PAUL M. HOPKINS
CONSULTING MINING GEOLOGIST AND ENGINEER
REGISTERED PROFESSIONAL ENGINEER AND LAND SURVEYOR

2222 ARAPAHOE STREET
CRESTVIEW 9-2313

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GOLDEN, COLO.

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10 June, 1966

Mr. Clarence T. Pulger, President
The Three Top Mining Corporation
4925 West 26th Avenue
Denver, Colorado 80212

Dear Mr. Pulger:

The enclosed report in duplicate is the study of the property of The Three Top Mining Corporation property in Gunnison County, Colorado. This study is based upon the information furnished by you and the several other sources mentioned in the body of the report.

If the values quoted can be confirmed, further evidence of mineralization of indicated grade suitable for mining can be delineated, and finally the potential of significant tonnages with economically attractive values can be predicted, the property has a major merit as a mining venture.

The proposed exploration program is based upon the desirability of following the program to completion with a favorable result at any one time being indicated. I will state that if I find unfavorable indications for a major mining venture, I will make known my evaluations at that time for the evaluation of further work by and for the company.

Yours very truly,

PMH

Paul M. Hopkins

PMH:ri

Encl. Report

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ECONOMIC STUDY AND EXPLORATION PROGRAM

of

THE THREE TOP MINING CORPORATION PROPERTIES

TOWNSHIP 12 SOUTH, RANGE 87 WEST

6th PRINCIPAL MERIDIAN

GUNNISON, COUNTY,

COLORADO

by

Paul M. Hopkins
Mining Geologist and Engineer

10 June, 1966

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Marble Geologic Quad Map (USGS 512)	In Pocket
Transparency Overlay with Property Lines	In Pocket
Property Map with all initial known information	In Pocket

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THE THREE TOP MINING CORPORATION PROPERTIES

GUNNISON COUNTY, COLORADO

INTRODUCTION

The following report is an engineering-geologic summary of the records tendered and available from the several sources as indicated. Based upon this preliminary study, the properties have attractive features which warrant the expenditure of monies to explore for and delineate such mineral resources as may be found.

The apparent targets of major exploration efforts are the veins as shown on the maps and the potential replacement deposits in their proximity, more especially at the intersection of the several veins with the calcareous sedimentary horizons. Only after the full reconnaissance of the property will these targets be confirmed. The areas of apparent interest are discussed in the body of the report for general guidance for your consideration. Additional areas of interest may be found and additional work will be devoted to these new areas as feasible. If any of the target areas of initial investigation prove to have minimal interest for immediate potential, the reconnaissance will so indicate.

PROPERTY The property consists of 18 lode mining claims, 15 of which were located in April, 1966 and 3 were located in June of 1966. The location of the several claims are shown on the attached plat. The claims are located in unsurveyed Township 12 South, Range 87 West, 6th Principal Meridian, in the area that would normally correspond to Sections 5 and 6. The approximate center of the group of claims is about 2,500 feet east of the Skyline Mine as shown on the 7-1/2 minute quadrangle map, Marble Quadrangle, published by the United States Geological Survey. The claims are generally on or adjacent on the northeasterly side of the ridge line connecting Treasure Mountain to the southeast and Whitehouse Mountain on the north.

The property includes part of the operations of the Skyline Mine and a number of prospects to the east and southeast. "Possessory Lode Mining Claims" are the source of title to the property and encompass an area of approximately 300 acres.

ACCESSIBILITY The access by auto to the property from Denver, Colorado is via U. S. Highway 6 to Glenwood Springs, 171 miles; thence southeasterly via Colorado Highway 82 and 133 to Carbondale, 13 miles; thence southerly via Colorado Highway 133 and a county road to Marble, 29 miles; thence south up the valley of Yule Creek to a jeep trail to the east and ascending Treasure Mountain to the vicinity of the Skyline Mine, approximately 6 miles. At this point the party will

have to walk and/or pack to the area of the various mine workings and prospects, generally in an easterly direction for distances not to exceed 1-1/2 miles.

CLIMATE

The climate in the valley of Yule Creek and Crystal River is mild and accessible without major periods of adverse weather, particularly snow, throughout the year. However, the climate of the area where the claims are located, is best summarized as "Arctic," which means heavy snows, high winds, sub-zero temperatures during the winter and a short cool summer, the latter with frequent afternoon showers. An operating period would be limited to the months of June through October unless suitable preparations are made for the adverse conditions. May is not severe from the temperature range encountered but is during the period of the "spring thaw" with the resulting heavy surface water flow making access difficult to maintain.

PREVIOUS REPORTS

The general geology of the Snowmass region and the Treasure Mountain Dome is discussed in United States Geological Survey Bulletin 884, "Geology and Mineral Resources of the Snowmass Area, Gunnison County, Colorado," by John W. Vanderwilt, published in 1937. A more recent geologic map is the United States Geological Survey Geologic Quadrangle Map 512, Marble Quadrangle, published in 1966, a copy of which is in the pocket.

A short report of three (3) pages on the Skyline Mining Company property by E. J. Martine is on file and available in the Scientific Branch, Denver Public Library, Denver, Colorado. This report is undated.

Five reports by Mr. Harald W. C. Prommel, Consulting Engineer, on properties in the Treasure Mountain Dome area have been obtained and are available for reference. However, these reports are not on the specific property. These reports contain many details of the mineralization characteristics of the district which are not available in the other sources.

Examination of the records of the Colorado State Bureau of Mines has produced no information on the specific property.

REGIONAL GEOLOGY

The regional geology with its many variations as to specific data is discussed in the United States Geological Survey Bulletin 884 cited previously. A brief summary of the immediate area of Treasure Mountain Dome and the area of the property is given below.

Pre-Cambrian schists and gneisses form the basement. Some pre-Cambrian intrusion is also probable although not specifically recognized in the local area. The basement, after metamorphism, tectonic activities and a major period of erosion was a surface of low relief. Upon this surface the Paleozoic and subsequent sedimentary formation were deposited.

