small and intermittent, on pumping or bailing. Most of the dry mines are still so far above the drainage level that they must undergo considerably more development and demonstrate the downward continuity of their ores before the water problem can affect them. Of the eight mines that have reached present drainage level, the Portland has already been worked about 1,000 feet, the Cresson about 400 feet, and the Granite (Ajax) and Vindicator 100 feet or more below the present tunnel. The Cresson and Granite mines have the bulk of the known and probable deep reserves. A deeper tunnel could be so planned as to reach the southern part of the crater at an altitude of about 7,000 feet, or about 100 feet below the winze from the bottom level of the Portland mine, 600 feet below the lowest level of the Cresson mine, and 1,000 to 1,100 feet below the other six deep mines.

Cresson Mine

Development and production

The Cresson mine, owned by the Cresson Consolidated Gold Mining & Milling Co., is one of the most productive in the district. It is situated along the upper part of Eclipse Gulch, in the south-central part of the breccia area. It is opened by a 2-compartment shaft 2,398.5 feet deep (altitude of collar 10,030 feet) and has 18 levels, numbered 3 to 20. Its downward development on a 3-compartment shaft followed the lowering of water down to level 17 (altitude 8,110.75 feet), which is connected by a lateral with the Roosevelt drainage tunnel (1,600 feet south of the shaft). After this connection was made, the shaft, with 3 compartments, was deepened and reached level 20 (altitude 7,631.5 feet) in 1924. Development of level 18 began in 1924, and that of levels 19 and 20 in 1925.

Production and mining costs quoted from the company's annual reports for 1922-33, mostly abstracted in annual volumes of "Mineral Resources of the United States," are tabulated on the next page.

Production (1903-33) *and costs* (1922-33) *of the Cresson mine*

YEAR	DRY TONS	GROSS VALUE		NET VALUE PER TON[a]	COST PER TON
		TOTAL	PER TON		
1903 to Aug. 31, 1921[b]	855,967	$19,365,364	$22.62	$16.80	.....
1922	121,074	1,811,601	14.96	9.70	$4.92
1923	123,734	1,883,138	15.22	10.05	4.93
1924	123,205	2,001,458	16.24	10.67	5.27
1925	112,068	2,139,725	19.00	13.15	6.43
1926	98,289	1,377,849	14.01	8.85	6.25
1927	104,145	1,351,057	12.97	8.26	5.50
1928	106,041	977,159	9.21	5.36	5.04
1929	118,075	902,513	7.64	4.22	3.87
1930	78,570	659,310	8.39	5.14	5.01
1931	[c]62,606 [e]17,873	545,141	8.70	5.06	[d]4.99
Sept.-Dec. 1931	[c]20,235 [e] 6,726	139,940 95,969	6.90 14.26	3.58 9.26	[d]5.18 .....
1932	[c]50,474 [e]26,540	444,535 332,367	8.80 12.52	5.05 7.80	[d]3.66 .....
1933	[c]63,136 [e]29,816	516,192 463,544	8.15[f] 15.54[f]	4.63 10.40	3.19
	2,122,298	35,331,783.95	16.65	11.54	

Dividends, $12,454,472.50.

[a]After deduction of freight and treatment charges.
[b]The company's fiscal year extended from Sept. 1 to Aug. 31 until 1931. Since then it has coincided with the calendar year.
[c]Company ore.
[d]Ratio of total costs to company ore.
[e]Lessee ore.
[f]At about $24.00 per ounce of gold; previous years at $20.00 per ounce of gold.

It is noteworthy that the general average value for 1903-21 is higher than that for any subsequent year, although it was approached in 1925, when the principal production was coming from level 17. The ore found on the three lowest levels has been of distinctly lower grade, but decreases in costs of freight and treatment, which have made it profitable to mine comparatively low-grade ore throughout the mine, account largely for the lower average value in recent years.

Considerable ore of fairly high grade, however, has been mined above level 17 since 1925.

The average cost of operations per ton of ore shipped has fluctuated considerably. According to the company's annual report for 1922 the average cost during that year was 97 cents greater than in 1921, largely because a large amount of ore was broken and stored in the stopes to offset the depletion of broken-ore reserves caused by labor shortage in the few preceding years. Costs in 1924-28 were considerably affected by increased taxes and by the greater expense of pumping and operating on the deepest levels. According to the company's annual report for 1925, the pumping cost for power alone in that year was 35 cents a ton, to which, according to Superintendent Al Bebee, should be added 16 cents a ton ("$1,500 a month") for labor and an indefinite though small amount for upkeep and repairs. The quantity of water pumped, which amounted to about 4,000 gallons a minute in October 1925, increased to 5,800 gallons a minute when open ground in the eastern part of the mine was tapped and so nearly equaled the capacity of the pumps that development of the lower levels had to be curtailed. The flow had diminished to about 3,500 gallons a minute by the spring of 1929, when, after the plugging of drill holes into the open ground, the water level was being held in check but not appreciably lowered. Owing to the low grade of ore on the lowest levels and the high cost of pumping, according to the company's report for 1929, the pumps were removed in that year, and the levels below 17, although not fully developed, were abandoned. The water level in 1933 was a few feet below level 17. Cessation of pumping, curtailment of development work, and increased shipments of ore, evidently account for the comparatively low cost per ton in 1929.

Intensive development of the remaining levels was then undertaken and doubtless was a large factor in the relatively high cost of operations per ton of ore in 1930 and 1931; but considerable ore was developed, and the annual reports for 1932 and 1933 showed increases in reserves of developed ore.

