Colorado: [specimens] 42328-42394, 42561-42575. No. 349 1901

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U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

9-891

LAKE SUPERIOR DIVISION.

INSTRUCTIONS.

1. Ordinarily at least two pages of this book will be devoted to one section. On the left-hand page, place a map of as much of the section as has *actually been seen*. Denote rivers, lakes, marshes, etc., by the usual topographical signs. Denote the ledges of rock, when no structure is made out, by cross-hatching, making the cross-hatching cover as nearly as possible the areas occupied by the exposures. If the rock is a massive one, but still more or less plainly bedded, use the same sign with a dip arrow and number attached, showing the direction and amount of the dip. Denote a shaly or other very plainly bedded ledge by right parallel lines, and a ledge having a secondary structure by wavy parallel lines running in the direction of the strike, with dip arrow and number attached as before. The greatest care must be taken to avoid confusing slaty or schistose structure with bedding, and in all cases where there is the least doubt about the true bedding direction, indicate it by a query. To each exposure on the face of the map attach the number of the specimen representing it. In mapping the section count each of the spaces between the blue lines as 100 paces, and twenty of these spaces to one mile, or 2,000 paces. Usually the southeast corner will be placed at the bottom of the page, or at the first black line above the bottom of the page, and at the right-hand side. If, however, for any reason, it is desirable to show portions of an adjoining section, the southeast corner may be shifted up, or the map may be turned around and the north placed at the left-hand side of the page. The ruling of the left-hand pages is also arranged so that, if desirable, a larger or a smaller scale can be used, eight inches, two inches, one inch, or one-half inch to the mile. With the two-inch scale, the squares outlined in black represent sections, and those in red, quarter sections and "forties," while the space between the blue lines is 200 paces.

2. On the right-hand page place the notes descriptive of the exposures. Begin in each case with the number of the specimen, placing the number on the left-hand side of the red line, after which give in order on the right of the same red line the position of the ledges as reckoned in paces from the southeast corner of the section and the dip and strike when observable, the latter always being expressed from the north; for instance 4025, 250 *N.*, 300 *W.*, *Strike*, *N.* 78° *E.*, *Dip* 50° *S.* Then follow with a full description of the ledge. When topographical maps are used for locations this paragraph applies only in part.

3. Collect a specimen from every ledge, or wherever there is a change of rock on any one ledge, taking care to get fresh material, unless for a special purpose the weathered surface is desired. In case of trips made on foot or in canoes, for long distances, neighboring ledges, unquestionably of one kind of rock, need not be specimened. The position and extent of the ledges not specimened should be marked on the map, with notes that each is of a rock identical with specimen so-and-so. Under the same conditions small-sized specimens, trimmed to a uniform size of 2 x 2½ x ¾ inches will be allowed, but in all other cases *large-sized specimens*, trimmed to a size of 3 x 4 x 1 inches, must be selected, in accordance with section 3, chapter IV, p. 44, Regulations of the U. S. Geological Survey. Specimens should not be placed together without protection in the collecting bag, as the fresh surfaces, important in determining the character of rocks, are thus destroyed. They should be damaged by no temporary mark, but the numbers should be at once marked in at least two places upon the inclosing paper or cloth bags. Specimens may be permanently marked in camp by painting the numbers upon them in white upon a black background, using Silver White and Ivory Black oil tubes for color, with turpentine as a diluent.

4. On the last twenty-five pages of the book give, as may seem desirable, a general account of the examination of the region mapped in the previous pages, correlation of observations, sketches, cross sections, etc.

5. Forward this note book as soon as filled as registered mail matter to C. R. Van Hise, U. S. Geologist, Madison, Wis.

C. A. Van Tuyl,

Colorado, 1901

Aug. 7, 1901.

South Boulder Creek, Col.

Visited South Boulder canyon. Just before reaching the mouth of the canyon we saw the Laramie beds dipping rather steeply away from the mountains; then came a break with no exposures along a ravine; and behind this appeared the massive, beautiful red beds of the Triassic, which in great thick layers dipped steeply away from the mountains. (50-55° N.E.) The strike at one place was taken, and is N. 35 W. (magnetic).

These red beds occupy a breadth of nearly a half mile, and immediately behind these comes a white, vitreous quartzite, which at the one place determined had a strike of N. 5° E. (mag.) Dip 55 S. However the strike and dip seemed to be rather persistent, and ever everywhere to the south.

The main purpose of the day's trip was to attempt to determine the relations of this quartzite to the granitoid series farther up the creek. No time was spent upon the relations of the quartzite series and Triassic, since it has long been known that these are unconformable, and that the quartzite was in its present metamorphosed condition before the Triassic was laid down as shown by the innumerable pebbles of the quartzite in the red sandstone.

Lakes, sent to visit the localities to get additional light if he could upon the quartzite and granite, reached conclusions substantially the same as those of Marvin; viz., that there is a gradation between the two. The strike of the quartzite series is approximately parallel with the general trend of South Boulder creek. The quartzites apparently end on a side revine about a mile up the creek from where they first appeared, and here a continuous outcrop was found between the typical quartzite and the ordinary massive granite. The facts in passing downward are as follows: the vitreous quartzite first becomes a fine grained quartzite conglomerate, and this a
42331 coarser quartz conglomerate (42331) containing many quartz pebbles, but apparently no granite pebbles. This quartzitic variety of rock grades somewhat rapidly into a micaceous schistose rock which contains granite pebbles, and seemed to me to be perfectly clearly a metamorphosed clastic rock in which there are very numerous more or less mashed and metamorphos-
42328 ed granite pebbles (42328, 42333). Speci-
42333 men of the schistose matrix (42334) in
42334 which the pebbles are contained was collected. While the pebbles are somewhat metamorphosed, they seem to be very similar to the massive phases of granite lower down. The conglomerate schist containing granite pebbles was traced down to a definite plane, and there every pebble abruptly ended, not another one being found beyond a position knife-like in sharpness.

Immediately below this, without a break of a fraction of an inch, is
42329 found a schistose rock (42329) which which is very similar indeed to the schist constituting the matrix of the conglomerate, but which grades along the strike and across the strike, step by step, without any sudden break whatever into an ordinary unmistakeable
42332 granite (42332).

For my part I have little doubt that the schistose varieties of rock below the conglomerate are extremely mashed and sheared phases of the granite. The unusual metamorphism is due to the very great differential movement on the contact plane of two different series. The granitic series is cut through and through by many pegmatite dikes and veins. None of these were observed anywhere in the quartzite formation, although they were looked for closely. All these pegmatite dikes extend directly to the quartzite; indeed one pegmatite dike was found at the place above fully described in which the pegmatite cuts through the schistose granite almost directly to the quartzite; but unfortunately at this particular spot the quartzite is not exposed at the contact, and I could not assert that it there abruptly stops, although I have no doubt that this is the case.

I can readily understand that a person without a good understanding of

the principles of metamorphism and dynamic geology might conclude, as have Marvin and Lakes, that the quartzite grades into the granite; but this explanation has insuperable difficulties. In the first place this sort of a gradation has never been proved anywhere in the world. A quartzite is not of the correct composition to make a granite. The granite might be explained to be intrusive in the quartzite, but this would be a pure assumption for which there is no evidence. The third explanation seems to me to be the only tenable one; viz., that the quartzite and schist conglomerate represent a new series derived from and resting upon the pre-existing eroded granite and gneiss floor. This theory explains every one of the facts. Where the basement rock is granite the detritus is laggely of the same material, and thus whether the rock was originally granite or clastic material resting upon it, it would have somewhat the same composition and be metamorphosed to a similar schist. Second, the numerous granite pebbles in the conglomerate is explained, and the rock from which they are derived accounted for. The even, homogeneity of the schistose granite is just the sort of rock into which homogeneous igneous rocks pass by the process of mashing.

Thus from this locality I believe the granite of the series is Ar-

chean, and that the quartzite belongs with the Algonkian.

On the north side of the creek another locality is observed in which the quartzite and granitic series are almost in contact. Here the phenomena are very similar to, although somewhat different from those fully described above. The quartzite grades down into a quartz conglomerate even more emphatically than on the other side of the creek. This grades down into a schist which is conglomeratic, containing granite pebbles, but the pebbles are not quite so clear as on the other side of the creek.