The Paleozoic sedimentary section begins with the Upper Cambrian Sawatch Quartzite and Peerless Shale; thence followed by deposition of the Manitou Dolomite, Harding Quartzite and Fremont Limestone of Ordovician age; no Silurian deposits are known in the local area or in the region; thence the Devonian Chaffee formation consisting of the Parting Shale and Dyer Dolomite members; thence the Mississippian Leadville Limestone formation. Above these lower and middle Paleozoic sedimentary formations are the Upper Paleozoic formations of Pennsylvanian and Permian age. Mesozoic and later sedimentary formations are above the Paleozoic sedimentary formations. The Pennsylvanian and later sedimentary formations are of no apparent immediate economic interest as they are apparently outside the limits of the property under discussion.

Orogenic and/or emergent land-mass periods are present and are represented by missing stratigraphic sections and unconformities within this geologic column. In addition there is some erosion marking the inter-formation periods in the stratigraphic section.

Subsequent to this period of deposition, the region was folded, faulted and orogenic uplift as expressed by the Elk Mountain thrust fault, Whopper fault and the doming of the Treasure Mountain Dome which is directly attributable to the intrusion of the Snowmass Mountain massif to the northeast and under the present location of Treasure Mountain. This orogenic activity is correlative in age to the Laramide orogeny found

throughout Colorado from the Front Range to the San Juan Mountains. It may be that the "slow" intrusion with doming of the Treasure Mountain area and its then superjacent sedimentary deposits is due to a local apophyses of this main magmatic intrusion and is locally more granitic in composition than the main mass and of which only the very upper limits are presently exposed to examination. This intrusion and formation of the Treasure Mountain Dome was attended by faulting, fissuring, metamorphism and some very apparent mineralization on the north, east and southeasterly flanks of the dome. Erosion in the mid- and late-Genezoic with local glaciation, rock glaciers, and talus slopes has resulted in the present land forms. The property is generally very close to the apex of the dome and has evidence of mineral deposition. Some past production has been made from this property and nearby areas contrary to the general impression one would gain from reading of the United States Geological Survey Bulletin 884 cited previously.

PREVIOUS MINING HISTORY

The mineral deposits of this district--the Snowmass area--were first discovered in 1880 with the first mineral surveys for mining claims about 1883. The early production was high-grade silver ore which, due to a lack of roads, was "packed" 30 to 50 miles for shipment to smelters or reduction plants. Subsequent to the initial discoveries, the major activity in the district was during the period from 1880 to 1890 and again from 1898 to 1904. Subsequently, only intermittent

activity has been known through 1965. Records of production from this period and up to 1934 indicate a district production approaching $500,000. This production was from both vein and replacement deposits. "Contrary to the early exploration efforts centering on the veins, the major apparent potential is in the replacement deposits in the calcareous and/or dolomitic parts of the sedimentary section, e.g., Manitou, Fremont, Dyer, Leadville, Hermosa, Morrison and Niobrara member of the Mancos formation with local interest in the Dakota (?) quartzite" is an essential summary of opinion as expressed by Vanderwilt in United States Geological Survey Bulletin 884.

The private reports of Prommel indicate this statement is essentially correct for the future development of the district. Studies in other areas of similar lithology and orogenic sequences indicate the potential of the "replacement deposits" as being a very real item for consideration.

THE THREE TOP MINING CORPORATION PROPERTY

The enclosed Marble Quadrangle geologic map (USGS GQ 512) shows the geologic setting of the area. The enclosed transparency is the overlay for the same showing the described claims on the same scale, i.e., 1 inch equals 2,000 feet.

A property map of the company's possessory lode location claims is drawn on the scale of 1 inch equals 200 feet. On this property map, all information that was assembled from the various sources has been noted

for study and correlation. The information includes such items as adits, shafts, pits, tunnels, assays or claimed values. The assays and claimed values are from a map furnished by Mr. Pulger, a member of the corporation. This information is of unknown reliability as the map is unsigned and not dated.

Based upon the above information, including Martine's report and a study of the aerial photos of the area, the following paragraphs discuss the information available and the potential as best indicated from these several sources.

The property has produced limited quantities, variously quoted as a few tons to several hundred tons of lead and zinc ore with the silver content varying from a low of about 10 ounces to 150 ounces and in one case a reported 500 ounces per ton. Lead values show a similar wide variation with a maximum reported assay of 74 per cent. Zinc has not been quoted. Some small values in gold are reported.

Descriptions of the several adits, cuts, shafts and other workings indicate major values are found in replacement deposits controlled by fissures or mineralized faults with replacement ore in the dolomitic and/or calcareous portions of the sedimentary formations. The major exception is the area of the Shari, Velma K, Louise and Dicky claims. These workings are apparently in the pre-Cambrian gneiss and schist and/or the Tertiary granitic intrusive. Field examination of the several prospect pits,

tunnels and outcrops in the area will clarify this relationship and indicate the structural and other depositional controls of the mineralization.

PROPOSED EXPLORATION

Based upon the information to date, the following program is offered for consideration. The program is always subject to specific changes as to details dependent upon information as developed during any phase of the field work:

1. A brief reconnaissance of the entire property to obtain the preliminary proof of values and mineralization as indicated on the claim map.

2. Geologic mapping including the sampling of the surface outcrops of the veins and replacement deposits as found on the property and immediately adjacent areas. This work is required to obtain the specific geology of the property and its correlation to the district. A secondary result may be the extension of the veins and/or replacement deposits into presently unknown areas.

3. The examination, mapping and sampling of all accessible mine workings on the property.

4. Reconnaissance survey to the west on the flank of the Treasure Mountain Dome to establish one or more locations of crosscut tunnels or adits to work the deposits presently indicated as occurring on or near the apex of the mountain ridge between Treasure Mountain and Whitehouse Mountain.

5. Reconnaissance survey to the northeast, i.e., toward the Crystal River valley, to locate possible tunnel site locations for cross-cut tunnels at moderate depth below the outcrops of one or more of the veins and/or replacement ore bodies as found as the result of work outlined in paragraphs 1 to 3 above.

