April 30, 1958

Memorandum

To: E. W. Ellis, Defense Minerals Exploration Administration

From: T. H. Kiilsgaard, U. S. Geological Survey

Subject: Review of Field Team Report, DMEA Docket 4949 (Uranium)
Hilary Mineral Company, San Miguel County, Colorado

In a well-documented report, Field Examiners recommend a modified contract for the applicant. Their conclusions are based on widespread drilling done by the Geological Survey and on production from nearby properties. They believe there is an excellent possibility of finding one or more deposits containing 2,000 to 5,000 tons of ore, averaging from 0.25 to 0.30 percent U_3O_8 and about 1½ percent V_2O_5. They have not, however, concurred with the applicant in that they do not believe that the southern part of the applicant's property warrants exploration, as they consider these claims to be on unfavorable ground. They would instead confine all work to favorable ground at the northern part of the Philmon group.

The examiners' report amply justifies DMEA participation in this contract, and I recommend that the modified program as proposed by the examiners be approved for contract.

T. H. Kiilsgaard

cc: DMEA (3)
James Paone
C.I. Gardner
Director's reading
Branch reading
Chron. file
Docket file
THKiilsgaard/mm
G-MD-4-30-58

4949

224 New Customhouse
Denver 2, Colorado
April 22, 1958

Memorandum

To: Secretary to the Operating Committee

From: Acting Executive Officer, DMEA Field Team, Region III

Subject: Docket No. DMEA 4949 (Uranium) Hilary Mineral Company (Grass Flat and Philura claims) San Miguel County, Colorado - Joint Report of Examination

Enclosed are the original and three copies of the Joint Report of Examination on the subject property by H. F. Robertson, USBM, and N. L. Archbold, USGS.

The field examiners conclude that the probability for making a significant discovery is sufficiently promising to justify Government participation. Accordingly, they recommend that the Applicant's work proposal be approved, as modified by them, in which the field team concurs.

Arithmetical errors have been corrected in this office with a pen in order to save time.

Also enclosed are eight extra copies of Figure 4 for use in the contract.

In accordance with the Chairman's letter dated March 13, 1958, on the subject dealer Consent to Lien and Subordination Agreement forms have been forwarded the Applicant for execution by Beaver Mesa Uranium, Inc.

Original signed by
E. N. HARSHMAN

E. N. Harshman

HMC:dp
cc: Harshman)
Salsbury) W/copy
Hasler) of
DMEA/DFC) subject
Baker) report
Docket)
Chron.

Reviewed by
DMEA OPERATING COMMITTEE

(date)

FOR UNITED STATES GOVERNMENT USE ONLY

DMEA
DEPARTMENT OF THE INTERIOR
APR 21 1958
REGION III
DENVER, COLORADO

UNITED STATES
DEPARTMENT OF THE INTERIOR
FRED A. SEATON, SECRETARY

DEFENSE MINERALS EXPLORATION ADMINISTRATION

REPORT OF EXAMINATION BY EXAMINING TEAM
REGION III

TRANSMITTED

APR 22 1958

DMEA 4949

Hilary Minerals Company, Inc.

Philura claims

San Miguel County, Colorado

Uranium

Joint Geologic and Engineering Report

by

N. L. Archbold
U. S. Geological Survey

H. F. Robertson
U. S. Bureau of Mines

April 1958

Reviewed by
DMEA OPERATING COMMITTEE

(date)

EXTRA COPY
DMEA
RECEIVED APR 24 1958

DATE	INITIALS	CODE

DMEA 4949
HILARY MINERALS COMPANY, INC.
PHILURA CLAIMS
SAN MIGUEL COUNTY, COLORADO

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DMEA 4949
HILARY MINERALS COMPANY, INC.
PHILURA CLAIMS
SAN MIGUEL COUNTY, COLORADO

INTRODUCTION AND SUMMARY

On February 21, 1958, Hilary Minerals Company, Inc., 729 DuPont Building, Miami, Florida, applied for assistance in the exploration of leased mining claims in the Slick Rock mining district, San Miguel County, Colorado (figs. 1 and 2). A total of 51 unpatented lode mining claims, the northwestern part of the large Philura group, was included in the proposed project area. Parts of the Philura group of claims have been concerned in three previous applications for Government participation which were subsequently denied. However, the Philura claims included in docket no. DMEA 4949 cover, in part, an area which is classed as favorable for the occurrence of uranium-vanadium minerals. The claims covering the less favorable southern four-fifths of the area were later withdrawn from the application.

The property was examined on March 13, 1958 by H. F. Robertson, U.S. Bureau of Mines, and N. L. Archbold, U. S. Geological Survey; the examining team was accompanied by the applicant's representative, Mr. Raymond C. Robeck, consulting geologist.

The project proposed by the applicant consists of a two stage drilling program designed to explore for significant uranium deposits in the uppermost ore-bearing sandstone in the Salt Wash member of the Jurassic Morrison formation. The first stage would consist of 53 holes requiring

an estimated 4,900 feet of core drilling and 11,400 feet of non-core drilling and would generally explore the more favorable parts of the project area. The second stage consists of 50 holes, totaling 4,500 feet of core drilling and 10,500 feet of non-core drilling and would be drilled as 100- or 200-foot offsets to holes found to be mineralized or to contain very favorable sandstone. The applicant estimates that his proposed project would cost $129,122.50 with DMEA participation of 50 percent or $64,561.25.

As a result of drill hole data from U. S. Geological Survey exploration programs in the Slick Rock area and from USGS drill holes on the applicant's property, the examining team does not believe the claims lying south of the Philura No. 9 cover ground favorable enough to justify Government participation. Accordingly, the program recommended by the examining team covers only the Grass Flat claim and the Philura Nos. 1 through 9 claims. Since no DMEA work is anticipated on the remainder of the area, the applicant requested that only 10 claims instead of 51 be subordinated in the event of a contract with the Defense Minerals Exploration Administration.

The exploration project recommended by the examining team consists of exploration by drilling in the northern part of the applicant's property. Approval is recommended for a three-stage program designed to test the most favorable area for uranium ore deposits in the 3,000 to 5,000 ton class. The probability of finding such deposits is considered

good enough to justify Government participation in the recommended program which would cost an estimated $~~22,714.07~~ 22,907.19. DMEA participation at 50 percent of the total cost would be $~~11,357.00~~ 11,453.60.

ACKNOWLEDGMENTS

Production data were obtained from records of the Atomic Energy Commission in Grand Junction, Colorado.

Drill hole data obtained by USGS exploration drilling in the Slick Rock area were used in the general evaluation of the applicant's property.

Memoranda of review by James Paone, USBM and N. E. Nelson, USGS were noted.

LOCATION, TOPOGRAPHY, AND PHYSICAL FEATURES

The Philura claims leased by the applicant cover parts of sections 32 and 33, T. 44 N., R. 18 W., and sections 4, 3, 9, and 10, T. 43 N., R. 18 W., New Mexico Principal Meridian, Slick Rock Mining District, San Miguel County, Colorado. The property is accessible over State Highway 80 from Naturita or Dove Creek, Colorado. The highway crosses the north boundary of the Philura group about one-half mile east of the Slick Rock bridge.

The project area lies on a long slope along the southwest side of the Dolores River. For the most part, the surface is smoothly rounded hills formed by erosion of the Brushy Basin shale member of the Morrison formation. Unconsolidated residual stream gravels up to 20 feet thick are present in many places, and these gravels may be difficult for rotary drills to penetrate. The southern part of the area is littered with huge Burro Canyon boulders.

Annual precipitation in the immediate area of Slick Rock is light, occurring mostly as localized downpours. The area is classed as semi-arid and supports a moderate growth of juniper and pinon on rocky terrain and abundant sagebrush where soils are thick. Cactus and sparse grass are widely distributed.

Labor, supplies, and light equipment can be obtained at Naturita or Uravan about 40 airline miles north of Slick Rock. Water for drilling and mining is easily obtainable from the Dolores River on the east side of the claim group. Domestic water is obtained from a well near the Slick Rock bridge.

Ore treatment plants are located at Uravan, Colorado, about 60 miles distant and Monticello, Utah, about 50 miles distant. Most of the uranium ore produced in the general area is hauled by truck to the Union Carbide and Nuclear Company mill at Uravan, Colorado.

HISTORY AND PRODUCTION

Exploration for uranium-vanadium deposits in the Slick Rock district dates from about 1911. The resulting discoveries were mined primarily for their radium content until 1923, when the Belgian Congo pitchblende deposits began to supply radium. The mines were mostly idle from 1923 to 1937, but since 1937, they have been mined extensively, first for vanadium and in more recent years, for both vanadium and uranium.

From 1948 to 1955 the U. S. Geological Survey, on behalf of the Atomic Energy Commission, carried on extensive exploratory drilling in the Slick Rock mining district. Nineteen of the Government-drilled holes are located on the property concerned by the subject application. In the past few years, exploration by private industry has resulted in the discovery of large uranium deposits about one mile northwest of the applicant's claims. Four nearby properties, two of which included parts of the Philura group, have been examined by DMEA personnel.

The Grass Flat mine, in the extreme northwest part of the subject property, is credited with a production of a total of 2,771 tons of ore averaging 0.19 percent U_3O_8. The mine was abandoned in November 1957 and all equipment removed from the premises. Several other mines of moderate size are currently operating to the northwest and west of the applicant's property (fig. 2). The total production from six of the nearby properties, through January 1958, is shown below. The Upper and Middle Groups and the Ellison mine are A.E.C. leases.

Mine	Tons produced	Percent U_3O_8	Percent V_2O_5
Upper Group (Mining Lease 44)	13,134	0.27	1.68
Middle Group (Mining Lease 30)	14,809	0.24	1.19
Full Moon No. 1	5,793	0.20	1.13
Hawkeye (abandoned)	1,307	0.34	1.09
Grass Flat (abandoned)	2,771	0.19	0.94
Ellison (Mining Lease 32, abandoned)	1,743	0.36	1.67

OWNERSHIP

The property included for subordination under the applicant's original proposal consisted of 48 Philura claims, 2 Philura fractions, and the Grass Flat claim, all unpatented lode mining claims and covering an area of about 970 acres (fig. 2). Since no DMEA work is recommended on the claims located south of the Philura No. 9, the applicant withdrew 39 Philura claims and the 2 Philura Fractions from the proposal. In the event of a contract, the claims which would be subordinated are the Grass Flat claim and the Philura claim Nos. 1 through 9. The applicant controls the property by means of a mining lease, dated January 4, 1958, from the owner, Beaver Mesa Uranium, Inc. Location notices of the 10 claims are recorded at Telluride, Colorado,the county seat of San Miguel County as follows:

	Location Certificate			Amended Certificate 1/	
Claim Name	Date	Book	Page	Book	Page
Grass Flat	2-10-53	216	435	258	341
Philura No. 1	3-19-53	224	202	258	343
Philura No. 2	3-3-53	224	203	258	345
Philura No. 3	3-3-53	224	204	258	347
Philura No. 4	3-3-53	224	205	258	349
Philura No. 5	3-3-53	224	206	258	351
Philura No. 6	3-3-53	224	207	258	353
Philura No. 7	3-3-53	224	208	258	355
Philura No. 8	3-3-53	224	209	258	357
Philura No. 9	3-3-53	224	210	258	359

1/ All the claims located in February and March 1953 were amended to comply with the provisions of Public Law 585.

The actual location of the claims on the ground is correctly marked by the required corner posts and discovery pits and no unresolved conflicts with other claims are noted. Thus, it appears that the applicant has adequate and valid control of the area proposed for subordination. A Consent to Lien and Subordination Agreement would be required from the owner, Beaver Mesa Uranium, Inc., whose mailing address is 1129 Colorado Ave., Grand Junction, Colorado, since a ten percent royalty on all proceeds (excluding haulage allowance) is withheld.

PRESENT STATUS

Exploration and Development

Exploratory work on the subject property has been confined to relatively close-spaced core drilling around the Grass Flat mine and wide-spaced drilling (1000 to 1500-foot) by the U. S. Geological Survey in conjunction with the Government's evaluation of the uranium potential of the Slick Rock district (figs. 2 and 4). Results of the drilling to date indicate that part of the applicant's property covers an area favorable for uranium deposits of moderate size.

Development work on the subject property consists of the Grass Flat mine, a small operation in the southwest corner of the Grass Flat claim (fig. 3). By using a modified room and pillar mining method, an irregular tabular ore deposit, 1 to 4 feet thick, was recovered. Total production from the mine, now abandoned, was 2,771 tons of ore averaging 0.19 percent U_3O_8 and 0.94 percent V_2O_5. No further mining has been undertaken since the applicant obtained the lease on the property.

Mining Equipment and Other Facilities

The applicant had no mining or exploration equipment on the property when examined. Equipment for the proposed exploration would be furnished by the independent contractor doing the work. The applicant, of course, would provide the necessary vehicle and office trailer for the geologist-supervisor.

Several access roads, some needing minor repairs, cross the property and could be utilized in the proposed drilling program. Drillsite construction should present no unusual problems.

GENERAL GEOLOGY

The Philura claims are located in the northern part of the Slick Rock mining district. The axis of the northwesterly trending Dolores anticline lies about 3 miles to the southwest of the property, and the axis of the Disappointment syncline, also trending northwesterly, lies about 2 miles to the northeast of the property. Sedimentary formations on the property strike about N.25°W. and dip as much as 15 degrees to the northeast. A northwesterly trending zone of normal faults is present on the flank of the Dolores anticline about midway between the property and the axis of the anticline, but no faults are known on the property.

Jurassic and Cretaceous formations exposed in the vicinity of the property are briefly described in Table 1. The Morrison formation of Jurassic age is the only formation exposed on the property, and the proposed exploration program is concerned only with the Morrison formation; therefore, it is the only formation that will be considered in detail.

Table 1. Sedimentary formations exposed in the vicinity of the Philura claims.

Age	Formation	Thickness in feet	Description
Cretaceous	Dakota	125	Lenticular sandstones and conglomerates with interbedded coal and carbonaceous shale. Shale dominant in lower part.
	UNCONFORMITY		
	Burro Canyon	125-260	Conglomeratic sandstone with beds of limestone, chert and green and purple shale. No carbonaceous material. Forms cliff and caps mesas.
Jurassic	Morrison	450-600	Brushy Basin member.-Reddish brown to greenish gray bentonitic mudstone with lenticular sandstone and conglomerate. Sandstone and conglomerate lenses are more abundant near base of member.
		300-350	Salt Wash member.-Lenticular, quartzose sandstones and interbedded reddish brown mudstone.
	Summerville	100-120	Reddish brown siltstone with layer of very fine reddish brown sandstone near center of formation. Contains abundant ripple marks.

The Morrison formation is divided into two parts, the Salt Wash and the overlying Brushy Basin member. The Salt Wash member ranges from 300 to 400 feet in thickness and is composed of interbedded lenticular sandstones and reddish brown mudstone. Three units are present within the Salt Wash member: (1) a basal sandstone unit 60 to 140 feet thick and composed of interconnected sandstone lenses, locally separated by mudstone seams up to 20 feet thick; (2) a central zone of reddish brown mudstone 100 to 180 feet thick and containing broad, scattered lenses of sandstone; and (3) an upper sandstone unit 15 to 120 feet thick formed by coalescing sandstone lenses, but locally containing mudstone seams up to 20 feet thick. Contacts between the three units interfinger and may be difficult to draw in individual sections or drill holes.

The Brushy Basin member of the Morrison formation ranges from 450 to 600 feet thick, though a full section is not present on the Philura claims. The member is composed of reddish brown and greenish gray bentonitic mudstone with scattered broad lenses of sandstone and conglomeratic sandstone which are more numerous toward the base of the member. Most commonly, Brushy Basin mudstone directly overlies and interfingers with the upper sandstone unit of the underlying Salt Wash member, though locally a Brushy Basin sandstone lens may lie directly on the upper sandstone unit of the Salt Wash. In individual sections and drill holes, Brushy Basin sandstone lenses can generally be detected by their conglomeratic nature, but if pebbles are absent or very sparse, such lenses can easily be mistaken for the upper sandstone unit of the Salt Wash member.

ORE DEPOSITS

All known uranium-vanadium deposits, in the vicinity of the Philura claims, occur in the Morrison formation, and all significant deposits occur in the upper sandstone unit of the Salt Wash member. Small deposits are scattered in sandstone lenses in the middle unit of the Salt Wash member and the basal part of the Brushy Basin member, but these are too small to justify an exploration program.

Deposits probably occur in the basal part of the Brushy Basin member on the Philura 10, 11, 12, 14, 15, 16, and 17 claims (fig. 2), as wide spaced drill holes in this area have penetrated mineralized Brushy Basin sandstone. Rim exposures, around the southern part of the Philura claims, indicate that small deposits are present in the middle unit of the Salt Wash member. Inasmuch as any deposits in the Brushy Basin member and middle unit of the Salt Wash member would contain less than 500 tons of ore, they are excluded from consideration in this report.

