PRELIMINARY REPORT ON THE GEOLOGY

OF THE

ATLANTIC CITY-SOUTH PASS MINING DISTRICT

by

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ILLUSTRATIONS

PRELIMINARY REPORT ON THE GEOLOGY OF THE ATLANTIC CITY-SOUTH PASS MINING DISTRICT WYOMING

ABSTRACT

The Atlantic City-South Pass mining district is in the southwest corner of Fremont County, Wyo., in an area of pre-Cambrian metamorphosed sedimentary rocks. The rocks trend northeast, dip steeply, and have been isoclinally folded. The folds are slightly overturned to the northwest and plunge northeast. The area is cut by east-west and north-south faults. Ore-bearing quartz veins are intimately associated with the east-west system of faults. The ore minerals are arsenopyrite and gold. Future development of the district is dependent upon the recognition of the relationship between faulting and ore deposition and the proper metallurgical treatment of the sulfide ore. It is believed that under favorable conditions a few small mines can be developed.

INTRODUCTION

Purpose

In connection with the full development of the resources of the Missouri valley, the Bureau of Reclamation asked the Geological Survey to investigate the Atlantic City-South Pass district, Fremont County, Wyo., in order to evaluate its future as a mining district. The work on which the present report is based was started in February 1946 and continued to May 1947. Field work was started the middle of April 1946 and terminated the end of September 1946. After September only part time was devoted to the study of specimens and the preparation of the report and maps. The lack of an adequate base map delayed the work and it is hoped that one will be available for future work. Most of the time prior to July 1, 1946, was spent in establishing a triangulation system for control of a map to be made by multiplex methods from aerial photographs. This is a report of recent development in the area, and a review of the geologic work done thus far, summarizing new conclusions reached and their possible bearing on future work.

Location

The Atlantic City-South Pass mining district is at the extreme southeastern end of the Wind River Range in the southwest corner of Fremont County, Wyo., about 23 miles due south of Lander (fig. 1). Mineral deposits have been found in an area of pre-Cambrian schist covering approximately 250 square miles (fig. 2) which includes both the Atlantic City-South Pass and Lewiston districts. The Atlantic City-South Pass district occupies a belt approximately six miles wide extending from a few miles southwest of South Pass City to Miner's Delight on the northeast, a distance of about 12 miles, and covers an area of about 72 square miles.

Access

Atlantic City is approximately 33 miles by road from Lander and may be reached by following U. S. Highway 287 about 15 miles southeast from Lander at which point a new highway runs southwest for 8 miles. From this point the road is an unimproved dirt road which is impassable in bad weather. The dirt road runs through Atlantic City and South Pass City southwest to about 20 miles northeast of Farson where it meets the other end of the new highway.

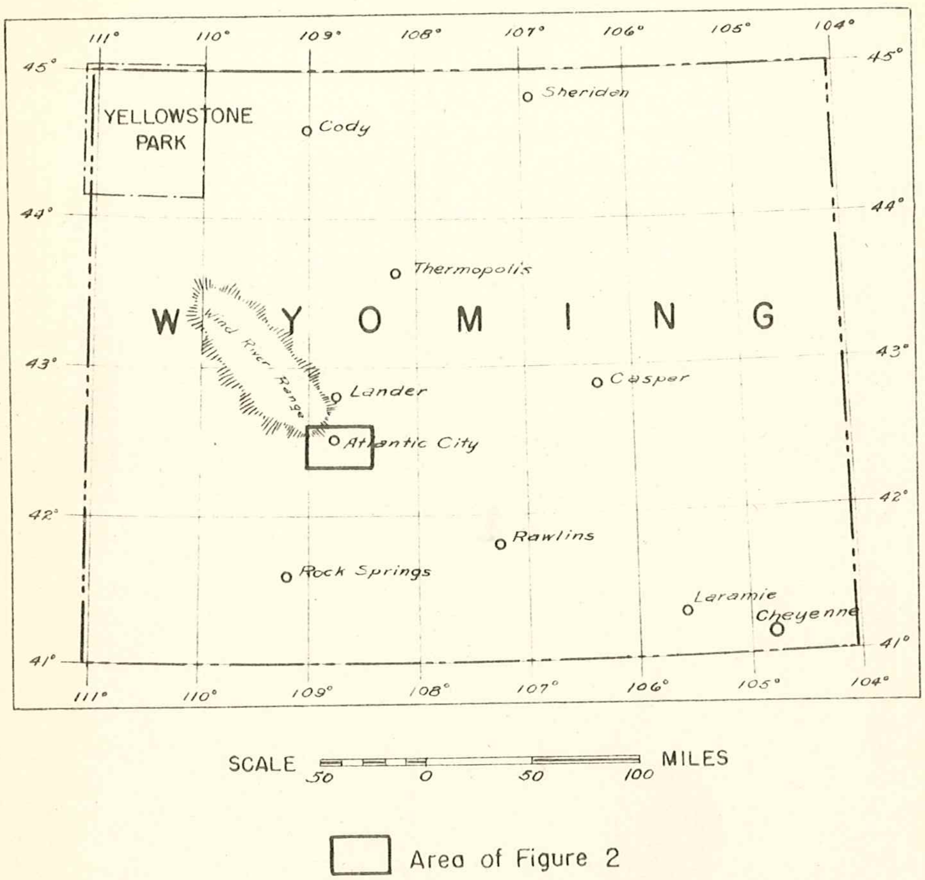

FIGURE I, INDEX MAP

ATLANTIC CITY - SOUTH PASS DISTRICT

FREMONT COUNTY, WYOMING

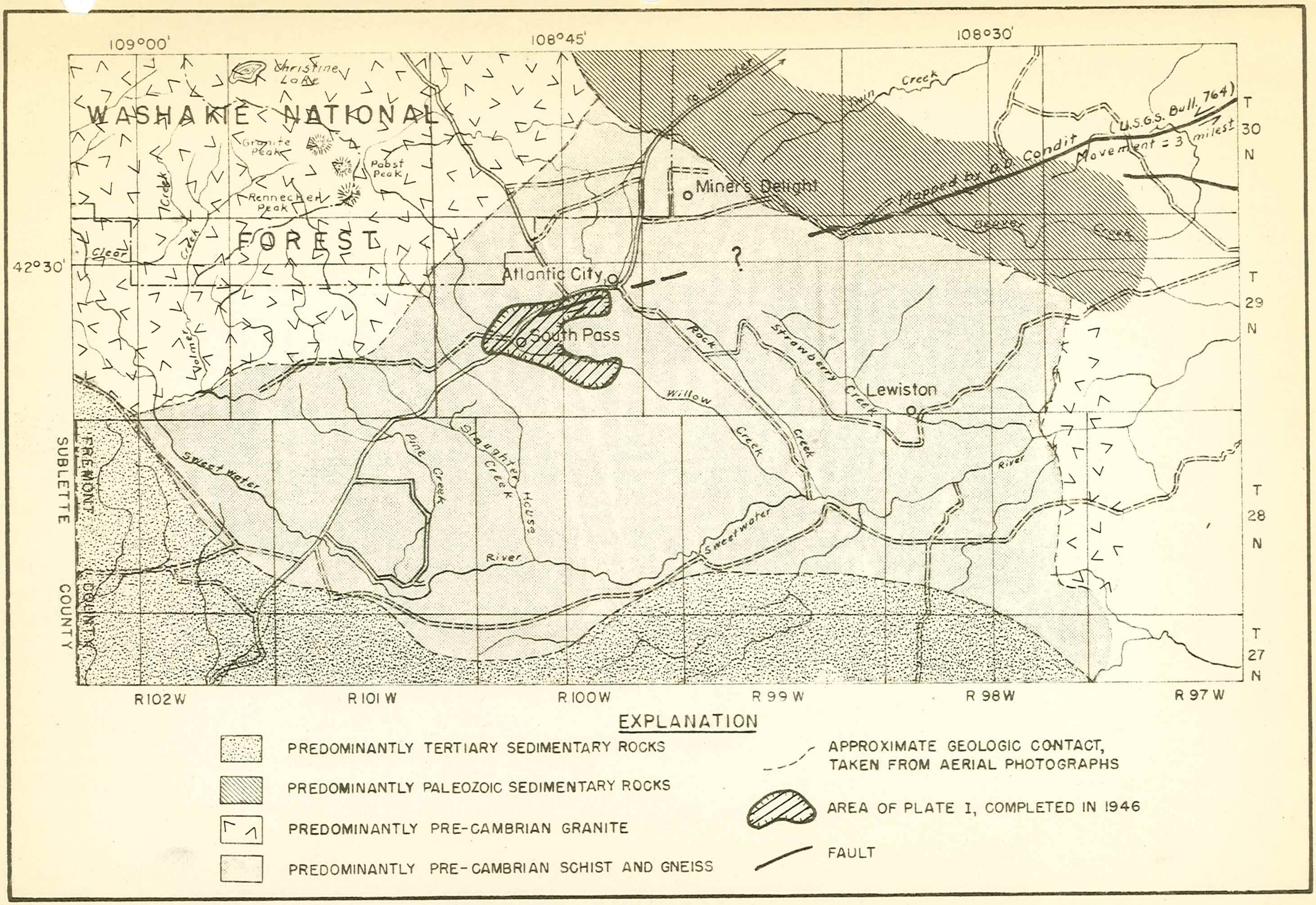

FIGURE 2, GEOLOGIC SKETCH MAP, ATLANTIC CITY-SOUTH PASS DISTRICT, FREMONT COUNTY, WYOMING

SCALE 0 4 8 12 16 MILES

Work is progressing on the new highway, but it is not expected to be completed until the fall of 1948, and unfortunately it passes through neither South Pass City nor Atlantic City but runs about 2 miles northwest of the former and about 4 miles northwest of the latter. It is expected that side roads will be built from the nearest points on the highway to both of the towns.

The nearest town served by a railroad is Lander, the western terminus of the Wyoming and Northwestern Railway which connects with the Chicago and Northwestern Railway at Casper. The next nearest railroad is 88 miles southwest of Atlantic City at Rock Springs which is on the transcontinental line of the Union Pacific Railroad.

Topography

The northwestern part of the Atlantic City-South Pass district is an area of gently rolling topography which forms the foothills of the Wind River Range. The southeastern part of the area is flat-lying, sagebrush-covered desert. Elevations in the district range from 7,000 feet in the south to 10,000 feet in the north. Bench marks at South Pass City and Atlantic City are at 7,805 and 7,684 feet elevation, respectively.

The northeastern area is drained by Twin and Beaver Creeks which flow east for a short distance and then north into the Little Popo Agie River and thence to the Missouri River by way of the Big Horn and Yellowstone Rivers. The southeastern part of the area is drained by Strawberry, Rock, Willow, Slaughter House, and Pine Creeks, tributaries of the Sweetwater River, which rises in the extreme western part of the area on the west slope of the Wind River Range, flows south around the end of this range, east along the southern margin of the district, and continues east to the Pathfinder Reservoir where it joins the North Platte River. The flow of the Sweetwater River varies considerably throughout the year, and the lower courses of many of its major tributaries are intermittent streams. The streams of the northwestern part of the area are perennial and have a more equitable flow.

Climate and Vegetation

The winters in the mountains to the northwest are long and rigorous with abundant snowfall; the desert region has milder winters with little or no snowfall. The summers are hot and dry in the desert area, and warm with plentiful rainfall in the mountains where thunder storms are common. The Atlantic City-South Pass district lies midway between the above two extremes. The summers are hot and dry; the winters, long and cold with abundant snowfall.

As would be expected from the climatic conditions, the vegetation of the desert area is sparse and consists chiefly of sagebrush. The bottom lands along the creeks are heavily grazed by cattle and sheep. The foothill area is sparsely wooded and has many open parks which make good grazing land in the summer months. The mountainous area is heavily wooded with the grazing areas restricted to the open valley bottoms. Deer, moose, elk, antelope, and bear are plentiful and the streams and lakes abound in trout. The chief industries are cattle and sheep ranching.

Previous work

Many investigators have visited the Atlantic City-South Pass district but none spent sufficient time to do detailed geologic work. Much of the work was done so long ago that economic conclusions drawn from the same work today might well be different.

In 1901 W. C. Knight 1/ gave a good account of the history of

1/ Knight, W. C., The Sweetwater Mining District, Fremont County, Wyo.: Wyoming Geol. Surv. Bull. 5, June 1901, pp. 1-35, 1901.

the district up to that time, and in 1914 L. W. Trumbull 2/ published

2/ Trumbull, L. W., Atlantic City Gold Mining District, Fremont County: Wyoming Geol. Office Bull. 7, Series B, pp. 75-100, 1914.

a map of the main producing belt. Two years later the U. S. Geological Survey published a more detailed report by A. C. Spencer 3/ which

3/ Spencer, A. C., The Atlantic Gold District and the North Laramie Mountains, Fremont, Converse, and Albany Counties, Wyoming: U. S. Geol. Survey Bull. 626, pp. 9-45, 1916.

included a good estimate of gold production up to 1914. In 1926 Bartlett 4/ reviewed the work of the previous investigators and gave

4/ Bartlett, A. B. and Runner, J. J., Atlantic City-South Pass Gold Mining District: Wyoming Geol. Office Bull. 20, pp. 18-23, 1926.

the results of mill tests run on ores from the district. In the same report Runner made a brief study of the rocks and ores and pointed out the metamorphic character of Spencer's diorite and the late origin of the quartz veins. The most recent investigation of the area was submitted in 1938 by Wallace de Laguna 5/ to Harvard University as

5/ De Laguna, Wallace, Geology of the Atlantic City District, Wyoming: unpublished thesis, Harvard Library, 1938.

a doctor's thesis in which he expanded Runner's work on the metamorphic rocks and disagreed with Knight on the degree of folding in the schists.

