GENERAL GEOLOGY AND ORE DEPOSITS OF NORTH STAR MOUNTAIN AND LING MINE, SUMMIT AND PARK COUNTIES, COLORADO

BY

SAW ALARIC

JUNE 15, 1952.

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A THESIS SUBMITTED TO THE FACULTY AND THE BOARD OF TRUSTEES OF THE COLORADO SCHOOL OF MINES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT

North Star Mountain, a ridge along the Continental Divide, is situated approximately 7 miles north of Alma, Colorado, and west of Hoosier Pass. It is within Summit and Park counties.

North Star Mountain was developed by (1) arching of the Paleozoic sediments which dip northeasterly and rest on the Pre-Cambrian gneiss, schist, and granite, (The latter were intruded by sills and dikes of igneous origin) and (2) glacial entrenchment to develop the two U-shaped valleys of Monte Cristo Creek on the north and Platte River on the south, leaving North Star Mountain as a ridge. The sedimentary sections are composed essentially of shale, limestone, and quartzite. These sections include the Sawatch quartzite; Manitou limestone; Parting quartzite; the Dyer dolomite, which comes under the Chaffee formation; the Leadville limestone with a basal sand member; and the Weber grit formation. They dip northeasterly about 10 to 30 degrees.

The present workings of the Ling Mine are in Pre-Cambrian gneiss and schist, but the old workings, (No. 1 and 2 levels) are in Sawatch quartzite formation. The sulphide ore of the Ling Mine is mined for gold and silver. The ore is found in the mineralized zone fissures, in veins, or as replacement in schist in most cases. Mineralization in North Star Mountain is controlled by fractures, schistosity, and the bedding planes of the rocks.

The Blue River water tunnel, which is driven through North Star mountain, is owned by the City of Colorado Springs. It connects Platte River with Monte Cristo Creek.

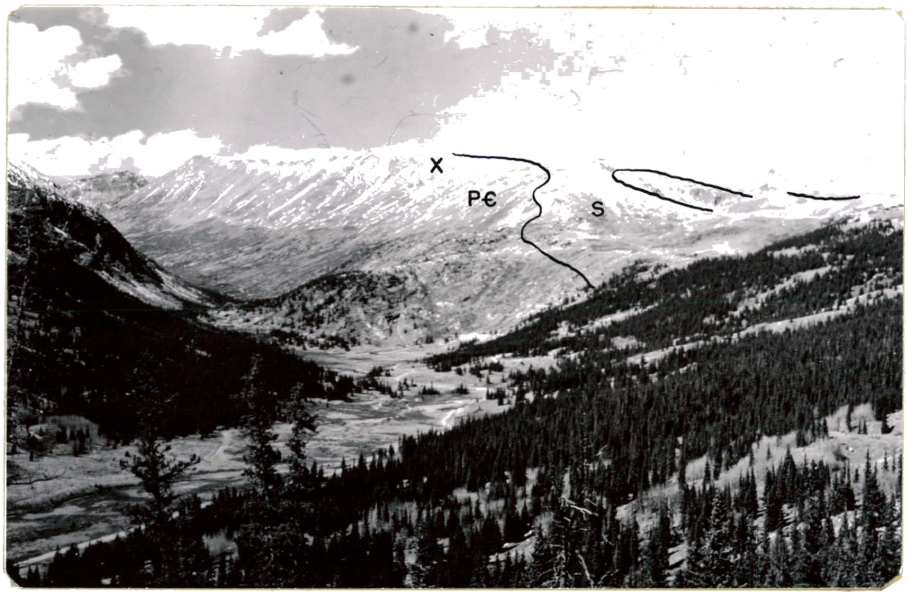


FIG. 1. PHOTOGRAPH OF THE NORTH STAR MOUNTAIN AS SEEN FROM HIGHWAY 9, SOUTH OF HOOSIER PASS.

P€ :- PRE-CAMBRIAN ROCKS.
S :- SEDIMENTARY ROCKS.
X :- LING MINE.

INTRODUCTION

Purpose and Scope of Investigation

The general geology of North Star Mountain was studied to determine the controls of mineralization of the Ling Mine and the area in general. The work was carried out on the surface as well as underground and included (1) stratigraphic, structural, petrographic studies, and (2) mineral studies, which include the making of polished sections and thin sections in the laboratory.

The identification and age classification of the sedimentary formations were made by lithologic and stratigraphic relationships, based on published data on the surrounding districts.

Field Work

The field work for this study was started in July, 1951, and was completed by the first week of September of the same year. U. S. Forest Service aerial photographs on a scale of 4 inches to 1 mile served as a base map for surface mapping; B. C. V. 24-81 through B. C. V. 24-83 inclusive are the numbers of the photographs. These were flown on September 28, 1938.

The underground mine maps supplied by Mr. Harry Dunn, mine operator, were prepared by means of a Brunton and tape survey on a scale of 1 inch to 50 feet. They were supplemented by additional maps based on surveys by the author. The map of the Blue River water diversion tunnel through North Star Mountain was prepared by means of a Brunton and tape survey

ON A SCALE OF 1 INCH TO 100 FEET.

THE ELEVATION OF THE LING MINE IS 12,915 FEET AT THE SOUTH PORTAL OF No. 5 LEVEL, AND THERE IS NO VEGETATION AT THIS ELEVATION. BECAUSE THE AREA AROUND THE MINE AND ALONG THE RIDGE OF NORTH STAR IS WELL COVERED WITH TALUS, SURFACE MAPPING WAS VERY DIFFICULT, ESPECIALLY ON THE WESTERN SLOPE OF NORTH STAR MOUNTAIN. THE SURFACE MAPPING AROUND THE MINE WAS BASED ON THE TYPE OF TALUS WHICH WAS DERIVED FROM THE RESPECTIVE FORMATIONS. THE EASTERN PORTION OF THE NORTH STAR, LOCATED WITHIN SEDIMENTARY ROCKS, IS FAIRLY WELL EXPOSED, AND, AS A RESULT, SURFACE MAPPING WAS MUCH MORE EXACT. THE AREAL DISTRIBUTION OF THE FORMATIONS THAT OUTCROP ON THE NORTH STAR IS REPRESENTED ON GEOLOGIC MAP. (PL. I., POCKET)

ACKNOWLEDGMENTS

THE AUTHOR WISHES TO EXPRESS HIS APPRECIATION TO THE FOLLOWING MEMBERS OF THE GEOLOGY DEPARTMENT, COLORADO SCHOOL OF MINES: DR. F. M. VAN TUYL FOR EDITORIAL WORK; DR. R. H. CARPENTER FOR SUPERVISION AND SUGGESTIONS IN CONNECTION WITH THE FIELD WORK, PREPARATION OF THE TEXT OF THE THESIS AND DRAFTING OF THE MAPS; AND DRS. T. H. KUHN AND W. R. WAGNER FOR ASSISTANCE IN LABORATORY WORK ON POLISHED SECTIONS OF THE ORE MINERALS AND THIN SECTIONS OF THE ROCKS.

MR. HARRY DUNN, LING MINE OPERATOR, GAVE PERMISSION TO WORK IN THE AREA AND THUS MADE THIS STUDY POSSIBLE. APPRECIATION MUST ALSO BE EXPRESSED TO HIM FOR HIS GUIDANCE IN THE FIELD AND FOR INFORMAL DISCUSSION OF THE GEOLOGY OF THE AREA AND PART OF THE HISTORY OF THE LING MINE. MY SINCERE THANKS TO MR. CLIFFORD E. REED, RESIDENT ENGINEER OF THE WATER DEPARTMENT OF THE CITY OF COLORADO SPRINGS, FOR PERMISSION TO MAP THE BLUE RIVER DIVERSION WATER TUNNEL, AND TO MR. EARL W. HITCHINS OF ALMA, COLORADO, IN HELPING TO MEASURE THE STRATIGRAPHIC SECTIONS.

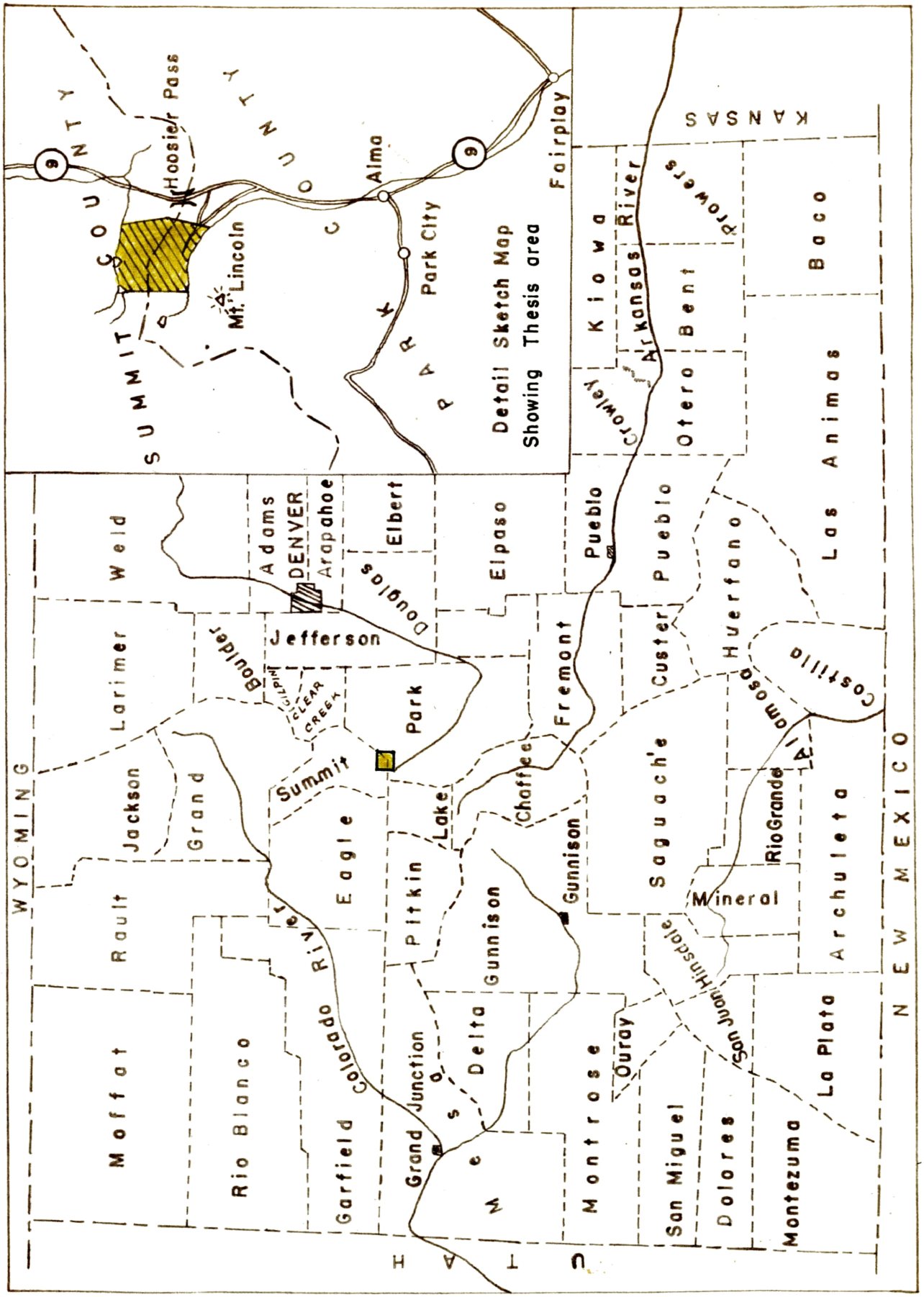


FIG. 2 INDEX MAP OF COLORADO

Showing Thesis area.

GEOGRAPHY

LOCATION

NORTH STAR MOUNTAIN IS A RIDGE RUNNING EAST-WEST LOCATED IMMEDIATELY WEST OF HOOSIER PASS. THE CONTINENTAL DIVIDE RUNS THROUGH THE CREST OF THE RIDGE, WHICH SEPARATES SUMMIT COUNTY AND PARK COUNTY OF COLORADO. THE NORTHERN SLOPE LIES IN SUMMIT COUNTY:, THE SOUTHERN SLOPE LIES IN PARK COUNTY. THE RIDGE IS BETWEEN MONTE CRISTO CREEK ON THE NORTH AND SOUTH PLATTE RIVER ON THE SOUTH. IT IS 7 MILES NORTH OF ALMA, COLORADO, AND 7 MILES SOUTH OF BRECKENRIDGE, COLORADO. FIG. 2 SHOWS THE LOCATION OF THE AREA STUDIED.

ACCESSIBILITY

STATE HIGHWAY 9, A GRAVEL ROAD FROM ALMA TO BRECKENRIDGE, GOES OVER HOOSIER PASS; FROM THE PASS A DIRT ROAD TO THE WEST ALONG THE RIDGE LEADS TO THE LING MINE. THIS BRANCH ROAD FROM THE MINE TO HIGHWAY 9 IS MAINTAINED BY MR. HARRY DUNN, THE MINE OPERATOR. IT IS DIFFICULT TO KEEP THIS ROAD OPEN AS NUMEROUS LAND AND SNOW SLIDES OCCUR DURING THE SNOW SEASON.