Dividends, which were suspended in 1928 or 1929, were resumed in 1933. Available figures do not show the exact cost of mining below level 17, but if deeper mining were to be resumed and work on higher levels to continue at the present rate, an average cost of $5.50 a ton exclusive of pumping seems a fair approximation, especially if a fairly large amount of deep development work is undertaken.

Geology

The geologic setting of the Cresson mine and the size, shape, and distribution of its ore bodies differ in some respects from those of any other mine in the district. The largest ore shoots are irregular masses along and in the local elliptical pipe of breccia called the "Cresson blowout." The ordinary breccia of the district, cut by dikes of latite-phonolite, phonolite, and basalt, is also present, but both breccia and dikes have been locally destroyed by the Cresson blowout, whose longest dimension is east-northeast, as shown in figures 2, 3, 21, and 22. The blowout as a whole has a steep southerly dip, as shown in figure 23. Between levels 10 and 11 it lengthens considerably eastward and begins to narrow downward. Below level 18, according to drill records and partial development, it separates into two "roots," as shown in figure 2 and less clearly in figure 22. The eastern root appears to contract downward rather rapidly, but the western root is as wide on levels 19 and 20 as on level 18 and evidently tapers very gradually on the whole. At the level of the proposed drainage tunnel the east root may have shrunk to very small dimensions, but the west root may be about as big as it is on level 20.

The easternmost workings on levels 11, 17, and 18, seen by Loughlin in 1925, partly expose the Dante collapse breccia, which overlaps the east end of the blowout (fig. 3) and is described on page 299. The open texture of this collapse breccia has made it a reservoir for a large volume of water, and its connection with extensive fissure systems has rendered the draining of it expensive. It was the tapping of this collapse breccia on level 19 that increased the rate of flow to a maximum of 5,800 gallons a minute. Another mass of collapse

breccia is said to have been opened recently on level 17 southwest of the blowout, but mine gas prevented us from seeing it. This mass may connect upward with the angular breccia in the Moose mine, 300 feet west of the blowout on level 12, but the fact that no extraordinarily large flow of water resulted from western development on level 19 would imply either that this mass is comparatively small or that it is separated from the blowout below drainage level by tight ground.

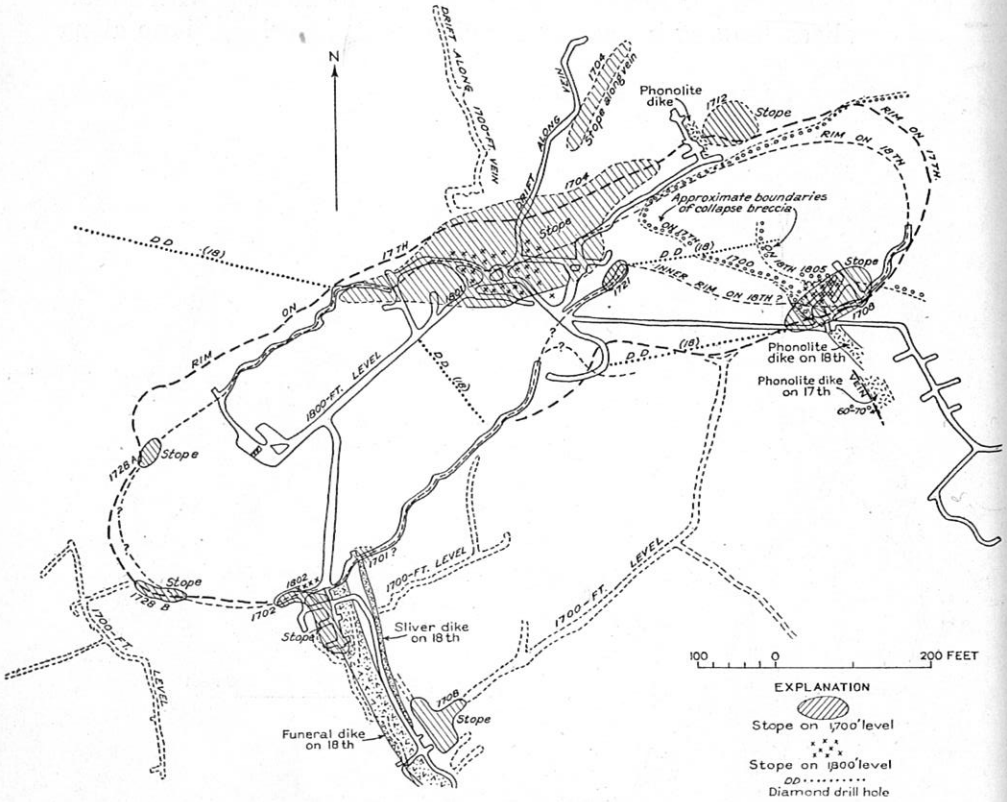

Figure 21.—Levels 17 and 18 of Cresson mine, showing boundaries of blowout and collapse breccia and distribution of stopes. Complete workings on level 18 shown by solid lines; workings on level 17, outside of blowout only, shown by dash lines.