Uranium deposits occuring in the upper sandstone unit of the Salt Wash member, in the immediate vicinity of the Philura claims, generally contain from 2,000 to 5,000 tons of ore, and this is the size of deposit to be expected on the Philura claims.

Uranium deposits in the upper sandstone unit of the Salt Wash member are always associated with certain lithologic features; these features, which constitute guides to ore, are listed below.

1) Sandstone has been bleached from its original light red to light gray or yellow brown

2) Mudstone within and underlying the host sandstone has been bleached from reddish brown to greenish gray.

3) The host sandstone contains abundant coalified plant fragments.

On the basis of bleaching and presence of carbonaceous material, an area considered favorable for exploration was outlined by wide spaced U.S.G.S. drilling (fig. 2). The southern part of the area is considered marginal, whereas the northern part is considered highly favorable and merits an exploration program. Four wide-spaced holes were drilled in the northern Philura claims; of these 4 holes, 2 were mineralized, all contained carbon and bleached sandstone, the average sandstone thickness was 45 feet, and there was an average of 2.0 feet of greenish gray mudstone at the base of the sandstone. In the southern part of the Philura claims, 11 wide-spaced holes were drilled; none were mineralized in the upper sandstone unit of the Salt Wash member, all contained bleached sandstone but only 5 contained carbon, the average sandstone thickness is 40 feet, and there is an average of only 0.4 feet of greenish gray mudstone below the host sandstone.

Locally, uranium deposits appear to be associated with narrow, elongate zones of thick sandstone, which probably represent the courses of ancient streams. Such a zone of thick sandstone is exposed slightly to the north of the Hawkeye mine portal. An isopach map (fig. 3) indicates this thick sandstone trends easterly through the Grass Flat mine, then turns southward. This thick sandstone probably has an overall southeasterly trend and may extend across the northern part of the Philura claims.

Within the host sandstone, deposits are not so closely associated with these thick zones that only the thick zones should be explored, but they do merit special consideration in the later phases of drilling.

A uranium deposit is generally composed of several individual bodies. These bodies may have an irregular lenticular shape ranging up to several feet thick and up to 100 feet in diameter or they may be in the form of a "roll", a narrow elongate, flat-lying body with a crescent shaped cross section. Rolls may have a long dimension of 100 feet or more, but the narrow dimension is commonly only a few feet, thus they may be difficult to detect by exploratory drilling.

EXPLORATION

Applicant's Proposal

The applicant proposes to explore for uranium-vanadium deposits in the upper sandstone unit of the Salt Wash member of the Morrison formation by drilling from the surface. The holes would be non-core drilled to about 10 feet above the Brushy Basin-Salt Wash contact, then core drilled through the ore-bearing sandstone and not more than 15 feet into the underlying red mudstone. All holes would be logged geologically and radiometrically and significantly mineralized portions would be chemically assayed.

Exploration of the area would be accomplished by means of a two-stage program; the first stage would consist of 53 holes spaced from 200 feet to 1,000 feet apart, the spacing dependent on the location of the holes with respect to known favorable parts of the project area. The

initial drilling would include 8 holes offset 100 feet from previously drilled mineralized holes. Stage II would require 50 holes drilled as 100 or 200-foot offsets to holes found to be mineralized or to contain very favorable sandstone.

The exploration program proposed by the applicant would require an estimated 21,900 feet of non-core drilling and 9,400 feet of core drilling at an overall cost of $129,122.50. Government participation in the program would be 50 percent of the total cost or $64,561.25.

Alternate Proposal

The examining team believes that only the northern part of the Philura claims merits a DMEA exploration program; therefore, a modified program consisting of three stages is recommended. The first stage consists of ten holes placed as shown on figure 4 to cover the area on 500 to 800 foot centers. The second stage, to explore mineralized and highly favorable areas, would consist of a maximum of 12 holes drilled not less than 200 feet from any existing holes. Stage III, consisting of a maximum of 12 holes, would be used to explore for ore by offsetting previously drilled ore and well mineralized holes. Stage III holes would not be spaced less than 100 feet from any previous holes.

Holes should be non-core drilled to approximately the top of the upper sandstone unit of the Salt Wash member, then core drilled through the sandstone unit, the underlying greenish gray mudstone, and not more than 10 feet of reddish brown mudstone.

The modified program proposed by the examining team was discussed with the applicant's representative, Mr. Raymond C. Robeck. Mr. Robeck has presented the program to Hilary Minerals Company, Inc., but as yet they have not notified Mr. Robeck as to whether they concur with the suggested modification.

Estimated Cost of Alternate Proposal

The applicant's brochure included three independent contractor's bids on the proposed drilling. The bids are summarized below:

		Price per foot	
	Interval	Non-core	Core
Avery and Johnston Drilling Co.	0-200'	$1.50	$3.50
	200-400'	1.80	4.75
	400-550'	2.15	5.25
	Standby	no charge	
V. and A. Drilling Corp.	0-200'	$2.35	3.35
	200-400'	2.60	4.20
	400-500'	3.25	5.00
	Standby	$12.50 per hour	
Minerals Engineering Company	0-100'	$2.50	$3.25
	100-200'	2.75	3.75
	200-300'	3.00	4.50
	300-400'	3.50	5.25
	400-500'	4.00	6.00
	Standby	$15.00 per hour	

The unit prices quoted by the Avery and Johnston Drilling Co. are the lowest and are normal charges for drilling in the Slick Rock area, thus are used as the basis for computation of the estimated cost of the proposed project. Only one rotary type drill rig, equipped for core

drilling will probably be assigned to the work since no guarantee can be given that more than the ten Stage I holes will be drilled. Data from the records of previous USGS work in the area indicates that the drilling rate should average approximately 75 feet per shift. Assuming that the drill will operate 25 days per month, the drilling should progress at a rate of about 1,900 feet per month. An estimated 5 months, including preliminary work and evaluation between stages, should be sufficient to complete the project.

The estimated cost of the recommended project, consisting of a maximum of 34 holes averaging 284 feet in depth, is shown below. Revisions have been made where the applicant's estimates were excessive.

(1) Independent Contracts

Drilling, non-core		
0-200 feet-6,800 feet at $1.50/ft.	$10,200.00	
200-400 ft.-306 feet at $1.80/ft.	550.80	
Drilling, core		
200-400 ft.-2,550 feet at $2.60/ft.	6,630.00	
Bulldozing, D-6 Caterpillar or equivalent		
70 hours at $12.00/hr.	840.00	
Total independent contracts		$18,220.80

(2) Supervision and Technical Services

1 full-time engineer-geologist		
5 months at $600/mo.	$ 3,000.00	
Total supervision and technical services		$ 3,000.00

(3) Operating Materials and Supplies

Surveying, drafting, and office supplies 5 months at $15.00/mo.	$ 75.00	
Fuel and repairs on field vehicle 5 months at $40.00/mo.	200.00	
Total operating materials and supplies		$ 275.00

(4) Operating Equipment

Rental-trailer for field office 5 months at $50.00/mo.		$250.00	
Depreciation (on 60 mo. basis)			
Jeep for engineer-geologist	$1,800		
Transit and accessories	900		
Hole probing unit	600		
Portable light plant	300		
Total value	$3,600		
$\frac{\$3,600}{60 \text{ mo.}}$ = $60.00 per month			
Depreciation 5 months at $60.00/mo.		$300.00	
Total operating equipment			$ 550.00

(5) and (6) Rehabilitation, Repairs, New Buildings, Improvements, etc.

None

(7) Miscellaneous

Accounting, 5 months at $50/mo.	$250.00	
Chemical assays, maximum of 34 samples assayed for U_3O_8 at $3.50/sample	119.00	
Compensation insurance and payroll taxes at 7 percent of $3,000.00	210.00 ~~21.00~~	
Core boxes - 255 boxes at $1.25 each	318.75	
Total miscellaneous		$ 897.75 ~~708.75~~
Total estimated cost of project		22,943.55 $~~22,754.55~~
Overall cost per foot of drilling	$\frac{\$22{,}943.55 \text{ (}\$22{,}754.55\text{)}}{9{,}656 \text{ ft.}}$ =	$ ~~2.36~~ 2.38
Incidental allowance per foot	$\frac{\$4{,}285 \text{ (}\$4{,}096.00\text{)}}{9{,}656 \text{ ft.}}$	$ ~~0.42~~ 0.44

(Total cost less independent contracts, core boxes, and chemical assays)

Summary of Costs Suggested for Contract Use

Stage I - 10 holes - Estimated time for completion - $1\frac{1}{2}$ months

Actual Cost Items:

Independent Contracts		
Drilling, non-core		
0-200 ft. - 2,000 ft. at $1.50/ft.	$3,000.00	
200-400 ft.- 90 ft. at $1.80/ft.	162.00	
Drilling, core		
200-400 ft.- 750 ft. at $2.60/ft.	1,950.00	
Bulldozing, D-6 Caterpillar or equiv.		
22 hours at $12.00/hr.	264.00	
Total actual cost items, Stage I		$5,376.00

Fixed Unit Cost Items:

Chemical assays for U_3O_8		
10 samples at $3.50 each	$ 35.00	
Core boxes-75 boxes at $1.25 each	93.75	
Incidental allowance	1,249.60	
2,840 feet at $0.44/ft.	~~1,192.80~~	
Total fixed unit cost items, Stage I		1,378.35 ~~$1,321.55~~
Total Stage I		6,754.35 ~~$6,697.55~~

Stage II - 12 holes - Estimated time for completion - 1-3/4 months

Actual Cost Items:

Independent Contracts		
Drilling, non-core		
0-200 ft.-2,400 ft. at $1.50/ft.	$3,600.00	
200-400 ft.- 108 ft. at $1.80/ft.	194.40	
Drilling, core		
200-400 ft.- 900 ft. at $2.60/ft.	2,340.00	
Bulldozing, D-6 Caterpillar or equiv.		
24 hours at $12.00/hr.	288.00	
Total actual cost items, Stage II		$6,422.40

Fixed Unit Cost Items:

Chemical assays for U_3O_8		
12 samples at $3.50 each	$ 42.00	
Core boxes-90 boxes at $1.25 each	112.50	
Incidental allowance	1,499.52	
3,408 feet at $0.44 per foot	~~1,431.36~~	
		1,654.02
Total fixed unit cost items, Stage II		~~$1,585.86~~
		8,076.42
Total Stage II		~~$8,008.26~~

Stage III - 12 holes - Estimated time for completion - 1-3/4 months

Actual Cost Items:

Independent Contracts		
Drilling, non-core		
0-200 ft.-2,400 ft. at $1.50/ft.	$3,600.00	
200-400 ft.- 108 ft. at $1.80/ft.	194.40	
Drilling, core		
200-400 ft. 900 ft. at $2.60/ft.	2,340.00	
Bulldozing, D-6 Caterpillar or equiv.		
24 hours at $12.00/hr.	288.00	
Total actual cost items, Stage III		$6,422.40

Fixed Unit Cost Items:

Chemical assays for U_3O_8		
12 samples at $3.50 each	$ 42.00	
Core boxes - 90 boxes at $1.25 each	112.50	
Incidental allowance	1,499.52	
3,408 feet at $0.44/ft.	~~1,431.36~~	
		1,654.02
Total fixed unit items, Stage III		~~$1,585.86~~
		8,076.42
Total Stage III		~~$8,008.26~~
		22,907.19
Total for Project		~~$22,714.07~~
		11,453.60
Government participation at 50 percent (rounded)		~~$11,357.00~~

CONCLUSIONS AND RECOMMENDATIONS

The examining team concludes that there is a good possibility of finding one or more deposits, containing 2,000 to 5,000 tons of ore averaging 0.25 to 0.30 percent U_3O_8 and about 1.2 percent V_2O_5, on the northern part of the Philura group. The southern part of the group does not, at this time, merit exploration.

The alternate exploration program recommended for approval consists of a maximum of 34 holes at an estimated maximum total cost of ~~$22,714.07~~ 22,907.19. The first stage holes should be located in approximately the positions shown on figure 4; hole locations in the subsequent stages will depend on evaluation of previous drilling and should require prior approval by the Government.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DEFENSE MINERALS EXPLORATION ADMINISTRATION
APRIL 1958
DOCKET 4949

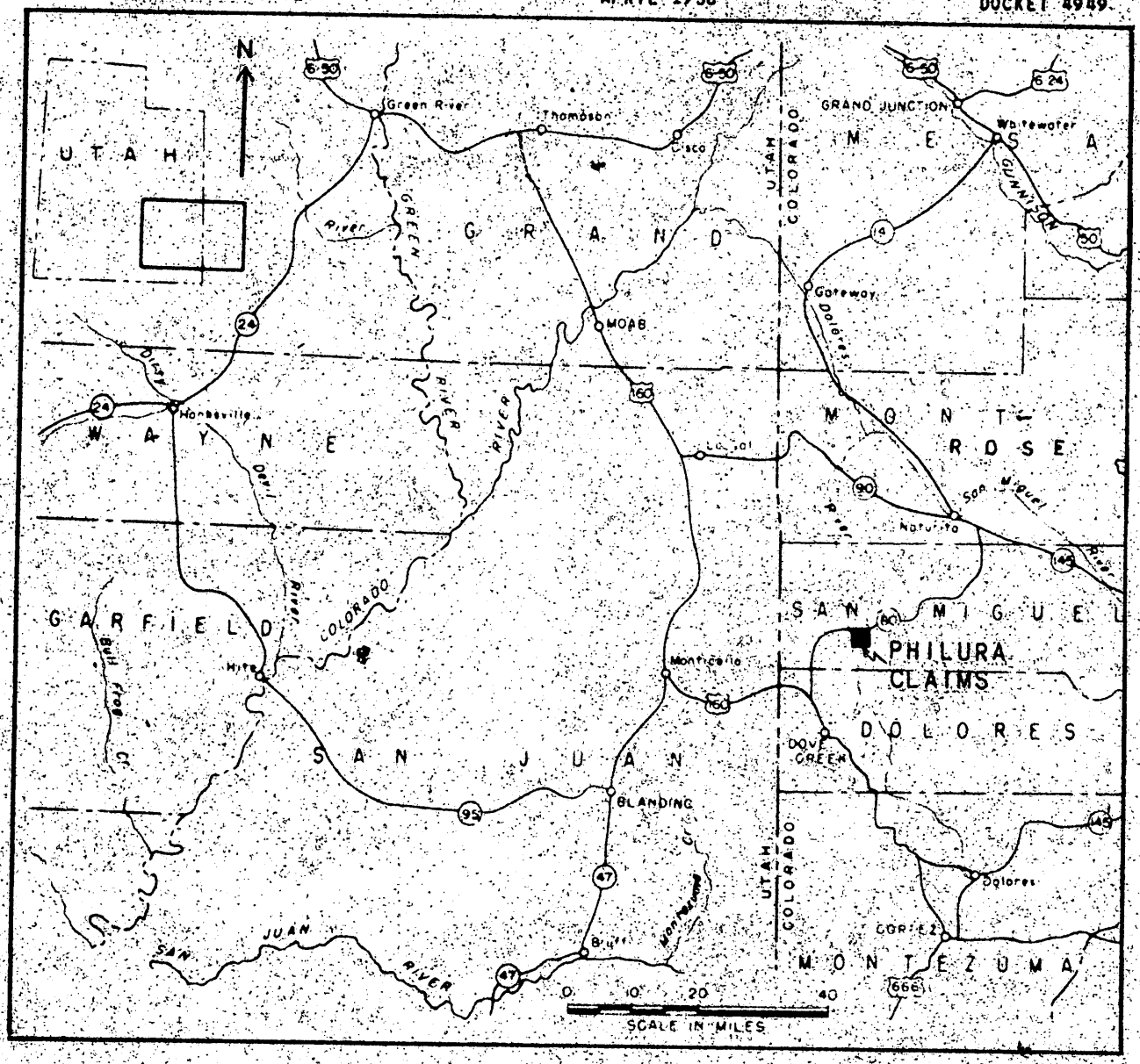

FIGURE 1.--INDEX MAP OF PART OF COLORADO PLATEAU SHOWING LOCATION OF PHILURA CLAIMS, HILARY MINERAL CO., INC., SAN MIGUEL COUNTY, COLORADO.