CLIMATE AND VEGETATION

THE CLIMATE AT NORTH STAR MOUNTAIN IS CHARACTERIZED BY LONG, COLD WINTERS AND SHORT COOL SUMMERS. BECAUSE OF THE ELEVATION, PATCHES OF SNOW CAN BE SEEM THE YEAR AROUND. AFTERNOON SHOWERS AND HAIL STORMS OCCUR DURING THE SUMMER.

The road from the Ling Mine to Hoosier Pass is closed by the snow as early as November and not until the last of middle June is the road again passable. The period of accessibility could be lengthened if a bulldozer were available to clear the snow.

The elevation of the Ling Mine is approximately 13,000 feet. The vegetation, mostly pine and aspen rises to about 11,000 feet, which is the "timber line" on both sides of the slopes of the North Star Mountain. Arctic willow flourishes in the valley of Monte Cristo Creek and of South Platte River.

Topography

South Platte River flows to the east in a glaciated valley, on the south side of the North Star Mountain. To the south of this valley is the Lincoln Mountain, another high peak of the Park Range. On the north side of the North Star Mountain, Monte Cristo Creek flows, approximately east to Highway 9 where it turns northward. In the headwater are two lakes, namely, the Upper Blue Lake and the Lower Blue Lake, whose origin is probably due to glacial scouring. From both rivers North Star Mountain rises into steep cliffs up to the crest, except on the eastern portion of the ridge near Hoosier Pass. The western side of North Star, along the ridge, is very sharp and covered with talus. Mechanical weathering is taking place at a high rate. The elevation of the river bed is about 10,000 feet compared to 13,000 feet along the crest of the divide. On the eastern flank of the North Star Mountain is a big basin like an amphitheater, which is due to erosion following glaciation. Silver Lake is located within this basin.

FIG. 3. PHOTOGRAPH OF NORTH STAR MOUNTAIN, LOOKING WEST FROM HIGHWAY 9, IN MONTE CRISTO CREEK, SHOWING TIMBER LINE.

FIG. 4. PHOTOGRAPH SHOWING THE VALLEY OF MONTE CRISTO CREEK, LEADING TO BLUE LAKE.

FIG. 5. PHOTOGRAPH TAKEN FROM NORTH STAR MOUNTAIN SOUTHEAST SHOWING U-SHAPED VALLEY ALONG THE PLATTE RIVER TOWARDS ALMA.

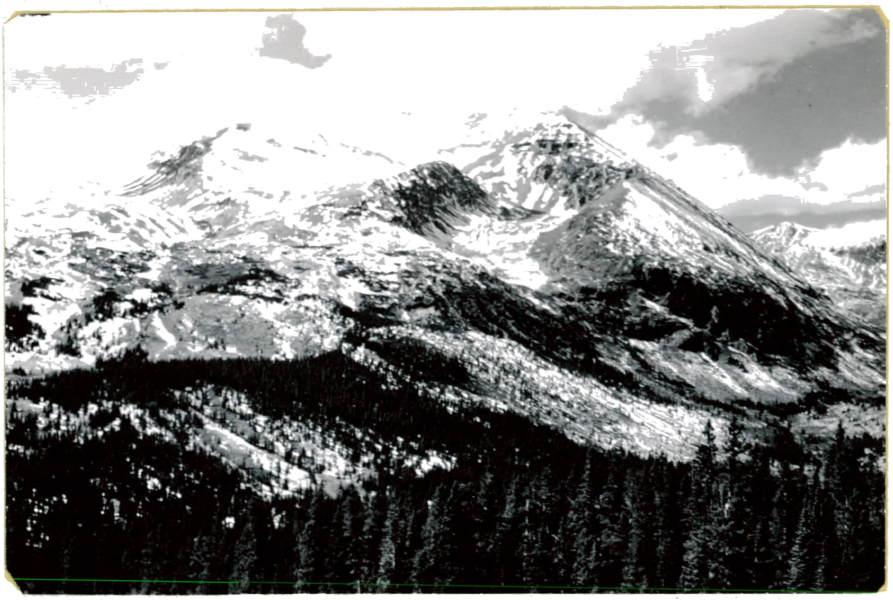


FIG. 6. PHOTOGRAPH OF MOUNT LINCOLN GLACIAL AMPHITHEATER, TAKEN FROM HIGHWAY 9, LOOKING SOUTHWEST.

GEOMORPHOLOGY

North Star Mountain is a ridge running in a general east-west direction, approximately parallel to Monte Cristo Creek on the north and to the upper part of South Platte River on the south. Its crest, especially on the west side of the range, is extremely narrow and sharp. It drops off comparatively steeply and, in places, precipitously; but the east side of the ridge forms a long, gentle slope before turning steeply towards Monte Cristo Creek on the north and the Platte River on the south. This gentle sloping section is composed of sedimentary rocks which dip gently to the northeast. These rocks rest upon Pre-Cambrian metamorphic gneiss, schist, and granite and form the flank of an anticline which extends to Lincoln Mountain on the southeast. In effect this area represents the eastern flank of the Ten Mile Arch, a portion of the Park Range.

The effect of glacial action is strikingly shown in both Monte Cristo Creek and South Platte River. The typical U-shaped valley of the South Platte River is shown in Fig. 5. Thus North Star Mountain is an east-west trend, a remnant between two glaciated valleys. Two periods of glaciation occurred in the Platte River. Drainage is excellent because of the steepness of the cliffs on both sides of the ridge.

FIG. 7. PANORAMIC PHOTOGRAPH OF AREA AROUND SILVER LAKE BASIN, SHOWING ROCK STREAMS ON EAST FLANK OF NORTH STAR MTN.

GEOLOGY

General Statement

North Star Mountain is composed of uplifted Paleozoic sediments which rest on Pre-Cambrian gneiss, schist, and granite. Quartz monzonite intrusives occur as dikes in Pre-Cambrian basement and as dikes and sills in the sediments.

In order of their importance, a probable low-angle thrust fault in the lower member of the Cambrian Sawatch quartzite, and minor faults related to the uplifted sediments comprise the structural features of North Star Mountain; the northeasterly dipping sedimentary beds forming a flank of a broad arch. The accompanying geologic map (Pl. I, in pocket) shows the relationship of the structure to distribution of the formation in as much detail as outcrop and map scale permit.

The ore deposits of North Star Mountain have developed as both fissure and fracture filling and as replacement bodies. Mineralizing solutions are believed to have deposited ore in areas of shattering as they work their way along the fractures and bedding planes of the sediments and fractures and planes of schistosity in the basement rock.

Sedimentary Rocks

The sedimentary rocks of the area consist of a group of quartzite, shale, limestone, and dolomite, all of Paleozoic age. The sedimentary section was studied on the east side of the North Star Mountain. Fig. 1.

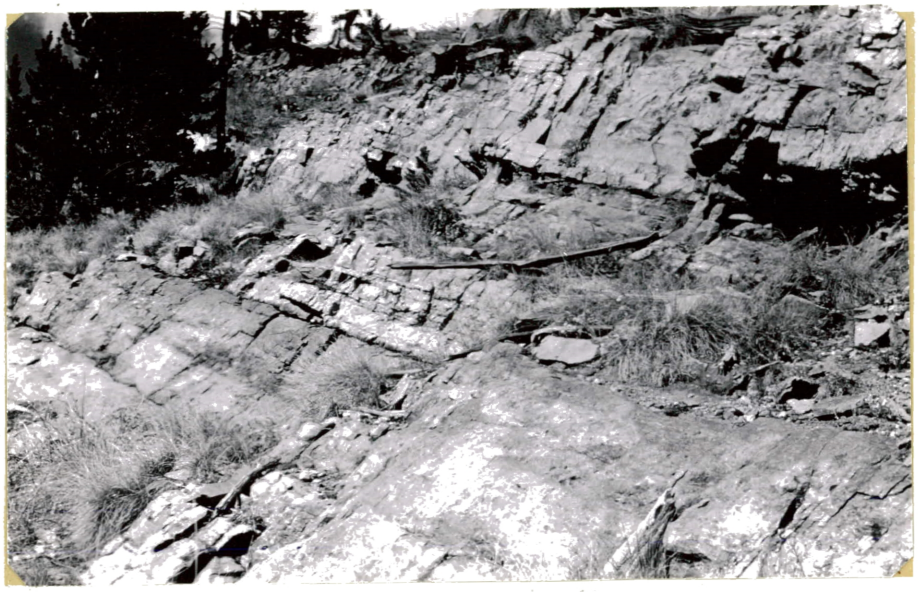


FIG. 8. BROWN SANDY LAYER IN THE LOWER SAWATCH QUARTZITE MEMBER ON THE SOUTH SIDE OF NORTH STAR MOUNTAIN.

FIG. 9. THE PEERLESS SHALE MEMBER OF THE SAWATCH QUARTZITE, SOUTH SIDE CLIFF OF NORTH STAR MOUNTAIN.

FIG. 10. BASAL CONGLOMERATE OF SAWATCH QUARTZITE, SOUTH SIDE OF NORTH STAR MOUNTAIN.

GENERALIZED STRATIGRAPHIC SECTION

AT

NORTH STAR MOUNTAIN

Summit and Park Counties, Colorado

Scale 1" = 30'

30' 10' 0 30'

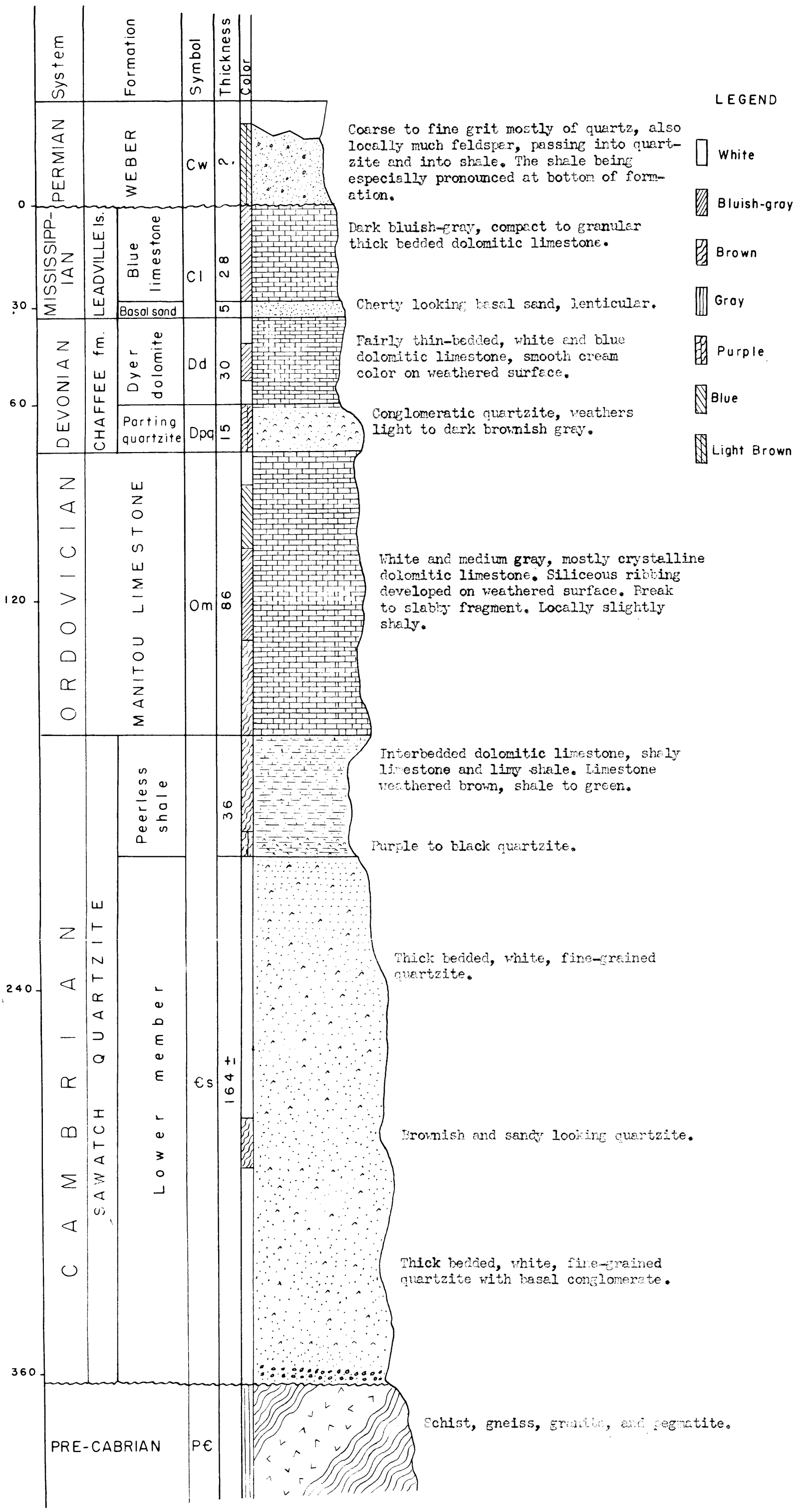


PLATE 5

THE GENERALIZED STRATIGRAPHIC COLUMN (PL. 5) IS BASED ON THE TWO STRATIGRAPHIC CROSS SECTIONS (PL. 4, IN POCKET), WHICH WERE MEASURED ALONG THE EAST SIDE OF THE RIDGE.