42330 Schistose quartzite near the contact with the granite, north side of South Boulder creek.

The schistose conglomerate here is broader than on the south side of the creek, being perhaps 100 ft. or more across. Unfortunately, just at the bottom of the schistose quartzose conglomerate there is no exposure, and immediately across the ravine, after an interval of a dozen feet, schistose granite appears grading into massive granite.

From the fact that the contact was found on both sides of the narrow belt of quartzite, it appears probable that this series is a closely appressed isoclinal syncline.. However, on the overturned, i.e. on the north side, of the fold the shear is more severe then on the other side, thus making a broad

S. T. R.

Olea p. 6.

belt of conglomerate schist, and also there is a sudden change from this schist to quartzite, and here apparently minor folding has occurred, at least the quartzite has resisted being mashed into a schist. (Photo 1)

Photo 2 shows the quartzite looking up the mountain from the Triassic area.

S. T. R.

(2) See page 6.

Aug. 8, 1901.

Golden, Col.

With Patton visited the Coal Creek canyon section.

On our way from Golden to the section Patton called attention to the fact that the sedimentary strata of the Carboniferous and Tertiary are on end or even overturned a short distance from the pre-Cambrian core; whereas the beds on the pre-Cambrian core are never vertical, but dip away from the mountains at angles of 45-60°. The more rigid pre-Cambrian core has yielded less, and the strata along it took its inclination, whereas away from the mountains a short distance in the soft sedimentary strata the rocks have reached the maximum of deformation. The rocks of Table Mt. just above Golden are practically flat-lying; yet the sedimentary rocks a very short distance to the west, probably not more than a half mile, and at the most not more than a mile, are on end.

After passing the sedimentaries on the south side of Coal Creek we came upon exposures of granite-gneiss and schist of various kinds, in short, Basement Complex material. This was seen also on the north side of the creek in a cut near the wagon road. However the first rocks well exposed on the north side of the creek after the last exposure of Trias belong to the quartzite series.

This series cuts diagonally across the creek to the south side, and there is close to the Basement Complex. Probably this Basement Complex is exposed below the quartzite on the south side of the creek for at least a mile. The Basement Complex here nearest the quartzite consists of schis-
42341 tose granite or gneiss (42341) which is cut through and through by pegmatitic granite, and is pegmatized parallel to the foliation. The quartzite, while only a short distance away from this material, was nowhere found in contact with it. The quartzite is here cut by several large pegmatite granite dikes, massive and showing no signs of mashing,- apparently intruded after the most of the folding and metamorphism.

Up the creek the massive quartzites with conglomeratic phases grade into a schist which at the valley of the creek extends upward for about a half mile where the road abruptly bends to the west, and here massive quartzite again appears. At a high point at this place Smith found quartzite and granite closely associated, between which is a crinkled schist which apparently belonged with the quartzite series, and may be an unconformable contact with the granite as was determined later up the creek.

The massive quartzite continues up Coal Creek until the creek makes a sharp bend to the north, and for some distance beyond this. Following up the
42338 creek along its north bend, the granite (42338)

and quartzite were observed to be close together high up on the spur at the right of the road. Following up along the place where the quartzite and granite are close together the massive quartzite was found to be strongly conglomeratic, interstratified with quartzite. The strike and dip here are strike N. 60° W., dip 40° N. E. (mag.) Below the quartzite conglomerate is a break of about 4 ft., and then is
42337 found micaceous quartzose schist(42337) which has a reddish color, but which struck me as having a sedimentary aspect. This grades down into a rock which is more granitic-looking, but is
42336 still a schistose quartzite (42336); and directly in contact with this is a little block, about 1 ft. in diameter,
42335 of schistose granite (42335). One might doubt whether this schistose granite is here in place, but at a locality a little lower down exactly the same relations obtain between the schistose
42340 quartzite (42340) and the schistose
42339 granite (42339), making it certain this is the contact between the two formations. High up at the crest of the spur the same schistose quartzite was seen, and the same schistose granite after an interval of a few feet.

On the talus slope were found innumerable fragments of the schistose quartzite. All of these facts show that this is not a small thing, but is a continuous persisten horizon next to the granite for some distance. For my own part I have no doubt that the schis-

tose granite represents the metamorphosed detritus which was laid down upon the granite floor. This rock still has some feldspar; much of it has doubtless passed into quartz and mica. however the rock as a whole contains very much more quartz than the granite immediately below, showing some assorting but still having enough feldspar to give a reddish color so as to make the rock on its weathered surface resemble granite. Indeed it was supposed so to be by Patton on passing by.

On this theory all the phenomena, including the persistent belt of quartzite conglomerate, above are completely explained. They are entirely inexplicable upon the theory of granitic intrusion, and certainly had no relation whatever to the theory of downward metamorphism of quartzite.into granite.

While the phenomena are somewhat different from those observed at South Boulder creek yesterday, the facts at both places equally agree with the theory of unconformable deposition of the quartzite upon a Basement Complex, and thus confirm each other.

While the granite was found below the quartzite in the spur at the right of the creek, quartzite again is found further to the west. This relation may be explained by isoclinal folding, but perhaps is more plausibly explained by a fault running parallel with the creek at this place, along which fault the western block is dropped down and

thus carries the quartzite further to the west. Corresponding with this suggesting is the appearance of a gray rock appearing to be quartzite high up on the mountain on the south side of the creek near the mouth of the canyon, the granite being on either side. This gray rock, if quartzite, might have been faulted in in the same manner. However upon the points of isoclinal folding or faulting to explain the very wide belt of quartzite at Coal creek, at least 2 or 3 miles, no adequate facts were collected. The truth may be either way, but my general impression was in favor of faulting rather than isoclinal folding, since it is well known that the sedimentaries to the east are faulted, and since it would so perfectly explain the distribution.

Aug. 9, 1901.

Idaho Springs, Col.

With Bain we visited the Newhouse tunnel at Idaho Springs. This tunnel strats just above the valley of Clear creek, and has been driven directly across the strike of the 3 zones of fracture along which are the ore deposits.toward Russell Gulch for a distance of about 12,000 ft. This tunnel goes through the granite-gneiss-schist complex the greater part of the distance

Thus far it has intersected several of the veins which have been mined at the surface. The most important of these are the Gem and Sun and Moon.

Where the Gem vein is struck a
42342 thick dike of porphyry is found (42342)
25 or 30 or even more feet in thickness
42343 which is more or less mineralized(42343
and thus are regarded by the company as part of the vein. Upon either side of this porphyry is however a well developed vein, several feet in width, very rich in pyrite carrying gold and s silver, indeed so rich that it can easi ly be mined as a milling ore. With the pyrite are purely subordinate quantities of other sulphides. The values in this pyrite are good, so that the tu nel seems to have struck this lode at a good ore chute. The depth to which the tunnel strikes the Gem was said to be about 1200 ft. vertical, or about 2000 ft. along the dip. The rock of th porphyr is much modified and decomposed

as result of metasomatic action, showing changes such as Lindgren described as characteristic of deep-seated metasomatic action in fissure veins. No evidence was discovered of oxidation, surface action, or secondary enrichment. This lode was the only one visited. However the material of the Sun and Moon was exmained on the dump. It contains pyrite and blende, and was said by the man in charge not to carry gold or silver values. As to th values which occur in the other veins cut no information was obtained.

Aug. 10, 1901.

Idaho Springs, Col.

With Bain we visited the workings carried on from the surface of the Silver Age mine, which is supposed to be a continuation of the main zone of fracture represented by the Gem properties, although between the two are otherproperties.

Here Bain showed us a main vein which is continuous to the chief ore carrier, and parallel with this, and frequently intersecting this or joining with it, are several subordinate veins which carry some values. The cheif ore chutes so far as he has become familiar with the mine are however in the main vein at places nearby, but not directly at intersections of the subordinate fissures with the main fissure.

