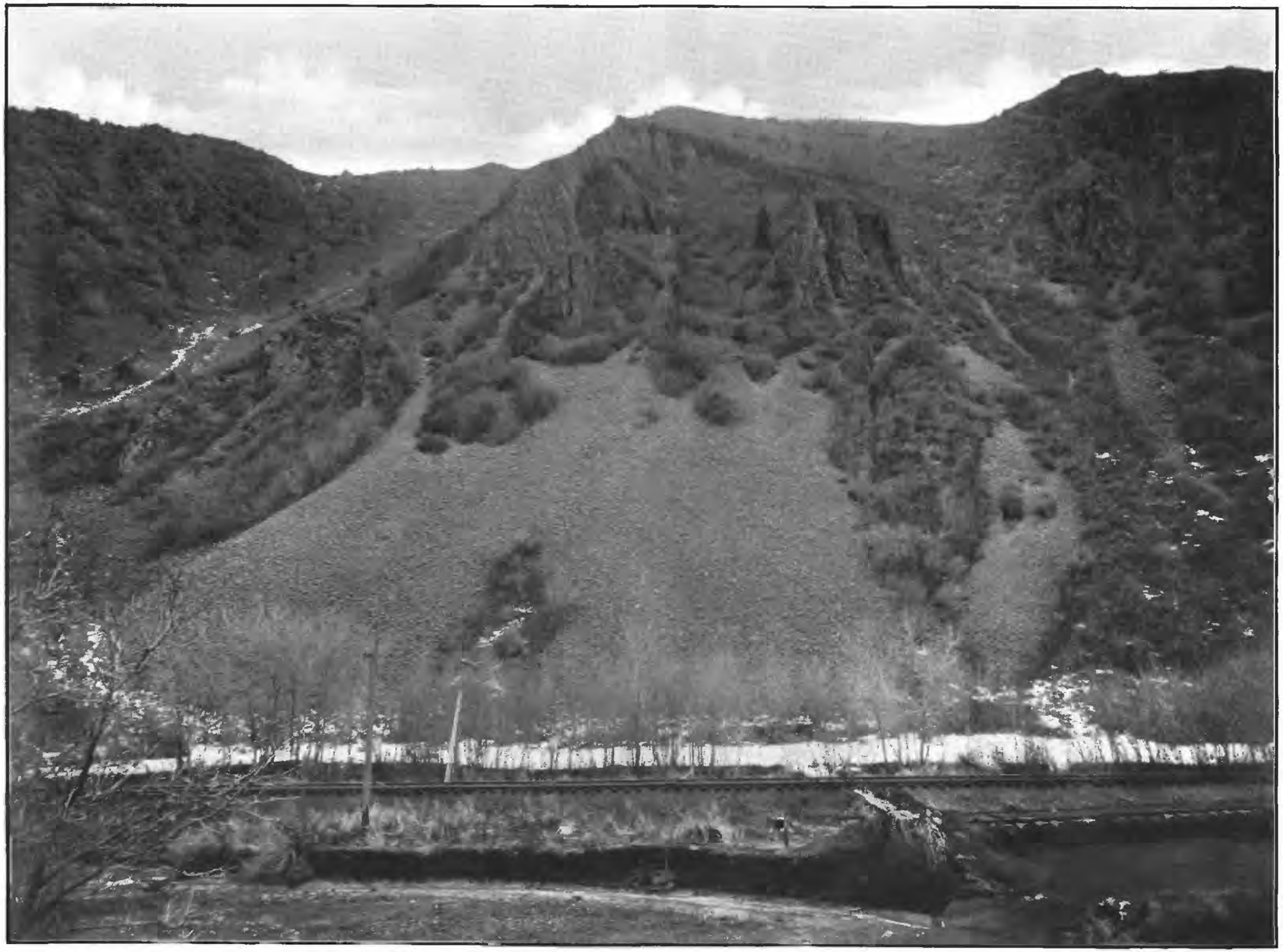
HEAD OF BINGHAM CANYON, 1 MILE SOUTHWEST OF OLD JORDAN.

Looking northeast.

HEAD OF CARR FORK, BINGHAM CANYON, FROM WEST MOUNTAIN GAP, 1 MILE SOUTHWEST OF OLD JORDAN.

Looking northeast.

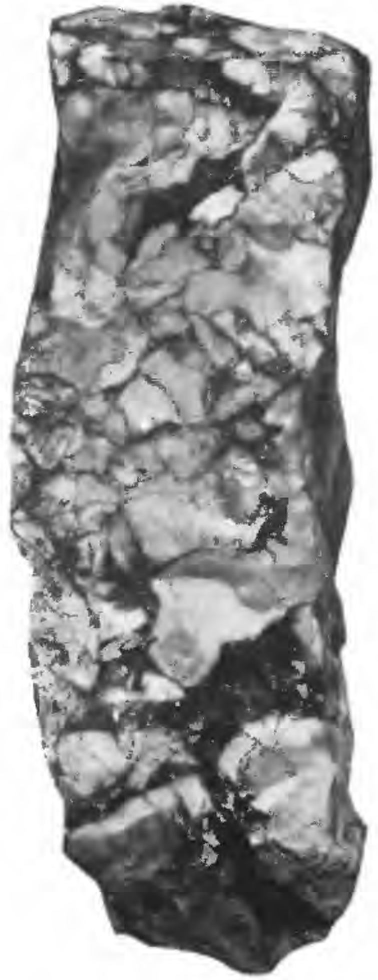


CLIFFS OF NEARLY VERTICAL BINGHAM QUARTZITE WITH TALUS SLOPE, SOUTH SIDE OF BINGHAM CANYON OPPOSITE MOUTH OF DRY FORK.

LEDGES OF JORDAN LIMESTONE AT HEAD OF BUTTERFIELD CANYON.

Looking southwest from West Mountain gap.

A



B

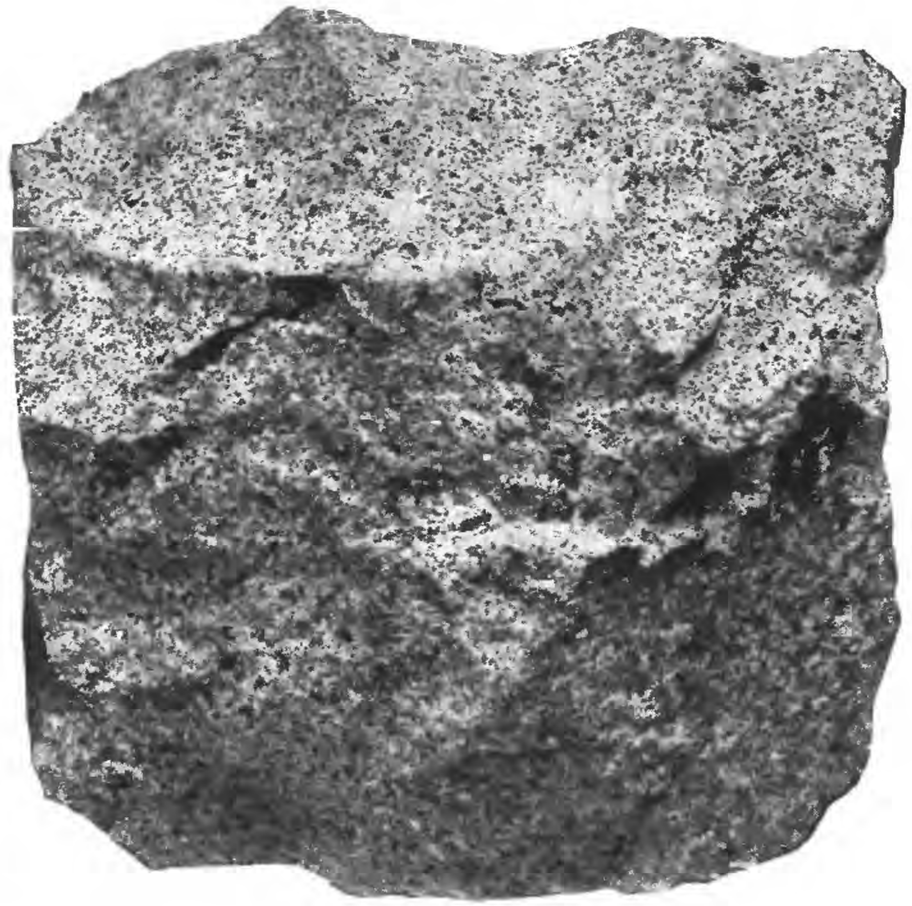
C

A. CHERT NODULES IN BUTTERFIELD LIMESTONE, THREE-FOURTHS MILE SOUTH OF BADGER MINE.
B. BLACK AND WHITE BRECCIATED CHERT FROM JORDAN LIMESTONE, ONE-EIGHTH MILE S. 80° E. OF OLD JORDAN MINE.
C. PYRITE GRAINS AND REACTION RIMS IN LIMESTONE, CARR FORK, 1,200 FEET NORTHEAST OF COTTONWOOD GULCH.

CHERT LEDGES IN COMMERCIAL LIMESTONE, ONE-THIRD MILE N. 55° E. OF TELEGRA[illegible] MINE.

Looking northeast.

A



B

A. COARSE PORPHYRITIC MONZONITE, 1,500 FEET SOUTHWEST OF FORTUNE MINE.
B. FINE PORPHYRITIC MONZONITE FROM UNITED STATES MINING COMPANY'S DELIA B. TUNNEL.

A

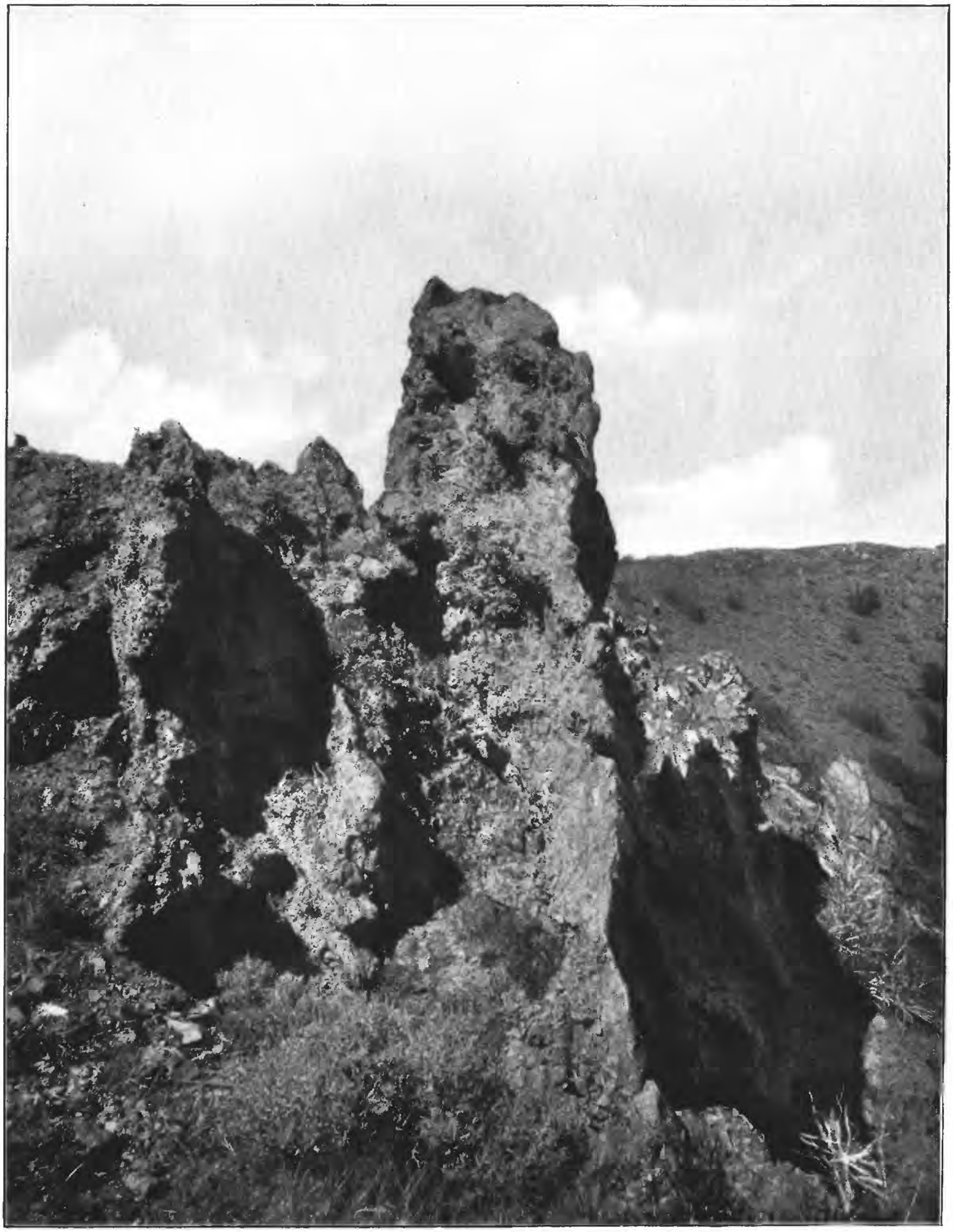
B

A. FINE-GRAINED MONZONITE, NEAR SILVER SHIELD MINE.
B. BLEACHED AND IRON-STAINED RINGS IN WEATHERED MONZONITE NEAR TELEGRAPH MINE.

BEDDED ANDESITE BRECCIA, ONE-FOURTH MILE EAST OF LEAD MINE.

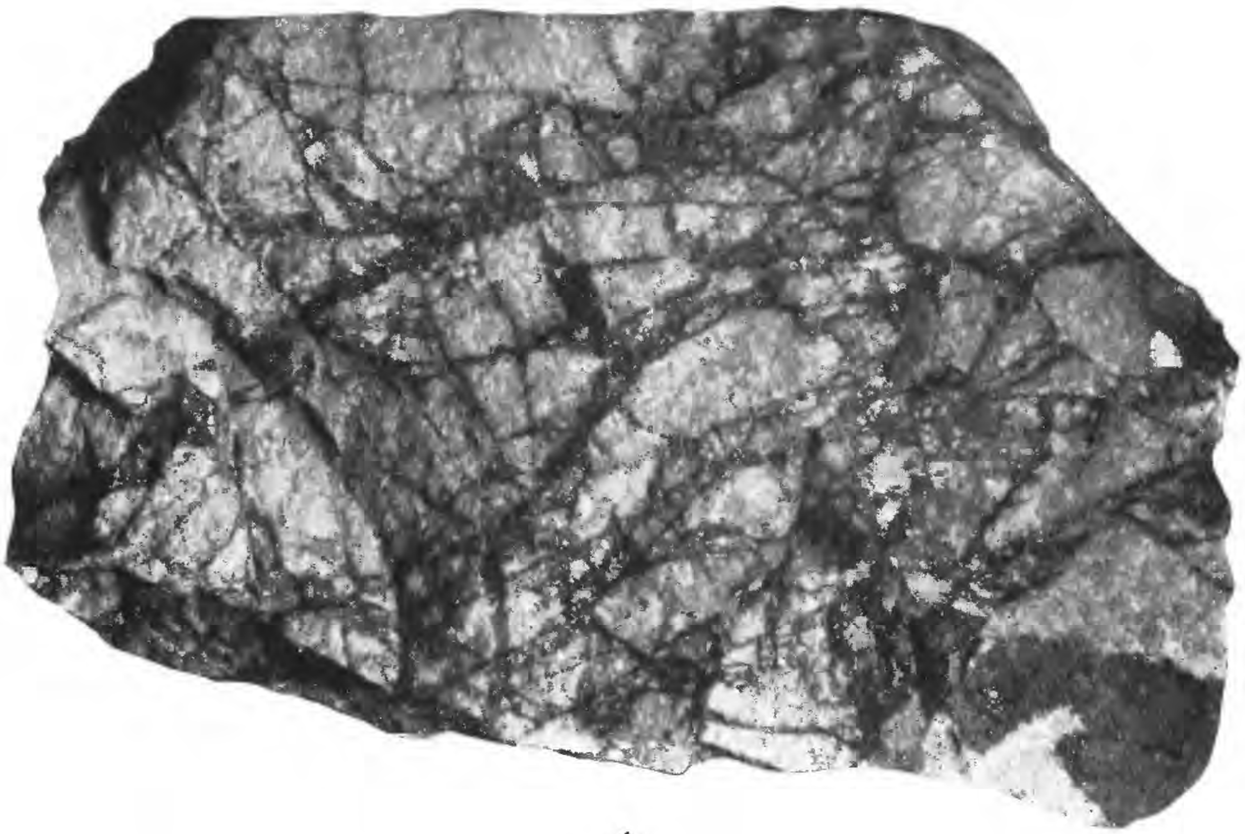
Looking south.

BEDDED FERRUGINOUS CONGLOMERATE ALONG BINGHAM CREEK ONE-HALF MILE BELOW UPPER BINGHAM.

