ART. VI.—*The Tin Deposits at Temescal, Southern California*; by HAROLD W. FAIRBANKS.

Introduction.—Several years ago, shortly prior to the final suspension of work upon the Temescal tin deposits, the writer was given exceptional facilities for a careful examination of the mine and the country immediately surrounding it. Subsequently a brief description was published,* but owing to the political importance of the question at the time no thorough report was attempted. Descriptions of the tin veins occurring here have been given by Blake† and Hanks,‡ although little has been published concerning the conditions under which the veins occur and the nature of the ore bodies. In the present paper the writer will add to what is already known, a more detailed description of the veins and the country in which they are found. The report of Hanks referred to above contains an outline of the history of the discovery and the excitement following it, the purchase of the old Mexican grant and the final development by the English company, so that this part of the subject will not be touched upon.

General Geology of the District.—The Temescal tin mine is located in the northwestern portion of the San Jacinto grant about five miles southeast of South Riverside. This portion of the grant consists of rolling hills having an elevation of nearly 1,000 feet, and formed of a great variety of rocks. To the west, separated by the Temescal valley filled with late Miocene sediments, is the Santa Ana range, the most striking topographic feature of the region. It is high and steep, contrasting strongly with the rolling though sometimes quite mountainous country to the northeast. Its elevation is doubtless due to a great fault line, the northern portion of which passes through the Temescal valley. Immediately adjoining the valley on the east is a more or less connected strip of highly metamorphosed rocks associated with porphyries, but the most of the country in that direction is granite.

The tin deposits lie nearly in the center of a rudely semi-circular area of granite about two miles in diameter and connected on the east with the great body of similar rock extending indefinitely in that direction. The sedimentary rocks along the edge of the granite area consist of quartzite, mica schist and conglomerate of unknown age. A part at least of the slates and limestones of the Santa Ana range are

* XIth Report of the State Mining Bureau, p. III.

† Mineral Resources of the United States, 1883-84, p. 614.

‡ IVth Report of the State Mining Bureau, p. 120.

Carboniferous, but further than that we have no information. Extensive bodies of porphyry also border the granite. They vary much in appearance, in some places being of a grayish color and almost devoid of distinct crystals, but more generally the rock presents a groundmass almost black in color in which are sprinkled white feldspar crystals and more rarely those of quartz. It is difficult to say which is the older, the granite or the porphyry. In the neighborhood of the junction both rocks change their character somewhat, although each is distinct. With perhaps one exception, none of the fine-grained granitic dikes abundant in the coarse granite were noticed penetrating the porphyry, but there are bunches and dike-like protrusions of the latter in the granite near the contact.

The granite is distinctly intrusive in the metamorphic rocks, as bunches of it project up through them here and there. The granite varies considerably in texture although the main body has a uniform composition. Macroscopically it shows two kinds of feldspar, one a pale brownish color and the other white, abundant quartz and a small amount of the dark silicate. Under the microscope it is seen to consist of plagioclase, orthoclase, and quartz in nearly equal proportions, with a much less amount of biotite mica. Towards the outer edges of the granitic boss in which the mine is situated are numerous dikes of a very fine-grained granite consisting almost wholly of quartz and orthoclase in interlocking grains. The proportion of quartz seems to be greater in some of these dikes than in the coarse granite to which they are genetically related.

The Vein System and Tin Deposits.—The semicircular area of granite and portions of the adjoining porphyry have been fissured in a general northeast and southwest direction along almost innumerable lines and a black vein matter deposited. The veins are generally small, varying from one-fourth to a few inches in thickness, but in the case of the main tin-bearing vein an enormous size is reached at Cajalco hill. As the hill is approached the veins become larger, and finally culminate in this elevation, which is about 300 by 250 feet in diameter at the base. The veinstone of which it is mostly composed rises in prominent and bold croppings. With one or two unimportant exceptions the material of which this as well as the other veins is formed consists wholly of tourmaline and quartz, with which the tin ores are locally associated. The larger veins, and the Cajalco in particular, are very irregular in size, sometimes appearing to be mere bunches in the granite. A few hundred feet northeast of the hill the vein has narrowed to 6 or 8 feet, and it is here that the large body of tin was first discovered and the main shafts sunk.