THE FORMATIONS WERE IDENTIFIED IN THE FIELD BY THE AID OF DESCRIPTION AND STRATIGRAPHIC SEQUENCES, AND THE AGE DETERMINATIONS WERE BASED ON REVIEW OF THE LITERATURE.

NO FOSSILS HAVE BEEN COLLECTED BY THE WRITER, BUT PROFESSOR J. H. JOHNSON (7) HAS COLLECTED A FEW FOSSILS FROM THE UPPER MEMBER OF THE SAWATCH QUARTZITE AND THE WEBER FORMATION.

CAMBRIAN

SAWATCH QUARTZITE

THE SAWATCH QUARTZITE WAS DEPOSITED UPON A SURFACE OF PRE-CAMBRIAN ROCKS WHICH HAD BEEN ERODED IN GENERAL TO A SMOOTH, FLAT SURFACE. THE LOWER PART OF THE FORMATION IS COMPOSED ENTIRELY OF CRYSTALLINE QUARTZITE WHICH RESISTS EROSION AND TENDS TO FORM PROMINENT CLIFFS. THE UPPER PART IS COMPOSED OF LIMESTONE AND SHALE WHICH ARE EASILY ERODED. IN SOME PLACES THE LIMESTONE TENDS TO FORM DISTINCT BENCHES, AS SHOWN IN FIG. 9.

THE BASE OF THE LOWER PART OF THE SAWATCH QUARTZITE IS A CONGLOMERATE, 6 TO 12 INCHES THICK, IN WHICH QUARTZ PEBBLES OF VARIOUS SIZE, NOT EXCEEDING ONE INCH IN DIAMETER, ARE ENCLOSED IN A MATRIX OF FINE-GRAINED WHITE QUARTZITE. THE SAWATCH QUARTZITE GRADES UPWARD INTO SEVERAL FEET OF MEDIUM-GRAINED QUARTZITE, THENCE INTO FINE-GRAINED WHITE QUARTZITE. A LAYER IN THE LOWER WHITE QUARTZITE ZONE HAS A CALCAREOUS CEMENT AND ON WEATHERING THIS LAYER ASSUMES A BROWNISH, SANDY APPEARANCE. IN SOME

PLACES THIS LAYER CONSISTS OF THIN-BEDDED FINE-GRAINED QUARTZITE, SANDY LIMESTONE, AND SOME DENSE LIMESTONE. THIS LAYER IS OVERLAIN BY FINE-GRAINED WHITE QUARTZITE WHICH RESEMBLES THE LOWER QUARTZITE.

THE UPPER MEMBER OF THE SAWATCH QUARTZITE IS KNOWN AS THE PEERLESS SHALE MEMBER. JUST ABOVE THE UPPER WHITE QUARTZITE OF THE LOWER MEMBER, THERE IS AN EASILY RECOGNIZED MARKER, A FINE-GRAINED, SLIGHTLY CONGLOMERATIC LAYER THAT HAS A PURPLISH TO BLACKISH COLOR CAUSED BY WEATHERING. LOCALLY THIS LAYER IS FERRUGENOUS. SMALL ANGULAR PEBBLES ARE SEEN ONLY ON CLOSE INSPECTION, AND COMMONLY REVEAL CROSS-BEDDING. IT IS MODERATELY SILICIFIED IN SOME PLACES.

ABOVE THIS PURPLISH QUARTZITE THE PEERLESS SHALE MEMBER CONSISTS OF INTERBEDDED LIMY BEDS, WHICH ARE SLIGHTLY SANDY, CRYSTALLINE DOLOMITIC LIMESTONE, AND SILICEOUS INDURATED SHALY BEDS. BEDDING PLANES ARE RATHER CLOSELY SPACED THROUGHOUT, BETWEEN 6 AND 12 INCHES, AND THE SHALY BEDS ARE FLAGGY. THE COLOR OF THE LIMESTONE, WHERE IT IS FRESH RANGES FROM WHITE TO BROWNISH IN COLOR. THE SHALE IS WEATHERED TO GREEN PLATY FRAGMENTS, BUT ON FRESH SURFACES SOME ARE LIGHT-COLORED AND SOME ARE DARK.

ACCORDING TO EMMONS (6) A FEW FOSSILS HAVE BEEN COLLECTED FROM MONTE CRISTO CREEK, NORTH OF HOOSIER PASS. THEY ARE SPECIES OF TRILOBITES AND BRACHIOPODS. PROFESSOR J. H. JOHNSON OF THE COLORADO SCHOOL OF MINES (7) HAS COLLECTED A FEW FOSSILS FROM THE PEERLESS SHALE MEMBER OF THE SAWATCH QUARTZITE.

ORDOVICIAN

MANITOU LIMESTONE

THE MANITOU LIMESTONE CONSISTS OF THIN BEDDED, WHITE TO BLACKISH-BLUE, CRYSTALLINE DOLOMITIC LIMESTONE THAT WEATHERS TO LIGHT GREY.

The formation has developed siliceous ribbing and usually breaks into slabby fragments. Locally the formation is slightly shaly at the top. The contact between the Manitou limestone and the Peerless shale member of the Sawatch quartzite formation is difficult to locate. The only diagnostic feature is the siliceous bands, which on weathered surfaces developed a pronounced ribbing in general parallel to the bedding. Most of the ribs are less than one-sixteenth of an inch in width, but in the upper part it ranges up to one-fourth inch. The limestone is predominantly pale bluish-gray, but some beds are white or gray or have been weathered to white. A few beds consist of medium-grained limestone and have dense texture.

Devonian

Chaffee Formation

Parting Quartzite

In general the Parting quartzite consists of brownish-grey gritty quartzite. It has the appearance of limy quartzite or sandy limestone. It is conglomeratic and cross bedded, and in places occasional shale partings.

Dyer Dolomite

This formation was included in the Blue limestone by Emmons as the lower limestone member. But later, Behre (2) named it the Dyer dolomite, and designated it as Devonian in age. It is difficult to locate the contact with the basal sand member of the overlying Leadville limestone. The Dyer dolomite consists of thin to moderately thick, well-bedded, mostly dense-textured dolomitic limestone. The color is creamy white to dark blue. The rock has a very smooth appearance on a weathered surface. In a few

PLACES IT HAS SILICEOUS RIBS SIMILAR TO THE MANITOU LIMESTONE, EXCEPT THAT IT IS CREAMY WHITE IN COLOR. THE BASE IS TRANSITIONAL WITH THE PARTING QUARTZITE.

MISSISSIPPIAN

LEADVILLE LIMESTONE

ABOVE THE DYER DOLOMITE MEMBER OF THE CHAFFEE FORMATION IS A SANDY BED KNOWN AS THE BASAL SAND MEMBER OF THE LEADVILLE LIMESTONE. ITS THICKNESS IS ABOUT 5 FEET. IT IS A WHITE, CHERTY-LOOKING SANDSTONE WITH A SUGARY TEXTURE. IT IS MEDIUM TO COARSE-GRAINED, AND ITS GRAINS ARE CEMENTED BY CALCIUM CARBONATE AND SILICA. IN SOME PLACES IT RESEMBLES QUARTZITE AND IN SOME PLACES GRADES TO A LIMESTONE WITH NUMEROUS INCLUDED QUARTZ GRAINS. IT IS LENTICULAR IN OUTCROP.

ABOVE THE SAND MEMBER, THE FORMATION CONSISTS OF MASSIVE AND DOLOMITIC LIMESTONE WHOSE TEXTURE IS DENSE TO VERY FINE-GRAINED. A STRIKING CHARACTERISTIC IS THE TENDENCY TOWARDS SHATTERING. CHERT NODULES AND STREAKS ARE COMMON. MOST OF THEM ARE BLACK, BUT A FEW ARE LIGHT COLORED. ON A WEATHERED SURFACE THIS MEMBER IS EXTREMELY PITTED. THE ROCK IS USUALLY DARK BLUE WITH ALTERNATE BANDS HAVING SLIGHTLY DIFFERENT COLORS.

WEBER FORMATION

THE WEBER FORMATION RESTS UPON THE LEADVILLE LIMESTONE. IT IS SEPARATED FROM IT BY AN EROSIONAL UNCONFORMITY. IT CONSISTS OF INTERBEDDED MICACEOUS QUARTZITE, SANDSTONE, GRIT, ARKOSE, CONGLOMERATE, SANDY SHALE AND SHALE. JUST ABOVE THE LEADVILLE LIMESTONE, A BLACK SHALY BED IS PRESENT AND LOWER PART OF THE WEBER IS GENERALLY SHALY. ARENACEOUS BEDS CONSTITUTE MOST OF THE FORMATION. IN GENERAL, THE FORMATION INCREASES IN COARSENESS OF GRAIN

TOWARDS THE TOP, AND ITS COLOR RANGES FROM WHITISH TO DARK GRAY. ALMOST ALL THE BEDS ARE CONGLOMERATIC AND MORE OR LESS ARKOSIC. THE HIGHLY ARKOSIC BEDS ARE RATHER FRIABLE ON THE WEATHERED SURFACES. THE CONGLOMERATES ARE PREDOMINANTLY QUARTZ AND SUBORDINATELY FELDSPAR WITH OCCASIONAL SCHIST PEBBLES OR COBBLES, RANGING ONE-FOURTH TO ONE INCH IN DIAMETER.

ACCORDING TO PROFESSOR J. H. JOHNSON (7) FOSSILS OBTAINED FROM WEBER FORMATION INCLUDE PLANTS AND ANIMALS. THE PLANTS ARE ALGAE AND LAND PLANTS.

QUATERNARY

THE QUATERNARY FORMATIONS INCLUDE THE GLACIAL MORAINE DEPOSITS AND THE RECENT DETRITAL FORMATIONS, WHICH ARE POST-GLACIAL.

GLACIAL DEPOSITS

THE GLACIER WHICH HAD ITS ORIGIN IN THE HEADWATERS OF THE PLATTE RIVER BASIN HAS LEFT ITS MARK AS EVIDENCE. THE MATERIAL ACCUMULATED BY THE GLACIERS WAS CARRIED SEVERAL MILES BELOW MONTGOMERY AND DEPOSITED THERE AS A LATERAL AND TERMINAL MORAINE. IN THE VALLEY JUST BELOW MONTGOMERY THERE ARE BOULDERS WHICH SHOW IRREGULAR SHAPES, TYPICAL OF GLACIATION. THERE ARE TYPICAL STRIATIONS ON THE ROCK CARVED IN THE BOTTOM OF THE PLATTE CANYON.

RECENT OR POST-GLACIAL GRAVELS

THIS FORMATION INCLUDES THE DETRITAL MATERIAL WHICH HAS BEEN CARRIED INTO THE VALLEY AS A RESULT OF CHEMICAL AND MECHANICAL EROSION OF THE SURROUNDING MOUNTAINS. THIS ALLUVIUM IS CONFINED TO SMALL AREAS ON EITHER SIDE OF THE PLATTE, IN THE VALLEY AROUND MONTGOMERY. IT IS COMPOSED OF AN AGGLOMERATION OF MANY TYPES OF ROCK DEBRIS CARRIED DOWN FROM THE STEEPLY SLOPING MOUNTAINS WHICH SURROUND THE RIVER.

Talus

The whole of the western side of North Star Mountain is covered with coarse angular talus debris originating from mechanical weathering of the rocks. There is practically no vegetation on talus covered area.

Pre-Cambrian Rocks

The Pre-Cambrian rocks within the area are thoroughly crystalline in texture. They consist of gneiss, granite, and schists of various composition grading into each other. Pegmatites and aplite also are abundant. Gneiss and schist make up a very large part of the area. The tendency towards banded structure is pronounced in almost every part of the area. Such banded gneiss and schist may have contrasting bands produced by alternating white and black parallel streaks. More frequently the banding is due to the segregation of the light and dark colored minerals in varying proportions. In contrast to the banded rocks there is a granite gneiss that can be distinguished from sheared granite, only with difficulty.

Gneiss

Two types of gneisses have been observed, namely the banded gneiss and the granite gneiss, which grade into each other. The granite gneiss is medium-grained rock, about the color of light-colored granite. In hand specimens, quartz, feldspar, and biotite are evident. The rock shows faint parallel arrangement of the minerals. The biotite in the granite gneiss distinguishes it from the granite.

Microscopically, the rock is composed largely of quartz, microcline, plagioclase, chlorite, and muscovite. Microcline, the most abundant

FIG. 11. PEGMATITE VEINLET INTERSECTING THE BANDED GNEISS.

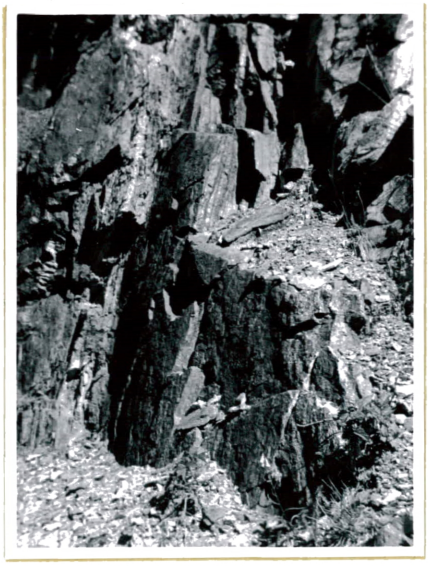


FIG. 12. FAHLBAND VEIN IN FAULTED ZONE IN PRE-CAMBRIAN GNEISS AND SCHIST.