EXTRA COPY
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RECEIVED APR 24 1958

DATE	INITIALS	CODE

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DEFENSE MINERALS EXPLORATION ADMINISTRATION
APRIL 1958
DOCKET 4949

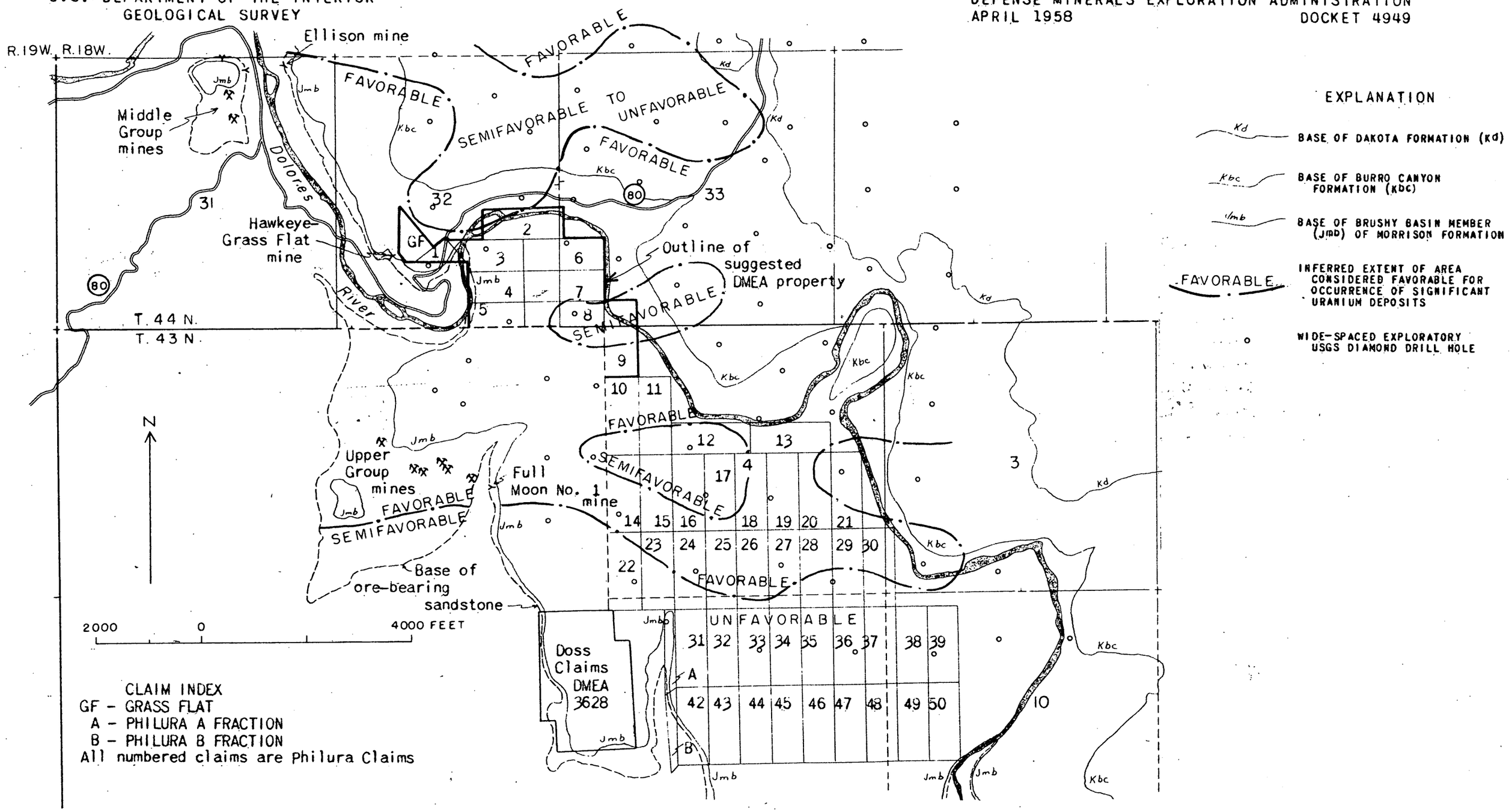

Figure 2.--MAP SHOWING GEOLOGY IN THE VICINITY OF THE PHILURA CLAIMS, HILARY MINERALS CO., INC., SAN MIGUEL COUNTY, COLORADO.

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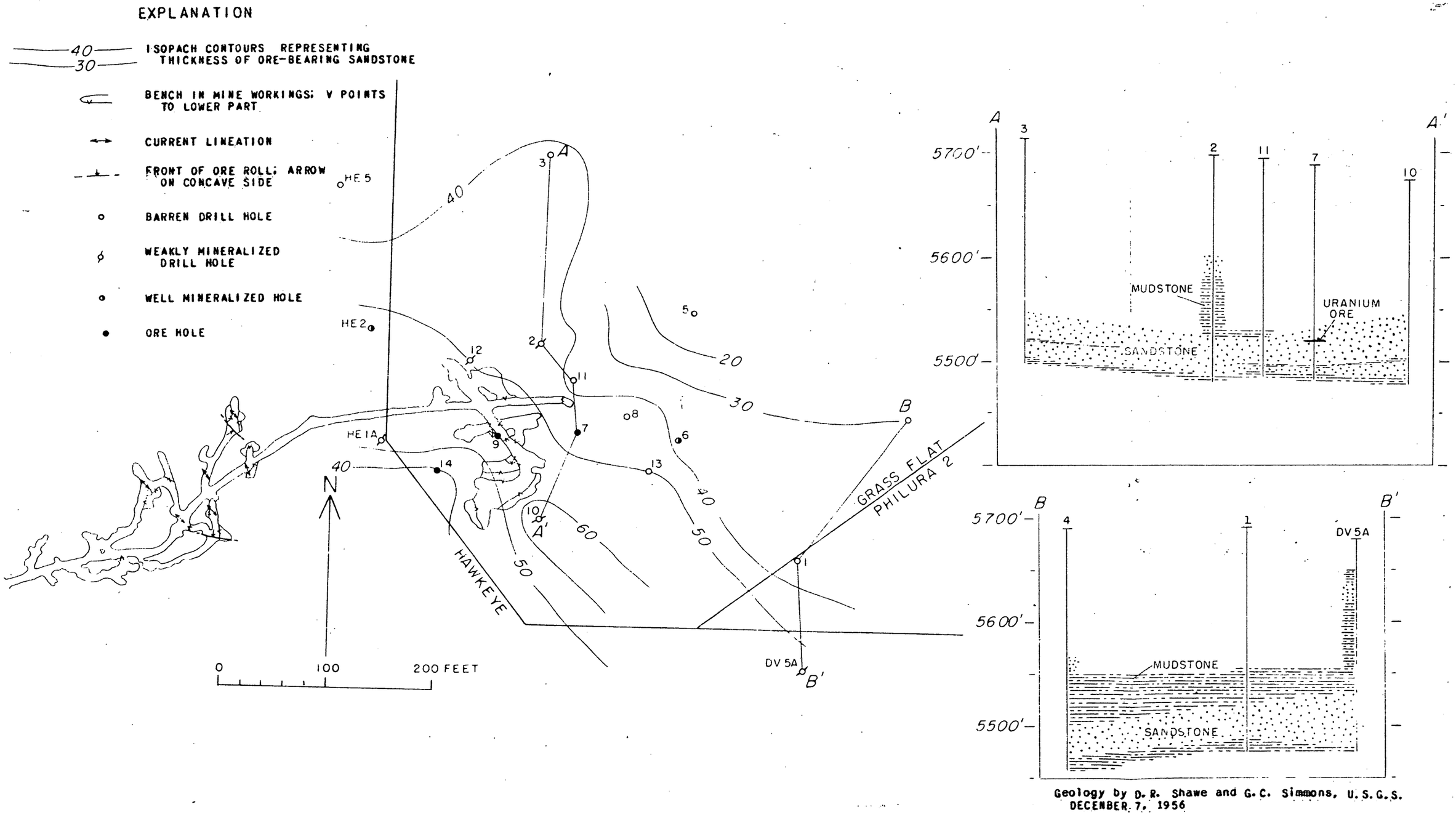

FIGURE 3.—GEOLOGIC MAP OF UNDERGROUND WORKINGS, HAWKEYE-GRASS FLAT MINE, HILARY MINERAL CO., INC., SAN MIGUEL COUNTY, COLORADO.

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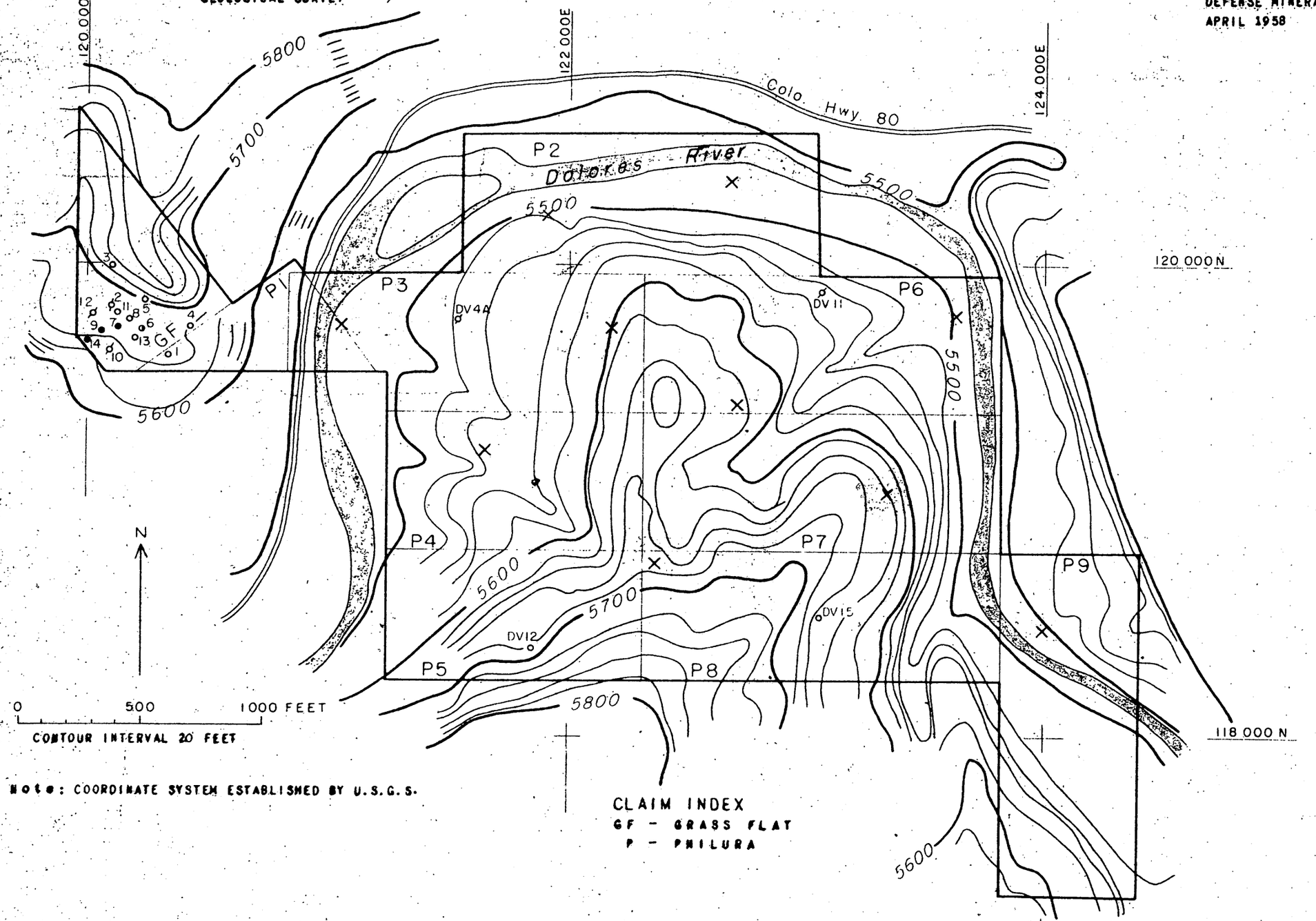

Note: COORDINATE SYSTEM ESTABLISHED BY U.S.G.S.

EXPLANATION

DRILL HOLES WITH PREFIX DV DRILLED BY U.S.G.S. HOLES WITH NO PREFIX DRILLED BY UTE URANIUM COMPANY

- ● ORE (AT LEAST 1.0 FEET OF MATERIAL CONTAINING AT LEAST 0.20 PERCENT U_3O_8
- ○ MINERALIZED (ORE GRADE, BUT LESS THAN 1.0 FEET THICK)
- ◊ WEAKLY MINERALIZED (AT LEAST 0.03 PERCENT U_3O_8, BUT LESS THAN ORE GRADE
- ○ BARREN
- × PROPOSED SITE OF DMEA STAGE I DRILL HOLE

FIGURE 4.—PROPOSED STAGE I DRILLING ON THE NORTHERN PART OF THE PHILURA CLAIMS, HILARY MINERAL CO., INC., SAN MIGUEL COUNTY, COLORADO.

EXPEDITE
DESK
RECEIVED
DATE
RETURNED
CODE

Form MF–103
Revised Oct. 1957

UNITED STATES
DEPARTMENT OF THE INTERIOR

Budget Bureau No. 42–R1035.3
Approval expires June 30, 1958

DEFENSE MINERALS EXPLORATION ADMINISTRATION

APPLICATION FOR AID IN AN EXPLORATION PROJECT

PURSUANT TO DMEA ORDER I, UNDER THE DEFENSE PRODUCTION ACT OF 1950, AS AMENDED

NAME OF APPLICANT (Full legal name and mailing address as it should appear on contract if one is executed)

Hilary Minerals Co., Inc.
729 DuPont Building
Miami, Florida

DMEA
DEPARTMENT OF THE INTERIOR
FEB 27 1958
REGION III
DENVER, COLORADO

APPLICANT NOT TO USE THIS BLOCK

Docket Number 4949
Date Received
Government Participation %
Region
Division Code

BUSINESS ORGANIZATION (Check one)

- Individual [ ]
- Corporation [x]
- Partnership [ ]
- Other (Specify) [ ]

State in which firm is organized New York

LIST CORPORATE OFFICERS OR PARTNERS HERE, IF APPLICABLE

Name	Address	Title
Joseph H. Kanter	729 DuPont Bldg., Miami, Florida	President
Leonard S. Fox	729 DuPont Bldge, Miami, Florida	Vice-Pres.
Leon Levy	25 Broad St., New York, N.Y.	Vice-Pres.
Elvin Kanter	729 DuPont Bldg., Miami, Florida	Sec.-Treas.

Mineral(s) for which you wish to explore
Uranium-vanadium

Estimated Cost of Project
$129,122.50

LOCATION OF PROPERTY

Name	County	State
Slick Rock Mining District	San Miguel	Colorado

GENERAL INSTRUCTIONS

Before filling out this application, please read DMEA Order–I, Revised, "Government Aid in Defense Exploration Projects." To assure prompt action, your application must provide all applicable material and information specified on the back of this application form. Avoid unnecessary correspondence and delays by submitting complete and accurate information. *Please submit four copies of this application and all accompanying papers* except as otherwise noted. Place your name and address on each sheet. Each item of information, maps, and reports required as a part of this application is described on the back of this form. Identify each attached statement by the item number to which it applies. If an item does not apply to your application, show the item number on your statement and after it write "not applicable." Maps or sketches should be used to supplement narrative descriptions of the property location and boundaries in item 1, existing mine workings and geology in item 2, and the proposed exploration project in item 4. When this information is not too complex, all of it may be shown on one map or sketch. All documents and other attachments submitted as a part of this application, except those in item 2(g) which you mark to be returned, become the property of the Government and will not be returned to the applicant. Send true copies, *not originals*, of leases, contracts, and other documents which are an essential part of your business records. *File this application with the Defense Minerals Exploration Administration, Department of the Interior, Washington 25, D. C., or with the nearest DMEA Field Office.*

CERTIFICATION

The undersigned, whether as an individual, corporate officer, partner, or otherwise, both in his own behalf and acting for the applicant, certifies that the information set forth in this form and accompanying papers is correct and complete, to the best of his knowledge and belief.

February 21, 1958
Dated

Leonard S. Fox
BY (Signature)

Vice-President
Title

A wilfully false statement or certification to any Department or Agency of the United States Government is a criminal offense. U. S. Code, Title 18, Sec. 1001.

INFORMATION REQUIRED WITH THIS APPLICATION

1. *Applicant's Property Rights:*

(a) State the legal description (section, township, and range; metes and bounds; patent number of claims) of the land upon which you wish to explore and all land adjacent to the proposed project area which you own or control. Describe any part of the project land or workings which should not be subject to Government lien for royalty payments. If the land consists of unpatented claims, state the book and page number for each recorded location notice, including amended locations, and the place where recorded (courthouse, recorder's office, county, and state).

(b) State all the names by which you know the property.

(c) State your interest in the land, whether owner, lessee, purchaser under contract, or otherwise. If you are not the owner, submit with this application one exact copy of the lease, contract, or other document (with address of owner) under which you control the property.

(d) Describe all liens, mortgages, or other encumbrances on the property.

2. *Physical Description:*

(a) Describe in detail and illustrate with maps or sketches all mining or exploration operations which you know have been or are being conducted upon the lands, including existing mine workings. Describe all production facilities.

(b) State your interest, if any, in operations stated in 2*(a)*.

(c) State, as far as you know, the past and current production, supporting your statement with copies of settlement sheets, mine records, or published data if available.

