

minutes at depth. The Pewabic lode dips at 54 degrees at surface and flattens more or less gradually to 38 degrees at a depth of one mile.

The Tamarack mine has five vertical shafts which have respectively the following depths: 3,409 feet, 4,355 feet, 5,253 feet, 4,450 feet, and 5,308.5 feet. No. 5 is the deepest vertical shaft in the world. From No. 3 shaft workings a winze started at a vertical depth of 5,223.5 feet has a further depth of 335 feet on the dip of the lode. The bottom of this winze is therefore 5,430 feet vertically from surface. The ore in the deep workings averages about 19 pounds copper per ton. To mine this without making new openings costs about 12 cents per pound. To continue openings further brings the cost up to 15 cents. At present the price of copper is 14 $\frac{5}{8}$ cents, and whether the mine will be in the future worked to greater depth depends upon conditions which cannot be safely predicted. The severe pressure at great depth results in crushing, and adds materially to the cost of mining. The ore at the lower levels is below the average grade, and we have here therefore a deposit which has decreased in value with depth, but has been profitably worked to a vertical depth of one mile, and which at greater depth contains ore which if near the surface could be profitably mined. Further development work has been discontinued because the openings recently made do not point to an improvement in values. Whether or not there is richer ore at still greater depth will remain unknown, unless it is found that the low grade ore can be profitably mined.

The Calumet and Hecla Mining Company is mining the Calumet conglomerate lode from nine shafts, one vertical, seven following down on the dip of the lode from surface, and one inclined shaft or winze starting below the 57th and running 1,588 feet parallel to the lode, but at an inclination of only 22 degrees. The vertical shaft is 4,900 feet deep. The seven incline shafts have respectively the following depths—6,155 feet, 7,995 feet, 6,186 feet, 7,465 feet, 7,570 feet, 6,102 feet and 7,529 feet measured on the incline starting at 38 degrees and changing to 37 degrees 30 minutes. Some of these shafts are being deepened. The others have been bottomed at the boundary between this property and the Tamarack. The ore now being mined is lower grade than that found nearer the surface. The company did not in the early days publish statements of the values contained in the ore mined. It was much richer than that now being taken from the deep workings. In 1900 the ore mined averaged 3 per cent. copper, but the workings below the 57th level in the northern part of the mine yielded ore of much lower grade. The average yield for ore mined in 1910 was 30.12 pounds per ton. The decrease has not been by any means a gradual one, and there are parts of the mine where payable ore was not encountered until great depth was reached. On the whole the Calumet lode shows a falling off in values with depth; but is still being very profitably worked at a depth of over 7,000 feet on the dip of the lode. Actual figures showing values in all parts of the mine are not available; but according to Dr. A. C. Lane and others the lode was at its best at a depth of 2,000 to 3,000 feet. We have, therefore, an increase with depth for 2,000 feet, maximum values to 3,000 feet, and then decline to greater depth. Neither increase nor decrease were very regular, and the figures given there are only approximates.

The Quincy is mining the Pewabic lodes by four inclined shafts, three of which, No. 2, No. 6 and No. 7, are over one mile deep on the dip of the lode. No. 8 is nearly one mile deep. Excluding virgin territory north of No. 8 shaft the bottom of the mine has reached an average depth on the dip of the lode of about 5,200 feet. If the copper contents continue to be as good as at the deepest present workings, the lode will, without doubt, be profitably mined to much greater depth. The ore now being mined yields 16 pounds per ton. In some of the workings near surface there was mined in the early days ore which contained a much higher percentage of copper. As in the case of the Calumet lode the general statement can be made that there has been a decrease in values with depth. The ore being mined at a depth of one mile is not as rich as the ore which was taken from the upper workings. It must not be inferred, however, that the decrease is a gradual one. There are levels at which the ore is not as good as that at the deepest workings, and there are splendid ore bodies at a depth of 4,000 to 6,000 feet, which in the upper levels show comparatively low values.

Instead of a single lode there is, at the Quincy mine a zone about 300 feet thick, in which there are several lodes. These vary considerably in different parts of the mine. For the most part they run parallel to one another and are separated by trap. In places they come together. There is commonly one lode that is better than the others and is known as the "main" lode. As the workings are continued this "main" lode becomes lower in values than one of the "east" or "west" lodes. What is known as the "main" lode in workings from one shaft is not called the main lode in another part of the mine. In places there are four parallel lodes being worked at once.

At the Quincy, therefore, the conditions are such that there is a greater chance than usual of finding ore shoots which are rich at depth; but not at surface high enough in values to tempt investigation. In mining one lode cross-cuts are frequently made and diamond drill holes bored into foot and hanging walls. This practice has resulted in the discovery of numerous ore shoots at great depth. Such lodes, richer at depth than at the surface might forever have remained undiscovered if they had not been situated within a short distance of a lode which was rich enough near surface to be profitably mined.

Cobalt Silver Mines.

At Cobalt there are no very deep mines. The ore shoots which outcrop at surface have failed suddenly in values at a depth of a few hundred feet. Similar ore shoots have been found which do not outcrop, and it is probable that others will be found by underground exploration. The ore is very rich and the veins are remarkably numerous. On either side of the rich veins there is usually a few feet of profitable low grade ore. Naturally, therefore, there is very good reason to expect that lateral exploration will result in the discovery of very large quantities of ore. Whether or not there are ore shoots at great depth is unknown and not likely to be determined in the near future. It will take many years to develop and mine the ore that is within 500 feet of the surface. Very important changes take place in the ore shoots before this depth is reached, and it is to these changes that the following notes refer.