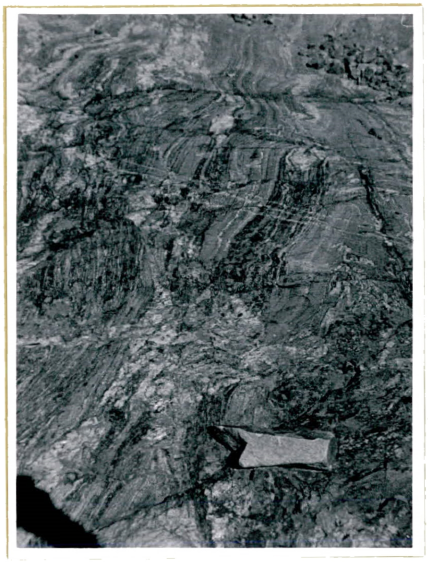


FIG. 13. BANDED GNEISS WITH GLACIAL STRIATION.

FIG. 14. BANDED GNEISS OF THE PRE-CAMBRIAN BASEMENT.

FELDSPAR, IS FAIRLY WELL DEVELOPED AND OCCURS IN BOTH LARGE AND SMALL GRAINS. PLAGIOCLASE IS NOT ABUNDANT. MUSCOVITE OCCURS IN FAIRLY LARGE PLATES, AND ALTERS TO CHLORITE.

BANDED GNEISS CONSISTS OF BANDS WHICH MAY RANGE FROM VERY FINE, ABOUT ONE-EIGHT OF AN INCH TO COMPARATIVELY COARSE. THE COLOR IS USUALLY GRAY, BECAUSE OF THE MIXTURE OF BIOTITE WITH QUARTZ AND FELDSPAR. THE BANDING USUALLY IS ESSENTIALLY PARALLEL BUT OFTEN IS FOLDED AND CRUMPLED.

SCHIST

THE SCHIST IS SHARPLY SEPARATED FROM THE GNEISS AND IN MOST CASES BLENDS INTO THE GNEISS OR OCCURS AS ALTERNATE BANDS. IT IS ON THE WHOLE A DISTINCTLY CRYSTALLINE ROCK IN WHICH THE MINERALS ARE EASILY RECOGNIZED IN THE HAND SPECIMENS. THE CLEAVAGE IS SUFFICIENTLY ABLE TO JUSTIFY THE USE OF THE TERM SCHIST.

AS FOR THE MINERAL COMPOSITION, IT CONSISTS FOR THE MOST PART OF QUARTZ, BIOTITE, AND MUSCOVITE. ALBITE AND SILLIMANITE ARE ALSO COMMON. IN SOME CASES HORNBLENDE IS PRESENT INSTEAD OF MUSCOVITE. BIOTITE AND QUARTZ ARE MORE ABUNDANT THAN ANY OTHER OF THE MINERALS. THUS THE SCHIST CAN BE CLASSIFIED AS BIOTITE-MUSCOVITE SCHIST OR BIOTITE-SILLIMANITE SCHIST WHERE SILLIMANITE AND MUSCOVITE ARE PRESENT AND BIOTITE-HORNBLENDE SCHIST WHERE HORNBLENDE IS ABUNDANT.

PEGMATITE

THE PRE-CAMBRIAN ROCKS ARE FREQUENTLY INTRUDED BY NUMEROUS VEIN-LIKE OR DIKE-LIKE MASSES OF LIGHT-COLORED ACIDS AND COARSE-GRAINED PEGMATITES. THE FISSURES WHICH FILL THESE BODIES RANGE FROM AN INCH AND UP TO SEVERAL HUNDRED FEET ACROSS AND FREQUENTLY FORM TOPOGRAPHIC FEATURES OF THE AREAS.

They sometime form a variable network of crossing and intersecting dikes and dikelets that penetrate the rocks in all directions. They also appear as streaks and gash fillings standing out in contrast to dark colored walls of schist. The pegmatite consists of quartz and whitish or pinkish feldspar, with or without muscovite, and occasionally with biotite. Usually the feldspar is the prevailing mineral. The most abundant feldspar is microcline, though albite in some instances is abundant. Orthoclase was noted in some places. The pegmatite cuts the granite in many places, but not as frequently as gneiss and schist.

Aplite

Closely associated with the pegmatites are narrow vein and veinlets of fine-grained quartz and feldspar that occur cutting gneiss and schist. Their grain size is less than 0.5 mm in diameter. They are usually very narrow ranging from one to one-half inch. In some instances they seem to grade into pegmatites. Sometimes they occur as veins a few feet in width. Mineralogically the aplite are composed of small quartz and microcline, with orthoclase as a minor constituent.

Granite

From its mineral constituents, the granite may be designated as a muscovite granite. The granite is usually a fine-grained to medium-grained, light-gray rock, with both biotite and muscovite evident in hand specimen. None of the constituents are porphyritic, although occasionally a feldspar individually shows a slight tendency toward idiomorphic form. The average grain size is about 1 to 2 mm in diameter. In

In some places granite is distinctly coarse in texture, with the individual phenocrysts ranging up to 3 mm in diameter. Under the microscope, granite consists of quartz, orthoclase, microcline, oligoclase, biotite and muscovite. The orthoclase is inclined to show carlsbad twinning. Microcline and oligoclase in some cases are altogether absent. All the feldspar, except microcline, show a tendency to alter to sericite. Biotite is more abundant than muscovite.

Tertiary Igneous Rocks

Intrusive igneous rocks occur as sills and dikes in the North Star area. Their age is supposed to be late Cretaceous or early Tertiary. These sills and dikes are quartz monozonite in composition. Cross in the Leadville Monograph (1) designated specific names for the porphyries in the area surrounding Leadville. These same rocks occur in the North Star area. They consist of the following:

1. The Lincoln porphyry.
2. The quartz monozonite porphyry.
3. The white porphyries.

Lincoln Porphyry

Cross (2) designated the type of rock that outcrops on the summit of Mount Lincoln as the Lincoln Porphyry. This same type of rock is found on North Star Mountain. It occurs as a sill or lacolithic sill near the base of the Weber formation on the eastern shoulder of North Star Mountain.

The most distinctive feature is the occurrence of large, well-formed, pink orthoclase crystals. They make up about 10 per cent of the rock volumn. They enclose smaller grains of biotite, quartz, and less commonly plagioclase.

THE LINCOLN PORPHYRY RESEMBLESTHE QUARTZ MONZONITE PORPHYRY DIKE. IT CONSISTS OF SMALL TO MEDIUM PHENOCRYSTS OF PLAGIOCLASE RANGING FROM 0.5 TO 1 MM IN DIAMETER, QUARTZ AND BIOTITE IN A MEDIUM-GREY GREENISH GROUNDMASS. WEATHERED SURFACES ARE EITHER LIGHT GRAY OR RUSTY BROWN. THE ONLY DIFFERENCE BETWEEN THIS PORPHYRY AND THE QUARTZ MONZONITE PORPHYRY IS THE PRESENCE OF ORTHOCLASE CRYSTALS RANGING FROM 1 TO 2 MM IN DIAMETER.

QUARTZ MONZONITE PORPHYRY

THE QUARTZ MONZONITE PORPHYRY OCCURS AS DIKES CONTAINING A CONSIDERABLE AMOUNT OF VISIBLE PLAGIOCLASE AND QUARTZ AND A SMALL AMOUNT OF ORTHOCLASE. THE ROCK IS A GREENISH-GREY COLOR ON A FRESH SURFACE, BUT ON A WEATHERED SURFACE IT MAY BE GREEN, BROWN TO LIGHT-GREY COLOR OR NEARLY WHITE. IN NUMEROUS PLACES PHENOCRYSTS OF FELDSPAR, QUARTZ, AND ALTERED BIOTITE AND HORNBLENDE ARE EMBEDDED IN A DENSE GROUNDMASS. NEAR THE MINERALIZED ZONE IN THE UNDERGROUND WORKINGS THIS ROCK MAY BE INTENSELY SERICITISED AND PYRITIC. IN SOME PLACES IT RESEMBLES THE WHITE PORPHYRY BECAUSE OF BLEACHING.

UNDER THE MICROSCOPE, ANDESINE, QUARTZ, AND BIOTITE ARE PROMINENT AS PHENOCRYSTS. ORTHOCLASE AND HORNBLENDE ARE SPARSE. THE GROUNDMASS IS COMPOSED OF PLAGIOCLASE, QUARTZ, ORTHOCLASE, AND BIOTITE. IN ADDITION TO THE ABOVE MINERALS, EPIDOTE AND RUTILE ARE PRESENT. THIS TYPE OF ROCK IS WELL EXPOSED UNDERGROUND IN THE LITTLE DAISY MINE, ON THE NORTH SIDE OF NORTH STAR MOUNTAIN.

WHITE PORPHYRIES

OWING TO ITS LIGHT COLOR, THE WHITE PORPHYRY CAN BE RECOGNIZED

AT A DISTANCE. SINGEWALD AND BUTLER (2) DIVIDE THE WHITE PORPHYRIES INTO TWO GROUPS, NAMELY, THE WHITE PORPHYRY AND THE LATE WHITE PORPHYRY. IN GENERAL THE WHITE PORPHYRY IS LACKING IN FELDSPAR PHENOCRYSTS, OR THEY ARE VERY SPARSE. IT OCCURS AS SILLS. THE LATER WHITE PORPHYRY COMMONLY HAS PHENOCRYSTS OF FELDSPAR AND GENERALLY OCCURS AS DIKES.

THE WHITE PORPHYRY CONTAINS MEDIUM-SIZED QUARTZ GRAINS RANGING FROM 0.5 TO 1 MM IN DIAMETER, AND ALTERED FELDSPAR. THE MUSCOVITE FLAKES WERE NOTED IN THE DENSE GROUNDMASS WHICH IS COMPOSED MOSTLY OF QUARTZ AND FELDSPAR. UNDER THE MICROSCOPE ORTHOCLASE, PLAGIOCLASE, AND QUARTZ ARE EVIDENT. THEY USUALLY FORM A MICROGRANULAR AGGREGATE OF ANHEDRAL GRAINS. APATITE, ZIRCON, AND MAGNETITE ARE OBSERVED IN THIN SECTIONS. QUARTZ IS EUHEDRAL TO SUBHEDRAL, OR ROUNDED AND EMBAYED.

THE LATER WHITE PORPHYRY IS WHITISH-GRAY IN COLOR, AND IN PLACES HAS A WELL DEVELOPED SHEETED STRUCTURE. IT HAS MEDIUM-SIZED PHENOCRYSTS OF FELDSPAR AND QUARTZ. ITS GROUNDMASS IS SIMILAR TO THAT OF THE WHITE PORPHYRY. UNDER THE MICROSCOPE FELDSPAR PHENOCRYSTS ARE FOUND TO BE BOTH ALBITE AND ORTHOCLASE, BUT ALBITE PREDOMINATES. THE GROUNDMASS IS MICROGRANULAR.

STRUCTURAL GEOLOGY

FOLDING

THE NORTHEAST REGIONAL DIP OF THE SEDIMENTS IN THE NORTH STAR MOUNTAIN AREA REFLECTS THE BROAD NORTHWEST TREND OF THE TEN MILE ARCH. THE DIPS ALONG THIS NORTHEASTERN FLANK RANGES BETWEEN 10 AND 30 DEGREES NORTHEAST.

MINOR ROLLS PARALLELING THE AXIAL TREND OF THE TEN MILE ARCH WERE IN THE PALEOZOIC SEDIMENTS WEST OF HOOSIER PASS. THESE MAY REFLECT THE PRESENCE OF ZONES OF WEAKNESS IN THE BASEMENT ROCKS BENEATH.

Faulting

It was noted in the study of the lower member of the Sawatch quartzite that a low-angle thrust fault of considerable throw may be present (as shown in Fig. 10) along the border of the white porphyry sill. It was also noted in approximately the same stratigraphic horizon adjacent to the sill on the north side of the ridge near Silver Lake.

Shearing is common throughout the area. The faults are mostly minor shears and trend northeast. The "Faults" in the Pre-Cambrian gneiss and schist are of short extent and of minor offset. Movement has taken place mostly along "joint" surfaces. Most of the persistent joints and faults are mineralized and are silicified on both sides. In some instances heavy limonite stains were observed. There is not enough evidence of movement along the fault planes in most instances to determine the direction or amount of movement. The general trend of the faults are northeasterly and dips range from 60 to 80 degrees to the east.

Jointing

The Pre-Cambrian gneisses and schists are massive, and jointing is prominent in all three rocks in the area. Of the sedimentary rocks the Sawatch quartzite and the Blue limestone are well jointed. Slight movement along the joints is common, and most of the minor faults are parallel to these joints as observed in the underground workings and in the Blue River Diversion Water Tunnel.

FIG. 15. SILL IN THE LOWER MEMBER OF SAWATCH QUARTZITE, SOUTH SIDE OF NORTH STAR MOUNTAIN.