(d) Describe known ore reserves on the property giving quantities and grades and sampling methods used, supporting your statement with copies of assay certificates and assay maps if available.

(e) Describe by narrative and maps or sketches the geologic features of the property, including ore minerals, geologic formations if known, and type of deposit (vein, bedded, etc.).

(f) State your reasons for expecting to find ore, and if you have sampled the area you propose to explore, show where the samples were taken, describe sampling methods used, and provide copies of assay certificates.

(g) Send with your application at least *two* copies of all geologic or engineering reports, assay maps, or technologic information which you may have, indicating on each whether you require its return to you.

3. *Accessibility of Project:*

(a) To aid DMEA representatives who may be required to examine the property, state the name and address of the person who will meet the DMEA representative; give directions for reaching the property; and describe accessibility of the property including the mine workings.

(b) Name the shipping and supply points and places where employees reside and state the distances between them and the property.

4. *The Exploration Project:*

(a) Describe fully the proposed exploration project giving individual footages and sizes of openings *for each item of work.* Use narrative, maps, plans, and longitudinal and cross sections as necessary. Show the location of the proposed work as related to geologic features such as veins, ore-bearing beds, contacts of rock formations, etc. Show also the relation of the proposed work to any existing mine workings and to *property boundaries* or to the closest identifiable corner.

(b) If an access road to the project must be built, show the location on the property map and state the length, type, and construction methods proposed.

(c) In the event that an exploration contract with DMEA is executed, how soon will the work start and how many months will be required to complete it? State your anticipated average daily or monthly rate of progress for each type of work.

5. *Experience:*

State your operating experience and background with relation to your ability to carry out this exploration project, and also that of the person or persons who will supervise the operations.

6. *Estimate of Costs:*

Furnish detailed estimates of the costs *for each item of the work proposed in 4(a)* under the headings listed below with a total for each heading and the estimated total cost of the project. Costs for any work to be performed by an independent contractor should be shown separately under category *(a)* below. Costs for any work that is not to be performed by an independent contractor should be given in detail under categories *(b)* through *(g)*.

(a) Independent contracts. State the cost of any proposed independent contract for the performance of all or any part of the work, expressed in units of work, such as per foot of drilling, per foot of drifting, per hour of bulldozer operations, per cubic yard of material moved. Cost estimates should be supported by bids from three contractors if possible. *(Note* – If none of the work is to be contracted, write "none" after this item.)

(b) Personal services. For necessary supervision, engineering and geological services, and labor, include an itemized schedule of numbers, classes, rates of wages, salaries or fees, and periods of employment. State whether these technicians and employees are available.

(c) Operating materials and supplies. List items of material and supplies with their cost. Include under this heading power, water, and fuel, and units of equipment and tools costing less than $50 each.

(d) Operating equipment. List items of operating equipment to be used giving specifications and indicating how each item is to be acquired – i.e., rented, purchased, or provided by the applicant. If it is rented or purchased, state the estimated rental or purchase price. If it is to be furnished by the applicant, give its present fair market value.

(e) Initial rehabilitation and repairs. Describe the type and the cost of necessary *initial* rehabilitation or repair of existing buildings, fixtures, installations (exclusive of mine workings), and movable operating equipment now owned by the applicant, which will be used on the exploration project.

(f) New buildings, fixtures, installations. Describe each building, fixed improvement, and installation to be purchased, constructed, or installed for the exploration project stating specifications and cost including labor, materials and supervision.

(g) Miscellaneous. For the operating equipment listed in 6*(d)*, describe the type and estimate the cost of repairs and maintenance expected during project operations. Do not repeat initial repairs listed in 6*(e)*. Show also the costs of analytical work, accounting, workmen's compensation and employees' liability insurance, payroll taxes, and other required costs that do not fall within the previous categories.

Note – No items of general overhead, corporate management, interest, taxes (other than payroll and sales taxes), or any other indirect costs, or work performed or costs incurred before the date of the contract, should be included in the estimate of costs.

7. *(a)* State whether you are prepared to furnish your share of the cost of the proposed project in accordance with the regulations on Government participation stated in Sec. 7 of DMEA Order–I, Revised.

(b) Explain to what extent you propose to furnish your share of the costs by providing money, by use of equipment owned by you, or otherwise.

* * * * *

INT.-DUP. SEC., WASH., D.C. 25960

INDEX

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Appendix:

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Exhibit 6, 14 Drill logs - Ute Uranium, Inc.
19 Drill logs - U. S. Geological Survey . . . . 25 - 61

Exhibit 7, Summary of drilling by U. S. Geological Survey . . 62

Exhibit 8, Three bids submitted by drilling contractors . . 63 - 65

INFORMATION REQUIRED WITH THIS APPLICATION

1. Applicant's Property Rights:

(a) The area to be explored contains 51 unpatented mining claims (or fractions thereof) (Exhibit 1 and 2) in Sections 32 and 33, T 44 N, R 18 W and in Sections 4 and 9, T 43 N, R 18 W, NMPM, San Miguel County, State of Colorado (Exhibit 3).

The applicant also holds under lease a group of claims lying south and adjacent to the claims mentioned above. However, the area containing this southern group is currently regarded as geologically unfavorable.

Book and page number (for each recorded claim - location notice) and recording information for the 51 unpatented claims subject to this application are listed in Exhibit 2).

(b) This application refers to those 51 claims known as the Slick Rock group, the Philura group and the Grass Flat Mine.

(c) The applicant is the lessee of the claims in question. The lessor is the Beaver Mesa Uranium Company of Grand Junction, Colorado. (See Exhibit 4 for copy of lease.)

(d) The lessee is obligated to pay ten percent gross royalty to the lessor on all ores shipped from the property.

2. Physical Description:

(a) One mine exists on the property. Known as the Grass Flat Mine (see map--Exhibit 5), it was in production from July, 1955 until July, 1957, at which time, all machinery and fixtures were removed from the property. The only facility remaining in the vicinity is a small bunk house which is actually located on a nearby claim known as the Hawkeye claim. During the two-year period indicated, the Grass Flat Mine was worked by Ute Uranium, Inc. whose operations lasted only until all available bonus payments were received. The bonus applied to the Grass Flat mining claim and the adjacent claims, Philura 1 through 8. No application has been made for bonus consideration on the remaining claims.

The Ute Uranium company had obtained an easement in order that shipping ore from the Grass Flat mine could be carried out through the adjacent Hawkeye mine. Neither of these mines is now in operation, however, they are open and available for inspection.

Uranium ore from the Grass Flat mine was shipped to Uravan, Colorado.

(b) The applicant had no interest in the property when the operations as stipulated above were underway. The mine was inoperative when the current lease was initiated.

(c) Ute Uranium, Inc. produced 2,770.77 tons of ore which averaged 0.195% U_3O_8 and 0.834% V_2O_5. (Individual settlement sheets are on file with the AEC, Grand Junction, Colorado.)

(d) Ore reserves are calculated from information shown on the UP 1-14 logs, plus the U. S. Geological Survey logs (see Exhibit 6 and 7), and from the habits of the ore as found in the Grass Flat and adjacent mines. Only a small tonnage of ore shows on the southwest working face in the Grass Flat mine. Two holes in areas not yet mined out are classified as ore holes, and four are classified as mineralized. There is only one ore hole in the area from which 2,770 tons have been mined out. This would indicate that at least 3,000 tons of 0.20 grade material may be present near the drill holes 6, 7, 10 and 14.

(e) The general geographic and geologic features of the area are described by Cater on the enclosed geologic map (Exhibit 3). Only those detailed features not mentioned before are considered in this application.

The known occurrences of commercial ore in the Slick Rock Mining District are in a general north-south belt which is part of the Uravan mineral belt. The individual ore deposits are located in the thicker portions of the Salt Wash sandstones, most of which, show sedimentary trends to the east or southeast. Studies by many geologists on the outcrops, in the mines and of the numerous drill cores have resulted in the following items, listed in their order of importance:

(1) Color of sandstone where oxidized should be light brown (not some shade of red). Unoxidized sandstone should be light gray.
(2) Thickness should be over 35 feet and preferably around 50 to 60 feet.
(3) Thickness of adjacent (usually below) mudstone should be over one foot and bleached to a green-gray instead of the normal red.
(4) The more abundant the carbon, the more favorable the sandstone.
(5) A favorable sandstone will contain a moderate amount of green-gray mudstone distributed throughout the sandstone as streaks, galls, or disseminated between the grains.

The thickness of the ore-bearing sandstone, as determined in the 33 holes already drilled, ranges from 11 to 124 feet. The uranium-vanadium mineralization is most often found in the upper 60 feet of the Salt Wash sandstone. The ore may be present at any one or more horizons in the sandstone such as is found in UP-9 and 14 drill holes. The ore is present as high-grade rolls or tabular streaks with some low-grade material, however, a combination of many rolls together in a very favorable sandstone may yield tens of thousands of tons.

The most abundant ore minerals are carnotite, uraninite, coffinite and some micaceous vanadium minerals. Not much carnotite will be found below the zone of oxidation.

(f) The studies on all available data indicate that the Salt Wash sandstone is favorable for ore in all of the claims except that near drill holes DV-17, 19 and 24. This unfavorable area appears to be an oval-shaped portion about 3000 feet east-west and 1,500 feet north-south. The finding of deposits in the Slick Rock District has shown that once an area is definitely established as favorable, it is merely a matter of drilling a sufficient number of holes along the sedimentary trends until ore is found. To date, most of the ore bodies are less than 100 feet long, ~~and in a general~~ oval shape. It has also been found that where any mineralization is found, at least small ore bodies are nearby.

(g) See Cater's report on reverse side of geologic map (Exhibit 3); also see list of literature cited.

3. Accessibility of Project:

(a) Raymond C. Robeck, consultant geologist, will be available to assist the DMEA field team in its appraisal of the property. Mr. Robeck can be reached at 535 Orchard Ave., Grand Junction, Colorado (CH 2-4943).

The property is accessible over State Highway 80 from Naturita or Dove Creek, Colorado. The Grass Flat mine is open for inspection, however, a temporary door has been nailed over the entrance on the Hawkeye claim. A few small roof cave-ins have occurred. Therefore, due caution should be taken when inspecting the mine. The air vent is open and operating by normal draft; thus, the air is safe for inspection purposes.

(b) Supplies are available at Grand Junction, Norwood or Dove Creek, Colorado. Dove Creek, 25 miles south of the property, is the nearest town. There are no camp facilities on the property. The applicant's contractors will furnish their own camp.

4. The Exploration Project:

(a) The applicant proposes to explore for uranium-vanadium deposits in the Salt Wash sandstone. All exploration will entail drilling from the surface. It is proposed to plug-bit most of the drill holes down to approximately 10 feet above the top of the Salt Wash; then to core (Bx, and in an emergency Ax) through the ore-bearing sandstone; and then at least 5 feet but no more than 15 feet into the underlying ~~sandstone~~. All holes will be probed and recorded on tape. Chemical assays will be made on all radioactivity above .02% eU_3O_8.

It is proposed that 3 holes be drilled with a plugged bit all the way through the ore-bearing sandstone. These hole locations are marked on the claims map (Exhibit 1) where the 'X' mark is circled. They should be drilled as inexpensively as possible in order to determine more exactly the extent of the unfavorable area. If favorable mineralized sandstone is found in these holes, it is proposed that cored offsets be drilled in Stage II.

The total depth of the holes will range from 100 feet near the outcrop to about 500 feet in the most northeastern holes. Most of the holes will be between 250 and 350 feet deep. The total of 53 holes in Stage I will effect approximately 16,300 feet of drilling. It is estimated that an approximate 30 percent of the footage will be cored. The sandstones are quite variable in thickness; thus, a reasonable margin of safety has been added.

Workers in the area believe that the best opportunity for finding substantial ore bodies lies in the northwest portion of the claims group, and that the number and size of ore bodies will decrease to the southeast. The entire drilling program is set up to follow this theory. It is therefore proposed that 8 holes be drilled as 100-foot offsets to the mineralized holes UP-2, 6 and DV-4A, 11, 3A (see Exhibit 1 and 5). Other holes in the Grass Flat mine area will be on 200 or 400-foot spacing. Southeast of claim Philura 9, the spacing changes to 500 feet and finally to about 1,000-foot centers in the southeast area.

It is proposed that Stage II drilling shall consist of 50 holes for a total of 15,000 feet, 30 percent of which will be cored. Every hole will be cored (Bx or possibly Ax). Stage II holes will be drilled as 100 or 200-foot offsets to holes found to be mineralized or to contain very favorable sandstone. Five or six holes may be drilled to prove up any favorable sedimentary trends.

(b) Roads exist into most of the area. They will require repairs. New drill sites will be established. These items will require 350 hours of D-7 caterpillar operation. The roads will be improved to satisfy only minimum requirements for moving the truck-mounted drill safely to the drill sites. To prepare sites for Stage II, 200 hours will be required.

(c) Work will commence as soon as possible after a contract is signed or within two months. Stage I should be completed within 5 months after drilling begins. Stage II should be completed within 3 months after drilling begins. Indications are that the project should be completed within 13 months. It is anticipated that the drilling will progress at the rate of at least 250 feet per 10-hour working day.

5. Experience

The stock of Hilary Minerals Co., Inc. is owned by the Warner-Kanter companies, Miami, Florida and Oppenheimer & Co., New York. The Warner-Kanter firm has completed over fifty million dollars worth of building construction in Cincinnati, Washington, D.C. and St. Louis during the past seven years. Oppenheimer & Co., 25 Broad Street, New York City, is a member of the New York Stock Exchange. Hilary's Board of Directors includes Mr. Ralph Stillman, president of the Grace National Bank, New York City, and Mr. Max Oppenheimer, president of Oppenheimer & Co.

Hilary's current minerals activity includes the exploration program for uranium ore in No Name Canyon, San Juan County, Utah, under the direction of Mr. Raymond C. Robeck, whose geological background is depicted on the following page. Mr. Robeck will delegate daily field-work assignments to two geologists and/or engineers.

The Hilary Minerals company is also completing negotiations for exploration programs in the states of Arizona, Colorado, Wyoming and Montana. These programs include the development of manganese and cobalt properties.

RAYMOND C. ROBECK, Consulting Geologist
535 Orchard Avenue, Grand Junction, Colorado

This paper is intended to present information on my geological experience.

I worked for the Dept. of Geology during the six years I spent studying at the University of Wisconsin, preparing the fossil and rock collections for classroom study. In 1941 I received a Bachelor of Philosophy degree. I worked for the Wisconsin Geological Survey during the summer of 1941 doing field work on the glacial geology to find usable gravel deposits. Graduate study and work on a Master's thesis was interrupted in 1942 when the Army requested that I work as a civilian for the Army Map Service in Washington,D.C. preparing bomb target charts for the Air Corps.

In September 1943 I joined the Fuels Branch of the U.S.Geological Survey. For the next two years I was engaged in geologic "spot" studies for the immediate war effort. The projects were all field mapping accompanied by drilling programs involving considerable self supervision and initiative. These projects were: coal at Paonia, Colorado; at Coos Bay, Oregon and Coaldale, Nevada. Asphalt, at Santa Rosa (Prelim Map 44); at Gallup, New Mexico and at Uvalde, Texas. Detailed work also was done on the oil shale at Rifle, Colorado.

The year of 1946 was spent doing geologic field mapping, logging of well cuttings and assisting in the direction of geophysical crews for the Texas Company. Mapping covered the area west of the Cascade Mountains and from Salem, Oregon, north to the Canadian border. The same type of field work was done for the Amerada Petroleum Corporation in central Kansas and northwest Arizona in 1947.

In October 1947 I rejoined the Fuels Branch of the U.S.G.S. and spent two years in detailed studies of uranium in the Chattanooga shale throughout eastern United States. A year was spent on geologic studies of fuels in the Glenwood Springs, Colorado, area. I spent several months in Korea and Japan studying the coal of Korea. During this time, I was evacuated twice when the Communists moved forward. Then I spent 2-1/2 years making a study of the coal resources of Mexico. Several weeks of this time were spent studying the fluorite deposits and the water resources of Coahuila. A detailed reconnaissance report and map were made of the coal fields of Coahuila, Mexico. In July 1953 I started a project on the geology of uranium in the San Rafael Swell, Utah. This project was completed on July 1,1956, at which time I resigned from the U.S.Geological Survey to set up private practice as a consulting geologist.

Projects since July 1956 have included mapping and drilling for uranium and jade deposits, appraisals of uranium and oil properties and mapping of surface and subsurface structures on oil properties.

Each of the above projects involved the use of air photos, plane table methods and altimeter surveys for the making of geologic maps. Intensive and extensive stratigraphic and structural studies were made in connection with most of the projects. Mine mapping and various types of surface and subsurface sampling were done in order to estimate reserves.

I was born in Denver, Colorado, in 1919. I married in 1953 and now have two daughters.

6. Estimate of Costs (a through g):

All work will be done on a contract basis. Equipment will be rented. (See Exhibit 8 for drilling bids from 3 drilling contractors.)