6. Reconnaissance of alternate road routes at moderate grades generally less than 10 per cent grade to the areas of interest from presently existing roads meeting these limitations.

7. After the general mapping of the property and its immediately adjacent area, additional information may be required that can be obtained by trenching and/or open cut exploration using mechanical equipment or, in some cases, hand labor. This work is provided for in the budget under the heading of tractor rental and labor costs. A rental of required equipment and purchase of expendable supplies is budgeted.

8. Diamond drilling program based upon the geologic information obtained in the several paragraphs listed above is proposed. The program will generally be limited to the search for and delineation of structure of veins and the possible adjacent replacement deposits. The location of the proposed diamond drill holes can only be determined after field work is completed, results evaluated and locations for the drill prepared and such access as required is constructed by heavy earth moving equipment or packing by animal transport is determined as feasible and the more reasonable.

EXPLORATION PROGRAM SCHEDULE

The field work to accomplish the exploration program to delineate and determine the mineral potential of the property is divided into phases.

1. The first phase is the reconnaissance to determine the justification of the full program. This phase is projected as requiring one week. The work consists of the spot sampling of outcrops, very approximate survey--probably using the planetable with alidade and stadia technique--of the major points of interest to establish the location as being within the property and to establish some estimate of potential tonnages, etc., for the property as a whole.

2. Assuming positive favorable results for the first phase, the second phase will be to map in detail the areas of major interest, map the connecting areas in sufficient detail only to prove "potential," map all underground openings, draft the results to a comprehensive set of working maps, evaluate the same and make the recommendations for the development of the property, as feasible and proven from the second phase.

The second phase involves the repair, maintenance of existing roads, extension of the jeep trail from the area of the Skyline Mine to one or more areas of prime interest for trenching, drilling and completion of the detail study as needed.

The exploration party for the first phase shall consist of the Engineer, an assistant, and one or more representatives of the interested company. A temporary camp either on the property or in Marble will be set up for this period.

The second phase of the program will require an additional assistant, the movement of the exploration camp to the property preferably near the Skyline Mine, and the hiring of personnel and renting of equipment as needed to expedite the exploration and delineation of the mineral resources of the property. It is not possible to give the specific points of interest and effort but the generalities have been discussed in the section titled "Proposed Exploration."

In the attached budget, provision has been made for: (1) the rental of a tractor, compressor, drills; (2) purchase of expendable supplies such as drill steel, bits, powder and small tools; and (3) local hiring of personnel for aiding in the search for and delineation of the potential.

As present indications of the potential are unconfirmed but the areas of interest are delineated earlier, it is considered that a truck road for access and hauling of the various equipment to two locations is a reasonable probability. The locations are: (1) the base of the cliffs either at the base of the Sawatch formation or at the base of the Manitou formation on the Nellie Jo claim and (2) the base of the cliffs at the same horizons on the Betty and/or Shari claims.

CONCLUSIONS AND RECOMMENDATIONS

A study of the data on the property map indicates three major potential areas. The areas are: (1) the Velma-K-Shari-Mark vein; (2) the Dicky-Betty-Diamond Bob vein; and (3) the Brandy-Nellie Jo-Martin Scott-Vicki Lyne vein.

The exploration program will begin by evaluating the potential of the property in the order of the three areas as listed above.

The Engineer-Geologist must have the discretion and consent of the parties to recommend and effect changes in the program, either for the omission of specific parts as determined by the reconnaissance period and subsequently during the detail examination, or additions to property as required for additional economic deposits. Further, it must be a definite premise that the reconnaissance is to "prove the prospect," thence the detail work that follows is to delineate and define the economics of the mineral deposits found. A minimal summary report is all that is contemplated at the end of the initial period, progress reports will be summaries of results without details and a final report only after the completion of detail examination.

In view of the above program as outlined, it is recommended that the initial reconnaissance period of this examination begin on or about the 18th of June with a positive recommendation relative to the second

phase to be made on or about the 25th of June. The property has sufficient merit to warrant the expenditures of funds to make this preliminary examination at this time.

Respectfully submitted

Paul M. Hopkins
Mining Geologist and Engineer

9 June, 1966

Enclosures: Marble Geologic Quad Map (USGS 512)
Transparency overlay with property lines
Property Map with all initial known information

Appendix: Budget

PMH:ri

APPENDIX

BUDGET

Reconnaissance Trip--7 days total time		
Professional Engineer Fee, 7 days @ $100.00 per day	$700.00	
Travel 700 miles @ $0.10/mile	70.00	
Engineer Assistant	150.00	
Food, quarters, assays, misc.	80.00	
Total		$1,000.00
Detail Examination: 45 days field time		
Professional fee @ $100.00/day	4500.00	
Engineering Assistant @ $600.00/mo. 2 men @ $600/mo.	1800.00	
Camp supplies:		
Building material for temporary camp--3 tents to be framed and floored, minimal interior furnishings	450.00	
Tents, 3 each, 10 x 12, wall @ $110.00 each	330.00	
Food, lights, heat @ $16.00/day for the field crew		
Engineering supplies	400.00	
Assays including transportation @ $7.00 per sample, 150 samples	1050.00	
Labor, 4 men 12 days @ $3.00/hr.	1152.00	
Tractor Rental (including operator) @ $15.00 per hr. 100 hours	1500.00	
Insurance, Taxes, etc. 10% of labor and salaries	295.20	
Travel - 1500 miles @ $0.10/mi.	150.00	
Mining Equipment and Supplies		
Compressor, Drill, rental 30 days @ $300.00/mo.	300.00	
Hand tools-expendable	150.00	
Powder, etc.	500.00	
Contingency	1000.00	
Total Field Examination 45 days		$13,577.20

