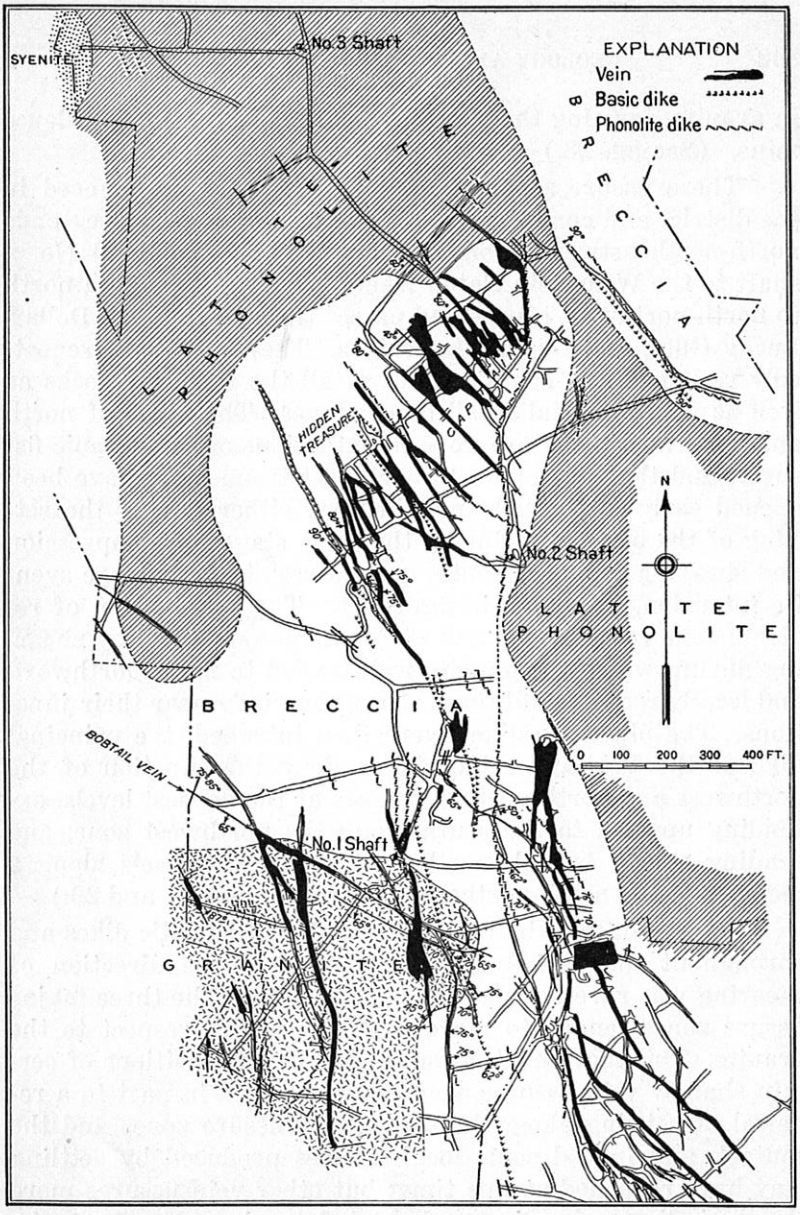

Figure 27.—Level 5 of Portland mine, showing network of veins in the main zone near the breccia-granite contact and the Hidden Treasure and Captain groups of veins in a mass of breccia that is surrounded by latite-phonolite. (After Ransome, F. L., U. S. Geol. Survey Prof. Paper 54, pl. 5, 1906, and more recent maps of the Portland Gold Mining Co. Reproduced from Am. Inst. Min. Met. Eng. Tech. Paper 13, fig. 9, 1927.)

in granite, forming the main fissure zone of the Independence mine. (See fig. 28.)

These fissure zones are among the most pronounced in the district and connect with a third master zone that extends north-northeastward from a point near the Portland No. 2 shaft to the Wisconsin claim, where it curves through a north to north-northwest course and passes through the Last Dollar, Lucky Guss, and Orpha May mines. They have been repeatedly reopened and contain dikes of all the intrusive rocks as well as vein material of all three stages. The zones of north and northwest trend are upward extensions of prevolcanic fissures, and the zone of north-northeast trend must have been opened early in the volcano's history, either during the settling of the breccia or during the early stages of compression and shearing from the south, or as a result of the large syenite intrusion, as shown in figure 11. The culmination of regional compression (pp. 280-281) was accompanied by shearing during which the granite wall tended to move northward and locally reopened all these zones, especially near their junctions. The phonolite dikes were then intruded, the principal dike of the Portland mine rising along the junction of the northwest and north-northeast zones at the deepest levels, extending upward to the south along the northwest zone, and sending a long branch northward at shallow levels along a member of the north-northeast zone. (See figs. 27 and 29.)

Later, evidently before the intrusion of basaltic dikes and throughout the period of vein formation, the direction of shearing was reversed and the breccia east of the three major fissure zones tended to move northward with respect to the granite. This movement, as suggested by the positions of certain shallow vein fissures, could be attributed in part to a renewal of settling along the three main fissure zones and the contact, and indeed some local fissures produced by settling may have reopened at this time; but other vein fissures more clearly indicate shearing and related tension. For example, the dense fluorspar of the first stage of vein deposition is locally so intensely sheared as to have a banded or schistose structure, and the associated slickensides on the vein walls are nearly horizontal.

The local arrangements of fissures were determined by differences in resistance of the different rocks to shearing. On level 5 (fig. 27), for example, local control was exerted by the large, irregular massive body of latite-phonoite. The principal movement took place along the western margin of its southeastern part, where a branch of the main phonolite dike had previously been intruded. The latite-phonolite escaped serious fracturing, and the dike fissure along it remained tight, but the weaker breccia between the two parts of the latite-phonolite was severely stretched northeastward and developed a closely spaced set of tension fractures, in which the rich Captain and Hidden Treasure ore bodies were formed. The latite-phonolite tapered downward into mere dikes, and the closely spaced vein fractures ended correspondingly. On level 10 few if any of these fractures and no feeder veins were found, so it must be concluded that the shallow, rich ore bodies were formed by solutions that rose along the main or contact fissure zone until it could spread horizontally into this local zone of tension fractures.

