mill sites, which are situated on or contiguous to a vein that has been traced on the surface for over a mile and averages 4 to 5 feet in width. This vein lies between a foot wall and porphyritic rock and a diorite hanging wall. It strikes northwest and dips 76° SW. In places it attains a width of 8 to 10 feet. The ore consists of a quartz gangue containing gold associated with 1 to 2 percent sulfides, which when concentrated contain from $150 to $500 a ton. Near the south end
of the Live Oak claim a cross vein, called the Roosevelt, extends into the Lincoln claim on one side and the Roosevelt claim on the other. Development consists of two shafts on the main vein in the Live Oak claim 212 feet apart. The south shaft, which follows the vein, is 140 feet deep and now caved. The north shaft is 250 feet deep and in excellent condition. It has a 322-foot drift south on the 67-foot level and a 250-foot drift both north and south on the 225-foot level. The owners estimate that 14,000 tons of ore remains between the two levels similar to a mill run of 300 tons of ore stoped between the two levels south of the shaft that returned 0.3 ounce of gold per ton. The property has not been operated since 1932. It is equipped with a 225-ton ore bin, a 5-stamp mill, an 8- by 10-inch Blake-type crusher, a 10- by 12-inch Sullivan compressor driven by a 30-horsepower motor, and a single-drum, 30-horsepower, Fairbanks-Morse electric hoist. Electric power has been brought to the mine from a main line of the San Joaquin Light & Power Co.

The Governor mine, consisting of the Governor and Monitor claims, is on the south extension of the Live Oak vein. On the Governor claim there are two adits on the vein, which is about 5 feet wide at this point. The lower adit is 112 feet long and the upper one, 50 feet or so above it, is 20 feet long with a 10-foot winze near its face. Ten samples at various places in both adits, most of them representing 4-foot cuts, are reported to have shown an average gold content of 0.39 ounce per ton. This sampling excluded a shoot of rich sulfide ore exposed in the 10-foot winze in the upper adit, samples from which assayed 2.3 ounces of gold per ton. Seven lots of sulfide concentrates from the Governor are said to have averaged $658 per ton.

HICKMAN MINES

The Hickman property comprises 280 acres purchased from the Mariposa grant in secs. 28, 29, 32, and 33, T. 4 S., R. 17 E. It includes the Dolman mine, formerly known as the Oyler Lode, and the Mexican mine. (See Nos. 88 and 89, fig. 36.) The mines are on the east flank of Bear Valley Mountain, the Dolman about halfway to the summit at an elevation of 2,500 feet and the Mexican near the base of the hill. Both mines are approximately 1 mile west of United States Highway 49 at a point 1½ miles south of Bear Valley. R. L. and E. P. Hickman, Flood Building, San Francisco, are president and secretary, respectively, of the company owning the mines, and Phil B. Dolman of Bear Valley is mine manager and engineer.

Dolman mine.—The Oyler Lode apparently occupies a fissure in a well-defined fault zone that strikes N. 35° W. and has an average dip of about 60° SW. The fault can be traced for nearly 2 miles and is of the reverse type, the hanging-wall side being upthrown. From the length of the fault and evidences of extensive movement, it is inferred that the vein persists to a considerable depth. Although it dips to the west, the source of its mineralization is probably the same as that of the east-dipping veins of the Mexican-Oso vein system nearer the foot of the mountain.

The Oyler Lode is in a greenstone-porphry belt lying within the Mariposa slates. At the Dolman shaft, in the NW ¼ of sec. 33, both
the hanging wall and foot wall are greenstone, but a porphyry dike is said to occupy a portion of the vein fissure toward the south. It was at the site of the Dolman shaft that Oyler did the first work on this vein in 1902, sinking a shaft to a depth of 50 feet and mining 25 to 30 tons of ore, which was hauled to the Princeton mill, where it is said to have yielded 0.75 to 1 ounce per ton in free gold. However, the width of the vein was disappointing, and Oyler soon abandoned it. In subsequent development by the Hickman interests, a 265-foot shaft was sunk on the vein and 1,445 feet of drifts was run on four levels, disclosing three ore shoots south of the shaft and one north of the shaft, which occur along intersections of the vein with zones of cross-fracturing. On the 100-foot level a 60-foot drift to the south enters the main south ore shoot, which is cut on the 175-foot level 80 feet from the shaft by a 340-foot drift to the south. This drift also intersects two smaller ore shoots to the south. On the 250-foot level a 255-foot drift to the south cuts the main south shoot 100 feet from the shaft, establishing its rake to the south as about 13° between this and the 60-foot level. On the lower level the average grade of the main south shoot is reported as $18 per ton. On the 200-foot level a drift runs north 760 feet, cutting a shoot 625 feet from the shaft that is reported to yield $8 per ton. Near the face of this drift, rapidly increasing sulfides indicate the possible proximity of another shoot. As might be expected from their situation at the intersection of cross fractures, the ore shoots are short, and the vein rarely exceeds 5 feet in width. The ore consists of quartz containing pyrite, pyrrhotite, chalcopyrite, or the oxidation products of these sulfides, and gold. No galena or arsenical sulfides have been observed in any quantity in the ore, although these minerals are common in ore of the Mexican mine farther down the mountain.

Although some ore is being milled, work at the Dolman mine consists principally of development. A report by the manager in April 1936 showed that 8,115 tons of developed and partly proved ore estimated to contain $81,044, or approximately $10 per ton, was available in the mine at that time.

Dolman mill.—Ore from the Dolman mine is dumped from the skip into a 75-ton bin, from which it is trammed to a 10-ton coarse-ore bin at the head of the mill, situated a few hundred feet northeast of the shaft. From this bin the ore passes over a 1-inch grizzly oversize, from which it goes to an 8- by 10-inch Blake crusher set to break to minus 1 inch. The discharge from the crusher and undersize from the grizzly are elevated to a 75-ton mill bin by a vertical bucket elevator 40 feet between centers and having buckets 8 inches long and 6 by 5 inches in triangular cross section.

From the mill bin the ore is discharged by a Challenge feeder with a variable speed regulator to 31-inch McFarlane rolls set to ½ inch and making 30 revolutions per minute.

The discharge from the rolls is carried by a belt conveyor 35 feet between centers to a 6-foot Huntington mill that makes 60 revolutions per minute and discharges its pulp through a 40-mesh wire screen to a series of three amalgamating plates 5 by 11 ½ feet each and having ½-inch drops between them. Inside amalgamation is employed in the mill.
The pulp from the plates flows to a 17-foot Overstrom table that makes 270 strokes per minute and yields a concentrate containing $250 to $300 per ton. Middlings from the table are returned to the Huntington mill and the tailings, which assay about $1.50 per ton, are treated in a three-cell Kraut flotation unit, the first cell of which makes a finished concentrate. The flotation tailings flow to a 9-foot Callow dewatering cone, the clear overflow from which is returned by a small pump to a 2,500-gallon mill tank. From 25 to 40 percent of the gold in the ore is extracted by amalgamation, depending on the degree of oxidation of the ore and where it comes from in the mine. With an average mill feed about 1.5 percent of concentrates is recovered from the ore, and the total recovery of gold by amalgamation and in the table and flotation concentrates is approximately 90 percent.

The mill is poorly balanced as to the capacities of its component units, the coarse crusher having over 10 times and the flotation unit twice the capacity of the Huntington mill and table, each of which can handle 25 tons per day.

Power for the mill is supplied by an 80-horsepower engine using either gasoline or distillate, and the same engine operates a 325-cubic foot Chicago Pneumatic air compressor. As the engine cannot supply enough power for both jobs, the mill is run only when the mine is off shift. Water for milling is obtained largely from the Mexican mine, whence it is pumped against a 500-foot head into a 5,000-gallon tank above the mill.

Mexican mine.22—The Mexican mine is situated about 1/4 mile east of the Dolman, a few hundred feet above the base of Bear Valley Mountain. The vein consists of a crushed zone of slate 4 to 6 feet wide impregnated by quartz. It strikes N. 35° W. and dips 70° NE., following a slate-porphyry contact that marks a vein system extending to the Oso mine, about 1 1/2 miles northwest. This vein system, which comprises a series of broken parallel veins and crossings, is known for its numerous rich pocket leads, which were explored to water level by the early miners. These leads apparently are confined to the junctions of east-west crossing fractures with the crushed zone slate.

At the Mexican mine over $50,000 in gold is reported to have been extracted from a shallow shaft by Mexicans before the property was acquired by the Mariposa grant. Later, the owners of the grant sank a 150-foot shaft on the vein about 75 feet southeast of the Mexican workings, but this shaft was not on a crossing and, as no rich ore was found and it was difficult to handle the great quantity of water that ran into the shaft, mining was discontinued. However, the shaft has since proved a valuable source of water supply for the Dolman mill.

A Hubbard deep-well pump driven by a 6-horsepower Fairbanks-Morse engine discharges water from the shaft into a 2,100-gallon tank at the surface. From this tank the water is elevated to a 5,000-gallon tank above the Dolman mill by a Triplex pump having a capacity of 2,000 gallons per hour against the head of 500 feet and run by another 6-horsepower Fairbanks-Morse engine.

22 Not to be confused with a mine of the same name in the Hites Cove district north of Jerseydale.
When visited in August 1938, a 150-cubic foot Gardner-Denver compressor and a small single-drum hoist were in storage at the mine in preparation for further development.

ORTEGA

The Ortega mine is 6 miles west of Mariposa on United States Highway 140, the main thoroughfare between Merced and the Yosemite Valley. (See No. 139, fig. 36.) The property, under lease and bond by John Q. Finfrock of Mariposa from the Mariposa Mining & Commercial Co., comprises about 125 acres in a rectangular tract 1,200 feet wide and 4,500 feet long extending along the strike of the main vein from the highway to the Mount Bullion road.

The tract contains two known veins, of which the larger was developed by Mexicans under the leadership of a Señor Ortega prior to 1856. They sank 10 shafts on the vein from the present main highway north over a distance of 1,485 feet. The greatest depth attained by these early workings is not known, but No. 4 shaft, which follows the dip of the vein, was cleaned out and reconditioned by Finfrock and was found to be 167 feet deep. All the other nine shafts are vertical and, from the size of the old dumps, the No. 4 shaft is judged to have been the deepest.

Ore from all the shafts except one was treated in arrastres, but the ore from No. 10 shaft, that nearest the road, was milled by a Mr. Turner in a 2-stamp mill, the site of which is plainly evident today. It is related that Turner also milled ore from the shafts of his Mexican neighbors that was too low-grade to be handled profitably in their arrastres and that he paid for this ore by pumping water from their workings.

When the title of General Fremont to the Mariposa grant was confirmed by court decisions in 1856 he ejected the operators of the Ortega, and no further work was done on the property until May 1934, when it was leased to Price, Willmer, Givens, and Givens. However, about 1900 considerable ore from the old dumps was hauled to the custom mill at the Princeton mine and, according to its records, yielded $14 to $27 per ton. Tailings from some of the old Mexican arrastres, which were re-treated by Finfrock, assayed $28 per ton. The considerable gold content of the dumps and tailings, when considered in conjunction with the continuous working of the vein for approximately 1,500 feet along its strike, attests the richness of the ore extracted, but there are no records of the early production.

While under lease to Price, Willmer, Givens, and Givens, the property was equipped with a second-hand 5-stamp mill, and No. 3 shaft was reopened and sunk to a depth of 180 feet, the last 80 feet following the dip of the vein. A drift was run 125 feet south on the vein from the bottom of the shaft, and good-grade ore was found below the old Mexican workings. Ten tons plated $91.60 per ton. However, the vein fissure in and near the shaft was filled largely by a dike, and the width of the ore was disappointing. The lessees had no funds to buy a proper hoist and shaft equipment, and their operation was condemned by the State mine inspectors as unsafe and was abandoned.
On April 1, 1936, Finfrock acquired a lease and bond on the property and proceeded to clean out No. 4 shaft and do other development work as described later.

The main vein, which the Mexicans mined, has an average width of about 3 feet. It strikes N. 21° W. and dips 50° to 60° to the west. The outcrop not only has been uncovered for about 1,500 feet but probably is also seen in the vein of the old Sorrel mine just south of the main highway.

A second vein has recently been uncovered about 500 feet east of No. 4 shaft. It is about 2 feet wide, and from the direction of its strike, which is apparently about N. 30° W., it is thought that it may intersect or join the main vein farther north. However, this smaller vein is undeveloped except for one or two shallow pits.

Both veins traverse a country rock of fine-grained granodiorite. In the case of the main vein a dike about 1 1/2 feet in average width has intruded the granodiorite and formed a fissure, in which the vein filling has been deposited. The dike is a normal feldspathic intrusive, which shows only a slight sericitization. Its feldspar is principally plagioclase, which has preserved its euhedral form well enough for one to discern remnants of the original graphic-granite structure of the work.

The vein is well adapted to mining by open-stope methods, as both walls are firm and hard and are separated from the ore by a light gouge, so that the ore breaks cleanly from the walls without dilution. In the workings of the No. 4 shaft the dike forms the foot wall of the vein, but in some other places it occupies the hanging-wall side of the fissure.

The minerals in both veins are similar. They consist largely of quartz, with plentiful pyrite and arsenopyrite accompanied by smaller quantities of chalcopyrite, galena, and sphalerite. Figure 50 shows a polished piece of the ore natural size. Optical examination of this piece shows that both the sphalerite and galena fill cracks in the arsenopyrite and that sphalerite fills cracks in the galena, indicating that the order of deposition of these sulfides was (1) arsenopyrite (2), galena, (3) sphalerite. The deep brownish black of this sphalerite shows that it has a high iron content, which, in turn, suggests that it was deposited in a high-temperature vein. Occasionally free gold is seen in the quartz, but most of it is too fine to be visible, and much of it is associated with the sulfides.

On reopening No. 4 shaft, it was disclosed that the Mexicans had worked the vein here at three levels—at depths of 100, 147, and 167 feet, respectively. All ore above the 100-foot level south of the shaft was stopped, but on the 147-foot level ore in place was found only 60 feet from the shaft. This level was driven in continuous ore with gradually increasing backs to a point 347 feet south of the shaft. The width of ore in this drift is as follows: In the first 125 feet south of the shaft it is 4 feet, in the next 75 feet it is 3 1/2 feet, and for the remaining 147 feet it averages 2 1/2 feet. The continuation of this ore shoot to the north for 170 feet to No. 3 shaft has been proved by a drift 30 feet north from the 167-foot level of No. 4 shaft and a drift 125 feet south from the bottom of No. 3 shaft. Thus, it has been determined definitely that the ore shoot is at least 527 feet long, and as there are remnants of ore dumps on the surface
**Figure 50.**—Quartz ore from the Ortega mine (actual size).

**Figure 51.**—Bonanza gold ore from the Cripple Creek dike near Mariposa (actual size).
200 feet south of the face of the 147-foot level, a continuation of the ore shoot to the south for at least this distance is expected.

A total of $19,796 was recovered by Finfrock from ore taken from the levels once operated by the Mexicans and from the remains of their surface dumps. Of this total, $10,154 was derived from 691 tons of newly mined ore, an average recovery of $14.69 per ton, and 346 tons of old gob yielded an estimated $5 per ton. As tailings from all types of mill feed averaged more than $2 per ton, it is safe to assume that the ore mined assayed $17 per ton or more. In milling, 9,700 pounds of concentrates were recovered, which assayed $171.54 per ton.

