SHASTA COUNTY.

Shasta County commands first and chief attention in a survey of the present condition of California's rising copper industry. In its great copper or "base-ore" belt, which curves as a thirty-mile string of ore deposits through its west central part, are the mines and smelting plants which yield most of the current copper output of the State, and the various extensive ore bodies whose exploitation gives the chief promise of an early and marked increase of copper production. While the copper industry is directly confined in Shasta County to one definite mineral belt, the county as a whole presents various features contributing to the exceptionally favorable conditions surrounding the industry.

The county lies in the mountainous region about the head of the Sacramento Valley, nearly equally distant from the western, northern, and eastern boundaries of the State, and is about 90 miles in length and 60 miles in width, having an area of 3675 square miles. The western border of the county is along the Trinity range summit, and the county reaches eastward high up the slope of the Sierra Nevada range, which bears westward and merges with the Coast Range in Shasta and Siskiyou counties. Short, irregular ranges fill the greater part of the county between the main ranges to the east and west. The Sacramento Valley thrusts its rapidly narrowing northern end a short distance up into the southwestern part, affording the principal agricultural and horticultural region of the county and meeting the long canyon of the Sacramento River a little above Redding, about 20 miles above the southern boundary.

In the southeastern corner of the county is Lassen Peak, an extinct volcano, the lavas from which have blanketed the eastern portion of the county as far as the Sacramento River. From the valley and lower foothills of the southern part of

the county the surface increases in ruggedness and elevation northward, as well as eastward and westward, until altitudes of 5000 to 6000 feet are reached. The copper belt occupies a position between these extremes, the altitudes of mountain summits and canyon floors along the belt generally ranging between 1000 and 3600 feet.

Nature has given this county a splendid water supply. The rainfall, occurring chiefly in the winter, exceeds forty inches as a rule, and the snows of the higher ranges maintain the streams throughout the summer months. The principal streams are the Sacramento, McCloud, and Pitt rivers, the first two rising in the mountains above the northern boundary, and the last in Modoc County. The Sacramento flows southward through the western half of the county in a deep, sinuous, and exceedingly picturesque canyon, crossing the copper belt a little above the apex of the Sacramento Valley plain. The torrential Pitt crosses the axis of the Sierra range through heavy forests and deep canyons to join the Sacramento in the midst of the copper belt. The no less picturesque McCloud discharges into the Pitt amid the gossan cappings of the copper deposits. Tributary creeks, prominently identified with the copper belt, also cross it on both sides of the Sacramento, and are valuable sources of water supplies. There is thus a general convergence of the important rivers and creeks of the county in and through the chief mineral region.

The streams afford exceptionally valuable power resources. Their fall is rapid, their volume reliable, and the opportunities for the utilization of their waters for generating electric power are many. The Pitt presents many falls and cascades, and Fall River flows over a precipice sixty feet high just before joining the Pitt, high in the mountains. Important electric transmission plants are now in operation.

The county has almost inexhaustible supplies of timber in heavy forests of yellow and sugar pine and fir, clustered in the higher ranges about the upper courses of the chief rivers, those along the Pitt being especially available. Most of the timber and wood now used in large quantities by the principal mining companies is floated down from these sources. Elsewhere through the county, and adjacent to the mining districts,

generally, the timber supplies are scant or inferior, as a rule, though on the higher ridges, and on the more moist northern slopes of others, the yellow pine is here and there found in satisfactory abundance, and is extensively utilized. In the foothill zone the forest growths comprise mainly black, white, and live oaks and "digger pine," and there are widespread growths of underbrush (chaparral), along with scrub oaks and small pines.

The California and Oregon line of the Southern Pacific railway system crosses the county and the copper belt along the course of the Sacramento River, and this important mining field thus has the advantage of close proximity to a main commercial highway. Several efforts have been made to accomplish the construction of a railroad westward from Redding through Trinity and Humboldt counties to Eureka on the Pacific coast, to open up a splendid mining region in the Coast ranges.

While the copper belt, with which this Bulletin is chiefly concerned, is now by far the leading feature of Shasta County's mineral resources, those resources are varied and quite widely distributed elsewhere. The eastern half of the county being generally buried under lava deposits which effectually hide the minerals that undoubtedly exist, the mining industry is confined to the western portion. The crescent-shape copper belt presents its eastern end a little south of the center of the county, the belt, as indicated by exposures, being prolonged eastward into the lava sheet; but with this exception, the county's mining industry is confined to the western third of the county, and mainly to the portion west of the Sacramento River.