The solutions that deposited the ore at the end of the second stage of mineralization started from beneath the roots of the blowout, rose along the bodies of collapse breccia and certain intervening dike-filled fissures, and spread upward where openings permitted within and around the blowout. The largest ore bodies of the mine have been found along the rim of the blowout, but others of small to considerable size occur within it and along veins to the south of it. A study of the ore bodies shows that the positions of the largest are controlled mainly by the junctions of the rim of the blowout with mineralized fissures in the surrounding rock, especially those along

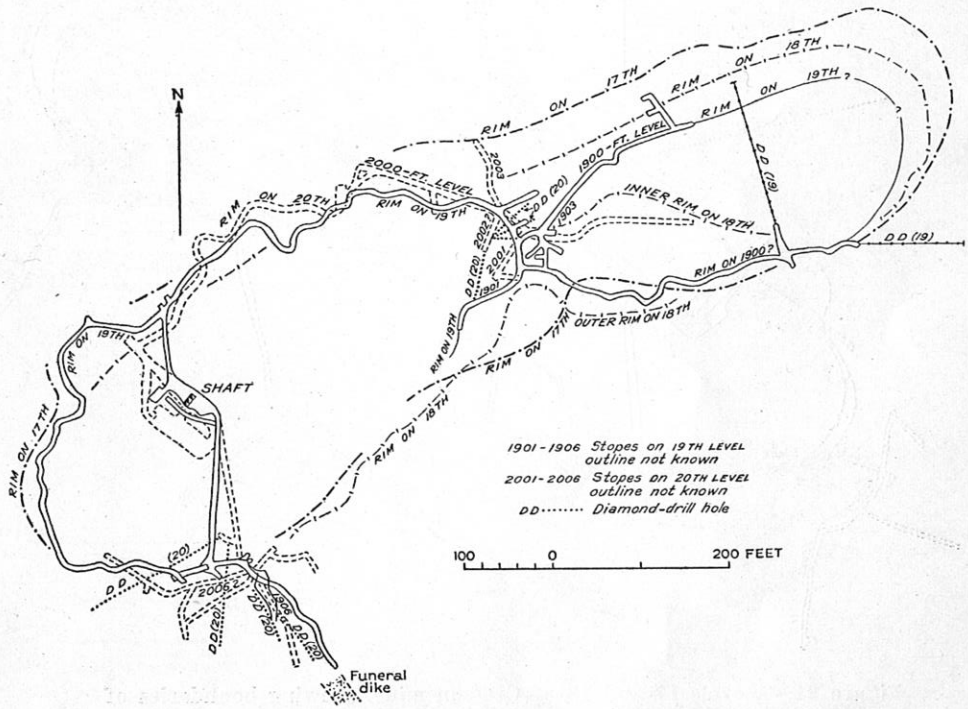

Figure 22.—Levels 19 and 20 of Cresson mine.

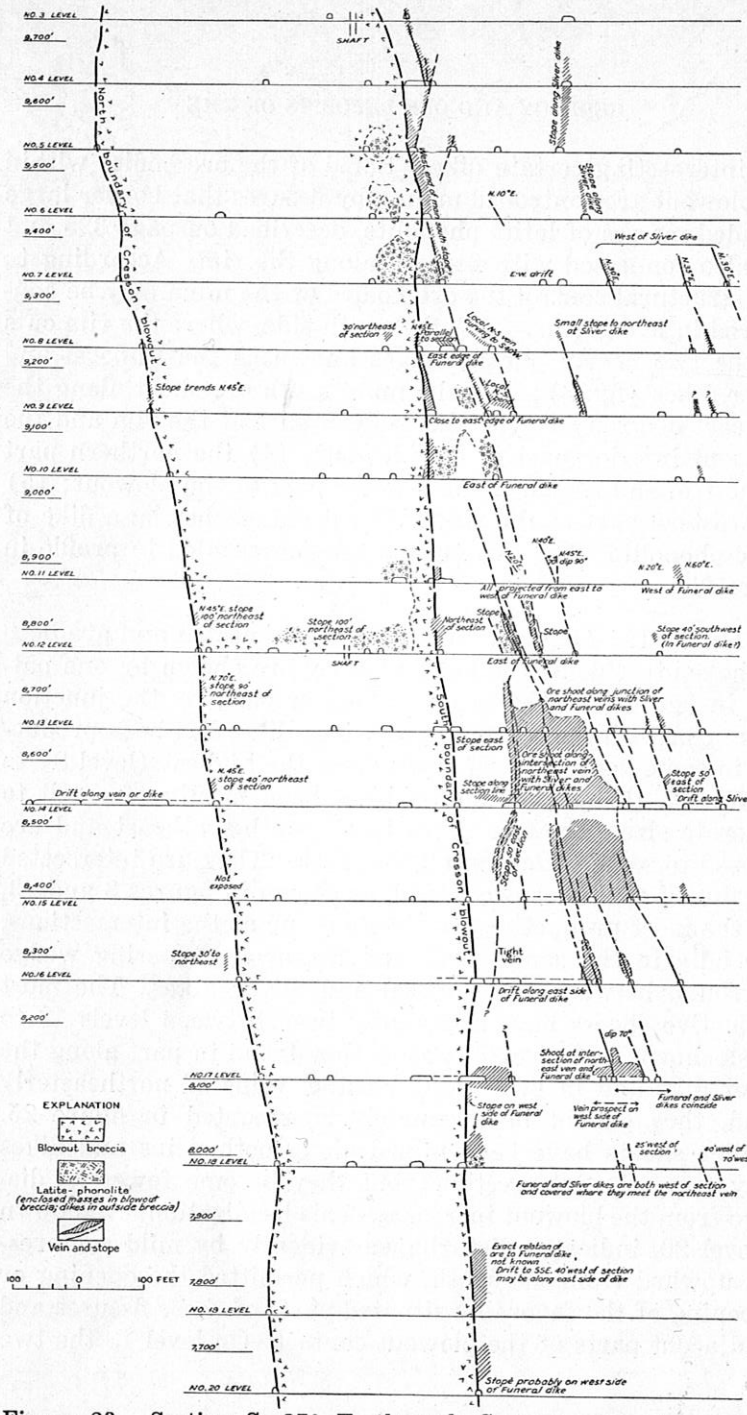

Figure 23.—Section S. 27° E. through Cresson mine along general course of Funeral and Sliver dikes. Shows relation of stopes along south wall of blowout to veins of northeast trend outside of blowout.