Stage I

Drilling	
53 holes, 16,300 feet (Using 2 or 3 drills simultaneously)	
Plugging at $2.10, 11,400 feet	$23,940.00
Coring at $4.75, 4,900 feet	23,275.00
Dozer work, 350 hours at $15.00	5,250.00
Geologist, assistant geologist and camp expenses 110 days at $100	11,000.00
Supervisor (R.Robeck), 25 days at $100.00	2,500.00
Instruments: probe and surveying - 110 days at $16.00	1,760.00
Reproductions, maps, logs, etc.	200.00
Core boxes (510) at $1.25	637.50
Accounting, typing	300.00
Chemical assays, 40 at $3.50	140.00
Total, Stage I	$69,002.50

Stage II

Drilling 50 holes, 15,000 feet	
Plugging, 10,500	22,050.00
Coring, 4,500	21,375.00
Dozer work, 200 hours at $15	3,000.00
Geologist, assistant geologist and expenses - 90 days at $100	9,000.00
Supervisor, 20 days at $100.00	2,000.00
Instrument, 90 days at $16.00	1,440.00
Reproduction	80.00
Core boxes (500)	625.00
Accounting, etc.	200.00
Chemical assays, 100 at $3.50	350.00
Total Stage II	$60,120.00
Grand Total	129,122.50
Government's share at 50%	64,561.25

7. Sharing of Costs:

(a) Hilary Minerals Co., Inc. is prepared to furnish its share of the cost of the proposed project in accordance with the regulations on Government participation stated in Sec. 7 of DMEA Order -1, Amended.

(b) The applicant proposes to furnish its share of the costs by providing money.

DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 1

Total depth 213'

Collar elev. T 5691 P

Area Slick Rock

COORDINATES

North 119,608 East 120,316

Tie

Claim Philura No. 1

Date started May 1954

Date completed May 1954

Logged by A.M.S.

Summary of log Favorable ; OBSS 163-203 Thick 35' ; SS color LBr/Gy MS under OBSS Gn 2' ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	133.0					Overburden
133.0	168.0	MS	R			
168.0	173.0	SS	L Br	M		
173.0	179.0	SS	Gy	MF	A	A, Cbn. streaks
179.0	200.0	SS	Br	MF		S, limonite specks
200.0	203.0	SS	Gy	MF	A	S, pyrite
203.0	205.0	MS	Gn			
205.0	213.0	MS	R			S, R, SS in more than 2" ribs
						Drilled by Johnson & Youvon

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. UP - 1

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COLORADO PRINTING CO., GRAND JUNCTION

DRILL HOLE LOG

SIMPSON & WOODARD
EXPLORATION CO.

Type of Drill Diamond Ax

Logged For
Ute Uranium, Inc.

Drill-hole No. UP - 2
Total depth 215'
Collar elev. T 5698 P
Area Slick Rock

COORDINATES
North 119,811 East 120,077
Tie

Claim Grass Flat
Date started May 1954
Date completed May 1954
Logged by A.M.S.

Summary of log Favorable ; OBSS 168-210 Thick 42' ; SS color Br/Gy ; MS under OBSS R ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	DESCRIPTION REMARKS
0.0	95.0	MS				Overburden
95.0	115.0	SS	Wh	F		
115.0	165.0	MS	R			S, SS ribs
165.0	168.0	MS	Dk/Bl			
168.0	170.0	SS			A	A, Cbn. streaks
170.0	172.0	MS	Bl			
172.0	185.0	SS	Gy		S	
185.0	194.0	SS	Br		N	Br. specks
194.0	195.0	SS	Gy		A	Sampled, A. Cbn. specks
195.0	204.0	SS	Gy		S	S, Cbn. streaks
204.0	206.4	SS	DkGy		A	Sampled, A, Cbn. specks & streaks
206.4	210.0	SS	Wh/LGy		S	
210.0	215.0	MS/SS	R			
						Drilled by Johnson & Youvon

y-Ray Log 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
195.0	1.0'	0.04	0.02	Tr	Tr
206.4	2.4'	0.02	0.03	Tr	Tr

Abbreviations

Wh --white	CG--conglomerate
Br--brown	SS--sandstone
R--red	MS--mudstone
Gy--gray	ST--siltstone
Bl--blue	F--fine
Gn--green	M--medium
Yw--yellow	C--coarse
Bk--black	N--none
Pp--purple	S--sparse
Cbn--carbon	A--abundant
OBSS--ore bearing sandstone	

Hole No. UP - 2

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill: Diamond Ax

Logged For: Ute Uranium, Inc.

Drill-hole No.: UP - 3

Total depth: 215'

Collar elev.: T 5713 P

Area: Slick Rock

COORDINATES

North 119,971 East 120,083

Tie:

Claim: Grass Flat

Date started: May 1954

Date completed: May 1954

Logged by: A.M.S.

Summary of log: Favorable ; OBSS 165-190' Thick 25' ; SS color LBr. ; MS Gn 5' ; Cbn. N
Semi-Favorable 195-210' 15' Br/Gy under OBSS Gn 2' S

DEPTH / DESCRIPTION

From	To	Rock	Color	Grain	Carbon	REMARKS
0.0	165.0	MS	R			Overburden
165.0	190.0	SS	LBr	MF	N	Clean SS
190.0	195.0	MS	Gn			
195.0	210.0	SS	Gy/Br	MF	S	S, Br. Specks
210.0	212.0	MS	Gn			
212.0	215.0	MS	R			
						Drilled by Johnson & Youvon

γ-Ray Log: 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh - white	CC - conglomerate
Br - brown	SS - sandstone
R - red	MS - mudstone
Gy - gray	ST - siltstone
Bl - blue	F - fine
Gn - green	M - medium
Yw - yellow	C - coarse
Bk - black	N - none
Pp - purple	S - sparse
Cbn - carbon	A - abundant
OBSS - ore bearing sandstone	

Hole No. UP - 3

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 4

Total depth 228'

Collar elev. T 5691 P

Area Slick Rock

COORDINATES

North 119,745 East 120,425

Tie

Claim Grass Flat

Date started May 1954

Date completed May 1954

Logged by A.M.S.

Summary of log semi-favorable OBSS 188'-218' Thick 30' ; SS color Gy/Br ; MS under OBSS R ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	123.0					Overburden
123.0	136.0	SS	Wh	M	N	Clean SS
136.0	188.0	MS	R			
188.0	195.0	SS	Gy/Br	MF		S, limonite specks
195.0	203.0	SS		MF	A	Much Cbn. in seams & specks
203.0	218.0	SS		F	S	
218.0	228.0	SS/MS	R			
						Drilled by Johnson & Youvon

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh - white	CG - conglomerate
Br - brown	SS - sandstone
R - red	MS - mudstone
Gy - gray	ST - siltstone
Bl - blue	F - fine
Gn - green	M - medium
Yw - yellow	C - coarse
Bk - black	N - none
Pp - purple	S - sparse
Cbn - carbon	A - abundant
OBSS - ore bearing sandstone	

Hole No. UP - 4

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill: Diamond Ax

Logged For: Ute Uranium, Inc.

Drill-hole No.: UP - 5

Total depth: 215'

Collar elev.: T 5711 P

Area: Slick Rock

COORDINATES

North 119,839 East 124,219

Tie:

Claim: Grass Flat

Date started: May 1954

Date completed: May 1954

Logged by: A.M.S.

Summary of log: Semi-favorable OBSS 202'-213' Thick 11'; SS color LGy; MS under OBSS R; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	155.0	MS	R			Overburden
155.0	200.0	MS	R			
200.0	202.0	MS	Gn			
202.0	207.0	SS	Gy	MF	A	Much Cbn. in seams
207.0	213.0	SS	LGy	F	S	
213.0	215.0	MS	R			
						Drilled by Johnson & Youvon

γ-Ray Log (0 – 1000)

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh--white	CG--conglomerate
Br--brown	SS--sandstone
R--red	MS--mudstone
Gy--gray	ST--siltstone
Bl--blue	F--fine
Gn--green	M--medium
Yw--yellow	C--coarse
Bk--black	N--none
Pp--purple	S--sparse
Cbn--carbon	A--abundant
OBSS--ore bearing sandstone	

Hole No. UP - 5

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 6

Total depth 203'

Collar elev. T 5691 P

Area Slick Rock

COORDINATES

T North 119,723 East 120,206

F Tie

Claim Grass Flat

Date started May 1954

Date completed May 1954

Logged by A.M.S.

Summary of log Favorable ; OBSS 166-197 Thick 31' ; SS color LGy/Br ; RIS under OBSS Gn. 5' ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	163.0	MS	R			Overburden
163.0	166.0	MS/ST	Bl			50% MS
166.0	169.0	SS	LGy	MF		
169.0	174.5	SS	Gy	MF	A	
174.5	175.0	SS	Gy/Br	F		Sampled #1
175.0	190.7	SS	Gy	F	A	
190.7	191.0	SS	LGy/Bk	MF		Sampled #2
191.0	194.0	SS	LGy	MF		
194.0	194.3	SS	Bk	F		Sampled #3
194.3	197.0	SS	LGy	MF	S	
197.0	202.0	MS/SS	Gn			S, Gy SS ribs less than 2"
202.0	203.0	SS	R			
						Drilled by Johnson & Youvon

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY % U_3O_8	LAB ASSAY % V_2O_5	FIELD EST. % U_3O_8	FIELD EST. % V_2O_5
175.0	0.5'	0.08	0.05	Tr	Tr
191.0	0.3'	0.26	0.74	.20	.50
194.3	0.3	0.04	0.16	Tr	.10

Abbreviations

Wh - white	CG - conglomerate
Br - brown	SS - sandstone
R - red	MS - mudstone
Gy - gray	ST - siltstone
Bl - blue	F - fine
Gn - green	M - medium
Yw - yellow	C - coarse
Bk - black	N - none
Pp - purple	S - sparse
Cbn - carbon	A - abundant
OBSS - ore bearing sandstone	

Hole No. UP - 6

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COLORADO PRINTING CO., GRAND JUNCTION

DRILL HOLE LOG

SIMPSON & WOODARD
EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 7
Total depth 205'
Collar elev. T 5688 P
Area Slick Rock
Summary of log Favorable ; OBSS 155-191 Thick 36' ; SS color Gy/Br ; MS under OBSS Gn 3' ; Cbn. A

COORDINATES
North 119,723 East 120,206
Tie

Claim Grass Flat
Date started June 1954
Date completed June 1954
Logged by A.M.S.

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	155.0					MS, overburden
155.0	162.0	SS	LGy	M	S	
162.0	165.5	SS	Wh	MF	N	Clean SS
165.5	168.5	SS	Gy	MF	A	Sampled
168.5	171.5	SS	LGy	MF	A	A, Cbn. streaks
171.5	173.0	SS	Gy/Bk	F	A	Sampled
173.0	175.0	SS	LGy	MF	S	
175.0	191.0	SS	LBr	MF	N	Clean SS
191.0	194.0	MS	Gn			
194.0	201.0	SS	LBr	MF	N	
201.0	205.0	SS/MS	R			50% MS

Drilled by Ute Uranium, Inc.

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
167.2	1.7'	0.10	0.15	0.10	0.10
168.7	1.5'	0.21	0.28	0.20	0.30
172.7	1.0'	0.11	0.09	0.10	0.10

Abbreviations

Wh--white	CG--conglomerate
Br--brown	SS--sandstone
R--red	MS--mudstone
Gy--gray	ST--siltstone
Bl--blue	F--fine
Gn--green	M--medium
Yw--yellow	C--coarse
Bk--black	N--none
Pp--purple	S--sparse
Cbn--carbon	A--abundant
OBSS--ore bearing sandstone	

Hole No. UP - 7

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COLORADO PRINTING CO., GRAND JUNCTION

DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill: Diamond Ax

Logged For: Ute Uranium, Inc.

Drill-hole No.: UP - 8

Total depth: 230'

Collar elev.: T 5690 P

Area: Slick Rock

COORDINATES

North 119,742 East 120,158

Tie:

Claim: Grass Flat

Date started: June 1954

Date completed: June 29, 1954

Logged by: A.M.S.

Summary of log: Favorable ; OBSS 178-225' Thick 47' ; SS color Gy/Br ; MS under OBSS R ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	175.0					MS, overburden
175.0	178.0	MS	Gn			
178.0	187.0	SS	LGy	MF	A	A, Cbn. streaks; some Gn MS pebbles
187.0	188.0	MS	Gn			
188.0	225.0	SS	LBr	MF	N	SS, mostly clean
225.0	230.0	MS	R			

Drilled by Ute Uranium, Inc.

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY % U_3O_8	LAB ASSAY % V_2O_5	FIELD EST. % U_3O_8	FIELD EST. % V_2O_5

Abbreviations

Wh--white	CG--conglomerate
Br--brown	SS--sandstone
R--red	MS--mudstone
Gy--gray	ST--siltstone
Bl--blue	F--fine
Gn--green	M--medium
Yw--yellow	C--coarse
Bk--black	N--none
Pp--purple	S--sparse
Cbn--carbon	A--abundant
OBSS--ore bearing sandstone	

Hole No. UP - 8

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DRILL HOLE LOG

SIMPSON & WOODARD
EXPLORATION CO.

Type of Drill Diamond Ax

Logged For
Ute Uranium, Inc.

Drill-hole No. UP - 9
Total depth 205'
Collar elev. T 5690 P
Area Slick Rock

COORDINATES
North 119,727 East 120,033
Tie

Claim Grass Flat
Date started July 1954
Date completed July 1954
Logged by A.M.S.

Summary of log Favorable ; OBSS 150-203.5' ; 53.5' ; SS color LBr/Gy ; MS under OBSS R ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	145.0					Overburden & MS
145.0	150.0	MS	Gn			
150.0	154.0	SS	Gy	M	S	S, Gn. MS pebbles
154.0	156.0	SS	Gy	M	A	Mineralized
156.0	161.0	SS	L.Br	MF	S	Light colored SS, fairly clear
161.0	169.5	SS	L.Br	MF	A	A, Cbn. streaks & specks
169.5	175.0	SS	LGy/Bk	MF	A	Mineralized
175.0	192.0	SS	L.Br	MF	S	S, Gn. MS pebbles
192.0	203.5	SS	LBy	F	S	S, Gn. MS streaks
203.5	205.0	MS	R			
						Drilled by Ute Uranium, Inc.

γ-Ray Log
0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY U_3O_8	LAB ASSAY V_2O_5	FIELD EST. U_3O_8	FIELD EST. V_2O_5
155.0	0.9'	0.23	0.35		
155.3	0.3'	0.36	1.50		
156.3	1.0'	0.18	0.13		
170.4	0.9'	0.04	0.46		
171.4	1.5'	0.44	2.99		
173.3	1.4'	0.06	0.51		
174.0	0.7'	0.43	1.42		
175.0	1.0'	0.03	0.63		
176.5	1.5'	0.19	0.99		
177.0	0.5'	0.05	0.51		

Abbreviations

Wh-- white	CG--conglomerate
Br--brown	SS--sandstone
R--red	MS--mudstone
Gy--gray	ST--siltstone
Bl--blue	F--fine
Gn--green	M--medium
Yw--yellow	C--coarse
Bk--black	N--none
Pp--purple	S--sparse
Cbn--carbon	A--abundant
OBSS--ore bearing sandstone	

Hole No. UP - 9

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 10

Total depth 193'

Collar elev. T 5674 P

Area Slick Rock

COORDINATES

North 119,636 East 120,078

Tie

Claim Grass Flat

Date started July 1954

Date completed July 1954

Logged by A.M.S.

Summary of log Favorable ; OBSS 130'-190' Thick 60' ; SS color Gy ; MS under OBSS R ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	130.0					Overburden
130.0	171.0	SS	LGy	MF	A	S, Gn MS streaks & pebbles
171.0	173.0	MS	Gn			
173.0	190.0	SS	Gy	MF	S	Few Cbn. streaks
190.0	193.0	MS	R			

Drilled by Ute Uranium, Inc.

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
150.0	1.8	0.07	0.54		
153.0	1.5	0.10	0.03		

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. UP - 10

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 11
Total depth 207'
Collar elev. T 5693 P
Area Slick Rock

COORDINATES
North 119,772 East 120,104
Tie

Claim Grass Flat
Date started July, 1954
Date completed July, 1954
Logged by A.M.S.

Summary of log Favorable ; OBSS 170-203' Thick 33' ; SS color D.Gy ; MS under OBSS Gn. 3' ; Cbn. A, S

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	163.0					Overburden
163.0	170.0	MS	Gn			
170.0	173.0	SS	Gy	MF	A	A, Cbn. seams
173.0	174.0	SS	Wh			
174.0	176.0	SS	Dk.Gy	F	A	mineralized
176.0	196.0	SS	L.Br.	MF	S	S, MS, Gn. pebbles
196.0	197.0	MS	Gn			
197.0	198.0	SS	Dk.Gy	MF	S	mineralized
198.0	203.0	SS	Dk.Gy	MF	S	S, Gn. MS pebbles
203.0	206.0	MS	Gn			
206.0	207.0	MS	R			
						Drilled by Ute Uranium, Inc.