All mining has been done by the open-stope method; and, as the walls are excellent, little timbering is necessary. Ore is hoisted in a ½-ton skip by a small, single-drum gasoline hoist. It is dumped onto a crushing platform in the head frame, from which it is fed to a 9- by 11-inch Dodge crusher set to break to 1½ inches. Undersize from the crusher falls into a 45-ton mill bin, from which it is discharged by a Challenge feeder to a 5-stamp mill having 1,250-pound stamps that drop 100 times per minute. The stamp-mill pulp, minus-40 mesh, passes over two amalgamation plates each 4 by 8 feet and thence to a No. 5 Willey table, the concentrates from which are shipped to a smelter. A 32-horsepower Victory semi-Diesel engine using tops is the main power unit in the mill. When visited in October 1938 the milling and power equipment was in poor condition, and the management was considering electrification of all machines by bringing electric power to the mill from the lines of the San Joaquin Light & Power Co. at Mount Bullion 2 miles away.

The workings of No. 4 shaft normally make about 24,000 gallons of water daily, which is raised from the shaft sump by a Wood & Little two-stage centrifugal pump run by a 5-horsepower electric motor, current for which is supplied by an 8½-horsepower direct-current generator operated by an automobile engine.

PETERSON

The Peterson, sometimes also called the B. & M. mine, is situated in the Buckeye district in sec. 3, T. 6 S., R. 18 E. (See No. 148, fig. 36.) The property is controlled by the heirs of Alice C. Peterson; Homer A. Peterson of Mariposa is in charge. Buckeye Creek flows through the tract of 31½ acres, and in 1933 placers along the stream were mined by the B & M. Mining Syndicate of Los Angeles by means of a power shovel and portable washing plant. After exhausting the small placer area the company began development of two parallel quartz veins on the property.

These veins strike nearly east and west and dip to the south at angles of 50° and 70°, respectively. Both veins have average widths of 2½ to 3 feet, and their walls are granite. Each is developed by shafts 100 feet deep, with 50 and 185 feet of drifts, respectively. A small tonnage of high-grade ore was mined in 1934 from both veins and a 5-stamp mill was erected, but development of ore lagged, so the mine was soon forced to close. Average mill heads are reported to have contained 0.7 to 0.8 ounce of gold per ton, about three-
quarters of which was free gold, the rest being contained in sulfides that constitute 1½ to 2½ percent of the ore.

GRANITE KING

The Granite King mine is an old property situated 1 mile southeast of Bridgeport, in secs. 3 and 10, T. 6 S., R. 18 E. (see No. 149, fig. 36), that was reopened in 1938 by M. T. McElligott, Guy Noble, and Howard Campbell and is being developed by them as a partnership.

The vein is in granite, striking northeast and dipping 30° to 50° SE. It is 2 to 5 feet wide, with an average width of 3 feet. The vein fissure has been intruded by a dike, and brecciated fragments of dike material and of the granite walls commonly occur in the vein. These enclosed fragments and the general structure of the vein are shown clearly in figure 60 (p. 169). The ore is quartz containing pyrite, galena, sphalerite, and gold, the last frequently occurring in specks large enough to be seen readily. The ore ranges in grade from 0.25 to 3 or 4 ounces of gold per ton. Not enough ore had been developed or milled when the property was visited in October 1938 to determine its average grade, but it probably approximates 1 ounce of gold per ton. The sulfides constitute 2½ to 3 percent of the ore, but at least 75 percent of the gold is free. The vein is developed by an 80-foot vertical shaft in the footwall and by about 100 feet of drifts. The ore is crushed in a 2-stamp mill driven by a gasoline engine, and after passing over amalgamation plates the pulp is concentrated on a 3- by 7-foot table. It is reported that development at this mine proceeded during the spring of 1939 with very gratifying results.

EAST BELT

The East belt of Mariposa County is a continuation of the same belt in Calaveras and Tuolumne Counties, but its mines are more broadly scattered. They occupy a belt paralleling the Mother Lode that is approximately 20 miles long and 15 miles wide, extending from the Argo mine (No. 10, fig. 36) on the north to the old Stockton Creek mine (No. 141, fig. 36) on the south and as far east as the Original mine (No. 71, fig. 36) at Clearinghouse.

The belt comprises the Colorado, Hites Cove, Jerseydale-Sweetwater, Kinsley, Mariposa, and Whitlock mining districts and the eastern portion of the Coulterville district. Beginning at the north and proceeding south, some of the principal mines are the Red Cloud, Louisiana, Bondurant, Hasloe, Texas Hill, Bandarita, Quail, Ferguson, Original, Hite, Our Chance, Diltz, Hayseed, Miner’s Hope, Spread Eagle, Whitlock, Colorado, Sweetwater, and Mariposa.

The geology of the East belt in its general characteristics is similar to that of the West belt, which has been described already in considerable detail. The principal difference is that the sedimentaries exposed are predominantly of the Calaveras formation and there is also much of the amphibolite schist that is prominent in Tuolumne and Calaveras Counties. The presence of masses of granodiorite is also more pronounced east of the lode, where the gold deposits frequently are present in the vicinity of their contacts.
Twenty or more typical mines of the East belt are described herein.

ARGO

The Argo mine consists of two claims in sec. 10, T. 2 S., R. 17 E. held by location by Walter D. McLean of Coulterville. (See No. 10, fig. 36.) The vein lies between a dark intrusive rock several hundred feet through, which forms the foot wall, and a hanging wall of altered slate. It averages about 2 feet in width, with a maximum width of 5 feet, and strikes N. 15° W. It dips about 50° E.

Two ore shoots have been discovered about 100 feet apart on the vein. The first, about 40 feet long and 75 feet deep, was little more than a pocket yielding 120 ounces of gold from about 150 tons of ore. The second has been worked from the surface to the 200-foot level and has yielded 408 ounces of gold from approximately 800 tons of ore, an average recovery of 0.51 ounce per ton. As the mill tailings contain 0.16 ounce per ton, the indicated average gold content of the ore mined from this shoot is 0.67 ounce per ton. On the 50-foot level the shoot was 30 feet long, but on the 100-foot level it lengthened to 120 feet and then contracted to 40 feet on the 200-foot level. The shoot on the 200-foot level is said to average about 1 ounce of gold per ton.

The property is equipped with a 3-stamp mill and concentrating table run by a 6-cylinder automobile engine and a small crusher operated by a 5-horsepower gasoline engine. A single-drum steam hoist is run by a 20-horsepower vertical steam boiler, which also furnishes steam for pumping. There is no compressor at the property. The mine makes only enough water to supply the mill. Several exceptionally fine specimens of ribbon gold in massive pyrite and partly released from it by oxidation were recovered from this mine by McLean. Erosion of the vein has formed a small placer, and during the winter of 1937 two men recovered $76 in gold in 3 days' work from a little stream 800 feet south of the mine workings.

GARIBALDI

The Garibaldi mine is covered by one patented claim in sec. 5, T. 3 S., R. 18 E., about 1 mile south of the Bull Creek road. (See No. 64, fig. 36.) It is owned by Walter McLean of Coulterville. The vein is associated with a porphyry dike 4 to 6 feet thick, striking a little east of north and dipping 45° E., that follows a contact between schist and limestone, the schist lying west of the dike while the limestone is east of it. The vein quartz occurs chiefly between the schist and the underside of the dike but also fills veinlets penetrating the dike itself to distances of 2 to 3 feet. On the hanging wall of the porphyry the limestone has been decomposed to a layer of blue mud 8 to 10 feet thick. This mud includes boulderlike masses of blue quartz that are in general very rich ore, and gold is also found in the limestone along the contact. The boulders of ore found in the mud presumably are remnants of ore that originally was deposited between the dike and the limestone either by solutions ascending along the hanging wall of the dike or, more probably, introduced through fractures of the dike from its footwall side.
In the past, three shafts and many shallow pits were sunk on the vein over a distance of 500 feet. The deepest shaft is said to have reached a depth of 320 feet on the vein; but it was lost, together with the other two shafts, by caving of the heavy blue mud on the hanging wall and inrushes of water from the limestone. The property was last worked from 1897 to March 1902, during which time a three-compartment shaft was sunk paralleling the vein 40 feet back in the schist footwall. The collar of this shaft is about 75 feet above the outcrop of the vein, so the crosscut to the vein at the bottom of the shaft is approximately on the old 300-foot level. There is no record either of the quantity or yield of the ore milled, but in the summer of 1938 there remained on the ground 1,700 tons of mill tailings that had not been washed away. These were found to contain $5.50 gold per ton and were being treated by John P. McCormick of Sonora by leaching on a prepared filter bed, 24 by 50 feet and having a 5-percent slope, with a 5-pound solution of cyanide. The drained solution was caught in a 3,000-gallon sump and pumped to a solution tank. The pregnant solution was precipitated with zinc dust.

It is thought that most of the ore above the 300-foot level of the mine workings has been stope. The richest ore, averaging between 2½ and 4 ounces of gold per ton, was said to have been found in a 12- to 18-inch streak on the schist footwall. Although the ore contained some fine-grained galena and tetrahedrite, which was undoubtedly auriferous, no concentration process was used in milling. Except for the little cyanide plant referred to, there is now no equipment of any sort on the property.

**LOUISIANA**

The Louisiana mine is about 8 miles east of Coulterville in secs. 25 and 26, T. 2 S., R. 17 E., at an elevation of approximately 3,000 feet. (See No. 13, fig. 36.) It consists of one claim on a quartz outcrop that can be traced for over 1,800 feet following the crest of a ridge on the west side of the North Fork of the Merced River. Adjoining the property on the southeast and on the same vein system is the Bondurant mine, which was reopened recently and is now in operation.

The Louisiana mine was patented on February 9, 1878, but little is known of its early history, although there are many remnants of interesting old equipment on the ground, for example, parts of a mill with two mechanically operated sledge hammers and an ancient walking-beam type of pumping engine made in England. It is known that about 1892 three shafts were sunk on the vein and a 4-stamp mill installed near one of them. There is no record of the tonnage of ore treated in this mill, but its tailing pile contains 1,500 to 2,000 tons, and evidently a much larger quantity was washed away. The mine was closed early in 1898, apparently because the ore became less oxidized with depth and contained too small a proportion of free gold to be profitable. After the mine closed five lessees worked it for 8 months and took out all readily available ore in No. 2 shaft but did no development work. Mint records show that these lessees shipped bullion totaling $10,330.98, which is re-
ported to have been obtained from 600 to 700 tons of ore. Since then no work whatever has been done on the property.

The vein is a massive white quartz that strikes N. 20° W. and dips about 60° E. In width it ranges from 2 to 15 feet and averages about 8 feet. Although it has not been sampled systematically the vein contains gold for the better part of 1,200 feet along its strike, assays on a majority of the samples taken ranging between $6 and $15 per ton. Near No. 2 shaft the vein apparently splits or a large feeder comes into it from the hanging-wall side. No. 1 shaft is on this hanging-wall split or feeder. At this point the vein narrows and does not widen again until near the south boundary of the claim, where it is transformed into a stringer lode 50 to 100 feet wide, with some stringers of solid quartz as much as 2 or 3 feet wide.

From the No. 1 shaft northwest the vein, wherever exposed, contains gold for over 1,500 feet. Beyond this it has not been prospected.

The country rock is in general a schistose slate, the hanging wall being more micaceous than the foot wall, while in many places a belt of hard true slate follows the hanging wall. A band of what is locally termed "mica porphyry" several feet thick follows one wall or the other of the vein but is not continuous on either wall. It is not known to cross the vein at any place, but there are sometimes partings of it between the various laminations of the vein. Its appearance and method of occurrence in the vein fissure suggest that it may be an altered intrusive.

The hanging-wall portion of the vein is more massive in character than the foot-wall portion, which is made up of thin layers of white or iron-stained quartz having a fine-grained structure locally referred to as "live quartz." Nearly all seams between the laminations show striations caused by movement in the vein. These striations generally dip 45° to 50° E. Both walls contain many stringers or feeders that come into the vein at all angles and range from tiny seams to veins a foot thick.

Near the surface the vein is filled with vugs, sericitic seams, and various minerals derived from the oxidation of the pyrite, galena, and sphalerite, which occur in the unaltered ore. There is little difference in the percentages of these three minerals. The pyrite apparently is a little more plentiful than the sphalerite, and there seems to be slightly more sphalerite than galena. Fifteen tons of ore from one of the dumps was milled and yielded about 300 pounds (1 percent) of concentrates; but as the ore was quite thoroughly oxidized, it is probable that the unaltered ore would contain 1½ to 2½ percent of concentrates.

Flakes of free gold are found on the sides of many of the vugs in the oxidized ore, and it is also associated with all three of the sulfide minerals. Gold occurs moreover in grains up to the size of a pinhead in the hard white quartz adjoining very thin seams of green sericite and occasionally without any other mineral near it. The best ore seems to be in the 3 to 6 feet of vein nearest the foot wall. The width of the vein apparently does not affect the grade of the ore. At No. 5 shaft, where the vein is about 15 feet wide, 30 inches of it on the foot wall is reported to assay $195 per ton. Evidently the best ore was found toward the southeast end of the property, as here the workings were mined out more completely by the old-timers.
No. 2 shaft is said to be 250 feet deep. No. 3 shaft is perhaps 150 feet deep. Near it are the remains of the old pumping engine previously mentioned and an old friction-drive steam hoist now entwined by a large manzanita.

An electric power line is 8 miles from the property, and several mines in the vicinity are considering sharing the expense of bringing in power. Obtaining an adequate water supply is the most serious problem. When the mine was operated, mine water was used for the small mill. Since then a long crosscut tunnel was driven from the South Fork of the Merced River with the idea of cutting the vein on the Bondurant property about ½ mile southeast at a depth of 1,000 feet. Although this tunnel has not been completed, the 1,100 feet driven is draining the country above it and will reduce the water supply still more. However, water could be pumped from Dutch Creek, a distance of about a mile and an elevation of 400 feet below the mine, or it could be obtained from a mine shaft about 3.4 mile away that has a very heavy flow of water. In this instance the lift would be only about 100 feet.

**BONDURANT**

The Bondurant mine is on the North Fork of the Merced River about 12 miles east of Coulterville by road at an altitude of 3,000 feet. It consists of 100 acres of patented mineral claims, 740 acres of timber land, two tunnel locations, and a mill site, totaling about 1,000 acres in secs. 24, 25, and 36, T. 2 S., R. 17 E. (See No. 14, fig. 36.) The original claims are covered by the second oldest mining patent in the county, issued in 1856, and the property is said to have a production record of over $350,000. It is owned by the Bondurant Mining & Milling Co., of which J. B. Zimmerman, 405 Montgomery Street, San Francisco, is president. In the early history of the property the ore was treated in arrastres, but in 1870 an 8-stamp mill was installed, which was succeeded in 1887 by a 10-stamp mill. From 1892 to 1926 the mine was idle except for a little work done by lessees in 1914 and 1915. Another period of activity began in 1927, and since then development has been carried on at more or less regular intervals.

There are three principal veins on the property—the Bondurant, Reynolds, and Louisiana—but the last two have had little work done on them. The Louisiana vein is a continuation of the vein in the adjoining Louisiana mine. The three veins are roughly parallel, striking northwest and dipping near the surface about 35° NE., but steepening to 60° at a depth of a few hundred feet. The veins occur in black slate. The ore consists of quartz carrying pyrite, sphalerite, and galena. It averages about 0.4 ounce of gold per ton.