BUDGET (continued)	Forward	$14,577.20
Diamond Drilling Program		
Engineer Assistant on property 2 months @ $600.00/mo.	$1200.00	
Travel, quarters, misc. @ $300.00/mo.	600.00	
Engineer-Geologist, Inspection and interim evaluation trips Fee and expenses (10 days)	1400.00	
Assays, 30 samples @ $7.00/ea.	210.00	
		$ 3,410.00
Diamond Drilling Program		
2,500 feet drilling @ $7.50/foot* *Cost to be negotiated after location, etc. is determined	$22,500.00	
Site preparation, access roads, misc. general requirements as dictated following phase 2 above	15,000.00	
		$37,500.00
Grand Total - Field Examination and Exploration		$40,910.00
Office: Evaluation, Report preparation, including maps: Estimate 30 days		
Professional Fee	$3,000.00	
Salary Assistant @ $600.00/mo.	600.00	
Draftsman, 100 hrs. @ $3.50/hr.	350.00	
Steno-typist @ $2.75/hr. 100 hrs.	275.00	
Miscellaneous office supplies, prints, etc.	400.00	
Total		$ 4,625.00
Grand Total - Field Examination and Office Preparation of the Reports		$60,112.20

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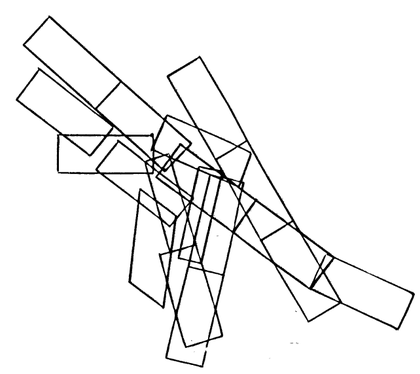
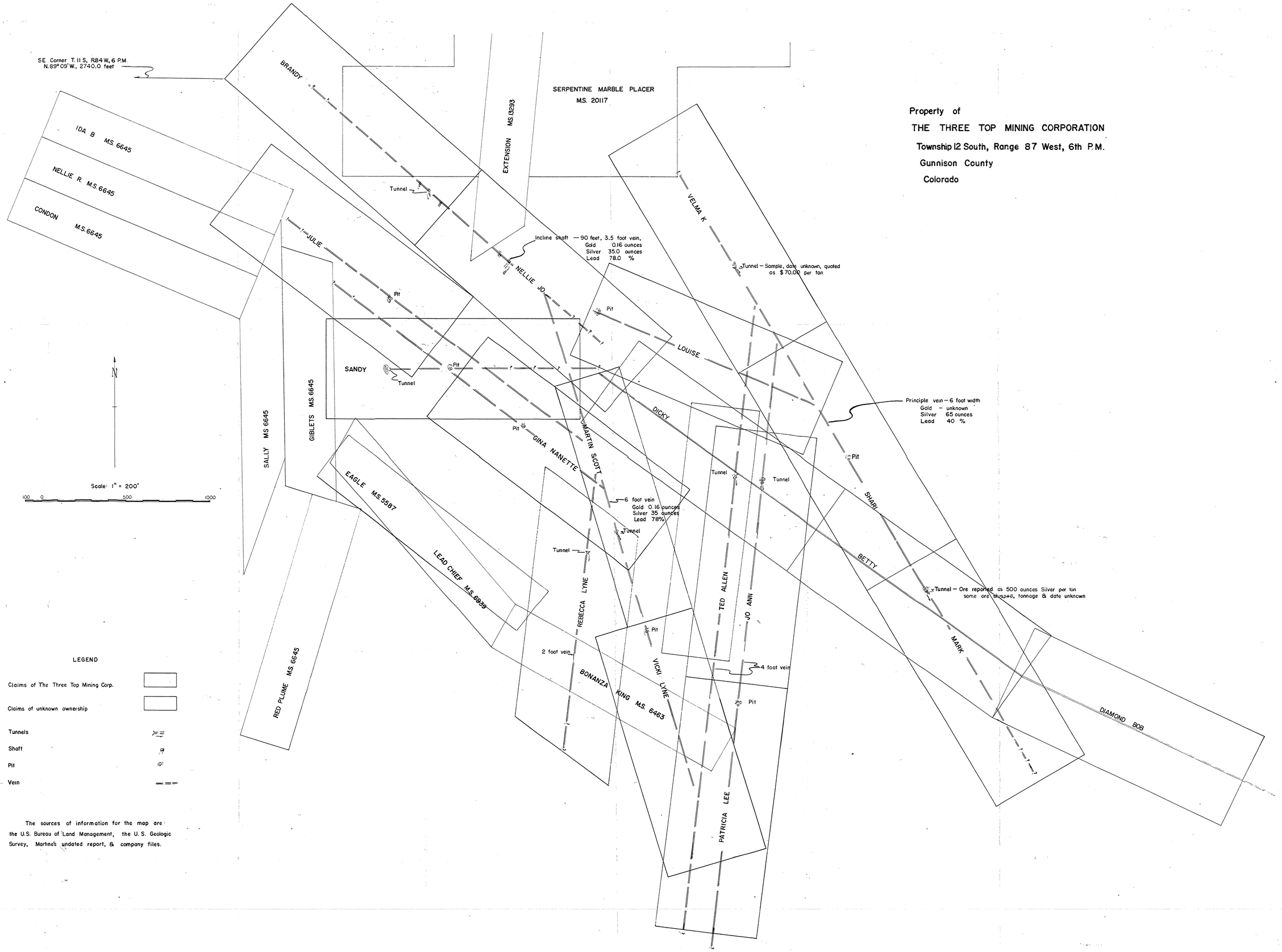


Claim Map Overlay
The Three Top Mining Corp
Marble Quadrangle
Colorado

Scale: 1" = 2,000'

June-66'
PH

Property of
THE THREE TOP MINING CORPORATION
Township 12 South, Range 87 West, 6th P.M.
Gunnison County
Colorado



LEGEND

Claims of The Three Top Mining Corp.

Claims of unknown ownership

Tunnels

Shaft

Pit

Vein

The sources of information for the map are: the U.S. Bureau of Land Management, the U.S. Geologic Survey, Martine's undated report, & company files.