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY U_3O_8	LAB ASSAY V_2O_5	FIELD EST. U_3O_8	FIELD EST. V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. UP - 11

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DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill: Diamond Ax

Logged For: Ute Uranium, Inc.

Drill-hole No.: UP - 12
Total depth: 210'
Collar elev.: T 5696 P
Area: Slick Rock

COORDINATES
North 119,792 East 120,018
Tie:

Claim: Grass Flat
Date started: July, 1954
Date completed: July, 1954
Logged by: A.M.S.

Summary of log: Favorable ; OBSS 155'-202' thick 47' ; SS color Gy ; MS under OBSS Gn. 4' ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	155.0					Overburden & MS
155.0	182.0	SS	LGy	M	N	
182.0	190.0	SS	Gy	MF	S	S, Gn. MS pebbles
190.0	190.5	SS	Gy	MF	A	Mineralized, sampled
190.5	199.0	SS	Gy	M	S	S, Cbn. streaks
199.0	202.0	SS	D.Gy	MF	A	Cbn. streaks and specks
202.0	206.0	SS/MS	Gn			Small amts. of SS
206.0	210.0	MS	R			

γ-Ray Log 0 1000

Drilled by Ute Uranium, Inc.

SAMPLE BASE	SAMPLE THICK	LAB ASSAY % U_3O_8	LAB ASSAY % V_2O_5	FIELD EST. % U_3O_8	FIELD EST. % V_2O_5
190.5	0.5'	0.08	0.28	0.5	0.20

Abbreviations

Wh - white	CG - conglomerate
Br - brown	SS - sandstone
R - red	MS - mudstone
Gy - gray	ST - siltstone
Bl - blue	F - fine
Gn - green	M - medium
Yw - yellow	C - coarse
Bk - black	N - none
Pp - purple	S - sparse
Cbn - carbon	A - abundant

OBSS - ore bearing sandstone

Hole No. UP - 12

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DRILL HOLE LOG

SIMPSON & WOODARD
EXPLORATION CO.

Type of Drill Diamond Ax

Logged For Ute Uranium, Inc.

Drill-hole No. UP - 13
Total depth 205'
Collar elev. T 5688 P
Area Slick Rock

COORDINATES
North 119,691 East 120,183
Tie

Claim Grass Flat
Date started Aug. 1954
Date completed Aug. 1954
Logged by A.M.S.

Summary of log Favorable ; OBS 155'-205' Thick 47' ; SS color Gy ; MS under OBSS Gn 1' ; Cbn. A, S

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	155.0					Overburden
155.0	180.0	SS	Gy	MF	A	A, Cbn. seams
180.0	202.0	SS	Gy	F	S	S, Gn. MS, seams
202.0	203.0	MS	Gn			
203.0	205.0	MS	R			
						Drilled by Ute Uranium, Inc.

γ-Ray Log 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY % U_3O_8	LAB ASSAY % V_2O_5	FIELD EST. % U_3O_8	FIELD EST. % V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone

Hole No. UP - 13

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COLORADO PRINTING CO., GRAND JUNCTION

DRILL HOLE LOG

SIMPSON & WOODARD EXPLORATION CO.

Type of Drill: Diamond AX

Logged For: Ute Uranium, Inc.

Drill-hole No. UP - 14

Total depth 191'

Collar elev. T 5692 P

Area Slick Rock

COORDINATES

T North 119,673 East 120,008

F Tie 119,[illegible] 119,[illegible]

Claim Grass Flat

Date started Aug. 1954

Date completed Aug. 1954

Logged by A.M.S.

Summary of log: Favorable ; OBSS 147'-187' Thick 40' ; SS color Gy ; MS under OBSS R ; Cbn. A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	145.0					Overburden, MS
145.0	147.0	MS	Gn			
147.0	151.4	SS	Br			S, limonite specks
151.4	152.7	SS	DkGy	MF	A	Mineralized, sampled
152.7	155.0	SS	Gy	MF	S	" " " "
155.0	156.1	SS	Gy/Bk	F	A	" " " "
156.1	157.0	SS	Gy	F	S	" " " "
157.0	158.0	SS	Bk	MF	S	" " " "
158.0	160.5	SS	Gy	MF	A	" " " "
160.5	170.0	SS	LGy	MF	S	S, Gn. MS, seams
170.0	170.8	SS	Gy	F	A	mineralized, sampled
170.8	178.0	SS	LGy	MF	S	
178.0	180.0	SS	Gy	MF	A	
180.0	187.0	SS	LGy	MF	S	
187.0	191.0	MS	R			

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK.	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
152.7	1.3'	0.07	0.66		
155.0	2.3'	0.08	0.50		
156.1	1.1'	0.34	0.83		
157.0	0.9'	0.08	0.56		
158.0	1.0'	0.10	0.73		
160.5	2.5'	0.03	0.22		
170.8	0.8'	0.16	0.46		

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. UP - 14

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COLORADO PRINTING CO., GRAND JUNCTION

DRILL HOLE LOG

Logged For

Type of Drill

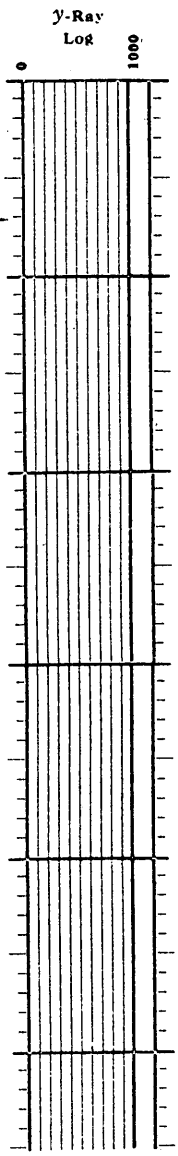
Drill-hole No. DV-4A
Total depth 201.5
Collar elev. T 5520.6 P
Area Slick Rock

COORDINATES
North 119776 East 121,531
Tie Sec.32, T44N, R18W
Co.State-San Miguel, Colo.

Claim
Date started
Date completed 4-30-54
Logged by NLA

Summary of log 1st ss unfavor, OBSS 75-86 Thick 11 ; SS color LGy ; MS GyGn ; Cbn. N
2nd ss-semifavorable 122-140 18 LGy under OBSS GyGn S
3rd ss-unfavorable 161-171 10 LGy GyGn N

DEPTH Base From	Thick To	Rock	Color	Grain	Carbon	REMARKS
75.0	75.0					Plug Bit
85.9	10.9	Ss	LGy	M	N	Very hard at base
122.0	36.1	Ms/St	RBr		N	Thin hard ss ribs up to 2' thick- locally sandy - mot GyGn
122.3	0.3	Ms	GyGn		N	
140.2	17.9	SS	LGy	F/MF	S	RBr Ms in ss 123.9-124.3- Very hard at top and base - 0.1' GyGn Ms Sm 123.8
142.2	2.0	Ms/St	GyGn		N	
160.7	8.5	Ms/St	RBr		N	Mot GyGn - thin hard ss ribs
170.7	10.0	Ss	LGy	VF/F	N	
171.0	0.3	St	GyGn		N	
201.5	30.5	Ms/St	RBr		N	Mot GyGn - locally sandy - Quartzite rib 0.5' thick near base



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-11

Total depth 340.0

Collar elev. T 5586.8 P

Area Slick Rock

COORDINATES

North 119,773 East 122,893

Tie Sec.33 T44N, R18W

Co.State- San Miguel, Colo.

Claim

Date started

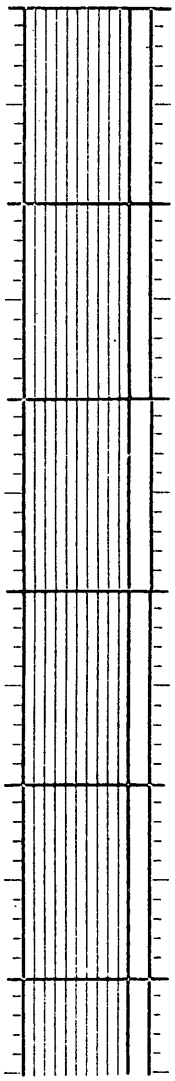
Date completed 5-5-54

Logged by NLA

Summary of log Favorable; OBSS 249-286 Thick 37; SS color LGy; MS under OBSS GyGn; Cbn. S

DEPTH Base	DEPTH Thick	DESCRIPTION Rock	Color	Grain	Carbon	REMARKS
180.0	180.0					Plug Bit
190.4	10.4	Ms/St	RBr		N	Mot GyGn- locally sandy
198.0	7.6	SS	LGy	F	N	Probably local rib in RBr Ms
200.6	2.6	Ms	RBr		N	
210.3	9.7	SS	LGy/R	F	N	Very muddy
216.8	6.5	Ms/St	RBr		N	Sandy- mot GyGn
234.1	17.3	SS	RBr/LGy	F/MF	N	RBrMs in top of unit grades to
						GyGn in lower portions
246.6	12.5	St	RBr		N	Mot GyGn- Thin SS ribs
249.0	2.4	Ms	GyGn		N	
286.3	37.3	SS	LGy	F/M	S	Cbn fM 276.2'
289.7	3.4	Ms	GyGn		N	
292.9	3.2	St	RBr		N	Mot GyGn
304.4	11.5	SS	LR/Lgy	F	S	Cbn in basal 2'
340.0	34.6	Ms/St	RBr		N	Thin SS ribs - mot GyGn
305.4	1.0	Ms	GyGn		S	Cbn in basal 0.2'

y-Ray Log



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
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Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

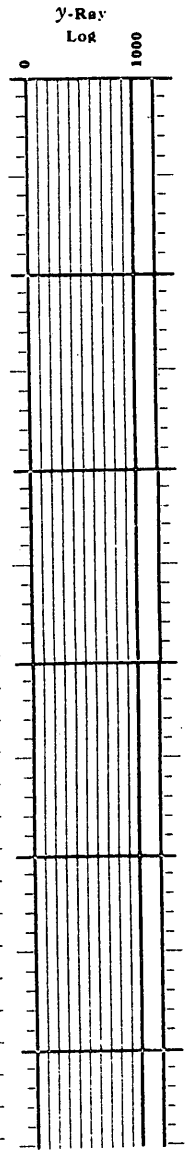
Drill-hole No. DV-12
Total depth 320.0
Collar elev. T 5663.4 P
Area Slick Rock

COORDINATES
North 118,888 East 122,115
Tie Sec. 32 T44N R18W
Co. State- San Miguel, Colo.

Claim Philura # 5
Date started
Date completed 5-7-54
Logged by NLA

Summary of log 1st ss Favor; OBSS 185-254 Thick 69; SS color LGy; MS under OBSS GyGn; Cbn S

DEPTH Base (Front)	DEPTH Thick (Tie)	Rock	Color	Grain	Carbon	REMARKS
180.0	180.0					Plug Bit
185.4	5.4	Ms/St	RBr		N	Mot GyGn Thin ss ribs
234.5	49.1	ss	LGy	MF	S	Cbn fm 229.0-230.4 MsSm confined
						to basal part
234.8	0.3	Ms	GyGn		N	
236.8	2.0	Ss	LGy	MF	A	Tightly cemented
254.0	12.2	Ss	LGy	F/MF	A	Cbn particles throughout
256.5	2.5	MS	GyGn		N	Silty
266.5	10.0	Ms/St	RBr		N	Mot GyGn
266.7	0.2	Ms	LGyGn		N	
271.4	4.7	Ss	LGy	F	N	GyGn Fm mot RBr
283.7	12.3	Ms/St	RBr		N	Mot GyGn- thin, hard ss ribs
301.2	17.5	Ss	LRBr	F	N	RBr Ms split 288.6'-289.2
302.4	1.2	St	RBr		N	
306.4	4.0	Ss	LRBr	F	N	
307.3	0.9	St	RBr		N	
316.0	8.7	SS	LR/LGy	MF	N	
332.0	16.0	Ms/St	RBr		N	Mot GyGn - thin ss ribs



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-15
Total depth 4435
Collar elev. T 5654.2 P
Area Slick Rock

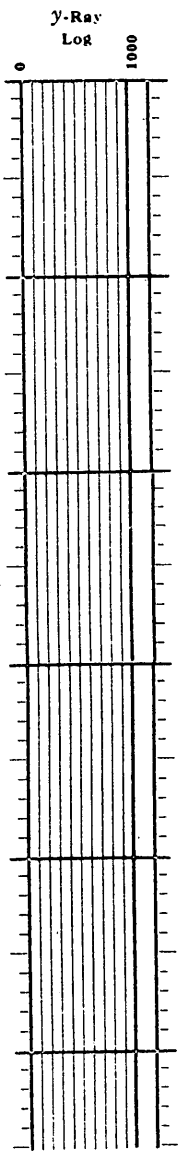
COORDINATES
North 118,505 East 123,047
Tie

Claim
Date started
Date completed 5-13-54
Logged by ELB

Co. San Miguel, Colorado

Summary of log Semi-fav; OBSS 291-347 Thick 55.1; SS color LGy; MS under OBSS Gn,E; Cbn S-A

DEPTH Base from	DEPTH Thick to	DESCRIPTION Rock	Color	Grain	Carbon	REMARKS
190.0	190.0	st/ms	r/GyGra		N	Plug Bit
225.8	35.1	st/MS	r/gyGn			Mottled BlGn Thick Calc SS ribs
235.1	9.2	ss	GnGy	F	N	Tight Calcareous
261.6	26.5	ms/st	r/rBr		N	Mottled BlGn,Thin sandy ribs
271.1	9.5	ss	rGy	F	N	R,MS Split; Calcite Cement
290.7	19.6	ms/st/ss	r/rGy	F	N	Mottled GyGn; SS Tight
291.4	0.7	ms	GyGn		N	
341.5	55.1	ss	LGy	F/M	S-A	MS R lower part-Calcareous
376.1	29.6	ms/st	RBr		N	Mottled GyGn, Sandy ribs
416.2	40.1	ss	Lr,rGy	F/M.F	N	Calcareous
443.5	27.3	MS/ST	R/RGy			Mottled GyGn; Sandy in part
						BBY Probed 4435, Barren



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV 16A
Total depth 312.0
Collar elev. T 5497.4 P
Area Slick Rock-

COORDINATES
North 117,276 East 124,725
Tie Sec.4,T43N,R18W
Co.State-San Miguel, Colorado

Claim
Date started
Date completed 5-20-54
Logged by WBG

Summary of log unfavorable OBSS 189-208 Thick 19 ; SS color Gy ; MS GN ; Cbn S
semi-favorable 216-258 42 LGy under OBSS GN A

DEPTH Base (From)	Thick (To)	Rock	Color	Grain	Carbon	REMARKS
75.0	75.0					Plug Bit - No Core
99.4	24.4	MS/ST	R/GN		N	QTZC ribs in places
126.0	27.5	SS/CG	R/WH	M/C		Basal 12' is CG
189.1	62.2	MS/St	R/GN		N	Thin QTZC ribs
207.7	18.6	SS	Gy	M-MF	S	S: LIM Stains
209.2	1.5	MS	GN		A	
215.4	6.2	MS	R		N	
215.7	0.3	MS	GN-GY		N	
257.8	42.1	SS	LGY	M-MF	A	GYGn Split 248.7 to 250.3, very carbonaceous
258.2	0.4	MS	GN-GY		N	
288.8	30.6	MS/ST	R/Gn		N	
309.1	20.3	SS	Br/LGy	M-MF	S	GnMs seams in Basal 5'
309.4	0.3	MS	GN		N	Mottled Red
312.0	2.6	MS	R		N	

y-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV - 3A
Total depth 434'
Collar elev. T P
Area Slick Rock

COORDINATES
North 116 369 East 126 630
Tie Sec 3 T43N R18W

Claim Philura No. 13
Date started
Date completed May 4, 1954
Logged by W. B. G.