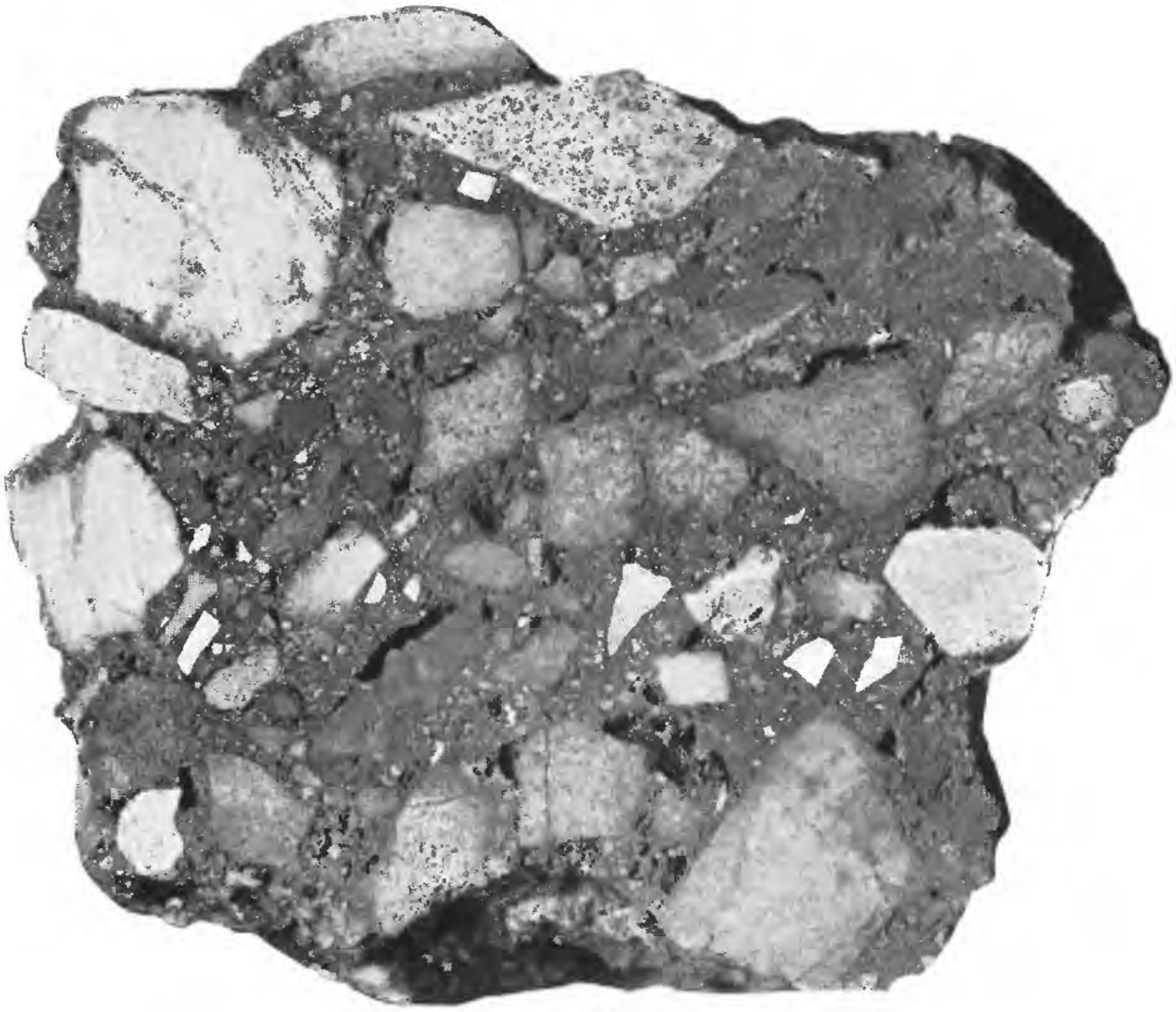


FERRUGINOUS BRECCIATED QUARTZITE OUTCROP, ONE-FOURTH MILE WEST OF ST. JAMES MINE.

Looking north.



A



B

A. SHATTERED QUARTZITE, ONE-FIFTH MILE EAST OF TELEGRAPH MINE.
B. FERRUGINOUS CONGLOMERATE OF QUARTZITE AND CHERT, OLD JORDAN MINE.

A

B

A. MOTTLED GRAY AND WHITE LIMESTONE, DUMP AT HEAD OF PETRO INCLINE.
B. SPOTTED BLUE AND WHITE LIMESTONE, HIGHLAND BOY MINE.

OLD JORDAN MINE IN 1900, SITE OF THE FIRST RECORDED MINING LOCATION IN UTAH.

The Jordan "discovery" is at the right in the middle ground. View is northwest and shows surface workings on Jordan limestone in fore and middle ground and old upper adit of Commercial mine on foot wall of Commercial limestone at right in background. Photograph by Savage.

PYRITE CRYSTALS, COMPROMISE LEVEL, OLD JORDAN MINE.

Specimens A and B are from the lining of the same vug. Natural size.

A

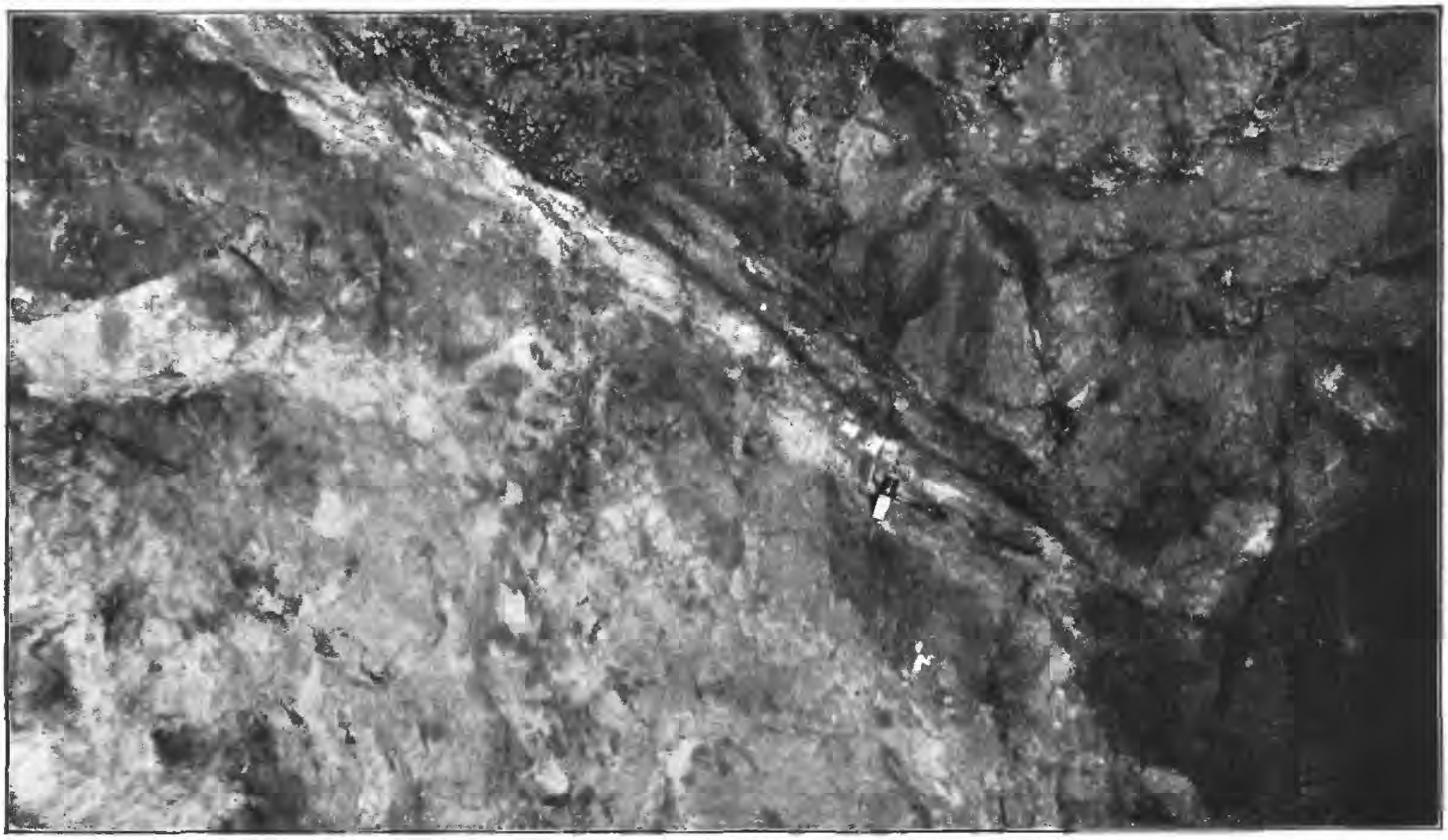
B

C

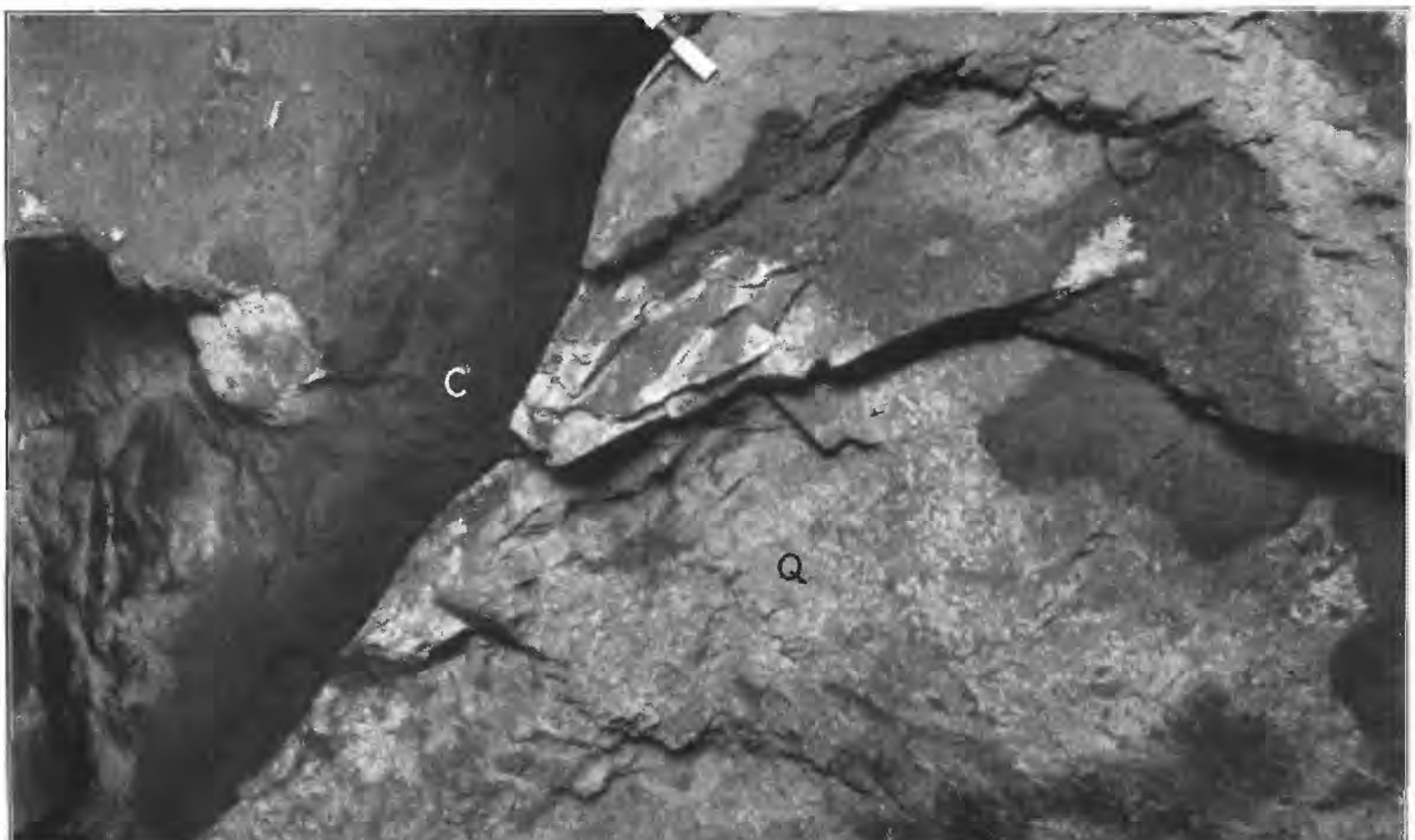
A. CRYSTALLINE ENARGITE, COMMERCIAL MINE. Natural size.
B. CRYSTALLINE ENARGITE, SHOWING ROSETTE HABIT, COMMERCIAL MINE. Natural size.
C. ROSETTE OF ENARGITE CRYSTALS SHOWN IN *B*, ILLUSTRATING CLEAVAGE. Six times natural size.

A HOEN & CO. BALTIMORE

STALACTITE OF PISANITE, OLD JORDAN MINE



A. NORMAL BARREN CONTACT BETWEEN HIGHLAND BOY LIMESTONE AND FOOT-WALL QUARTZITE, NO. 7 LEVEL, HIGHLAND BOY MINE; LOOKING WEST.



B. "ROLL" FAULT, NO. 1 LEVEL, OLD JORDAN MINE; LOOKING NORTHWEST.

The foot-wall quartzite (Q) is faulted up into contact with black copper-sulphide ore (C).

closely resembles a normal occurrence, was brought about, however, by extensive strike faulting, which has thrown an ore body that formed in the limestone high above its base into immediate contact with underlying quartzite (see Pl. XXI, *B* and Pl. XLII, *A*). Wide underground observation tends to show, on the contrary, that the contact is generally barren and that the ore bodies occur above within the great limestones (Pl. XXI, *A*). Furthermore, these shoots are not restricted to a single horizon within the limestone, but occur at various horizons, one above the other. The selective action exercised by the mineral for certain beds in the limestone is closely analogous to that shown for limestone in preference to quartzite.

Nowhere is this more clearly illustrated on both large and small scales than in the Highland Boy mine. At several places this was shown in miniature, as it were; a distinct fissure carries mineral which enlarges in certain beds, becomes constricted in others, and expands on coming into others (see fig. 2).

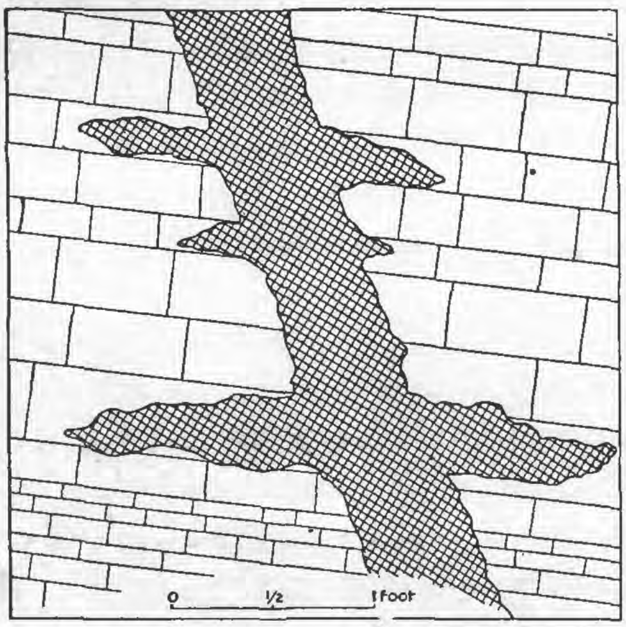


FIG. 2.—Copper ore making out from strike fissure along selected beds, Highland Boy limestone.

An occurrence of the same character is seen in the two main shoots opened on that portion of the Neptune fissure which lies within the Jordan limestone. Somewhat over 100 feet above the barren contact of the Jordan limestone with the foot-wall quartzite the normal fissure body of silver and lead ore expands from the fissure laterally into the limestone wall and forms a thick lens that extends in the direction of dip and contracts above to two prominent fissures in the barren limestone. Five to 8 feet higher a similar lateral extension of the ore body takes place on this same fracture zone, and forms a flatter, more bed-like shoot. An attempt is made to illustrate the results of this selective action in fig. 8 (p. 237). Similar action is shown on a grand scale on the No. 6 level of the Highland Boy mine, where two ore shoots, one of mammoth size, lie within marmorized limestone and are separated from each other and the foot- and hanging-wall quartzites by considerable thicknesses of barren marble. Other shoots may be revealed at a still higher horizon in the marble between the upper shoot and the hanging-wall quartzite.

In brief, these facts seem to show not only the superior affinity of ore-bearing solutions for limestone, but also a selective tendency of these solutions toward certain beds of limestone.