and intersecting certain dikes. Some of the ore bodies within the blowout are controlled mainly by fissures that border large included masses of latite-phonolite, described on page 325, but are also connected with fissures along the rim. According to this structural control the ore bodies of the mine may be considered in five groups—(1) the south side, where the rim cuts off the two nearly parallel dikes known as the Funeral and Sliver dikes (fig. 3); (2) the main south ore shoot along the rim east of group 1; (3) the eastern part of the rim and the adjacent interior part of the blowout; (4) the northern part of the rim and the adjacent interior part of the blowout; (5) the western part of the rim where it encroaches on a dike of latite-phonolite. The five groups are represented in profile in figure 25.

Group 1.—As groups 1 and 2 are connected and are both on the south side of the blowout, they are shown by one pattern in figure 25. The ground along or close by the junction of the rim with the Funeral and Sliver dikes has been productive to some degree on all levels from the highest (level 3) to the lowest, though the stopes have been mostly of small to moderate size. The two dikes trend south-southeast and are exposed to some extent on all the levels. They are intersected by veins of southwesterly trend, as shown in figures 3 and 23, and the most productive ore shoots occur at the intersections, especially in the southward- and downward-tapering wedge of ground between the Funeral and Sliver dikes. The most productive shoots have apparently been between levels 13 to 15, as shown in figure 23; but as they trend in part along the Sliver dike and in part along parallel veins of northeasterly trend, they cannot be adequately represented in figure 25. Smaller shoots have been mined along both veins and dikes away from the intersections, but they become fewer as distance from the blowout increases. This localization, even down to level 20, indicates disturbance evidently by mild compression upward from the south, which permitted the opening or reopening of the favorably situated parts of these fissures and of adjacent parts of the blowout contact. On level 18 the two

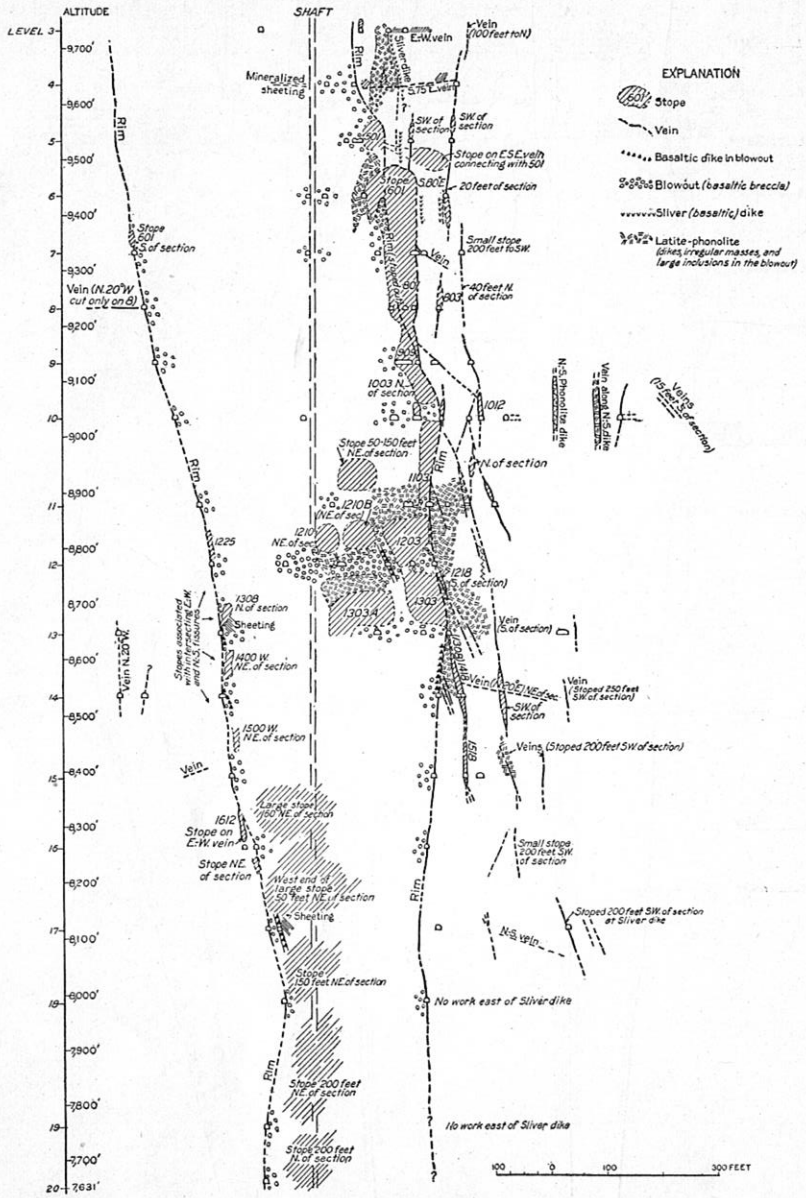

Figure 24.—Section S. 45° E. 175 feet northeast of Cresson shaft. Shows relation of stopes within blowout to veins outside of blowout.