S:- SILL.

Summary of Geologic History of the Area

The Paleozoic sediments were deposited on the flat surface of the eroded Pre-Cambrian basement complex. During the Laramide revolution, or the orogenic movement that formed the Rocky Mountains. Folding of Paleozoic sediments in this area resulted in arching that formed an anticline of which North Star Mountain is a part. This arching was followed by faulting and igneous intrusion.

The intrusion of the quartz monzonite probably was followed by mineralizing solutions. The next step was the deposition of the ore along the bedding planes and fractures in the sediments, and along the fractures, joints, and the schistosity planes of the Pre-Cambrian gneisses and schists. Differentiation of the quartz monzonite is believed to have produced the ore bearing mineralizing solutions which precipitated ore in the Ling Mine.

During the glacial time erosion took place along both sides of the North Star Mountain resulting in the exposure of the Sawatch quartzite, and a portion of the ore body in the vicinity of the Line Mine. At present along the ridge near the Ling Mine, talus completely covers the bed rock and makes mapping difficult.

ECONOMIC GEOLOGY

General Statement

North Star Mountain lies in highly mineralized area, surrounded by placer gold areas such as Fairplay, Alma, and Breckenridge. In addition Alma and Breckenridge also produced lead and zinc, and such mining districts as Breckenridge, Montezuma, Leadville which produced a large amount of gold, silver, lead and zinc, surround the North Star Mountain.

The ore minerals in the North Star area occur in small fissure veins resulting from solutions working their way through the fractures and the bedding planes of the rock. The ore is found in the Pre-Cambrian gneiss and schist, and in the Sawatch quartzite from which most of the abandoned mines produced their gold ore. The gold-bearing veins have galena, pyrite, chalcopyrite, calcite and dolomite as their accessory minerals. The writer noted only a trace of zinc in one or two places, otherwise zinc appears to be absent in the ore bearing vein.

In the area, a number of abandoned mines, such as Magnolia, Artic, and Atlantic-Pacific produced a considerable amount of gold. Because of caving of the tunnels, examination of the above mentioned mines, is impossible at present. The only mine which has been on a maintenance and development basis after it was reopened in 1949, is the Ling Mine.

History and Production

Mining activity in the Alma district began about 1861, when

DISCOVERIES OF PLACER GOLD AT TARRYALL, FAIRPLAY, ALMA, BRECKENRIDGE, AND CALIFORNIA GULCH (LEADVILLE) OCCURRED. PROSPECTING WAS CARRIED OUT UP STREAM IN THE MAIN SOUTH PLATTE VALLEY AND THE FIRST CAMP "CAMP MONTGOMERY" WAS ESTABLISHED SOME SIX MILES ABOVE ALMA. ALMA CAME INTO EXISTENCE SOME TWELVE YEARS AFTER THE SETTLEMENT OF MONTGOMERY, OR ABOUT THE YEAR 1873. FROM THAT DATE ON, VARIOUS CLAIMS ON NORTH STAR MOUNTAIN WERE DEVELOPED, AND FOR A NUMBER OF YEARS THESE DEPOSITS YIELDED GOOD RETURNS FOR SOME OPERATORS SUCH AS MAGNOLIA, ARTIC, ATLANTIC-PACIFIC, AND LING MINES.

FINDING ORE IN THE SCHISTOSE FORMATION AND THE SAWATCH QUARTZITE BED IN NORTH STAR MOUNTAIN AND MOUNT LINCOLN LED TO THE ERECTION OF MILLS ALONG THE RIVER, WHERE THERE WAS AN ABUNDANCE OF GOOD WATER FOR MILLING. ACCORDING TO PATTON (3) A TWO-FOOT VEIN FROM THE ATLANTIC-PACIFIC MINE DURING THE EARLY DAYS, AVERAGED ABOUT $35 PER TON OF GOLD.

LING MINE

MR. HARRY DUNN'S HOLDING IN THE NORTH STAR MOUNTAIN INCLUDES A NUMBER OF CLAIMS, WHICH ARE SHOWN ON PLATE (8) IN THE POCKET. THESE CLAIMS ARE HELD BY ASSESSMENT; THE PRINCIPAL WORKING OF THE LING MINE (NO. 5 LEVEL) LIES ON THE SOUTH SIDE, AND THE LITTLE DAISY LIES ON THE NORTH SIDE. THE TWO HAVE NOT BEEN CONNECTED AS YET. AN ATTEMPT IS BEING MADE TO CONNECT THE TWO ACROSS ON INTERVENING GAP OF 308 FEET.

THE LING MINE WAS DISCOVERED BY JOHN LING IN THE YEAR 1882. THE OLD WORKING COMPRISED LEVELS NO. 1, 2, 3, AND 5, WHICH ARE NOW LARGELY CAVED.

NO ORE HAS BEEN SHIPPED FROM THE MINE RECENTLY, ALTHOUGH THE MINE

HAS EXTENSIVE WORKINGS, AND DEVELOPMENT WORK HAS BEEN SLOWED DUE TO LACK OF LABOR. SOME SULPHIDE MINERALIZATION IS EVIDENT IN THE WORKINGS THAT ARE OPEN NOW. BOTH THE LING NO. 5 LEVEL AND THE LITTLE DAISY PENETRATE THE PRE-CAMBRIAN GNEISS AND SCHIST, AND IN THE LITTLE DAISY A QUARTZ MONZONITE PORPHYRY DIKE HAS BEEN ENCOUNTERED. ASSAYS OF THE MINERALIZED ZONES YIELD GOLD, SILVER, AND LEAD. ALONG THE WALL ON THE SOUTH SIDE OF THE LING, MALACHITE STAINING WAS OBSERVED. BORNITE IS ALSO PRESENT IN THE VEIN MATERIAL IN POLISHED SECTIONS. SURFACE INDICATION OF THE MINERALIZATION IS VERY MEAGER AT LING MINE BECAUSE OF TALUS COVER. BUT IN PITS AND DUMPS IN OTHER WORKINGS, ESPECIALLY IN THE SEDIMENTARY ROCK AREA, MINERALIZATION WAS OBSERVED IN THE MANITOU LIMESTONE AND THE SAWATCH QUARTZITE ALONG SMALL NORTHEAST TRENDING FAULTS.

MINERALOGY

THE ORE MINERALS OF THE NORTH STAR AREA ARE MADE UP OF BOTH SULPHIDE AND OXIDE MINERALS. THE OXIDIZED ORE OCCURS IN THE NO. 2 AND 3 LEVELS OF THE LING MINE WHICH WERE WORKED IN THE EARLY 1890'S. SULPHIDE MINERALS HAVE BEEN OBSERVED IN THE PRESENT WORKING IN THE NO. 5 LEVEL AND ALSO IN THE LITTLE DAISY. THE SULPHIDE MINERALS ARE PYRITE, CHALCOPYRITE, GALENA, AND ARSENOPYRITE. MALACHITE, AS MENTIONED ABOVE, WAS FOUND AS STAINS IN SOME PLACES ON THE WALL OF THE WORKINGS. SPHALERITE WAS ABSENT EXCEPT FOR A TRACE IN THE ONE ASSAY FROM THE LITTLE DAISY. ALTHOUGH GOLD AND SILVER ARE THE MAIN MINERALS TO BE MINED, SILVER HAS NOT BEEN OBSERVED MEGASCOPICALLY OR MICROSCOPICALLY. THEIR OCCURRENCE MAY BE IN SOLID SOLUTIONS WITH THE SULPHIDE MINERALS. FREE GOLD WAS OBSERVED AS FLAKE IN ONE OF THE POLISHED SECTIONS. (FIG. 19)

THE FOLLOWING ORE MINERALS HAVE BEEN RECOGNIZED AND STUDIED MICROSCOPICALLY BY THE WRITER:

PYRITE

CHALCOPYRITE

COVELLITE

GALENA

SPHALERITE

ARSENOPYRITE

GOLD

SILVER

HUBNERITE

BORNITE

MALACHITE

THE FOLLOWING GANGUE AND ALTERATIONS MINERALS HAVE BEEN OBSERVED AND STUDIED:

IRON OXIDE (LIMONITE AND MAGNETITE)

QUARTZ

CALCITE

KAOLINITE

SERICITE

DOLOMITE

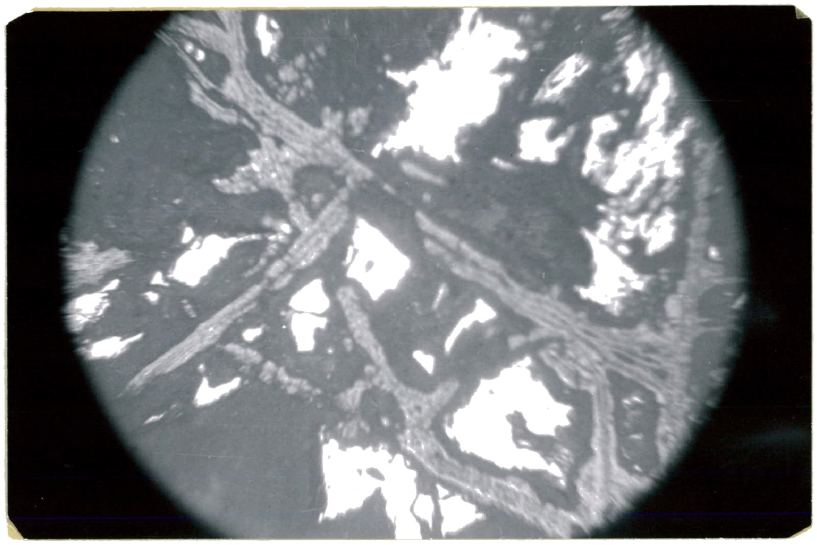


FIG. 16. POLISHED SECTION SHOWING BOXWORK STRUCTURE OF PYRITE ALTERING INTO LIMONITE.

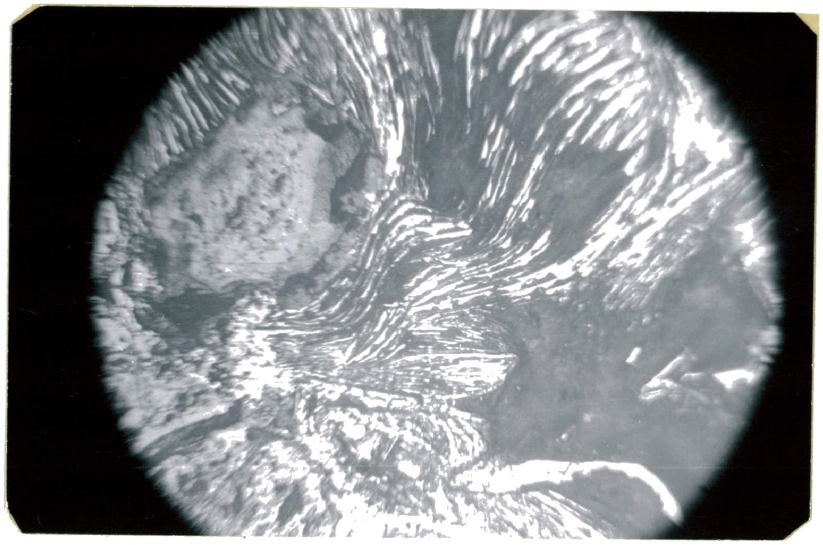


FIG. 17. POLISHED SECTION SHOWING SHEARED STRUCTURE OF LIMONITE IN FAULT ZONE.

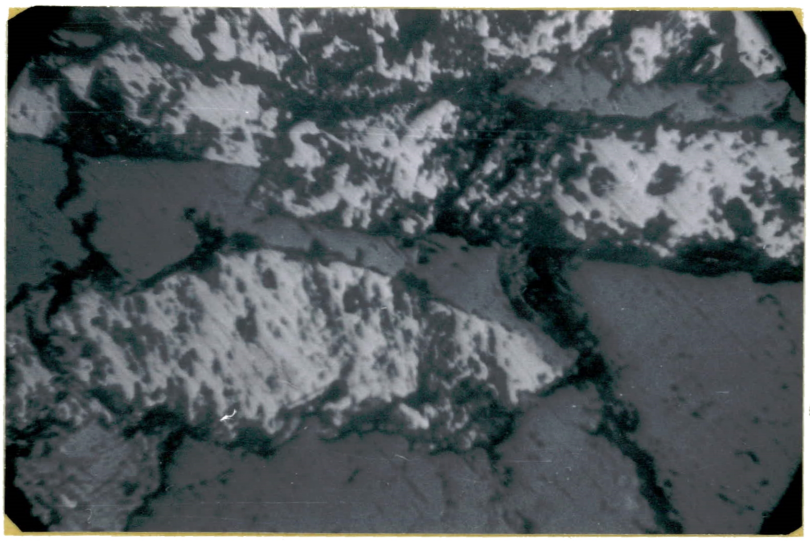


FIG. 18. POLISHED SECTION SHOWING HUBNERITE IN QUARTZ MATRIX.