There were rich early placers in this region, and extensive recent and ancient auriferous gravel deposits remain, affording opportunities for various forms of placer mining, including gold dredging. Quartz mining was of slow development, owing to the base character of the ores in most of the districts in which gold-bearing veins were early discovered. Several quartz mining districts have been more or less successfully exploited, the most noted one being the French Gulch district at the western side of the county, in which the important Niagara and Glad-

stone mines, yielding free-milling ores, were developed many years ago. Other quartz mining districts are distributed along the western side of the county for sixty miles. The ores of these districts are free-milling in some places, but are usually base, and they are variously characterized by the presence of gold, gold and silver, and gold, silver and copper, in association with baser metals. To these districts mining enterprise is newly turning, giving promise of important new discoveries and developments.

The recent exploitation of the copper mines has placed Shasta far in the lead of the mineral-producing counties of the State. Its total mineral output in 1906 was $5,745,843. Of this output, $4,338,121 was in copper. The gold and silver carried by the copper ores smelted and the silicious ores used as fluxes, together with the output of placer and quartz mines in districts outside the copper belt, afforded $1,253,627 in the precious metals, of which $819,144 was in gold and $434,483 (coinage value) in silver. This made Shasta also the leading silver-producing county of the State. In 1896, just before copper production began, the total mineral output was but $813,593. The mineral statistics for 1907 show that 27,844,364 pounds of copper were produced, valued at $5,568,873, further increasing Shasta's mineral preëminence. Shasta's total production of all minerals in 1907 was $7,084,706, of which $791,997 was in gold and $370,211 in silver. Various mineral products are minor features of the record.

The following table, giving the annual values of the three chief mineral products and the total annual mineral production from 1894 to 1907, inclusive, shows the expansion due to the recent development of the copper industry. Besides the value of gold, silver, and copper, the totals include the minor mineral products, embracing $1500 in iron in 1894, chrome in 1895 and 1900, and mineral waters, lime, limestone, and brick in most of the years. The gold increase is comparatively small, owing to the closing of several important gold mines at about the period that the Mountain Copper Company began producing gold as a by-product. The large increase in silver in 1900 was partly due to its being measured in coinage value for that year instead of in commercial value as in preceding years:

As these figures indicate, copper is the chief product and the chief basis of the mining prosperity and prospects of the county. All of the silver is produced by the smelters from ores mined chiefly for their copper; and in the temporary absence of production in some important mines, the gold output has, until recently, been sustained in the same way.

At the present time several prominent independent gold-producers are being operated, and the output, exclusive of gold produced by ores mined chiefly for copper, is as great as it has been at any time during the past ten or fifteen years.

THE COPPER BELT.

Shasta County's copper belt is composed of a series of ore deposits arranged in the form of a crescent, which bends through the low mountains and foothills directly north of the head of the Sacramento Valley, and which spans a distance of about twenty-five miles between the eastern and western horns. The apex of the Sacramento Valley plain and the city of Redding are near its western end and but a little south of the chord of the arc described by the belt. Iron Mountain, at the end of the western horn, is about ten miles northwest of Redding, in a direct line, and the eastern horn, in the Furnaceville district, is about twenty miles north of east from the same point. The length of the belt is approximately thirty miles, and the width from one half to four miles.

The term "belt" is used with the broad meaning which it

properly carries, and not as synonymous with "lode." The ore deposits do not mark a practically continuous fissure system in which directly related vein formations have resulted, but occur as disconnected masses, or groups of vein formations, forming individual lodes and districts. These groups of deposits vary in form of occurrence from massive, flat-lying, lenticular beds of sulphides on the west, to irregular vein formations in the eastern half of the belt, and they also vary in their mineralization; but they are successively ranged, with considerable regularity, along the curved line described, forming a belt three or four miles wide in places. In several ways this series of deposits presents features of unity and individuality, which enforce its conception as one definite mineral belt, and which set it apart from other ore deposits in that part of the State.