The veins of southeasterly trend in and beyond the southeast corner of the area shown in figure 27 evidently fill tension fissures roughly parallel to those of the Captain ore body but east of the local shear zone. The Bobtail vein, which trends in the same general direction but west of the shear zone, is evidently an old fissure reopened by tension at this time and filled with ore, especially near intersections with local northward-trending veins. Its dip, 65°-70° SW., and its filling of crushed granite[54] suggest that it was originally a compression or reverse fault formed during the culmination of compression from the south across the base of the granite prong (fig. 7) and extending for some distance into the breccia. Its position favored its reopening near the main shear zone and especially where crossed by fissures parallel to the shear zone.

The shelving character of the breccia-granite contact at shallow levels, the position of the Bobtail and closely parallel fissures, the main shear zone considered above, and the master shear zones in the Independence and Granite mines to the

[54]Lindgren, Waldemar, and Ransome, F. L., op. cit., p. 446.

south and southwest all favored the thorough fissuring of both the granite southwest of Portland No. 1 shaft and the breccia east of it, and the large number of shallow veins is thus explained. Veins are confined to the main fissure zones close by the granite contact. Below level 8, however, where the contact has become uniformly steep and the Bobtail and closely parallel fissures dip away from the main fissure zone, the masses of latite-phonolite have narrowed to mere dikes. As the northward-trending zone steepens more with increasing depth it tightens and has not been productive in the granite south of the contact, below level 14 of the Independence mine. As the junction of the northward-trending and northwestward-tending zones pitches to the north, the south limit of productive ground also pitches to the north, as shown in figure 28. The northwestward-trending zone was favorably situated for reopening by tension to the place where the granite contact curved sharply to the west. Beyond this place the wall rock was all breccia, and the continuous fissures passed into a steplike series of short fissures, some of which contained small ore shoots.

Extensive developments on levels 17 and 21 disclosed a member of the north-northeastward-trending zone which had failed to develop continuously through the latite-phonolite masses above. On level 17 this zone is poorly defined near the main or contact zone and is represented by a network of short, nonproductive fractures. Its more continuous part also is nonproductive until, in the Wisconsin claim, it has curved to a northerly course, which is more likely to have been opened by the north-northeastward shearing movement. The Wisconsin vein, which is in syenite, is cut by the Roosevelt drainage tunnel on level 21 about 60 feet west of its position on level 17 and along a local northward-trending contact between syenite on the west and breccia on the east. The syenite on level 21 has a very irregular boundary, as the main mass apparently lies north of the drainage tunnel and sends west-southwest and south branches that cross the tunnel. The east contact of one of the southerly branches evidently determined the position of the local vein fissure. Farther north and at higher lev-

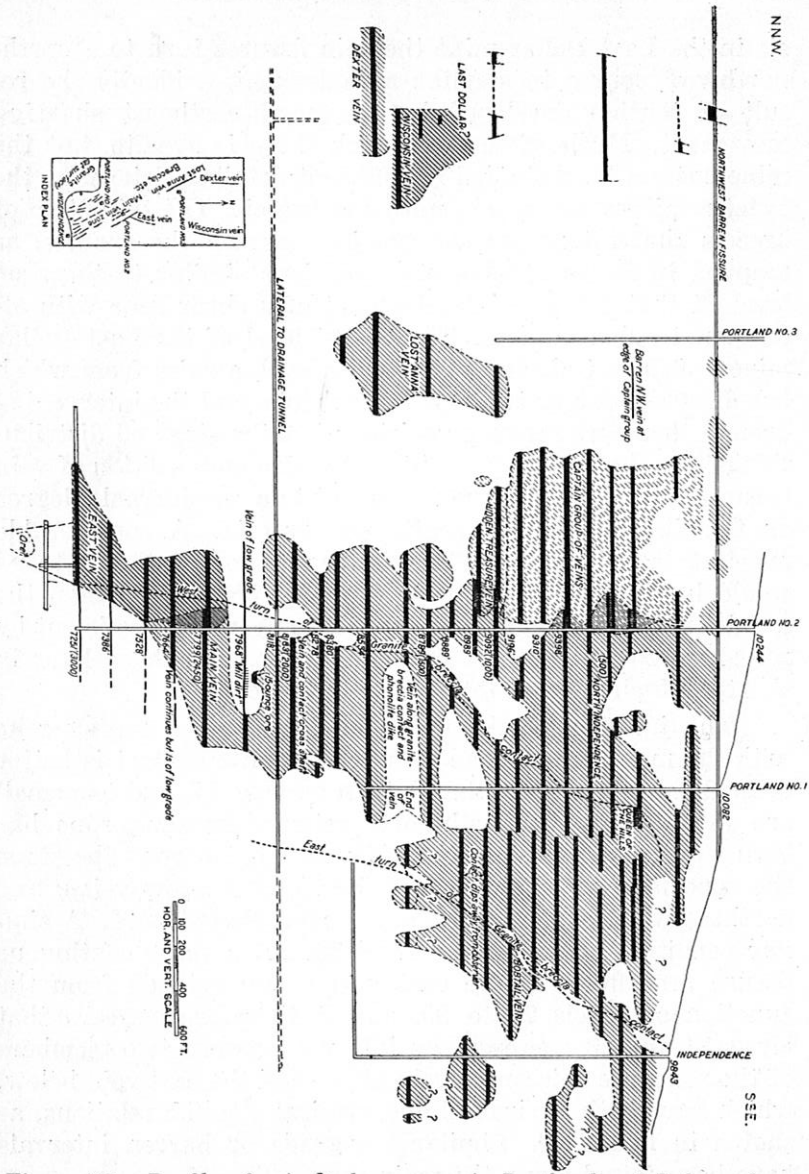

Figure 28.—Profile of principal ore zone in Portland and Independence mines. Heavy solid lines represent stope lengths on different levels. The outline between levels is inferred and may include local barren spots. (After Am. Inst. Min. Met. Eng. Tech. Paper 13, fig. 8, 1927.)