Carbonaceous and organic constituents exert other important chemical influences. Considerable thicknesses of calcareous shales containing a small amount of carbonaceous matter occur in the northwestern part of the Bingham mining district

A. BASAL CONTACT OF MONZONITE SILL WITH BINGHAM QUARTZITE, UTAH LEVEL, OLD JORDAN MINE.

B. HORSE OF BINGHAM QUARTZITE IN MONZONITE DIKE-SILL, UTAH LEVEL, OLD JORDAN MINE.

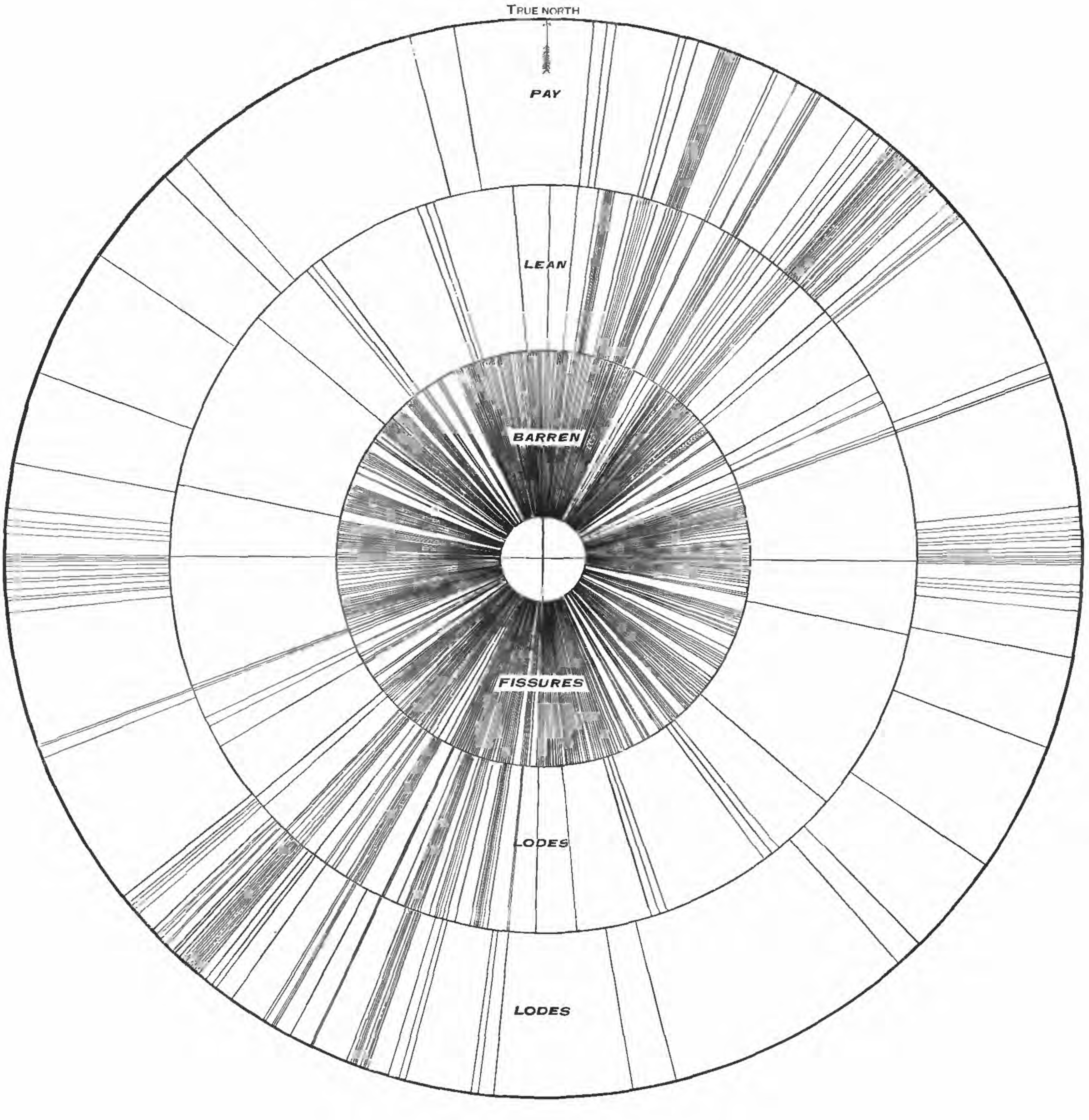
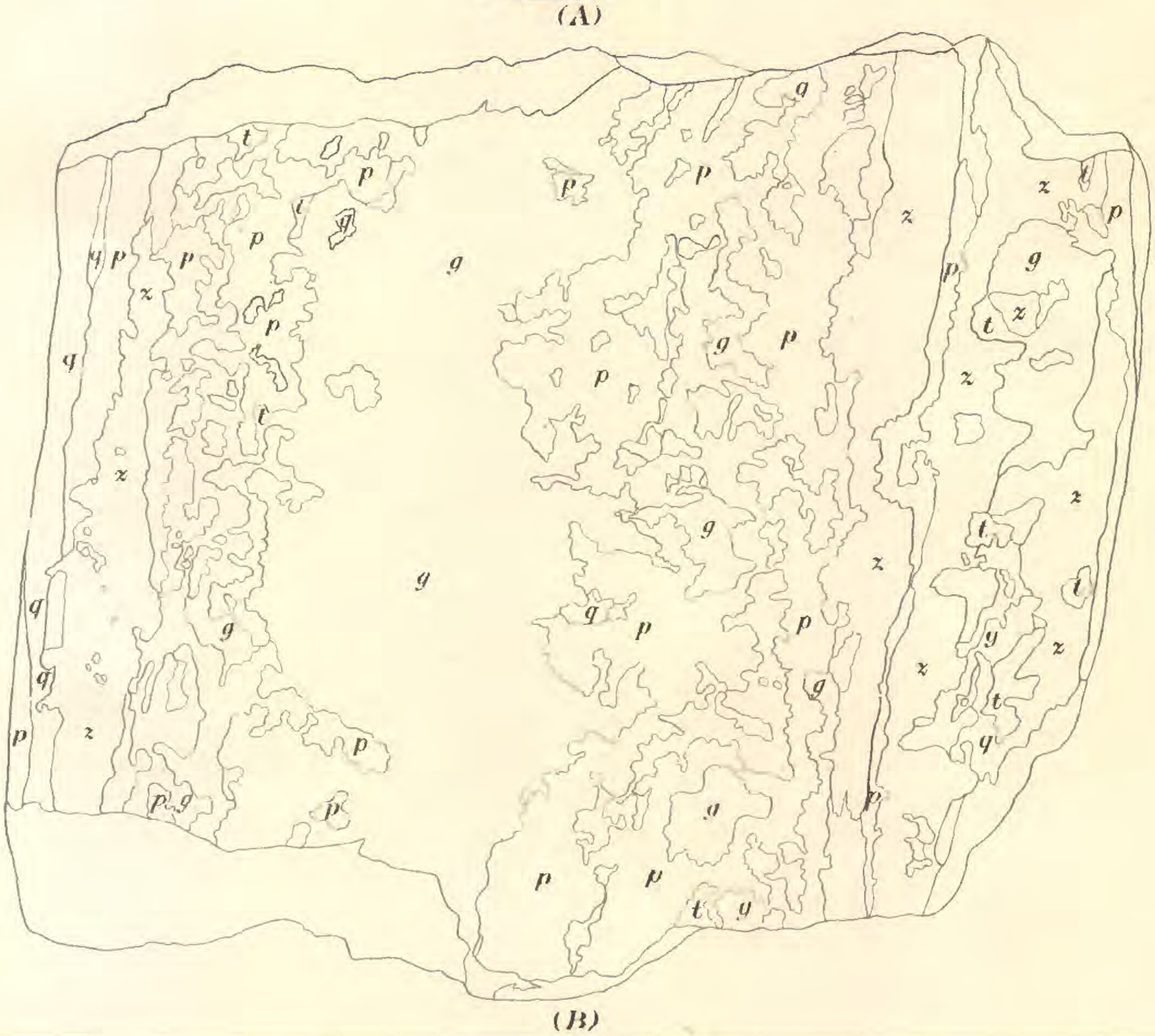


DIAGRAM SHOWING TRENDS OF BARREN FISSURES AND OF LEAN AND PAY VEINS AND LODES OBSERVED IN BINGHAM DISTRICT.

(A)



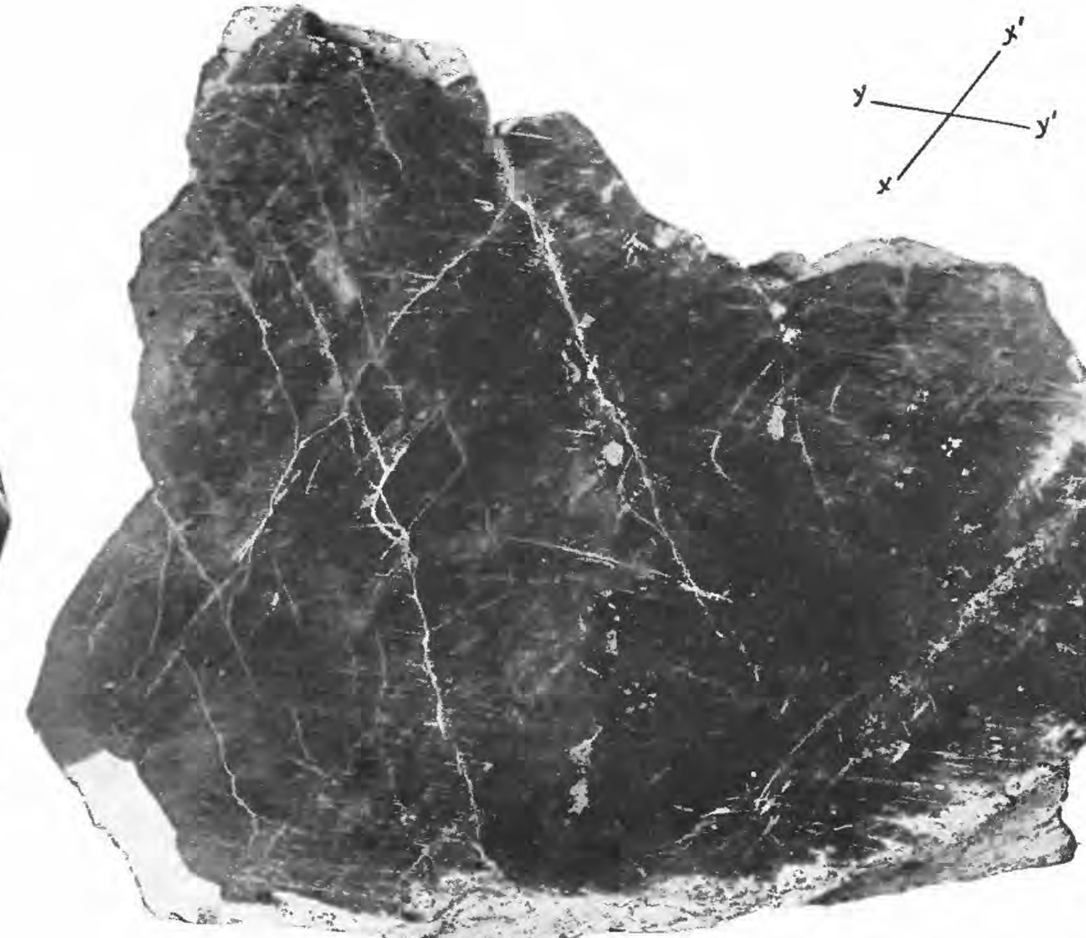
(B)

A. HOEN & CO. BALTIMORE

PAY STREAK OF RICH ARGENTIFEROUS LEAD ORE IN SILVER SHIELD LODE
SHOWING STRUCTURE AND MINERALOGICAL ASSOCIATION

A

B



C

A. SEAM OF ARGENTIFEROUS LEAD IN ALTERED INTRUSIVE, BENTON TUNNEL, NAST MINE.

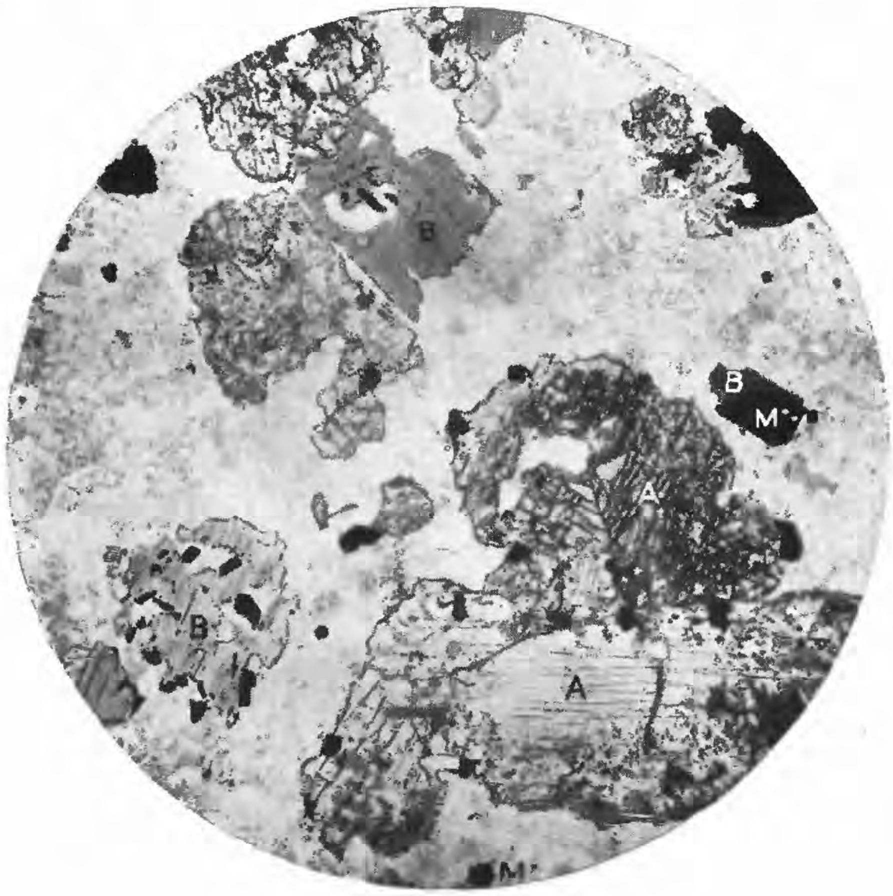
G=Galena, Ch=chalcopyrite, Z=sphalerite, Q=quartz, C=calcite, I W=intrusive wall rock. Natural size.

B. HALF OF PAY STREAK IN FERGUSON LODE, NAST MINE.

O=Open space, C=crystalline calcite, G=lobes of galena, P=pyrite, Ch=chalcopyrite, Q=quartz. Natural size.

C. SLICKENSIDED WALL OF GALENA LODE, UTAH LEVEL, OLD JORDAN MINE.

Face of galena and some pyrite polished by strong movement in direction x-x' and secondary movement in direction y-y'. Natural size.



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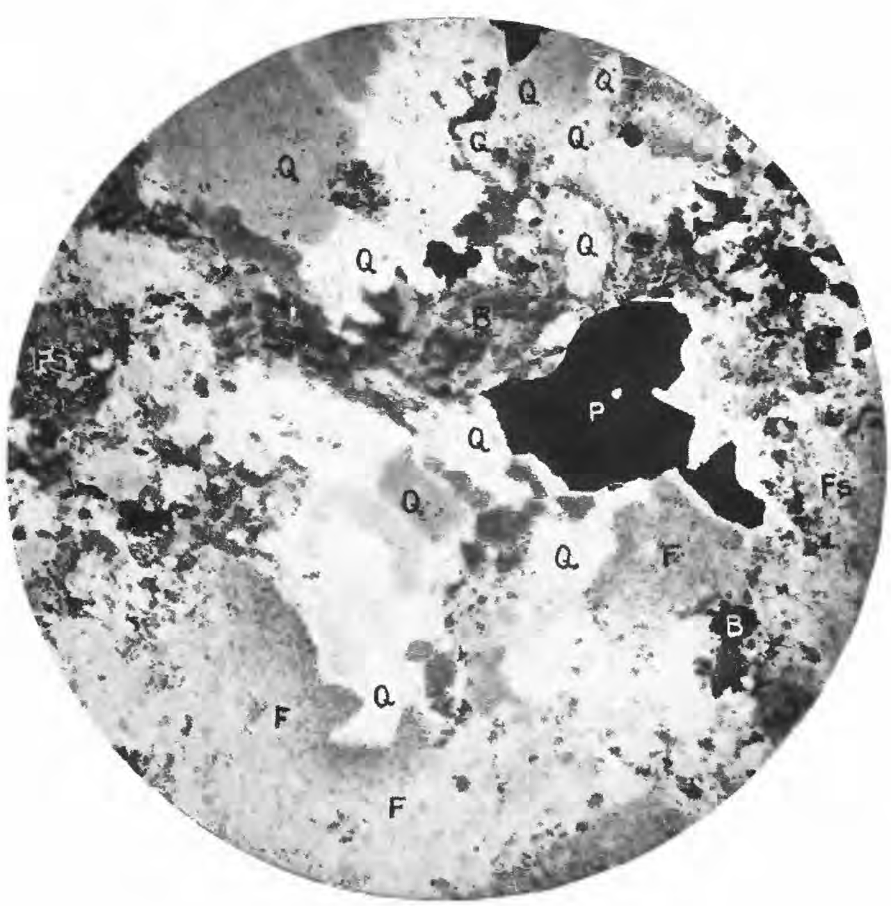
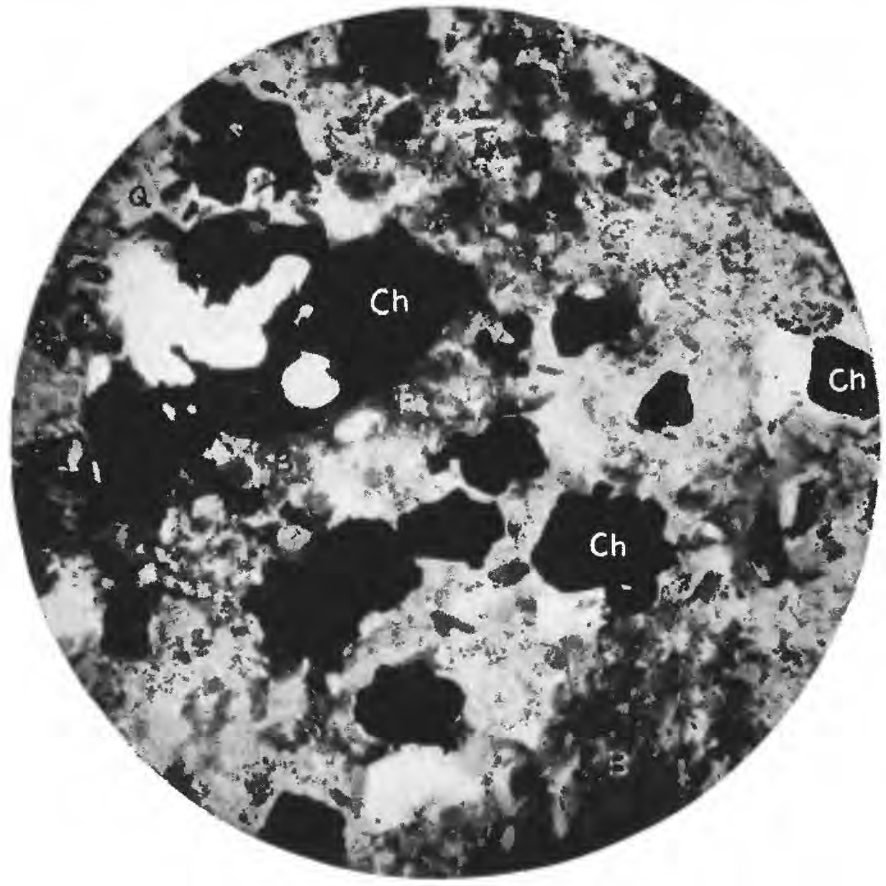
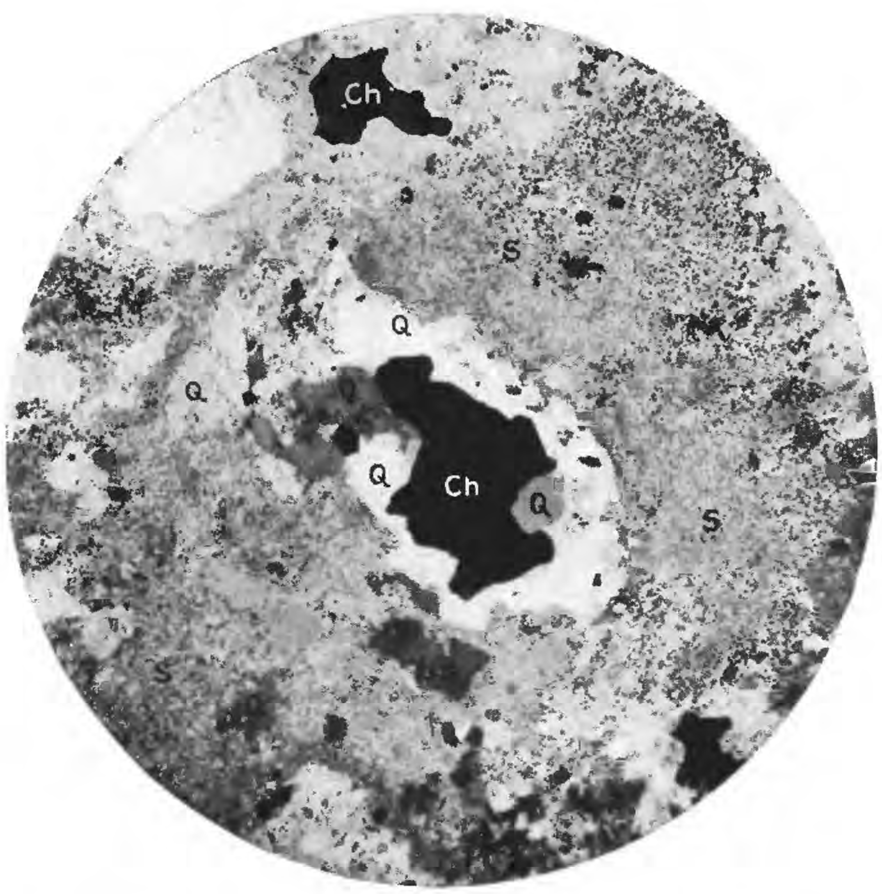


B

PHOTOMICROGRAPHS OF FRESH AND DECOMPOSED MINERALIZED MONZONITE.