Acknowledgments

The writer wishes to thank P. K. Sims, R. S. Cannon, and Helen Cannon, whose able assistance did much to further the progress of the present study. Of the many people in the district who took an interest in and aided the work the following should be specially mentioned: R. E. Tower, Manager of the Carissa mine, through whose cooperation all of the Carissa mine records were made available and who supplied many details of its past history and assisted in the mapping of the Carissa property; and Miss Ellen Carpenter, C. E. Carpenter, and J. W. Carpenter, whose detailed knowledge of the area, and the history and location of many of the smaller prospects, greatly expedited the work and who furnished much information concerning mines and mine workings no longer accessible. An expression of gratitude is due the U. S. Geological Survey for permission to use this report as a master's thesis and to the Spokane Office of the Survey for assistance in drafting the maps and typewriting the thesis. The writer especially wishes to thank Professors Goodspeed, Barksdale and Mackin of the Department of Geology of the University of Washington for their guidance in the preparation of this report. Finally the

author wishes to acknowledge the help he received from friendly discussion with the graduate students at the University of Washington whose assistance made the photographic illustrations possible.

Economic considerations

The development of a mine necessarily involves power, water, and timber supplies and the procurement of mining equipment. There is at the present time no electric power in the district nor is the availibility of power in the near future considered likely. Spencer 6/ mentions several possibilities for the development of a limited amount of hydroelectric power locally, but to date none of the mining operations has warranted the construction of such a plant. Wood and gasoline are too expensive for extensive operations. The Carissa mine in 1946 and 1947 used diesel oil which proved to be the most practical fuel.

Timber is not plentiful but the supply is sufficient for the needs of the present small scale mining in the district. If permission could be obtained to cut timber in the Washakie National Forest (fig. 2), an adequate supply would be available for almost any future development.

Water supply for a large mining operation might present a real problem because Rock and Willow Creeks are often reduced to a trickle in the summer. This difficulty might be overcome by ponding water upstream in the mountains for use during the dry months of the year. Enough water is thought to be available in the area to support several moderately sized operations without ponding. Ponding of the streams

6/ Op. cit., p. 38.

would require the consent of the ranchers who own the water rights. Spencer 7/ describes an attempt to utilize the waters of Christina

7/ Op. cit., p. 44.

Lake for operating placer deposits in Rock Creek which would offer another source of water.

Mining equipment and supplies could be shipped by rail to Lander or obtained at Rock Springs where coal mining is an important industry.

Conclusions

This report shows the geologic structure from the Carissa mine east to the Tabor Grand mine. The geology and ore deposits of other properties are also briefly mentioned. Knight's idea of folding in the schists is substantiated. Microscopic study of a number of vein specimens agrees with Runner's interpretation of a late origin for the quartz and shows fracturing of the quartz with the subsequent introduction of arsenopyrite and gold. Dating of the veins and the details of ore control will have to await further investigation. Partial study of the regional structure suggests major faulting and folding, with faulting being the controlling factor in the deposition of the ore which concept agrees with De Laguna's findings. Geologic work done so far indicates that the district might become a moderate-sized producer of gold provided that exploration is based on sound geologic principles and that modern methods of mining and milling are used.

GENERAL GEOLOGY

Principal features

The Wind River Mountains are composed of a central area of pre-Cambrian crystalline rocks flanked on the northeast by Paleozoic and Mesozoic sedimentary rocks and on the southwest by Tertiary sedimentary rocks. The mountains were elevated during the Laramide revolution in late Cretaceous or early Tertiary time and the Paleozoic and Mesozoic rocks were arched up to form a broad, northwest-trending, assymmetrical anticline. In Tertiary time the uplifted area was deeply dissected to uncover the central crystalline mass and form the present mountains. This period of erosion also resulted in the deposition of great thicknesses of sediments in the basins adjacent to the range.

On the southwest flank of the mountains the Tertiary sedimentary rocks are in contact with the crystalline rocks and the character of the contact has been in dispute. Branson 8/ considers this

8/ Branson, E. B. and Branson, C. C., Geology of the Wind River Mountains: Am. Assoc. Petroleum Geologists, Bull., vol. 25, no. 1, pp. 120-151, 1941.

contact to be the result of overlapping of the Tertiary deposits. Fenneman, 9/ however, believes this relation to be the result of

9/ Fenneman, N. M., Physiography of the Western United States: McGraw-Hill Book Co., pp. 166-168, 1931.

faulting. Recent work by Baker 10/ demonstrates the abundance of

10/ Baker, C. L., Geology of the Northwestern Wind River Mountains, Wyoming: Geol. Soc. America, Bull., vol. 57, no. 6, pp. 565-596, 1946.

faulting along the northwest flank of the range which fact tends to support the faulting hypothesis.

The southeast end of the Wind River Range and the desert lying immediately southeast of its foothills are underlain by pre-Cambrian schist and granite (fig. 2). This is the area of the report. The rocks in the area have been mapped as the schist, hornfels and granulite unit, amphibolite, diorite, granodiorite, aplite, conglomerate, and alluvium. A detailed description of the rocks, their relative ages and interrelationships, and a complete discussion of the metamorphism will have to await further work. Possible interpretations derived from the field work completed to date are described below.

Geologic formations

The schist, hornfels and granulite unit (pre-Cambrian)

The distribution of the schist, hornfels and granulite unit, which underlies most of the area mapped to date, is shown on plate I. Its topographic expression varies from place to place. South of Willow creek it forms an area of low relief; north of Willow Creek it forms the gently rolling foothills of the Wind River Range. There are no recognizable individual beds which form prominant outcrops or which can be traced very far with much degree of certainty. The predominant rock types of the unit are alternating layers of schist, hornfels and granulite with lesser amounts of amphibolite. The minerals in the schist are dominantly quartz, biotite, orthoclase, plagioclase, and small amounts of sericite. In the hornfels the principal minerals are quartz, biotite, a little feldspar, tremolite, and chlorite. Some of the schist and hornfels contain porphyroblasts of andalusite and can be termed knotenschiefer. The granulite and amphibolite contain quartz, biotite, tremolite, actinolite, hornblende, orthoclase, and some andalusite and kaolinitic material, and occasionally small garnets and grains of pyrite and magnetite. Some of the granulite contains radiating groups of amphibole which look like sheaves of wheat. This feature is termed garbenschiefer by Rosenbusch 11/ and is so used in this report. The textures of the

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11/ Rosenbusch, H., Elemente der Gesteinlehre: p. 108, 1910.

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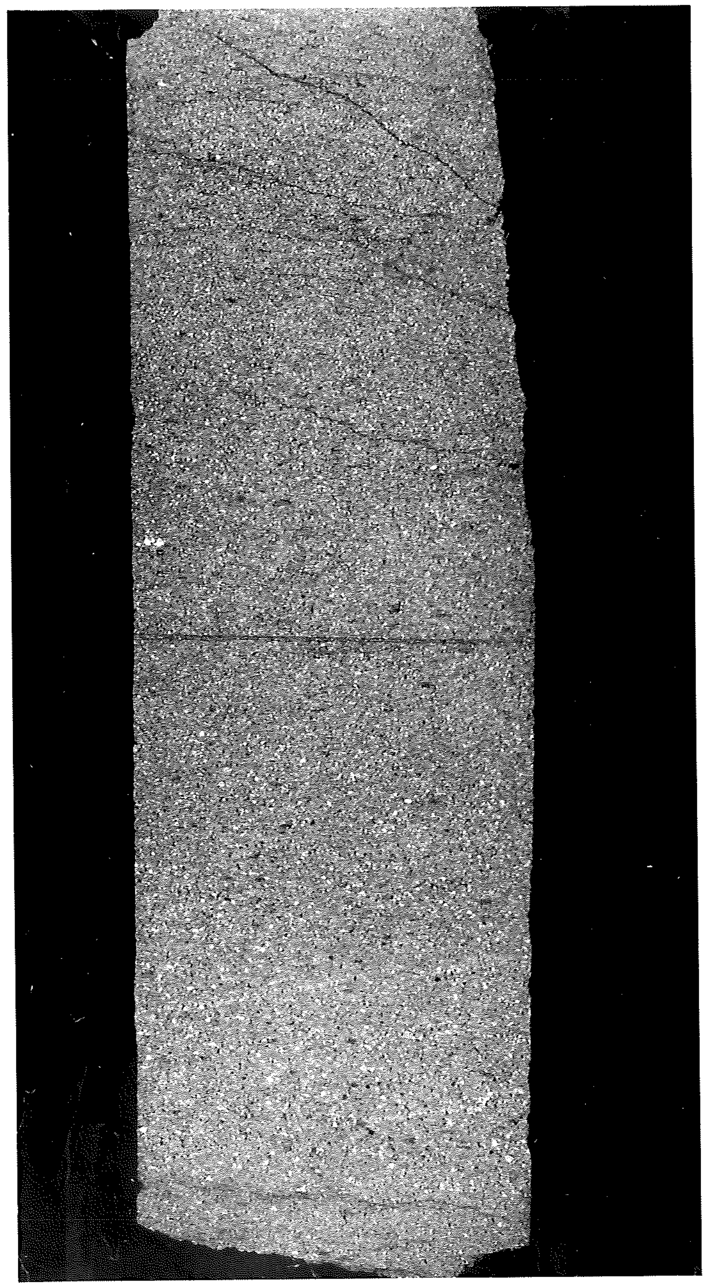
rocks can be termed schistose, granulose, maculose and locally decussate. Preliminary work seems to indicate that the schist, hornfels, and granulite unit was originally a series of shales, sandy shales, ferruginous shales, limy shales, a little shaly sandstone, and possibly some impure limestone. Cross bedding is very rare.

In spite of the metamorphism which has taken place, many of the original sedimentary features may still be seen. Bedding may easily be seen in the field; plates IX and X show graded bedding; plate XI, cross bedding. These features plus drag folds were the criteria used in working out the internal structure of the schist, hornfels and granulite unit.

Plate IX



Photomicrograph of a thin section of a specimen of the schist, hornfels and granulite unit showing graded bedding
(Crossed nicols, x 2.67 approx.)

Plate X

Photograph of a polished specimen of
schist, hornfels and granulite unit
showing bedding and graded bedding
(x 1.2 approx.)

Plate XI

Photograph of a specimen of the schist, hornfels
and granulite unit showing cross bedding
(about natural size)

The strike of the beds in the schist, hornfels and granulite unit varies locally from N. 10° E. to due east and the dips vary locally from 70° N. to 55° S. In a small area west of South Pass City, the strike is nearly north and the dip is about 40° E. The dominant trend in the area is N. 60° to 80° E. with steep dips in either direction. Schistosity is usually parallel to the bedding or at a small angle to it, but locally it may make a large angle with the bedding. Where mineral orientation, including orientation of the andalusite porphyroblasts, can be observed it plunges steeply to the southwest. The beds have been isoclinally folded with the axial planes vertical or slightly overturned to the northwest.

The schist, hornfels and granulite unit is considered to be pre-Cambrian. For a mile northeast of Miner's Delight (fig. 2) it is unconformably overlain by the Flathead sandstone of Cambrian age. It is tentatively dated as late pre-Cambrian solely on the basis of the degree of metamorphism.

Amphibolite (pre-Cambrian)

The amphibolite extends in a belt 150 to 1,000 feet wide from the western to the eastern margin of the area shown on plate I and forms conspicuous shiny black outcrops along most of its length. Topographically it forms a prominent ridge in sections 14 and 15. As it decreases in width to the west, its topographic expression becomes progressively less marked. The dominant minerals of the amphibolite are tremolite, hornblende, actinolite and plagioclase, lesser amounts of biotite, quartz and andalusite, and locally, some magnetite, muscovite, calcite and sericite. Megascopically some of the amphibolite appears to have an igneous texture but all the specimens examined microscopically have metamorphic textures. The amphibolite is dominantly schistose and locally decussate and diablastic with a slight garbenschiefer development in places. Of six specimens studied by Runner 12/ one was described as being of undoubted igneous

12/ Bartlett, A. B., and Runner, J. J., Op. cit., p. 20.

origin, another of probable igneous origin, one of possible igneous origin, and the remaining three as being almost certainly derived from impure limestone. In the east half of section 15, there is a zone in the center of the amphibolite which is composed solely of actinolite and calcite. Field relations seem to indicate that at least in part the amphibolite has cross cutting relationships with the schist, hornfels and granulite unit and may be a dike. This apparent relationship, however, may be the result of the irregular margin of a metamorphic zone rather than the result of intrusion. An interpretation by the author will have to await further field and petrographic investigation.

The schistosity in the amphibolite is essentially parallel to that in the schist, hornfels and granulite unit. No pronounced mineral orientation was observed. The age of the amphibolite is considered pre-Cambrian as indicated by its metamorphism and schistosity and it is believed to be contemporaneous with or younger than the schist, hornfels and granulite unit.

Diorite and Granodiorite (pre-Cambrian)

The rocks here called diorite and granodiorite look like igneous rocks in hand specimen and were so mapped in the field. Under the microscope, however, they show no igneous textures and are in reality metamorphic rocks. Both could be called granulites. Because the present investigation has not progressed far enough to state definitely the genesis of these rocks or their percentage compositions, and because diorite and granodiorite were used by De Laguna and are widely used in the area, it is thought best to retain these terms for this report.