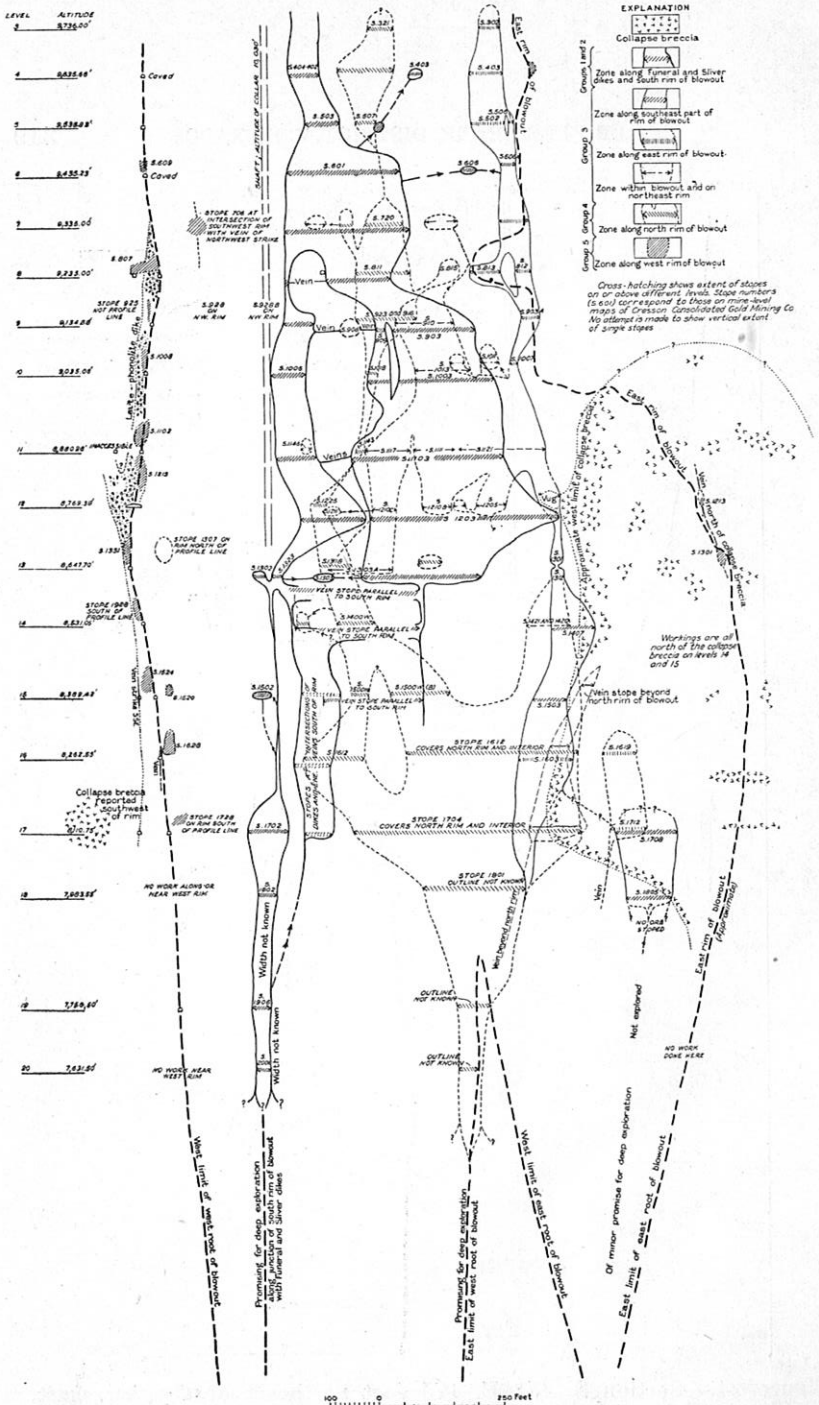

Figure 25.—Profile of Cresson ore zones projected to an east-northeast plane through the Cresson shaft (looking NNW). West rim of blowout and the associated dike of latite-phonolite are exactly along the east-northeast plane.

dikes practically coincide for a considerable distance from the rim (figs. 21, 23, and 26A) and the productive wedge of ground therefore pinches out. Furthermore, the Funeral dike,