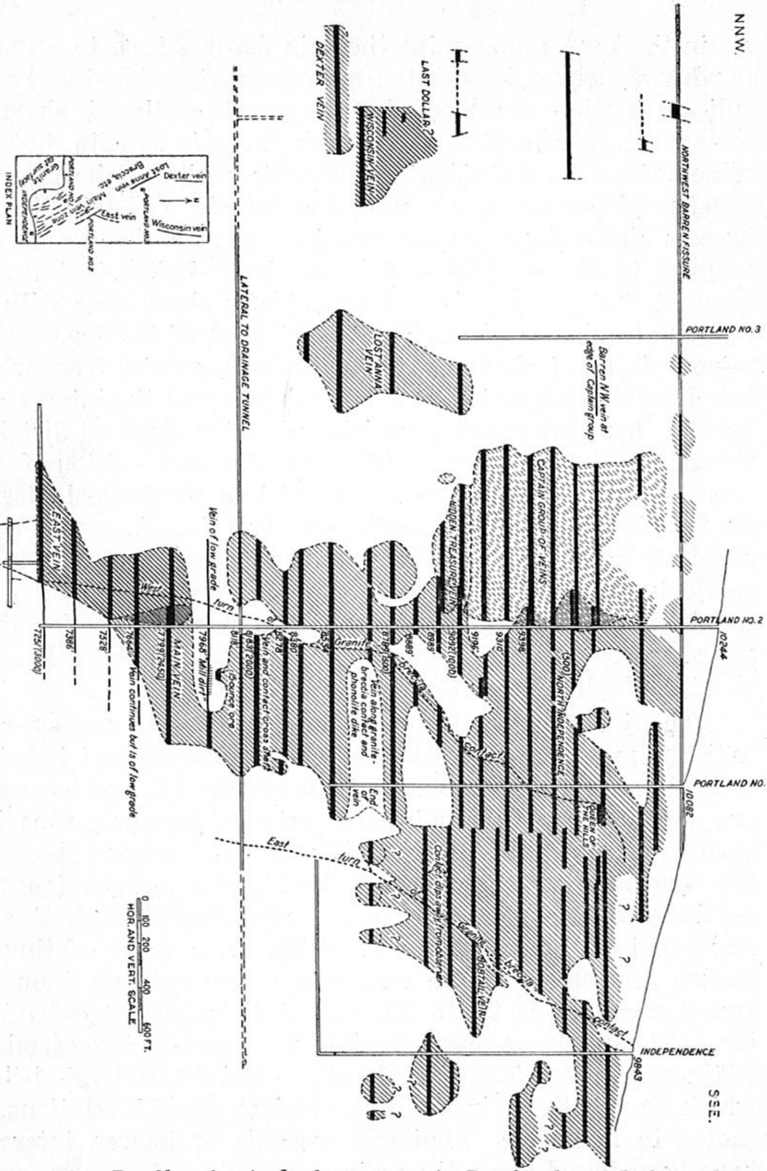

Figure 28.—Profile of principal ore zone in Portland and Independence mines. Heavy solid lines represent stope lengths on different levels. The outline between levels is inferred and may include local barren spots. (After Am. Inst. Min. Met. Eng. Tech. Paper 13, fig. 8, 1927.)

els in the Last Dollar mine the vein fissures turn to a north-northwest course in steplike arrangement, evidently the result of tension developed by the north-northeast shearing movement. Much of the wall rock there is syenite, but the mine has not been studied in sufficient detail to determine the exact relations between syenite and breccia. The thin strip of breccia that interrupts the syenite mass on the surface, as mapped in figure 1, suggests conditions similar to those on level 21 that favor the development of a shear zone with attendant tension fissures. The lowest level of the Last Dollar mine is 649 feet above the drainage level, a raise from which has disclosed one or two small ore shoots, and the intervening ground therefore seems promising; but the size and distribution of ore shoots is dependent on the size and position of vein fissures, which in turn are dependent to a considerable degree on the distribution of syenite and breccia. A considerable mass of breccia between syenite masses of northerly trend would be likely to contain more productive ground than the syenite itself, although where the main syenite mass is cut by the shear zone it may be productive also, though perhaps in shorter, steplike veins than those in breccia.

The junction of the north-northeastward-trending zone with the main fissure zone along the granite contact is better defined on level 21 (Portland) than on level 17, and one small ore shoot along the north-northeastward-trending zone has been stoped near the junction (fig. 29), but beyond the stope the zone is represented by a network of narrow veins, and northeastward exploration along it was discontinued. A similar condition is present on level 23, but a more continuous fissure zone filled by the east vein group extends from the junction on levels 24 to 30, and it therefore appears that levels 21 and 23 represent an interval between two members of the zone, the Wisconsin vein above and the east vein below, which have both horizontal and vertical steplike relations, as shown in figure 29. Similar low-grade or barren intervals have been found along the main zone.

The main zone has been continuously productive from level 24 to level 30. Its ore shoots, however, pinch southward

where the zone turns from a southeast to a south course and approaches the east turn in the breccia-granite contact (fig. 29), and they pinch northwestward just beyond the junction with the north-northeast or east vein zone, which becomes the most productive zone on the lowest levels (fig. 30)—in fact, the main zone may be feathering and dying out beyond the westward turn of the granite contact. Its northwesterly course was favorably situated for opening by the tendency of the breccia mass to move north-northeastward.