The main fissure away from the intersecting subordinate ones carries the values in pyrite. Near the intersections where it is much altered it is apt to carry the values in galena, blende, chalcopyrite, and tetrahedrite, but more dominantly in galena. These facts seem to indicate that the ore-bearing solutions in the main fissure w were mainly gold solutions with pyrite as the chief gangue; but that the intersecting fissures brought in lead and zinc and copper, and that here the

values go into these minerals. Indeed, in this connection Bain has worked out a definite order in which the values go. Where pyrite is alone the values are in this mineral. Where pyrite and galena are together, the values are in the galena. Where pyrite galena, and blende are together, they are in the blende. Where pyrite, galena, blende, chalcopyrite, and tetrahedrite, and especially the latter, the values are in the copper minerals. This relation is very interesting as according precisely with the respective affinities of the precious metals to these base metals as shown by metallurgical work.

The upper workings of this and other mines carry some native silver, also ruby silver , showing clearly enrichment. Frequently ore chutes had high values, in some cases several hundred, and locally even more than that, dollars per ton. No such values have anywhere been found in the deeper workings fromthe surface where the Company is now operating, nor have any such values been found where the veins are intersected by the Newhouse tunnel.

It thus appears that secondary enrichment has played a very important part in this district, although apparently the first concentration has been sufficient to produce valuable ore at very considerable depth,- 1200 ft. vertically at least.

As to general relations in this region there are three main zones of fracture,- one running just north of Idaho Springs, one running through Russell Gulch, and one through Central City and Blackhawk. The southern of these zones of fracture has one main vei and a large number of subordinate parallel or intersecting veins. There are numbers of veins in each of the other zones; but their relative importance was not ascertained. So far as one can see from the Newhouse tunnel, which has intersected the first or southern group, the number of veins decrease at depth. For instance, the consolidated Gem has a the surface a large number of veins, and at depth has only the two.

The general strike of these zones of fracture is east of north, probably about 60°. (Map of Idaho Springs and Gilpin county gives the locations of the main properties.)

The amount of water which is now found by the Newhouse tunnel in the drift 12,000 ft. long is insignificant. A small amount of water percolates in at different places, but the quantity obtained was so small that it is practically ignored in their drifting and arrangements. The cracks and crevices have been very thoroughly cemented, and since that time new fractures have not been formed so that the water could find access from the surface. In the workings from the surface, as would be expected, the quantity of water is greater, but not large.

Bain says for the entire district, including all three zones, the ores are continually associated with porphyry, being immediately adjacent to or in this rock, which of course is of far later age than the complex through which it cuts. Indeed in the hundreds of dump piles and shafts seen along the Idaho Springs zone and the Russell Gulch belt, the most prominant rock is the peculiar gray material which is the porphyry either fresh or modified. Doubtless the same is true of Central and Blackhawk, although we did not go far enough over to see the dump piles of these localities.

This very intimate relation between the ore deposits and the porphyry shows conclusively that the porphyry intrusions was one of the essentialy factors forming the ores. Doubtless one of the relations connected with their production was the furnishing, first, of openings along the contact for water circulation. The favorable conditions resultant upon, or at least connected with the igneous intrusions, are three, (1) the furnishing of cracks and crevices along and through the porphyry and along the contact between the porphyry and the adjacent rocks for the trunk channels of water circulation; (2) the furnishing of heat to make hot solutions, indeed thermal action has not entirely died out in this region as the springs of Idaho Springs are still warm; (3) the porphyries themselves may be the sole or

the chief source of the ores. This point can only be determined by very careful investigation of the amount of metals which are carried in the Archean and that carried in the unmodified porphyry, provided such a rock anywhere could be found.

Aug. 12, 1901.

Florissant, Col.

With Grant visited the northwest end of Blue Mt. west of Florissant starting at gap where crossed by road. Here to the northwest of the road is found fibro-
42344 litic quartzite (42344, 42345) which is
42345 cut through by coarse pegmatite granite dikes, and is injected by granite parallel to the foliation in a most complex fashion. At many places the alternating bands of fibrolitic quartzite and red granite material are but a fraction of an inch across, giving the rock a beautiful ribbon structure. This is shown not only by the coloring but by the weathering, the quartzite being the more resistant, and its ridges protruding. The bands are in many places corrugated in a very irregular fashion. The injection layers of granite vary in width; frequently however many of the parallel bands are approximately of the same size. In places the rock is mainly like the specimens of fibrolitic quartzite; at other places it contains granite and quartzite in varying proportions; and in certain places takes on much more of a granitic aspect than a quartzitic one. At one place especially the rock has a granite texture at one side, and gradually fades off into the banded structure of the granite and quartzite. The closeness of the interlamination of the two rocks

is only less minute than that of the cases of parallel injection at New Rochelle, New York.

At this spur there was also found besides the pegmatite a finer grained gray granite in subordinate quantity.

We now went northwest along the east slope of the mountain. About a mile northwest of the gap a tunnel is being driven into the mountain. This tunnel is several hundred feet long, and this section was examined, and also the section on the slope to the top of the mountain.

At the base of the tunnel, and exposed for a little way up the slope, is a coarse granite which we regarded as a portion of the Pikes Peak granite mass.

However this continues up the slope, is distinctly dike-like in its form, running across the other rocks On the slope of the mountain there is a broad 42346 belt of fine grained granite (42346) running parallel with it. The specimen is an average one taken from the dump of the tunnel. This granite contains very numerous inclusions of the quartzite 42347 (42347). Also on the top of the hill this same granite was found cutting 42348 through the quartzite. (42348) Therefore there appears no doubt that the gray granite is intrusive in the fibrolitic quartzite. The coarse granite supposed to be the Pikes Peak variety also contains many inclusions, some of which seem to be quartzite and some of 42349 which are the fine grained granite 42349

On the top of the hill the fibrolitic quartzite is in much greater force than at the gap. Here the parallel injection and fibrolitic character
42350 is maintained. The specimens (42350,
42350a 42350a, 42350b, 42350c) show beauti-
42350b fully the fine fibrolite, the minute bands of granite parallel with the quartzite, and lenticular areas of feld spar which have developed within the fibrolitic quartzite.

On the west crest of the hill the fibrolitic quartzite is the dominant
42351 rock (42351). The fibrolitic quartzite at this place is several hundred feet wide at least, and probably more than a thousand feet, although it was not measured.

On the crest of the hill at the place where the fine grained granite
42348 dike (42348) was found ~~xkx~~ prospecting for copper has occurred along the contact of this rock with the fibrolitic quartzite. At a number of pits a considerable amount of copper ore has been thrown out, mainly azurite and malacite, but containing beautiful cores of sulphides, bornite, chalcopyrite, and chalcocite. There is comparatively little doubt that the carbonates show surface alteration products of the sulphides.

As we drove from the mountain to Lake George we saw many exposures of coarse granite which are identical in appearance with the great mass of coarse granite at the tunnel, and doubt

less are continuous with it. While this coarse granite was more largely exposed than the other varieties of granite, these different phases were seen.

Leaving Blue Mt. we drove by Lake George to Rocky ; thence northwest about 2 miles. The belt which Cross has mapped as pure quartzite beds, passing into quartzitic micaceous and fibrolitic schists was found to consist almost wholly of schists, gneisses and granites of very great variety. By far the larger mass consisted of ancient gray and reddish banded gneisses, dark colored pyroxenic and amphibolitic schistscut through and through and injected in a parallel fashion by granite of a later age, and especially by pegmatite. So far as lithology is concerned, this mass seems to me to be identical with the Basement Complex.

Directly north of the road at Rocky P. O. quartzite is exposed interbedded with schist and cut and injected with granite, precisely as on Blue Mt.

Beginning about one mile northwest of Rocky, and extending for perhaps a half mile on the south slope of the ridge just north of the road fibrolitic quartzite is found in the talus, is seen at one or two places in proppect

pits, and outcrops in very small ledges at two or three places. This quartzite is associated with schists,
42352 one of which is represented by 42352, and is cut by granite, precisely as is the Basement Complex. To the north of the belt in which quartzite occurs, and south of it, the rocks have the typical Basement Complex characters, and include no quartzite. At the place where the deepest shaft has been sunk, depth 100 ft. or more, there was a light grained granite first taken out for 2/3 or 3/4 of the way, judging by the amount of material on the dump, and they then passed into quartzite represented by
42353 specimens 42353 and 42354, both of
42354 which are fibrolitic, and the smaller of which appears almost to have a clastic texture.