A

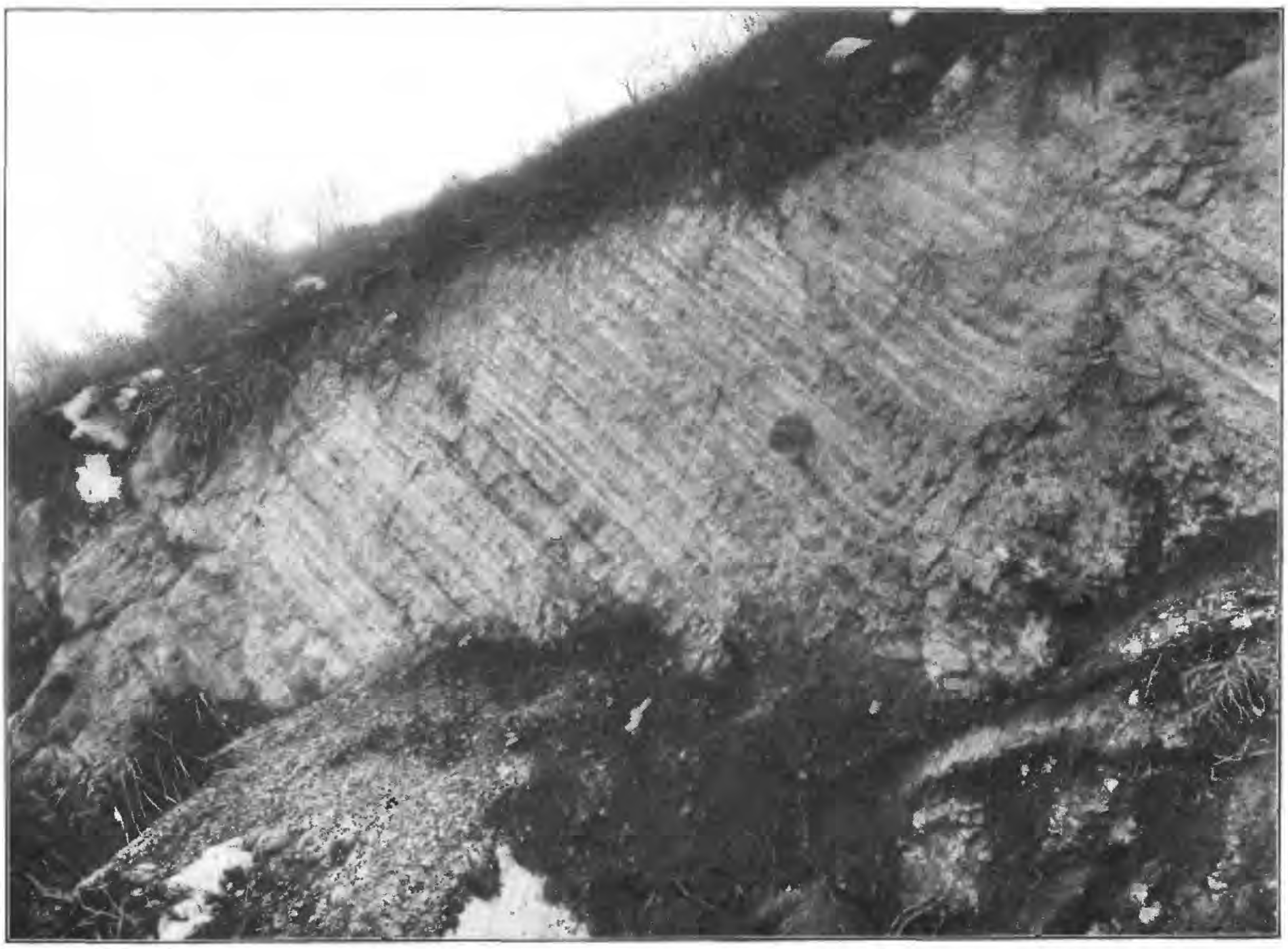


B

PHOTOMICROGRAPHS OF CHALCOPYRITE DEVELOPING IN ALTERED MONZONITE.

A. OUTCROP OF GALENA FISSURE IN METAMORPHOSED JORDAN LIMESTONE.

View is northeast.



B. METAMORPHOSED JORDAN LIMESTONE, NORTHWEST WALL OF GALENA FISSURE.

The alternate lighter and darker bands are marble and blue limestone beds. View is northwest along strike.

of Butterfield Canyon. An excellent opportunity was there offered to note the progressive metamorphism which has taken place in the same bed of limestone with diminishing distance from the intrusive. Fig. 5 shows the general relation of this bed of limestone to the intrusive and the localities from which specimens illustrating the changes observed were obtained. At a distance of about 700 feet from the outcrop of the intrusive the rock (No. 42) is a normal, fine-grained, blue limestone, with hackly fracture, bearing fossils and calcite veinlets, which stand out in relief on a weathered surface (see Pl. XXIX, *A*). This character is maintained to a point within about 525 feet of the intrusive, where the limestone (No. 43) becomes slightly lighter in color. Through the next 20 feet of approach toward the intrusive a striking change takes place. The limestone passes gradually into fine, even-grained, dense, partially crystalline rock, with a fracture between conchoidal, hackly, and feather, of a light-gray color, blotched with a black impurity. About 95 feet beyond, or about 410 feet from the intrusive, the alteration has

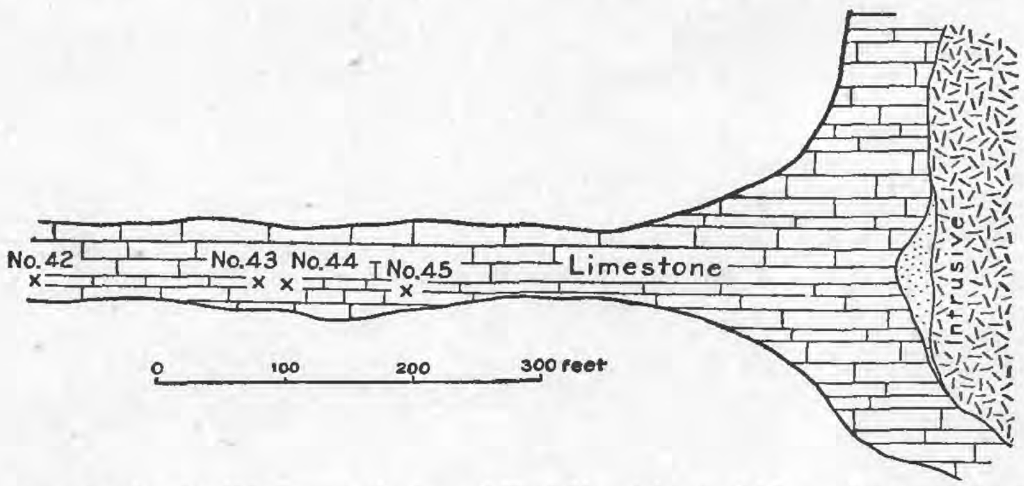
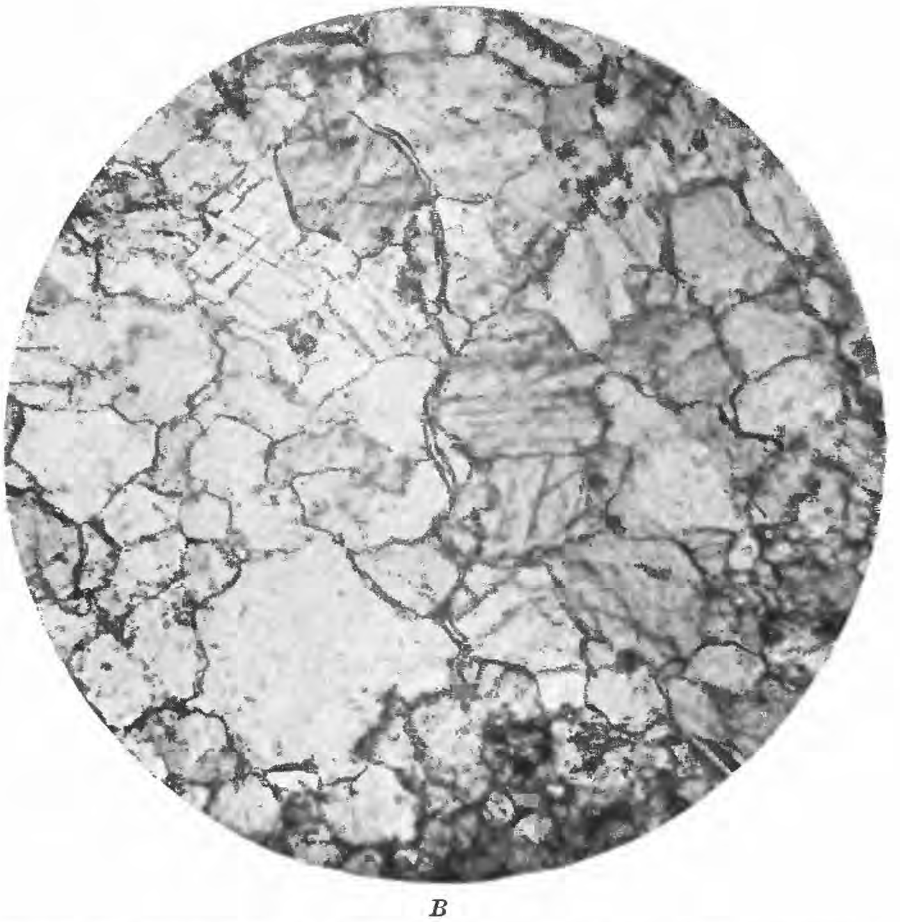


FIG. 5.—Sketch map showing localities on south slope of West Mountain at which specimens illustrating progressive metamorphism were collected.

progressed so far that the rock (No. 45) is an impure crystalline limestone or normal marble of medium-coarse grain. Numerous other occurrences show that these changes continue until a coarse-grained, highly siliceous marble results. In brief, these transitions, in the same bed, from normal blue limestone to crystalline limestone, observed in a rock as it approaches an intrusive, indicate contact metamorphism.

These features are borne out by examination of thin sections under the microscope. Thus, the normal blue limestone (No. 42) shows irregular grains of calcite, sections of fossils replaced by calcite, and small calcite veinlets in an impure calcareous groundmass. The next stage (No. 43) shows minute, round grains of calcite in a clouded, calcareous groundmass, and a few subangular grains of quartz, probably of detrital origin; and the next (No. 44) shows a clearing of the groundmass by concentration of the dark impurities into limited areas, and the continuation of the formation of marble by the crystallization of calcite in rounded grains in

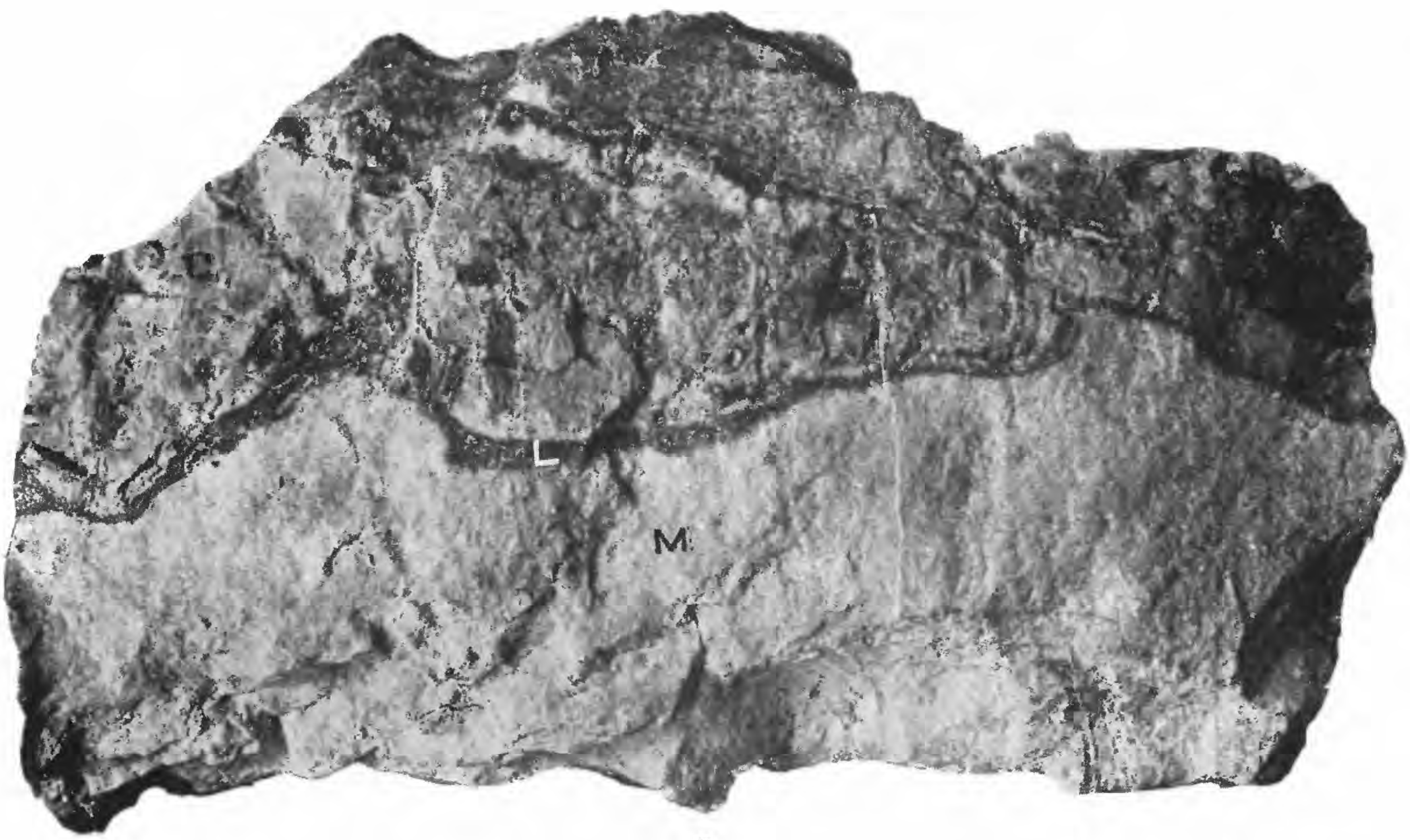
A



B

PHOTOMICROGRAPHS OF FRESH AND METAMORPHOSED LIMESTONE.