The more northward-trending part of the east-vein group was also favored by this movement and by local structural conditions. Considerable syenite is present near the granite contact on the lower levels, but it cannot be adequately represented in figures 29 and 30 without obscuring more important information, and the breccia, squeezed between the granite and syenite, has been especially subject to fissuring ever since the syenite stage of intrusion. A compression fissure of westerly trend and steep south dip, exposed on levels 27, 30, and 31, was formed about 300 feet north of the granite contact, and the intervening wedgelike mass was cut by tension fissures of northerly trend, parallel to the east vein and therefore included in the east-vein group. The most open of these tension fissures contain dikes of phonolite, trachydolerite(?), locally called "black rock," and basalt. The north-northeastward shearing movement that preceded ore deposition allowed this wedge-shaped block to expand eastward and reopen its fissures for mineralization, especially near their junction with the main, northwestward-trending vein.

Above level 27 the compression fissure is not continuous, and no corresponding tension fissures of importance have been found. Instead the dip of the east vein decreases upward, and the vein passes into a local conjugate system of northward- and northwestward-trending fissures east of its main course (figs. 29 and 30). Small discontinuous ore shoots have been mined along these conjugate fissures, especially at and near their intersections, but they become smaller with decreasing depth and have evidently not been worthy of exploration above level 21. Their failure to persist detracts from the suggestion,

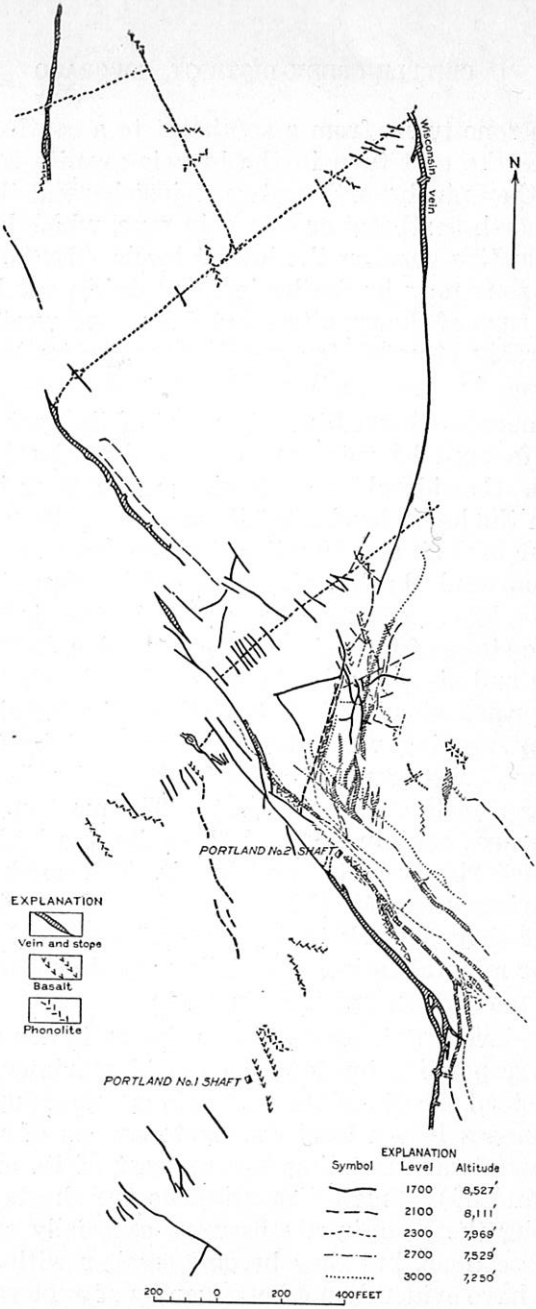

Figure 29.—Relations of veins and stopes on levels 17, 21, 23, 27, and 30 of the Portland mine.