I have no doubt that some of the schists associated with the quartzite are sedimentary; but it was difficult, if not impossible, with the poor exposures to determine precisely the boundary between such rocks and the rocks which I have regarded as equivalent to the Basement Complex.

At one place in a pit a small amount
42355 of limestone is found (42355); but whether this was a vein or belonged to the sedimentary series could not be determined. Smith says the same rock is exposed for some distance, 100 yds. or more, leading up to this pit. This makes it rather probable that the sedimentary series has limestone facies.

If one were to examine the rocks adjacent to Rocky and considered the

jacent to Rocky and consider the phenome na without reference to any other locality, he would doubtless conclude that all the schists, limestones, quartzites, and the banded gneisses, amphibolites, etc., belonged to the same series. Indeed, in this area there is no evidence to the contrary." It however appears to me that the phenomena of this area are to be interpreted in the light of known relations in other parts of the Front Range. In our work of the previous week we found the quartzite and schist series at Coal and South Boulder creeks to be beyond question unconformably upon a Basement Complex. However the metamorphism is there so extreme that Marvine described the two series as grading into each other, and the same determination was made by Lakes,and Prof. Patton did not discriminate the recomposed quartzite from the granite. At these localities the amount of injection of the sedimentary series by later igneous rocks is insignificant. Moreover the exposures are remarkably fine and continuous, so that the true relations could probably be worked out.

But at Rocky the great mass of Pikes Peak granite surrounds the Rocky sedimentaries; indeed, is regarded by Cross to include them, and certainly it does intrude them in the most irregular way, metamorphoses them profoundly, so that if there was an unconformity between the inconsid-

erable belts of material which are certainly sedimentary and the other rocks which appear to have the characters of the Basement Complex, it would be remarkable if almost all evidence of that unconformity were not obliterated even if the exposures were good and continuous, which they are not.

In the light of these facts, it seems to me that the interpretation of the probable structure should be that given above, with which interpretation there are no facts against, but in favor of which there is nothing decisive in the Rocky area itself.

About 2 miles below Rocky towards Lake George the quartzite is again seen associated with schist and cut by granite. In reference to the cutting Pikes Peak granite, this is finely seen in the quartzite and schists just above the Post Office at Rocky. Here the schists run substantially east-west; whereas the great masses of Pikes Peak granite swing north across the strike, turn east and surround them on the north, and then swing south again, leaving a triangular area of quartzite north of the road surrounded upon three sides and cut direc ly across by the granite. Also the same granite, as already explained, penetrates the quartzite and schist parallel to their structure.

August 13, 1901.

Cripple Creek, Colo.

Visited Mr. Moore, consulting engineer of the Portland mine, who showed us many speciems illustrative of the occurrence of the ores in the Cripple Creek district, and also full sets of plats of the Portland mine. Mr. Moore further gave us information concerning the occurrence of gold and silver at other properties.

The plats of the Portland mine illustrate beautifully the very comple nature of the ore deposits of the Cripple Creek district. This mine is one in which nearly all of the varieties of rock characteristic of the district are associated. The main values of the mine are in the breccia but values are also found in the granite, in the andesite, and in fact in almost every rock in the mine. The order of the rocks as given by Mr. Moore is that of the Pike's Peak and Crepple Creek special folios. The veins of ore certainly show a decided preference in the Portland mine for the phonolite dikes following along one wall or the other, but being partly at the contact of the phonolite and the intersected rocks and partly in the phonolite or the rock cut by the phonolite. Occasionally a vein

for some little way follows the late basalt dikes, but this is an exception. Specimen 42355 A is of
42355 A mineralized basalt, the Conundrum mine of the Anchoria-Leland M. & M. Company, running 5 to 10 ounces of gold per ton. This is one of the very few cases in the Cripple Creek district in which there is any deposit of telluride of gold in a basalt dike. Specimen given by V. G. Hills, Cripple Creek. In many cases the veins are traced for long distances with poor or insignificant values, and then a rich ore shoot may be struck. Wherever there is a vein it seems to be the policy of the mine to follow it whether it shows values or not, with the hope that an ore chute will be struck.

At one place there is a plexus of intersecting phonolite dikes, and while they are sulphides associated w with these the ore values are small. However adjacent to this area, or at least not very far from it are some of the richest values in the deeper parts of the mine. The Portland mine started like the other mines in the district as mainly a free gold mine in the oxidized zone. At depth the values passed into telluride and in the deeper parts of the mine the values are found both in telluride and in sulphide of iron.

Higher up associated with the rich tellurides are sulphides of iron but these are very low grade. This relation of oxidized products tellurides at a lower level below the belt of waathering, and in the few deep mines tellurides with values partly in the sulphides, Mr. Moore stated was general for the district with the possible exception of the Last Dollar mine which will be mentioned later.

The depth at which the sulphides at the Portland begin to have value is about 700 feet, but whether this depth corresponds with the belt of oxidation I forgot to ask.

Mr. Moore showed us some very interesting specimens from the Gold Coin. The Gold Coin is exceptional in that its values are wholly in the granite. It occurs in a shear or fracture zone of the granite. There is no such thing as a definite vein. Indeed in most places it is only possible to tell where the ore ends and the barren granite begins by assays. The rock at the Gold Coin is a coarse porphyritic granite containing large feldspar crystals and much biotite. In many places these constituents are partly leached out and especially does this take place along the veins. In these cases the biotite first disappears, then quartz, and the feldspar is the most persistent material, this being quite fresh in the specimen which he showed us, even when the mica was

all gone and most of the quartz had disappeared. This seems to me to be practically conclusive evidence against fumerole action as the cause of the solution of the granite and the deposition of the ores.

Mr. Moore also stated as very general for the district that where quartz or chert seams come in that ore is likely to be found. This is apparently an important guide to the ore although ~~the dominant~~ an important gangue mineral of the district associated with the tellurides is fluorite.

It is evident by merely looking about the camp at Cripple Creek and Victor that many of the small prospects have been worked out or if not worked out at least the ore deposits which were originally mined have been lost and as yet have not been followed at depth. Of the very many small shafts and outfits only a comparatively few are working. If one should go by appearances certainly 20 would include all the important mines in the vicinity of Cripple Creek. The stopping of work at many small places may be partly due to the fact that these properties have passed into the hands of the larger companies and are being worked through their larger shafts.

S. T. R.

Fluorite-quartz veins in tuff breccia. Portland Mines.

Cripple Creek, Col.

August 14, 1901.
Cripple Creek, Colo.

We went to Victor and stopped first at the Gold Coin. Here the rock of the railroad cuts seemed to be granite. Also granite is the material of the dump, and granite also
42356 is the material of the ore (42356).

We next went to the Portland and there looked over the rock pile and ore. At the Portland dump pegmatitic granite was found which shows the solution of the mica and part of the
42357 quartz, the feldspar remaining.
42357 A 42357 A typical granite ore from Portland mine 800 foot level, carrying 2.06 ounces of gold per ton, showing solution of mica and part of the quart with the feldspar remaining. From one of the cars of ore two or three specimens of different varieties were taken
42358 The first, 42358, apparently being phonolite carrying ore (?); the
42359 second, 42359, phonolite and fluorite together in bands; and the third
42360 42360, being granite with a siliceous layer upon which is oxidized vein mat-
42359 A erial carrying values. 42359 A typical phonolite dike from Portland
42359 B mine running $12 per ton. 42359 B specimen of drusy phonolite ore bearing from dike four feet thick in the granite about 100 feet from the contact of the eruptive rock from the Ajax mine, Battle Mountain. This is

This is a rare structure in the
42360 A Cripple Creek dikes. 42360 A, dike of verite cutting granite (see Trans. A. I. M. E. Vol. 30, p. 761, specimen taken from just below the cut). Specimen 42357 A, 42359 A, 42359 B, 42360 A given by V. G.Hills Cripple Creek.

We next went to the Last Dollar mine in which we were taken by Supt. Charles Walden.