Diorite.--The rock mapped as diorite lies in the southeastern quarter of sections 16 and 17 and in those places forms the northern limit of the area mapped (pl. I). Its outcrop does not form prominent topographic features and in section 17 its presence is mapped on the basis of float. In hand specimen it is a fine-textured, gray rock showing a vague lineation and what appear to be feldspar phenocrysts. Microscopically the minerals in it are seen to be hornblende, plagioclase, orthoclase, and quartz, and minor amounts of biotite, sericite, kaolinitic material, and andalusite. The microscopic texture is granulose with feldspar porphyroblasts which show micropegmatic intergrowth with quartz. Some epidote has developed along a set of northwest trending joints. Conclusive evidence for dating the diorite is lacking, but it is believed to be pre-Cambrian.

Granodiorite.--Granodiorite crops out in two boss-like bodies in section 14. There is another granodiorite body in the central part of section 20 immediately north of the amphibolite, but it is too small to be shown on plate I. The easternmost body forms a bare, slightly iron-stained, rounded hill. The other two outcrops are inconspicuous. Megascopically the granodiorite is a light-colored, medium-grained, moderately metamorphosed rock with an igneous appearance. Microscropically, however, there are no relict igneous textures in the specimens examined, and the specimens show sieve and maculose structure and the development of porphyroblasts. The minerals present are quartz, orthoclase, sodic plagioclase, biotite, hornblende, and a little sericite, kalonitic material, pyrite, and limonite. Two of the specimens collected from near the margin of the largest body are extremely fine-grained (.03 to .06 mm.) and are composed of quartz and albite with a little sericite and kaolinitic material. Much of the quartz shows wavy extinction indicating dynamic metamorphism. The crosscutting relation between the granodiorite and the amphibolite and the schist, hornfels and granulite unit suggests an intrusive origin for the granodiorite, but the absence of relict igneous textures, coupled with the metamorphic character of the rock microscopically, casts doubt on this interpretation. Final interpretation must await additional field and petrographic work. No schistosity nor mineral orientation was observed in the granodiorite. Two sets of joints, one striking N. 50° - 70° E., the other N. 40° W., and both dipping steeply are prominent. The joints and their intersections appear to have had some control in the localization of the ore at the Mary Ellen mine. The granodiorite is believed to be pre-Cambrian and because of its structural relations to the amphibolite is younger than the amphibolite.

Aplite (post-Permian)

A few coarse-grained (2 mm. ±) aplite dikes varying in width from one quarter of an inch to 8 feet form inconspicuous outcrops south of Willow Creek in the southwest quarter of section 26, the northwest quarter of section 27, and the northeast quarter of section 28. Their strike varies from N. 10° W. to N. 40° E. The dikes which strike N. 10° W. have an almost vertical dip whereas those striking N. 40° E. dip about 25° NW. The former occur in fault zones and the latter apparently along joint planes. The aplite was not examined microscopically. The dominant megascopic minerals are quartz, feldspar, and muscovite in that order of abundance. The middle portions of the wider dikes are often pegmatitic. Almost all the larger dikes exhibit a crude zoning. The margins are dominantly muscovite; the central portion has a halo of feldspar concentration around a core which is practically all quartz. In one case a few ovoid, glassy feldspar crystals one by one and a half inches in size were observed near the margin of a dike. The contacts with the enclosing schist, hornfels and granulite unit are sharp and frequently the rock adjacent to the dike is marked by a slight silicification and concentration of course biotite crystals. Structurally the dikes crosscut the schist except for a few apophyses which show sill-like relationships. Further work may show that the dikes are replacement pegmatites. The dikes are transected by east-west and northwest trending fractures along which the south side has been offset to the east. In most cases the offset is a matter of a few inches but one five-foot offset was observed. Some of these fractures are filled with dark-colored quartz veins which contain brown and black tourmaline. Subordinate fractures commonly are found parallel to the walls of the dikes. A schistosity parallel to that of the enclosing rocks and approximately parallel to the strike of the fractures which offset the dikes is moderately well developed in a few places. One of the dikes contained two inclusions of schist whose margins have been altered. The occurrence of the dikes in north trending faults which cut the amphibolite, dates the dikes as post amphibolite and also probably post granodiorite. The dikes are tentatively dated as post-Permian.

Conglomerate (Tertiary)

Conglomerate, probably the Beaver Divide conglomerate of Nace, bounds the southwestern margin of the area mapped and a small patch of it occurs in sections 16, 20, and 21 (pl. I). It forms practically no outcrops being exposed mainly in pits and a washed-out road. The maximum thickness recorded is about 50 feet which was observed in a shaft north of the road in section 16. Plate VIII shows a cross section of the conglomerate on the Carissa property. The conglomerate is poorly consolidated and contains angular and sub-angular, flat boulders and cobbles of basic and ultra-basic igneous and/or metamorphic rock in an arkose sand matrix. It is horizontally bedded and unconformably overlies all of the rocks previously described.

On the basis of lithology it is tentatively correlated with Naco's 13/

13/ Naco, R. L., Geology of the Northwest Part of the Red Desert, Sweetwater and Fremont Counties, Wyoming: Wyoming Geol. Survey Bull. 27, p. 32, 1939.

Beaver Divide conglomerate of lower Oligocene age. The exposure described by Naco in the west part of sec. 2, T. 26 N., R. 101 W., was examined and appears to be identical with the exposures in the vicinity of South Pass City and the Carissa mine.

Alluvium (Quaternary)

The valley flats and stream bottoms are covered with horizontally bedded Quarternary alluvium which unconformably overlies the rocks previously described.

Structure of the pre-Tertiary Rocks

General fatures

The accompanying geologic map (pl. I) shows that most of the structural features have a prevailing northeast trend although a few faults trend from northwest to a little east of north. Folding is the earliest recognized type of deformation and was followed by two periods of faulting. Deformation of the rocks produced schistosity and linear features. The most constant structural characteristic in the region is the northeast plunge of the linear features. This is best defined by the lines of intersection of the bedding with the axial planes of drag folds. The major structural feature of the area, which is shown in cross-section A-A' of plate I, is an anticlinorium slightly overturned to the northwest flanked by two synclinoria. The anticlinorium axis, which plunges 35° to 50° N. 60° to 80° E., lies near the minor anticlinal axis which cuts the line of cross section just south of the road in section 27. The regional structure as diagramatically illustrated in plate XII is similar to the structure described by Balk 14/ in Dutchess County, New York.

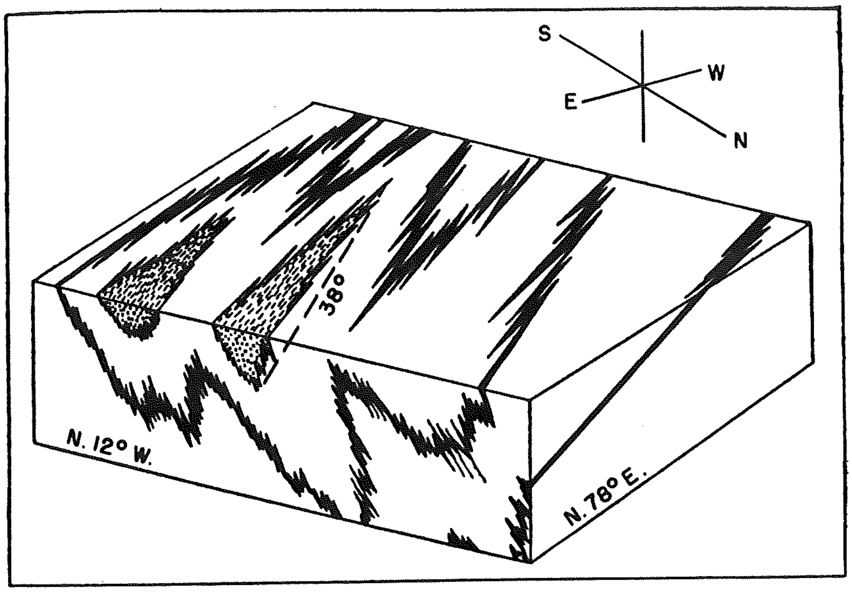
14/ Balk, Robert, Structural and Petrologic Studies in Dutchess County, New York: Geol. Soc. America Bull., vol. 47, fig. 4, p. 703, 1936.

Folding

The two most important criteria for working out the folding in the schist, hornfels and granulite unit are graded bedding and drag folds, and occasionally cross bedding is sufficiently well preserved to be used. The drag folds are small, ranging from less than an inch to about a foot in amplitude, and are the only feature megascopically visible in fresh specimens. The plunge of their axes and attitude of their axial planes were used to interpret the regional structure.

Cross bedding and graded bedding are evident only in outcrops where weathering has accentuated them. In graded bedding the grain size of the rock is so small and the size variation within a single bed so slight that close scrutiny of a weathered surface is necessary to detect it. The variation in grain size is from coarse at the bottom to fine at the top and in every case has checked with the interpretation of structure arrived at by using drag folds. As shown in plate IX, the variation in the size of the larger allogenic grains from bottom to top of a bed is only from 0.28 to 0.08 mm. Microscopic examinations showed that some of the larger grains in the coarse, bottom part of the beds are authigenic. It is believed that their

Plate XII



Diagramatic representation of probable regional structure in the Atlantic City-South Pass district. Diagram prepared by Balk to illustrate structure in Dutchess County, New York, and modified only to show its orientation in the Atlantic City-South Pass district.

growth was possible because of the greater permeability of the coarse part of the bed and the resulting more rapid circulation of solutions from which material was deposited. Even though some of the present coarseness of grain size is the result of the development of mineral grains *in situ*, it is possible to use this feature as a reliable indicator of structure for it is probably the result of an original coarseness of grain size.

In many places more than one cleavage was observed. It was found that cleavage could not be used as a reliable indicator of structure and only in cases where cleavage agreed with already known structure was it used to obtain the plunge of the axis and the attitude of the axial plane of the fold. Schistosity is moderately well developed throughout the area except in the more massive, coarser-grained beds. It has also been developed in the amphibolite. In most cases it is essentially parallel to the bedding. Both the schistosity which parallels the bedding and fracture cleavage which transects it are warped and faulted locally. This feature, coupled with the presence of more than one cleavage, is interpreted as indicating more than one period of deformation and probably a change in direction of the deforming forces.

In general, the beds of the schist, hornfels and granulite unit strike northeast and dip steeply either side of vertical. They have been folded into a series of asymmetrical, isoclinal folds which are gently overturned to the northwest. The fold axes plunge 25° to 50° N. 60° to 80° E., the most usual plunge being 40° N. 65° E. A mineral orientation can often be observed in the schist on the flanks of the folds and is best displayed by hornblende and elongated feldspar whose direction and amount of plunge is variable but is dominantly steep to the southwest. This is the orientation to be expected in an overturned, isoclinal fold plunging gently northeast in which adjacent beds have slipped past one another in the process of being folded. South of Willow Creek in section 35 the axial planes of the folds are essentially vertical but overturning to the northwest increases progressively until the large fault near the northern margin of plate I is reached. Immediately north of the fault the beds in the schist dip north and have not been overturned. North of this the structure in the schist is not well known.

The attitude of many joints was measured, but with only a few exceptions, no intelligible interpretation can be made. One set of prominent joints which strikes northwest and dips steeply southwest might, in the light of the known structure, be interpreted as AC joints which form normal to the plunge of folds. Jointing, however, could not be used to work out the structure. In the granodiorite at the Mary Ellen mine the ore deposits appear to be controlled by jointing.

The complete interpretation of the folding in the vicinity of South Pass City must await additional field work. The schistosity in this area is highly developed and is essentially parallel to the bedding. It strikes a little east of north and dips about 45° E. Good examples of graded bedding indicate that the folds are greatly overturned to the northwest.

Faulting

In the area shown on plate I there are two dominant fault systems, one trending from a little north of east to northeast; the other, which is younger, striking slightly east or west of north. Both systems dip nearly vertically. The most prominent fault in the area is the one just north of the amphibolite in sections 14 and 15. This fault commonly has a minimum width of 100 feet but locally may be much wider. It was from this area that the mylonite of plate XIII was obtained. In many places this fault zone is filled with 50 percent or more quartz and is iron- and copper-stained.

In many places movement has taken place along the planes of both the schistosity and the fracture cleavage with the offset indicating that the south or overriding side moved north. This type of movement indicates that the overturned folds might pass into high-angle reverse faults, and there is evidence in some of the faults which tends to indicate that such a transition has taken place locally.

The westward extension of this fault is not definitely identified but is believed to have been displaced by a fault of the north-south system and to continue south of the Carissa mine as shown on plate I. The presence of mylonite north of the Carissa mine in section 20 casts some doubt upon this interpretation. The fault zone is wide, however, and is known to have many faults branching from it so that these two seemingly separate zones may represent different branches of the same fault enclosing the Carissa mine between them. The eastward extension of the fault is known to extend beyond the area of plate I, through Atlantic City, across Rock Creek and over the hill a mile east of Atlantic City. It is believed that this fault can be traced eastward to the Paleozoic rocks and probably joins the fault mapped by Condit 15/ farther to the east. This relationship

15/ Condit, D. D., Phosphate Deposits in the Wind River Mountains, Near Lander, Wyoming: U. S. Geol. Survey Bull. 764, p. 17, 1924.

is indicated on figure 2. Condit shows an offset of three miles along the fault with the south side moving east. Evidence in sections 14 and 15, particularly northwest of the Mary Ellen mine, indicates the same direction of movement with the south side moving northeast and up at an angle of about 45°. This direction of movement coupled with the easterly dip of the Paleozoic sedimentary rocks would exaggerate the apparent horizontal movement of the Paleozoic rocks. The true heave is more likely of the order of one and a half miles.

If the large fault in sections 14 and 15 is the same as the one mapped by Condit, then a large part of the movement along it is post-Permian for Condit's fault cuts the Embar formation and younger rocks. However, it is believed that the faulting was probably initiated in the pre-Cambrian at the time of the folding and that the post-Permian movement represents movement along an already established zone of weakness. The importance of this possibility is pointed out under the heading, ORE DEPOSITS.