Paul M. Hopkins
PE & LS
Mining Geologist & Engineer

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC QUADRANGLE MAP
MARBLE QUADRANGLE, COLORADO
GQ-512

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS:

Qal Alluvium and pond deposits.

Qf Alluvial fan and cone deposits.

Qt Talus deposits—talus aprons, cones, and scree slopes. Includes inactive soil-mantled talus, rubble streams, and slope wash.

Qr Rock glaciers—includes protalus ramparts.

Qu Surficial deposits, undifferentiated—includes large areas of talus, glacial debris, and extensive areas of solifluction, slope wash, and landslide material.

Ql LANDSLIDE DEPOSITS—landslide and slump blocks.

Qm GLACIAL DEPOSITS— undifferentiated morainal material.

ga GABBRO DIKES—dark-greenish-gray to black altered porphyritic rock; consists of plagioclase phenocrysts in an intersertal matrix of calcic plagioclase feldspar laths, chlorite, calcite, and ilmenite.

la LAMPROPHYRE DIKES—thin dark- to greenish-gray fine-grained altered dikes.

qm QUARTZ MONZONITE—light-gray medium-grained porphyritic rock that consists of quartz, plagioclase, alkalic feldspar, and biotite. Conspicuous anhedral quartz crystals, ¼ to 1 cm long.

qmp QUARTZ MONZONITE PORPHYRY—light-gray porphyritic rock that consists of phenocrysts of zoned plagioclase, biotite, and hornblende set in a fine- to medium-grained matrix of quartz and alkalic feldspar. Contains crystals of pink orthoclase, ½ to 7 cm long, and smaller embayed quartz crystals, ¼ to 1 cm long.

gr GRANITE PORPHYRY—White to pink fine- to coarse-grained porphyritic granite in Treasure Mountain dome. Contains perthitic orthoclase, sodic plagioclase, and quartz phenocrysts. Includes a few felsite and white quartz porphyry dikes on southwest side of Treasure Mountain dome.

gp GRANODIORITE AND GRANODIORITE PORPHYRY—light- to medium-gray porphyritic to equigranular rock; forms part of Snowmass stock. Contains plagioclase, biotite, and hornblende phenocrysts set in a fine-grained matrix of quartz, alkalic feldspar, plagioclase, and biotite. Color darkens near roof pendants.

gpb Granodiorite porphyry breccia—fragments of granodiorite porphyry and sedimentary rocks cemented by calcite; associated with roof pendants of the Snowmass stock.

Kmv MESAVERDE FORMATION (about 2,000 ft)—interbedded sandstone, shale, and carbonaceous shale, locally a few thin to thick beds of coal. Top eroded.

Kmvb Second sandstone unit (60-120 ft)—medium-gray to white thick-bedded massive fine- to medium-grained sandstone separated from basal sandstone unit (Kmva) by 170-220 feet of dark-gray marine shale that locally contains sandstone beds.

Kmva Basal sandstone unit (50-100 ft)—medium-gray to white thick-bedded massive fine- to medium-grained sandstone; intertongues with shale of upper member of Mancos Shale. Probably equivalent to Rollins Sandstone Member of Mesaverde Formation at type locality.

MANCOS SHALE (about 4,300 ft):

Kmu Upper member (about 4,000 ft)—generally dark-gray laminated silty marine shale. Includes thick zones of sandy shale and siltstone and thin to very thick massive and crossbedded fine-grained lenticular sandstones. A few thin beds of sandy limestone, limy sandstone, and carbonaceous shale in upper part. About 700 feet of calcareous shale of probable Niobrara age at base.

Kmf Fort Hays Limestone Member (40-90 ft)—mainly dark-gray very thin- to thick-bedded dense fossiliferous limestone, scattered shaly limestone, and limy shale. Contacts gradational.

Kml Lower member (240-300 ft) (Benton age)—upper part, light-gray calcareous shales transitional with overlying Fort Hays Member; middle part, indurated medium-light-gray siliceous shale and medium-dark-gray fissile shale; lower part, grayish-black indurated silty shale alternating with thin beds of siltstone and quartzite. Beds locally metamorphosed to argillite and hornfels.

Kd DAKOTA SANDSTONE (120-215 ft)—mainly gray to white very thin to very thick bedded medium- to fine-grained quartzite; generally conglomeratic at base; contains a few thin to thick beds of dark gray sandy siltstone and shale metamorphosed to hornfels.

Jm MORRISON FORMATION (320-380 ft)—greenish- to dark-gray and varicolored siltstone, shale, and marlstone; a few beds of white to gray quartzite and light- to dark-gray limestone and dolomitic limestone. Locally metamorphosed to varicolored hornfels, slate, and white marble; contains specularite, epidote, and tremolite.

Je ENTRADA SANDSTONE (20-45 ft)—greenish- to olive-gray to white crossbedded sandstone. Some beds are well sorted; others have medium to coarse sand grains scattered in fine-grained sandstone. Some shale partings. Locally conglomeratic at base. Metamorphosed to quartzite on Treasure Mountain dome.

PIPm MAROON FORMATION (0-2,500 ft)*—light-gray to white, reddish-brown, and maroon crossbedded calcareous conglomeratic arkosic sandstone; includes lenses of arkosic conglomeratic and beds of calcareous micaceous siltstone and shale. In northwest corner of quadrangle a white to gray massive generally coarse to very coarse grained conglomeratic quartzose sandstone (about 12 ft thick) at top mapped with the Maroon. This bed possibly equivalent to Triassic strata elsewhere.

IPm MINTURN FORMATION (0-1,900 ft)*—gray to greenish-gray calcareous arkosic sandstone that contains scattered quartz and feldspar pebbles; includes dark- to light-gray calcareous siltstone and shale, light-gray to black limestone and sandy limestone, and beds of limestone pebble conglomerate with a calcareous sandstone matrix. Generally metamorphosed to quartzite, marble, hornfels, and argillite.

IPb BELDEN FORMATION (0 to about 350 ft)*—light- to dark-gray sandy cherty limestone, dolomitic limestone, and dolomite; gray to greenish-gray calcareous sandy siltstone and sandstone. Formation is sandier in upper part and contains fossiliferous sandy detrital limestone near top. Locally metamorphosed to white marble and gray hornfels.