A



B

A. CONTACT METAMORPHISM OF SILICEOUS LIMESTONE.

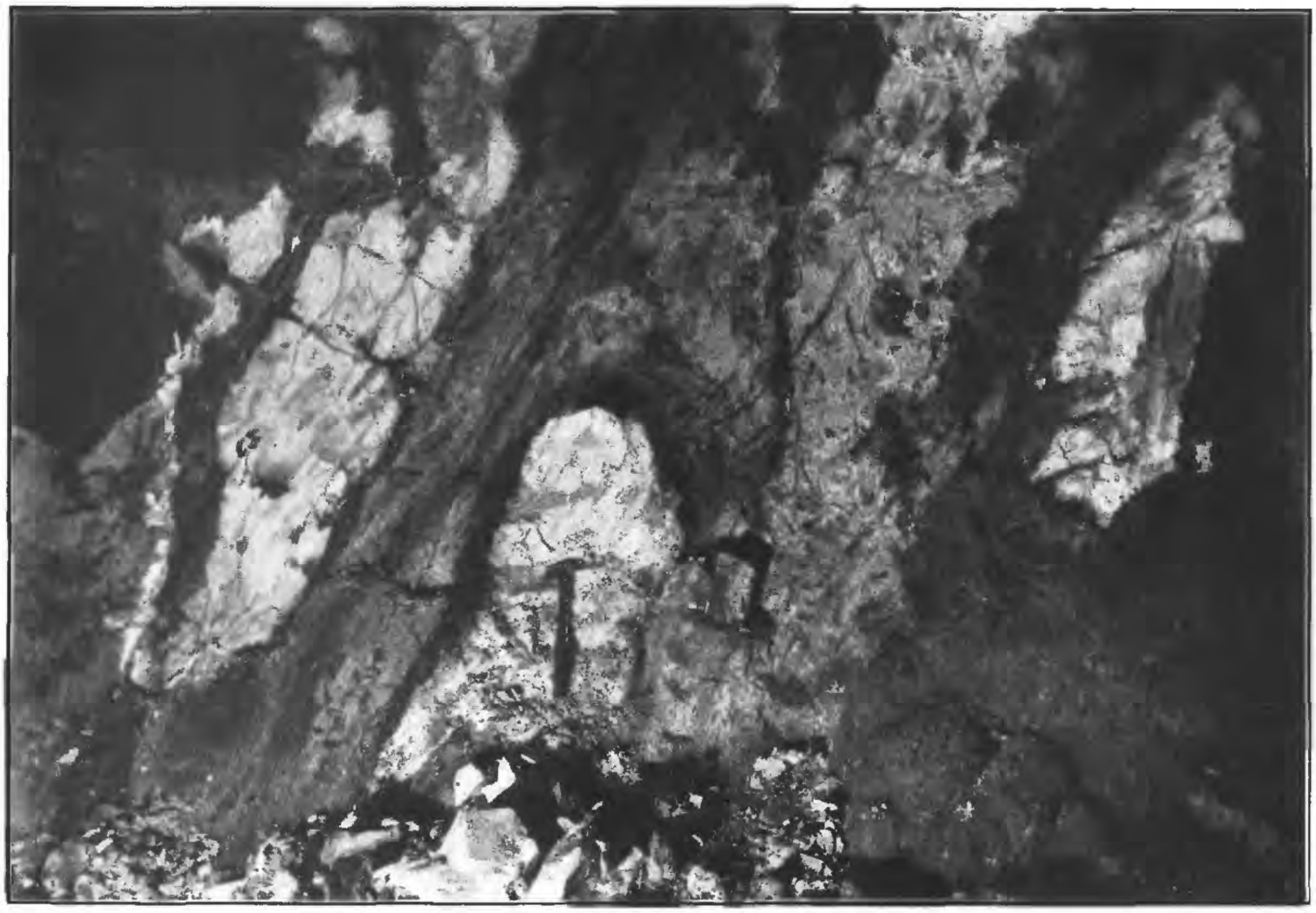
Dark circular areas are chiefly garnet inclosing grains of pyrite and chalcopyrite.

B. EARLY STAGE IN FORMATION OF CHERT NODULES IN MARMORIZED LIMESTONE.

M, Marble; L, impure limestone partially marmorized; C, incipient chert.

A. EARLY STAGE IN REPLACEMENT OF LIMESTONE BY COPPER ORE.

Banded, partially marmorized limestone cut by strike fissures, Highland Boy mine, No. 6 level; looking west. In the walls of these fissures characteristic contact metamorphic minerals appear, and chalcopyrite and specularite replace metamorphic limestone. A sketch cross section of one of these fissures is shown in fig. 2, and replacement is shown in Pl. XXXVII, *B*.



B. LATER STAGE IN REPLACEMENT OF LIMESTONE BY COPPER ORE.

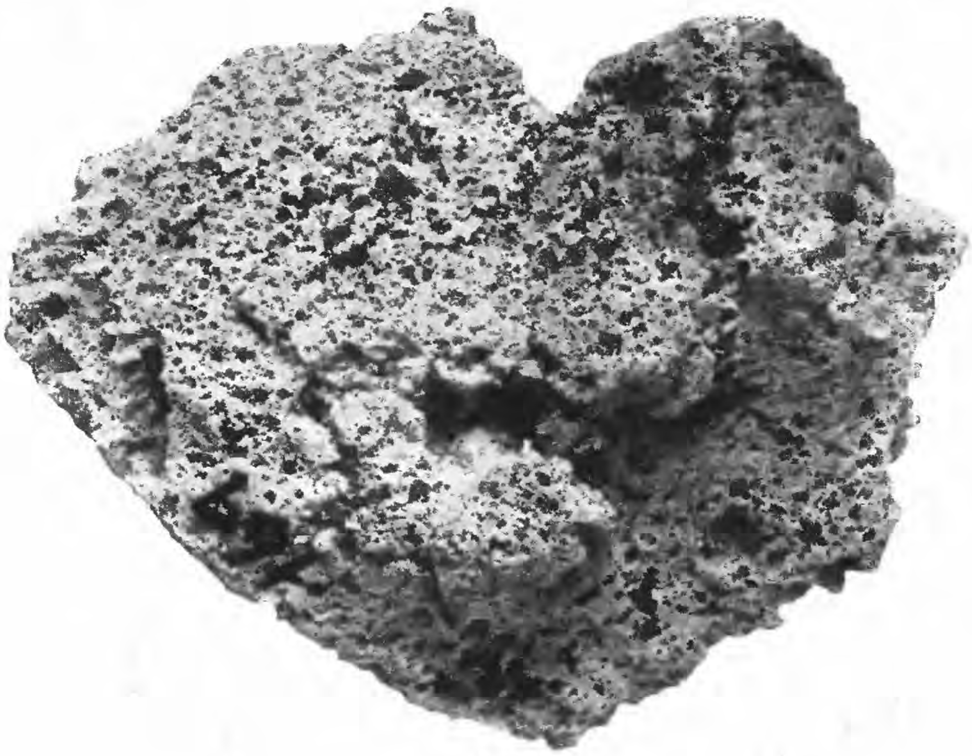
Sulphide copper ore composed of chalcocite, chalcopyrite, and pyrite replacing marble along strike fissures. Highland Boy mine, No. 5½ level; looking east

A. ADVANCED REPLACEMENT OF LIMESTONE BY COPPER ORE.

The dark bands are chalcocite, chalcopyrite, and pyrite; the light ones are granular quartz and cherty siliceous limestone. Retention of bedding structure indicates replacement. Telegraph mine, Grecian Bend level.

B. COMPLETE REPLACEMENT OF LIMESTONE BY COPPER ORE.

Massively bedded cupriferous pyrite, with quartz gangue indicating original bedding. Highland Boy mine, new stope.

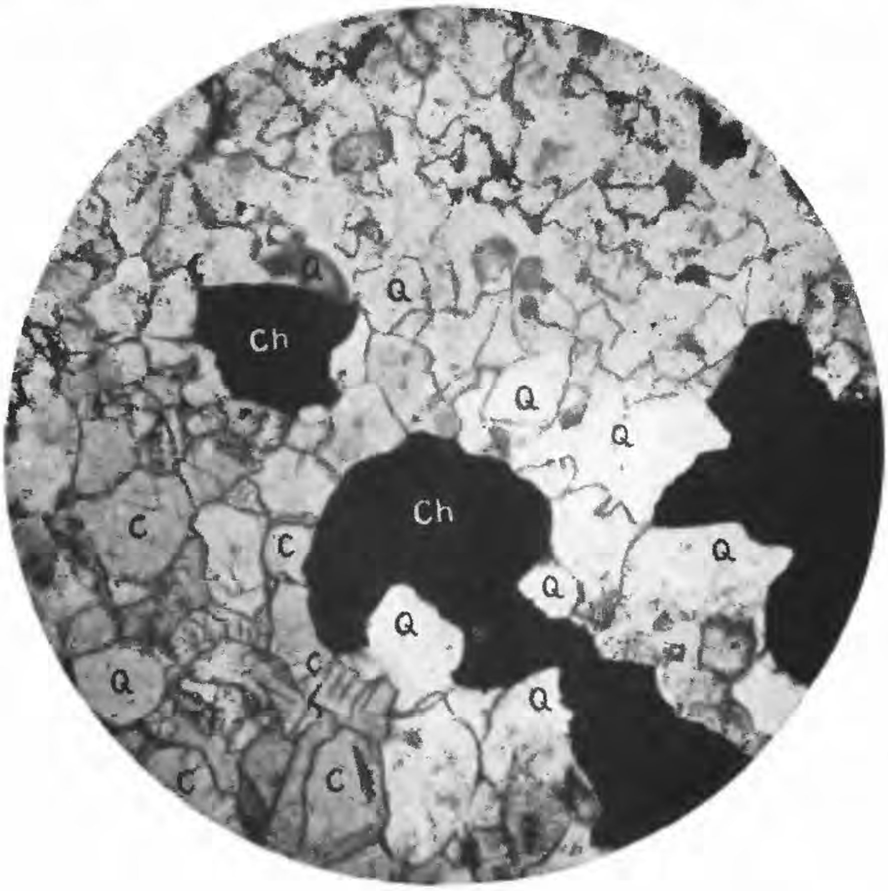


A

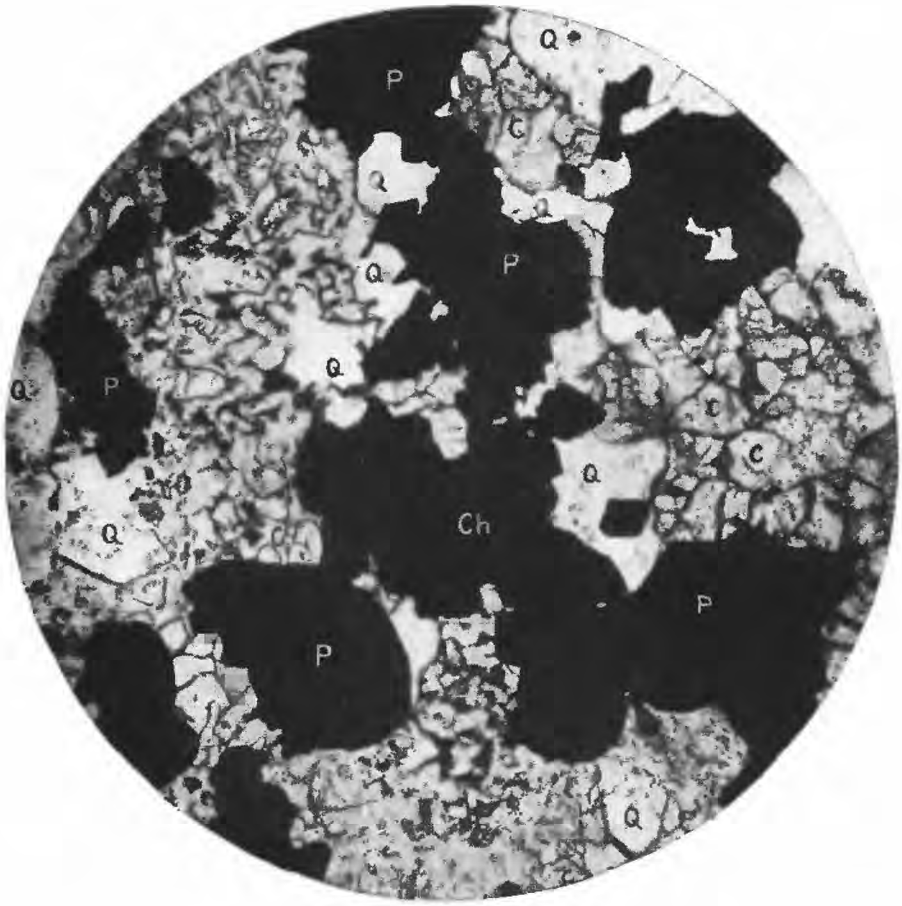
B

A. POROUS, CAVERNOUS STRUCTURE IN QUARTZ.
Characteristic of silica replacing limestone.

B. BANDED PYRITE, CHALCOPYRITE, AND GALENA IN MARBLE.
Retention of original bedding structure indicates replacement.

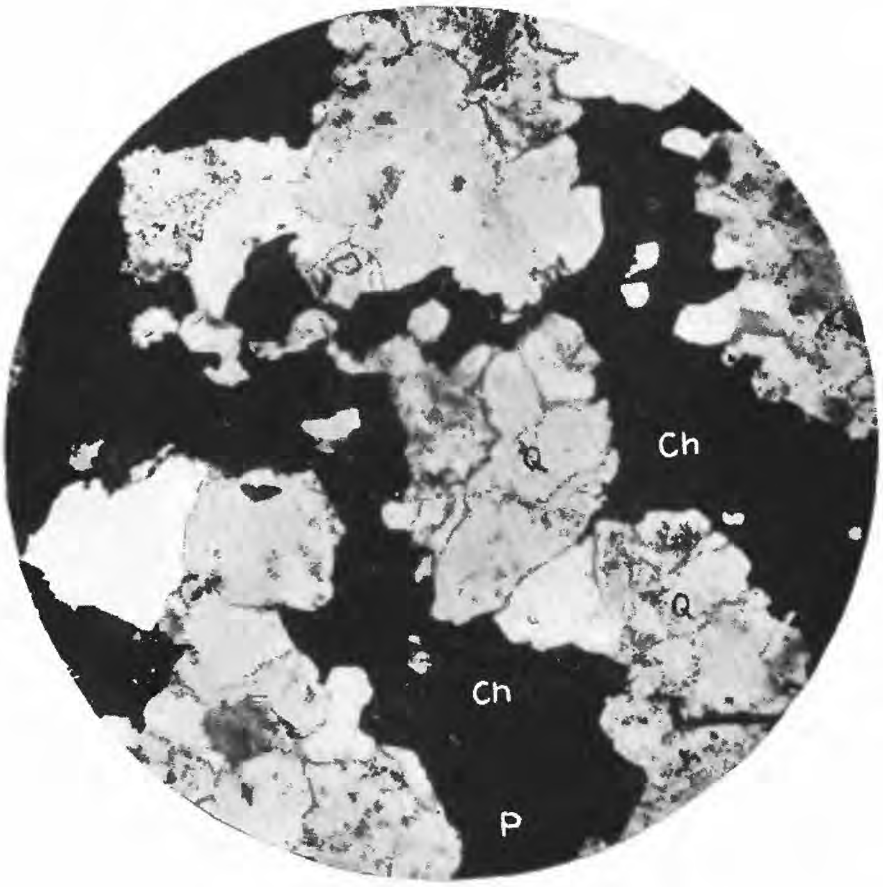


A

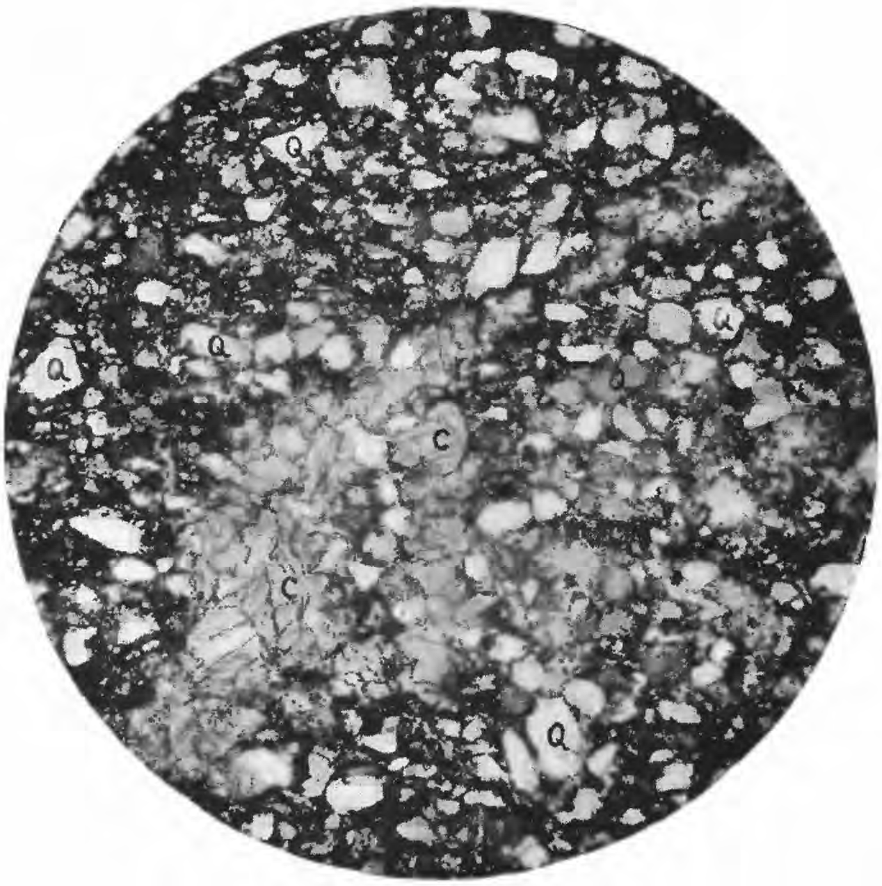


B

PHOTOMICROGRAPHS SHOWING REPLACEMENT OF METAMORPHOSED LIMESTONE BY CHALCOPYRITE AND PYRITE.



A



B

PHOTOMICROGRAPHS SHOWING (*A*) REPLACEMENT OF METAMORPHOSED LIMESTONE, AND (*B*) NORMAL CALCAREOUS SHALE.

embracing quartzite, limestone, shale, and intrusives is much crushed, fractured, and fissured. Within certain northeast-southwest fracture zones, between porphyry, quartzite, and limestone walls, continuous ore occurs. Within limestones and calcareous shales, adjacent to these ore-bearing fracture zones, ore occurs in flat bodies corresponding to limestone strata.

A natural supposition arises that the ore-bearing agent entered strong, deep-reaching fissures, rose along them, depositing ore in transit, entered readily soluble, calcareous rocks, and made out laterally from the fissures along more easily replaced limestone strata.