Throughout the area many smaller faults occur which are subparallel to the fault described above. Although the direction of movement along most of them is not known, it is thought that the south side moved up as is the case in some of them. This agrees with the idea of overthrusting from the south as stated in the section on folding.

The north-south fault system cuts the east-west fault system and is therefore younger. Faults of the former system offset the amphibolite as shown on plate I. The maximum width of these fracture zones is about 300 feet, and it is along them that the aplite dikes described above occur. The positions of the two main faults of this system in the unmapped portions of sections 22, 23, 26, and 27 are not accurately known. As indicated by drag of the bedding the east side of the eastern one moved south but nothing can be said about the amount of movement. In the south central part of section 14 much silification and epidotization has taken place along the fault. Neither Spencer 16/ nor De Laguna 17/ mapped the northwest trending

16/ Op. cit., pl. I.

17/ Op. cit., pl. I.

fault which is shown on plate I passing through sections 15, 22, and 27. Although the portion of section 22 through which the fault passes has not been mapped, the present evidence seems to necessitate the presence of such a fault. The two faults shown in the northeast quarter of section of 27 were actually observed. The fault in the southwest quarter of section 15 is covered, therefore it is represented on plate I by a dashed line. One indication of the presence of a northwest trending fault at this locality is the abrupt termination of the amphibolite. Another indication is the slight drag exhibited by the amphibolite and the curving, also believed to represent drag, of the anticlinal and synclinal axes which lie immediately south of the amphibolite. There appears to have been a horizontal displacement on the northwest trending fault of about 1,800 feet, the west side moving south with respect to the east side. If a reconstruction is made using 1,800 feet horizontal displacement, it is seen that the amphibolite on opposite sides of the fault lines up reasonably well. Using the same displacement the curved anticlinal and synclinal axes on opposite sides of the fault also line up fairly well. The same may be said of the portions of the main east-west fault which lie on opposite sides of the northwest trending fault. Therefore the mapping in this locality of a northwest trending fault is probably warranted. Since the amphibolite, the main east-west fault, and the axial planes of the anticlines and syncline dip nearly vertically, it was not considered necessary in making the reconstruction to take into consideration possible vertical movement on the northwest trending fault.

Mylonitized zone.--Petrographic work has demonstrated the presence of mylonite in the northeast trending fault zone in sections 14 and 15 along the northern edge of the area mapped (pl. I). In hand specimen the rock is not sufficiently different from the schist, hornfels and granulite unit to be mapped separately. Two specimens from the northeastern part of section 20 are also believed to be mylonite but the area will have to be examined again before the fault zone can be mapped accurately. In a few places the mylonite zone is indicated topographically as a sag, and everywhere it is a zone of practically no outcrop covered with small rhombic pieces of float. The total thickness of the zone is unknown. Megascopically the mylonite is very fine-grained, massive, and slightly iron-stained. Little or no schistosity is evident. Microscopically the minerals are seen to be quartz, hornblende, feldspar and perhaps the amorphous glass pseudotachylyte with lesser amounts of chlorite, sericite, pyrite, limonite, and a little calcite. The feldspar and calcite occur as incipient porphyroblasts; the hornblende is alined; chlorite occurs in fractures; and all the quartz has pronounced undulatory extinction. These features, coupled with the development of cataclastic structure and the field occurrence of the rock definitely prove it to be a mylonite (plate XIII). A specimen from the northeast quarter of section 20, showing extremely fine color banding in hand specimen and composed entirely of quartz which shows vague optical alinment, is believed to be hartschiefer. In addition, there is an alinment of a mineral of high relief which is too fine to be positively identified but which may be garnet.

A prominant outcrop of quartz-hematite fault breccia occurs in this same fault zone in section 15 just east of where the road crosses Big Hermit Creek. In this rock, quartz fragments with wavy extinction are cemented in a hematite matrix which also contains some limonite and a little arsenopyrite.

Plate XIII

Photomicrograph of a thin section
of mylonite
(Plane light, x 17.5)

Amphibolite and granodiorite

The structural relation of the amphibolite to the enclosing schist is not entirely clear. It appears to be concordant with the bedding in the schist, but in detail there is some evidence of a slightly crosscutting relationship. Detailed mapping of a few well-exposed areas and petrographic study should disclose the correct relationship. The amphibolite is cut by both the east-west and north-south faults and schistosity has been developed in it parallel to that in the schist, hornfels and granulite unit. Linear features of the amphibolite have the prevailing north-east plunge.

The granodiorite crosscuts the trend of the amphibolite and the bedding in the schist. Little or no schistosity and only minor faulting is evident. There are two prominent sets of joints, one trending N. 50° to 70° E. and the other N. 40° W. Both are vertical and the former is the more prominant of the two. The little faulting that has occurred is localized along these two trends.

Relation to ore deposits

The main control in the localization of ore has been faulting. Folding has played a part only to the extent that there may be a small amount of ore along overturned sides of broken anticlines. This possibility is suggested by the abundance of quartz float along the north side of an anticline as shown in the southeastern corner of Plate III. Evidence cited under the section ORE DEPOSITS indicates that the ore is associated with late faulting and is localized near zones which have been the site of a great deal of recurrent movement.

Geologic history

Lack of sufficient information allows only the briefest statement about the geologic history of the area. In late pre-Cambrian time, a great thickness of shale, ferruginous shale, sandy shale, limy shale, a little shaly sandstone, and possibly some impure limestone was deposited. These sediments were then folded by compressive forces and the east-west faulting was probably initiated at this time. After the folding the granitic core of the Wind River Range was emplaced and the amphibolite, diorite, and granodiorite may represent late manifestations of the batholith. It is possible that the ore was formed immediately after the formation of the granitic rocks but, as discussed below, it may be of much later origin. Next followed a long period of erosion, then subsidence of the area at the start of Cambrian time, and the deposition of the Paleozoic and Mesozoic rocks. In late Cretaceous or early Tertiary time the area was elevated with renewed east-west faulting probably occurring at this time or somewhat earlier. Subsequent to the east-west faulting the north-south faulting occurred, and the fractures were later filled with the aplite dikes. Post-Cretaceious erosion has unroofed the broad uplift exposing the granitic core and forming the present mountains. The dating of the faults and the ore is tentative, and the above is offered only as a possible explanation.

ORE DEPOSITS

History and production

The history of the Atlantic City-South Pass district prior to 1901 has been previously covered by Knight 18/. Spencer 19/ gives

18/ Op. cit., p. 6, 1901.

19/ Op. cit., p. 23, 1916.

an account of the district for the years 1901-14 together with a summary of the work by Knight. The early history is mentioned by De Laguna 20/ who also gives an account of the major activities from

20/ Op. cit., p. 108, 1938.

1914 to 1936. A summary of De Laguna's information plus more detailed and later information is given below.

From old records the Bock Mining Company is known to have operated the Duncan mine from at least October 1911 to the end of 1913 and produced approximately $41,000 during that period. The mine is reported to have closed because of poor management. In 1924 the Golden Gate Mine and Timber Co., a subsidiary of the Homestake Mining Co., Lead, S. Dak., did some work on the Midas property just north of Atlantic City and outside the area described in this report. A fire which destroyed the entire plant put a stop to the work. Development was not resumed because the tonnages blocked out were said to be too small to interest the Homestake Mining Co. Lessees are reported to have produced about $50,000 from this property in 1934. Undoubtedly the most successful operation in the district was that of the E. T. Fischer Co. From 1933 to 1941 the company mined a placer deposit on Rock Creek below Atlantic City and during that time produced a little more than $400,000.

With the end of the war in 1945, interest in gold mining revived and during the summer of 1946 three properties were active. Lessees shipped a few tons of ore from the Duncan mine which assayed several ounces of gold per ton. At the Midas mine lessees rehabilitated one of the old adits and made preparations to start development in the summer of 1947. The most extensive recent work in the district is at the Carissa mine, which is being developed by the Mica Mountain Mining Co., Salt Lake City, Utah, with Ray E. Tower as the mine manager. With the exception of the Homestake Mining Co., this is the first time that a company with adequate financial resources and a knowledge of lode mining has made a concerted effort to develop one of the mines in the area. A 100-ton cyanide mill equipped with diesel-electric power was constructed and the mine was rehabilitated. In March 1947 21/ the mill was treating 30 tons of ore a day averaging just under $12.00 per ton. Some metallurgical difficulties were being experienced, but it appeared that these would soon be corrected and expectations were that the mine would soon be producing 100 tons a day of $12.00 rock.

21/ Tower, R. E., Personal communication, 1947.

The milling problem has been the principal reason for the slow development of the area although litigation involving many of the properties of the area and mismanagement have contributed to lack of development. In the early days the prospectors mined the oxidized outcrops and abandoned the claims when the veins had been worked down to the unoxidized sulfide zone. It is thought that modern mining and milling methods can successfully treat the arsenopyrite ore bodies. At the present time it is not expected that the district will ever become a major gold district but perhaps as many as four moderately sized operations could be developed.

Records of early production from the area are lacking. Taking all factors into consideration, probably Spencer 22/ made the best

22/ Op. cit., p. 27, 1916.

estimate of total production up to 1916; De Laguna accepted his figure of $1,500,000; and the writer is inclined to do likewise. Production to 1938 was estimated by De Laguna to approach $2,000,000. The writer estimates that the production to May 1947 is probably slight in excess of $2,000,000. This figure includes production from the Miner's Delight and Lewiston areas which areas are not covered in this report.

General geologic features

All the ore deposits shown on plate I occur in fault zones and the largest ore bodies found to date occur in the areas of most intense fracturing. With the exception of those at the Mary Ellen and Empire State mines, all the ore-bearing fault zones strike northeast and dip approximately vertically. The width of the fault zones varies from less than a foot to over 100 feet. To date, however, the principal ore bodies have been found in medium-sized faults adjacent to large faults rather than in the latter. The large fault which crosses the northern part of plate I can be traced several miles, but many faults can not be traced more than 1,000 to 2,000 feet. The faults and veins within the larger zones branch and split, giving rise to multiple, sub-parallel, brecciated zones and veins.

In addition to being brecciated the fault zones contain discontinuous quartz veins which range in width from a fraction of an inch to 10 feet or more. A few of the wider sections of the large fault contain up to 80 percent quartz, but little or no ore has been found in this fault. Most of the ore-bearing veins are from 2 to 6 feet wide. No individual quartz vein is very long, the maximum length observed being about 50 feet. Within the vein zone veins overlap one another in en echelon fashion resulting in longer ore zones; at the Carissa, one ore-bearing vein zone has been traced more than 1,000 feet.

The ore shoots are lenticular bodies which range from a few inches to about 6 feet in width. In a few cases shoots 12 and 14 feet wide have been discovered. Most individual shoots are short, but one at the Carissa is at least 200 feet long, and the Mary Ellen shoot may have a length of nearly 600 feet. There is little reliable information on average grade which varies from mine to mine, and from stope to stope within individual mines. Ore being mined at the Carissa mine in March 1947 averaged just under $12.00 a ton.

If sufficient quartz and sulfide minerals are in the fault zone, it may form a prominent iron-stained outcrop; otherwise the zone tends to be inconspicuous. Underground within the fractured zone, the quartz veins have a lenticular shape.

The type of enclosing country rock appears to have little influence on the occurrence of ore, for ore is found in the schist, hornfels and granulite unit, in the amphibolite, and in the granodiorite. Adjacent to the veins the wall rock has been silicified.

The mineralogy of the veins is simple. Quartz is the gangue mineral, and, in a few places, tourmaline occurs both in the quartz and in the wall rock. In the specimens examined for this report, tourmaline was observed most frequently in the wall rock although "black quartz" is reported 23/ to be rather common and owes its color

23/ Spencer, A. C., Op. cit., p. 32, 1916.

to the presence of tourmaline. Megascopically, the unweathered quartz is white, visibly fractured, and contains arsenopyrite and occasionally gold and pyrite. Locally there may be a little limonite stain. The weathered outcrop of quartz, containing abundant sulfides and arsenides, is cellular and limonite-stained. Veins which do not contain ore minerals do not change appreciably on weathering. In cases where the cells in the rock show a determinable shape, they appear to be casts of arsenopyrite. Spencer 24/ identified scorodite ($Fe_2O_3 \cdot As_2O_5 \cdot 4H_2O$)

24/ Op. cit., p. 32, 1916.

in specimens from the Carissa mine, and much of the limonite-like material may be scorodite. The coarser pieces of gold are seen to occur along fractures in the quartz.

Microscopically the quartz shows microbrecciation, mortar structure, and strain shadows (pl. XIV); all are indications of dynamic metamorphism. The individual grains have sutured borders, contain inclusions, and in some cases relict schistosity is preserved. The quartz can be seen to have replaced the country rock, and the replacement has taken place most readily along the subparallel planes of schistosity and along fractures. Unaltered inclusions of schist occur in the veins with the schistosity still parallel to that of the enclosing rocks. The arsenopyrite occurs between the grains of and along fractures in the quartz and replaces it. No evidence of the filling of open fractures was observed. The arsenopyrite shows sieve structure, and much of it is surrounded by a black opaque rim which is probably an alteration product of the arsenopyrite. The gold also occurs along fractures in the quartz and replaces it. In the one polished thin-section in which gold was observed, its relation to the arsenopyrite is not evident. It is believed to be, at least in part, later than the arsenopyrite. Some of the gold also has a black opaque rim around it. This coating has caused metallurgical difficulties as discussed later under the Carissa mine. The paragenesis is, first quartz, then arsenopyrite. Gold was deposited either contemporaneously with the arsenopyrite or a little later, perhaps both. Neither the arsenopyrite nor the gold is fractured so probably they are younger than the last faulting.