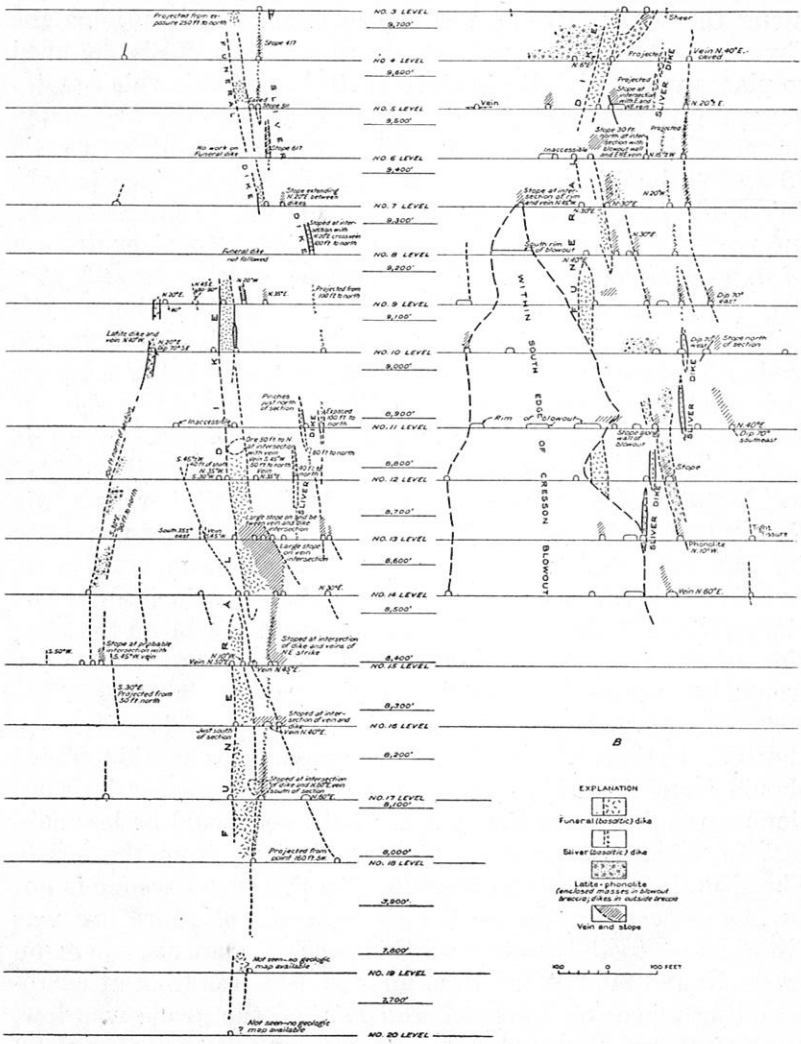

Figure 26.—East-west sections through Funeral and Sliver dikes: A, 310 feet south of Cresson shaft; B, 110 feet south of shaft.

which is the west limit of ore on the higher levels, changes its dip on levels 17 and 18 (fig. 26A) from very steep easterly to vertical or even steep westerly, and the Sliver dike makes a similar change at higher levels. It is also true of the vein along the basalt dike in the Moose mine, which adjoins the Cresson on the west, that ore shoots are practically confined to places where the dip is steep easterly. If this rule applies generally to this part of the district, it adds to the discouraging conditions along the coinciding dikes on level 18. Levels 19 and 20 in this part of the mine were opened since Loughlin's study in 1925 and are now flooded, but, so far as can be inferred from the mine maps and from downward projection of exposures on level 18, the two dikes, which intersect at a very small angle, still coincide and even maintain their vertical to steep westerly dip. They may, however, begin to diverge again and resume their prevailing easterly dips below level 20, and may therefore enclose another intervening wedge of ground that broadens downward and southward. There is every reason to believe that the zone of cross veins that intersect the dikes continues to still lower levels, and there is a fair chance that some fissures in this zone may be found nearer to the rim than the downward projections of those exposed on level 18. It is interesting to note that the ore mined along the rim on levels 19 and 20 in this section appear to be on the west side of the Funeral dike, where the thin end of the wedge would be expected. In so far as the localization of open fissures has been due to settling along the rim of the blowout, the intersections of the dikes and cross veins in this wedge should have afforded openings that could be reached by solutions spreading from the contact; but they would be less subject to opening by compression upward or from the south. The situation as a whole, therefore, in this lower wedge is not as favorable as in the wedge above level 18. More ore was mined close to the contact in this section than elsewhere on levels 19 and 20, but the total amount was less than at corresponding places on levels 17 and 18, and the grade was low, averaging less than 0.4 ounce to the ton. Between level 20 (altitude 7,631.5 feet) and the proposed drainage level (alti-

tude about 7,000 feet) the junction of the Funeral dike and the blowout may continue to be mineralized and may even represent the course along which the local ore-forming solutions rose; but there is no valid reason for expecting any increase in size or grade of the ore body. South of the contact the occurrence of ore bodies would apparently depend upon a resumption of easterly dip by the dike and on its intersection with hitherto undiscovered cross veins.

Group 2.—The main south ore shoot, discovered on level 6, coincided with group 1 on that level and was continuous with it down to level 8, but pitched northeastward from that point to level 12, where it attained its maximum size and connected with group 3 near the "vug." (See fig. 25.) It contracted below level 12 and was bottomed a short distance below level 13, although a long stope on that level extends southwestward from beneath it and indicates another probable connection between it and group 1. No ore corresponding to this ore shoot has been found along the rim on lower levels, and structural conditions indicate that it was formed by the coalescence of solutions spreading from groups 1 and 3 where the rim was so close to a local abundance of intersecting fissures of east-northeast and north-northwest trend that the ground was unusually open and especially suited for the formation of a large ore body. Below this shoot the fissures become fewer and tighter and dip farther and farther from the rim, which changes its slope from steeply southeast or overhanging to steeply northwest. (See fig. 24.) Between levels 17 and 19 the slope again becomes slightly overhanging, but no local shattering has been disclosed, and there is no indication of conditions favorable for ore deposition. No estimate of deeper ore in this section, therefore, is justified.

Group 3.—Group 3 is shown in figure 25 by three connecting zones. Along the easternmost parts of the rim down to level 10 the stopes are of small to moderate size. On levels 9 and 10 they extend westward within the blowout. Below level 10 the blowout extends farther to the northeast (fig. 2) and is overlapped by the collapse breccia. The stopes, however,

continue almost vertically downward and are close to the irregular margin of the collapse breccia, though well within the blowout. On levels 11 and 12 the stopes are large and have contained some extremely rich ore. These large stopes are closely associated with a large, nearly horizontal mass of basalt. The stope called the "vug" (p. 304, figs. 20 and 25) represents a large cavity thickly lined with calaverite, from which ore with a net mill settlement of $1,200,000 was mined.[53] Below this mass, on levels 13 to 15, the stopes again become small but lead to another very large shoot from which the principal production on levels 16 and 17 has come. This large shoot lies above a large mass of basalt that is exposed on level 18 and also above the junction of the two roots of the blowout and along a considerable part of the north rim (fig. 21). The structural control of this shoot could not be determined in detail but is evidently related to the junction of shattered ground in the blowout with two converging veins of southerly trend in the outside rock. The eastern vein was productive close to the main shoot on level 17 but tightened upward and downward. Besides this main shoot two smaller shoots of good grade were mined to the east of it along the northern and southern rims at junctions with outside veins (fig. 21), but did not persist below level 18. The veins follow parts of a phonolite dike that has been crosscut by the blowout. Too little is known about the structural control of these two ore shoots to warrant a statement regarding the possible presence of other shoots below them.