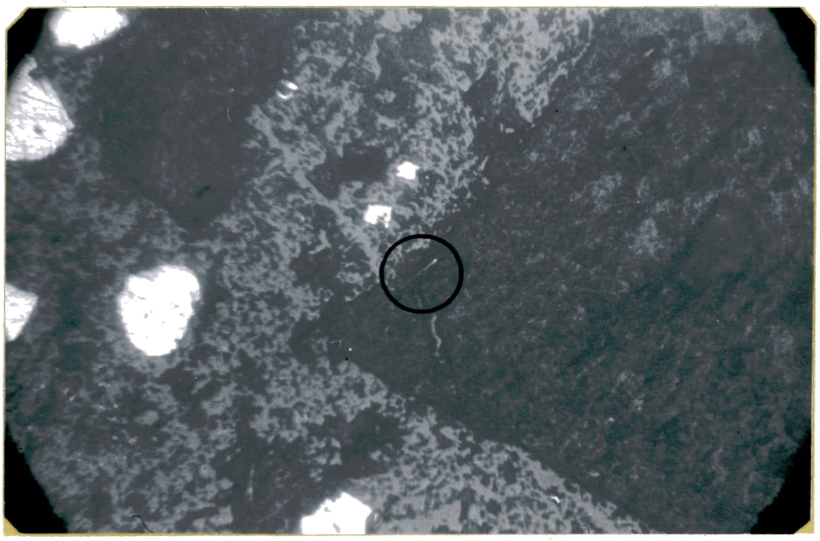


FIG. 19. POLISHED SECTION SHOWING GOLD FLAKE. (IN CIRCLE)

Pyrite

Pyrite is the most common mineral, and is commonly found disseminated in the wall rock for a distance of 6 inches to a foot from the mineralized channels, as well as in the mineralized shear zones and veins. It commonly occurs as euhedral pyrite. In many places chalcopyrite appears localized around pyrite that is evidently being altered to chalcopyrite. Pyrite is persistent throughout the mineralized zone and is more abundant than any other mineral.

Chalcopyrite

Chalcopyrite occurs in a small amount usually localized around pyrite, as evidenced in polished sections from the Ling Mine. Also in the specimens from the old dumps of the abandoned mines, chalcopyrite is abundant megascopically as well as microscopically and again is associated with pyrite.

Covellite

Covellite was not observed in ore specimens from the Ling Mine, megascopically or microscopically. In one specimen of silicified vein from the Sawatch formation, it was observed microscopically. It has replaced galena along the cleavage planes.

Galena

Galena is fairly common both in the veins of the Ling Mine and as a replacement in the sediments especially in Manitou limestone. Crystals of galena are subhedral where they filled open spaces. Galena is locally replaced by covellite and sphalerite.

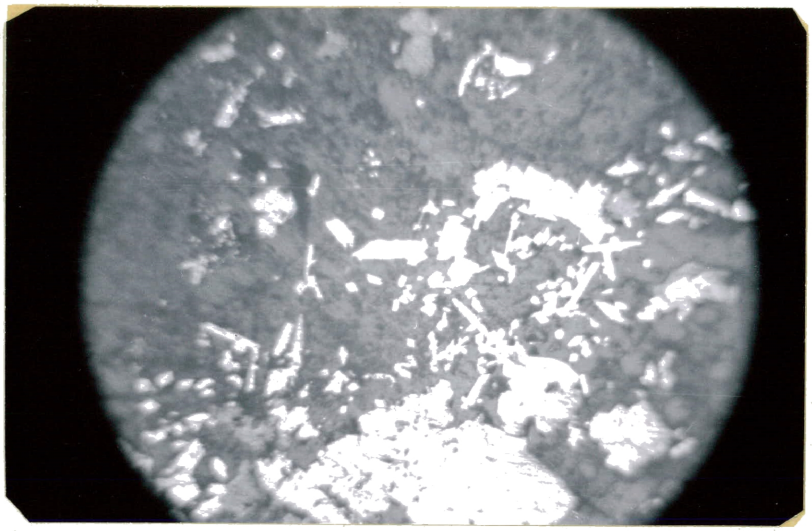


FIG. 20. POLISHED SECTION SHOWING EUHEDRAL CRYSTALS OF ARSENOPYRITE.

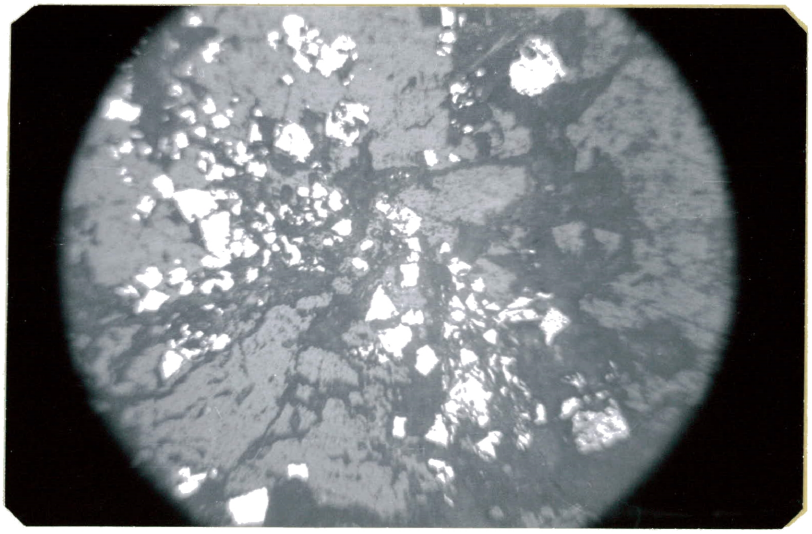


FIG. 21. POLISHED SECTION SHOWING ABUNDANCE OF EUHEDRAL CRYSTALS OF PYRITE IN VEIN MATERIAL.

Arsenopyrite

The arsenopyrite observed in specimens in the area is commonly associated with pyrite and occur as euhedral crystals. It was probably deposited at the same time as pyrite.

Hubnerite

Hubnerite was observed in two places. One specimen in the granite in the water tunnel, in small disseminated fissures. The other specimen was in the pegmatitic quartz fissure veins above Upper Blue Lake in Pre-Cambrian gneiss and schist. These veins rage from one-half to six inches in width.

Bornite

Bornite was observed in only one place associated with chalocopyrite in the No. 5 level of the Ling Mine.

Gold

Free gold was observed as flake in one of the polished sections although its presence is known by assay in most of the veins of the North Star Mountain. It is probably in solid solution with pyrite or chalco-pyrite in most instances. Assays run from a trace to 8 oz. per ton from the few samples taken by the operator in the mine.

Silver

The silver content of the ore is lower than gold, and no silver minerals were observed by the writer.

Malachite

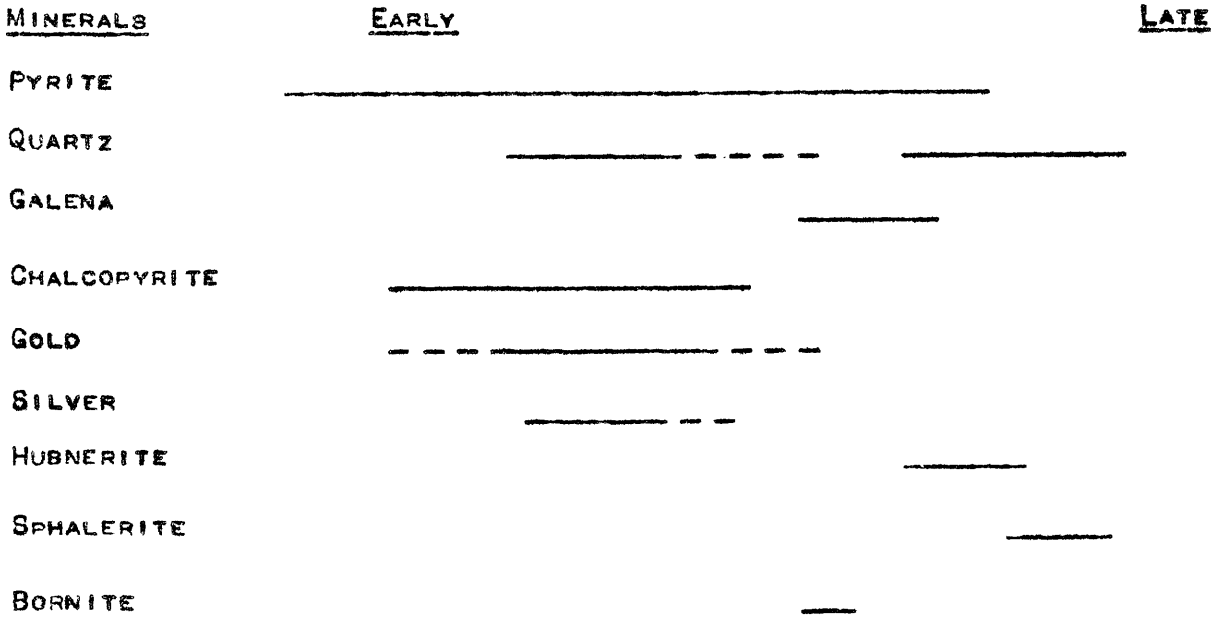
It was observed in two places in the No. 5 level as stains and also in one specimen microscopically.

Gangue and Alteration Minerals

Among the gangue and alteration minerals, limonite and sericite are the chief minerals observed. Limonite can be found in almost every fault zone. Sericitization is intense in the wall rock adjacent to the veins as well as in the mineralized zone, and kaolin usually accompanies it. Quartz is abundant in some of the fissure veins and in the fault zones. Calcite and dolomite usually occur as replacing material in the faulted and mineralized zones.

Paragenesis

The determination of the paragenetic sequences of the minerals was based on replacement and fracture filling texture as observed in polished sections of the ore. In polished section the later minerals commonly filled in around crystal faces or cleavage planes of earlier minerals or filled fractures in these minerals. The depositional period of pyrite was extensive ranging from early to late as shown below. The paragenetic sequence of the minerals is given in the chart form below:



Types of Deposits Noted

At least four types of deposits are observed in the area:

1. Veins
2. Replacement
3. Impregnation
4. Placers

Veins of various kind were noted especially in the Pre-Cambrian rocks. Fissure veins are numerous, and vary from less than 1 inch to 2 or 3 feet in some cases, especially in the gneiss and schist. The vein walls are mostly sharply defined, as observed in abandoned open pits from which high grade ore had been taken out. But where a vein cuts the sediments, there are often off-shoots of ore along the bedding planes. Impregnation or replacement of the wall rock by the vein solution is fairly common, and large ore bodies have been produced in this way. Nearly all the fissure veins also are common. Gash veins are common in the Manitou limestone and Blue limestone. Replacement veins are also common in the Manitou limestone. In some cases one or more small fissure veins are found, frequently in the interior of faulted zones. In the alluvial deposits in the Platte River, gold occurs as flakes as was observed by panning.

Wall Rock Alteration

Hydrothermal alteration is apparent underground. The solutions have permeated the walls on both sides of the channel fissures for a distance up to a foot. But in the fault zones it is most apparent on

THE HANGING WALL SIDE. NEARLY EVERY FAULT OBSERVED AT THE SURFACE SHOWS EVIDENCE OF HYDROTHERMAL ALTERATION, ALTHOUGH SULPHIDE MINERALIZATION AND VEIN QUARTZ ARE ABSENT. MOST OF THE FAULT VEINS ARE COMPOSED OF LIMONITE STAINS.

IN THE FAULT ZONES, KAOLINIZATION AND SERICITIZATION ARE MORE INTENSE THAN SILICIFICATION, AND SERICITIZATION IS STRONG IN ALMOST EVERY CASE. SILICIFICATION IS VERY SLIGHT. KAOLINIZATION IS BELIEVED TO HAVE DEVELOPED FIRST, AND SERICITIZATION LATER. LEAN VEINS SHOW ONLY SERICITIZATION AND KAOLINIZATION WITH SILICIFICATION LACKING. STRONG MINERALIZED VEINS SHOW INTENSE SERICITIZATION IN ADDITION TO KAOLINIZATION AND SILICIFICATION. LIMONITE, WHICH FREQUENTLY OCCURS ALONG THE FAULTS IS DERIVED FROM PRIMARY IRON-BEARING MINERALS. SPARSE MALACHITE AND OTHER OXIDATION PRODUCTS WERE OBSERVED ON THE WALLS IN SOME PLACES. MINOR SILICIFIED VEINS CONTAINING HUBNERITE OBSERVED ON THE NORTH SIDE OF NORTH STAR MOUNTAIN, ABOVE UPPER BLUE LAKE.

THE WALL ROCK

PRE-CAMBRIAN GNEISS, SCHIST, AND QUARTZ MONZONITE PORPHYRY ARE THE THREE ROCKS APPEARING IN THE WALLS OF THE UNDERGROUND WORKINGS OF THE LING MINE. ALL HAVE BEEN DESCRIBED. THEY INFLUENCE THE TREND OF THE MINERALIZATION IN THE FORMATION OF THE VEINS AND FISSURES. THE MOST PRONOUNCED INFLUENCE IS THE TREND OF THE SCHISTOSITY AND FOLIATION PLANES OF THE SCHIST WHERE IT INTERSECTS THE FAULT ZONE. THE PORPHYRY DIKE IS SLIGHTLY FRACTURED, AND AT THE CONTACT WITH THE PRE-CAMBRIAN SCHIST, FISSURE VEINS AND POCKETS OF HIGH GRADE ORE DEVELOPED.