Plate XIV

Photomicrograph of thin section
of strained vein quartz showing
mortar structure, Duncan Mine
(Crossed nicols, x 17.5)

Heretofore all the workers in the district have considered the ore to be of pre-Cambrian age. However, if the large east-west fault connects with the fault mapped by Condit, most of the ore is at least post-Permian in age. Although the age of the ore is still in doubt, there appears to be an excellent chance that much of it will be found to be post-Permian.

The causes for the localization of ore shoots are not thoroughly understood though explanations can be offered for several bodies. It appears that favorable places for the localization of ore are the intersections of veins or fault zones and zones of recurrent fracturing near areas of major faulting.

On the basis of structural relations, mineralogy, texture, and mechanism of formation, the deposits are classed as hypothermal. It is believed that the major faults of the region served as channel-ways along which ore-forming solutions rose. The solutions permeated the country rock along subsidiary fractures and deposited most of the ore minerals in favorable areas relatively near the main channelways.

Future development

The future development of the area is dependent upon the recognition of the intimate relationship between faults and ore and the discontinuous, branching, and sub-parallel nature of the veins within the ore zones. In the development of any one mine, the walls of the stopes and the intersection of faults and veins should be thoroughly explored.

Recent experience at the Carissa mine and metallurgical tests conducted by the U. S. Bureau of Mines 25/ show that grinding to

25/ Leaver, E. S., Woolf, J. A., and Towne, A. P., Gold-Silver Ore from South Pass City, Atlantic City Mining District, Wyoming: U. S. Bureau of Mines, R.I. 3629, p. 87, 1942.

about 100 mesh followed by cyanidation and 48-hour agitation, is the best method for treating the sulfide ore. Heretofore flotation has been tried unsuccessfully and has contributed to the failure of previous operations.

Finally, the availability of electric power at low rates would permit the profitable mining of lower grade ore and allow the development of properties not operable under present conditions. The completion of the new highway will increase the accessibility of the area and further improve operating conditions.

It is believed that under favorable conditions a few small mines can be developed.

Mine descriptions

Carissa mine

History, development and production.--The Carissa mine is in the northwest quarter of section 21 and is shown on plate I. The ore deposit was discovered on June 8, 1867, by H. S. Reedall. Spencer 26/

26/ Op. cit., 24, 1916.

states that the following winter "by crushing quartz from the lode in a hand mortar and by washing detritus from the lode", the miners "extracted nearly $9,000 in gold." He further states:

> "Between April 20 and July 1, 1869, 480 tons of ore, averaging $47.00 a ton, was treated. The rock crushed came mainly from the Carissa lode----. The Carissa appears to have been idle from about 1873 until 1900 or 1901, when it was acquired by the Federal Gold Mining Co. In 1901 the shaft was sunk to 300 feet and somewhat later to 387 feet, but the depth of the lowest level at present is 360 feet. The recorded production during the period 1902 to 1906 is about 2,800 tons of ore that returned a total in gold and silver of somewhat more than $25,000. The bullion produced was about 0.845 fine. Since 1906 no mining has been done. For several years the mine has been kept free from water so that the workings might be available for examination. The shaft is about 387 feet deep and the workings extend along the vein for about 750 feet. There are five levels, with horizontal workings below the first level amounting to nearly 2,600 feet."

About 1932 the American Smelting and Refining Co. unwatered and sampled the mine but did no further work on the property. The results of this sampling were made available to the writer by the present operators but are not a part of this report. It may be said that a few moderate-sized shoots of medium grade ore were indicated. In the summer of 1946 the mine was reopened by the Mica Mountain Mining Co. of Salt Lake City, Utah, under the direction of Ray E. Tower, the resident manager. At the same time a cyanide mill with a rated capacity of 100 tons a day was constructed. A jig was installed in which a concentrate was to be made before the ore went to the cyanide plant.

Spencer's statement quoted above fairly represents the state of development of the mine in the summer of 1946. In August 1946 the surface and the second and third levels, the only ones accessible at that time, were mapped and some samples taken from underground. The results of this work, plus information taken from other sources, were used to prepare plates III, IV, V, VI, VII, and VIII of this report. The explanation to accompany these maps is plate II. Since this work was completed, the third level has been driven to the west and stoping has been started in stopes B and D on the same level. In March 1947, 30 tons a day were being mined from the openings mentioned above, which averaged just under $12.00 a ton. From this a clean high-grade concentrate averaging about 20 ounces of gold per ton was being made in the jig. Difficulty was being experienced amalgamating the concentrate, and the concentrate tails carried as much as 6 to 7 ounces of gold per ton. In the cyanide plant the tails ran about 70 cents per ton, but at times ran double that figure. Tower states that microscopic examination of the concentrates showed that much of the free gold is covered with a jet-black coating which is no doubt the cause of the metallurgical difficulty. He believes that the ore being milled is from a zone of mixed oxidized and sulfide ores and that straight sulfide ore will offer no milling difficulty. In May 1947 it was reported that an overall recovery of 93 percent was being made from presumably the same ore, so it appears that the metallurgical difficulty had been overcome.

There are no accurate figures on the production from the Carissa. Bartlett 27/ estimates $1,000,000 production which is probably much

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27/ Op. cit., p. 4, 1926.

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too high. Judging from the size of the old workings, from what is said by the old-timers in the district about the high grade of the oxidized ore, and from what is known to have actually been produced, it is probably safe to estimate that somewhere between $100,000 and $500,000 has been produced from the Carissa with the lower figure probably being closer to the truth.

Geologic features.--The surface geologic relations at the Carissa mine are shown on plate III. The ore occurs in a fault zone which lies between an anticline in the schist, hornfels and granulite unit on the south and the amphibolite on the north. The fault strikes in a northeast direction and has a steep but variable dip as shown in the cross sections on plate VII. The vein exposed in Discovery Shaft and other features suggest that the main fault zone and vein splits and has offshoots and sub-parallel faults and veins adjacent to it. The fault zone in which the ore occurs appears to continue to the northeast but, so far as is known, no ore has been found in the amphibolite. In the western part of the property (pl. III) the fault zone has been prospected beneath the Tertiary cover. There are many quartz vein outcrops but most of them are not large enough or sufficiently high grade to be considered ore. The area of abundant quartz float in the southeast corner of plate III is located on and a little north of the crest of an anticline. If ore has been localized near the broken crests of overturned anticlines the area of quartz float may be a good one to prospect.

Plates V and VI show the geology on the second and third levels, respectively. It will be seen that the quartz veins within the fault zone split and are lenticular in detail. A pronounced split is shown just east of stope D on plate VI. The presence of splits in the vein and sub-parallel or en echelon veins, both in plan and in section, may be important in the development of the mine. A study of plate VI, cross section D-D' on plate VII, and of plate VIII shows that at one time a vein was mined which most certainly is a split from the vein exposed in stope D (pl. VI) and is not the same as the vein in stope B (pl. VI). A study of plate III and cross section C-C' (pl. VII) shows that the vein in Discovery Shaft is probably a split from the main vein. It is significant that a high assay was obtained on the second level (pl. V) near their projected intersection. In Old Shaft the skids are on the south side. Between the surface and the third level the shaft is inclined at a steep angle to the north. A recent communication from Tower states that stoping on the third level just west of Old Shaft has disclosed a split or intersection in the vein. With these facts in mind, the reader's attention is now directed to plate IV. If the positions of the fourth and fifth levels can be assumed to be correct, then if all the levels are driven on the same vein, the dip of that vein is abruptly variable in the extreme. It is the writer's opinion that there is an intersection of at least two veins or a splitting of the main vein to simulate such an intersection and that all the levels are not driven on the same vein, nor is any one level for its entire length necessarily on the same vein. The position of Old Shaft is probably near the western end of the intersection. The eastern end of the intersection is probably near the eastern end of the second level. It will be noted on plate IV that within these limits all the levels very nearly superimpose. If this explanation is correct, it would eliminate the necessity for sharp bends in the vein below the third level as shown in cross sections A-A' and D-D' (pl. VIII). This explanation would further mean that, at least in the eastern part of plate IV, the fourth level is driven along the north vein; the fifth, along the south vein. In the western portion of plate IV the relations are not so clear but appear to be the same. This in turn would mean that on the fourth level another vein should be looked for to the south and on the fifth level another vein should be looked for to the north. This is especially true with respect to the eastern parts of the two levels.

The veins occur in quartz-biotite-hornblende schist. Commonly their walls are not well defined for the schist adjacent to the veins has been silicified. The veins vary in width from a fraction of an inch up to 10 feet, and their length is equally variable, the one on the third level being at least 250 feet long. On the surface what appears to be the same vein, is at least 1,000 feet long. Not much is known about the ore shoots within the veins. Plate VIII shows three old stopes which vary in length from 100 to 200 feet. Sample records from the fourth and fifth levels show ore shoots about 150 feet long. The greatest width is probably about 15 feet, the average being close to 5 feet. Plate VIII and old sample records vaguely suggest a rake of the shoots to the southwest at about 85°. No explanation can be offered for the localization of the ore shoots other than the intersection of veins as mentioned above, but this does not seem to be an essential for ore formation. The ore appears to be associated with late fracturing and the introduction of quartz.

The mineralogy of the veins is relatively simple. Quartz, which has replaced the enclosing schist, is the principal gangue mineral in the veins. No evidence of filling was observed. The quartz contains relicts of the schist and vacuole and other inclusions which give some of the quartz a cloudy appearance. The schist inclusions often occur as bands parallel to the wall rock with the original structures of the schist undisturbed in the inclusions. The quartz shows microbrecciation, cataclastic structure and wavy extinction which indicates dynamic metamorphism. Much of the quartz is coarsely crystalline with sutured borders. In a few specimens tourmaline is present in the schist adjacent to the quartz veins and in the quartz veins.

The ore minerals are gold and arsenopyrite. Although no gold was observed in the arsenopyrite, the latter is reported to be auriferous. The arsenopyrite occurs between grains of quartz, fills fractures in it, and also appears to replace quartz. It is therefore later than the quartz. There is a suggestion that there may be two generations of arsenopyrite, for in one specimen it appears to have replaced hornblende and to be earlier than the quartz. However, most of it is later than the quartz. A few of the grains of arsenopyrite are surrounded by a thin film of black, opaque, anisotropic material whose composition was not determined. This is probably the same material that caused the metallurgical difficulty. Most of the arsenopyrite shows a sieve structure with quartz occupying the holes. No gold was seen in the thin sections from the Carissa, but one specimen from the east end of the second level at the locality of the high assay (pl. V) appeared megascopically to contain visible gold. Tower 28/ reports that bullion produced in early 1947 was

28/ Personal communication, 1947.

about .800 fine.

Spencer 29/ identified scorodite in specimens from the Carissa.

29/ Op. cit., p. 32, 1916.

One specimen shows a pseudomorph of what is probably scorodite after arsenopyrite. The mineralized outcrops of the vein have weathered to cellular, limonite-stained quartz. Probably much of the limonite-like material is scorodite. The cellular nature of the outcrop is the result of the weathering out of pyrite and arsenopyrite as is indicated by the shape of the casts and color of the staining. The ore minerals are late and the sampling shows that the values are associated with badly fractured quartz. Therefore, ore shoots will probably be found only in the more intensely fractured areas.

Conclusions.--Recent experience has shown that the ore can be successfully treated by modern milling methods. The possibility of multiple splits and branching of the veins emphasizes the need for thoroughly prospecting the walls adjacent to a vein. Short diamond drill holes are recommended as the most economical means of doing this. Present data indicate that ore shoots are most likely to be found at vein intersections and in the more highly fractured areas.

Empire State mine

The Empire State mine, sometimes known as the B. & H. mine for Bane and Hansen the present owners, is located in the center of section 22 and is designated by the number 2 on plate I. Information about discovery, development and production, as given below, was obtained from Peter Sherlock and Bane, both residents of South Pass City. The ore deposit was discovered in 1890 by Martin Collins who worked it by hand methods intermittently until 1923 when J. J. Marrin took it over. He held it until 1926 when it came into the possession of the present owners, Bane and Hansen. It is developed by a two-compartment, 110-foot shaft from the bottom of which about 120 feet of drift have been driven. There are two open stopes on the vein at the surface. One of them is about 40 feet long and 5 to 7 feet wide. It is reported that a little stoping was done on the bottom level. In addition to the above, there are many prospect pits and shafts on the property. So far as is known, practically all the work has been carried on by hand with a crew of one or two men and never more than six. It has been primarily assessment work or the work of prospectors or lessees. Bane estimates that the total production amounts to about

600 tons averaging approximately 0.75 ounces of gold per ton. An unpublished report made in 1929 by the Golden Cycle Mining and Reduction Co., Colorado Springs, Colo., and a report by the U. S. Bureau of Mines 30/ clearly show that the ore is best suited to cyanidation

30/ Leaver et al, op. cit., p. 87, 1942.

and not flotation or gravity concentration.

The mine occurs in a zone in which the geology has been complicated by both north-south and east-west faulting. It is thought that the deposit is on the south limb of an anticline. The veins occur in fault zones and might be described as lodes rather than veins. There appear to be two main vein systems, one being essentially east-west and the other north-south as shown on plate I. Both dip nearly vertically. The main vein on which the shaft is sunk and on which an open stope occurs, strikes from N. 80° E. southwest of the shaft, to N. 5° E. northeast of it. This swing is no doubt the result of the intersection of the two systems. The veins vary from a few inches up to something less than 6 or 7 feet wide, as indicated by the open stopes. The overall length is unknown, but the quartz-bearing zones can be followed for several hundred feet. The vein known as the "cross vein" strikes N. 80° E. It is reported that at the intersection of the main vein and "cross vein" the best ore was found. The drift on the bottom level is estimated by Bane to be within 20 feet of this intersection. Sherlock 31/ reports that the maximum width of the vein at the bottom

31/ Sherlock, Peter, verbal communication.

of the shaft is 18 inches and averages about 12 inches.