IPmo MOLAS FORMATION (0-50 ft)*—dark-, greenish-, and reddish-gray to black argillite grades upward into gray fine-grained argillaceous sandstone and siltstone in upper part. Lower part contains reworked varicolored nodules, pebbles, and fragments of chert and quartzite on karst surface of Leadville Limestone. Metamorphosed to hornfels and quartzite.

Ml LEADVILLE LIMESTONE (about 220 ft)—upper 90 to 100 feet, white fine to very coarse crystalline (calcite) marble. Lenses of dolomite and pods or stringers of chert locally. Lower 120 to 130 feet, white to medium-dark-gray, buff- to gray-weathering very fine- to coarse-grained dolomite marble and dolomitic limestone. Thin beds of sandy limestone, limy quartzite, or hornfels at base. Lime- and magnesium-silicate minerals widespread.

CHAFFEE FORMATION (0-160 ft)*:

Dcd Dyer Dolomite Member (60-100 ft)—light-gray to white, generally buff-weathering fine-grained thin- to very thick-bedded locally sandy dolomite and limestone. Locally cherty. Metamorphosed to lime-silicate marble and occasional serpentine marble.

Dcp Parting Member (50-65 ft)*—white to medium-gray limestone and dolomite with partings and thin beds of greenish-gray shale and siltstone. Includes a thick gray quartzite at top and locally a dolomite pebble conglomerate at base. Metamorphosed to fine-grained marble, hornfels, and argillite.

Of FREMONT LIMESTONE (45-60 ft)—medium-dark-gray to white fine- to medium-grained very thick massive- to thin-bedded limestone and dolomitic limestone. Locally cherty. Metamorphosed to lime-silicate marble.

Ohm HARDING QUARTZITE AND MANITOU FORMATION, UNDIFFERENTIATED (about 150 ft):

Harding Quartzite (0-5 ft)*—dark-gray to white fine-grained sandstone, siltstone, or shale. Metamorphosed to quartzite, hornfels, and argillite.

Manitou Formation (140-150 ft)—medium-light-gray to white, buff- to gray-weathering very fine- to medium-grained thin to very thick even-bedded sandy dolomite, limestone, and dolomitic limestone with gray chert bands, lenses, and nodules in upper part. Metamorphosed to lime-silicate marble.

Om MANITOU FORMATION— mapped where Harding Quartzite is cut out by unconformity at base of Entrada Sandstone.

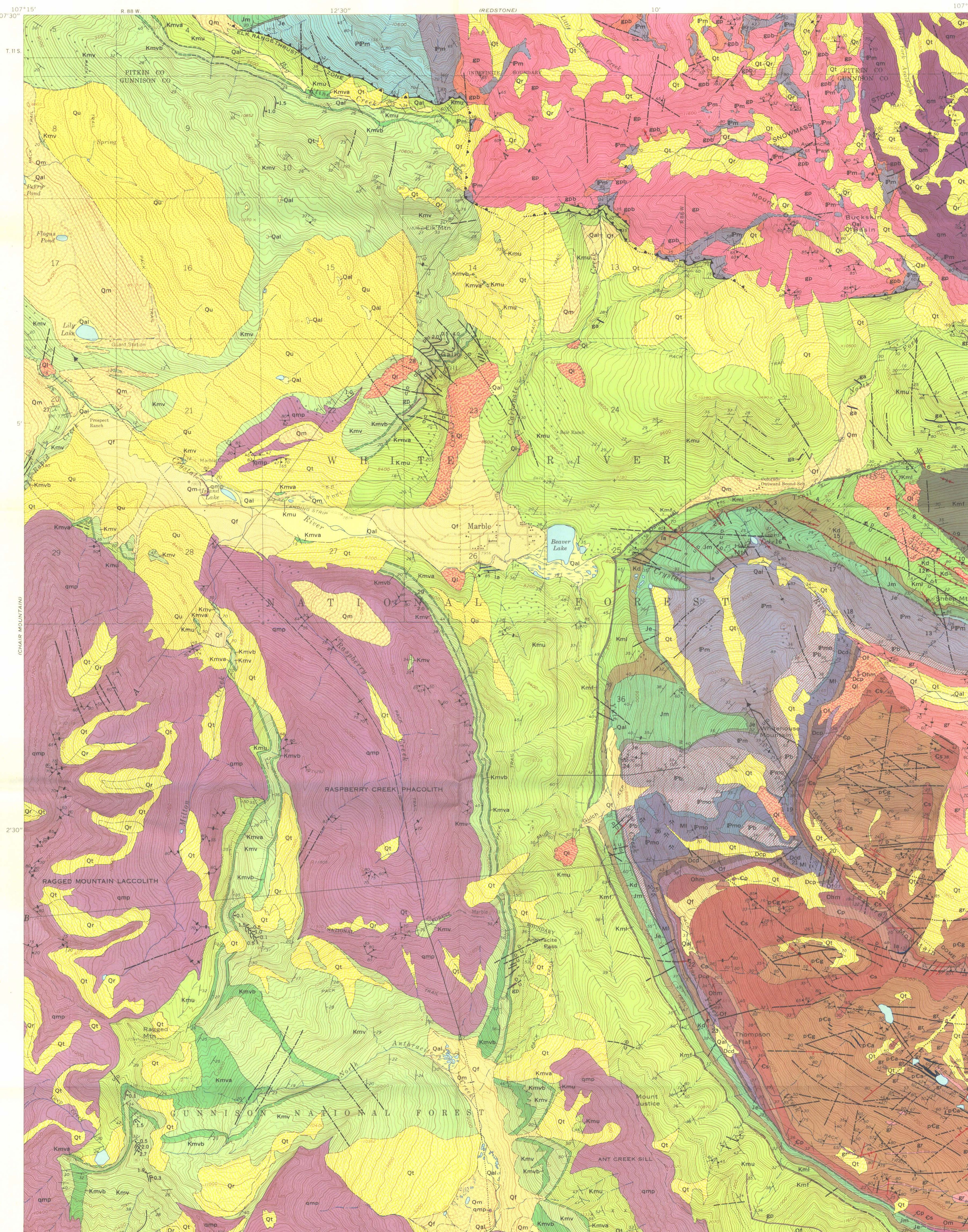
€p PEERLESS FORMATION (about 90 ft)—white to dark- and greenish-gray very fine- to fine-grained quartzite interbedded with limestone and dolomitic limestone, dark-greenish and purplish-gray shale, and purplish-gray arkosic quartzite. Metamorphosed to quartzite and hornfels that contain serpentine and epidote.