A slide prepared from one of the smaller veins, which in the

hand specimen appeared to consist wholly of tourmaline, showed bunches of tourmaline crystals radially arranged and embedded in interlocking quartz grains. The crystals are recognized as tourmaline by the hexagonal cross section, parallel extinction, polarization and frequent presence of fibrous terminations, although the terminal crystal faces are sometimes present. In the most of the sections prepared the tourmaline appears to be exceptionally opaque, sometimes the border is opaque while the center is feebly translucent. With the blow-pipe the material fused easily with slight intumescence and became magnetic. The reaction for boron was pronounced.

The large Cajalco vein consists of tourmaline and quartz in almost equal proportions. This aggregate breaks up quite easily, as it is porous, the spaces being lined with drusy crystals of both components. The deposits have evidently been formed in fissures through a gradual replacement of the granite walls. Judging from an examination of the seam-like veins the silicates appear to have been attacked easier and removed first. In places the larger veins seem to blend into the granite and it was at first thought that some of the quartz might be a remnant of the granite, as it is rarely if ever segregated in bunches. A microscopic examination showed that this view was undoubtedly false, as the grains interlock in a different manner from those in the granite, and in addition contained fluid and liquid inclusions. The relative proportions of quartz and tourmaline in the Cajalco vein are so constant that it presents a uniform appearance. Although the mine reports speak of the occasional presence of arsenical pyrites and copper, nothing of the kind came under the observation of the writer. The bunches in these veins, and especially the enormous one forming Cajalco hill, could have been formed in no other way than by replacement, although it is difficult to conceive of its having taken place on such a large scale.

With the earlier reports upon this property nearly all the veins were considered tin-bearing, but at the time the writer made the examination shortly before the mine closed, after diligent prospecting the company had succeeded in finding traces of tin in only one or two veins besides the one worked. Tunnels had also been run into Cajalco hill, but in this great body of vein matter nothing was found. The narrower portion of the vein to the northeast furnished all that was ever milled. At the time of the examination the vein had been opened to a depth of 180 feet by two working shafts, exposing the vein horizontally for 300 feet. Here the vein has a width of 8 feet or less. The main ore body occurs in the center of the mine between the two shafts and extends down on the dip of the vein. The tin oxide is distributed either through the

vein matter or in stringers and bunches. In the latter case it is sometimes found in nearly pure condition. The average of the ore milled was however only about 5 per cent of the oxide. Seams of clay are generally found on or near the sides of the vein, showing some movement since the deposition took place. The walls are quite irregular and sometimes bunches of granite are found wholly inclosed in the vein. The analysis of the ore made by Genth, and quoted by both Blake and Hanks, shows silicic acid 9.82 per cent, tungstic acid .22, oxide of tin 76.15, oxide of copper .27, oxides of iron and manganese, lime and alumina 13.54. This must have been an exceptionally pure specimen and wholly free from tourmaline.

The tin ore occurs in two forms; the more important and common variety is either massive and of a brownish color, or in clear reddish brown crystals lining cavities; the less common variety is that of "wood tin," which appears uncrystallized and in the form of thin layers.

It is not known to the writer whether the ore body which was being followed down finally ran out or not, but at any rate it appears that it was unprofitable to work. The great richness of the ore in places is one of the remarkable features of this deposit when compared with most of the other known occurrences of tin. Another remarkable fact is the great size of the main vein as shown in Cajalco hill and its uniformity and simplicity of composition. It appears that the contents of the veins represent the entire replacement of the granite bordering what were originally narrow fissures. The agent which accomplished this was probably heated water carrying various minerals in solution, the economically valuable one, tin, being deposited only in places under exceptional conditions.