The gangue mineral is quartz. It has replaced the country rock, which is a dark brownish-gray, fine-grained granulite containing quartz and feldspar and a little biotite and amphibole. The vein quartz shows sieve structure, relict schistosity, and vacuole inclusions. A little tourmaline occurs with the quartz. The ore minerals are arsenopyrite and gold. No gold was recognized in the two polished thin sections examined. The arsenopyrite occurs along fractures and between individual grains of quartz. One pseudomorph of arsenopyrite after what apparently was amphibole was recognized. Most of the arsenopyrite shows a rim of brownish, anisotropic material which apparently is an alteration product of the arsenopyrite, perhaps scorodite. The north-south vein is reported to be high in pyrite and arsenopyrite which makes it difficult to extract the values. The east-west vein is reported to be higher grade and free-milling, but shows an increase in iron content near the north-south vein. Smelter returns from a few small shipments show that the silver-gold ratio in the ore is about 2 to 1, which is said to be the highest in the district.

The future of this property is believed to be a relatively modest one even for the Atlantic City-South Pass district. Future exploration should be directed to investigating the projected intersection of the two vein systems.

Duncan mine

The Duncan mine is in the northwest quarter of section 14 and its location is shown by the number 3 on plate I. Not much is known of the early development of the property. Spencer 32/ states:

32/ Op. cit., p. 26, 1916.

"A recent undertaking has been the development by the Beck Mining Co. of the Duncan mine, 1 mile west of Atlantic City. After an exploration of the Duncan vein by about 1,500 feet of workings, four Nissen stamps and amalgamating devices were installed in 1911. The saving of the gold contained in the ore is reported to have been about 60 percent, and in 1912, a system of all sliming followed by cyanidation was adopted, with results that are said to have been very satisfactory.----Mine developments in 1913 and 1914 appear to have been not very encouraging, and it may be that the financial success of this company will depend upon securing control of other mines than the one for which the technically successful extraction process has has been worked out."

Old records and Mint receipts found at the mine show that between October 1911 and December 1913 the Beck Mining Co., shipped a total of $40,646.66 in gold to the U. S. Mint at Denver, Colo. At the present time, Charles F. Brown of Victor, Colo., owns the property. In the summer of 1946 he and a lessee mined from an old open stope a little less than 12 tons of ore which were shipped to the American Smelting and Refining Co. smelter at Salt Lake City, Utah. The ore ran 6.34 ounces of gold and 0.08 ounces of silver per ton. A shipment of mill clean-up material of a little less than 5 tons to the same smelter ran 1.49 ounces of gold and 0.35 ounces of silver per ton. During the summer of 1946 the mill was dismantled and most of the usable equipment sold to the Carissa mine.

The Duncan mine is developed by a vertical shaft, reported to be about 250 feet deep, and several hundred feet of drifts and crosscuts and several open stopes. None of the underground workings were mapped for most of them were inaccessible or considered unsafe. A short visit was paid to a portion of the 100-foot level but no mapping was attempted because of the dangerous condition of the openings. It is reported that a tunnel about 1,000 feet long, driven from near the road northwest of the shaft, connects with the bottom of the shaft. If the underground workings were accessible, this mine would warrant detailed surface and underground mapping.

In contrast to the Carissa mine, the ore at the Duncan, so far as is known, occurs in a fault entirely within the amphibolite. The main vein on which most of the stoping has been done strikes N. 65° W. at the southeast end, N. 26° W. near the middle, and N. 85° E. at the west end, with a dip of about 80° N. The changes in strike are abrupt and repeated. Adjacent to the N. 26° W. portion of the vein, the banding in the amphibolite strikes N. 63° W. and dips 85° N. The overall length of the vein is unknown but is in excess of 200 feet. Its width varies from 3 to 10 feet and averages about 5 feet. At the southeast end of the 100-foot level, the main vein is cut off by a cross vein which strikes N. 45° E. and is vertical. The latter appears to be about 50 feet long and 4 to 6 feet wide. Nothing is known of a possible continuation of the main vein to the southeast. The intersection has been mined out about 40 feet above the 100-foot level in a stope approximately 10 feet wide and the cross vein can still be seen in the back. So far as is known, the main vein is open at the west end. Some of the vein next to the shaft was not mined; however these blocks may have been left as pillars to support the shaft.

The vein is brecciated, slightly limonite-stained, banded quartz with the banding parallel to the walls. Part of this banding undoubtedly represents recurrent fracture planes. The vein was not seen to crop out, and in one open stope 3 feet of overburden covered it. The only ore mineral seen was gold, but the limonite-like stain is undoubtedly indicative of the former presence of arsenopyrite or pyrite. A specimen from the shipment made in 1946 contains abundant gold which, with a hand lense, can be seen to occur along fractures in the quartz, indicating that it is late. A black substance along fractures in the quartz is associated with much of the gold. A thin section made from this specimen shows fracturing of the quartz, mortar structure and strain shadows (pl. XIV). No ore minerals are present in the thin section. U. S. Mint reports found at the property show that the bullion shipped by the Beck Mining Co. ranged from 0.785 to 0.857 fine with an average of about 0.820 and contained about one part of silver to every 8 parts of gold.

This property lies just south of the large fault which passes along the northern edge of plate I, has veins which show recurrent fracturing and veins which interesect, and has produced a little ore in the past. For these reasons it may warrant further development.

Mary Ellen mine

The Mary Ellen mine is in the northeast quarter of section 14 and is shown as number 4 on plate I. Not much is known of its early history, Spencer states 33/ "The Mary Ellen has been another

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33/ Op. cit., p. 26, 1916.

occasional producer, though between 1902 and 1915 the property was involved in litigation." According to J. W. Carpenter 34/ of

34/ Verbal communication.

Atlantic City, lessees using hand mining methods have been able to make a little money, but companies have never been able to conduct a profitable operation. The present owner is Roy Cowden of Atlantic City who in 1946 was planning to do a little development. Spencer 35/ quotes

35/ Op. cit., p. 28, 1916.

Jamison's 36/ estimate of the production from the Mary Ellen as

36/ Jamison, C. E., The geology and mineral resources of a portion of Fremont County, Wyo.: Wyoming State Geologist Bull. 2, p. 80, 1911.

$125,000.000. The writer has no evidence to change this figure one way or the other. The mine is developed by several hundred feet of drifting and a shaft inclined 50° N. 75° W., reported to be about 250 feet deep. The vein is reported to be practically all stoped out for 240 feet down the dip. Near the creek bottom northwest of the shaft, an adit was driven southeast to intersect the northwest trending vein. It is reported to have been driven 300 feet and to have cut 50 feet of amphibolite at its southeastern end but was not driven far enough to cut the vein. Parts of the first and second levels near the shaft were inspected but not mapped.

The Mary Ellen mine is the only mine in the district which occurs in granodiorite, the petrology of which has been briefly discussed above. The granodiorite is cut by two prominent sets of joints which strike N. 50° to 70° E. and about N. 40° W. and dip steeply. The northeast trending set is the more prominent and is best developed in the southern and southeastern part of the granodiorite. The veins occur in faults whose strikes at least appear to have been controlled by the jointing. Development has been along two veins or one vein which, at the south end, strikes N. 40° W. and dips 30° to 40° S.W., and at the north end, strikes N. 40° E. and dips 30° S.W., forming in plan a "V" open to the west. The richest ore is reported to have been at the bend or intersection. On surface the veins are marked by a string of dumps and open stopes. The northwest branch is 200 feet long and the southwest, 400. The stopes along both are from 5 to 8 feet wide. The northwest trending vein appears to end going northwest and the northeast trending vein appears to split up to the southwest. The veins probably do not continue to the southeast and northeast or do not carry values, for these extensions were not developed by the operators. The zone mined is reported to have been about a 5-foot width of bleached, altered and brecciated granodiorite with a 5- to 10-inch quartz vein on the footwall and a 4-inch quartz vein on the hanging wall. In mining, the footwall vein was taken for ore, and the rest of the zone broken to make room for mining. The hanging-wall vein and altered granodiorite is reported to carry values in gold, but not enough to have been ore under the former operating conditions. Underground the vein is seen to be a brecciated, limonite-stained zone with 1- to 18-inch wide, discontinuous quartz veins in it. The only ore mineral is reported to be native gold which is the purest in the district averaging .950 to .980 fine. Although many spectacular specimens are reported to have been found in the mine, no gold or other ore minerals were seen in the hand specimens examined. No microscopic work was done.

The Mary Ellen is favorably situated with respect to the major fault in the area and may possibly be developed into a small mine. Future work should prospect the downward projection of the intersection of the two veins and investigate the possibility of modern milling methods making it feasible to take the full width of the fault zone for ore.

Tabor Grand mine

The Tabor Grand mine is in the northeast quarter of section 14 and is indicated by the number 5 on plate I. Little is known of the history or production of the Tabor Grand, but some ore was mined from it. All of the following information dealing with underground data, history and production was obtained from J. W. Carpenter of Atlantic City. The mine is developed by two vertical shafts and a few hundred feet of drifts, winzes, and crosscuts. The discovery shaft is a one-compartment shaft about 180 feet deep. The other is a three-compartment shaft about 160 feet deep. About 120 feet below their collars both connect with an adit driven from the bottom of the draw east of the shafts. Most of the vein above the adit level has been stoped out to within approximately 20 feet of the surface. Development below the adit level consists of the 40-foot sump of the three-compartment shaft, a 30 to 40 foot winze near the west end of the adit, two short drifts driven on the vein from the bottom of the discovery shaft, and two shorter drifts driven on the vein about midway between the adit level and the two lower drifts. About a hundred feet from the portal of the adit a small body of ore was mined which is reported to have cut across the adit and assayed about $100.00 in gold a ton. It extended a little above and below the adit level. The average grade of all the ore mined is reported to have been about $10.00 a ton.

The three-compartment shaft is sunk in amphibolite the banding in which strikes N. 85° W. and dips vertically. The vein has essentially the same strike and dip at the surface but below the adit level is reported to dip 70° N. In the vertical portion the vein is said to average about 4 feet wide and below the adit about 6 feet wide. It is reported to occur in "altered rock" and to have a south wall of amphibolite. The gangue mineral is quartz and the ore mineral is said to be arsenopyrite. The water table is reported to be about 30 feet below the adit level and seems to have had some control on the grade of the ore. Above the adit, the ore was high grade and below it lower grade. It is believed that this represents passage from the oxidized to the sulfide zone.

The Tabor Grand is near the major fault running through the district. Not enough is known about the property to recommend development, but it may be that modern milling methods might profitably handle the low grade ore below the water table.

Carrie Shields mine

The Carrie Shields mine is in the southeast quarter of section 21 and is indicated by the number 6 on plate I. All of the following information except the few surface observations made at the mine was supplied by Peter Sherlock 37/ of South Pass City. The ore deposit

37/ Verbal communication.

was discovered in 1868 and has been worked intermittently since that date. The present owner is the Smith-Sherlock Co. of South Pass City. Sherlock estimates a production of about $100,000.00 from the property but Spencer 38/ in quoting Jamison 39/ estimates only $35,000.00. It

38/ Op. cit., p. 28, 1916.

39/ Op. cit., p. 80, 1911.

is believed that the lower figure is more nearly correct. The average grade of the ore mined is reported by Sherlock to have been about $20.00 in gold per ton but some ran as high as $100.00 per ton. The property is developed by a vertical shaft 180 feet deep and a few hundred feet of drifts. Most of the drifting from the shaft has been to the east, and one drift was driven a distance of 250 feet east from the shaft. Sherlock reports that the shaft was sunk on a quartz vein which averages 12 inches wide and is 20 inches wide at the bottom of the shaft and carries $4.00 to $5.00 in gold per ton. The vein at the face of the 250 foot drift is reported to carry $12.00 in gold per ton. The width is unknown. An adit driven from a draw to the southwest meets the shaft 65 feet above its bottom.

On surface the vein zone is a 3-foot fractured zone containing discontinuous quartz stringers which have a maximum width of two inches. It occurs in medium-gray, slightly greenish, biotite-rich schist of the schist, hornfels and granulite unit. The bedding in the schist strikes N. 65° E. and dips 85° S.; the vein strikes N. 65° E. and dips 65° S. On surface the vein zone can be traced about 400 feet northeast of the shaft. Its outcrop is marked by the presence of a slight amount of limonite in rock which otherwise is indistinguishable from the wall rock. In the adit a weak fracture zone with a narrow quartz vein along its north side is exposed.

The Carrie Shields is outside the zone of major faulting in the district. The fracture zone exposed does not appear to be very large or intensely broken. It is therefore believed that the property holds little promise of becoming one of the major producers of the district even though a few small bodies of ore may be found.

Midas mine

The Midas mine is one mile north of Atlantic City and north and east of the area shown on plate I. It is mentioned here because it was being reopened in 1946 and a polished thin section from it showed gold. Lessees are reported to have produced $48,000.00 from the mine in 1934. It is considered one of the properties in the district more likely to develop into a small mine.

The polished thin section shows that the gold is late and that it and the arsenopyrite have entered along fractures in the quartz and along quartz grain margins where it locally replaced the quartz. The relationship between the arsenopyrite and the gold is not shown.

Completely enclosing the gold, at least in this thin section, is a rim of black, opaque, anistropic material which shows vermicular margins with the gold. The material was not identified, but no doubt is the same as that which caused metallurgical difficulties at the Carissa mine.