This supposition appears to be somewhat further strengthened by several criteria gained through detailed studies. The principal copper bodies are either adjacent to or apparently cut by strong mineralized fractures. In country rock which has not been penetrated by fractures such ore shoots are unknown. Neither the ''filling ores'' in the fractures nor the ''replacement'' ores in the limestones are older than the intrusives, and it is not known that the two were not formed contemporaneously. That the solutions were ascending appears to be proved in localities where mineralized fissures bifurcate and terminate upward (see fig. 6). Finally, several occurrences exhibit bands of ore (argentiferous galena in the Neptune and cupriferous and auriferous pyrite in the Colorado) in fissures diverging laterally from their parallel vertical course and continuing horizontally into limestone (see fig. 7).

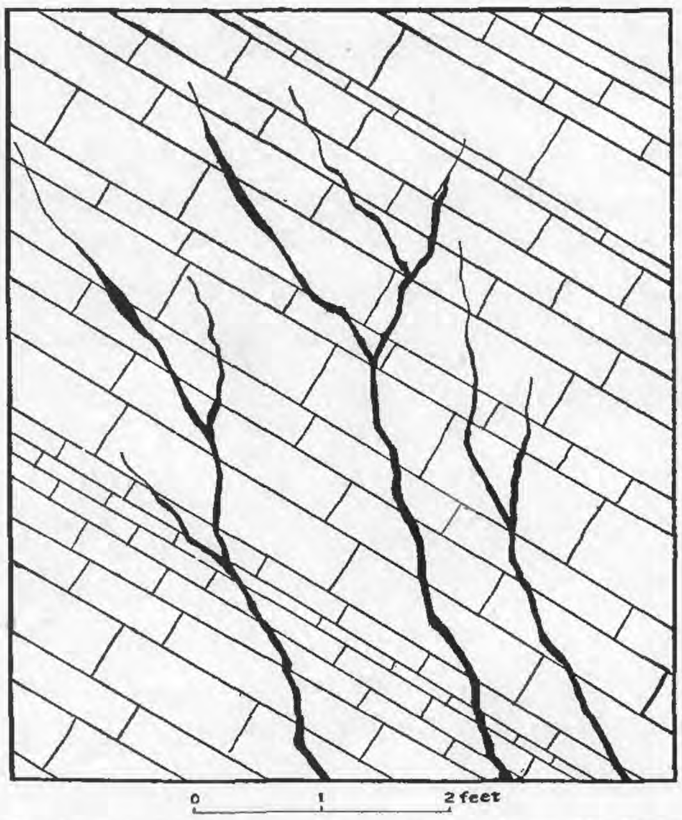


FIG. 6.—Seams of copper and iron sulphides in marble, bifurcating and terminating upward, No. 1 level, west, Commercial mine.

On the other hand, it is to be noted that the typical replacement ore in limestone is essentially a copper ore and the typical lode ore is essentially a lead-silver ore. Thus, the No. 1 shoot in the Highland Boy mine is a mixture of copper and iron sulphides with associated gold and silver in minor amounts, while the typical lode ore, e. g., Silver Shield and Galena lodes, is an argentiferous galena with occasionally argentiferous tetrahedrite and a scattering of copper and iron sulphides. These two types of ore, the pyritous copper and the argentiferous lead, so far as known, have not been observed to grade one into the other, but are mineralogically distinct. Furthermore, while the copper bodies occur in limestone adjacent to lodes, the physical connection of one with the other was not found in the course of underground study. Although ore bodies are unknown in unfractured ground, much fractured country rock has been explored which did not show ore. As regards the relative date of the deposition of the lode ore and of the replacement ore, the former is later than the intrusives, the latter, in part at least, is probably roughly contemporaneous with intrusion. The age of the bulk of the replacement ore has not been proved. It was probably either contemporaneous with intrusion or contemporaneous with the subsequent deposition of the lode ore. Certainly not all replacement ore was deposited simultaneously with lode ore.

Regarding the occurrence in the Colorado mine of copper sulphide in a fissure feeding replacement ore in limestone, it is to be noted, first, that the example is an isolated and extremely limited one, and, second, that the occurrence is unusual, the copper ore in the fissure not being the typical lode ore.

Although these comparisons throw doubt on the probability that the lode fractures were the channels by which the copper-bearing solution reached the limestone, they do not disprove that supposition. Search for conclusive evidence on these critical points was unsuccessful. Additional evidence is required to warrant the conclusion that strong fissures were the sole sources of copper-bearing solutions. Until that is obtained, the part played by fissures in the generation of these ores can not be definitely stated.

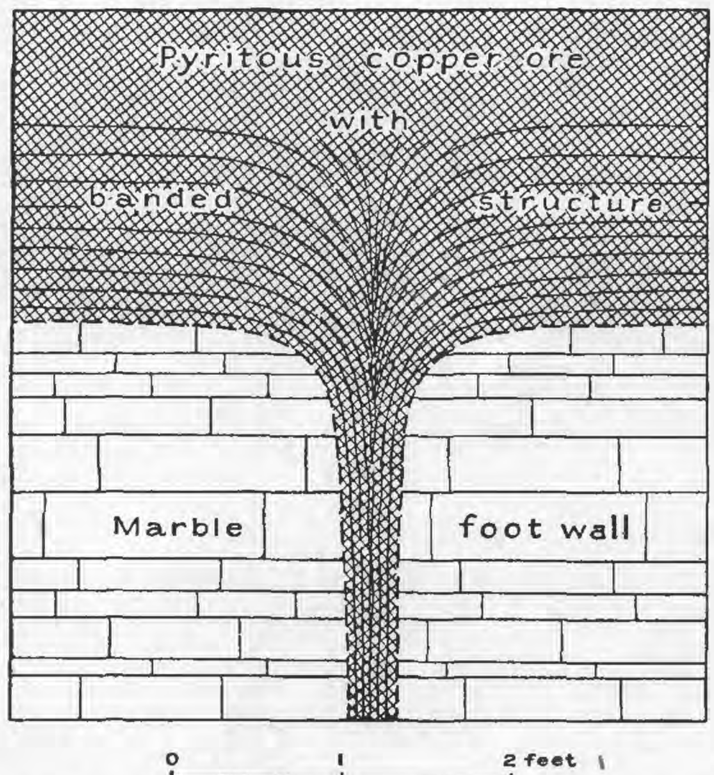
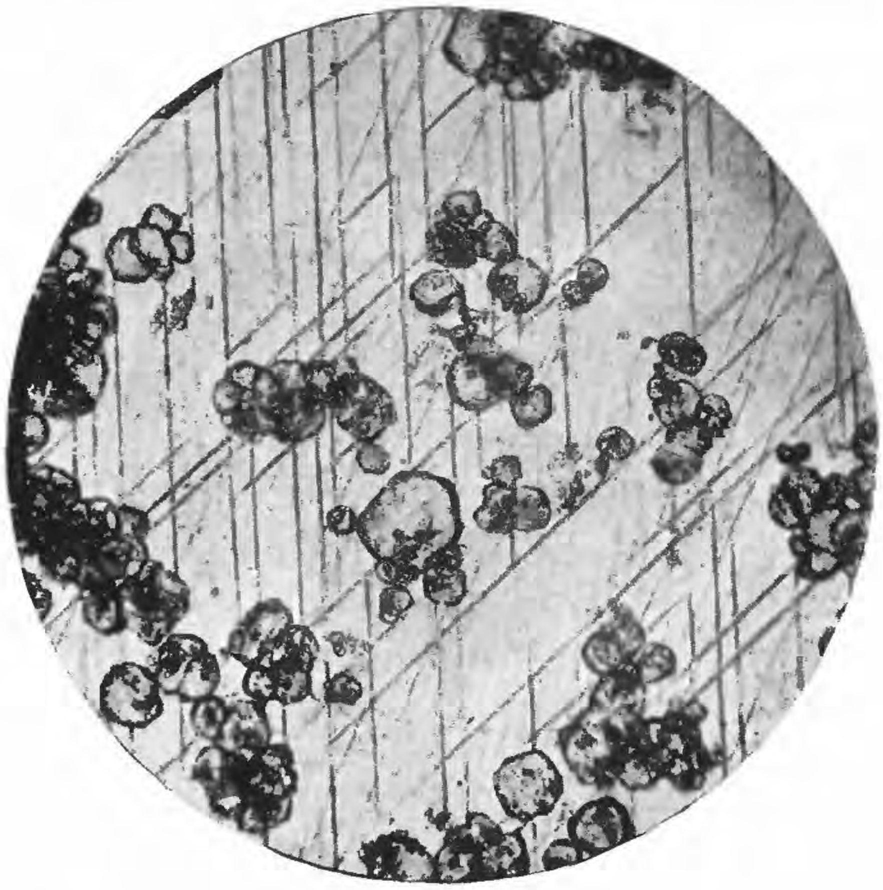


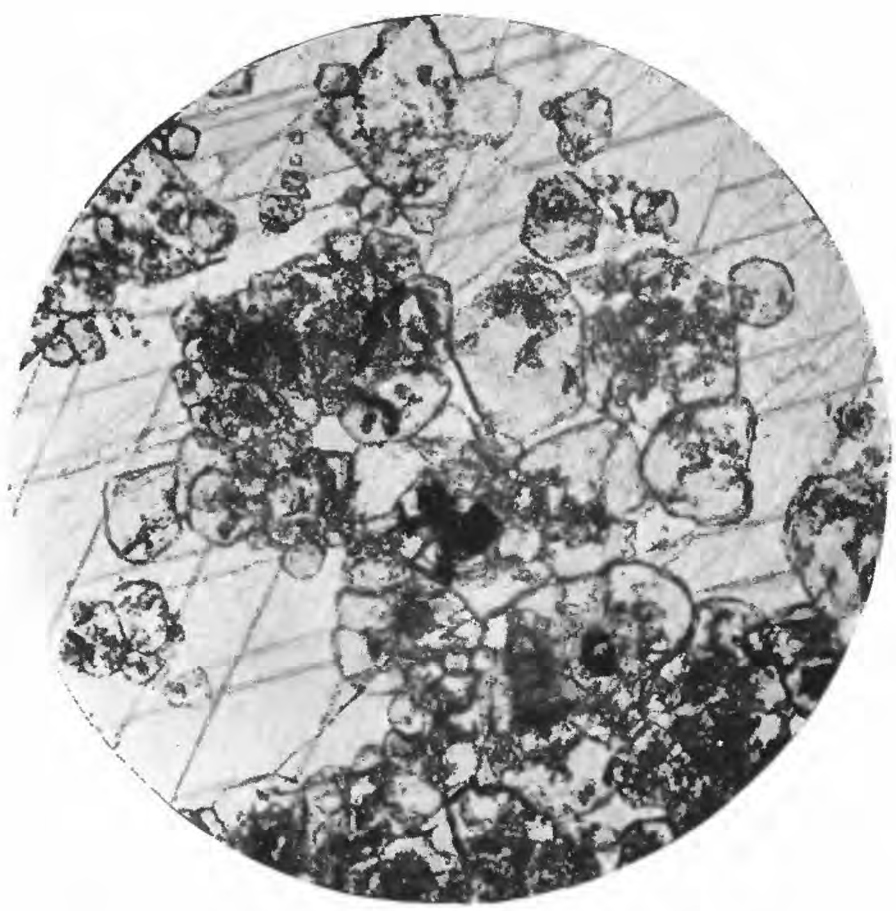
FIG. 7.—Sketch of replacement copper ore in limestone, with feeder, Colorado upper tunnel.

Relation of intrusives to deposition of copper ore in limestone.—It is a common observation that intrusives are causatively related to the generation of ore. The precise character of this relation has never been acceptably determined. Recently microscopic study has served greatly to increase knowledge of this problem. It tends to show that a distinct type of ore, indicated by characteristics of composition and association, is formed through the agency of intrusives. Ores of this type may be termed "contact deposits."

"In many schemes of classification and description the term 'contact deposit' has been somewhat loosely applied to all accumulations of useful minerals (other than those of unquestioned sedimentary origin) which are enclosed between two

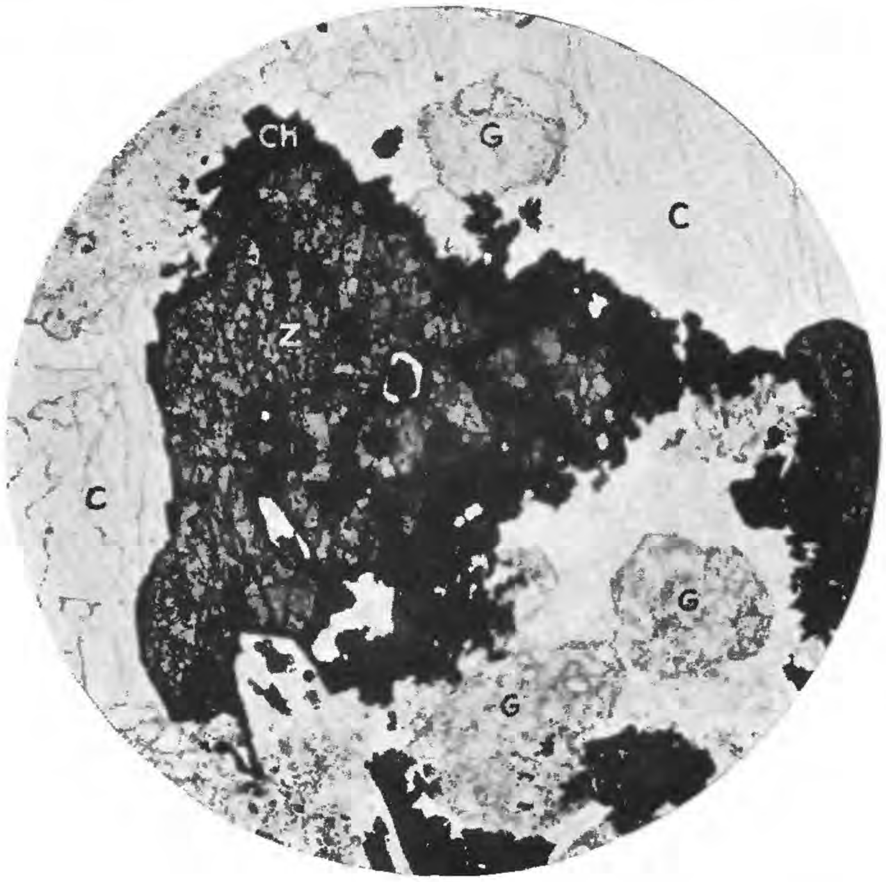


A



B

PHOTOMICROGRAPHS OF CHALCOPYRITE AND PYRITE ASSOCIATED WITH CONTACT METAMORPHIC MINERALS.



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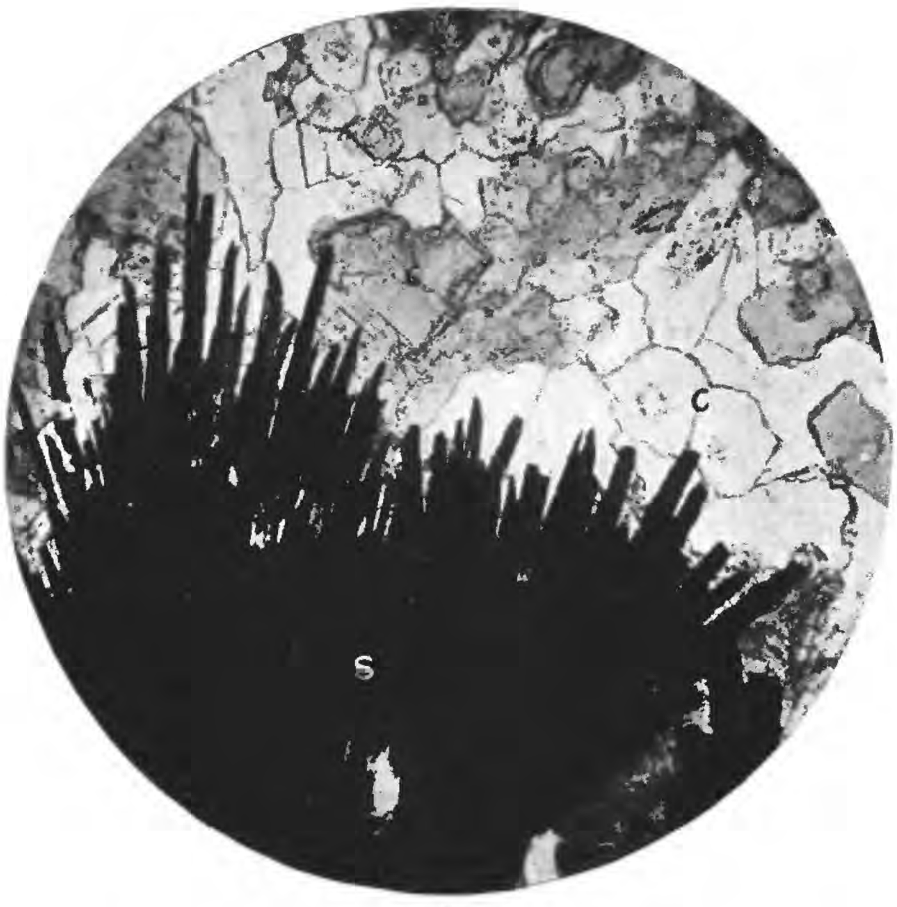
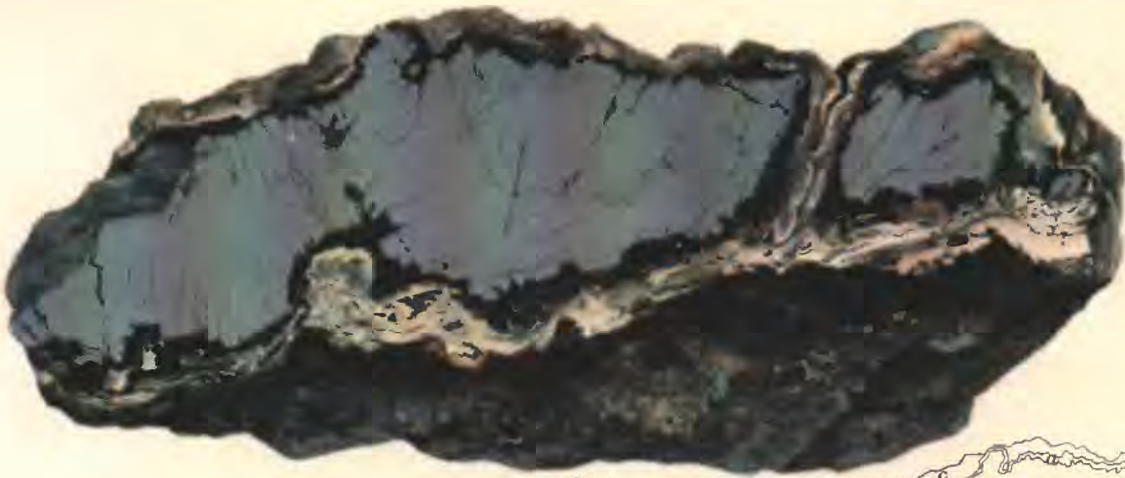
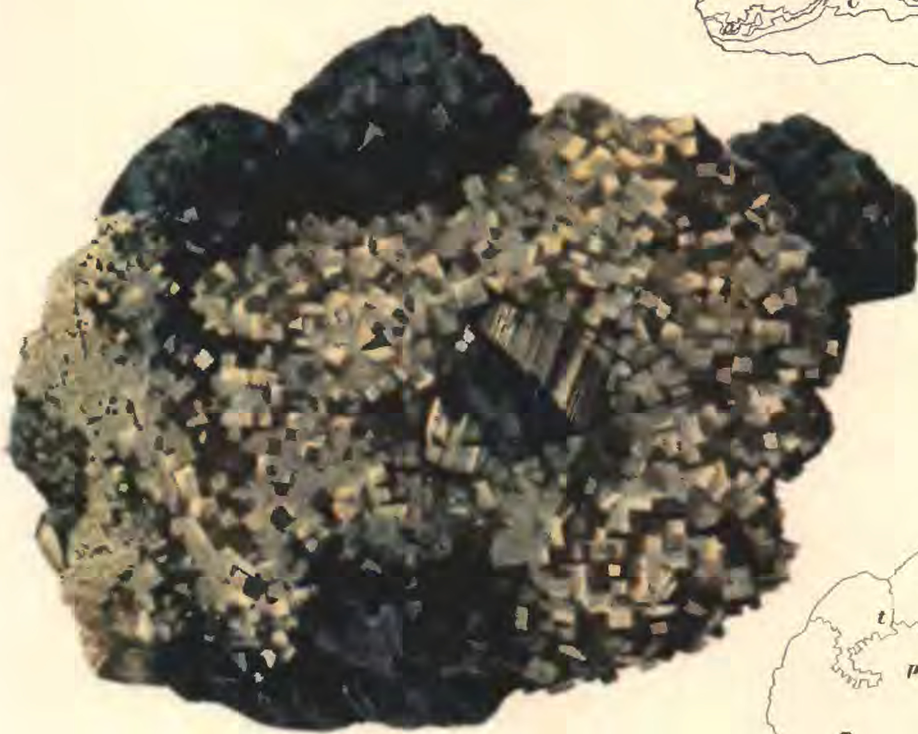