The Bondurant vein, on which the principal development work has been done, is 18 inches to 4 feet wide and is opened by an inclined shaft 412 feet deep, with a total of 2,500 feet of drifts on the 100-, 150-, 250-, 300-, and 350-foot levels. A 1,700-foot crosscut adit is being driven from just above the river level to intersect the vein at a depth of 1,100 feet on its dip. When the mine was visited in July 1938 the adit had been driven 1,100 feet and was presumably within 600 feet of the intersection with the vein.
In the mine is a backfill made about 1860 estimated to contain 10,000 tons of ore with an average gold content of 0.3 ounce. This will be reclaimed. Ore in sight averages $15 to $18 a ton. The mine makes 30,000 gallons of water per day, which will be used in milling.

Eight men were engaged in installing a 40-ton mill, which was nearly completed and scheduled for operation by September 1, 1938. A 50-horsepower Diesel engine drives a 300-cubic-foot Gardner-Denver compressor, and a second similar engine operates a 37-kilowatt alternating-current generator, which supplies power in the mill.

Ore is hoisted by a small, single-drum electric hoist and dumped into a 40-ton bin that discharges over a 1-inch grizzly to a 12- by 16-inch Dodge crusher. The discharge from this crusher, together with the undersize from the grizzly, is fed to a 3½- by 4½-foot grate-type Williamson ball mill, which discharges to a 12- by 12-inch Pan-American jig. From mill tests on the ore, the hatch from this jig is expected to contain about 85 percent of the total gold recovered. The hatch will be cleaned by treatment in a 1½- by 2-foot amalgamation barrel and the residue shipped to a smelter. The jig tailings are discharged to a Dorr-type classifier in closed circuit with the ball mill. The overflow from the classifier goes to four Kraut flotation cells using pine oil and American Cyanamid Z6 as flotation reagents. In ore tests the flotation concentrates have run $300 per ton and will be shipped to the smelter at Selby, Calif.

HASLOE

The Hasloe mine is on Gentry Gulch 1 mile east of the North Fork of the Merced River in secs. 1 and 2, T. 3 S., R. 17 E. (See No. 60, fig. 36.) It is owned by Walter McLean and R. S. Hudgson of Coulterville and Dolf J. Jacobs of Sonora, Calif. The mine was first opened in 1851 or 1852 and consists of two patented claims and two claims held by location.

The vein strikes S. 76° E., dips about 30° N., and averages 30 inches in width, with a maximum width of 4 to 5 feet. Both walls are black slate. The ore consists of ribbon quartz in which pyrite, galena, tetrahedrite, and occasionally a little arsenopyrite are associated with native gold. The presence of tetrahedrite is considered an indicator of the gold content. The ore averages about 0.6 ounce of gold per ton, but occasionally pockets are found that contain beautiful specimens of native gold. In some specimens the gold is spread as a polished and sometimes striated slickenside over many square inches by movement of the wall rock against which the gold occurred.

The vein is developed by a main adit driven 700 feet on the vein and a 450-foot shaft on its dip. The face of the adit is 290 feet below the surface on the dip of the vein. Except for the 80 feet nearest its face, all ore above the adit has been stoped. Almost all of the gold has been found near the walls of the vein and on the foot wall in particular. A porphyry dike 1 inch to 3 feet wide has intruded the slates along the strike of the vein and in the west ore shoot for a length of about 200 feet, which is near the face of the
adit, and the dike material is mixed with the ore owing to shattering of both the vein and the dike. However, in the east ore shoot nearer the portal of the adit and for a length of about 100 feet, the ore is on the upper side of the dike. The walls of the vein, particularly near the face of the adit, are exceptionally flat and smooth, as it plane by movement along the vein.

Ore from the mine is delivered by autotruck to the nearby mill. It is dumped over a 1½-inch grizzly, the oversize from which is broken to minus 1½ inches in an 8- by 10-inch jaw crusher. The discharge from the crushe and undersize from the grizzly fall into a 20-ton mill bin, from which the ore is delivered by a Hendy feeder to a 5-stamp mill, where it is crushed to pass a 30-mesh punched screen. The stamps and crusher are driven by an automobile engine. The pulp from the stamps flows over a 5- by 8-foot amalgamation plate and thence to a Wilfley table, on which about 2 percent concentrates containing approximately 3.5 ounces of gold per ton is recovered. About $16 per ton is saved by amalgamation and $2.40 per ton as concentrates, making a total yield of about $18.40 per ton from average mill heads containing about $20.

**QUAIL**

The Quail mine is situated on Indian Gulch 2 miles above its confluence with the North Fork of the Merced River in sec. 16, T. 3 S., R. 17 E. (See No. 56, fig. 36.) It consists of nine claims totaling approximately 180 acres, four of which are patented and five held by location. The property was sold recently by the family of Frank J. Bruschi, of Coulterville, to Quail Gold Mines, Inc., of which Jerome Drumheller of Spokane, Wash., is president and Otto D. Rohlfs of Coulterville is manager. The property is credited with a total production of $400,000 from three previous mills, which had 2, 5, and 10 stamps, respectively; the last mill was destroyed by fire in 1917.

The vein strikes almost due north, dips from 30° to 35° E., and has an average width of 4 feet between slate walls. An aplite dike about 2 feet wide has intruded the vein fissure, sometimes following the vein foot wall and sometimes its hanging wall. The ore is quartz containing pyrite, galena, sphalerite, tetrhedrite, and native gold.

The mine is developed by two adits on the vein, which are about 90 feet apart vertically. The lower adit is 700 feet long and the upper 550 feet. From the lower adit a 135-foot raise 200 feet from the portal connects with the upper adit, and a 328-foot raise 300 feet from the portal extends to the surface. The elevation of the lower adit is about 2,300 feet and it is 900 feet on the dip of the vein from the level of this adit to the crest of the hill. A dump at the portal of the upper adit, consisting of ore from the raise above it and from 200 feet of the tunnel adjacent to it, is said to contain 3,700 tons of ore averaging $10.10 per ton. A dump at the mouth of the lower adit, representing ore from its last 350 feet, is estimated to contain 4,600 tons of ore averaging $7 per ton.

When the mine was visited in August 1938 a 60-ton amalgamation and flotation mill was being established and was nearly ready to
run. In this mill ore from the mine is delivered to a 100-ton coarse-ore bin, from which it is drawn over a 1-inch grizzly and the oversize reduced by an 8-by 12-inch Denver Wheeling crusher to minus 1-inch size. The discharge from the crusher and undersize from the grizzly are delivered by belt conveyor to a 30-ton mill bin, from which a Challenge feeder delivers the fine ore to a 4-by 5-foot ball mill with a grate discharge. The pulp from this mill goes to a 12-by 18-inch two-compartment Denver jigger, the hutch from which is concentrated on a Wildfley table and the concentrates batch-ground in a 36-inch Wheeler pan. The jig tailings go to a 24-foot Akins classifier in closed circuit with the ball mill. The overflow from the classifier is discharged over amalgamation plates to seven 22-by 27-inch Denver sub-A flotation cells. The flotation concentrates and tailings from the Wheeler pan are delivered by a diaphragm pump to a 2-by 4-foot Oliver filter. The filter cake will be shipped to a smelter. Mill tests, in which the ore was ground to minus 85-mesh size, made 30 percent of the total recovery by amalgamation and the rest as a concentrate containing 3.77 ounces of gold per ton. The concentration ratio was 50 to 1.

**BANDARITA**

The Bandarita mine is on the west bank of the North Fork of the Merced River in sec. 12, T. 3 S., R. 19 E. (See No. 61, fig. 36.) It was discovered in 1856 and was worked almost continuously until 1887 and sporadically since then. It is credited with a total output of over $1,500,000, most of which was produced from 1881 to 1887. The property belongs to the Bandarita Mining Co., owned by Nelson M. Leona of Lemoore and J. E. Brown of Oakland, Calif., but when visited in the summer of 1938 it was being operated by four leasing partners, William Beatty, W. M. Boyer, Carl Crouse, and G. A. Ogdon, and three additional men.

The vein is in slate and ranges in width from 2 to 10 feet. It strikes S. 84° E. and dips 47° S. The ore is quartz containing pyrite, galena, sphalerite, tetrahedrite, and native gold, and its gold content is said to be roughly proportional to the quantity of tetrahedrite present. Four granodiorite dikes strike nearly due north and intersect the vein at about right angles, and it has been faulted at these intersections with throws of 1 to 42 feet.

The vein is developed by a 1,380-foot crosscut adit, the portal of which is 50 feet above the river level, and by six adits on the strike of the vein, of which two are on the east side of the hill and four are on the west side. The longest of three adits, 800 feet, is on the east slope. The crosscut adit, completed in 1881, taps the vein about 850 feet vertically beneath the surface, where it has 1,200 feet of backs. In the 800-foot adit are three ore shoots that have been stoped 75 to 650 feet to the surface. It is reported that there are over 275,000 tons of gob in the old stopes of the mine that will pay to mill at the present price of gold. The mine was reopened with the purpose of drawing these old stopes, but the present lessees are mining ore from the Goodman shoot, which is reported to average 0.57 ounce of gold per ton.

A 30-ton mill on the bank of the river near the portal of the crosscut adit is equipped to treat the ore by amalgamation and
flotation. Ore from a 30-ton bin is delivered to a 12- by 14-inch Blake-type jaw crusher, which breaks the ore to minus 1-inch size. It is then delivered to a 15-ton fine-ore bin and thence to a 3-stamp mill, the pulp from which, after passing over amalgamation plates, is ground in a small ball mill. The discharge from the ball mill goes to a 12- by 12-inch Pan-American jig, the hutch from which assays about $1,100 per ton and contains about half of the total gold recovered. This product is cleaned in a little amalgamation barrel. The overflow from the jig goes to a belt-type classifier with metal rakes that is in closed circuit with the ball mill. The overflow from the classifier is delivered to two Kraut flotation cells, the concentrates from which go to wooden settling tanks. The concentrates contain about $112 per ton and, after drying, are shipped to a smelter. Power is supplied by a 5-foot Pelton wheel. The water for its operation comes from a 4-foot concrete diversion dam on the river through a 3-mile ditch carrying from 4 to 5 second-feet of water. It is delivered to the wheel under a 250-foot head through a pipe 22 inches in diameter at the penstock but diminishing in diameter to 10 inches at the wheel, which develops 114 horsepower with an inflow of 3 second-feet at the penstock. During 9 months of the year there is enough water to supply all required power, but in the late summer and early fall there is not enough to operate the three-drill Ingersoll-Rand compressor and the mill simultaneously. Accordingly, during this period the compressor is run during the day and the mill at night. In June 1938, $3,700 was recovered from intermittent mill runs.

GOLD BUG

The Gold Bug mine, owned and operated by N. D. Madden of Coulterville, Calif., is situated in the southeast corner of sec. 28, T. 3 S., R. 17 E. (See No. 57, fig. 36.) Many years ago this property produced several thousand dollars worth of gold from rich pockets near the surface of an 8- to 10-inch vein and was purchased recently as a prospect by the present owner. Thus far its development has yielded several pockets containing up to $10,000 in gold each and about 200 tons of very rich ore.

The vein, which is 6 inches to 2 feet in width, strikes N. 18° W. and dips 30° E. It generally follows the contact between a slate hanging wall and a diorite foot wall, but in places it cuts through masses of slate that project into the diorite. It is in the places where the vein is wholly in the slate that its quartz is accompanied by calcite, in which the richest pockets of gold are contained. The mine is developed by a 200-foot adit on the vein, the face of which is about 70 feet vertically below the surface. Near the face of the adit, an ore shoot 40 or 50 feet in average length has been stoped to the surface, 110 feet on the dip of the vein. When the mine was visited in September 1938 the shoot had been followed below the adit level for 60 feet or more, and the ore from it was averaging over $100 per ton. A mill run on 25 tons that yielded $260 a ton had just been completed. The gold is principally in the calcite in coarse form with individual masses sometimes weighing as much as 2 or 3 ounces. Figure 58 (p. 168) is a photograph of a piece of characteristic bonanza ore from this property in which the gold is pres-
ent in massive calcite showing well-developed cleavages. Although the ore contains 1 to 2 percent sulfides, consisting largely of pyrite, these are only of medium grade, with a gold content of about $80 per ton.

A McCormick-Deering four-cylinder gas engine runs a two-cylinder Rix air compressor, which provides air for drilling.

The ore is crushed in a 6- by 8-inch Wheeling-type Universal crusher to minus 1½-inch size, and when enough has been accumulated for a mill run (20 to 25 tons) it is fed to a 3-stamp mill having 1,050-pound stamps and a 30-mesh screen. About 75 percent of the gold recovered by amalgamation is taken from the battery and the balance from a 4- by 9-foot amalgamation plate over which the pulp is discharged. When the property was visited, a mill run had just been completed and five pieces of gold each weighing over 2 ounces had been taken from between the dies in the battery. The discharge from the amalgamation plate goes to a 3½- by 12-foot Dunham concentrating table, which yields 1 to 2 percent concentrates. These were being stored for shipment to a smelter.

ORIGINAL AND FERGUSON

The Original and Ferguson mines are on the north bank of the Merced River at Clearinghouse, 63 miles from Merced on United States Highway 140 in sec. 21, T. 3 S., R. 19 E. (See Nos. 70 and 71, fig. 36.) The Yosemite Valley R. R. also passes through Clearinghouse. The elevation of the property at the river is about 1,500 feet, but its highest point is approximately 1,500 feet above the river. There are 10 claims patented in 1925 and several claims held by location, the property being owned by the Original Mining & Milling Co. of Merced.

This company worked the Original mine with slight interruption from 1911 until December 1934, when its properties were leased to the San Juan-Ramsey Co., 50 Congress Street, Boston, Mass., of which W. C. Smith is president and A. S. Wyner of Incline is general manager.

Operations at the Original mine were continued by the San Juan-Ramsey Co. until December 1937, when they were stopped by a flood that washed out the highway and railroad. The total production of the Original mine is reported to have been approximately $2,000,000.

The Ferguson mine was first worked from 1860 to 1880, since when it remained idle until reopened by the present lessee. Its early production is said to have been $1,250,000.

The Original and Ferguson veins lie on opposite sides of a mass of granodiorite that intrudes Calaveras slate. The Original vein is on the east side of the intrusive, striking N. 7° E. and dipping 68° E. The granodiorite forms its foot wall and the slate its hanging wall. In the Ferguson vein on the west contact of the intrusive the foot wall is again granodiorite whereas the hanging wall is slate as the vein dips 70° W. Its strike is N. 21° E. Both veins have average widths of about 3 feet, but they often pinch to less than 1 foot or widen to 6 feet or more. The ore in both veins consists of ribbon quartz containing arsenopyrite, pyrite, galena, sphalerite, and gold.
The Original mine is developed by a two-compartment shaft serving 10 levels down to and including the 1,100-foot level, from which a winze 150 feet north of the shaft is sunk 250 feet farther. The elevation of the adit level is 1,575 feet. In all, there are 11 levels averaging over 1,300 feet per level, their total footage being nearly 3 miles. Virtually all of this development is north of the shaft. Four parallel ore shoots raking 40° N. and ranging from 50 to 125 feet in length have been developed. Little timbering is required, as the ground stands well. On the 950-foot and 1,100-foot levels two faults cut off the vein, but it was found again on the lower level and had widened to 6 to 10 feet. A 1,200-foot cross-

![Figure 52.—Longitudinal section, south end of the Ferguson mine.](image)

...cut was driven west through the granodiorite foot wall 510 feet north of the shaft to the Ferguson vein, but this crosscut missed the ore body there, owing to a faulty survey.