Control for Mineralization

The condition observed throughout the various mineralization zones are very similar. Almost all specimens studied in polished sections shows that the order of deposition was pyrite, chalcopyrite, quartz, gold, silver, galena, and sphalerite (when present). Gold and silver seem to have been deposited at the same time as pyrite and chalcopyrite. Hubnerite was deposited with the quartz. Locally the controls for mineralization may be described as follows:

1. Control and Nature of Wall Rock: Gneisses form very poor loci for mineralization, as they are not sufficiently reactive and they do not shatter readily. The schists are generally altered and mineralization is more consistent than in thegneisses, Along the contact of the Pre-Cambrian rocks and the porphyry dike, disseminated pyrite mineralization formed, and many ore shoots are found along this contact. In some cases fractures in the pegmatitic veins havebeen mineralized such as in the case of the small veins of hubnerite in the pegmatites.

2. Structural Controls: The intersection of faults with the zones of strong foliation, schistosity, and jointing are important as centers of mineralization. Most of the mineralized "faults" are minor faults and in most cases these faults are controlled by joints.

Origin of the Ore

As has been observed by the author, the mineralized zones or ore shoots are localized along the planes of schistosity in the vicinity of igneous intrusions. Thus, the following conclusion has been reached. After the deposition of the sediments, igneous intrusions occurred as dikes and sills. At some later time, ore-bearing solutions came upward through vertical or inclined fissures and porous zones. Then, the solutions worked their way through the fractures and bedding planes of the sediments and deposited their metallic contents by metasomatic replacement of the country rock and filling of open fissures. It seems probable that the ore-bearing solution represents an extreme type of differentiation of the magma from which the porphyry intrusions were derived. Therefore, the ore may be said to be genetically connected with the intrusions.

FIG. 22. CORDILLERA CORPORATION MILL IN THE PLATTE RIVER VALLEY.

BLUE RIVER DIVERSION TUNNEL

THE BLUE RIVER DIVERSION TUNNEL IS APPROXIMATELY ONE AND ONE-HALF MILES LONG. THE ELEVATION AT THE SOUTH PORTAL ON THE PLATTE RIVER SIDE IS 10,854 FEET, AND AT THE NORTH PORTAL ON THE MONTE CRISTO CREEK IS 10,865 FEET. THE GEOLOGY OF THE TUNNEL IS SHOWN IN PLATE 2. (IN POCKET). THE TYPES OF ROCKS ENCOUNTERED WERE GRANITE, GNEISS, SCHIST, PEGMATITE, AND THE LOWER MEMBER OF THE SAWATCH QUARTZITE, WHICH HAS ALREADY BEEN DESCRIBED. THE TUNNEL IS 7,018 FEET LONG.

THE GRANITE IS THE LEAST ALTERED AND FRACTURED, WITH PEGMATITE INTERSECTING THROUGH IT. SILICIFICATION OCCURS TO A CERTAIN EXTENT IN THE FAULTED AREA. GASH VEINS CONTAINING HUBNERITE HAVE BEEN OBSERVED. THE GRANITE FORMS A FAIRLY STRONG WALL, WITH FRESH SURFACES SHOWING ONLY SLIGHT KAOLINIZATION AND SERICITIZATION. A FEW DISSEMINATED PYRITE VEINLETS WERE OBSERVED ALONG THE WALL, AND ON ONE OCCASION A PYRITE VEIN UP TO 6 INCHES WAS OBSERVED.

THE GNEISS AND SCHIST ARE MORE HIGHLY SHATTERED, AND JOINTS ARE MORE COMMON. ALTERATION, NAMELY, KAOLINIZATION AND SERICITIZATION ARE MORE INTENSE AND NOTICEABLE. MINERALIZATION IS OBSERVED IN THE FAULTED AND SHATTERED ZONES OF THESE ROCKS. THE FAULTS ARE MORE OR LESS CONTROLLED BY THE JOINTS.

THE LOWER CRYSTALLINE MEMBER OF THE SAWATCH QUARTZITE CONTAINS SPARSE DISSEMINATED PYRITE IN MOST CASES. JOINTING IS COMMON. A FEW LOW-ANGLE FAULTS WERE OBSERVED IN THE ROCK WHERE WATER SEEPS DOWNWARD IN A CONSIDERABLE AMOUNT. SMALL MINOR FAULTS ARE MINERALIZED, AND LIMONITE STAINING IS COMMON.

THE BLUE RIVER DIVERSION TUNNEL IS OWNED BY THE CITY OF COLORADO SPRINGS. THE PURPOSE OF THE TUNNEL IS TO TAP THE WATER FROM THE MONTE CRISTO CREEK AND THE WATER SHED OF THE SURROUNDING AREA INTO THE PLATTE RIVER, IN ORDER TO SUPPLY THE CITY OF COLORADO SPRINGS WITH WATER FOR DOMESTIC USE. BOTH THE PORTALS OF THE TUNNEL WILL BE SEALED UP, AFTER SPILLWAYS ARE BUILT.

CONCLUSION AND RECOMMENDATION

FROM THE PRESENT STUDY THE AUTHOR HAS COME TO THE CONCLUSION THAT NORTH STAR MOUNTAIN IS NOT, ECONOMICALLY, A MINING AREA OF MAJOR IMPORTANCE. SOME OF THE MINERALIZED VEINS IN THE AREA ARE NEVERTHELESS OF ECONOMIC VALUE AND CAN BE FURTHER DEVELOPED ON A SMALL SCALE, PROVIDED THE OPERATOR CAN CONDUCT THE WORK IN AN EFFICIENT MANNER.

HOWEVER, NUMEROUS FACTORS MUST BE CONSIDERED, SUCH AS THE WATER PROBLEM FOR DOMESTIC USE AS WELL AS FOR THE WORK, AND THE NEED FOR ADEQUATE ROADS PERMITTING OPERATIONS TO BE CARRIED OUT DURING THE ENTIRE YEAR.

IT MUST ALSO BE REMEMBERED THAT ONLY THE MOST EASILY MINED ORE BODIES HAVE BEEN EXTRACTED. THE ORE SHOOTS UNDOUBTEDLY CONTINUE TO DEPTH AND PROBABLY CAN STILL BE MINED AT A PROFIT AFTER THEY ARE DEVELOPED. THE ONLY FEASIBLE WAY IS TO OPEN UP THE OLD WORKINGS, LOCATE THE MAJOR ORE ZONES AND DEVELOP THEM. SURFACE PROSPECTING IS EXTREMELY DIFFICULT IN MOST PLACES, BECAUSE THE AREA IS COVERED WITH TALUS OR THE OUTCROPS ARE IN HIGH PRECIPITOUS CLIFFS. DEVELOPING THE VEINS BY WINZES AND DIAMOND DRILLING ARE THE TWO METHODS BEST ADAPTED TO SEARCHING FOR NEW ORE BODIES.

BIBLIOGRAPHY

1. Emmons, S. F., Geology and Mining Industry of Leadville, Colo., U. S. Geol. Survey Mon. 12, 1886, pp 323-344.
2. Singewald, Q. D., and Butler, B. S., Ore Deposits in the vicinity of the London Fault of Colorado: U. S. Geol. Survey Bull. 911, 73 pp., 1941.
3. Patton, H. B. Hoskin, A. J., and Butler, G. M., Geology and ore deposits of Alma District, Colo. Geol. Survey Bull. 3, 272 pp., 1912.
4. Vanderwilt, J. W., Mineral Resourses of Colorado, Mineral Resourses Board, State of Colo., 497 pp., 1947.
5. Newhouse, W. H., Ore deposits as related to structural features, pp. 1-9, 63-94, Princeton Univ. Press, Princeton, New Jersey, 1942.
6. Emmons, S. F., Geology and Mining Industry of Leadville, Colo: U. S. Geol. Survey Mon. 12, p. 60, 1886.
7. Johnson, J. H., Paleozoic Formations of the Mosquito Range, Colo., U. S. Geol. Survey Professional Paper 185-B, pp 15-43, 1934-1935.
8. Lovering, T. S., Geology and Ore Deposits of the Breckenridge Mining District, Colo. U. S. Geologic Survey Professional Paper 176, 163 pp. 1934.

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MAP SHOWING GEOLOGY OF NORTH STAR MOUNTAIN

AND

THE LING MINE

SUMMIT AND PARK COUNTIES, COLORADO

APROXIMATE SCALE

1 inch = 528 Ft.

1/4 Mi. 1/10 0 1/4 Mi.

JUNE 1, 1952 BY SAW ALARIC

N

MN 14 1/2°

Lower Blue Lake

Upper Blue Lake

Monte Cristo Creek

Blue River Water Tunnel

Covered

LITTLE DAISY

LING MINE No. 5 level

Om

Cs

PC

Dd

Cl

Cw

Dpq

ATLANTIC-PACIFIC

MAGNOLIA

Blue River Water Tunnel

MONTGOMERY

MILL

South Platte River

A

B

C

D

LEGEND

Quaternary
- Alluvium
- Talus
- Glacial drift

Tertiary
- Quartz monzonite porphyry
- Later white porphyry
- Lincoln porphyry
- White porphyry

Permian
- Cw Weber formation

Mississippian
- Cl Blue limestone
- Cl Sand member

Leadville limestone

Devonian
- Dd Dyer dolomite
- Dpq Parting quartzite

Chaffee formation

Ordovician
- Om Manitou limestone

Cambrian
- Cs Peerless shale
- Cs Lower member

Sawatch quartzite

Pre-Cambrian
- Pegmatite
- Aplite
- Granite
- Gneiss & Schist

- Faults
- Dip
- Joints
- Foliation
- Lake
- Dump
- Mine
- Tunnel
- Road
- Trail
- Building

PLATE I

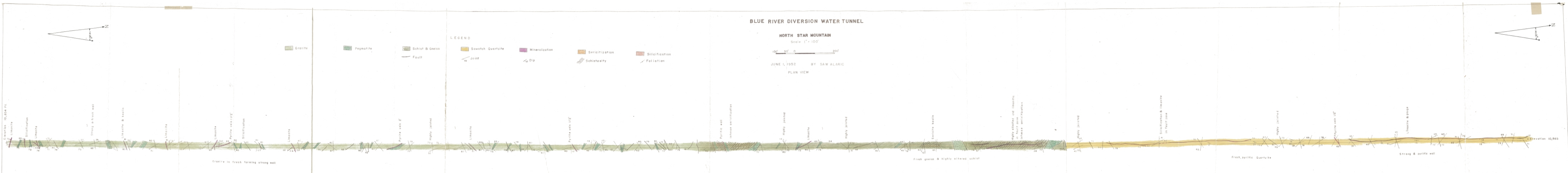
BLUE RIVER DIVERSION WATER TUNNEL
NORTH STAR MOUNTAIN
Scale 1" = 100'
100' 50' 0 200'
JUNE 1, 1952
BY SAW ALARIC
PLAN VIEW
LEGEND
Granite
Pegmatite
Schist & Gneiss
Fault
Sawatch Quartzite
Joint
Mineralization
Dip
Sericitization
Schistosity
Silicification
Foliation

PLATE 2

GEOLOGY AND WORKINGS

OF

NO.5 Level, Ling Mine and Little Daisy

Scale 1" = 50'

0' 50' 100'