B

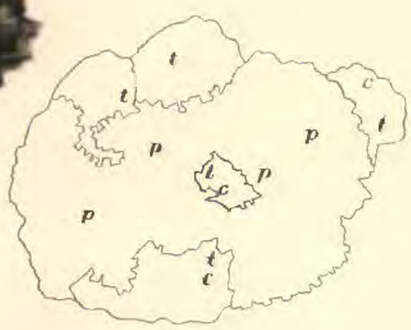
PHOTOMICROGRAPHS OF (*A*) CHALCOPYRITE ASSOCIATED WITH CONTACT METAMORPHIC MINERALS AND (*B*) SPECULARITE REPLACING CALCITE.

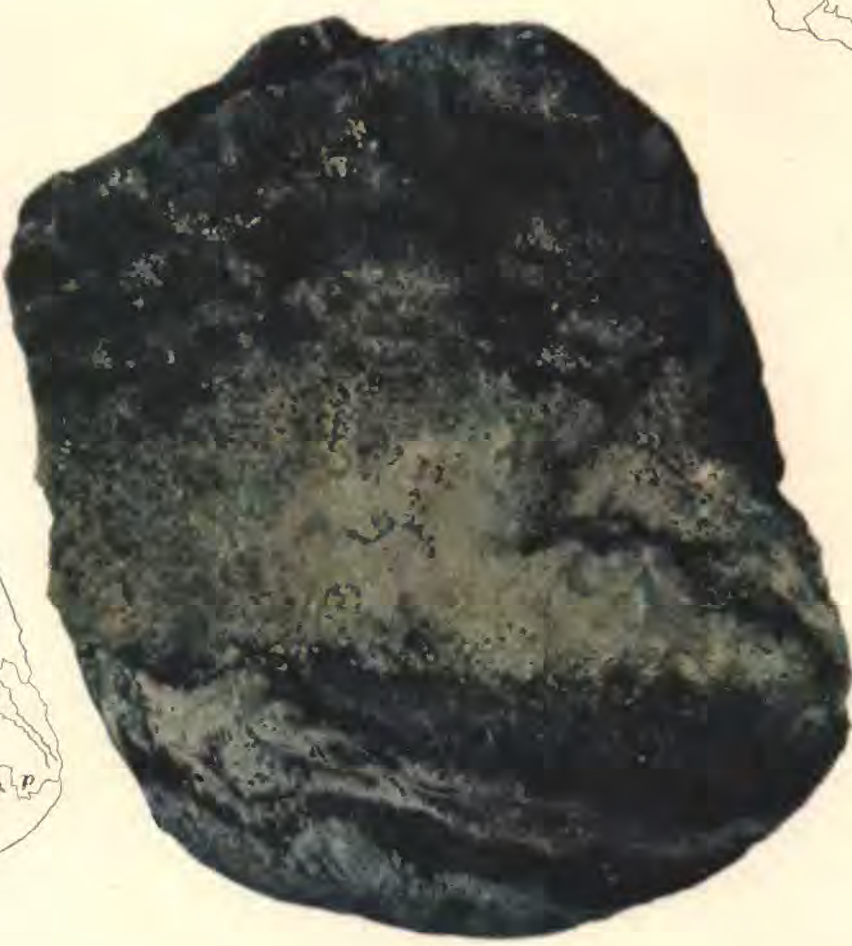


(A)



(B)





(C)

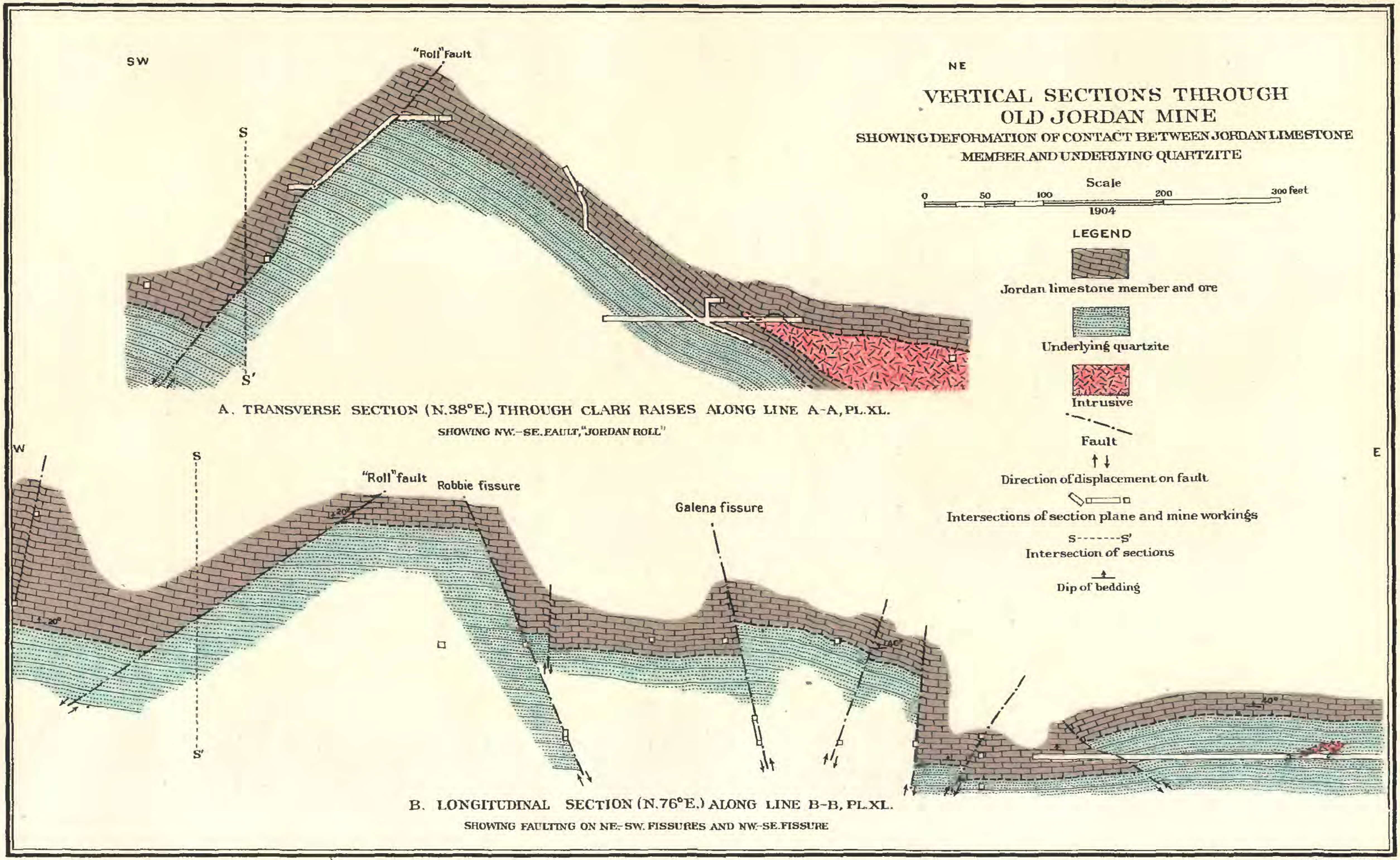
SUPERFICIAL ALTERATION OF SULPHIDE ORES

SURFACE WORKINGS ON THE GALENA FISSURE.

View is southwest.

VERTICAL SECTIONS THROUGH OLD JORDAN MINE

SHOWING DEFORMATION OF CONTACT BETWEEN JORDAN LIMESTONE MEMBER AND UNDERLYING QUARTZITE



A. TRANSVERSE SECTION (N.38°E.) THROUGH CLARK RAISES ALONG LINE A-A, PL. XL.

SHOWING NW.-SE. FAULT, "JORDAN ROLL"

B. LONGITUDINAL SECTION (N.76°E.) ALONG LINE B-B, PL. XL.

SHOWING FAULTING ON NE.-SW. FISSURES AND NW.-SE. FISSURE

A. HOEN & CO. BALTIMORE

VERTICAL SECTIONS THROUGH TELEGRAPH MINE

SHOWING DEFORMATION OF CONTACT BETWEEN JORDAN LIMESTONE MEMBER AND UNDERLYING QUARTZITE

Scale

0 50 100 200 300 feet

1904

LEGEND

Jordan limestone member and ore

Underlying quartzite

Intrusive

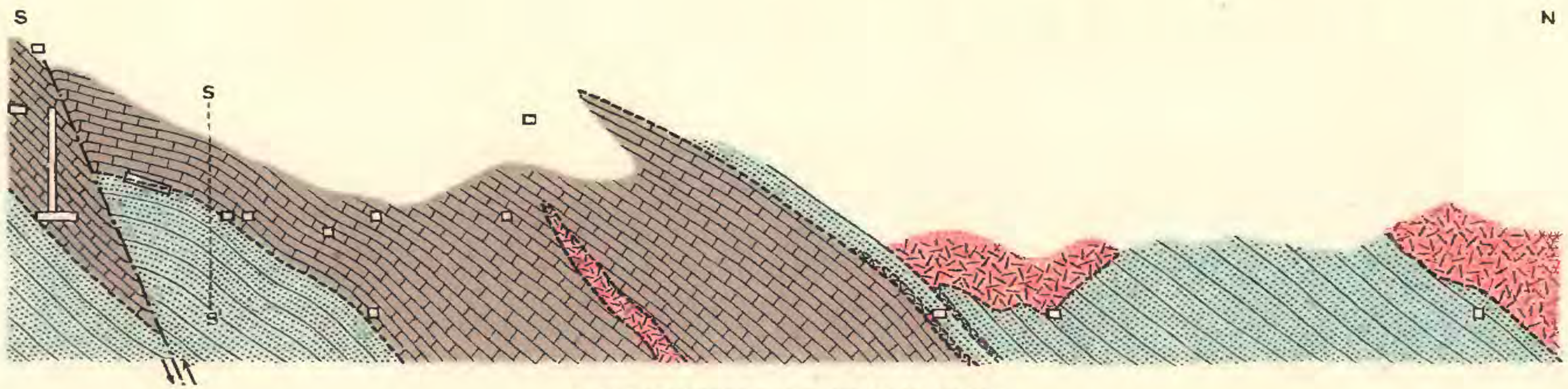
Fault

Direction of displacement on fault

Intersections of section plane and mine workings

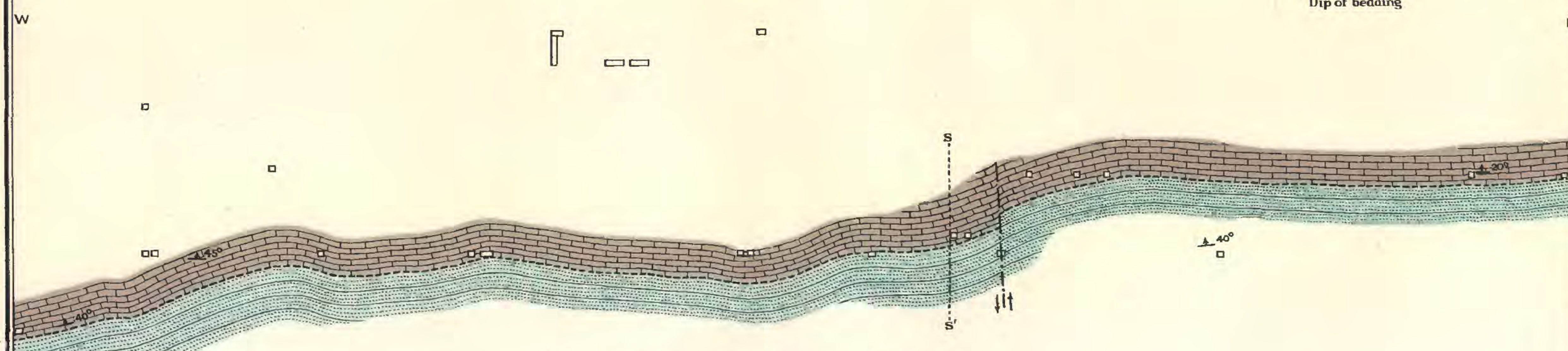
S-------S'
Intersection of sections

Dip of bedding



A. TRANSVERSE SECTION (N.6°W.)

SHOWING STRIKE FAULT AND INTRUSIVES



B. LONGITUDINAL SECTION (N.76°E.)

SHOWING ROLLING CHARACTER OF CONTACT ALONG THE STRIKE

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The Robbie fault is marked at three main levels—No. 1, Delia B, and Drain—and in extensive stopes along its course. It hades eastward at angles ranging from 12° to 15° and offsets the limestone from 90 to 100 feet in the plane of the longitudinal section shown on Pl. XL, section B. The Galena fissure appears on the Delia B, Compromise, Drain, and Utah levels in the mine proper, and, as previously stated, has been explored to the southwest below the limestone for a horizontal distance of about 3,000 feet and a vertical distance of over 600 feet. It trends from N. 29° E. to N. 40° E., hades eastward at an angle of about 15°, and offsets the limestone in the plane of the section approximately 30 feet. The Robbie fissure attains its highest economic importance within the limits of the Jordan limestone, but on the Galena fissure the main values have been taken from below the limestone.

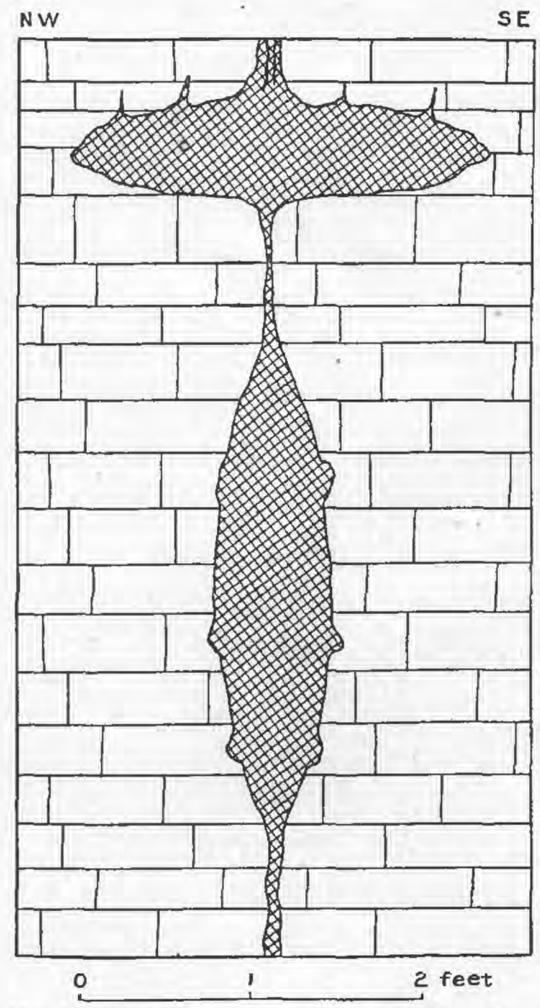


FIG. 8.—Transverse section of ore bodies of argentiferous lead on Neptune fissure in Jordan limestone, Neptune tunnel, looking northeast.