Summary of log Favorable ; OBSS 311-374 Thick 63 ; SS color L Gy ; MS Gn under OBSS ; Cbn A

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	250.0					Plug
250.0	272.8	SS	L. Br	F/C	N	A Hematite - A Bk OP - A
						A R MS Pbl. (Acces. Minerals)
272.8	275.5	MS	Gy Gn		N	Mot. R
275.5	310.9	MS/ST	R		N	Mot. Gn
310.9	374.2	SS	Lt. Gy	M/MF	A	A Cbn Debris between 340.2 -
						342.6 A Bk OP - A Gn MS
						Pbl. Alt. Fld.
374.2	385.6	MS/ST	R/Gn		N	Mot. Gn
385.6	392.0	SS	R	F/VF	N	A Pyrite Stains
						A Bk OP (Acces. Minerals)
						S, F, Gy (MS in SS)
392.0	434.0	MS/ST	R/GyGn		N	

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
22.2					
23.1	0.9	0.010			
322.3					
323.2	0.9	0.014			

Logged between 3.8' - 434.0'

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-17
Total depth 289.3
Collar elev. T 5557.5 P
Area Slick Rock

COORDINATES
North 115,868 East 125,307
Tie Sec.4,T43N, R18W
Co.State-San Miguel,Colorado

Claim
Date started
Date completed 5-13-54
Logged by NLA

Summary of log Semifavorable; OBSS 2 Thick 29; SS color LGy/R; MS GyGn/RBr under OBSS; Cbn S
186-215

DEPTH Base From	DEPTH Thick To	Rock	Color	Grain	Carbon	REMARKS
150.0	150.0					Plug Bit
186.6	36.6	ST/Ms	RBr		N	Mot GyGn-Thin hard SS
						ribs-Ls rib 160.9-161.2
189.0	2.4	SS	LGy/LR	F	N	
189.3	0.3	ST	RBr		N	
190.1	0.8	SS	LGy	F	N	
190.3	0.2	MS	GyGn		N	
193.4	3.1	SS	LGy	F	N	Mot RBr
194.0	0.6	SS	RBr	F	N	cg/213.5-214.0 - Cbn 201.5 -
215.4	21.4	SS	RGy	F/MF	A	205.5 - Cbn + Bk;op in same zone
215.5	0.1	MS	GyGn		N	
236.4	20.9	MS/ST	RLr		N	Mot GyGn- Locally sandy
256.6	20.2	SS	LGy	C/MF	N	
289.3	32.7	MS/St	RBr		N	Mot GyGn - Thin, hard LGy
						RBr SS Ribs.

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
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R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

Page 1 of two pages

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-48
Total depth 358.0
Collar elev. T 5801.6 P
Area Slick Rock

COORDINATES
North 115,709 East 123,441
Tie T45N R18W

Claim Public Land
Date started
Date completed 7-30-54
Logged by GCS

Summary of log Favorable ; OBSS 51' 253-304 Thick 51' ; SS color Gy ; MS Gy .8' under OBSS ; Cbn. Trace

DEPTH Base	DEPTH Thick	Rock	Color	Grain	Carbon	REMARKS
171.5	171.5					Plug Bit no core
173.5	2.0	Ss	Gr	M		Calc. 3%, int Ms GnGy 173.4-173.6
174.1	0.8	Ls	Gr	Dense		
174.4	0.3	Cs	Gr			Calc. 2% int.
175.0	0.6	Cs	GnGy			Calc. 3%
178.2	3.2	St/ss/st	GnGy	MF		Calc. 2%, int.
187.5	4.3	Ss	GrGn	VF		
183.2	5.0	Cs	RBr			
188.7	1.2	Ms	GnGy			Ms, D R; 188.5'-188.7'
189.9	1.2	Ss	GyGn	F		Calc. 1%, int.
191.9	2.0	Ms	D R Br			Calc. 2%, int.
193.2	1.3	St	GyGn/RBr			Calc. 3% int.
196.3	3.1	Ms	BrR/GyGn			Calc. 2% int.
223.8	27.5	St/Ms	BrR			Calc.2% int.
226.1	2.3	Ss	GnGy	VF		Calc. 2% int
227.3	1.2	Ms	BrR			Ms,GyGn, spots 5%
228.8	1.5	Ss	Gy	VF		Calc. 1% int.
230.1	1.3	St	BrR			
231.4	1.3	Ss	Gy	VF		Calc. 1% int.
246.1	14.7	St/Ms	BrR			Calc.,Tr; int. MsGyGn, 2%
250.4	4.3	SS	GnGy/RBr	VF		Calc. 1% int. Ms; RBr 248.6-248.8
253.1	2.7	MS	BrR/GnGy			Calc. 2% int.
276.6	23.5	Ss	Gy	F		Alt. Feldspars; 1%
281.8	5.2	St/Ms	RBr/GnGy			Calc. Tr, int.
304.0	22.2	SS	Gy			Calc; Tr; int.
304.8	0.8	Cs/Ms	Gy			
306.2	1.4	Ss	Gy	VF		Calc; 2%, Int.
309.5	3.3	Ms/St	DGy			Calc. 2% int.
312.2	2.7	Ss	Gy	GF		Alt.Feldspar; 1%; Calc. 2%, int.
313.3	1.1	St/Ms/St	D Gy			Calc., 3%, int.
314.2	0.9	Ss	Gy	F		Calc., 3%, int.
315.9	1.7	Ss	D Gy	VF		Calc. 1%, int.
320.8	4.9	Cs/St	GnGy/GyR			Calc.Tr int

y-Ray Log 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
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Gy—gray	ST—siltstone
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Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For .....

Type of Drill .....

Drill-hole No. DV-48

Total depth .....

Collar elev. ..... T ..... P

Area .....

COORDINATES

North ..... East .....

Tie .....

Claim .....

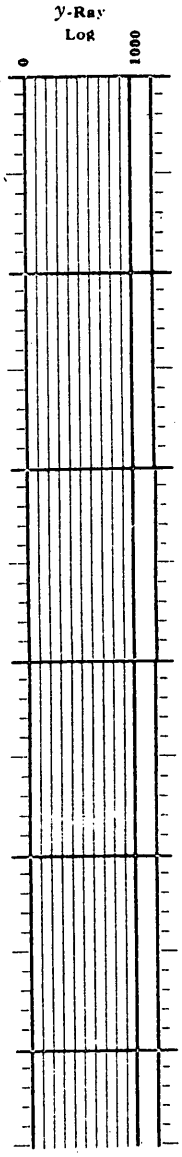
Date started .....

Date completed .....

Logged by .....

Summary of log ..... ; OBSS ..... Thick ..... ; SS color ..... ; MS under OBSS ..... ; Cbn .....

DEPTH Base	DEPTH Thick	DESCRIPTION Rock	Color	Grain	Carbon	REMARKS
327.3	6.5	Ss	LRGy	F		Calc. 2% int RGn, MS, 320.9-321.2'
340.4	13.1	Ms/St	GyGn/RBr			Calc.1% int.
357.0	16.6	Ss	GyR	F		Calc.1% int
358.0	1.0	Ms	BrR			Calc. 3%, int.



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. .....

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-18
Total depth 609.2
Collar elev. T 5820.6 P
Area Slick Rock

COORDINATES
North 114,579 East 123,892
Tie Sec.4, T43N R18W
Co.State-San Miguel,Colo.

Claim
Date started
Date completed 5-21-54
Logged by DRS

Summary of log Favorable; OBSS 207-280 Thick 73'; SS color LGy; MS Gn under OBSS; Cbn A

DEPTH Base	DEPTH Thick	Rock	Color	Grain	Carbon	REMARKS
80.0	80.0					Plug Bit, No Core
84.7	4.7	Ms/St	LBr/LGnGy		N	
98.3	13.6	Ss	VLBrGy	M/C	N	Ch granules at bottom
110.0	15.7	Ms/St	LGnGy/ RBr		N	GnGy predominates
126.2	12.2	Ss	VLBrGy	F/M/C	N	A cly ChP and granules in bottom .6' Cg at 121,125'
173.4	47.2	Ms/St	LGrGy/ RBr		N	GnGy above 142', some bleached St ribs in lower part
196.6	23.2	Ss	LBrGy/ LGy	VF/F	S	
206.2	9.6	Ms/St	RBr		N	
206.5	0.3	Ms/St	GnGy		N	
279.7	73.2	Ss	LGy	VF/F	S-A	.8',.4',.6' GnGy MS splits at 268.0',271.9',274.4' Calcite most A, 269.4'-279.7' MS most A, 268.0-279.7'. A pyrite with cbn 11' at Base
280.4	0.7	Ms	GnGy		N	
288.0	7.6	St/Ms	RBr		N	LGnGy at top
310.7	22.7	Ss	LRBr	F/M	N	Some St ribs with A RBR int Ms
315.5	4.8	Ms/St	RBr		N	Some mottled GnGy around St Nobs
373.1	7.6	Ss	LRBr	VF	N	LGy at base with A calcite GnGy MS
353.8	30.7	Ms/St	RBr/GnGy		N	RBr predominates,GnGycolor around st splits
373.3	19.5	Ss	LRBr/LGy	F/M	S	Ms GnGy near base
392.1	18.8	Ms/St	RBr		N	silty parts bleached GnGy
440.7	48.6	Ss	LRBr	F/M	S	422.4-424.0 RMS split
448.0	7.3	Ms/St	RBr		N	Gradational into ss below
474.4	26.4	Ss	RBr/LRBr	VF/M	N	Top 10' RBr, 3' RBrMS at 458'
480.0	5.6	Ms	RBr		N	Silty, GyGn near top, bottom
494.2	1922	Ss	LRBr/RBr	VF/M/F	N	
509.8	10.6	Ms/Ss/ St	RBr	VF/F	N	S mottled GnGy in MS

γ-Ray Log 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone

Hole No.

Page Two of Two

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-18
Total depth 609.2
Collar elev. T 5820.6 P
Area Slick Rock

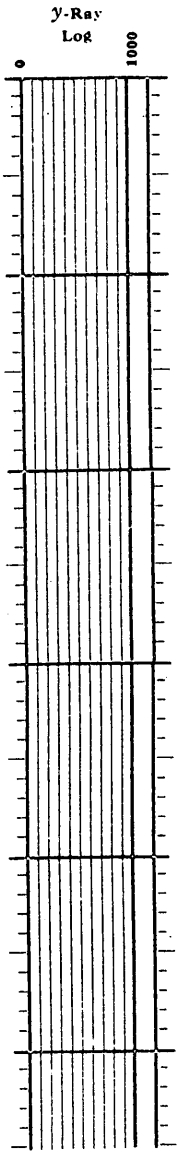
COORDINATES
North 114,579 East 123,892
Tie Sec. 4, T43N R18W
Co. State-San Miguel, Colo.

Claim Philura No. 14
Date started
Date completed 5-21-54
Logged by DRS

Summary of log Favorable; OBSS 207-280 Thick 73'; SS color LGy; MS under OBSS Gn; Cbn A

DEPTH Base (From)	Thick (To)	Rock	Color	Grain	Carbon	REMARKS
520.4	10.6	SS	LRBr	F	N	Dense
558.2	37.8	Ms/St/	RBr/LGyGn	VF	A	Cbn A at 538.0 in Gy MS
		Ss				S calcite in lower half
571.5	13.3	Ss	LBr/LRBr	M	N	Gradational into St below
609.2	37.7	St/Ms	RBr/LRBr		N	S mottled GnGy MS, St

DESCRIPTION



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-19
Total depth 337.5
Collar elev. 5700 T P
Area Slick Rock

COORDINATES
North 125,455 East 117,580
Tie Sec.4, T43N R 18W
Co.State-San Miguel,Colo.

Claim
Date started
Date completed 5-10-54
Logged by ELB

Summary of log Semifavorable; OBSS 235-300 Thick 65; SS color Br/BlGy LGy MS Gn under OBSS Gn; Cbn. N S

	DEPTH Base From	DEPTH Thick To	DESCRIPTION Rock	Color	Grain	Carbon	REMARKS
	140.0	140.0	SS/CG	Br/Gy/ BlGy	VC-M	N	Plug Bit
	154.0	14.0	SS/CG	BrGy/ BlGy	VC-M	N	CG Find; "Xmas Tree"
	187.6	33.6	Ms/St/	BlGn/R	F	N	R MS mottle BlGn Cont' F SS ribs
	196.8	9.2	Ss	BlGy	F	N	R/Gn Ms split 189.1
	235.4	38.6	Ms/St	R		N	Mottled GyGn; Thin Ss ribs
top -	254.6	19.2	Ss	LGy	F	N	
	255.0	0.4	Ms	Gn		N	
	276.2	21.2	St/Ss/	R/RGy	VF	N	Mottled BlGn
	300		Ms				
base - OBSS	300.2	24.0	SS	LGy	F	S	
	300.5	0.3	Ms	GyGn		N	
	307.9	7.4	Ms	R		N	
	312.5	4.6	MS	RGy	F	N	
	337.5	25.0	Ms/St	R		N	Mottled BlGn SS rib 323.5-325.1/

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill: Core By U.S.G.S.

Drill-hole No. DV-22
Total depth 310.0'
Collar elev. 5915' T. P
Area Slick Rock

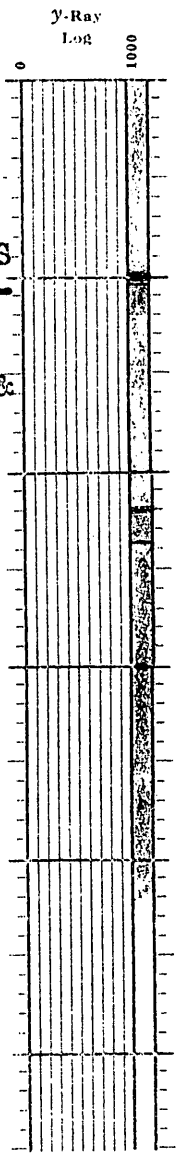
COORDINATES
North East
Tie Sec.4, T43N, R18W, NMPM

Claim Philura No. 22
Date started
Date completed 5-24-54
Logged by N.L.A.

Summary of log Semi-favorable OBSS 210-276' Thick 68'; SS color LGy; MS under OBSS Gy.Gn; Cbn. N

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	100.0					Plug bit
100.0	148.0	MS//ST	R.Br		N	Local, thin, hard Fgr, R-Gy SS ribs - Mot. Gy-Gn.
148.0	151.5	SS	LGy	MF	N	MS in SS; S, Gy. Int.
151.5	152.9	MS	RBr		N	
152.9	159.6	SS	LGy	MF	N	MS in SS; A, R.Br, Gy, Gn.MS
159.6	209.8	MS//ST	RBr		N	Thin, hard SS ribs; mot. Gy-Gn. sandy in basal part
209.8	210.1	ST	D.Gy		N	Sandy
210.1	217.6	SS	L.Gy	F/MF	N	Gradational contacts above & below. MS in SS; S, Gy-Gn. Fm; Int.
217.6	218.8	MS	Gy.Gn		N	
218.8	278.3	SS	L.Gy	F/M	N	MS in SS; A, Gy-Gn.Sm. Pb.
278.3	310.0	MS//ST	RBr		N	Mot. Gy-Gn - thin hard SS ribs

γ-Ray Log



SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. DV-22

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EXHIBIT No.1

COLORADO PRINTING CO., GRAND JUNCTION

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-23
Total depth 435.2
Collar elev. T 5550.8 P
Area Slick Rock

COORDINATES
North 115,387 East 128,199
Tie Sec.4 T43N R18W

Claim Philura No.
Date started
Date completed 5-28-54
Logged by ELB

Summary of log Semi Fav ; OBSS 380-400 Thick 19.7 ; SS color LGy ; MS under OBSS BlGn/GyGn ; Cbn. N

DEPTH Base	DEPTH Thick	DESCRIPTION Rock	Color	Grain	Carbon	REMARKS
300.0	300.0					Plug Bit
305.4	5.4	SS	RGy/GnGy	F	N	Tight
360.4	55.0	Ms/St	R		N	Mottled BlGn A, tight ss ribs
						(Fine,1.0'-2.0' thick)
366.8	6.4	Ss	LRGy	F		Mn Stained lower part
379.8	13.0	St/ss/	R/Gy	F	N	Mottled BlGn in part
		Ms				
379.9	0.1	MS	BlGn		N	
394.6	19.7	Ss	LGy	F/M	N	A; Gn Sm, Int.
401.1	0.5	Ms	GyGn		N	
435.2	34.1	Ms/St	R		N	Mottled GyGn A; F, Tight
						ss ribs up to 1.5' thick
						Barren

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone.

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-24
Total depth 470.0
Collar elev. 5765.0 T 5679.0 P
Area Slick Rock

COORDINATES
North 126,835 East 115,070
Tie Sec.4, T43N, R18W
Co.State-San Miguel, Colo.

Claim Philura No.19
Date started
Date completed 6-2-54
Logged by WBG

Summary of log ss.2 semifavor OBSS 387-415 Thick 28 ; SS color LGy ; MS Gn ; Cbn. A
ss.3 unfavorable 421-440 19 LGy under OBSS Gn S

	DEPTH Base	DEPTH Thick	DESCRIPTION Rock	Color	Grain	Carbon	REMARKS
	310.0	310.0					Plug Bit- No Core
	312.1	2.1	SS	WH	MF-F	N	Tightly cemented
	354.4	42.3	Ms/St	R		N	Tight R SS ribs
	355.2	0.8	St	Gy/Gn		N	
No.1	364.0	8.8	Ss	LGy	MF	S	
	366.7	2.7	Ms/St	R/GyGn		N	
	376.9	10.2	Ss	LGy	M/MF	N	
	377.3	0.4	St	GyGn		N	
	387.0	9.7	Ms/St	R		N	Mot Gn
No.2	415.0	28.0	SS	LGy	MF-F	A	
	421.3	6.3	Ms	R		N	
No.3	440.2	18.9	Ss	LGy		S	
	441.0	0.8	Ms	Gn		N	
	470.0	29.0	Ms/St	R			Mot Gn in places
							Barren Hole

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-25
Total depth 496.0
Collar elev. T 5821.5 P
Area Slick Rock

COORDINATES
North 113,531 East 127,018
Tie Sec.4 T43N R18W
Co.State-San Miguel,Colo.