Over an 8-year period the average recovery from the Original ore was 0.67 ounce of gold per ton; treatment was by amalgamation and concentration. The concentrates contained 5 to 6 ounces of gold per ton and the concentration ratio was approximately 200 to 1.

After the flood the San Juan-Ramsey Co. did not reopen the Original mine but confined its operations to the Ferguson vein, reconditioning the old workings and deepening the shaft. A longitudinal section of the south end of this mine is shown in figure 52. The elevation of the adit level is 1,625 feet, or 50 feet higher than
the adit level of the Original mine. The ores of both mines are
similar, but there is much arsenopyrite on the borders of the ore
shoots in the Ferguson, and the sulfide content of its ore is about
twice that of the Original ore. The Ferguson vein has three lateral
veins, known as the Spanish, Golden Rule, and Moonstone, coming
into it from the west. The first two of these are on contacts of
parallel dikes. These three veins are reported to give promise of
commercial ore and await development.

The ore is treated by amalgamation and flotation in a 30-ton mill.
An 8- by 12-inch Blake-type jaw crusher breaks the ore to about
1½-inch size. Any oversize in the discharge of the crusher is re-
moved by a trommel with punched holes 1½ inches in diameter and
delivered to a 6- by 12-inch Wheeling-type Pacific jaw crusher set
to break to minus ¾-inch size. The undersize from the trommel and
the discharge from the secondary crusher are delivered to a 10-stamp
mill having 1,000-pound stamps with drops of 5½ inches and 50-
mesh punched screens. The height of the battery discharge is 6
inches, and the pulp from each 5-stamp battery flows over a 6-inch
by 5-foot lip plate and two 5- by 10-foot amalgamation plates. The
pulp from the plates goes to three Fahrenwald Denver sub-A flotation
cells that yield about 1 percent of concentrates, the value of which
ranges from $100 to $200 per ton with the grade of the ore, corre-
sponding to $10 and $20 heads, respectively. Fifteen men are em-
ployed in the mine on two shifts, and one man on each of three
shifts runs the mill.

Hite

The Hite mine, one of the most noted of the East belt, is
situated at Hites Cove on the South Fork of the Merced River in
sec. 27, T. 3 S., R. 19 E. (See No. 73, fig. 36.) It was located in
1863, and up to 1882 is reported to have yielded about $3,000,000.
The outcrop, which ranges in width from a few inches to 12 feet, is
said to have been studded in places with gold. Hite, the discoverer,
though penniless at the time, was able, with the help of some In-
dians, to pound out enough gold in hand mortars to finance develop-
ment and the building of an arrastre. This enabled him to construct,
at considerable expense, a stamp mill and a road through the moun-
tains to the mine. The property was thus made to pay from the day
of its discovery and ultimately made Hite a very rich man. In 1882,
however, the mine was considered to be worked out and was closed,
notwithstanding the fact that the fissure in the lower workings was
still strong, and it is said that there were indications of commercial
ore in the hanging wall.

The property was acquired recently by Minerals Engineering Co.,
Subway Terminal Building, Los Angeles, of which Norman Whit-
more is president; C. B. Cole is the mine superintendent, and the
property is being reopened with a small crew of men.

The Hite vein strikes N. 70° W. and dips about 75° NE. It has
an average width of 2½ to 3 feet and occurs in slates that are soft
and gougelike near the vein, a condition that makes the ground so
difficult to support that considerable timbering is required. The
vein is remarkable in that on its outcrop a large offshoot splits away
from it and returns to the main vein in a sweeping curve within ap-
proximately 600 feet. This offshoot also reunites with the main fissure at a depth of about 600 feet. The horse of slate between the two parts of the fissure is thus about 600 feet long by 600 feet deep, with a maximum thickness of 45 to 50 feet. Both the main vein and its branch were rich in gold.

The vein was developed principally through a 1,200-foot crosscut adit intersecting it at a vertical depth of 725 feet below the outcrop. Due north of the portal of this adit and 600 feet above it is another adit 300 feet long. The present operations are directed to exploration of the hanging wall of the vein on the level of the lower adit.

DILTZ

The Diltz mine in the Whitlock district is about 6 miles north-west of Mariposa in sec. 29, T. 4 S., R. 18 E. (See No. 98, fig. 36.) It consists of 11 claims comprising about 150 acres and owned by the Diltz Mining Co., of which H. C. Fowler of Los Angeles is president, and A. F. Grant of Mariposa vice president and operating manager.

The Diltz claim, which is situated on the west bank of Sherlock Creek at an altitude of 2,850 feet, was first located in the 1860's. At long intervals it was worked in a small way by various owners and lessees until consolidated in the present group of claims in October 1931.

The vein strikes N. 10° E., dips 38° to 40° E., and has an average width of about 2½ feet, though it widens in places to as much as 10 feet. The hanging wall is a greenstone, and the foot wall is made up of a dark granitic rock and a basic dike rock. The ore contains arsenopyrite, chalcopyrite, pyrite, tetrahedrite, galena, and gold in a matrix of ribbon quartz, often accompanied by calcite and oxides of manganese. Arsenopyrite is the predominating sulfide. The ore occurs in well-defined shoots in fractured areas of massive quartz that have been recemented by calcite. Apparently deposition of the larger part of the gold was concurrent with that of the calcite. The mine is famous for its pockets of beautifully crystalized gold, of which a magnificent specimen weighing 52 troy pounds was taken on May 12, 1932, from the 100-foot level north. This single piece yielded 43 pounds 2 ounces of fine gold worth $10,707 at the old price of the metal. Another fine specimen 9 inches long, 6 inches high, and weighing 20 pounds 2 ounces yielded $3,862. Although pockets containing $100 to $500 each are common, the average gold content of the ore, excluding pockets, is only about 0.2 ounce per ton.

The mine is developed by a 650-foot shaft on the vein that has a single hoisting compartment and manway and by approximately 4,700 feet of drifts, the deepest level being at 600 feet. The andesite hanging wall is blocky, and considerable timbering is required to support it. Mining costs are high, as the vein does not dip enough to move the ore in the stopes and it is all shoveled by hand. An overthrust fault 600 feet north of the shaft is expected to cut off the vein at a depth of about 850 feet in the shaft. Air for drilling is supplied by a 12- by 14-inch Ingersoll-Rand compressor rated at 528 cubic feet and driven by a 75-horsepower motor. The mine makes about 30,000 gallons of water per day, which is handled by a 15-
horsepower Cameron electric pump. Two Byron-Jackson sinking pumps are kept in reserve.

Ore is hoisted by a 25-horsepower, single-drum electric hoist. Fifty to fifty-five tons per day is treated by amalgamation in a 15-stamp mill. No concentration process is employed, as nearly all of the gold is free. The ore is dumped from the skip into a 50-ton bin, from which it is delivered to an 8- by 20-inch Wheeling jaw crusher run by a 25-horsepower motor and is broken to minus 1 ½-inch size. Thence it goes to a 200-ton fine-ore bin, from which it is discharged by three Challenge feeders to three batteries of 5 stamps, each weighing 1,250 pounds and dropping 5½ inches 90 times per minute. The stamps are driven by a 50-horsepower motor. The stamp-mill pulp is crushed through 35-mesh punched screens and, after passing over a 5- by 8-foot amalgamation plate below each battery, is delivered by launder to a drag classifier on the tailings dump. The sands from the classifier are deposited on the dump, and the overflow goes to two Callow dewatering cones 8½ and 10½ feet in diameter, respectively. The clear overflow from the cones, comprising 80 percent of the water used in the mill, is returned to an 11,500-gallon mill tank. The spigot from the cones is discharged to waste. The water lost in the mill circuit is replaced by pumping from a spring on Sherlock Creek. The mine is operated only one shift and the mill three shifts. Thirty men are employed. Since the mine came under the present management in 1931 it has produced approximately $100,000 of gold per year.

**OUR CHANCE**

The Our Chance mine adjoins the Diltz property on the west in sec. 29, T. 4 S., R. 18 E. (See No. 96, fig. 36.) It consists of three claims—the Our Chance, Ten Spot, and Triangle—and is owned and operated by Arthur E. Clark of Mariposa. The vein strikes to the north and dips 27° NE. It ranges in width from 4 inches to 4 feet and has an average width of about 14 inches. The hanging wall is formed by a dike and the foot wall is meta-andesite.

This mine contains excellent milling ore, but it has also been noted for the handsome gold specimens it has yielded from pockets. Albert Austin, who owned the Our Chance claim in its early days, is said to have recovered over 2,000 ounces of gold with a hand mortar and arrastre from pockets near the outcrop of the vein, and a single pocket recently taken out by Clark is reported to have yielded $17,000. Much of the gold is beautifully crystallized, and arborescent forms, often coated with manganese minerals, are common. The ore contains arsenopyrite, pyrite, galena, chalcopyrite, and gold in a gangue of ribbon quartz sometimes associated with calcite and oxides of manganese.

The mine is developed by an 800-foot adit driven northeast to the vein and has about 2,500 feet of active workings. From the face of the adit there is a 500-foot drift to the southeast, which has a 200-foot winze 200 feet from the adit. At a depth of 100 feet on the winze is a drift 100 feet southeast and 70 feet northwest. Above the 500-foot drift ore has been stopped to a height of 50 to 60 feet for a length of 175 feet between the adit and the winze and to a
height of 100 feet between the winze and the end of the drift, a
distance of 300 feet. The walls are firm and require almost no
timbering.

Figure 54 shows the vein with its characteristic ribbon structure
and overlying dike. The dike, which has an average width of 3
to 4 feet, is drilled and shot first, and the rock from it is used as
backfill. The stripped vein is then taken up by hand, care being
taken to clean all depressions in the foot wall thoroughly as these
commonly contain little pockets of rich ore. In fact, the foot wall is
brushed thoroughly with brooms. Ore in the stopes is shoveled
into ½-ton rubber-tired buggies, which are lowered to the main
drift, where they are emptied into mine cars. A 10- by 12-inch
Chicago Pneumatic compressor driven by a 50-horsepower motor
supplies air for drilling.

Ore from the mine is dumped into a 10-ton bin, which feeds
a 7- by 14-inch Wheeling jaw crusber driven by a 20-horsepower
motor. The discharge from the crusber (minus ⅜-inch size) falls
into a 15-ton fine-ore bin, from which it is delivered by a home-made
dumping feeder, actuated by a cam and spring, to a 5-foot Hunt-
ington mill driven at 75 r. p. m. by a 7½-horsepower motor,
in which the ore is crushed through a 30-mesh screen. Three
amalgamation plates with a total area of 42 square feet receive the
discharge from the mill. Quicksilver is added inside the mill, and
95 percent of the recovery is effected there. The discharge from
the amalgamation plates is wasted. When the mine was visited in
August 1938, mill heads were averaging about 0.85 ounce of gold
per ton and approximately a ton per hour was being milled. Water
for milling is pumped from Sherlock Creek, which flows through the
property. Five men were employed.

SPREAD EAGLE AND MINER’S HOPE

The Spread Eagle and Miner’s Hope are two adjacent mines on
the east side of Whitlock Gulch in secs. 29 and 30, T. 4 S., R. 18 E.
(See Nos. 102 and 103, fig. 36.) They are owned by the Whitlock
Mines Corporation, 141 Milk Street, Boston, Mass., of which P. T.
Jackson is president. They include a tract of 106 acres covered
by eight mining claims and a mill site, all of which were patented
in 1884. The claims are the Spread Eagle, Miner’s Hope, Toll Gate,
Fanny, Little Charlie, Mohawk, Monarch, Empire, and Empire mill
site.

These mines probably were discovered and worked between 1850
and 1860, as Whitlock Gulch was the scene of extensive placer op-
erations shortly after the first discovery of gold in California. The
principal workings are in two nearly parallel veins that strike almost
due north but diverge in depth. The Spread Eagle dips about 45°
E., and the Miner’s Hope, which outcrops 600 to 700 feet to the west
of it, dips about 60° E.

Both veins have been worked in at least three periods—a very
early one, another in the latter part of the last century, and more
recently by the present owner. Their production is not known at
all accurately, but is reputed to have been $200,000 from each, total-
ing approximately $400,000. In each of these periods there was
**Figure 53.**—Head frame and mill, Cotton Creek mine, Hunter's Valley.

**Figure 54.**—Vein and overlying dike, Our Chance mine, Whitlock district.
a mill—probably a very primitive one at first, followed by a standard California 5-stamp mill whose ruins are still to be seen in the gulch, and finally the present Spread Eagle mill, which is now being operated by leasers.

*Spread Eagle.*—The Spread Eagle vein was worked through an 8- by 5-foot inclined shaft 345 feet deep, which is intersected by an adit at a depth of 125 feet on the dip. A drift at the tunnel level is about 1,000 feet long, but the workings have a total length of 1,150 feet. Below the adit level are about 1,250 feet of drifts. The average width of the vein is about 20 inches, but in stoping areas it has been considerably wider, up to a maximum of 7 feet. Both walls are greenstone. The ore consists of quartz carrying gold, pyrite, chalcopyrite, and occasional galena, the sulfides composing about 1 percent of it. Above the adit level, which corresponds closely with the water level, the ore was almost wholly free-milling, while below it about one-fourth of the gold is contained in the sulfides, the concentrates from which average about $250 per ton. The ore mined above the adit level averaged about 1 ounce of gold per ton, but the vein contained frequent pockets of high grade, and 2- and 3-ounce ore was not exceptional. It is of interest that ore shoots were found at two places where the vein bends sharply to the east and becomes more nearly parallel to the foot-wall fissures, which will be described later as containing ore in the Miner's Hope claim. The upper part of the shaft is caved, and no work has been done in the mine recently, but it is said that there was no decrease in values in depth, operations having ceased because they became submarginal with respect to the available equipment and rate of production. The vein probably can provide tonnage for another operation and is now being worked in the Hayseed mine adjacent on the north.

The Spread Eagle mill is equipped with a 20-ton ore bin, an 8- by 12-inch Blake jaw crusher, 5 stamps weighing 1,250 pounds each, amalgamation plates, and a Wilfley table. Power is provided by a 25-horsepower gas engine.

*Miner's Hope.*—The early workings of the Miner's Hope included numerous deep trenches, shallow shafts, pits, and adits extending over 1,000 feet along the vein but principally within 600 feet at the north end of the claim. There the vein is said to have averaged over 4 feet in width for at least 300 feet, attaining a maximum width of 12 feet in one stope. South of this section, however, its width was 14 inches to 2 feet. The vein follows rather closely the contact of a schist on the foot wall and greenstone on the hanging wall, the latter probably representing a basic premineral intrusive. The ore shoots are said to have been associated with small fissures coming through the schist to an abutment against the greenstone. Some of these fissures contained a fine-grained dike rock.

Beneath the early workings an adit level was driven that intersects the vein 188 feet below the surface, measured along the dip, at a point about 800 feet south of the north endline. All ore above this level is believed to have been mined. The old drifts are caved about 200 feet from the adit, both north and south. From this level a raise on the vein was put through to the surface and was equipped as a two-compartment shaft. Beneath the adit level this shaft was
later extended to a depth of 190 feet on the dip with a smaller ladder compartment than in its upper portion, and finally it was extended full size to a level 308 feet below its collar with a 20-foot sump below it. The total depth of the shaft is thus 328 feet. The 190-foot level extends from the shaft 85 feet to the north and 367 feet to the south. The 308-foot level runs 133 feet north of the shaft and 188 feet south. Neither of these levels has reached the region of the old stopes, evidenced by caves on the surface to the north of the shaft, though the lower level is possibly within 100 feet of their southern limit. There is an unexplored block of ground with 170-foot backs between the 138- and 308-foot levels, above which as much as half of the 600 feet to the endline of the claim is believed to have been stope in good ore.