Rock Creek placer

A study of the placer deposits in the Atlantic City-South Pass district would involve the study of the complicated physiographic history of the area. Lack of time and an adequate topographic map precluded such study. Moreover, it is the writer's opinion that the successful mining future of the district is dependent upon the development of lode mines rather than placer deposits. This report would be incomplete, however, unless some mention were made of the E. T. Fischer Company's placer operation in Rock Creek. The following information was furnished by Mr. Charles S. Crawford of Seattle, Wash., who was in charge of the placer operation from its inception.

The E. T. Fischer Co. operated a gold placer dredge in Rock Creek during the summer months, from 1933 to 1941 inclusive. During that time about 3,000,000 cubic yards of gravel were moved which averaged about 12 1/2 cents a yard. The yield from some of the gravel was quite a bit higher, and the production for a few months averaged over 50 cents a yard. Total production was a little over $400,000.00. The last dredging was done at Emmigrant Crossing several miles below Atlantic City on Rock Creek where the gravel was low grade. The operation was discontinued, and later the equipment was sold to an outfit which had plans for dredging at Wilson Bar on the Sweetwater River.

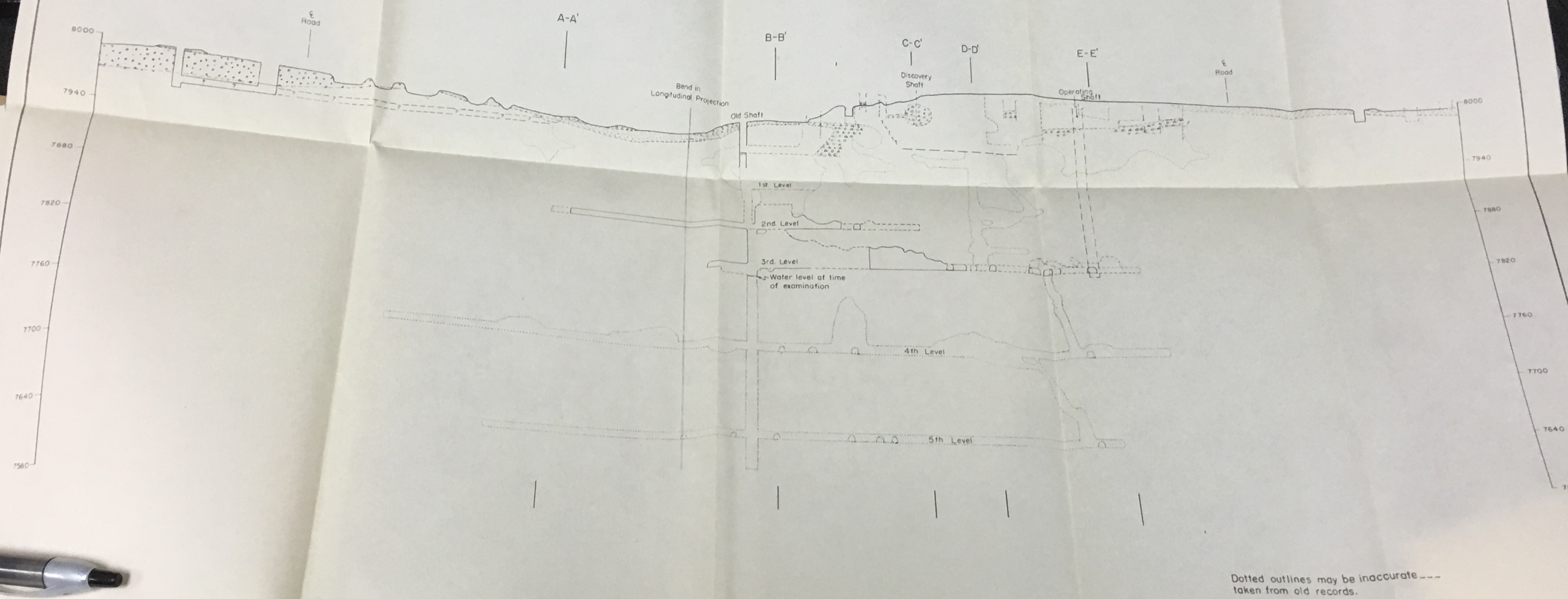
Seventy-five percent of all the gold occurred within from 1 to 3 inches of the bedrock in a kind of concentrate which Crawford said he would not call a black sand. Where the bedrock was schist of the schist, hornfels and granulite unit, it was overlain by an impervious layer a few inches thick, and practically no gold occurred in the bedrock. Where the bedrock was blocky material, gold was concentrated in cracks, and these portions proved particularly rich. Crawford's description of the appearance and position of the blocky, bluish-black bedrock strongly suggests that it is amphibolite. Much of the gold showed indications of not having traveled far, and it was common to find wire gold in the higher grade areas. Most of the gold occurred in the form of minute, rounded pellets. The gold averaged 0.880 to 0.0896 fine and usually carried one part of silver for every 10 parts of gold. At Emmigrant Crossing the bedrock forms riffles across the stream bed, but little or no gold was caught in them. The gold recovered showed evidence of having been transported some distance, for it was very flaky.

The richest gravel was found about one mile below Atlantic City. This is just downstream from the place where the large fault shown on the north margin of plate I crosses Rock Creek. Bluish-black, blocky bedrock, which might well be the eastward extension of the amphibolite, trapped the gold. The values decreased rapidly upstream from the fault crossing until just above Atlantic City it became unprofitable to work the gravels. It was thought that the junction of Smith Gulch and Rock Creek would be a rich area, for gold had been placered in Smith Gulch; however, on dredging the junction was found to be very low grade.

From the above information, it appears that the placer gold has not traveled far and is concentrated in the first suitable trap downstream from a lode deposit.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY MAP
PLATE VIII