The belt is throughout superficially marked by massive exposures of the gossan which nearly everywhere caps its mineralized formations. Upon the elevations between the canyons cut by the streams, these dark croppings of the iron oxides resulting from the decomposition of surface sulphide ores stand out in places with striking boldness. A cursory survey of the belt as a whole shows these ferruginous surface formations to be practically continuous throughout, but in an irregular and disjointed way, and coursing in varying directions. Especially striking is the great gossan cap of Iron Mountain, with which the belt worthily begins, or ends. The ridge forming this mountain rises nearly a thousand feet above Slick Rock and Boulder creeks on either side, over a mile apart, and at the top the gossan formation, 300 feet wide, displays nearly perpendicular walls that rise high above the top of the slope into which the tunnels of the Mountain Copper Company open. Southerly from Iron Mountain but two or three known copper deposits, widely separated, occur, the mineral formations of the belt being succeeded through the adjacent regions by gold quartz veins.

For ten miles northeasterly from Iron Mountain and nearly to the Sacramento River, the belt is outlined by a quite continuous succession of both gossan outcrops and important groups of copper claims, in many of which exploration is steadily proceeding. For the distance named, the belt, as

indicated by the distribution of copper mining claims, exhibits a width of approximately three miles. Between Boulder Creek, at the northern side of Iron Mountain, and the Sacramento River, the belt is cut through by three deep creek canyons.

The belt intersects the Sacramento River at about the point where it receives the Pitt, and for nearly ten miles eastward it exhibits its gossan croppings on both sides of the latter stream, but mainly on the northern side. About four miles east of the Sacramento the Pitt is joined by the McCloud River, which thus ends in the midst of the copper belt. Farther eastward the belt is entered by the Pitt where it turns on its final westward course, and it is crossed by streams tributary to the Pitt and Sacramento. Through the whole course of the belt a multitude of gulches help give a very rugged character to the region. These gashes made by the waters in the "iron hat" of the belt further diminish its apparent continuity, the gossans having here and there been eroded away or covered by surface wash, and being found principally on the elevations.

The geology and mineralogy of the belt are specially treated of in the succeeding section. The ore deposits are composed mainly of sulphides occurring in eruptive formations. West of the Sacramento the deposits are in the form of irregular lenses in flat or inclined positions. They have been shown, in some cases, to be several hundred feet in length and breadth, with thicknesses of 50 to 300 feet, displaying contents amounting in the Iron Mountain and Balaklala mines to quantities exceeding a million tons, and indicating similarly large proportions in other properties of smaller development. In the central and eastern portions of the belt the ores occur in vein formations.

The ores all carry gold and silver. West of the Sacramento River the percentages of the precious metals are small, though constituting an important element of the ore values. The Iron Mountain ores are stated to yield about $1 in gold and two ounces of silver per ton, and these quantities are probably characteristic of the ores of the other deposits of that part of the belt. These ores carry very low percentages of the baser metals, as zinc, antimony, arsenic, etc. In the central and eastern districts of the belt the gold and silver, as well as the copper values, are frequently much higher than in any large

ore bodies developed to the west, and they carry the baser elements in much greater quantity and variety. Throughout the belt, the most important copper properties have in past years been worked for the gold and silver values remaining in the decomposed portions of the deposits near the surface and above the copper sulphides to which attention is now directed.

Adjacent to different parts of the belt are gold quartz districts, in which are many veins carrying low, medium, or high grade ores, which are base, as a rule, and can not be efficiently and profitably reduced by milling processes. The western horn of the belt is practically surrounded by such veins. They occur notably in the region of the old town of Shasta, four miles south of Iron Mountain, and are distributed for several miles south and east of this end of the belt through the Shasta and Flat Creek districts, the latter lying between the belt and the Sacramento River. Eastward from this portion of the belt, across the Sacramento River and within and without the chord of the belt's arc, is the Old Diggings district, presenting groups of quartz claims extending over several miles. Some important quartz mines have been developed in these districts, including the Mount Shasta in the Shasta district, and the Texas Consolidated in the latter. Other quartz districts similarly attend the belt at other points along its course, and gold quartz veins are abundant in close proximity to the belt generally. These silicious ores thus provide abundant and convenient fluxing materials for use in smelting the sulphide copper ores. In turn, the smelters have created a market for these ores and enabled the development and mining of a number of quartz properties. The stimulus thus afforded quartz mining in this region is one of the important local benefits of the development of the copper industry. Gold ores are not only supplied from closely adjacent districts, but are hauled by teams and shipped by rail from quite remote localities, including points in Siskiyou and Trinity counties, the ores being rich enough to stand the large transportation costs.