We first wnnt to the 11th level, 1150 feet below the surface. Here is some of the richest if not the riches tellurides which they have found,
42361-2 42361 - 42362. These were found along a vein which was rich for 300 feet below the surface but contained nothing from that depth until the vein became paying at about the 10th level.

About the 10th level this same vein is found, but is not so rich although it does there carry high values not only in the vein material but
42363 in the phonolite 42363. From this level I picked a large piece of the
42364 fresh ore 42364. Also in this level
42368 the phonolite 42368 is very weal exposed.

We next went to the 8th level where is the transition zone between the oxidized and unoxidized products. At the 8th level there is beutifully shown the oxidation of the pyrite and the formation of the brown iron cores.

At this level also is obtained material in which the ore is partly as telluride and is partly as free
42365 gold 42365. Specimens 42366-7 taken
42366-7 from about this level.

Above the 8th level the values were mostly native gold. This mine is near the top of a high hill and is 200 or 300 feet above the Portland and 500 or 600 feet above the Gold Coin. The belt of oxidation actually has extended to a considerable depth. It seems to me it is probable that the telluride belt which they are now working represents the rich belt below the level of ground water comparable with the rich sulphide belt below the level of ground water in other districts, and that as the mine goes deeper the values will partly pass from the tellurides into the sulphides and ultimately that a low grade sulphide deposit bearing very subordinate quantities of telluride will be found.

The Last Dollar mine is very interesting in reference to one or two general points. The mine is very dry from top to bottom. Indeed in the deepest workings the walls are dry and powdered. The only water which comes in is a small amount from the surface. This again corresponds with the fact that the mine is below the crest of a ridge and there would be no heavy drainage of water into it from the surface nor would one expect

the rising water to be strong at such a place. However notwithstanding the present absence of water, in no mine which I have seen is there clearer evidence of ancient water channels. These go everywhere winding in and out in the phonolite and in the andesite. Sometimes these water channels are nearly a foot wide and several feet long. More commonly they are much smaller and of course irregular. It is in the mining of this water channels that the beautiful crystallized specimens of gold telluride are found. In a small way
42367 specimen 42367 shows the appearance of the water channels.

The mine is interesting also in that the country rock is mainly andesite. The values are found partly in the andesite free from any dike, or any other material, and partly associated with the phonolite dike. Where the phonolite occurs as a definite dike the values seem to be more persistent than elsewhere.

The Last Dollar mine is interesting also in another respect as compared with the Gold coin. For instance for the most part veins are confined by perfectly well defined walls. Where the richest ore is found in the 11th level the wall on either side is slickensided and is perfectly definite giving a zone of about 3 feet in width which is worked out and beyond which no work is done. Where the

phonolite dike occurs the walls are not quite so definite but still well marked, frequently showing slickensided surfaces. The ore in such cases occurs partly in the open cracks and vuggs, and clearly marked water channels and partly as an impregnation of the phonolite itself.

At the present time and apparently at previous levels they have been at work upon two veins also called main vein and a cross vein. The cross vein has not upon the whole been very profitable. However it is notable that the very rich values which they have found, at least at the levels where we visited it, were comparatively close to the cross veins, that is they have distances varying from 50 to 150 to 200 feet. At many places were shown walls of andesite impregnated with iron pyrites and even containing bands or veins of iron pyrites which Mr. Walden told me contained no values whatever.

While there is almost no water in the Last Dollar in the Portland and Gold Coin which are low down on the slope of the hill above Victor a large amount of water has to be handled. The amount at the Portland is so great that it has led them to put in a pumping outfit of first class capacity comparable to that of the wettest iron mines of the Lake Superior region, as is shown by the last annual report of the Portland

Company. The absence of water in the Last Dollar mine high up on the hill and the abundance of water in the lower levels of the mines down on the slope of the hill which are somewhat deeper upon a horizontal plane than the low r levels of the Last Dollar is quite in accordance with the general theory of under ground water circulation.

In the afternoon searched for sch schist area mapped by Cross northeast of town, but was unable to find same. So far as we could make out the area covered by the schists is really occupied by the breccia and possibly some of the other volcanic series.

Returning to town when we got on the area mapped as granite by Cross Grant found a recomposed granite which resembles the original granite in a most marvellous fashion. It contains very numerous unmistakeable pebbles and even boulders of granite as the dominant large clasti ic element, but contains a subordinate number of pebbles of other character. Where these fragments are the clastic character is of course unmistakeable, but even here the matrix looks almost exactly like granite until it is examined with a lens, and even then the differences are not very marked. However where

the pebbles are small or inconspicuous the rock looks almost identically like granite, being composed as it is of quartzose feldspar and the other constituents of the original granite which are little water worn unassorted and therefore have about the same minerals in about the same proportions as granite. The rock as a whole looked like consolidated wash brought down by rivers from granite areas. It was doubtless covered up by volcanic material and certainly has been thoroughly cemented. The rock occurs at the reservoir cite just above the town, but how large an area it covers we do not know.

Aug. 14, 1901.

Felch's Creek, Col.
(W. N. Smith)

Went up Cooper Mt. between Potato and Felch's creek, following along the saddles beginning on Silurian sandstone and limestone. Then passed into granite of various textures cut at frequent intervals by large and small pegmatite veins.

Very few rocks were seen on this part of the way which had Basement Complex aspect, although some rusty schists and fine grained, dark colored schists were seen.

The granite seemed to be of three kinds, (1) a rather coarse greenish, very biotitic granite, which included at intervals small patches of the black amphibolitic (?) schists, (2) this was cut by a finer pink granite in which the black mica was not so prominent, (3) pegmatite veins cutting both the above granites. The coarse biotitic granite was more prominent lower down the slopes, while the pink granite, both coarse and fine grained, became prominent high er up.

The quartzite was found forming the crest of the highest point of Cooper Mt. Here it extends in a long narrow belt, striking N. 40° W. (mag.), and with a practically vertical dip. The belt varied from 20 to 30 yds. to something over 50 yds. in thickness, and apparently extended for several miles

in length. This quartzite is clearly included in the granite. The contacts between it and the granite or schist are sharp, and exposures were found where
42378 the granite (42378) included fragments
42377 of the quartzite (42377) in it.

The southwest contact of the quartzite was so far as observed always with the granite proper or pegmatite. But on the northeast side the contact of
42369 the quartzite was with a schist (42369,
42371 42371, 42379). No gradation between
42379 the two was observed, but the contact was sharp and clear. However the foliation of the schist corresponded with the structure of the quartzite. Also near this contact the schist was in places found extending into the quartzite body in layers parallel with the structure of the quartzite.

At places near the contact of the schist and quartzite, the quartzite seemed to have been affected by the
42370 schists (feldspathidized ?), (42370 and
42373 42373), although at other places where the quartzite was found immediately in contact with the schist this fact was
42372 not seen. 42372 represents the quartzite immediately in contact with the schist.

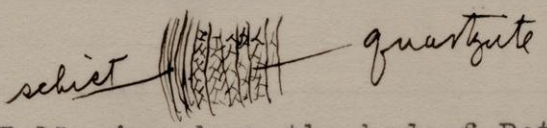
In the middle of the quartzite mass the rock has the true quartzitic char-
42374 acter (42374). Also toward the southwest side of the area it has the conglomeratic appearance noticed in the quartzite of South Boulder creek, but no conglomeratic contact was found.

The schist apparently varies somewhat in character away from the contact of the quartzite. 42375 and 42376 represent phases of the schist taken about 50 yds. from the quartzite contact across the structure of the schist. The schists here weather in such a manner as to give them a conglomeratic appearance.

42375
42376

Both the schist and quartzite are cut by pegmatite veins, and as stated before the quartzite is cut by and included in granite.

On the end of this belt, down the slope of the mountain to Potato creek, the relations of the schist and quartzite are well shown; thus



Following down the bed of Potato creek about 1/4 mile below where the quartzite is exposed comes in rock which has the appearance of being Basement Complex. "Rusty schists, biotitic granites, an intricate mixture of amphibolitic (?) schists, granites, and gneisses, cut by pegmatite". However between this Basement Complex material and the quartzite comes a large mass of the granite above mentioned, and no relations between the quartzite and Basement Complex material were found, unless the conglomeratic-looking quartzite in the main quartzite mass can have been derived from this Complex.