Age of Jordan roll and northeast faults.—On the question of the relative age of the faults that form the roll, and of the northeast faults, the evidence is contradictory. The roll fault has been recognized at several points west of the Robbie fissure and also at the opposite end of the mine, in the Utah stope, where it has southwestward dips of 38° and 40°, respectively. The planes there observed were probably causatively related, genetically contemporaneous, and originally united; and, if this be true, the present displacement of the roll along the northeast fractures proves the later movement on the latter. Apparently opposing this conclusion, but less worthy of credence, is the relation of northeast and northwest slip planes at the crest of the roll in Utah stope. There the planes trending N. 40° E. clearly seem to be cut cleanly by one trending N. 40° W. It may be, however, that at this point the later movement on the northeast fissure did not take place. This explanation would remove the apparent contradiction in a reasonable manner and leave the conclusion that in general the relatively later movement was on the northeast planes.

In brief, the Jordan roll is cut by the Galena and Robbie faults into three great fault blocks, the western one extending from the Robbie westward; the eastern from the Galena eastward, and the central being included between the Robbie and Galena fissures. The movement on the faults is neither systematic

A. HIGHLAND BOY TUNNELS, UPPER TERMINAL OF AERIAL TRAMWAY, AND OLD CYANIDE MILL.

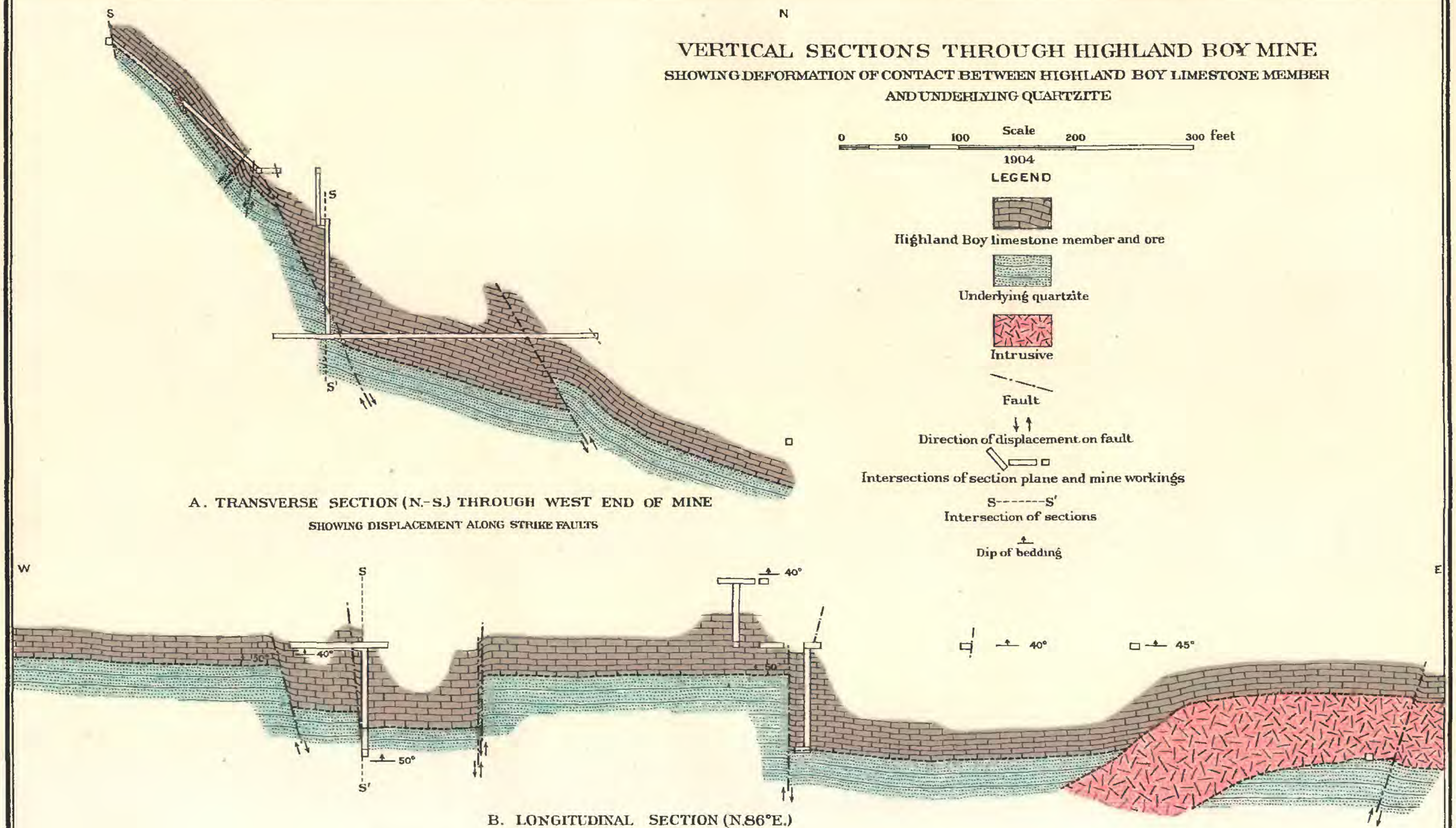
View is west, up Carr Fork (left) and Sap Gulch.

B. QUARTZITE FOOT WALL OF YAMPA LIMESTONE ON NORTH SLOPE OF SAP GULCH.

View is north, over old Highland Boy cyanide mill.

VERTICAL SECTIONS THROUGH HIGHLAND BOY MINE

SHOWING DEFORMATION OF CONTACT BETWEEN HIGHLAND BOY LIMESTONE MEMBER AND UNDERLYING QUARTZITE



A. TRANSVERSE SECTION (N.-S.) THROUGH WEST END OF MINE

SHOWING DISPLACEMENT ALONG STRIKE FAULTS

B. LONGITUDINAL SECTION (N.86°E.)

SHOWING DISPLACEMENT ALONG DIP FAULTS

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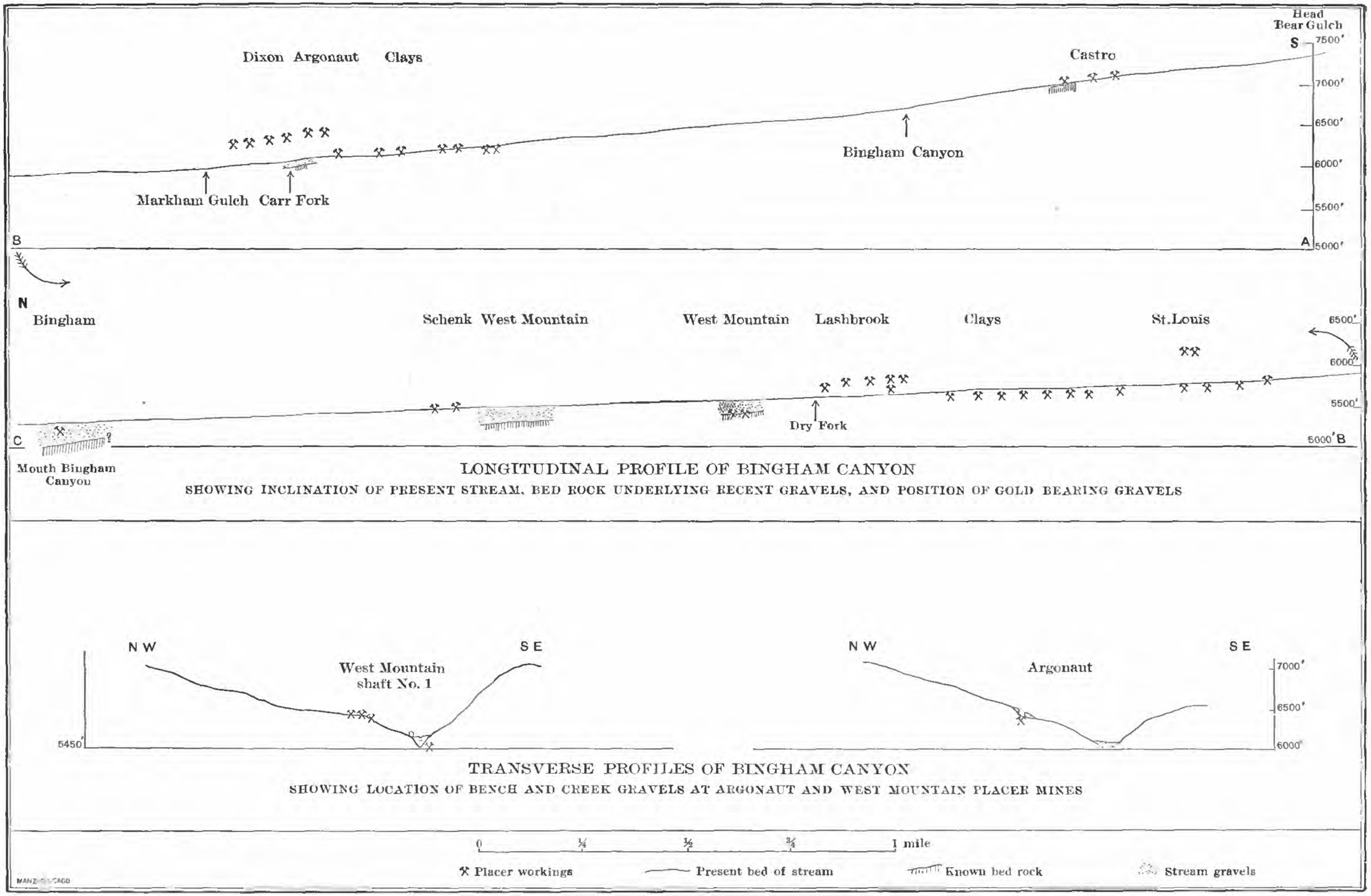
OUTCROP OF QUARTZITE FOOT WALL OF BROOKLYN ORE BODIES.

View is northeast.



PROFILES OF BINGHAM CANYON.

A. DISSECTION OF BOTTOM GRAVELS BY BINGHAM CREEK IN LOWER BINGHAM CANYON.

View is northeast.

B. RECENT DISSECTION OF BONNEVILLE BENCH BY TOOELE CREEK ON WEST SLOPE OF OQUIRRH RANGE.

View is northward along west slopes of Oquirrhs. In the middle background Stansbury Island appears above Great Salt Lake.

ingly valueless in interpreting the great stages of erosion. Evidence of glaciation has not been found. In his study of Lake Bonneville history Gilbert described a fault along the west base of the Oquirrhs, on which he believed the range to be relatively rising on the east. Further, he determined a broad epirogenic movement of the same phase which, like that on the fault, tends to tilt the range in post-Bonneville time toward the east. Such a movement, even of that recent date, would not affect the great erosion stages, and it is believed the movements began at a much earlier period. As regards the influence of Lake Bonneville upon the deposition of the latest thick gravel deposits in lower Bingham Canyon, it is to be noted that the general upper limit of that water body assigned by Gilbert is 5,200 feet, while the present elevation of the surface of the gravels on West Mountain placer ground is 5,500, and their base at that point about 5,250, and that the Bonneville

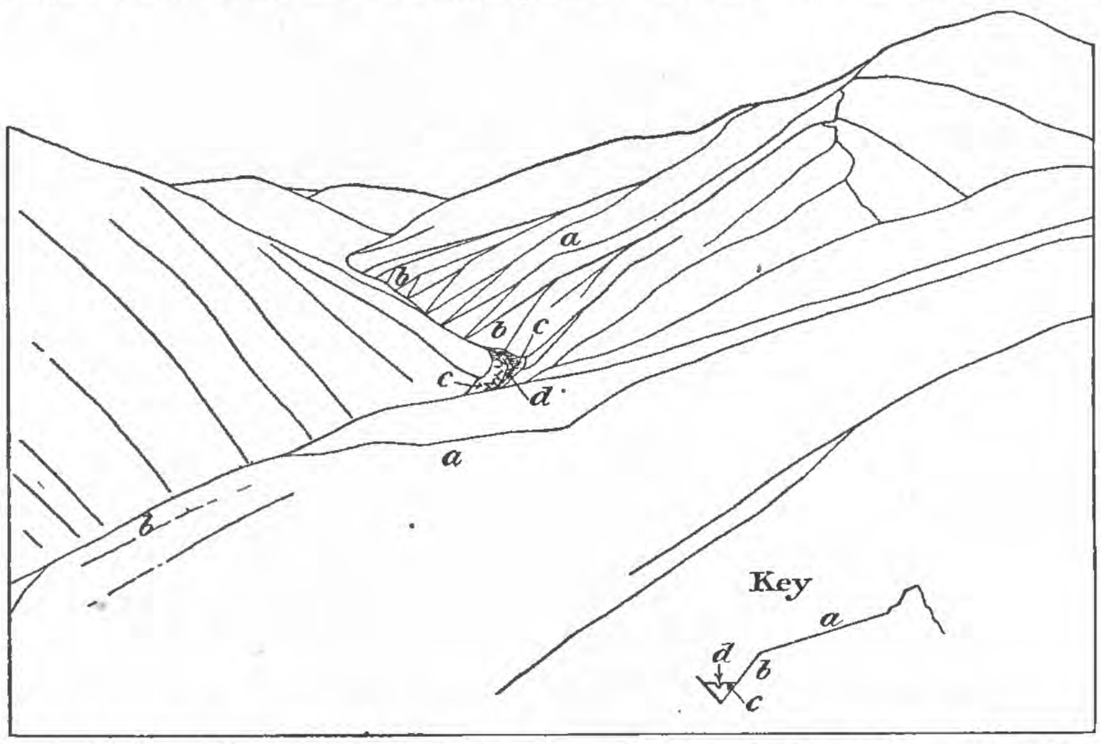


FIG. 9.—Profiles of Bingham Canyon, showing stages of erosion. Looking south up canyon from Black Dog tunnel. *a*, Mature cycle, bench gravel stage; *b*, youthful cycle, canyon stage; *c*, aggradation cycle, creek gravel stage; *d*, present cycle, recent dissection stage.

bench on the eastern slope of the range within the Bingham area was not noted at or above the 5,250 level. These evidences are in accord with Gilbert's opinion of the extent of Lake Bonneville in this locality as depicted on his map, which shows the upper limit of the lake extending considerably to the east of the eastern foothills of the Oquirrhs, and thus below Bingham Canyon. Although this would appear to eliminate this factor in the deposition of even the most recent gravels, the question is a broad one whose final solution must await more extended study of recent land movements and of the eastern continuations of the Bingham Creek gravels than was practicable during the present survey. Lithologic differences and geologic structures fail to explain the systematic topographic features. The land forms themselves can best tell their history.

AURIFEROUS GRAVELS IN UPPER BEAR GULCH.

View is west. Tunnels in foreground are driven on west rim for pay dirt at base of gravels.

A. ARGONAUT OPEN CUT IN AURIFEROUS BENCH GRAVELS.

View is south-southeast up Bingham Canyon.

B. AURIFEROUS CREEK GRAVELS IN BINGHAM CANYON BELOW UPPER BINGHAM.

View is north-northwest.

by two parties, the upper 600 feet by one Crowley, the lower 600 feet by the Clays Brothers. The Crowley ground was not found to pay, but the Clays ground was exceedingly rich and was most thoroughly worked. Accordingly it was more thoroughly known than any other portion of these rim workings. The precise relation of the Old Channel to the Clays rim is in some doubt. Though they are commonly considered the same, Mr. Daniel Clays has noted that the form of the rim channel in his ground is quite unlike that of the Old Channel, and further, that while a portion of the basal gravel from his workings was somewhat cemented, so that it was frequently desirable to expose it to alternate freezing and thawing to break it up, the Old Channel basal gravel was unconsolidated. Inasmuch as the Clays ground is so well known as a separate successful working, it will be here described separately.

Clays rim.—The rim gravels exploited by the Clays Brothers are located on the southeast side of Bingham Canyon, below the creek level, and extend from the mouth of Damphool Gulch upstream to a point nearly opposite the mouth of the next small gully, a distance of something over 600 feet.

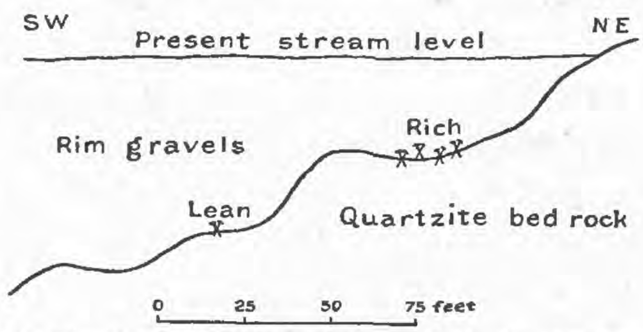


FIG. 10.—Transverse section of lower Clays rim, showing three pay channels.

Exploration has revealed a series of three side channels or rims, 30, 50, and 65 feet beneath the surface of present creek gravels, averaging 60, 20, and 30 feet, respectively, in width (see fig. 10). The upper level is at this point at the level of the Old Channel bar, and, though the gravel upon it is partially cemented, the two are commonly considered portions of the same rim deposit. Bed rock in the Old Channel stretch is said to have been even and waterworn, with only one pothole. This feature of this and other lower rims is in notable contrast with the steep unevenly potholed beds of some of the high benches, such as the Dixon and St. Louis.

The single rim of the Old Channel gives way at the head of the Clays workings to the composite three-channeled rim above described. And similarly, in the lower end of the Clays ground, at the point where these three channels swing northward, they are replaced by a single channel which enters the main canyon. As this lowest part carried especially high values, its continuation downstream was energetically sought. Shafts were sunk on both sides of the canyon, but no further trace of this rich rim was found beyond.

The Clays ground on this rim was thoroughly explored by sinking shallow shafts averaging 20 feet, to bed rock, and by stoping laterally from the bottom of the shafts for distances ranging from 6 to 20 feet, according to the character of pay and of the ground. This method was found more economical of time, money, and life than