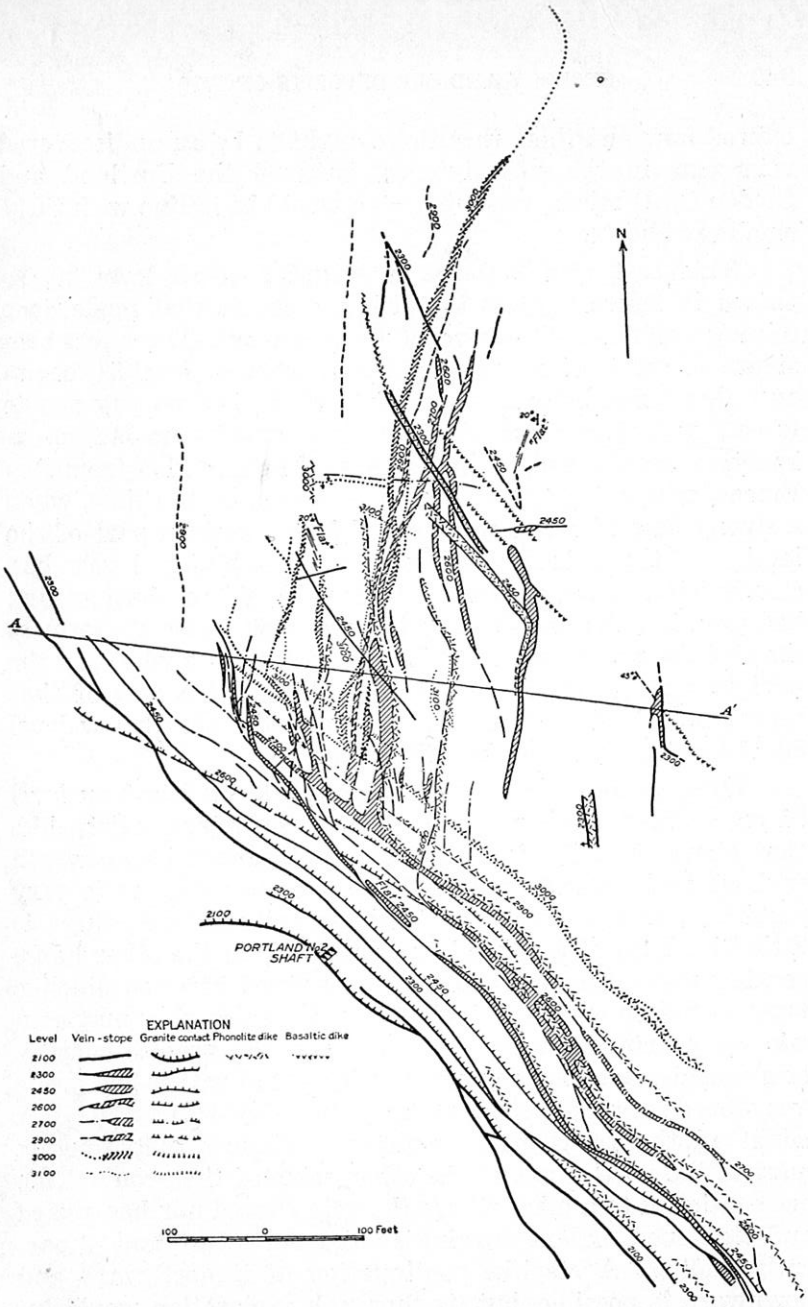

Figure 30.—Lowest levels of the Portland mine, showing the breccia-granite contact, the main or No. 1 vein, of northwest trend, and the "east" vein group of north-northeast trend. A-A', line of section in figure 31.

offered now and then, that there ought to be an undiscovered vein zone in the wide interval between the Portland and Golden Cycle mines, as such a zone would be in line with these small ore shoots.

This east vein becomes interrupted below level 30, as shown in figure 31, and the rich ore shoots that made deep mining profitable above level 30 have died out. There was considerable exploration of the east vein group on level 31, begun and abandoned between Loughlin's visits, but no pay shoots were found. Development of the level was by no means exhaustive and stopped, according to oral information from Ray Emens, who was engineer for the company at the time, when a strong flow of water was opened in the eastern part of the level. As the principal watercourses on higher levels had closely followed the ore shoots, he felt that this eastern ground had promise. An ore shoot to the east would also conform to the steplike arrangement of the fissure zone as a whole, as the part between levels 30 and 24 is a little to the east of that represented by the Wisconsin vein, and the part below level 30, if consistent, should be still farther east.

Whether another good ore shoot could be found on level 31 or whether another essentially barren interval exists, like that above level 23, is a question that cannot be answered without more specific data. If the syenite mass, as is very possible, extends downward to the granite contact, there is little likelihood of another large shoot; if, on the other hand, considerable masses of breccia are enclosed between dikelike masses or even within a single mass of syenite, they may contain ore-bearing fissures, either close to the granite contact, or a considerable distance north of it. Ore of rather low grade was stoped from the principal east vein on level 30 for 360 feet north of the transverse compression fissure that roughly marked the north limit of the other veins of the group. This ore continued to a place where the vein curved northeastward and tightened, before curving to the northwest and apparently ending. A steplike continuation of it northward and downward is possible, but its thorough exploration would involve the deepening of the shaft and the driving of drifts

1,000 feet long at and below the drainage level of the proposed deep tunnel, whereas the maximum amount of ore to be found would in all probability be somewhat less than that mined within an equivalent vertical range above level 30.

The local source of the ore-forming solutions was evidently below the large syenite mass. The north-northeast and main or contact fissure zones afforded the principal channels along which they rose and mineralized not only the Portland

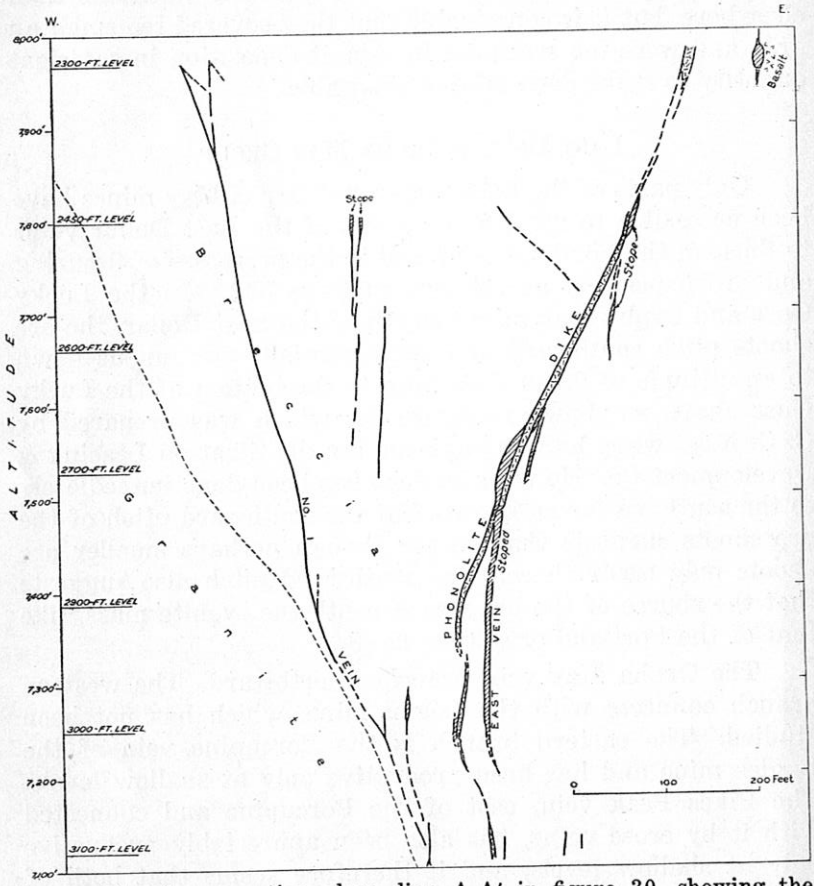

Figure 31.—Cross section along line A-A′ in figure 30, showing the steepening dip and discontinuinty of the east vein with increasing depth.

ground, but that of the Last Dollar, Modoc, and other small mines, along the upper part of the north-northeast zone, and the Independence and, in part at least, the Strong and adjacent mines, along southward continuations of the contact zone. These solutions, as stated on page 305, could travel indefinitely long distances without deposition until they found favorable structural conditions. Below level 30 such conditions are more likely to have occurred along the main and north-northeast fissure zones at or near their junctions than elsewhere, but it is conceivable that they covered too small an area and were too scattered to permit deposition in sufficient quantity to make deep mining profitable.