S. T. R.

Royal Gorge of Arkansas, Col.

Aug. 15, 1901.

Felch's Creek, Col.
(W. N. Smith)

Went up Burnt Mt. south of Felch's creek. Here found the quartzite on the highest range of crests the same as yesterday, but in much larger mass. Also the fact that the quartzite is included in granite similar to the Pikes Peak granite is clearly shown here. As previously, the southwest contact is with granite while the northeast contact is always, so far as observed, with a schist similar to that found on Cooper Mt.

The conglomeratic quartzite is much more noticeable in this mass than in that of Cooper Mt. Also the conglomeratic appearance is much more prominent in the middle layers of the mass than on either side.

Basement Complex looking rocks were not observed on the ride up to the quartzite, but in the bed of Ute Creek, which cuts this mass of quartzite almost in the middle, a black schist, or amphibolite (?), was found which had the same Basement Complex appearance as that found in the bed of Potato creek yesterday. This was not far from the exposure of quartzite, and apparently below it.

It is possible that the schist which is in contact with the quartzite is really a metamorphosed sedimentary

S. T. R.

Royal Gorge of Arkansas, Col.

rock. It varies in character across its strike, and is itself cut by granite.

This area of quartzite strikes approximately N. 40° W. (mag.), and the dip, as in the previous area, is almost vertical.

42380 Granite intruding quartzite, south of Felch's creek.
42381 Finer grained granite cutting quartzite
42382 Coarse " " " "
42383 Quartzite at contact with granite.
42384 Quartzite conglomerate.
42385 Quartzite impregnated with granite (?) northwest slope of mt. south of Felch's creek.
42386 Amphibolite (?) From bed of Ute creek about 125 yds from quartzite, apparently below the quartzite.
42387 Quartzite from center of area.
42388 " " " "
42389 Schist a few inches away from the contact with granite.
42390 Garnetiferous schist immediately in contact with the quartzite. South of Ute creek.
42391 Quartzite in contact with the schist.
42392 Granite vein cutting the schist which is in contact with the qua rtzite along its northeast edge.
42393 Schist just northeast of granite(42392)
42394 Another phase of the schist further away from the quartzite.

S. T. R.

Royal Gorge of Arkansas, Col.

August 15, 1901.
Canyon City, Colo.

Drove north from Canyon City with party to Morrison beds of the Jura-Triassic beds where dinosaur bones are found. Here occurs a beautiful section of beds from the Pierre shales to the Dinosaur beds (Jurassic). The only structual thing of especial interest is in the Pierre shales. Where excavation has here taken place and weathering of course has gone on the bank looks as if it were covered with a lot of cobble stones. These, however, are broken up concretions in the shales which have been weathered out and broken up by the weathering forces. Some very large concretions with Septaria were exposed. Hatcher said some of them with casts of fossils but others very much larger. Hatcher says it is impossible to tell exactly where the Dakota ends and the Jurassic begins in this area. At least he says he does not know within 100 feet where the boundary is of the two sediments.

We next went to the Trenton fish beds discovered and described by Walcott. Found a vast quantity of gannoid scales, remains of fins, etc. One bed a few inches thick is literally full of these scales. The same were found at various other horizons.

S. T. R.

Royal Gorge of Arkansas, Col.

Aug. 16, 1901.

Royal Gorge of Arkansas, Col.
(Rc photos, pp. 41-45)

We walked up the Arkansas canyon from the mouth of the canyon to Parkdale. The background of the rocks for the entire distance until within about 1 mile from Parkdale is Archean; that is to say, there are a set of old gray gneisses, red gneisses, and black amphibolites, with intricate relations which are cut most intricately by the granite and by other igneous rocks. For two or three miles below Parkdale the typical coarse Pikes Peak-Cripple Creek granite is exposed, and there cuts the ancient gneisses. This granite, as well as the gneisses, is both cut still more intricately by a red granite which frequently passes into pegmatitic phases. This red granite is the intricately injecting granite which in innumerable bands parallel to the schists gives the rocks the beautiful ribbon structure which has led so many to believe that the Front Range of the Colorado is metamorphosed sedimentary material. At the mouth of the canyon this banded ribbon material is almost parallel in its strike and dip with the Jurassic, showing that at the time the Jurassic was laid down upon them they were nearly horizontal, and that the injection must have taken place when the ~~series~~ gneiss was in a hori-

S. T. R.

Weathering of dike,
Royal Gorge of Arkansas, Col.

zontal attitude or nearly so. However the gneissic structure does not all strike in the same direction, but a little way up the canyon apparently dips in the opposite direction, but detailed obervations were not taken of the strike and dip of the gneiss.

If one were mapping the belt of rocks above described he would undoubtedly be obliged to place the entire mass as Archean until the Pikes Peak granite comes in. However quite as much of the material thus mapped would be Algonkian granite as Archean schist. The Pikes Peak granite comes in in sufficient masses so that the larger ones could be separately mapped and, indeed, many of the larger masses of the later red granite by very close work could be discriminated from the Archean schists cut by this granite; but it would be quite impossible to map Archean areas which are free from intrusive granite, so complex is the intrusion.

At Parkdale in a basin was seen the series which was supposed to go from the Jura up through the Dakota. The interesting thing at Parkdale is the fact that these beds although in a small basin retain exactly the same characters as along the Front, show no signs of shore action, are inclined steeply along the borders. In short, look precisely like a synclinal fold rather than a basin in which the beds were deposited. In fact, I have no-

S. T. R.

Weathering of igneous dike,
Royal Gorge of Arkansas, Col.

where seen any evidence that various park basins are not the result of orogenic movements later at least than the Dakota, and so far as I can see no evidence is easily ascertainable showing that all of the Archean cores were not as equally covered with the sedimentary beds as the basins.

August 18, 1901.
Aspen, Colo.

We found Aspen Mountain to be topographically very steep. Of course this is shown by the topographic maps, but one does not appreciate the steepness with which Aspen mountain rises above the town until it is seen. This steepness of topography has led to a method of mining in this district and other similar districts new to me. That is the driving of tunnels as low down in the valley as practicable intersecting the veins which have been discovered at the surface, and then developing by rising or stoping and shooting down to the tunnel level, and tramming out the ore.

We rode from Aspen Mountain to Castle Point, on top of the mountain from which we had a magnificent view of Sopris and the other ranges in the vicinity. Off to the south we saw the continuous succession from the Archean through the Carboniferous Triassic and Jurassic.

We went down the spur of the mountain into Castle Creek and here went into the Newman tunnel about 1000 feet and then went up about 300 feet as I remember it, which put us about 700 feet below the surface, and at 800 feet we saw a magnificent body of lead carbonate which was said to be 300 feet long and 60 feet wide.

Whether this is true or not I could not say, but certainly it was so large that I suggested to the Supt. that it was as large as the iron ore deposits which in the Lake Superior region are worked on a sinking system. He replied that he intended to adopt that system for the deposit after he had learned its confines.

Much of the lead carbonate showed the little crystals of cerussite making the so called carbonate zone here and there in it are crystals of galena showing the derivation of the carbonate from the galena but the amount of these is exceedingly small.

One curious thing about these levels is that more of the ~~carbonate~~ galena is in the upper of the three levels than in the lower one. Nowhere was the roof seen, but at many of the mines at Aspen Mountain and in the Mountain across from Aspen there is a roof of black carboniferous shale, and I suspect the explanation is in this case that the upper levels are more protected by the shale than on the lower levels. The ores at Aspen Mountain, as explained by Spurr's report, occur mainly in the Carboniferous limestone, and are often closely related with upthrow (?). In many cases they are near the contacts of different formations of the sedimentary series, but in

general follow faults a very complex system of which Spurr has worked out. In many cases the faults and the bedding correspond so that the differential movement along the bedding is equivalent to that of a fault. The ore occurs in the brown limestone rather than in the blue. In many cases the original sulphide deposits, and especially the polybasite deposits occur under or close to the black shales. In other cases the black shales have clearly been over the deposits, but have subsequently been removed by erosion. It is interesting to find so nearly completely oxidized great deposits of lead carbonate so deep below the surface, but this is still high above the valley, and in an open broken formation like the Carboniferous limestone, is still above the effect of descending oxidizing waters. Indeed one would expect such waters in the case of Aspen Mountain to go quite to the level of the valley if they did not go considerably deeper.