South of the shaft an ore shoot about 90 feet long was discovered on the 308-foot level in 1937 and was mined up to the 138-foot level, though its length decreased rapidly above the 190-foot level. This shoot produced 2,500 tons of ore, mostly from between the two lower levels. Its average value was $9.70 per ton, of which $7.20 was recovered by amalgamation, returning $18,000. Only $2,500 of this came from above the 190-foot level. At the time this ore was milled there was no table on which concentrates could be recovered, but the stamp-mill tailings were panned regularly, and the concentrates were weighed and assayed to keep track of their value. The gold content of these sulfides was very high. Of 37 samples, only 7 showed less than 5 ounces of gold per ton, 13 showed 5 to 10 ounces, 9 showed 10 to 15 ounces, and 8 contained more than 15 ounces, the highest yielding 22.5 ounces. The average gold content of the 37 samples was 10 ounces per ton, and the records indicate that the sulfides constituted about 0.7 percent of the ore. Unfortunately, after a table had been installed concentration of the tailings was prevented by a torrential storm, which swept them away.

In addition to the $18,000 yielded by the south ore shoot the present company is said to have recovered $6,000 in 1934. Recently, Martin Tresidder and R. C. Poor, who are leasing the property, recovered $6,800 from 1,286 tons of mixed ore and waste derived from the late shaft sinking and drifting and from old dumps. The total production of the present company thus exceeds $30,000.

The Miner’s Hope is well equipped with an excellent shaft, a 100-ton ore bin built into the head frame, a new 530-cubic-foot 2-stage Ingersoll-Rand compressor, a motor-driven, 75-horsepower, single-drum Hendy hoist, a 2-stage, 15-horsepower Ingersoll-Rand pump, cables, skip, blower, and shaft installation of pipes, and cable for air, water, and electricity. Power is bought from a subsidiary of the Pacific Gas & Electric Co.

In the Fanny claim west of Whitlock Creek is a strong quartz vein said to show no gold ore at the surface; but on the Milburn claim, adjoining it on the south, good ore has been discovered recently in the same vein. In the Empire claim, south of the Miner’s Hope, is a small vein called the Dolph, which is said to have produced $25,000. It lies about 100 feet east of the southern extension of the Miner’s Hope vein and dips 70° E. The Mohawk claim contains the northerly extension of the Whitlock vein, one of the famous early producers of the district.
GOLDEN KEY

The Golden Key Mining Co. of Oakland, Calif., owns six patented claims—the Hayseed, Regan, Golden Gate, Coronado No. 2, Dusenberry, and Haywire Fraction—and three mill sites on the east side of Whitlock Creek in sec. 29, T. 4 S., R. 18 E. (See Nos. 99-101, fig. 36.) This group of claims adjoins the Miner’s Hope and Spread Eagle mines of the Whitlock Mining Co. on the north and has been leased recently by J. P. Collins of Montrose, Calif., who is employing about 20 men on its development. The principal veins, the Regan and Hayseed, both strike north and dip to the east, the Regan at 65° and the Hayseed at 40°. Their outcrops are about 50 feet apart, that of the Regan lying to the west and the veins diverging with depth. The Regan vein is considered to be an extension of the Miner’s Hope vein and the Hayseed an extension of the Spread Eagle vein. These two main north-and-south fissures are crossed at nearly right angles by four cutter veins called the Nos. 1, 2, and 3 Golden Gate and Coronado No. 2 veins. They are credited with an output of $130,000 to a maximum depth of 135 feet.

The Regan vein traverses the Hayseed, Regan, Golden Gate, and Dusenberry claims, in the order named, toward the north. At the south end of the Regan claim is a caved shaft on the vein 310 feet deep, but here the vein is reported as virtually barren. North of this old shaft, 360 feet, is the Arndke shaft, sunk in the hanging wall to a depth of 85 feet and also caved. This shaft is supposed to be on the intersection of the Regan and Coronado No. 2 veins, the latter of which dips 30° S. A 39-foot drift at the bottom of this shaft on the Coronado vein is said to show 22 inches of ore averaging $15 a ton. Two other shafts on the Regan vein are 190 and 110 feet deep, respectively, and are reported to show 4 feet of $8 ore. The three northern claims are developed by a long adit called the Greensite tunnel, which runs southwesterly from the county road to cut the Nos. 1, 2, and 3 Golden Gate veins in succession and proceeds to within 480 feet of the workings of the Hayseed shaft.

The Hayseed claim is developed by a shaft inclined at 37° on the vein and extending to a vertical depth of 322 feet. There are four levels from this shaft at vertical depths of 110, 220, 250, and 300 feet and 650 feet of drifts, most of which are to the north of the shaft. On the 300-foot level south is an ore shoot 73 feet long with an average width of 5 feet, which is said to contain $10 to $12 per ton. The management plans to sink the shaft to the 400-foot level and drift 125 feet south, blocking out this shoot between the two levels. The 300-foot level north will also be continued 250 feet to cut the Whistletigger and Pedro ore shoots on that side of the shaft. Then the Greensite tunnel will be extended 480 feet to beneath the Hayseed workings, where it will develop 1,250 feet of backs. A good road was built to the Hayseed shaft from the county road during the summer of 1938.

MILBURN

The Milburn mine is on the west side of Whitlock Creek opposite the Miner’s Hope in sec. 31, T. 4 S., R. 18 E. (See No. 95, fig. 36.) This was an old prospect on which little work had been done because the inflow of water along the vein was too great to be handled with
early pumping facilities. It was recently purchased and is being
developed actively by the M. K. B. Mining Co., of which L. H.
McPherson, Escalon, Calif., is president and W. C. Krath of Mariposa
is operating manager.

A strong quartz vein in schist is 8 to 13 feet wide and has an
average width of 10 feet. It strikes north, dips 80° E., and is de-
volved by a 120-foot vertical shaft in the hanging wall with a 60-
foot drift north on the 80-foot level. Sampling of an old dump near
the present shaft is said to have shown a gold content of $16 per ton.
Ten tons that were milled yielded $13 per ton in free gold and con-
centrates assaying $279 per ton, the concentrate ratio being about
100 to 1. While installing a water pipe line from the shaft to a
10,000-gallon redwood tank on the hill it was necessary to trench
the outercrop of the vein, and specks of free gold were observed in much
of the vein material dug.

When visited in September 1938 the shaft was making 60 gallons
of water per minute, which was being handled by a 7½-horsepower
Sterling electric pump with automatic control. The shaft is served
by a 15-horsepower, single-drum electric hoist. Electric power,
brought to the mine over a line from the Miner's Hope property, is
purchased from the San Joaquin Light & Power Co. Four men
were employed in development.

NUTMEG

The Nutmeg mine consists of one claim held under location by
C. O. Willey and wife of Winton, Calif., and Sam Le Barry of
Mariposa in sec. 29, T. 4 S., R. 18 E. (See No. 91, fig. 36.) The
vein has an average width of 3½ feet, strikes northwest, and dips
55° NE. It occupies a contact between a slate foot wall and a por-
phyry hanging wall and is developed by a 106-foot vertical shaft
with drifts 140 feet north and 20 feet south on the 50-foot level and
210 feet north and 90 feet south on the 100-foot level. Four pay
shoots averaging 25 feet in length and $10 to $12 per ton are reported
to have been cut. Some of the ore contains up to 1 ounce of gold
per ton. At the time the mine was visited in September 1938 there
were 200 tons of ore on the dump, and 1,000 tons more were said to be
in sight. The mine was making about 10 gallons of water per
minute, which was handled by a 3-horsepower jack pump. A
2-stamp mill was being erected.

GEARY

The Geary mine, adjoining the Nutmeg to the south (see No. 92,
fig. 36), is a patented claim of 20 acres traversed by the vein that
crosses the Nutmeg. It is supposed to have a shoot of rich ore and
was developed by two shafts 160 and 70 feet deep, respectively, the
shallow shaft being 300 feet south of the deeper one. The vein
averages from 3 to 4 feet in width. It strikes northwest and dips
80° NE. It is at a contact between a slate foot wall and a porphyry
hanging wall. On the surface it has been mined by an open-cut for
almost 400 feet and is reported to have a drift 325 feet long on the
70-foot level. The mine is owned by J. Sheldon Potter of San
Francisco, but it has been leased recently by H. L. Womacks of
Springdale, Calif., and Chas. E. Farson of Mariposa, who are opening the old shafts and expect to install a stamp mill.

COLORADO

The Colorado mine is situated at an altitude of 3,000 feet near the head of Saxon Creek, about 5 miles in an air line north of Mariposa in sec. 27, T. 4 S., R. 18 E. (See No. 111, fig. 36.) It consists of one patented and three unpatented claims on the well-known Colorado vein, which is traceable for several miles and on which a number of other mines are situated. The vein strikes northwest and dips 60° to 80° NE. Both walls are slate, and the vein has an average width of 1½ to 2 feet and a maximum width of 5 feet. It is developed by a 200-foot inclined shaft and a 500-foot adit at the level of the mill that intersects the shaft at a depth of 125 feet. On the 95-foot level is a 200-foot drift to the south, above which most of the ore is said to be stope to the surface. The ore shoots, ranging in length from 30 to 75 feet, rake to the north at about 45°. The ore is a banded quartz and is free-milling to the maximum depth mined. It is reported to have an average gold content of about 0.5 ounce per ton. The shaft house is equipped with a single-drum hoist driven by a 30-horsepower electric motor and an 8½ by 10-inch Sullivan air compressor run by a 75-horsepower motor. The mine has not been operated for a number of years, but a 10-stamp mill on the property is still in fair condition, although its concentration section has been dismantled, presumably because it served no useful purpose, as the ore is so largely free-milling.

Ore was trammed from the portal of the adit level about 75 feet to the mill, where it was dumped over a 1½-inch grizzly, the oversize from which was broken to minus 1½-inch size by a 10- by 14-inch jaw crusher driven by a 15-horsepower motor. The discharge from the crusher and undersize through the grizzly fell into a 30-ton bin, from which the ore was delivered by two Challenge feeders to a Joshua Hendy 10-stamp mill, which crushed it through 30-mesh punched screens. The stamp mill was driven by a 30-horsepower motor. The pulp from each 5-stamp battery flowed over a 5- by 10-foot amalgamation plate and thence over concentration tables to waste.

FICK AND OXFORD

Henry Fick and Oscar Oxford of Mariposa have three claims on the southern slope of Sawmill Gulch covering an extension of the Colorado vein and adjoining the Colorado mine on the northwest. (See No. 110, fig. 36.) The vein is 1 to 5 feet wide here and has an average width of about 18 inches. It is developed by three small open-cuts and by a 60-foot crosscut adit, the face of which was estimated to be within about 50 feet of the vein when the property was visited in September 1938. Samples from the open-cuts are reported to contain $4.50 to $7 of gold per ton.

EUREKA

The Eureka mine is on the west slope of Mount Buckingham at an altitude of about 3,000 feet in sec. 2, T. 4 S., R. 19 E. (See
No. 145, fig. 36.) It consists of one claim owned and operated by J. C. Donnelly of Mid Pines, with E. L. Siegle and Fred Colvard as partners.

The deposit consists of a quartz vein averaging about 2 feet in width that strikes nearly due east and extends almost vertically between slate walls. It is developed by three adits on the vein, the lowest of which is 410 feet long. Fifty feet vertically above this lower adit a second adit has been driven on the vein for 300 feet, and 100 feet still higher the upper adit extends for 30 feet. Twelve samples taken at various places in the 300-foot adit are reported to have averaged 1.26 ounces of gold per ton. Concentrates contain about 10 ounces of gold per ton. When visited in September 1938 development work was being done in the upper adit, and a private road had been completed from the county road on the ridge of Buckingham Mountain to within 100 yards of the property. Upon completion of the road the owners plan to install a small mill.

MARIPOSA

The Mariposa mine is less than half a mile southeast of the town of Mariposa in sec. 23, T. 5 S., R. 18 E. (See No. 140, fig. 36.) It is a property of the Mariposa grant and is said to have been discovered in the spring of 1849 by Kit Carson and two associates, Carson being the famous scout who guided Fremont on his Oregon Trail expedition of 1843.

Although its production has been only about $2,200,000, the Mariposa is a relatively famous mine because of its identification with the early history of the Mother Lode. Very high grade ore was found in its outcrops, and at the foot of the hill were rich early-day placer mines, supposed to have derived their gold from the deposit above them. Aside from a few shallow operations by Mexicans, the Mariposa was probably the first lode mine worked in California; and it undoubtedly had the first stamp mill, as the first one on the Mariposa was operating by midsummer of 1849. This mill derived its power from a huge water wheel. It was employed merely to crush ore from the mine, the gold being then separated from its gangue by rockers such as were used commonly for placer mining.

An estimated production of 13/2 million dollars to a depth of 275 feet is mentioned by Logan as attributable to the period from 1849 to 1870, during which the mine had five mills.23

After Fremont took possession of the property in 1859, it was worked profitably by a lessee until 1864, when operations were taken over by the Mariposa Co., which had purchased the grant from Fremont. The new operations showed a loss on $25 ore, according to Browne.24

A new inclined shaft was begun in 1900, and from 1901 to 1905 production was reported to have been $693,000 from ore averaging about $6.80 per ton, the recovery having been about $6.20 per ton. There is an interesting record that in 1905 costs had been reduced to $2.10 per ton for mining and $1.10 for milling, a total of $3.20.

24 Browne, J. Ross, Work cited, p. 28.
The mine was in a section of the vein whose course was N. 50° W. It dipped 50° to 70° S. The vein filling was of quartz 3 to 4 feet wide, with walls of slate and greenstone. From the main vein, what is described as a branch diverged at an acute angle on a N. 70° W. course. East of their junction, values are said to have been fairly even, the gold having been distributed throughout the quartz, while west of it most of the quartz was barren, but it included occasional rich pockets of gold ore. One of these pockets yielded $15,000; $80,000 was taken from another, and there were several smaller ones.

A plan of the mine workings is shown in figure 55. The shaft, begun in 1900, was sunk with three compartments to a depth of 1,550 feet along the incline, the vertical depth being about 1,250 feet. In all, there are over 9,000 feet of workings. Eight levels were driven from the shaft, the first at 275 feet; thence to the fourth level (800 feet along the incline) were regular stopes for about 560 feet. Immediately below the fourth level were some smaller stopes extending for 120 feet, but there were none below the fifth level (970 feet). The bottom of the stopes had a pronounced rake to the east.

It is claimed by F. T. Maguire, manager of the Mariposa grant, who was familiar with the mine in 1915 before it was closed, that in the nearly 600 feet below the fifth level the workings were off the vein. He concluded that in depth the vein had been disclosed only in a single place. This was on the sixth level, where an old map shows a crosscut to the northeast, on which it is marked that there were "stringers." Upon examination of the map this seems plausible, to the extent that the stringers were where the vein might be expected.

However, there is another concept that deserves some consideration, that of faulting, as suggested by G. D. B. Turner in a report of 1919, a copy of which is among the records of the Mariposa grant. From a study of the surface, underground maps, and other records Turner concluded that the vein having the N. 50° W. course was the main ore-bearing vein and that it was faulted by the vein whose course was N. 70° W., being displaced to the west on the north side of the fault. He thought the even easterly rake of the stope bottoms with an inclination of about 30° marked the intersection of the fault with the vein.