€s SAWATCH QUARTZITE (130-190 ft)—white to pinkish-gray quartzite. Conglomeratic at base

p€a AMPHIBOLITE— thin dark-greenish-gray coarse-grained amphibole and plagioclase in lenticular bodies that strike parallel to foliation in gneiss.

p€g GNEISS— light- to medium-gray interlayered quartz biotite gneiss, granite gneiss, pegmatite, and biotite schist. Includes some dark mylonitic or lamprophyric dikes along faults.

*Units younger than the Manitou Formation and older than the Entrada Sandstone are locally cut out along the unconformity at the base of the Entrada around the Treasure Mountain dome.



Base by U.S. Geological Survey, 1960

APPROXIMATE MEAN DECLINATION, 1966

SCALE 1:24 000

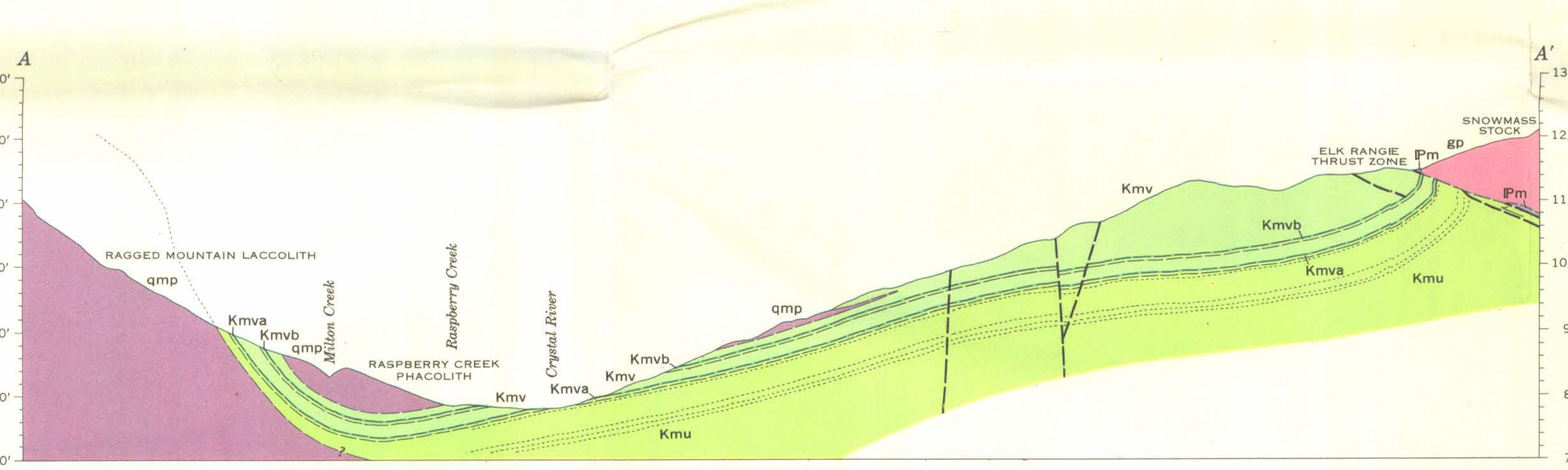
1 MILE

1 KILOMETER

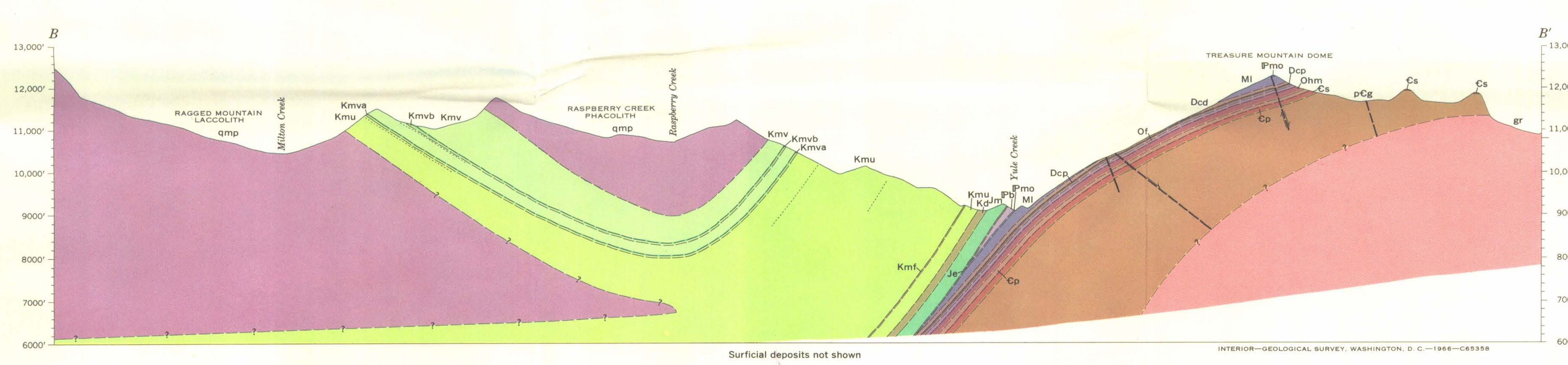
CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