The other great deposits on the opposite side of Aspen and Aspen Mountain were not visited.

S. T. R.

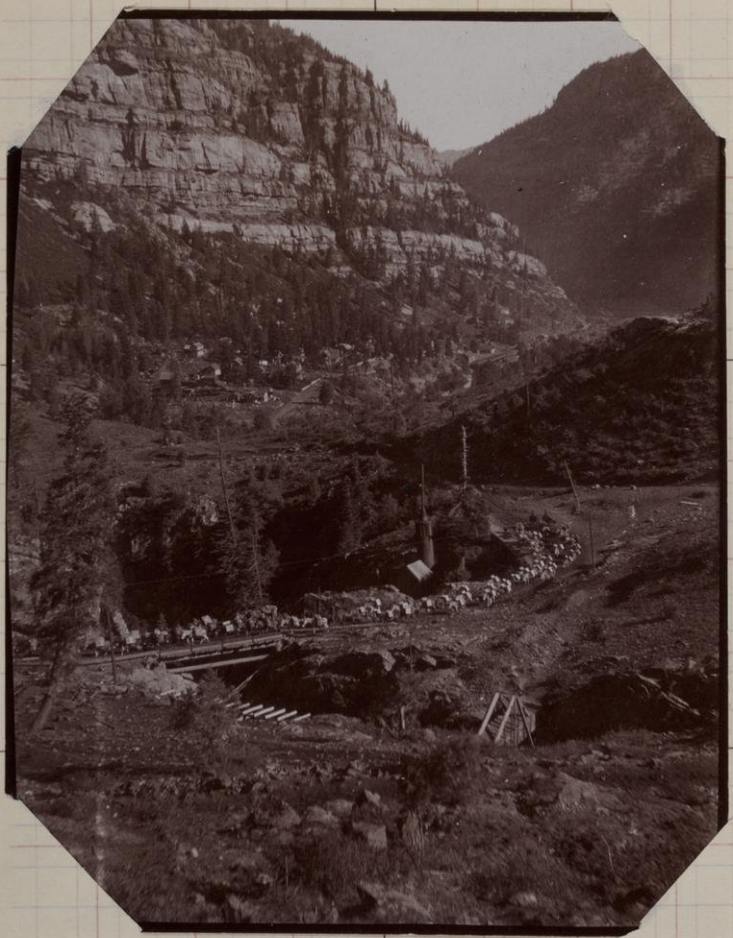
Sneffle Mts. looking north from
Camp Bird Mine
Ouray, Col.

August 20, 1901.
Ouray, Colo.

Visited the Camp Bird mine. First visited the upper workings 1700 feet from the surface of the ground and 300 feet from the lower tunnel along the dip, 1225 feet vertically, this lower tunnel being the one to which the ore is dropped and trammed down to the mine.

At the mouth of the upper tunnel the rock is barren on the east side for 100 feet which as far as the vein has been prospected. The vein, however, is distinct, and can be easily followed. A short distance west of the mouth of the tunnel pay ore is reached extending for .... hundred feet. Then the vein pinches out and barren ground is followed for 700 (?) feet. Then comes in an enormous body of ore which has been traced for 1200 feet. The vein varies in width but the average width is great, often as much as 12 or 15 f feet. This rich portion of the vein outcrops at the surface and also is struck in the lower workings 300 feet below the upper workings. The ore in this vein consists of pyrite, chalcopyrite free gold and tellurides (?). Galena and blende also occur, the galena vein carrying high values. It averages 4 to 8 ounces per ton.

S. T. R.



Eugenie Valley
below Camp Bird Mine
Ouray, Col.

No oxidation effects whatever were noticed unless the existence of free gold can be called such.

The vein is a quartz vein which is plainly visible. In places the vein consists entirely of this quartz. At other places it branches into several rather narrow veins and in other places is so broken as to be breccia. Generally a rather distinct wall of pay ore can be followed, but this is not always the case, the mineralizing gradually playing out. The vein is nearly vertical, the dip being about 30 feet in 100 feet.

The paying part of this vein occurs in the andesitic breccias which cap the mountains in this part of the San Juan range, about 5000 feet thick. Very many other veins of quartz may be seen extending through the whole sedimentary and igneous series along the canyons in these mountains, but a comparatively few of them carry values. Also several dikes of igneous rock (rhyolite?) cut through the sedimentaries and the andesitic brecciation. In the upper workings a dome of rhyolite was struck in the first section of the paying vein mentioned above. The values ran up to the dike as it was approached from the east, but the rock was barren for some distance on the west side of the dike. The

S. T. R.

Erosion Peaks, at Virginius Pass,
below Ouray & Telluride, Col.
(below Camp Bird Mine)

dike breaks the vein up very considerably where it cuts across it.

A very large amount of water circulates through the mine.

The Camp Bird is operated according to the method described as used at Aspen. The tunnel visited which showed the most extensive development is about 300 feet above the level of the camps, the latter being at an elevation of about 11,000 feet. This tunnel extended into the intersection of the vein. The vein has been opened for about 3000 feet at this tunnel level, of which some 2300 feet to the west was traversed. Of this distance nearly 2000 feet is in ore shoots the barren ground being in two places of about 700 and 400 feet in length. Where the tunnel strikes the vein we are in the midst of an ore shoot and this continues for some hundres of feet to the west. We then struck barren ground which continues for 700 feet and then comes the great ore chute. Just east of the tunnal barren ground again comes in for 400 feet and the ore chute beyond that was not visited. The richest of these ore chutes is that farthest west.

S. T. R.

Here the stopes vary from 4 to 12 or 15 feet wide, separated rather sharply from the walls, the whole thing from wall to wall being handled together and stoped out and mined as ore which, according to the statements of Mr. Benson runs from 4 to 8 ounces of gold per ton. The walls while very clean cut in places are also in many places more or less brecciated and veined. The vein so called is not by any means solid quartz, but is quartz and brecciated rock with many fragments of the wall material in it between and around which is the comb structure of vein quartz and in which are the values. In many cases the comb structure passes directly around the included fragments. The richest parts of the ore follow along little fractures in the quartz giving the quartz dark streaks. There are present in and through the veins chalcopyrite, galena, pyrite, and a very little blende. The copper material, however, is very subordinate. Where the lead is plentiful the gold values in it are large frequently forty ounces or more per ton in the concentrates. The fine black material along the veins are called tellurides by the company but I suspect the same to be largely free gold from the fact that 75% of the values of the ores is collected on the plates, and this would be an

unheard of thing for telluride. It strikes me the probable explanation is that the values were originally in finely disseminated tellurides but that the oxidizing waters have largely decomposed these transforming the major part of the gold to the metallic state, leaving some residual tellurium, but of course this is a mere conjecture which can only be proved by careful chemical and microscopical work.

Of the remaining 25% of the values about 20% are said to go into the concentrates from the vanners and the Wilfly tables and the second concentrates contain 25% of the values are cyanided and from this they claim to abstract about 80% of the value.

The vein was discovered at the surface in the capping rhyolite, but there was much less valuable than at depth, being a moderate value free milling gold proposition. The rich values came in 200 or 300 feet below the surface, and have continued to the depth of the level above fully described so far as the ground has been opened, according to the statement of the officers. The deeper part of the level which has been described is 1700 or 1800 feet below the surface, which would make the lower level at the camp 2000 or 2100 feet below the surface. The lower tunnel so far as shown us had

struck the vein on barren ground followed this barren ground until values were struck near the end of tje drift, but this was only for a few feet, and as yet the ground is not opened up so that one can tell anything about the relative width and value of the lower tunnel as compared with the tunnel 300 feet above. The lower level where it struck the vein was apparently in the easternmost of the two areas of barren ground. We then in following the vein passed ten chutes which came down from one of the ore chutes above, and along this part of the vein above there were beautiful water channels and veins. However, the rest was not examined as to values nor questions asked as to the relative values of this portion of the mine as compared with the corresponding portion 300 feet above. We then passed through in going west a distance of 700 feet corresponding probably to the 700 feet of barren ground of the level above, and had just run into values again. This portion of the vein is presumed to correspond with the beginning of the richest portion in the level 300 feet above.