In that case there would be a gap without any vein to the west of the stope bottoms, which represent the abutment of the southern segment of the vein against the fault. The gap would extend as far west as the abutment of the northerly segment against the footwall of the fault. Such faulting might explain the earlier shallow workings (west of these about the main shaft) as having been in the vicinity of the abutment of the north segment of the vein against the fault. It might, furthermore, explain the change in character of the vein going west from the intersection near the shaft. The part east of the intersection, where the gold was distributed regularly through the quartz, would represent the original vein, while the part west of the intersection, where the vein suddenly became barren except for bunches and pockets, would be explained as fault quartz that has included fragments of drag from the vein. The
lower part of the shaft would then be out of the vein, as suggested by Maguire; it would be in the fault, as no vein would be there.

The vein north of the shaft, however, would not represent the same horizon as that south of it, but a deeper horizon if the fault is normal or a higher horizon if the fault is reverse. That is to say, the direct extension of the ore south of the fault, where the ore was stoped, would not be found at the same level north of the fault. If the fault is normal, direct extensions of ore north of the fault may have been eroded away, but if it is a reverse fault, as is more usual along the Mother Lode, they would lie below the present surface.

On the whole, it seems probable that if the mine is ever worked again it will be found that the vein was lost, as its termination at
so shallow a depth would be unusual with respect to the habits of Mother Lode veins of such strength and extent as the Mariposa displays at the surface. Miners of former times usually accepted faults of considerable displacement as misfortunes beyond remedy.

It is said that the mine made very little water and that below the first 150 feet its walls were exceptionally strong and required no timbering. After it had been closed down some very rich ore was taken out by leasers through an old whim shaft from the extreme west of the second level, the depth of which is 475 feet. Presumably the mine had filled with water below that point, and lower levels had never reached that far west.

KANE

The Kane prospect, containing 25 acres, is on the southwest slope of Kane’s Hill at the junction of Rocky Gulch and Stockton Creek about 1 mile east of Mariposa. (See No. 138, fig. 36.) The property is leased by G. C. and L. G. Kane of Mariposa on a royalty basis from the Mariposa Mining & Commercial Co.

The vein consists of a well-laminated quartz showing much movement and carrying galena, pyrite, and free gold. It strikes N. 20° W. and along its outcrop dips slightly northeast. However, at a depth of 50 feet the dip is 68° SW., corresponding to that of the enclosing rocks. The outcrop has been traced for 1,500 feet and has an average width of 3 to 4 feet.

Development consists of a series of open-cuts over a distance of 1,300 feet, a 50-foot shaft on the vein, and a 170-foot crosscut adit from the southwest slope of the hill which taps the vein at a depth of 100 feet below the collar of the shaft. The vein in the shaft averages 40 inches in width and where crosscut by the adit is about 4 feet wide.

The adit traverses 160 feet of altered andesite and then cuts an acid dike 8 feet wide, which forms the hanging wall of the vein. The foot wall is a sheeted and altered serpentinite. A crosscut through the vein at the end of a 20-foot drift from the face of the adit to the north along the foot wall shows the same ribbon quartz and mineralization in the vein as at the surface. The andesite in the hanging wall extends across Stockton Creek to the southwest about a mile and is succeeded by a slate belt. The serpentinite on the foot wall is about 300 feet wide and is followed by a belt of silicified slate about 1,000 feet wide where exposed in Rocky Gulch. The dike forming the immediate hanging wall of the vein can be traced for several miles.

Fifty tons of ore mined in development is piled in dumps, but none has been removed from the property. Development has been guided by careful panning, but the numerous oil exposures have not been sampled thoroughly. The few assays made have yielded $2 to $20 per ton in gold and silver. An excellent mill site is available, and Stockton Creek can furnish an abundance of water.

The power lines of the San Joaquin Light & Power Co. are within three-quarters of a mile at the Mariposa mine.

CRIPPLE CREEK DIKE

The Cripple Creek dike is about 1 1/2 miles north of Mariposa in sec. 11, T. 5 S., R. 18 E., about a quarter of a mile east of United
States Highway 140. (See No. 136, fig. 36.) It is under lease from the Mariposa grant to F. T. Schlage and George Gilbert of Mariposa.

An aplite dike having an average width of 3 to 4 feet, striking northwest and dipping about 45° SW., carries free gold, highly auriferous arsenopyrite, and pyrite along its contact with a serpentine foot wall and a slate hanging wall and also in small fissures in the dike. The outcrop of this dike, which can be traced for nearly a mile, was worked for free gold over a distance of several hundred yards and to a depth of from 15 to 20 feet by early miners. However, they evidently failed to discover that some arsenopyrite present in an unoxidized portion of the dike was amazingly rich in gold. Figure 51 (p. 192) is a photograph of a characteristic piece of the ore showing the well-developed crystallization of the arsenopyrite. This mineral is penetrated occasionally by wires of gold, and free gold often is found adjacent to the outer surfaces of its crystals, while arsenopyrite in which no gold is visible even with a magnifying glass often will contain $20,000 to $50,000 per ton. If roasted at red heat in an oxidizing atmosphere to expel the arsenic, the arsenopyrite will sweat beads of gold in the same way as will a rich gold telluride ore.

About 30 pounds of lump arsenopyrite picked from the ore by hand was analyzed at the Selby smelter, with the following results:

<table>
<thead>
<tr>
<th>Analysis of arsenopyrite from Cripple Creek dike</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic oxide</td>
<td>37.00</td>
</tr>
<tr>
<td>Ferric oxide</td>
<td>31.00</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>19.00</td>
</tr>
<tr>
<td>Antimony</td>
<td>0.65</td>
</tr>
<tr>
<td>Copper</td>
<td>0.50</td>
</tr>
<tr>
<td>Insoluble</td>
<td>5.20</td>
</tr>
</tbody>
</table>

**Ounces per ton**

- Gold: 877.20
- Silver: 188.00

The quantity of gold shown by this analysis corresponds to a content of over 3 percent and to a value of $30,702 per ton, or over $15 per pound. The lessees, conducting their development by hand methods, have sunk a vertical shaft about 80 feet and run a few feet of crosscut and drifts at its bottom in the hope of finding more of the rich arsenopyrite.

**PLACER MINES**

**GENERAL REVIEW**

Although the placers of Mariposa County yielded millions of dollars to the early miners, they consisted chiefly of creek deposits that were both shallow and narrow. In consequence, they were quickly exhausted. In some localities the placers were fairly rich, but they never approached the bonanza gravel deposits of Tuolumne and Calaveras Counties either in richness or yield. No remnants of rich Tertiary placers such as exist in Calaveras and Tuolumne Counties have been preserved, as the protective blanket of lavas and other ejecta from the great volcanic eruptions of the late Tertiary that filled many stream valleys to the north did not extend as far south as Mariposa County. Hence, the Tertiary gravels of the county
were swept away, and all of the existing placers may be classified as Quaternary.

The principal placer localities of the past were the headwaters of Mariposa Creek in the vicinity of Mariposa and Mormon Bar and its tributaries, Agua Fria, Buckeye, and Stockton Creeks; Bear (west of Cathay), Corbett, Hornitos, and Burns Creeks; and the bars and tributaries of the Merced River west of Clearing House, including the North and South Forks and Sweetwater, Feliciana, Bear (tributary to the Merced at Briceburg), Saxon, Sherlock, and Maxwell Creeks.

There are no authentic records of early placer production, but it probably did not exceed $10,000,000. Virtually all of this was produced prior to 1870, by which time all the richer deposits had been worked out. Although accurate records of the production of placer gold in the county before 1903 are not available, it is improbable that this exceeded 1,000 ounces in any year between 1870 and that date. The average annual output between 1903 and 1934 was 220 ounces, with a maximum of 603 ounces in 1933. (See fig. 34.) However, under the stimulus of a higher price for gold, production increased to 1,100 ounces in 1934; and with the installation of several draglines and floating washing plants that are working small acreages of gravel too low in grade to have been profitable heretofore, production increased to 7,137 ounces in 1937 and probably exceeded 10,000 ounces in 1938. Any further increase in the placer production can be only temporary, and it is inevitable that within a few years the output will decline as it again becomes dependent on small sporadic operations that characterized it for so many years. It is of interest to note that several hundred persons, including many itinerants, were engaged in "sniping" for placer gold in this county during 1938. The "sniper" is generally one who owns no ground but moves about from place to place to work small bits of virgin ground by hand for a short time, or to dig in crevices of exposed bedrock for a little gold brought down by rains of recent years. At several places, notably on the headwaters of Agua Fria and Bear Creeks, small camps of 20 to 30 shacks, tents, and trailers were established by the snipers. Their earnings, which generally average less than $1 a day, were increased somewhat in 1938 by the unusually heavy rains of the preceding winter, which reconcentrated many shallow deposits and in streams with steep gradients exposed considerable areas of bedrock for crevicing.

In the summer of 1938 three draglines and floating washing plants were in operation in the county, all on Mariposa Creek. One, belonging to the Trebor Corporation, was mining at Mormon bar and the other two, owned by Placer Properties, Inc., and the K. R. Nutting Co., respectively, were operating about 20 miles farther downstream near the western boundary of the county. Both companies last named expected to work out their ground in 1938, and the Trebor Corporation had only a small yardage left at Mormon bar. Although there are a few other small areas in the county that may be worked profitably by draglines, the steep gradients of the creeks and the generally hard and unevenly eroded bedrock do not favor this type of mining. It is evident, therefore, that the companies now operating draglines in the county soon will be
forced to seek elsewhere for workable deposits and, on the whole, it seems improbable that even the present small production from placer mining in Mariposa will be maintained for more than a few years.

Brief descriptions of the principal placer operations in the county in 1938 follow.

**DRAGLINE OPERATIONS**

**PLACER PROPERTIES, INC.**

In March 1936, Placer Properties, Inc., of which H. G. Kumle, Oregon House, Calif., is president, placed a dragline and floating washing plant in operation on a 125-acre tract on Mariposa Creek, about 8 miles by road east of Le Grand in sec. 31, T. 7 S., R. 17 E. (See No. 160, fig. 36.) L. Brier of Le Grand is superintendent.

The pay gravel extends along the creek and has an average width of 600 feet and depth of 14 feet. The gravel is loose and of medium size and contains no clay and only occasional bedrock boulders. The gold content averages about 15 cents per cubic yard. The gold is chiefly fine, although some individual pieces worth as much as 25 cents are recovered occasionally. The bedrock at the lower end of the property is diorite, and upstream this is succeeded first by granite and then by slate.

The washing plant is mounted on a boat 42½ by 30 by 3 feet, consisting of five steel pontoons, and has a steel superstructure. Power is supplied by a 120-horsepower caterpillar Diesel engine. The trommel is 26 feet long and 5 feet in diameter and has an 18-foot screen section with 3/8-inch holes. It is chain-driven at 12 r. p. m., and has three retarding rings in its screen section. The trommel is supplied with 4,000 gallons per minute of wash water from the creek by a 12- by 14-inch Fairbanks-Morse pump driven from the motor shaft by V-belts.

There are six gold-saving tables on one side of the boat and seven on the other, each 12 feet long and 30 inches wide. These tables have wooden riffles, in which quicksilver is used. They are cleaned up three times a month, and the retorted gold is shipped to the smelter at Selby, Calif., or to the mint. The recovery is reported as about 13 cents per cubic yard.

Oversize from the trommel is discharged by a 51-foot stacker with a 27-inch heavy-duty rubber belt driven at 400 feet per minute by gears from a jack shaft driven by V-belts from the motor shaft.

A Bucyrus-Erie 46-B dragline with a 52-foot boom and 2-cubic-yard bucket constitutes the digging unit. It is operated by a 160-horsepower Diesel caterpillar motor that normally uses 175 gallons of fuel oil per 24 hours. This oil costs 4½ cents per gallon delivered. A set of four bucket teeth is replaced every 48 hours.

Many cottonwood trees grew along the creek in this area. They were blown out with stumping powder. A caterpillar bulldozer (R. D.-7) is used for leveling and for the removal of bedrock boulders lifted out of the pit by the dragline. About 100,000 cubic yards of gravel is excavated and washed per month. When visited in the summer of 1938 the tract was nearly worked out, and it was expected that the operation would be concluded in October of that year.
Figure 56.—Dragline and washing plant of the K. R. Nutting Co. on lower Mariposa Creek.

Figure 57.—Gold-washing plant of the Trebor Corporation on Mariposa Creek at Mormon bar.
In February 1938 the K. R. Nutting Co. of Le Grand began mining with a dragline and floating washing plant on a 70-acre tract on Mariposa Creek about 4 miles east of Le Grand in sec. 1, T. 7 S., R. 16 E. and just within the western boundary of Mariposa County. (See No. 159, fig. 36.) T. J. Booth of Le Grand is superintendent. The pay gravel follows the general course of the creek and averages 700 feet in width and about 13 feet in depth but has a maximum width of 1,000 feet. Its gold content is said to average about 15 cents per cubic yard.

The dragline is a K-48 Link-Belt machine with a 50-foot boom and is operated by a 135-horsepower Diesel engine. The washing plant is supported on a floating 40- by 34- by 3-foot wooden hull, and is operated by a 135-horsepower Diesel engine. The trommel, which is 28 feet long and 54 inches in diameter, is chain-driven at 12 r. p. m. and has a 20-foot screen section with $\frac{3}{8}$-inch holes. It is supplied with 2,800 gallons of wash water per minute from the creek by two 8-inch Byron Jackson pumps. The undersize from the trommel passes over seven gold-saving tables 30 inches wide on each side of the boat. Quicksilver is used in the riffles. Sands are discharged through double tailraces. The oversize from the trommel is wasted by a 50-foot stacker with a 30-inch special heavy rubber belt. A general view of the dragline and washing plant is shown in figure 56.

When the property was visited in August 1938, the stripping of about 180,000 cubic yards of overlying soil with an average depth of $3\frac{1}{2}$ feet was in progress. A 90-horsepower tractor hauls a 12-cubic-yard Austin Western scraper. This scraper is otherwise self-powered. It has a 32-horsepower gasoline motor that drives the pumps that actuate its hydraulic lifts, its operation being controlled electrically from the tractor hauling it.

About 2,800 cubic yards of gravel per day was being excavated and washed, with a reported average recovery of about 13 cents per cubic yard. Including the superintendent, 13 men were employed each day, the plant being operated three shifts with three men per shift and the additional services of a welder, roustabout, and bookkeeper on the day shift. It was expected that this particular tract would be worked out by January 1, 1939.

TREBOR CORPORATION

During the summer of 1938 the Trebor Corporation, of which Robert D. Mueller of Mariposa is president and general manager, acquired placer leases on Mariposa and Agua Fria Creeks from the Mariposa grant and installed a dragline and floating washing plant on the former creek at Mormon bar. (See No. 146, fig. 36.) Figure 57 is a general view of this plant.