LITTLE DAISY

JUNE 1, 1952 BY SAW ALARIC

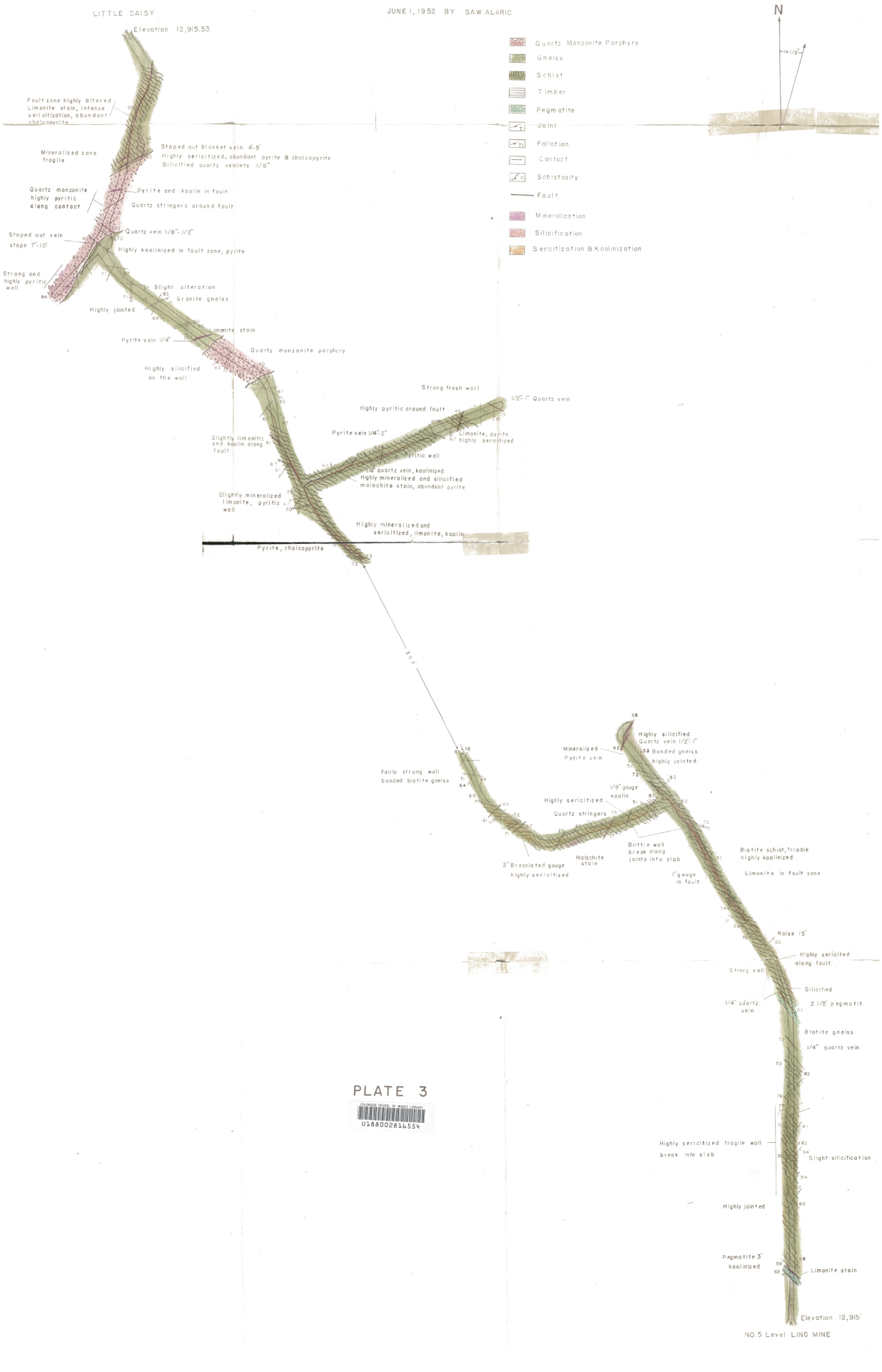

PLATE 3

COLORADO SCHOOL OF MINES LIBRARY
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STRATIGRAPHIC SECTIONS
and
TRAVERSE

Horizontal & Vertical Scale 1 inch = 100 feet.

100' 50' 0 100'

June 1, 1952 By Saw Alaric

Sec. AB:- Section near Silver Lake

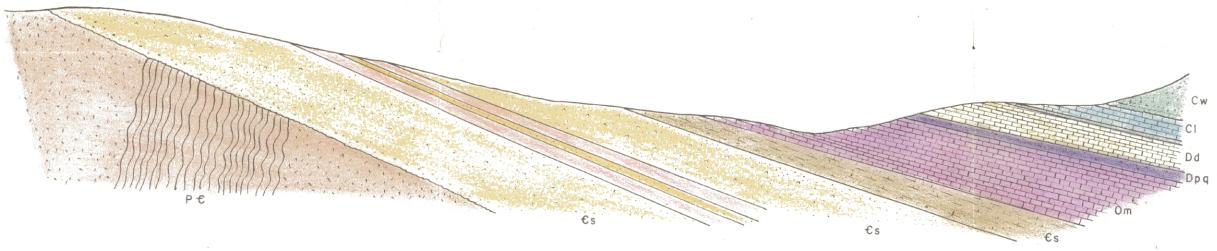
Sec. CD:- Section above Montgomery

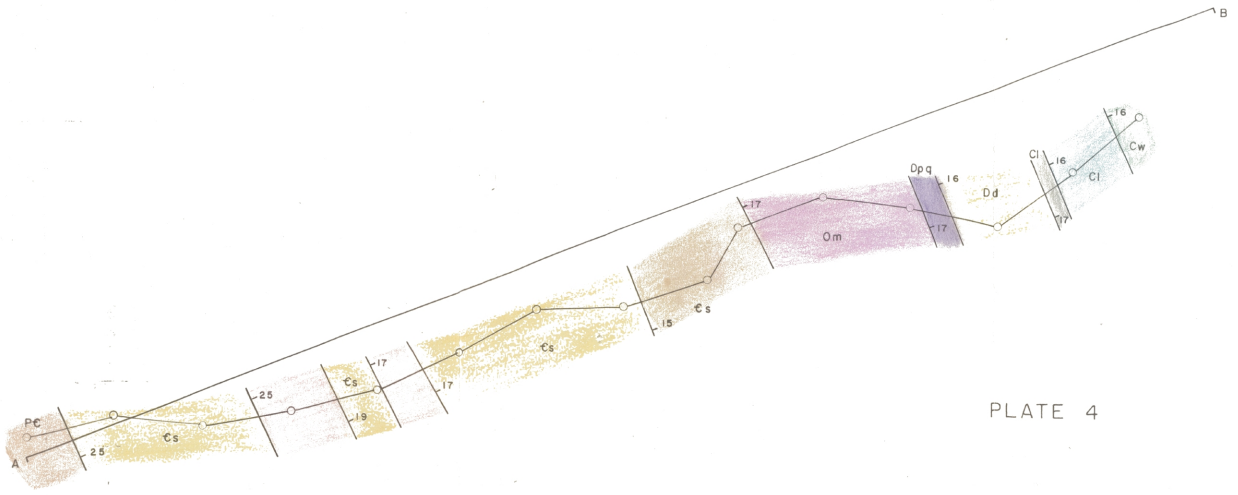
LEGEND

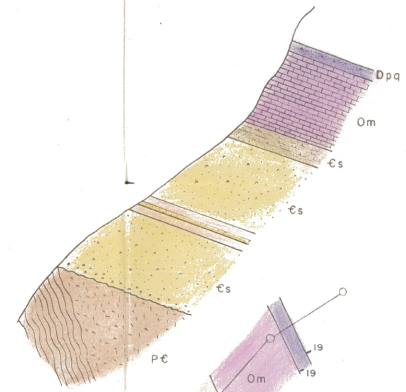
Tertiary		White porphyry	
Permian	Cw	Weber formation	
Mississippian	Cl	Blue limestone	LEADVILL LIMESTONE
	Cl	Sand member	
Devonian	Dd	Dyer dolomite	CHAFFEE FORMATION
	Dpq	Parting quartzite	
Ordovician	Om	Manitou limestone	
Cambrian	€s	Peeless shale	SAWATCH QUARTZITE
	€s	Lower member	
	P€	Pre Cambrian	

THICKNESS

Blue limestone	28'	LEADVILLE LIMESTONE
Sand member	5'	
Dyer dolomite	30'	CHAFFEE FORMATION
Parting quartzite	15'	
Manitou limestone	86'	
Peerless shale	36'	SAWATCH QUARTZITE
Lower member	164'	
White porphyry	19'	







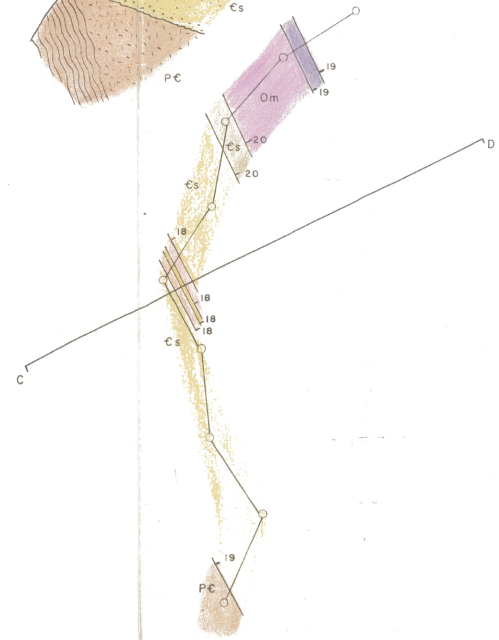


PLATE 4

CLAIM MAP OF LING MINE OPERATOR

Summit and Park Counties, Colorado
Scale 1" = 300'

300' 0 300' 600'

JUNE 1, 1952 BY SAW ALARIC

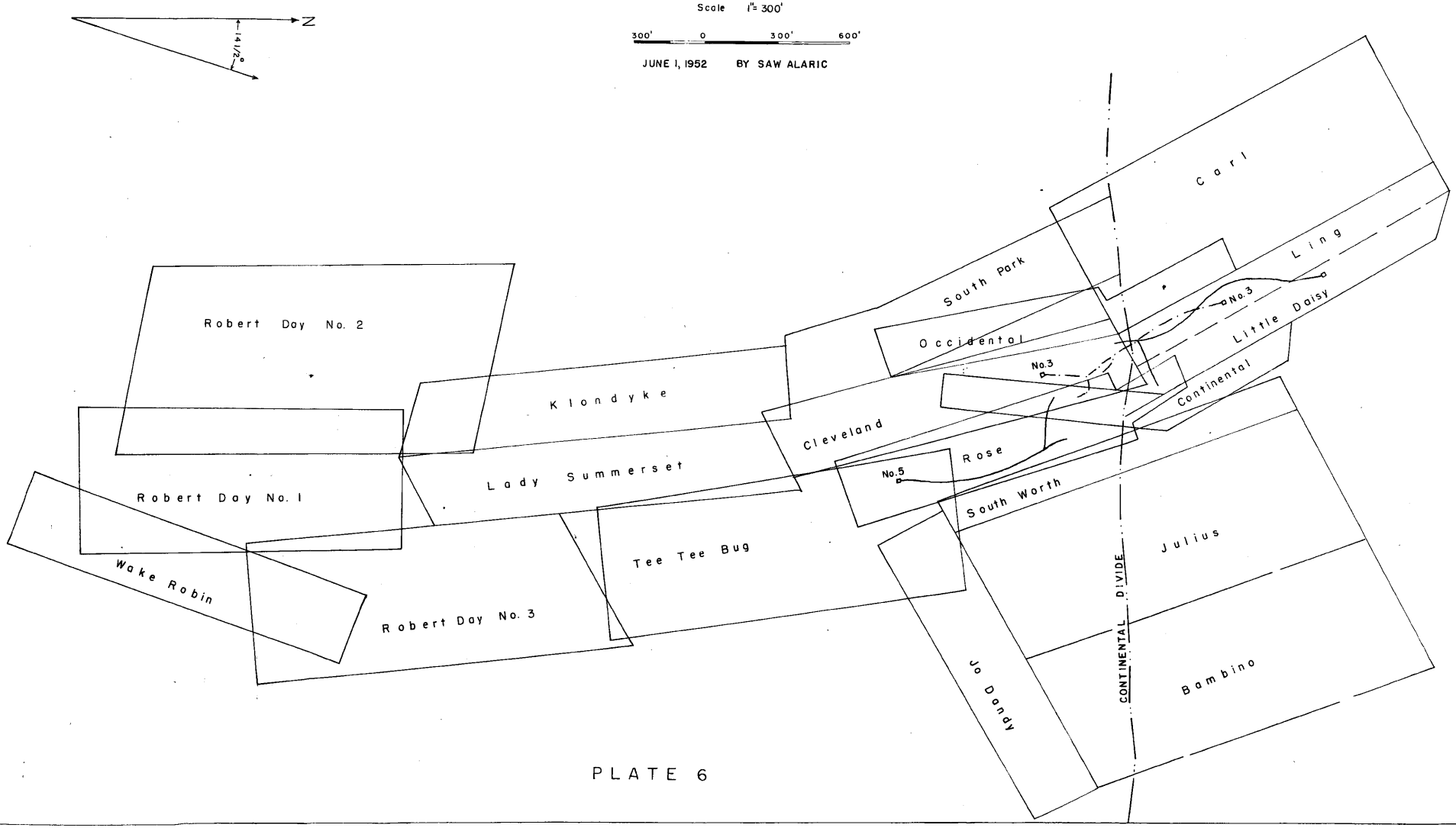


PLATE 6

SECTIONS TO ACCOMPANY GEOLOGIC MAP OF NORTH STAR MOUTAIN

Summit & Park Counties, Colorado

Horizontal scale 1"= 528' Vertical scale 1"= 1000'

JUNE 1, BY SAW ALARIC

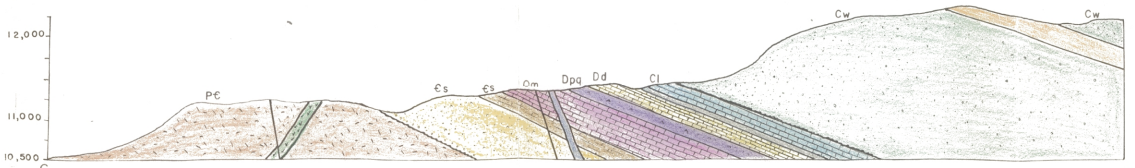
N

141/2°

LEGEND

Tertiary		Later white porphyry	
		White porphyry	
		Quartz mozonite porphyry	
		Lincoln porphyry	
Permian	Cw	Weber formation	
Mississippian	Cl	Blue limestone	LEADVILLE LIMESTONE
	Cl	Sand member	
Devonian	Dd	Dyer dolomite	CHAFFEE FORMATION
	Dpg	Parting quartzite	
Ordovician	Om	Manitou limestone	
Cambrian	€s	Peerless shale	SAWATCH QUARTZITE
	€s	Lower member	
		Pegmatite	
	P€	Pre-Cambrian gneiss & schist	

SECTION AB



SECTION CD

PLATE 7