So far as I could see there was no difference in the character of the deposit in either of the levels. In neither was any oxidation observed

the ore all appearing to be sulphides, and yet from the method of extraction as already explained, a large portion of the gold is probably free, and it is believed th that the entire vein so far as developed is in the belt of secondary enrichment by descending waters although the process has not gon on so far as to oxidize the product. The only evidence of this, however, is the free milling character of the ore.

I have never before seen a great fissure vein of which the Camp Bird is certainly a perfect example. The cleanness of the wall, the breadth of the vein, the brecciated material in it, the comb structure of the quartz, in fact everything corresponds perfectly with the description of great fissure veins as given in the text books.

At one place before the barren 700 feet was reached in the upper level described, the vein splits into two parts, depreciates in value, and Mr. Benson did not know which to follow. He consulted Mr. Emmons, who told him to follow the soft ground and that the vein might come in, Mr. Emmons giving as a reason that the values had gone out on account of the ground being soft and the walls coming together so that the vein

could not form. My statement of the case would be that the soft ground allowed the walls to settle together and prevented the ready circulation of water, and therefore the deposition of the values. In my hurried examination it seemed to me that since that time secondary deposition has taken place, and that a large part of the values has been introduced along these secondary cracks especially the dark gray streaks which are so rich in gold. It seemed to me that the galena and blende are in part the original concentration and that these little streaks of dark material rich in gold represent a large part of the work of the second concentration. But no such detailed study was made of the relations of the minerals and gangue as to warrant any positive statment in these particulars.

Where the westernmost rich chute is struck after passing through the barren ground there is a big offshoot from the main vein which again carries values. It is to be remembered that there was an offshoot where the barren ground first appeared and it is entirely possible that the values may continue along this secondary vein all the way and that in following the soft barren ground the main vein was missed for this distance, which perhaps follows

an irregular instead of a straight
42561-2 cource. Specimens from Camp Bird
42563-4 mine 42561-2-3-4-5.
42565

Mt. Potosi, San Juan Mts.
near Ouray, Col.

August 21, 1901.
Revenue Tunnel, Virginias mine,
Colorado.

We rode to the workings of the Revenue company which is a consolidation of the old Revenue tunnel, the Virginias mine, and other properties.

This tunnel starts just above the level of the valley, goes into the mountain 7500 feet before it strikes the vein. The vein is then followed at this level and at places is 3000 feet below the surface. We first went down the shaft below the level of the tunnel 550 feet, which would put us 3550 feet below the surface provided this shaft is sunk below the deepest part of the ground. However, no stopes have been here opened up and nothing more could be seen except that a vein there exists.

Some of the stopes were visited on the tunnel level which very clearly showed oxidation. The quartz is stained, the sulphides are oxidized in part, and there is the clearest sort of evidence of the oxidizing process, although it is not anything like complete.

42566-7 Specimens 42566-7 are from this oxidized belt. Indeed at this

Looking north from Virginias Pass, Col.

level Mr. Kricher told us that nice speciments of silver chloride had been found. The ore at this level, however, has been pretty well worked out, and we could not see any exceptional value in it.

We then went up 300 feet where we could better see the ore in the stopes. Here the oxidation process has gone up further in places than below. However, at other places the vein is comparatively little oxidized and here nice specimens of gray copper with galena and iron sulphide were found (42568). At this stope I noticed the ore chutes were separated by areas of poor ground and here again the ground was soft. I asked Mr. Kricher if he did not find the soft ground to diminish in values. He said that wherever the vein was vertical the values would be apt to be good; where much inclined the values would be likely to be poor. My interpretation of this, however is that where the wall is nearly vertical the vein keeps open and allows the circulating waters to concentrate the ore, whereas where the vein is flat the rock above not only rests upon the rock below, but grinds against it and makes the gouge or soft ground which largely excludes the circulating water.

42568

We next went up 900 feet on the incline of the vein and there examined another stope. This was much

Virginius Pass, Col.

much similar to that below so far as we could see except that the evidence of oxidation was much more marked. Not only was the vein oxidized but the walls of the rocks were extensively modified and kaolinized.

We next went up 1400 feet to within 300 or 400 feet of the surface, but here we saw little as the entire body had apparently been stoped out.

Mr. Kricher upon questioning him said that while the values kept up very well with depth the deeper levels were lower grade. However he said that the vein was wider so that the profits were about the same. That is the veins are smaller and richer at the surface and wider but poorer below. The values of the mine are mainly silver and these are carried mainly in the gray copper.

Mr. Kricher told me that the Revenue ore chute at the shallow workings was only about 300 feet in length, and steadily increased with depth so that at the tunnel level if I remember correctly it had been developed for a length of 3000 feet. In other words we have here an ore chute which lengthens out somewhat as the topography lengthens and gives

Virginias Pass, San Juan Mts. Col.

another link in favor of the theory of concentration.

One interesting feature was seen in the mine, the point of which I did not appreciate. A little slip appears at one end of the ore chute, but does not look like an important fault. The vein material and parallel dike continues without being broken, showing that this slip must have occurred anterior to both of these. And yet beyond this slip the vein carries no values. The statement that the vein and dike continue was made by Mr. Kricher, but was not verified by my personal observation.

One important point in reference to this vein is that it is one which is parallel to an andesitic dike cutting the breccias. In some cases the main values are on one side of the andesite dike; in some cases are on the other. Occasionally values are found on both sides of the dike. Sometimes the main values follow the vein cutting diagonally across the dike. However in general the main values are under rather than over the dike although upon this point my recollection is not absolutely clear. Mr. Smith's recollection is similar Indeed as I think of it it seems quite clear that this is the case because they say that the main values are along the foot wall and

Glacial cirque, Virginius Pass,
San Juan Mts. Col.

they mine the dike in order to get room for stoping. This very clearly suggests that the dike was the impervious rock along which the solutions making the first concentration followed, and that the contact between the dike and the breccia was a trunk channel of circulation as it would be sure to be under these circumstances. That is the brecciation before it was cemented was of pervious material through which the circulation would be almost ideal, but this circulation would be interrupted by the dike and along this the solutions would follow. However, it appears perfectly clear to me that there has been most impotant secondary concentration and with this this steady diminution in values corresponds. I suspect the diminution in values will be found to continue much more rapidly below the tunnel level for very much below this tunnel level will carry them below the valley.

The values are mainly in gray copper. The vein is a small one for the most part only a few inches or a foot or two in width, where solid, although its high values have made it very profitable.

Although not visited by us, another vein, the Terrible, intersects the tunnel much nearer the

valley than the Virginias vein. This vein in its upper part was very rich bearing 300 ounces in silver at the surface in a gangue material of gray copper, galena and pyrite. The amount of this silver steadily diminished fifty ounces per level of 100 feet until at the 400 foot level bore only about 60 ounces of silver, and below that level has not been worked. This vein ran east-west while the general course of the value bearing veins is northwest-southeast. Another party spent 10,000 dollars striking this vein at the lower level, but did not take out anything of value. Where intersected at the tunnel level the vein was recognized and here is a hard pure quartz vein having besides the quartz mainly iron sulphide with galena very sparsely disseminated and bearing only about 7 ounces of silver to the ton and therefore not worked. Whether the high values near the surface were in galena or in copper I do not recollect, but Mr. Hills says in the gray copper.

42569 42569, country rock andesitic
42570 breccia (?). 42570-country rock.
42571-2-3 42571-2-3 ore from Virginias mine.

In the afternoon went into the lower Liberty Bell tunnel. Here saw a moderate sized vein showing characteristic parallel sheeted and brecciated structure so

characteristic of the district. We did not get to any great depth but
42574-5 saw both unoxidized (42574-5) and
42576-7 oxidized (42756-7) material; the structures of which are the same, the usual sulphides, pyrite, and galena, and perhaps other sulphides being present.