Last Dollar-Orpha May Group

Only parts of the Last Dollar and Orpha May mines have been accessible to us. The relations of the Last Dollar veins to those of the Portland mine and to the processes of fissuring and ore deposition are shown on page 332. In the Lucky Guss and Orpha May mines, north of the Last Dollar, the ore shoots pitch southward and are essentially continuous down to an altitude of 9,620 feet, close to the bottom of the Lucky Guss shaft, as shown in figure 32, which was prepared by C. O. Moss when he was engineer for the Stratton Leasing & Development Co. No work so deep has been done immediately to the south, so far as known, but the southward pitch of the ore shoots suggests that deeper though perhaps smaller ore shoots may occur there. The southward pitch also suggests that the source of the ore was beneath the syenite mass, like that of the Portland ore. (See fig. 8.)

The Orpha May vein branches northward. The western branch connects with the Logan mine, which has not been studied. The eastern branch is the Porcupine vein of the Eagles mine and has been productive only at shallow levels. The Pikes Peak vein, east of the Porcupine and connected with it by cross veins, has also been appreciably productive only at shallow levels, and it therefore seems that both of these veins have derived their ore through the Orpha May zone.

GRANITE (AJAX) MINE

The present Granite mine includes the formerly independent Granite, Gold Coin, Dillon, Monument, Dead Pine, and Ajax mines which were consolidated by the Granite Gold Mining Co. a few years ago and were purchased by the Colorado International Mining Co. in 1933. The property is in and just north of the town of Victor and is bounded on the east by the Portland and Strong mines. It is now operated mainly through the Ajax and Gold Coin shafts. The Ajax shaft is within the breccia close to the granite contact at an altitude

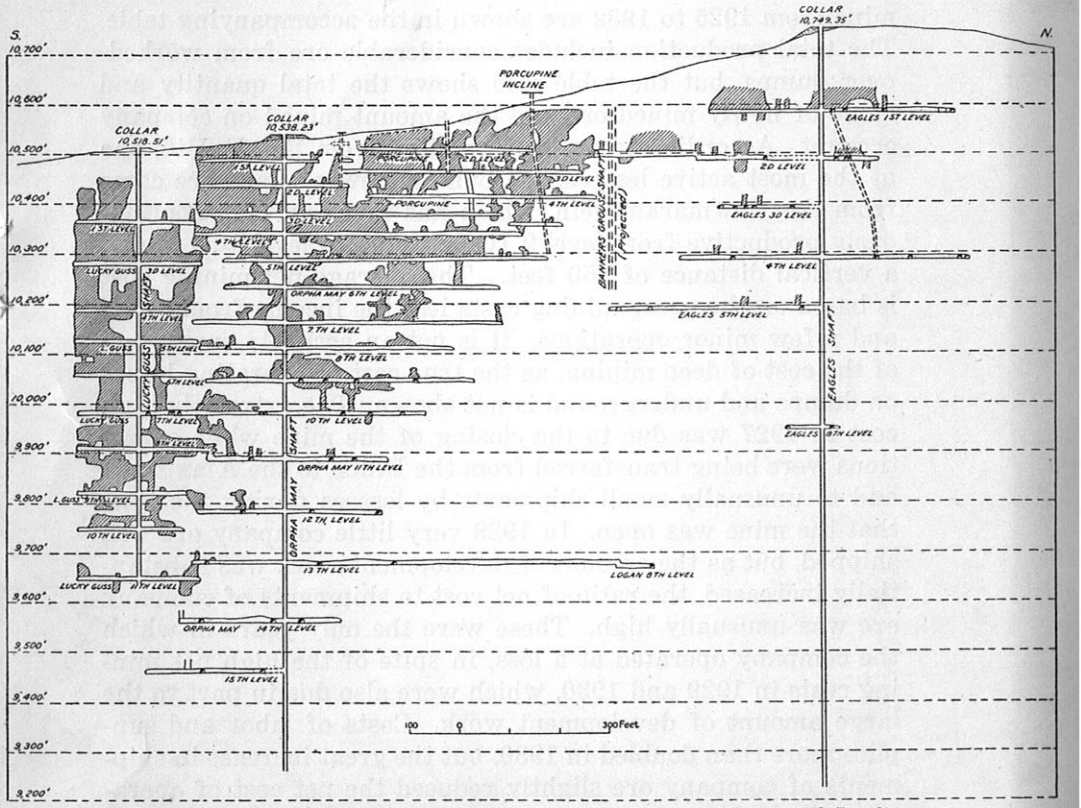

Figure 32.—Profile of stopes in the Porcupine, Orpha May, and Lucky Guss mines, looking west. (By C. O. Moss, formerly engineer for the Stratton Leasing & Development Co.)

of 10,108 feet. It has 20 levels, the lowest of which, at an altitude of 8,156 feet, is almost down to drainage level. When the Cresson mine was being pumped, the water in the Granite mine was lowered, and ore in two of the veins was followed down and mined through winzes; but this deep ore became flooded in 1929 when pumping at the Cresson stopped. The present owners have completed a cross-cut connecting with the present drainage tunnel through the Portland mine and are unwatering the mine for a distance of 250 feet or more below level 20.