Other fluxing materials are equally plentiful and convenient. Iron ores and limestone are also used for fluxing. Limestones are the most abundant, and are found along large belts near the smelters. The supply is practically inexhaustible. Iron ores, both magnetite and limonite, have been used for some of

the more refractory sulphides, but the former has not been found to be suitable for such uses. It is now believed that a mixture of ores from this belt can be made that will obviate the use of iron ores.

The copper belt thus presents many favorable conditions for copper mining and smelting. There are distributed through a long mineral belt massive ore deposits whose quantities, as well as values, are attractive to conservative mining capital. These deposits are usually embedded in great hills, and can be economically explored and mined through tunnels. Water is especially abundant, and desirable sites for reduction works are conveniently available. Opportunities for the generation of electric power are widely present. The belt is bisected by a main railroad line, and highways reach the various districts. Climatic conditions are all favorable. The wood and timber supply is ample. At the Keswick smelters wood now costs about $4.25 per cord. Alabama coke, carrying 16 per cent ash, can be delivered at Redding for about $13 per ton. Belgian coke, with 15 per cent ash, has been obtained for $12.20 per ton.

From 1895, when the Iron Mountain mine was recognized as a copper mine and passed into the possession of the Mountain Mining Company, until a few years ago, this property at the western end of the copper belt, and the Bully Hill mine at the eastern end, were the two principal producers. Up to January 1, 1902, the Iron Mountain mine had produced 825,000 tons of ore, which were carried on the narrow gauge railway eleven miles to the company's smelting plant at Keswick for treatment. The resulting matte and blister copper were shipped to the company's refinery in New Jersey and yielded 120,000,000 pounds of fine copper. The company had paid in dividends up to December 31, 1900, over 50 per cent of the capital stock of $6,250,000. The Bully Hill mine is credited with having reduced 50,000 tons of ore averaging 10 per cent copper, affording 5,000 tons, or 11,200,000 pounds of copper, with an equal value of precious metals, during the first ten months after beginning operations in May, 1900. This is an unofficial estimate, but is believed to be approximately correct.

Groups of claims are closely ranged for ten miles northeast of Iron Mountain, embracing broken and wooded canyons,

hillsides and elevations, and covering widths of three miles in places. Several of these properties have developed within the last three or four years into paying mines, equalling or surpassing in importance the Bully Hill mine. These are: the Balaklala, which has recently completed a large smelter, and the Mammoth, whose smelter has been running for several years, and has lately been considerably enlarged. The mines of the Trinity Copper Company, headed by Thomas W. Lawson, of Boston, the chief property of which, the Shasta

King, adjoins the Balaklala, about four miles east of Iron Mountain, are being prospected. Of the properties in the eastern portion of the belt, the Afterthought has made the greatest progress, having erected a smelter near the mine. In the Donkey mine near by work has been resumed and many improvements made. In 1902 the number of mines in the Shasta copper belt was given as 57, and the number of feet of tunnels and drifts as 39,000, approximately, aside of the workings of the Mountain Copper mine. A computation of the extent of the underground workings at the present time is not possible, because the data are not obtainable, but it is

safe to say that the number of mines has increased about 50 per cent, and the amount of work has at least doubled.

Shafts cut a noticeably small figure along the copper belt, and they may be practically regarded as non-existent. They have nearly all been early prospect shafts sunk in preliminary surface exploration. Throughout the belt development and mining are conducted through tunnels, which the topography so generally favors.

The range of the altitudes credited to the mines is wide, and illustrates the rugged nature of the country. The highest properties are in the elevations west of the Sacramento River. The top of Iron Mountain is 3000 feet above the sea and 2400 feet above the Sacramento River. The Marshall and Waters group, two miles north of Iron Mountain, includes a point 3500 feet in altitude, and the Summit group, farther north, lies at 3000 feet. The lowest property is the Hotchkiss, 750 feet, a little south of Bully Hill, which rises to 1400 feet. Forty-four properties are above 1000 feet, twenty above 2000 feet, and fourteen are at altitudes below 1000 feet. Redding, on the Sacramento River, is 550 feet above the sea.

The development of water powers and electrical plants, the building of towns and branch railroads, the stimulation of gold mining, lumbering, manufacturing, and other industrial enterprises, and increase of population and of general prosperity are among the features incidental to the progress of the copper industry and mainly consequent on it.