The main shoot, which furnished the bulk of the ore produced on levels 16 and 17, was mined on levels 18, 19, and 20 but was much smaller and of lower grade. The stopes on level 19 averaged 0.50 ounce of gold to the ton, those on level 20 averaged 0.35 ounce, and the general average of the two levels was 0.45 ounce. It is said that the ore in the floor of level 20 was of higher grade than that in the stope above the level, and if mining were to be continued downward this part of the mine would undoubtedly be a principal prospect. This statement prompts the inference that the relatively poor re-

[53]Company records obtained by C. W. Henderson.

sults thus far obtained on levels 18 to 20 are comparable with those on levels 13 and 15, and that larger shoots of higher grade await discovery below level 20; on the other hand, it is a general rule in the district that ore shoots tend to become smaller with increasing depth and that, unless there are strong indications of favorable structural conditions below level 20, there is little reason to expect a marked improvement in the quantity and grade of ore. The ground in question includes the partition between the roots of the blowout, which is likely to be considerably though irregularly shattered, and the converging veins on the north side of the rim, which should join the west root just west of the partition. Its structure is therefore worthy of consideration. It is also possible that the small stope that averaged 0.48 ounce of gold to the ton farther west, on the north rim of the west root, will be found to lead downward to a shoot of ore of equal or better grade. The overhanging position of the rim, its local bending to a north-northeast trend, and the suggestion of an intersection with a vein of northerly trend (fig. 21) are favorable structural conditions.

The ore bodies studied along the large pillarlike inclusion of latite-phonolite east of the shaft are between levels 7 and 13. The largest, on levels 8, 11, and 12, lie along the southeast, overhanging side of the pillar, and smaller bodies on levels 11, 12, and 13 lie on its west side. This localization of ore justifies further exploration of mineralized fissures along or near the sides of the pillar.

Group 4.—In group 4, along the north rim, ore shoots of small to moderate size were mined, though not continuously, down to level 16, where they proved to be upward branches from the large shoot, already mentioned, that was mined mainly on levels 16 and 17. They are therefore of no further significance as regards the continuity of ore below the present workings.

Group 5.—In group 5, along the westernmost part of the rim, no ore has been found above level 6, but this fact may be due in part to incomplete development. Level 6 was not ac-

cessible to Loughlin in 1925, but on levels 8, 10, 12, and 13 the ore was present where the rim encroached on a dike of latite-phonolite of north-northwest trend and a branch of the dike of more northerly trend, as shown in figure 25. The dike was opened by closely spaced mineralized fractures (sheeting) and was followed southeastward by a low-grade vein. The opening of the fractures by adjustment along the rim of the blowout was evidently the factor that determined the localization of ore. The encroachment of the rim on the dike continued at least down to level 13, and each level was productive. Ore in closely corresponding positions has since been stoped on levels 14 to 17, and the same structural conditions evidently continue to level 17. The only deeper development, on level 19, has not been productive but is insufficient to show whether the dike and veins continue along the rim. The prevailingly vertical to very steep westerly dip of dike and vein would cause them ultimately to diverge from the rim, and a steplike offset of the dike downward to the west would increase the divergence; but if the dip has turned to steep easterly, a change common to some dikes in the vicinity, the dike may continue along the rim or may even be entirely engulfed by the blowout. In short, although favorable structural conditions for the occurrence of an ore shoot may be found in places on and below level 18, the outlook on the whole is less favorable than on the higher levels.

Summary.—To summarize, two favorable places for the continuation of ore shoots below level 20 can be clearly recognized—one at the junction of the Funeral and Sliver dikes with the west root of the blowout and one along the east end of the same root. In both places the ore found on level 20 was of rather low grade, although at the new price of gold its gross value probably exceeds the combined cost of mining, freight, and treatment. Deeper development, however, must be based on the possibilities that shoots of higher grade along these zones will occur at intervals below level 20, as they have at higher levels; that structural conditions along the Funeral and Sliver dikes south of the rim will again become favorable;

and that thorough development will disclose other favorable conditions similar to those that controlled ore deposition on higher levels but not predictable from information at hand. Operations on and above level 17 since 1929 have disclosed several ore shoots of small to moderate size that had apparently been overlooked but have put the mine on a paying basis, and intensive development below level 17 may produce similar results, although it should again be recalled that structural conditions favorable for the occurrence of ore become smaller and fewer with increasing depth.