A 2-cubic-yard, heavy-duty Marion dragline equipped with a 1$\frac{1}{2}$-cubic-yard Page bucket delivers gravel to the hopper of the washing plant, which is supported on a hull consisting of steel pontoons. The washing plant, built by the Bodinson Manufacturing Co. of San Francisco, has a capacity of 2,000 cubic yards per day and is powered by a caterpillar engine. The trommel, 25 feet long and 54 inches in diameter, discharges its oversize to a 45-foot stacker. All
drives on the boat are Tex-rope. A No. 76 Allis-Chambers gasoline tractor equipped with a bulldozer blade is used for leveling and clearing brush. Twelve men are employed in the operation of the plant, and three more constitute a crew that is engaged in sampling gravel deposits held under lease. Mining was begun in September 1938, and 1,600 cubic yards per day was handled until the available yardage was worked out early in 1939, when the plant was moved to another placer on Agua Fria Creek.

The average depth of the gravel at Mormon bar was only 6 feet, and mining was rendered difficult by many large boulders and bad bedrock conditions. Pinnacles of bedrock that often projected well above the water level gave trouble in maneuvering the boat. The management stated that maintenance and mining costs were excessive, owing to the rough operating conditions, and that actual running time averaged only about 16 hours per day. A recovery of 22 cents per cubic yard is reported.

**HANAS PLACER**

The T. D. Hanas placer lies in the steep V-shaped valley of Mariposa Creek in sec. 9, T. 7 S., R. 17 E., about 1½ miles northwest of White Rock and 8 miles downstream from Mariposa. (See No. 155, fig. 36.) It contains 40 acres and extends about 6,000 feet along the creek. The gravel is 9 to 25 feet deep and is said to average more than 50 cents per cubic yard. The bedrock is an unevenly eroded slate.

In 1937 a partnership was formed to mine the placer with a dragline and floating washing plant, but difficulties arose that resulted in removal of the dragline from the property. When visited in August 1938 the plant had no excavating machinery, and the washing unit was of necessity idle. The washing machinery is carried on a 25- by 19-foot hull made of three steel pontoons and having a 22-inch draft. A trommel 16 feet long and 3 feet in diameter, a 40-foot stacker with a 20-inch rubber belt, and a 6-inch centrifugal pump that supplies wash water are all run by a Paige automobile motor. Most of the gold in this deposit is fine, but pieces worth 5 to 10 cents each are common and nuggets valued up to $2 are found occasionally. Hanas was negotiating for a dragline and hoped to operate the plant during the winter of 1938.

**MISCELLANEOUS OPERATIONS**

**KOCKEL PLACER**

A creek placer that has been covered by a slide is being developed by Trangott Kockel on the south slope of Sherlock Gulch in sec. 24, T. 4 S., R. 17 E., in the Sherlock mining district. (See No. 86, fig. 36.) A few pounds of exceptionally heavy gold has been taken out, with nuggets weighing up to 1½ ounces, but development is as yet in the preliminary stage, all work having been done by hand.

**SILVER MINES**

Mariposa County is unique among the three counties of the southern Mother Lode in having two mines worked primarily for
silver. These properties are in the granite area south of Boot Jack only a few miles southeast of the southern extremity of the Mother Lode. They are described only briefly, as silver minerals rarely are present in commercial quantities in ores of the Mother Lode region.

SILVER BAR

The Silver Bar mine is situated 3½ miles south of Boot Jack in sec. 15, T. 6 S., R. 19 E. (See No. 152, fig. 36.) It consists of four full-size claims and is owned and operated by Richard E. Jeffrey of Mariposa.

The ore occurs in a quartz fissure vein in the granite, which strikes nearly due west and dips 50° to 57° S. The width of the vein ranges from a few inches to 5 feet, and the ore occurs in irregular lenses in its quartz filling. The ore often is heavily mineralized and contains native silver, argentite, proustite, pyrargyrite, pyrite, galena, and gold. It is reported to contain an average of about 15 to 20 ounces of silver and 0.15 ounce of gold per ton, or $15 to $18 at present prices. The mine is developed by an inclined shaft on the vein 257 feet deep, with drifts on the 100- and 200-foot levels. On the 100-foot level a drift has been driven east 235 feet and west 85 feet from the shaft station, and on the 200-foot level a drift runs east 263 feet and west 245 feet from the shaft. About 1,000 tons of ore has been stope and 3,000 tons is reported as blocked out. The mine makes only about 750 gallons of water per day, which is carefully conserved for use in the mill. The shaft is served by a single-drum hoist operated by a 35-horsepower gasoline engine, and air for drilling is supplied by a 250-cubic-foot, two-stage compressor run by a 50-horsepower Pierce-Arrow engine.

The milling plant, of 35 tons daily capacity, is adjacent to the shaft. Ore from a counterbalanced skip is dumped over a 1½-inch grizzly, the oversize from which is crushed in a 7- by 9-inch Blake-type jaw crusher and falls with the undersize into a 20-ton mill bin. From this bin it is discharged by a Challenge feeder to a 5-foot Huntington mill making 55 r. p. m. and equipped with 20-mesh woven-wire screens. The coarsely ground discharge from the Huntington mill goes to a cyclone rod mill 1½ by 7 feet in inside dimensions and carrying 1 ton of ½- to 2½-inch steel rods. The rod mill makes 62 r. p. m. and has a peripheral discharge with no screens. The pulp from the rod mill is delivered by a diaphragm pump to a pulsating hydraulic jig, the hutch from which consists of heavy sulfides and some native silver. This product is said to contain most of the total gold recovered. The overflow from the jig goes to the first of two Kraut flotation cells with the impellers driven at 800 r. p. m. A shipping concentrate is taken from the first cell, and its tailings are re-treated in the second cell. The flotation reagents used are American Cyanamid 301, potassium ethyl xanthate, and pine oil. The flotation concentrates usually run $200 to $225 per ton. About two-thirds of this value is in silver and one-third gold.

They are shipped to the smelter at Selby, Calif. The ratio of concentration in the mill is about 1:30. All machines are driven by a 60-horsepower Pierce-Arrow engine, the radiator of which during the winter is hooked up with the mill water supply through tempera-
ture controls so that the water in the flotation cells is kept at about 70° to impart maximum efficiency to the flotation reagents. Water for milling is stored in eight 750-gallon and two 1,500-gallon wooden tanks. In summer the supply is adequate only for occasional mill runs and is derived entirely from the mine. In the winter this supply is supplemented by pumping from a neighboring gulch that contains a little water during the rainy season.

SILVER LANE

The Silver Lane or Goldenrod mine is half a mile south of the Silver Bar mine and about 4 miles south of Boot Jack in sec. 15, T. 6 S., R. 19 E. (See No. 152, fig. 36.) The mine, comprising 20 acres covering 1,320 feet along the strike of the vein, belongs to the Silver Lane Gold Mining Co., a Nevada corporation.

The vein is in granite and strikes east and west, paralleling the strike of the Silver Bar vein. However, it is a little flatter than the Silver Bar, dipping 35° to 40° S. The vein has an average width of about 4 feet but at one place is 16 feet wide. It is developed by a 240-foot inclined shaft having a 92-foot drift east on the 100-foot level and a drift 72 feet east and 21 feet west on the 200-foot level. The vein filling is quartz, which commonly exhibits a comb structure with plentiful vugs, indicating that it was deposited in an open fissure. The ore, which is in lenses, contains native silver, cerargyrite, argentite, proustite, pyrargyrite, pyrite, galena, and a little gold. Occasionally, small scales of un tarnished native silver may be seen in the freshly broken quartz, but characteristically the metal occurs as argentite, proustite, and pyrargyrite associated with a very coarsely crystallized pyrite, which the silver minerals have entered through cracks. When the mine was visited in September 1938 a few tons of high-grade ore was piled near the shaft, and it is reported that several tons of this ore shipped to the smelter at Selby, Calif., contained $38.50 per ton in silver and $5.50 in gold. Harold Wallman of Ben Hur, former foreman at the mine, kindly furnished specimens of ore particularly rich in native silver and argentite for photographing.

The present owners began operations in 1933 and attempted to treat the ore by giving it a chloridizing roast and then cyaniding the calcine. Operations were hampered greatly by lack of water, particularly during the summer, and the mine was soon closed after only a small tonnage had been treated, though reserve ore containing about $60,000 is reported to have been developed.

COPPER MINES

The Foothill copper belt of California traverses Mariposa County a few miles west of the Mother Lode from its northwest to its southeast boundaries, a distance of about 35 miles. There are copper prospects throughout this belt, but most of the mines are in the southwest corner of the county in the White Rock district, so-called from the frequency of its white-quartz outcrops, the largest of which is White Rock, a quartz blow-out that caps a hill and is so huge that it can be seen for miles. Throughout this district runs a belt 3 or 4 miles wide, in which heavy croppings of gossan appear on almost every knoll. These gossans have a generally north and south trend and
are often 50 to 150 feet wide. The copper ore generally occurs as replacement in schist.

A crude smelter was built in this area near Green Mountain about 1860 and is said to have been the first smelter in California. Thousands of tons of ore averaging 20 to 35 percent copper and often containing considerable gold were mined from the zone of secondary enrichment beneath the gossans of the vein, but none of the deposits was explored in depth. The best of the more accessible surface ores had been mined by 1875, and as large capital for development of the leaner sulfides was not available, the mines soon were neglected. Some 800 tons of copper was mined between 1903 and 1916, but there has been little activity since. Most of the old surface plants are in ruins or have been removed, and many of the old workings have caved. Figure 34 shows the annual production of copper in the county from 1903 to 1917, inclusive. The following descriptions of some of the principal properties were largely abstracted from Copper Resources of California.  

GREEN MOUNTAIN

The Green Mountain mine, consisting of 20 claims, is situated on Green Mountain, a considerable hill 6 miles northwest of Raymond in sec. 33, T. 7 S., R. 18 E., and secs. 3, 4, and 10, T. 8 S., R. 18 E. (See No. 165, fig. 36.) This mine, first worked in 1863, was developed by several thousand feet of adits and drifts and is reported to have produced substantial quantities of high-grade cuprite, malachite, and azurite ore and smaller amounts of sulfide ores, principally chalcopyrite and pyrrhotite but possibly some marcasite. The gossan outcrop of the copper vein is 50 to 100 feet wide and passes directly through the summit of the mountain in a foliated schist lying between granodiorite to the east and diorite to the west. The copper ores occur as replacements in the schist.

The lowest adit is said to be 600 feet long and to have intersected a vein of sulfide ore 60 feet wide 400 feet from its portal. The face of this adit is reported to be in the main ore body and to be connected with a drift above it by a 60-foot raise. The upper drift is presumably in or just beneath the zone of secondary enrichment, as sulfide ore here was said to be overlain with high-grade oxide ore containing some native copper and chalcocite in a band of schist 60 feet wide. About 50 feet higher than the adit described and 900 feet west of it another adit several hundred feet long is said to have reached the vein at about the same level as the drift above the lower adit and presumably in the zone of secondary enrichment, as a large quantity of rich sulfide and carbonate ore is said to have been extracted from workings at its face. In this mine the zone of secondary enrichment apparently is about 100 feet below the gossan outcrop. With access to the air, oxidation of the iron and copper sulfides in the old workings has progressed with amazing rapidity, and some of the openings are completely coated with sulfates of iron and copper. The ore oxidizes so easily that the heat generated sometimes has caused spontaneous combustion.

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26 California State Mining Bureau: Bull. 50, 1908, pp. 253–264.
In 1919, the United Chemicals Co. of San Francisco installed a leaching and precipitating plant at Raymond to treat the oxidized ore from this mine. The ores were leached with water, the copper sulfate being precipitated on scrap iron. An average yield of 6 percent copper is said to have been obtained. In 1923, the Floraferro Co. of San Francisco operated the property and marketed the finely ground oxidized ore as a soil corrective and insecticide under the trade name "Floraferro."

LONE TREE

The Lone Tree mine, in the northwest corner of the Green Mountain property (see No. 164, fig. 36), contains ore like that in the main Green Mountain workings. In the Lone Tree, however, are two distinct veins in the belt of schist, which here is about 300 feet wide. These veins have been traced for several hundred yards by shallow workings on their outcrops. A shaft 200 feet deep was sunk on the east vein, and stopes above its 150-foot level are said to be in the transition zone between oxidized and sulfide ores. Considerable quantities of carbonate ores are reported to have been shipped from stopes above this level and from workings 25 to 100 feet deep along the outcrops.

POCAHONTAS

The Pocahontas mine, consisting of 160 acres of patented land in sec. 14, T. 7 S., R. 17 E. (see No. 158, fig. 36), covers a series of veins in a belt of altered igneous rock between granodiorite on the east and diorite on the west. In places this belt is 1,000 feet wide. The main vein has been traced throughout the length of the property and both ways into adjoining ground. It is developed by a 200-foot shaft on top of the hill. Above the 100-foot level in this shaft the vein has been stopped to the surface. A 25-foot winze from this level is reported to be entirely in dark sulfide. On the 150-foot level, a drift running 30 feet south showed 4 feet of good-grade chalcopyrite ore. South of the main shaft, an old 60-foot shaft connects with a 300-foot adit. Some excellent oxidized ore was taken from this shaft and adit and good sulfide ore from a winze in the latter.

The ore occurs in lenses, and one of these in the workings of the main shaft was 50 feet long, 4 feet wide, and over 100 feet deep. It consisted of sulfides carrying from 6 to 12 percent copper and 0.12 ounce of gold per ton. The transition zone between the oxidized and unoxidized ore is at a depth of about 100 feet. A carload of malachite ore yielded 35 percent copper, and several other carloads gave 30 percent. Over $30,000 worth of copper was shipped from the property by Wilcox Bros., former lessees. The mine has not been operated for many years.

WHITE ROCK

The White Rock copper mine lies about 1 mile south of White Rock in sec. 14, T. 7 S., R. 17 E. The ore occurs in a schistose igneous rock locally called diabase, 25 feet or more in width, that
lies about one-fourth mile west of the granodiorite. The vein has been traced southward for 3½ miles to the Green Mountain mine and northward one-half mile. There are heavy gossancroppings at frequent intervals along the strike of the vein. A vertical shaft 150 feet deep and 175 feet of drifts constitute the principal developments. Several carloads of carbonate and oxide ore yielded 35 percent copper, and one over 40 percent. The transition to sulfides seems to be complete at a depth of about 100 feet, and the bottom of the shaft is said to be in good sulfide ore. The ore carries 0.07 to 0.12 ounce of gold and from 1 to 3½ ounces of silver per ton. An open pit 15 feet long, 10 feet wide, and 40 feet deep has been sunk in the gossan about 100 feet east of the main shaft. Here the gossan is reported to contain from 4 to 7 percent copper. When visited in September 1938 the workings in the shaft were inaccessible.

**CAVAN-SAN JOSÉ**

The property of the Cavan-San José Co. is 9½ miles northwest of Raymond in secs. 4 and 5, T. 8 S., R. 18 E., and comprises 235 acres. The ore horizon is in a belt of schistose igneous rock, 400 to 500 feet wide, locally called metadiabase, that has been traced for nearly 2 miles along its strike. The ore bodies are lenticular and to a depth of 75 feet contain oxidized ores, malachite, azurite, cuprite, etc., while below this depth they consist of pyrite and chalcopyrite.

On the Rothchilds claim, an adit 700 feet long was driven to cut veins in this and the Good View claim at depths of 250 and 375 feet, respectively, but whether the adit was advanced to intersect the veins as contemplated is not known. At the south end of the Good View claim is a 20-foot shaft on a 6- to 8-inch vein averaging 15 to 25 percent copper. This vein shows on the surface at intervals for over 1,400 feet and ranges in width from 6 inches to 6 feet. A shaft 140 feet deep traversed oxidized ore to a depth of 75 feet and then met with solid sulfides. Two other shafts, 40 and 54 feet deep, were sunk on the vein and showed 10 to 24 inches of ore from top to bottom. On the Sunset claim a 58-foot shaft disclosed a 6- to 30-inch vein said to average 17 percent copper. On the Copper King two shafts, one 20 feet and the other 50 feet deep, showed an equal width of similar ore. The San José claim is developed by an adit 170 feet long and having three winzes, 40, 80, and 115 feet deep, respectively. The deepest winze is in an ore shoot 65 feet long and 4 feet wide that shows good ore from top to bottom. On the Stonewall Jackson claim are surfacecroppings of quartz and chrysocolla 5 feet wide.