Data on production and costs of operation in the Granite mine from 1925 to 1932 are shown in the accompanying table. The total production includes considerable ore from worked-over dumps, but the table also shows the total quantity and value of newly mined ore and the amount mined on company account. According to oral information from Ben F. Hill, one of the most active lessees, the bulk of newly mined ore came from the Newmarket vein, which has thus far been continuously productive from level 9 (Gold Coin) to level 20 (Ajax), a vertical distance of 750 feet. The average net mining cost is based on the gross mining costs less the income from leases and a few minor operations. It is not an accurate expression of the cost of deep mining, as the true cost of operating leases on dumps and underground is not shown. The extremely high cost in 1927 was due to the closing of the mine while operations were being transferred from the Dillon to the Ajax shaft and to unusually small shipments by lessees during the time that the mine was open. In 1928 very little company ore was shipped, but as the amount of development work was substantially increased, the ratio of net cost to shipments of company ore was unusually high. These were the only years in which the company operated at a loss, in spite of the high net mining costs in 1929 and 1930, which were also due in part to the large amount of development work. Costs of labor and supplies more than doubled in 1930, but the great increase in shipments of company ore slightly reduced the net cost of operation. The net cost in 1931 is probably the nearest approximation to the true cost of deep mining, as about 90 percent of the

ORE PRODUCED IN THE GRANITE MINE, 1925-32

[Compiled from annual reports of the Granite Gold Mining Co.]

Year	TOTAL ORE (Mine and Dump)		MINE ORE (Company and Lessees)			MINE ORE (Company Only)			Average Net Value[a]	Avg. Net Mining Cost[b]
	Quantity (dry tons)	Gross Value	Quantity (dry tons)	Gross Value Total	Gross Value Average per Ton	Quantity (dry tons)	Gross Value Total	Gross Value Average per Ton		
1925	14,961	$383,843.02	14,961	$383,843.02	$25.66	7,488	$239,765.33	$32.02	$24.72	$ 6.58
1926	28,918	366,131.21	15,133	309,091.58	19.58	5,155	153,007.16	29.68	22.86	8.70
1927[c]	5,361	53,870.26	1,900	38,766.63	20.40	1,201	22,440.42	18.68	12.98	21.12
1928	6,181	110,014.98	4,585	102,588.55	22.37	681	9,048.95	13.28	8.30	17.84
1929	9,249	159,612.42	7,556	150,824.72	19.96	2,973	64,937.11	21.84	15.81	12.62
1930	14,618	292,853.72	14,006	285,281.43	20.37	10,462	224,809.50	21.49	15.01	12.31
1931	19,980	399,792.39	15,820	364,159.50	23.02	14,221	335,931.13	23.62	16.69	6.79
1932	19,374	267,701.18	9,032	202,423.30	22.41	4,139	93,109.10	22.49	15.82	4.46

[a]Net value after freight and treatment charges are deducted from gross value calculated at $20.00 an ounce.
[b]Based on gross mine expenses less income from lessees and from minor sources.
[c]Small production and high net cost in 1927 due to temporary closing of mine while moving operations from Dillon to Ajax shaft.

new ore mined was on company account. In 1932 lessees produced more than half of the newly mined ore and operating expenses were reduced about one-third, although the amount of development nearly equaled that done in 1931.

Our study has been confined to the lower half of the mine, but the thorough description of the upper half by Lindgren and Ransome[55] makes a consistent interpretation of the geology possible. The workings cross the breccia-granite contact, which trends west and dips north in the upper part (fig. 7) but changes to a northwesterly trend and steeply overhanging dip in the lower part. In the eastern part the breccia fills a wedgelike embayment with overhanging walls and southerly pitch. The fissure zones belong to three main sets, of west-northwest, north-south, and north-northwest trends, and fall within the master shear zone that was developed by compression from the south and was locally controlled by the breccia-filled embayment and the prevolcanic fissures beneath it. (See pp. 278-280.) Their relations on the lower levels are shown in figure 33.

The west-northwest set dips southwest and includes the Bobtail and closely parallel fissures, which extend into the property from the Portland mine (pp. 333-334). This set, as shown on the upper levels, curves to a more northwesterly course near the Granite shaft and continues to a point northeast of the Triumph shaft and about 1,400 feet north of the Ajax shaft. The Apex fissure, which parallels them on the southwest, is the most persistent in the northern part of the mine and, as shown in plate 3 of Professional Paper 54, has been followed almost continuously for a distance of 1,600 feet, from the vicinity of the old Dead Pine incline northwestward to the Battle Mountain tunnel. It is in line with fissures in the southern part of the old Granite workings. Shorter fissures of parallel trend are exposed on the upper levels southwest of the Ajax shaft. Some short fissures of northeasterly trend intersect or branch from the fissures of northwesterly trend and have influenced the local distribution of phonolite dikes and ore shoots. Another fissure zone that appears closely re-

[55]Lindgren, Waldemar, and Ransome, F. L., op. cit., pp. 478-484.

lated to the west-northwest set trends nearly east and dips 65°-70° N.; it contains the Hamlin phonolite dike, which marks the approximate north limit of ore shoots on the lowest levels.

The north-south set, whose members strike from a few degrees east to a few degrees west of north, is best represented by the Coin vein, which dips east. On the upper levels the Granite and Monument fissures and on the lower levels the Dorothy and Newmarket veins, which dip steeply west, also belong to this set. The northern part of the Montana vein may coincide with a steplike continuation of the Coin vein on the lowest levels, but its southern part follows a phonolite dike along a fissure of northwest trend.

The only important representative of the north-northwestward-trending set is the Mohican or B vein, which dips steeply west-southwest and crosses obliquely from the Dorothy to the Newmarket vein. It has been developed between level 11 (Gold Coin) and level 20 (Ajax), or altitudes 8,670 and 8,156 feet.

A barren premineral fault, called the "Cashen fault" by Lindgren and Ransome,[56] is exposed on some of the upper levels east of the Gold Coin shaft. It strikes N. 20° E., dips 51° NW., and marks the southern limit of productive ground in that part of the mine.