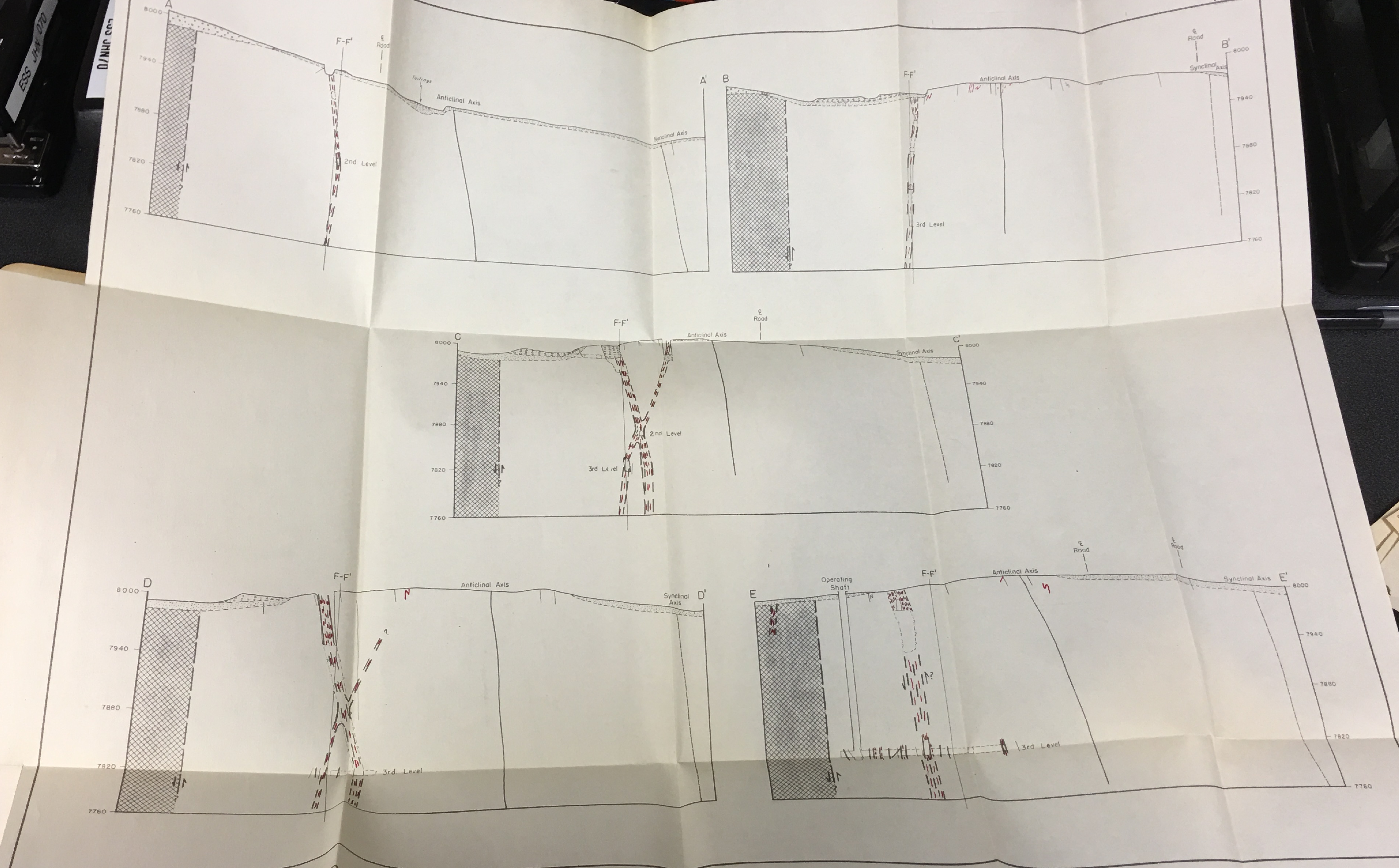


VERTICAL LONGITUDINAL PROJECTION, CARISSA MINE, FREMONT COUNTY, WYOMING

SCALE 0 60 120 180 240 FEET

[...]ARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY MAP
PLATE VII



CROSS SECTIONS, CARISSA MINE, FREMONT COUNTY, WYOMING

SCALE 0 60 120 180 240 FEET

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

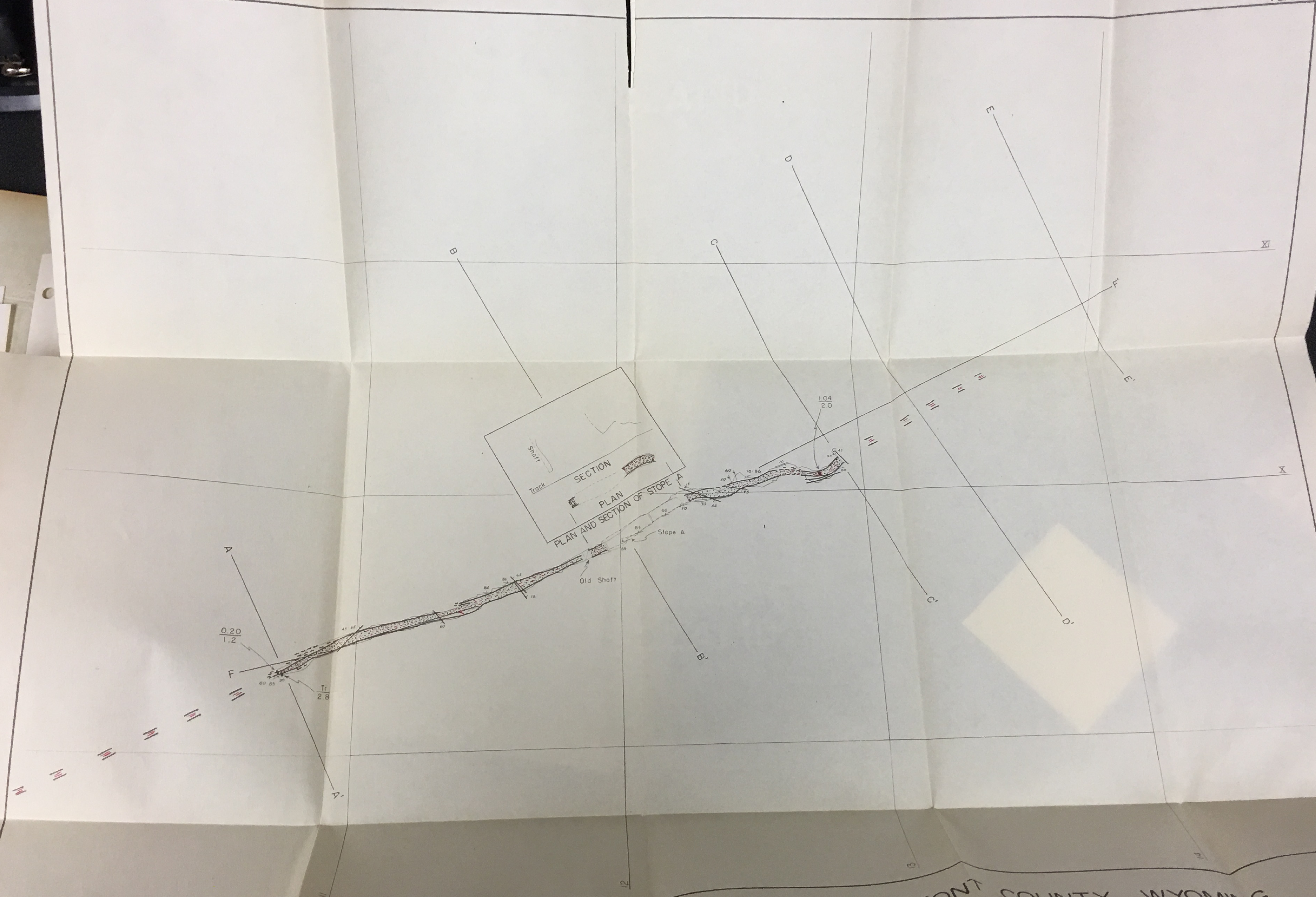
PRELIMINARY MAP
PLATE VI

GEOLOGY OF THIRD LEVEL, CARISSA MINE, FREMONT COUNTY, WYOMING

SCALE 0 30 60 90 120 FEET

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY MAP
PLATE V

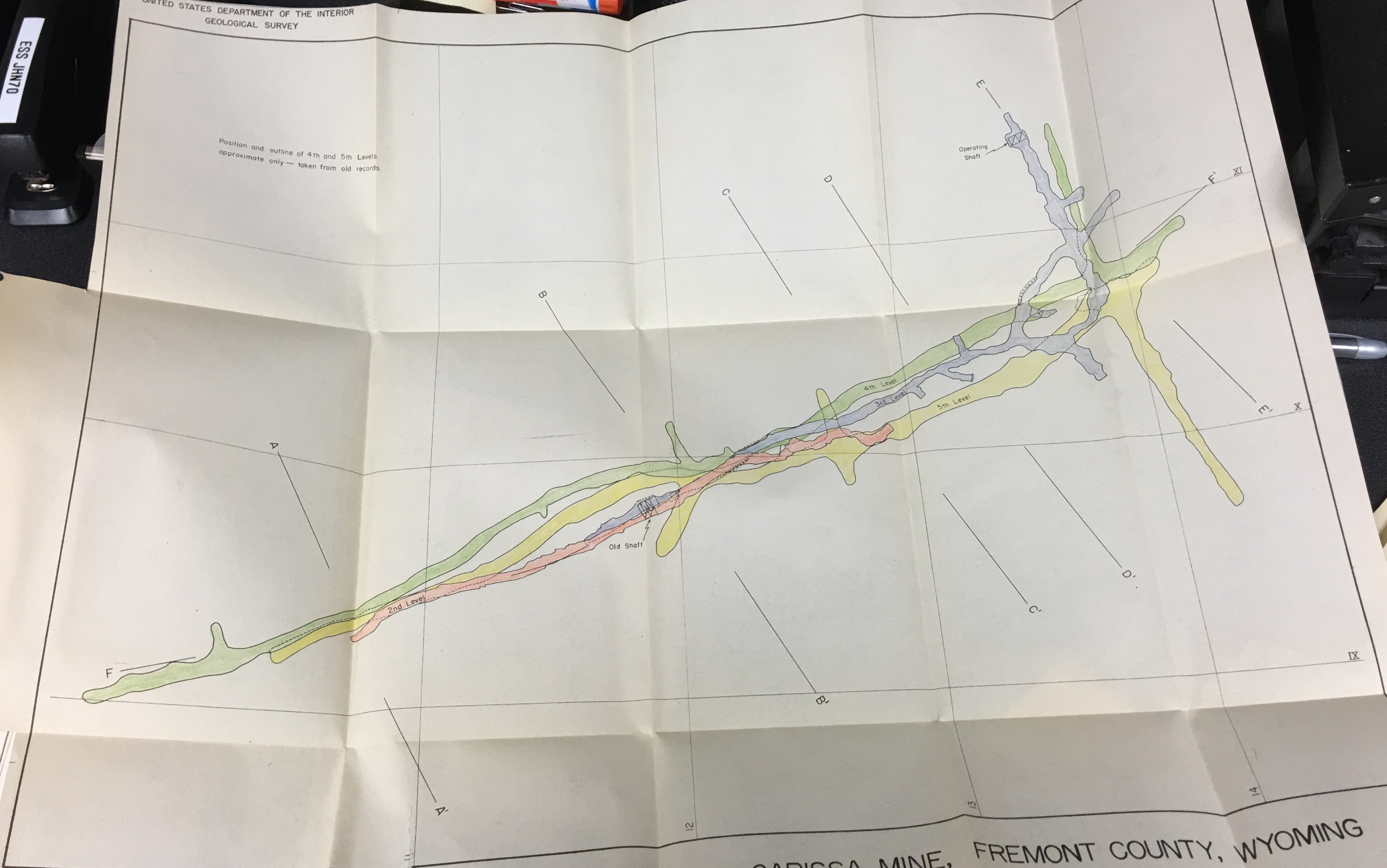


GEOLOGY OF SECOND LEVEL, CARISSA MINE, FREMONT COUNTY, WYOMING

SCALE 0 30 60 90 120 FEET

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY
PLATE

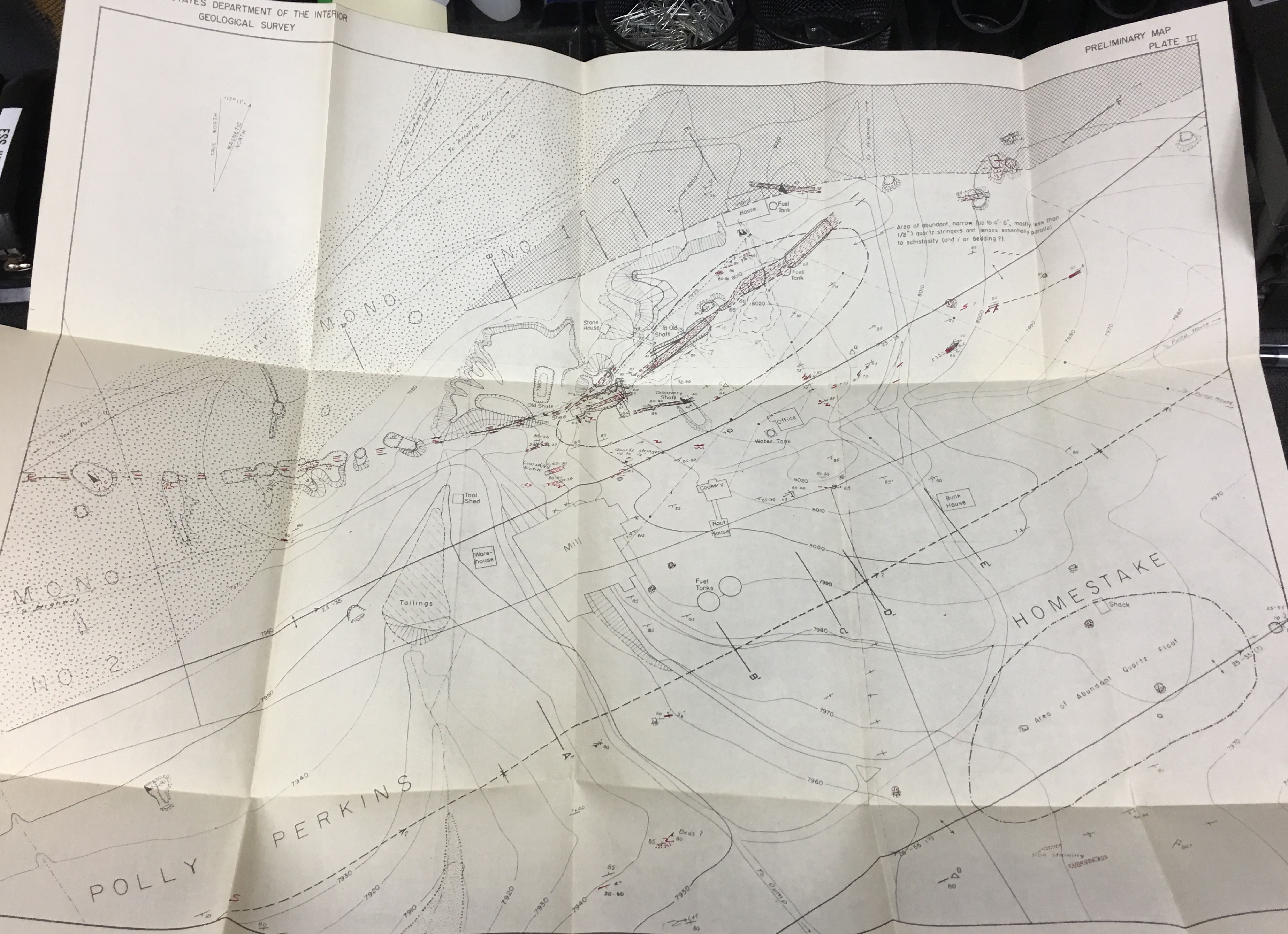


COMPOSITE MAP OF UNDERGROUND WORKINGS, CARISSA MINE, FREMONT COUNTY, WYOMING

SCALE 0 30 60 90 120 FEET

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PRELIMINARY MAP
PLATE III



TOPOGRAPHIC AND GEOLOGIC MAP, CARISSA MINE, FREMONT COUNTY, WYOMING

SCALE 0 60 120 180 240 FEET

U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE II

PRELIMINARY MAPS

CARISSA MINE

FREMONT COUNTY, WYOMING

F. C. ARMSTRONG
P. K. SIMS

AUGUST
1946

EXPLANATION

Dump or fill in mine workings, in sections only

QUATERNARY AND RECENT

Overburden, in sections only

Alluvium

TERTIARY

Conglomerate (lower Oligocene ?)

PRE-CAMBRIAN

Amphibolite

Schist, hornfels and granulite unit

Fault zone with quartz

Quartz

Arsenopyrite; density indicates abundance in general way

Geologic contact; dashed where inferred, dotted where approximate

Axis of anticline showing angle of plunge

Axis of syncline showing angle of plunge

Strike and dip of beds; top unknown

Strike of vertical beds; top unknown

Strike and dip of beds; top up

Strike and dip of beds; overturned

Joint, showing dip

Direction and angle of plunge of linear features

Cleavage

Drag folds; black = beds; red = quartz

Breccia

Pit; caved where hachured

Dump

Shaft

Triangulation station

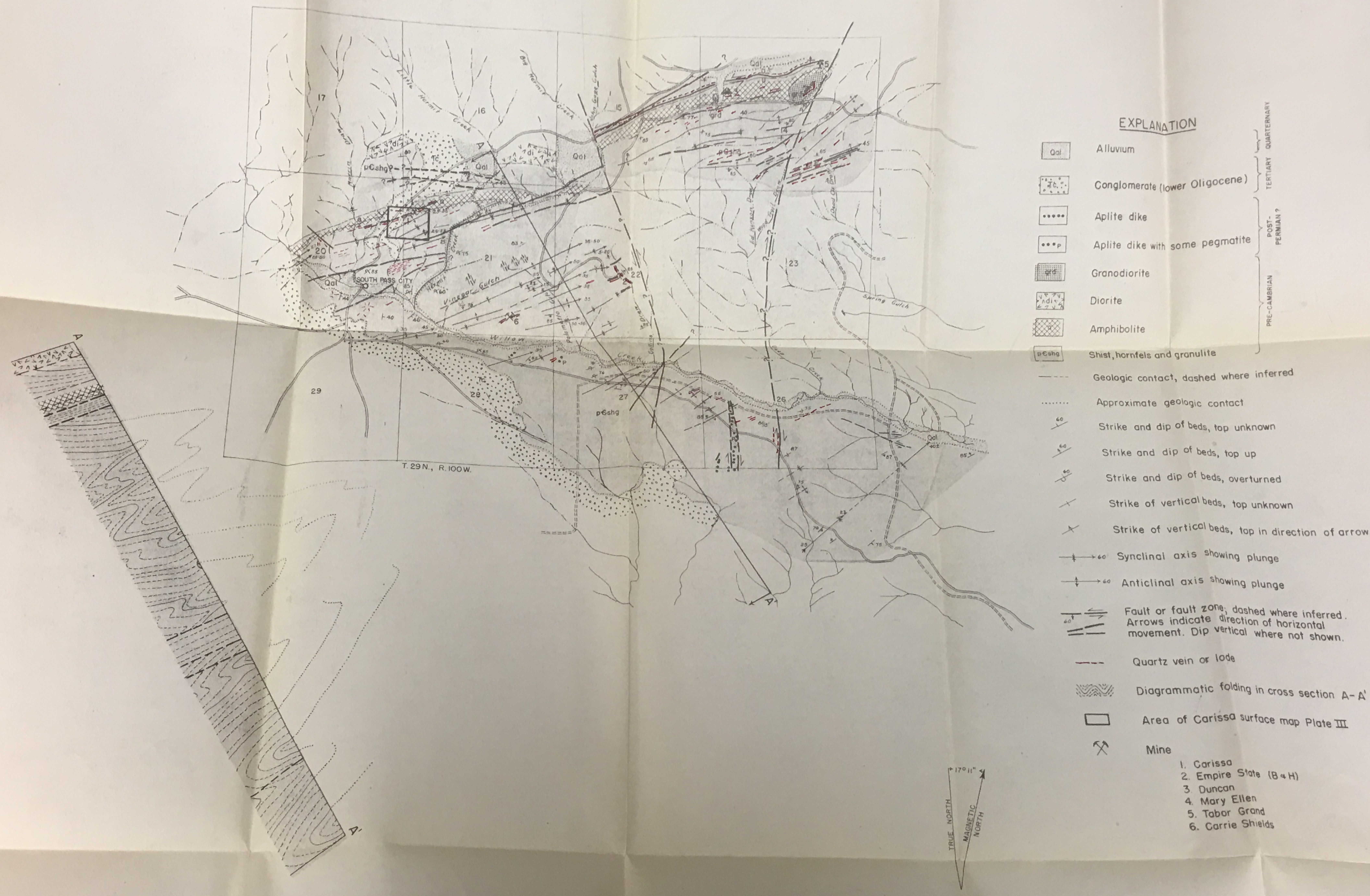
$\frac{0.25}{1.8}$ Assay value $\frac{\text{Ounce of gold}}{\text{Width in feet}}$

Tr = trace

Telephone line

Power transmission line

PRELIMINARY MAP
PLATE I



F. C. Armstrong
P. K. Sims

July – August
1946

Map compiled from
aerial photographs

GEOLOGIC MAP, SOUTH PASS CITY AND VICINITY, FREMONT COUNTY, WYOMING

SCALE 0 2000 4000 6000 8000 FEET
APPROXIMATELY