**LA VICTORIA**

La Victoria mine is in the northwest portion of the Foothill copper belt of the county in Hunter Valley, in secs. 4, 9, and 10, T. 4 S., R. 16 E. (see No. 76, fig. 36), and covers 7,400 feet along the strike of a belt of schistose igneous rock locally called diabase, in which the copper ore occurs as replacement. This belt of highly altered rock is 300 to 600 feet wide, and the granodiorite that borders it on the east here presents a facies resembling diorite. A wide variety of copper minerals, including cuprite, malachite, azurite,
chalcocite, covellite, chalcopyrite, and tetrahedrite, occurs in lenses in the schistose rock, with heavy gossans capping the ore. In places there are no surface indications of mineralization, but frequent patches of gossan indicate the general north-south trend of the vein.

In 1864 and 1865 the property was worked by a French company said to have employed 300 men in the mine and metallurgical plant erected at the property for treatment of the ore. Records show that 2,000 tons of ore was shipped to Europe via Stockton at a shipping charge of $74 per ton, 2,000 tons of ore was roasted and leached at the mine, and evidently some ore was smelted locally as there is a record of the production of 200 tons of matte containing 40 to 60 percent copper and 20 to 25 ounces of gold per ton.

The principal development was by a 200-foot shaft and a 390-foot adit that crosscut the vein diagonally, from which the ore was breasted to a width of 125 feet. Six other shafts had an average depth of 75 feet, and there were many open-cuts. The mine was worked last in 1919 and 1920 by W. C. Kroh and C. A. Felts, who shipped ore to the smelter at Tacoma, Wash. As shipping and smelting charges amounted to $19.50 per ton, only high-grade ore could be handled, and work was stopped in 1920.

BARITE MINES

Deposits of both barite and witherite occur as replacements in limestone in a narrow belt extending from a mile west of El Portal almost due south for at least 7 miles. The area covered by this belt is very mountainous, and throughout most of its length it is difficult of access and has not been prospected at all thoroughly. Several good showings of barite and witherite have been reported in this area, but the only deposits that have been developed are at the El Portal mine on the Merced River and the Egenhoff mine 6 miles south. These are described. Because there is now only one producer of barite in the county, production statistics cannot be disclosed.

EL PORTAL

The National Pigments & Chemical Division of the National Lead Co. is operating a barite deposit a mile west of El Portal under a lease from the El Portal Mining Co., 485 California Street, San Francisco. The property consists of six claims and a mill site on the Merced River in secs. 18 and 19, T. 3 S., R. 20 E. (See No. 74, fig. 36.) E. H. Murchinson of El Portal is general superintendent. The Merced River, with the Yosemite Valley R. R. on its north bank and the Yosemite Highway on the south bank, intersects the deposit. Barite was first discovered on the north bank of the river in the 1880's, and mining was confined to this locality until March 1927, when development was begun on the south side of the river. Those workings have furnished nearly all of the output in recent years. Figure 61 is a general view of the mill and workings on the north bank of the river.

The barite is in lenses in an intricately folded limestone, which it has replaced. The lenses of commercial ore range in length from 100 to 300 feet and in width from 6 to 40 feet, but barite of non-commercial grades has been traced in some of them for 1,500 feet.
Figure 58.—Bonanza ore from Gold Bug mine, showing free gold in calcite (slightly reduced).

Figure 59.—Barite ore from National Lead Co. mine near El Portal, showing intense folding (actual size).
Figure 60.—Vein in the Granite King mine.

Figure 61.—Barite mine and mill of the National Lead Co. on the Mereed River near El Portal.

Figure 62.—Open-cut in barite mine of the National Lead Co. near El Portal, with opening into stopes.
In no instance has the barite ore been followed to a greater depth than 200 feet below the surface. The lenses strike N. 45° W. and generally dip about 70° NE. The ore normally contains 85 percent barite, 2 to 3 percent witherite, 0.5 percent pyrite, and traces of sphalerite, and the rest is silica. However, the composition of the ore varies considerably, and on the north side of the river there is much massive white witherite, while in the present workings on the south side most of the ore is closely banded with fine, dark-colored streaks that consist largely of minute particles of pyrite. This banding is generally parallel and apparently follows the original bedding planes of the limestone, which the barite replaced; but it often shows faulting or very complex and irregular folding, as illustrated in the actual-size photograph (fig. 59).

On the south side of the river the mine workings are on the hill 400 feet or more above the highway. The principal development is made by two levels connected by a 90-foot transfer raise. On the lower level is a 700-foot drift north of the raise and an 800-foot drift to the south. The upper level has 1,000 feet of development work, and near the south end of the mine is an intermediate level with a 300-foot drift. Figure 62 shows an open-cut on one of the lenses of ore with openings into the stopes beneath. The ore is mined by shrinkage stoping. An Ingersoll-Rand type 10 compressor run by a 100-horsepower motor supplies air for drilling and running a drill sharpener. The mine is operated two shifts with 30 men.

Ore drawn from the stopes is trammed to a 50-ton crusher bin, which discharges to a 12- by 40-inch jaw crusher run by a 30-horsepower motor and set to break to minus 2-inch size. The discharge from the crusher is delivered by a 24-inch belt conveyor to a 50-ton bin, from which it is drawn into half-ton buckets on an aerial tram 1,000 feet long, which transports the ore downhill and over the highway and river to the mill. This tram handles 24 tons of ore an hour and delivers it to a 60-ton mill bin, which supplies feed to a 2-foot Symons cone crusher that breaks the ore to minus 3/8-inch size. The discharge from the crusher is carried by a belt conveyor to a trommel with a 3/4-inch screen, which removes any oversize and delivers it to an 8- by 3-foot Hardinge mill driven by 10 V-belts from a 150-horsepower motor. The undersize is jigged, the concentrates and hutch go to the Hardinge mill, and the tailings are sold as ballast to the Yosemite Valley R.R. As the barite ore is soft, no ball charge is used in the Hardinge mill, the siliceous waste in the ore acting as the grinding medium. The discharge from the mill is screened, and the oversize on 60-mesh is wasted. The undersize is delivered to a 7-foot duplex turret-bowl Dorr classifier in closed circuit with the Hardinge mill, the underflow being returned to the mill and the overflow going to four 5-foot Callow dewatering cones. The overflow from these cones is wasted, and the underflow is fed against 200-mesh flat screens set at an angle of 25°. The undersize, 90 percent of which is minus-325 mesh, goes to a Dorr thickener 30 feet in diameter and 8 feet deep. The thickened pulp is dried on the outer surfaces of two rotating, steam-heated, cylindrical driers each 14 feet long and 5 1/2 feet in diameter, and the dried barite is removed from the shell by wire brushes.
The dry product is elevated to three storage bins with a capacity of 500 tons each. From these bins it is automatically weighed into self-sealing 100-pound bags and is marketed under the trade name "Baroid" as a weighting agent for muds used in drilling oil wells.

On the north side of the river witherite and barite are mined through adits in the steep hillside and are batch-ground to 20-mesh size in a small Sturtevant mill. The product, consisting of a mixture of the two minerals, is sold as a flux to glassmakers. The mill is operated three shifts, and 20 men are employed.

EGENHOFF

The Egenhoff barite mine consists of three full-size claims situated at an altitude of about 5,000 feet on the east side of Devil’s Gulch in sec. 17, T. 4 S., R. 20 E. The surrounding country is very mountainous and, although only 6 miles in an air line south of the Yosemite Valley R. R. at El Portal, the mine is difficult of access. It was discovered in 1917 and is now owned by the California Barite Corporation, Ltd., 1141 Subway Terminal Building, Los Angeles, Calif., of which M. A. Wright is the manager.

The barite occurs along the contact between a quartzite foot wall and a limestone hanging wall and is presumably a replacement of the limestone. The vein strikes a few degrees west of north and dips slightly to the east. It has been traced for 4,500 feet, and large quantities of high-grade barite and witherite have been developed by crosscuts, but commercial shipments are awaiting the completion of a road to the property.

LIMESTONE AND MARBLE QUARRIES

Mariposa County has large deposits of limestone and marble but, due to their inaccessibility and high transportation costs, little if any of these minerals was mined before 1927. The principal deposits are immediately east of the south end of the Exchequer reservoir in sec. 18, T. 4 S., R. 16 E., along a belt that runs from Jenkins Hill on the Merced River in a northwesterly direction for about 7 miles to Bowers cave, and at Marble Point on the South Fork of the Merced River in sec. 2, T. 4 S., R. 19 E. The latter deposit consists of a handsome, fine-grained variegated marble with dark-blue veining. This marble deposit is over half a mile wide and rises 600 feet above the river, but it has not been developed because of its inaccessibility. At the Emory Quarry, near Jenkins Hill, limestone has been mined almost continuously since 1927 for use in the manufacture of cement. This quarry is described.

EMORY QUARRY

The Emory quarry, comprising 700 acres, is situated just north of the Merced River in secs. 7 and 8, T. 3 S., R. 19 E. (See No. 69, fig. 36.) It is owned by the Yosemite-Portland Cement Corporation of Merced, Calif., and is served by the Yosemite Valley R. R., which transports the quarried product direct to the cement plant of the company at Merced. The quarry was opened in 1927,
and first shipments were made in September of that year. The limestone deposit here strikes a little west of north and dips about 85° E. The rock, though high-grade, is discolored by 1 to 1½ percent carbonaceous material, but this is removed in burning and does not affect the color of the cement. The quarry is worked by a face that advances across the deposit from a bench 800 feet above the level of the railroad. The blasted rock is loaded by a Marion electric shovel into 6-cubic-yard dump cars, which are hauled in trains by a gasoline locomotive to the crushing plant about half a mile away. Here the rock is broken to about 1½-inch size and is delivered by conveyor belt to a 600-ton storage bin. This bin is connected with a 275-ton loading bunker at the railroad by an inclined double-track tramway with two 15-ton cars operating in balance, that is, the loaded car, descending by gravity, pulls up the empty car. The cars are dumped automatically at the bunker. Electric power purchased from the San Joaquin Light & Power Co. is used in the quarry and crushing plant.

CONCLUSION

The varied aspects of mining in these counties are best seen from several viewpoints. Historically, the placers of Tuolumne County stand out as of chief importance, although from the viewpoint of resources now available they are negligible. They were the source of a vast treasure easily won that represented a realization of centuries-old dreams of adventurous explorers, who had sought in the New World for the golden sands of Eldorado. The hopes of these men were not fulfilled, but the gold they sought actually existed in the placers of Tuolumne on the far side of the continent.

Linked in historical and romantic interest with the gold in the streams are the pocket mines of the area from which the richest placers of Tuolumne were derived through erosion. Their importance, like that of the placers, likewise has diminished as the exhaustion of gold pockets discoverable by showings at the surface makes further exploration far more difficult and less likely to succeed.

Then came the lode mines, nearly alike in both counties. They were often profitable, generally less so than the great size of their veins and the richness of some of their outcrops were thought to promise. The glamor of the earlier period of abounding good fortune survived, but that ever-memorable era was followed by drab decades when the ores produced were nearly marginal with respect to the costly practices then available for their mining and treatment.

From the geological viewpoint the meaning of the lode's history is more easily understood. It is recognized that the great wealth of the placers represented a slow accumulation through ages of small amounts of gold brought down here and there from the erosion of rocks that really contained very little of the precious metal per unit of volume or of weight. Probably they were no richer than the rock mass of the pocket belt as it is known today, which could not possibly be mined as a whole at any profit.

As to the lode mining, much of the futility and disappointment with which it has been linked have been due to the persistent hope that the massive veins of ankerite and quartz, yielding very little
gold, if any, must somewhere contain large bodies of such high-grade ore as actually occurs at their margins in narrow, more recent veins, or in relatively narrow fissuring within the massive quartz and ankerite. It is now recognized that the huge veins originated in an early time when little gold was being deposited. Their intensive exploration therefore has proved disappointing when attempted. The course of these great veins nevertheless often determined that of later fissuring when the solutions present were more competent to deposit gold. That is the apparent reason why shattered ground, either within or on the margins of the great veins of the Mother Lode, frequently has provided ore that was profitable, even in small-tonnage operations.

The opportunity to discover such ores is now greatly increased through the relatively new technology of exploration by diamond drilling that is aimed less at the actual discovery of ore bodies than at the rapid and cheap determination of structures favorable for ore deposition. Because of the multiplicity of parallel fissures of different ages and gold content that characterize the Mother Lode mineral zones, frequent crosscutting into the walls of mine workings is especially advisable, but surprisingly little of it has been done in the old mines. Many of their workings provide access to immense volumes of ground that would amply warrant the moderate expense of exploration by diamond drilling.

Much that has been said as to the history and the present state of the mines of these counties provides cumulative indications that they probably contain an enormous tonnage of low-grade ores. Although most of it is still submarginal with respect to the kind of operations that usually have been conducted on the Mother Lode, there is little doubt that there are great tonnages capable of yielding substantial profits from mass mining on a large tonnage basis. The careful studies of the Harvard mine, previously reviewed, seem to indicate mass averages from 1.5 to 0.2 ounce per ton, and it was concluded that ore probably could be mined in quantity operations from which there would be a recovery of about $4.50 per ton at the present price of gold. Other properties, including the Dutch-App, the Rawhide, and in fact all others north of the Harvard as far as the Stanislaus River, constitute extremely interesting possibilities of the same general nature. In Mariposa County likewise it is now well understood that in the wide section of ground between the Pine Tree and Josephine veins there is another large body of low-grade ores suitable for mass mining, the full extent of which appears to be as yet undetermined. South of it in the vicinity of May Rock there are strong surface indications of another area of low-grade mineralization that is also of interest.

Most surprising is the fact that there appear to be sections of the lode of appreciable extent that are still wholly unexplored. It is anticipated that in the fullness of time the lode in these counties inevitably will be identified with a new era of low-grade operations whose production easily might rival that of the more prosperous early periods of lode mining. The low-grade operations of the Carson Hill mine in Calaveras County suggest the general nature of operations that might be anticipated.
Attention should also be called to the excellent results obtained from the East belt of mines in Tuolumne County and to the fact that the cessation of mining there was due largely to the presence of a considerable volume of water, so that the cost of pumping proved excessive. This difficulty should now be overcome far more easily than formerly, especially if a number of the mines should be worked at the same time to aid a general lowering of the water level.

Also worthy of especial mention is the limited evidence of rich gold deposition that characterizes a great number of the small veins in Mariposa County. They are of interest and promise for the future, although success in mining them will demand a high order of skill in exploration, with careful study of underground structures. Usually they are associated with dikes that may have functioned chiefly as aids to fissuring that later provided channels for gold-bearing solutions.

The Foothill copper belt of Mariposa County also is a showing of considerable interest because of its undetermined possibilities. The outcrops are impressive because of their size and extent. Although it is true that the zone of secondary ore mined beneath some of them was scattered and of no great thickness, little seems to be known as to the character of the deeper-lying primary mineralization.
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