Portland Mine

Development and production

The Portland mine, north of Victor, was opened in 1893 and has been the largest producer in the district, although in recent years its output of newly mined ore has been small. The Portland Gold Mining Co., the original owner, sold its interest in 1928, but the succeeding owner was referred to by the same name until 1934, when the mine was acquired by the United Gold Mines Co. Its total production of shipping ore and mill dirt from April 1, 1894, to December 31, 1931, amounted to 6,230,785 tons, with a gross value of $62,255,484. It is opened by three shafts, Portland Nos. 1, 2, and 3. The bottom of shaft 2, which is 3,000 feet deep and is by far the deepest in the district, is at an altitude of 7,250 feet, and a winze from the 3,000-foot level extends 155 feet deeper. The extension of the Roosevelt drainage tunnel gradually drained the mine to the 2,100-foot level, which was connected with the tunnel by a lateral in 1918. Sinking below this drainage level was begun promptly and continued to 1921, when the 2,600-foot level was reached, but operating conditions had been so discouraging and the company's resources so depleted that $100,000 had to be borrowed to continue the work. Discovery of a good ore shoot on the 2,600-foot level justified deeper exploration. The 3,000-foot level was reached in 1924, and the winze and 3,100-foot level (altitude about 7,155 feet) were opened in 1926. The rates of pumping on the subdrainage

levels, according to annual reports of the Portland Gold Mining Co., were as follows:

	Gallons a minute
1919, from the 2,300-foot level	300
1920, from the 2,450-foot level	650
1921, from the 2,600-foot level	795
1923, from the 2,722-foot level	"No greater"
1925, from the 3,000-foot level	About 1,000
1926, from the 3,135-foot level	950
1927, from the 3,135-foot level	972
1928, from the 3,000-foot level	793
1930, pumps pulled from bottom level. Water held temporarily at 2,300-foot level.	

According to the company's annual reports, 508,344,000 gallons was pumped at a cost of $35,657.95 in 1927, and 417,017,600 gallons at a cost of $27,143.44 in 1928. These costs amounted to $2.79 per ton of shipping ore in 1927 and $1.78 per ton in 1928, both years of small production. In 1926, when production was much greater, the cost must have been less than $1.30 per ton of shipping ore and much less per ton of total output, although figures showing the total cost are not available.

The production and gross value of ore shipped without concentration from 1915 to 1931 are quoted below from the company's annual reports. This period is sufficient to reflect operating conditions from prosperous pre-war days almost to the present. No record of the large quantity of low-grade mill dirt is quoted, as such ore has been mined mainly on the upper levels and has no significance regarding the outlook for further deep mining.

The company was prosperous in 1915 and 1916, but conditions were bad in 1917 and grew worse until 1921, when the company's surplus was exhausted. The deficit grew in 1922 and 1923 but was overcome later in 1923. Operations continued so successfully during the next two years that the company resumed dividends in 1926 and part of 1927, but the fail-

Ore of shipping grade produced in the Portland mine, 1915-31

YEAR	DRY TONS	GROSS VALUE	
		TOTAL (Gold at $20 an Oz.)	PER TON
1915	72,192	$1,710,277	$23.69
1916	96,046	2,236,842	23.29
1917	86,688	1,768,972	20.41
1918	53,887	1,120,851	20.80
1919	45,417	1,173,616	25.86
1920	31,426	867,381	27.60
1921	7,807	223,667	28.65
1922	27,337	576,328	21.08
1923	30,346	675,219	22.25
1924	21,531	656,068	30.47
1925	18,150	437,999	24.13
1926	27,409	647,697	23.64
1927	12,779	149,302	11.68
1928	15,280	200,013	13.09
1929	36,159	398,491	11.02
1930	40,040	369,107	9.22
1931	23,388	264,936	11.33

ure to find sufficient deep ore to offset exhaustion of the stopes on levels 26 to 29 and the poor returns from shallow low-grade ore treated in its mill at Victor resulted in operation at a loss during the next two years. The 3,135-foot level was abandoned in 1927, and the mill was closed in November 1928, after the mine had changed hands. During that year and the next two years the lower levels were intensively developed and production was substantially increased, but operations were conducted at a loss. The pumps were pulled from the 3,000-foot level in 1930, water was held at the 2,300-foot level long enough to permit the removal of ore in sight, and the mine was then turned over almost entirely to lessees.

No very significant data on the cost of deep mining have been published, as the company's figures represent only the aggregate cost of both high-grade ore and mill dirt; but the cost of deep mining must have been comparatively high be-

cause of the large amount of shaft sinking and the development work necessary to offset the curtailed operations in 1917 to 1922, together with the cost of pumping. This fact is borne out by monthly reports of the mine manager for the years 1924 to 1926, to which we have had access. According to these reports the deep mining, in spite of the good grade of the ore mined, was conducted at a loss during most of 1924 and 1925, but the loss was more than offset by the returns from mill dirt. In 1926, however, when the rich shoot on the 2,900-foot level was being stoped, deep mining became profitable, even though the quantity of ore shipped, 574 to 888 dry tons a month, was small. Monthly shipments of this ore in 1926 ranged from $50 to $93 a ton and were augmented by small quantities of extremely high grade ore that ranged from $4,817 to $11,102 a ton.

Developments on the 3,100-foot level, though extensive, have not been exhaustive, and additional development on that level would not be extremely expensive if the level were to be permanently drained by the proposed deep tunnel and the shaft and operating equipment were to remain in good condition. It might prove necessary, however, to develop one or two still deeper levels before adequate search for another ore shoot of satisfactory size and grade could be made.

Geology

The Portland mine lies along the east edge of the eastern granite prong shown in figures 5 and 6. The upper workings (fig. 27) are partly in granite and partly in breccia and large masses of latite-phonolite. The workings below level 15 are mainly in breccia and syenite close by the granite contact, but some exploration has been conducted a considerable distance from it on levels 17 and 21. The contact as a whole dips steeply eastward and northeastward, but its upper part is undulating, with local benches or terraces of gentle dip. It was formed along master fissure zones of northwesterly and southerly trends. The northwesterly zone dominated in the northern and deeper part; the southerly zone dominated in the southern and upper part of the mine and continued southward