Geology mapped in 1962-63



Surficial deposits not shown



Surficial deposits not shown

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1966—C65358

EXPLANATION

QUATERNARY

Recent

Qal Qf Qt Qr Qu — Surficial deposits
Qal, *alluvium*
Qf, *fan deposits*
Qt, *talus deposits*
Qr, *rock glaciers*
Qu, *surficial deposits, undifferentiated*

Pleistocene and Recent

Ql — Landslide deposits

Pleistocene

Qm — Glacial deposits
Black circles indicate isolated patches of glacial deposits

UNCONFORMITY

TERTIARY

Upper Eocene(?) and younger

ga — Gabbro dikes

la — Lamprophyre dikes

qm — Quartz monzonite
Forms central part of Snowmass stock

qmp — Quartz monzonite porphyry
Forms laccoliths and sills

gr — Granite porphyry

gp, gpb — Granodiorite and granodiorite porphyry
gpb, *brecciated granodiorite porphyry in roof pendants*

CRETACEOUS

Upper Cretaceous

Kmv, Kmvb, Kmva — Mesaverde Formation
Kmvb, *second sandstone; dots indicate base of sandstone beds between* Kmvb *and basal sandstone*
Kmva, *basal sandstone unit*

Kmu, Kmf, Kml — Mancos Shale
Kmu, *upper member; dots indicate base of prominent sandstone beds*
Kmf, *Fort Hays Limestone Member*
Kml, *lower member*

Lower and Upper Cretaceous

Kd — Dakota Sandstone

UNCONFORMITY

JURASSIC

Upper Jurassic

Jm — Morrison Formation

Je — Entrada Sandstone

UNCONFORMITY

PENNSYLVANIAN AND PERMIAN

PIPm — Maroon Formation

PENNSYLVANIAN (CARBONIFEROUS)

IPm — Minturn Formation

IPb — Belden Formation

IPmo — Molas Formation

UNCONFORMITY

MISSISSIPPIAN

Lower and Upper Mississippian

Ml — Leadville Limestone

UNCONFORMITY

DEVONIAN

Upper Devonian

Dcd, Dcp — Chaffee Formation
Dcd, *Dyer Dolomite Member*
Dcp, *Parting Member*

UNCONFORMITY

ORDOVICIAN

Middle and Upper Ordovician

Of — Fremont Limestone

UNCONFORMITY

Lower and Middle Ordovician

Ohm — Harding Quartzite and Manitou Formation, undifferentiated

Om — Manitou Formation

CAMBRIAN

Upper Cambrian

€p — Peerless Formation

€s — Sawatch Quartzite

UNCONFORMITY

PRECAMBRIAN

p€a — Amphibolite

p€g — Gneiss

Coal bed
Thickness of coal, in feet, measured at triangle

Contact, showing dip
Dashed where approximately located, short dashed where gradational or inferred

Fault or shear zone, showing dip
Dashed where approximately located; dotted where concealed. U, *upthrown side;* D, *downthrown side*

Thrust fault
Sawteeth on upper plate; dashed where approximately located; dotted where concealed

Quartz vein in fault zone, showing dip
U, *upthrown side;* D, *downthrown side. Dots indicate places where vein contains sulfide minerals*

Fault or lineament from aerial photographs

Anticline
Showing crestline and direction of plunge; dotted where concealed

Syncline
Showing troughline and directon of plunge. Short arrow indicates steeper limb. Dashed where approximately located, dotted where concealed

Strike and dip of beds

Strike and dip of overturned beds

Strike of vertical beds

Strike and dip of foliation

Strike of vertical foliation

Strike and dip of layering coincident with foliation

Strike and dip of joint

Strike of vertical joint

Strikes and dips of multiple joint systems

Slump and landslide scarps

Shaft

Portal of adit

Marble quarry

Mine or prospect

List of mines and prospects

1. Gold Pan
2. Virginia
3. Valley
4. May (Pioneer)
5. August Flower
6. Margaret D.
7. Climax
8. Big Indian
9. Monarch
10. Cleopatra
11. Kershaw
12. Gothic Belle
13. Black Eagle
14. Leviathan
15. Silver Nugget
16. Lizard Lake
17. Silver Crop
18. Catalpa-Tennessee
19. Skyline (Lil Darlin)
20. Lead Bullet
21. Wacker
22. Yule Creek
23. Thompson Flats
24. Mormon Tunnel
25. Yule marble quarry
26. Strauss marble quarries
27. Genter
28. Gallo
29. Graphite

ECONOMIC GEOLOGY

About 7,000 tons of high volatile B bituminous and anthracitic coal has been mined from the Mesaverde Formation in the Marble quadrangle. Seven or more coal beds (0.1 to 4 ft. thick) crop out locally in the lower 900 feet of this formation. The writers estimate that the coal reserves (beds over 14 in. thick with less than 1,000 ft. of overburden) total about 30 million tons.

Marble has been the major economic mineral deposit in the quadrangle. Approximately 1½ million tons of marble have been produced from the Yule quarries in recrystallized Leadville Limestone on Yule Creek. It was used in the construction of the Lincoln Memorial in Washington, D. C., as well as many other public buildings in this country. Other thick marble beds in lower Paleozoic and Pennsylvanian formations may have future commercial value.

Zinc, lead, copper, silver, and iron sulfide deposits are associated with the northwest-trending system of faults and fissure veins cutting the Treasure Mountain dome. Replacement sulfide deposits occur in Paleozoic carbonate rocks in the Crystal River canyon and on the Treasure Mountain dome. A few small contact metamorphic sulfide deposits are associated with roof pendants in the Snowmass stock area. Most of the prospects and small mines were originally staked and worked in the 1870's and 1880's. Since that time, they have been worked intermittently.

Part of the quadrangle might be valuable prospectively for oil or gas, but due to large igneous intrusions, local metamorphism, and truncation of the sedimentary rocks around the Treasure Mountain dome, the prospect of oil and gas production is small.

GEOLOGIC MAP OF THE MARBLE QUADRANGLE, GUNNISON AND PITKIN COUNTIES, COLORADO

By
David L. Gaskill and Larry H. Godwin

1966

For sale by U.S. Geological Survey, price $1.00