The distribution and arrangement of the different fissure systems accords with the interpretation of deformation presented on pages 278-279 and 333-334. The earlier shearing movement, during which the ground between the present Independence and El Paso mines tended to press into the crater, developed the major shear zones and produced the Bobtail group of compression fissures, which extend across the root of the eastern granite prong (figs. 7 and 8) and into the upper part of the breccia on each side. West of the prong, where the breccia-granite contact turns northwestward and steeply overhangs, the direction of compression was locally deflected more to the northeast, and the strike of the Bobtail group of fissures accordingly turned to parallel approximately the trend of the contact. The Apex and other fissures of this set were evidently

[56]Lindgren, Waldemar, and Ransome, F. L., op. cit., p. 489.

formed at the same time, and the Apex, rather than the Bobtail, may represent the principal fissure of the set in the northwestern part of the mine. The northward-trending fissures, in part at least, and those of northeast trend were developed at the same time and served as local zones of shearing. The Coin fissure, which extends from a point south of the Gold Coin shaft to the Bobtail zone in the Dead Pine claim, was the principal one of these shear zones at shallow depths. Its position was determined by the bend in the contact and bears the same structural relation as the Independence fissure does to the contact in the Portland mine. The block east of the Coin fissure tended to crowd upward along its junction with the Bobtail zone and to develop a steplike group of fissures in its northern part, represented by the Granite and Monument fissures. No noteworthy fissures north of the Bobtail zone appear to have formed either at this or at later stages of movement. The block west of the Coin fissure was broken near the Gold Coin shaft by shearing along the Dorothy zone and by minor parallel fissures, and near the Ajax shaft by fissures of northeast trend, roughly normal to the Apex fissure. The Newmarket and Mohican fissures may have originated at this time, but there is no proof that they were formed until later.

Brief recoil from compression, together with the upward thrust of phonolite magma, opened some of these compression and shear fissures and produced others, notably the Hamlin fissure, of easterly trend and a dip of 50°-70° N. The more continuous of these reopened and newly formed fissures were filled by phonolite dikes.

Renewal of compression, during which the east walls of northward-trending fissure zones tended to move north or north-northeast, opened or reopened fissures of north-northwest to northwest trend and was followed by the intrusion of basaltic dikes, some of which are deflected for short distances along phonolite dikes before resuming their normal courses. Continuation of the movement reopened the same fissures or produced new fissures at small angles to those filled by dikes. The Newmarket fissure, even if partly developed before, became a continuous fissure at this time. Tensional stress in the

block between the Dorothy and Newmarket fissures produced or opened the Mohican fissure, and similar stresses west of the Newmarket produced the X-10-U-8 fissure, which marks the apparent west limit of the master shear zone. Fissures of northwesterly trend intersecting with or branching from local shear zones were opened for short to considerable distances from those zones.

This movement, especially at shallower levels, produced openings available for ore shoots at junctions between fissures of the northward-trending and west-northwestward-trending or Bobtail groups in the northeastern part of the mine and between the northeastward-trending and northwestward-trending or Apex groups in the northwestern part. The continuous Coin fissure, which for the most part trends slightly west of north and dips steeply east, was especially well situated and formed an ore shoot that has been productive for a maximum horizontal distance of 850 feet and an equal vertical distance. Its productive part ends at its intersection with the Cashen fault (strike N. 20° W., dip 51° NW.),[57] along which the premineral shearing in a north-northeasterly direction appears to have been locally concentrated. The Coin vein contained only small, isolated ore shoots below level 9, where it evidently had a steplike shift to the east, and its downward continuation coincided with the northern part of the Montana vein.

Only the lowest three levels (Dillon 14, 16, and 17) were accessible to Koschmann along the Montana vein in 1931, and even these levels were partly caved; but the stope lengths evidently range from 300 to 400 feet, and a drift 150 feet long in ore has been driven from the Montana winze below level 17 (Ajax 20). From April 1928 to April 1929, inclusive, 773 tons of ore, 49 percent of the total muck hoisted through this winze, had an average gold content of 1.713 ounces to the ton, and ore assaying 1.25 ounces to the ton was said to lie in the bottom of the stope when it became flooded.

Just north of this stope the Montana vein on level 17 (Dillon) intersects the Bobtail group of dikes and fissures,

[57]Lindgren, Waldemar, and Ransome, F. L., op. cit., p. 489.

which dip southwest. The intersection, which pitches about 34° SE., may mark the north limit of productive ground here, as well as on higher levels, and suggests that the length of the ore shoot decreases downward. Some honeycombed or "bug-hole" granite is present where the Montana vein joins the Bobtail zone, about 600 feet northwest of the Dillon shaft on level 17, and indicates intense corrosion and alteration of the granite during the first stage of mineralization by solutions rising from beneath the south end of the breccia embayment. It also suggests that the junction of the veins marks one of the channels along which ore-forming solutions rose later, but as the "bug-hole" granite averages only 0.2 ounce of gold to the ton, it must be concluded either that the solutions passed through it too readily and did not deposit appreciable quantities of ore until reaching higher levels or that the "bug-hole" granite was sealed off between the first and second stages of mineralization and the ore-forming solutions rose south of the junction.

The principal ore shoot mined at shallow levels in the northwestern part of the mine extended along the Apex dike from a point 450 feet north of the Ajax shaft to the Triumph shaft, a maximum distance of 500 feet. It was widest at junctions with transverse fissures of northeast trend. The dike is not accompanied by ore below the breccia-granite contact. At the northwest end of level 18, however, 850 feet from the Ajax shaft, it is close to a partly exposed body of collapse breccia that consists of granite rubble cemented by dense fluorspar and quartz of the first stage and coarse-grained pyrite and zinc blende of the early part of the second stage of mineralization. This body is almost directly down the dip from the principal ore shoot along the Apex dike, but no direct connection with it has been proved, and here, as at the Montana vein, it cannot be told whether ore-forming solutions rose through this collapse breccia to higher levels or were diverted from it below level 18. The prevailing tightness of the Apex dike on level 18 southeast of the collapse breccia suggests that prospecting farther northwest on and above level 18 would be of interest, as the collapse breccia was doubtless formed at