Claim Philura No.27
Date started
Date completed 6-10-54
Logged by NLA

Summary of log Semifavorable; OBSS 332-456 Thick 124; SS color LGy; MS under OBSS LGyGn; Cbn S

DEPTH From	DEPTH To (Thick)	Rock	Color	Grain	Carbon	REMARKS
300.0	300.0					Plug Bit
303.7	3.7	St	LGyGn		N	
332.3	28.6	Ms/St/	RBr/GyGn		N	Mottled-thin, tight, sandy ribs
334.1	1.8	Ss	LRBr/LGy	MF	N	Mottled
360.7	26.6	Ss	LGy	F/MF	S	Cbn 357.2' to base of unit- charcoal nature
361.0	0.3	Ms	GyGn		N	Sandy
362.5	1.5	SS	LGy	F	S	
369.7	17.2	Ms/St	RBr		N	Sandy in basal 5', mottled GyGn
406.2	26.5	SS	LGy	F/MF	S	Cbn fm in basal 8'
406.5	0.3	St	GyGn		N	
410.0	3.5	Ss	LGy	VF	N	Hard
429.2	19.2	Ms/St	RBr		N	Thin, hard ss ribs, mot GyGn
431.6	2.4	Ss	LR	F	N	Tightly cemented
431.9	0.3	Ms	RBr		N	
456.0	24.1	Ss	LGy	F/MF	S	Locally hard + calcareous
457.1	1.1	St.	Gy		N	
496.0	38.9	Ss/ms/ St	RBr/LR		N	ss ribs up to 5' thick, F grained hard, LR

γ-Ray Log 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-26
Total depth 477.5
Collar elev. T 5756.1 P
Area Slick Rock

COORDINATES
North 113,223 East 127,990
Tie Sec.4, T43N, R18W
Co.State-San Miguel, Colo.

Claim Philura No.29
Date started
Date completed 6-7-54
Logged by NLA

Summary of log Unfavorable; OBSS 379-401 Thick 22; SS color LGy; MS GyGn; Cbn N
425-443 18 LR/LGy BBr under OBSS GyGn N

DEPTH Base From	Thick To	Rock	Color	Grain	Carbon	REMARKS
330.0	330.0					Plug Bit
337.6	7.6	SS	LGy	F-VF	N	
378.6	41.0	Ms/St/	RBr/GyGn	F-VF	N	
		Ss				
400.7	22.1	Ss	LGy	F	N	
401.0	0.3	Ms	LGyGn		N	
424.8	23.8	Ms/St/	RBr/Gy	F-VF	N	Grades into unit below
		Ss				
443.0	18.2	SS	LR/LGyBr	F-MF	N	LR in top 3' - A,Bk;op in top 3'
						locally tight
477.5	34.5	Ms/St/	RBr/LGy	F-VF	N	Tight Ss R; bs
		Ss				

γ-Ray Log 0 1000

SAMPLE BASE	THICK	LAB ASSAY (%) U_3O_8	V_2O_5	FIELD EST. (%) U_3O_8	V_2O_5

Abbreviations

Wh—white
Br—brown
R—red
Gy—gray
Bl—blue
Gn—green
Yw—yellow
Bk—black
Pp—purple
Cbn—carbon
OBSS—ore bearing sandstone
CG—conglomerate
SS—sandstone
MS—mudstone
ST—siltstone
F—fine
M—medium
C—coarse
N—none
S—sparse
A—abundant

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV-51
Total depth 278.0
Collar elev. T 5765.8 P
Area Slick Rock

COORDINATES
North 113,464 East 125,386
Tie Sec.4, T43N, R18W
Co.State- San Miguel,Colo.

Claim
Date started
Date completed 7-26-54
Logged by NLA

Summary of log Semifavorable; OBSS 151-253 Thick 102; SS color LGy; MS under OBSS GyGn; Cbn. S

DEPTH Base	DEPTH Thick	Rock	Color	Grain	Carbon	REMARKS
110.0	110.0					Plug Bit
151.1	41.1	Ms/St	RBr		N	Mot GyGn - Thin, Hard ss ribs
172.8	26.7	SS	LGy	F	N	Tightly cemented at top
173.0	0.2	Ms	GyGn		N	Silty
175.2	2.2	SS	LRBr-LGy	F	N	Tight
178.7	4.5	SS	LGy	F	N	Tightly cemented at top
180.3	0.6	St	RBr		N	Mot GyGn
184.0	3.7	Ms	RBr		N	Tight SS rib at top
187.3	3.3	St	GyGn		N	Sandy-Grades between above +
						below units
189.0	1.7	SS	DGy	MF	A	
196.0	7.0	SS	LBr	FMF	N	Very tight + hard at top
196.1	0.1	Ms	GyGn		N	
216.9	20.8	Ms/St	RBr		N	Locally sandy - mot GyGn
236.8	19.9	SS	LGy	F	VS	Locally LR in upper part - RBr;Ms;
						P in top part only
237.4	0.6	St	GyGn		N	
253.4	15.6	SS	LRBr/LGy	F/MF	N	Very muddy in top 6'
278.0	25.0	Ms/Ss	RBr-LR	F	N	SS ribs tightly cemented

y-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No.

DRILL HOLE LOG

Logged For

Type of Drill AX

Drill-hole No. DV 106
Total depth 424'
Collar elev. T 5971.4 P
Area Slick Rock

COORDINATES
North 111891 East 126625
Tie Sec 4 T43N R18W

Claim Philura No. 33
Date started
Date completed July 15, 1955
Logged by W.B.R. / N.L.A.

Summary of log Unfavorable ; OBSS 350-389 Thick 39 ; SS color LG/LR MS under OBSS R Br ; Cbn. N

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	230.0					Plug
	15.0	MS	R Br		N	Mot. Gy Gn
	35.0	MS	Gy Gn/R Br		N	
	40.0	MS	R Br		N	
	75.0	MS	Gy Gn		N	
	85.0	MS/SS	Gy Gn/L Gy	F	N	
	90.0	MS	Gy Gn		N	
	105.0	MS	R Br		N	Mot. Gy Gn
	135.0	SS	L Br	F	N	S Gy Gn MS in SS; S Lim
	145.0	MS/SS	GyGn/L Gy	F	N	S; Pyrite, Limonite, Barite
	165.0	SS	L Br	MF	N	S; Gy Gn MS
						S Lim, Bk OP (Acces. Minerals)
	185.0	MS	L Gy Gn		N	
	200.0	MS	Gy Gn		N	Limonitic Nodules 190-195
	220.0	MS/SS	LGy Gn	M	N	
	230.0	SS/MS	LGy/DGy	M	N	S Lim - End plug bit zone
						Begin coring at 230.0'
	245.5	MS	Gy Gn		S	Calc; A/S/A - Acces. Minerals
						Cbn. flakes in upper 1'
	246.5	ST	LR Br		N	A Calc; Gradational Contacts
	251.7	SS	L Gy	VF	N	Calc A/M/A; Med Int Gy Gn
						MS in SS S Bk OP
	253.4	MS	Gy Gn		N	Calc S/A; Sandy in lower half
						Local small Ls Nodules
	264.0	MS	R Br		N	Calc A/S; Thin tight SS Ribs
	274.9	SS	L Gy	F-M	N	Gy Gn ST Seams 269.1-269.7,
						272.6-272.8; 273.2-274.1
						A Calc in SS (Acces. Minerals)
						A Gy Gn Seams (MS in SS)
						S/A Calc. in MS
	290.7	Cgl.	L Gy	M-VC	N	M-A Calc; S Wh Gy Pbl MS in SS
						Alt. ch. Feld ? Pb

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
290.7					
291.3	0.6	e 0.029	0.1		

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

DRILL HOLE LOG

Logged For

Type of Drill: AX

Drill-hole No.: DV 106
Total depth: 424'
Collar elev.: T 5971.4 P
Area: Slick Rock

COORDINATES
North: 111891 East: 126625
Tie: Sec 4 T43N R18W

Claim: Philura No. 33
Date started:
Date completed: July 15, 1955
Logged by: W.B.R. / N.L.A.

Summary of log: Unfavorable ; OBSS 350.389 Thick 39 ; SS color LG/LR MS under OBSS R Br ; Cbn. N

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
	294.0	MS/SS	Gy Gn	F - VF	N	A Gy Gn Int MS in SS Calc
						A/S/A
	349.6	MS/ST	R Br		N	Locally Sandy - Mot. Gy Gn -LG;
						Ls 316.2 - 316.7 - Grad. Zone
						343.0 - 349.6
	369.3	SS	LGy/LR	VF-F	N	S; Ch Bk OP (Acces. Minerals)
						A/S/A Calc (Acces. Minerals)
						M; R Br; Sm Int (MS in SS)
						LR in top 1/2 only - Top SMS
	369.5	MS	Gy Gn		N	S Calc
	375.4	MS	R Br		N	M-A Calc.
	388.3	SS	L Gy	MF-M	N	M-A Calc; S Gy Gn P Fm
						(MS in SS)
	388.6	ST	Gy Gn		N	Tr; R Br; Mot.
	424.0	MS/ST	R Br		N	Mot. Gy Gn, Locally Sandy
						L Gy, SS rib 396.5-401.0

γ-Ray Log (0 – 1000)

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) eU3O8	LAB ASSAY (%) V2O5	FIELD EST. (%) U3O8	FIELD EST. (%) V2O5
272.9	1.2	0.019			
273.9	1.0	0.012			
280.8	2.7	0.005			
285.9	5.1	0.010			
290.0	0.9	0.037			

Abbreviations

Wh—white	CG—conglomerate
Br—brown	SS—sandstone
R—red	MS—mudstone
Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

(Page 1)
For Log

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV 107
Total depth 459'
Collar elev. 5853.4 T 5853.4 P
Area Slick Rock

COORDINATES
North 111867 East 128452
Tie
Sec. 9 T43N R18W

Claim Philura No. 36
Date started
Date completed July 19, 1955
Logged by W.B.R.

Summary of log Unfavorable; OBSS 322-391 Thick 69; SS color L Br; MS L Gy; Cbn N
L Gy under OBSS

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	215.0					Plug
	25.0	MS	R Br		N	10% Alt Gy Gn MS
	30.0	MS	R Br/GyGn		N	
	40.0	SS	Br	M	N	A Intbd. R Br MS
	50.0	MS	Gy Gn		N	
	65.0	MS	Gy Br		N	
	75.0	LS	D Gy		N	Silty
	85.0	MS/LS	Gy/R Br		N	
	90.0	MS	Gy Br			
	115.0	MS	GyGn/R Br		N	
	130.0	SS	Br	F	N	A Lim; 15% intbd R Br Gy MS
	145.0	MS	Gy;GyGn		N	Sandy
	155.0	SS	L Br	F	N	A int. MS
	175.0	SS	L Gy	MF	N	S Dop; S Barite; A int Gy R Br MS
	185.0	SS/MS	Gy/GyGn	M	N	
	215.0	MS	Gy, GyGn		N	5% R Br MS
						End Plug Zone
	236.4	MS	LGn/GyGn		S	T Pyrite; Locally very sandy
	254.8	ST/SS/MS				
			GyGn/Br	VF, F	T	S Biot
	264.0	SS	L Gy	F	N	Cg Locally; S Barite; 5-10% L Gy MS
	278.1	SS	L Gy	MC	M	Cg; M Barite
	283.3	MS/ST/SS				
			Gy Gn	VF	N	25% Int Gy Gn MS
	308.0	SS	L Gy	MC	S	Cg; A P int Gy Gn MS
	312.9	ST/MS	LGnGy		N	
	321.8	MS/ST/SS				
			R Br	VF	N	A int R Br MS Partially Alt.
	338.0	SS	LBrLGy	F	N	8% int L Gy MS
	340.3	MS/SS	R Br	VF	N	60% R Br int MS Alt at Top
	347.3	SS	L Gy	VF	N	10% int L Gy MS; S Dop; M ch

γ-Ray Log: 0 — 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) ~~XXXX~~ $CaCO_3$	FIELD EST. (%) V_2O_5
269.7					
271.4	1.7	0.087	0.1	4.83	
273.0	1.6	0.071	0.1	3.75	
274.5	1.5	e0.029	0.12		
276.2	1.7	0.085	0.21	3.45	
276.6					
277.8	1.2	0.044	0.1	9.45	
283.6					
284.2	0.6	e0.028	0.1		
303.0- 303.3	0.3	e0.028	0.1		
308.0- 308.3	0.3	0.083	0.1	7.50	

Abbreviations

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Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV 107
Total depth 459'
Collar elev. 5853.4 T 5853.4 P
Area Slick Rock

COORDINATES
North 111867 East 128452
Tie
Sec 9 T43N R18W

Claim Philura No. 36
Date started
Date completed July 19, 1955
Logged by W.B.R.

Summary of log Unfavorable ; OBSS 322-391 Thick 69 ; SS color L Br ; MS L Gy ; Cbn N
L Gy under OBSS

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
~~36~~	365.2	MS/ST	R Br		N	
	366.5	MS	Gy Gn		N	Sandy
	391.2	SS	L Br	F	T	0.4' MS split 379.8; 10% int
						SM Lt Gy MS
	402.0	MS/SS	R Br	VF	T	30% int R Br MS; S Dop in SS
	409.5	SS	LBr/LGy	VF-F	T	15% int SM LGy MS
	412.8	MS/SS	R Br	VF	N	25% int R Br MS
	418.6	SS	LR Br	F	N	20% int. SM L Gy MS
	419.8	MS	R Br		N	Sandy
	425.6	SS	L Gy	VF	T	10% int L Gy MS
	432.3	SS/MS	D Gy	VF	VA	A int SM MS
	441.7	SS	L Gy	F	T	A Gy Gn MS; SM, P in lower .5'
	451.5	MS	R Br		N	
	459.0	SS	R Br	F	N	25% R Br MS; M Dop

y-Ray Log
0 — 1000

Gamma Log

Base	Thick	eU3O8
219.2	0.8	0.005
252.9	1.2	0.010
253.8	0.9	0.011
264.5	3.3	0.005
266.6	2.1	0.011
270.0	3.4	0.018
270.8	0.8	0.076
271.4	0.6	0.062
274.4	3.0	0.016
275.3	0.9	0.090
276.5	1.2	0.030
277.6	1.1	0.049
278.5	0.9	0.015
283.6	1.1	0.024
286.0	0.7	0.010

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) eU3O8	LAB ASSAY (%) V2O5	FIELD EST. (%) U3O8	FIELD EST. (%) V2O5
290.2	0.8	0.011			
291.3	1.1	0.010			
294.0	0.8	0.014			
296.1	1.2	0.010			
299.1	3.0	0.010			
300.5	1.4	0.010			
301.5	1.0	0.010			
302.3	0.8	0.022			
304.3	2.0	0.010			
306.5	2.2	0.010			
307.2	0.7	0.072			
308.9	1.7	0.005			

Abbreviations

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Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant

OBSS—ore bearing sandstone

DRILL HOLE LOG

Logged For

Type of Drill

Drill-hole No. DV 108
Total depth 524'
Collar elev. T 5708.7 P
Area

COORDINATES
North 111952 East 129978
Tie
Sec 10, T43N, R18W

Claim Philura No. 38
Date started
Date completed July 27, 1955
Logged by W.B.R/ B.R.S.

Summary of log Semi-Favorable ; OBSS 323-397 Thick 74' ; SS color L Gy ; MS under OBSS GnGyRBr Cbn. S - M

DEPTH From	DEPTH To	Rock	Color	Grain	Carbon	REMARKS
0.0	175.0	MS/SS/ ST/MS				Plug Bit - Has detailed logging on U.S.G.S. log.
175.0	236.8	SS/ST/ MS	L Gn Gy	SF - M	N	A int Gy Gn MS; in places dense some C.S. Layers MS predominate; S. R Carbonate 203; Top 3.4'; SS; S R Br bottom 20'
	294.7	SS	L GyGn	F/M	S	A int Gn Gy MS
	299.8	ST/MS	LGnGy		N	A sand in ST; A $CaCO_3$
	322.2	SS/ST/ MS	LGyGn/ RBr/LGy	SS F-M	N	VA $CaCO_3$
	322.5	MS	LGnGy		N	
	337.3	SS	L Gy	VF-M	S	A int Wh, Gn, Gy; Mod. Gn Gy seams p near base
	338.1	MS/LS/ SS	LGnGy	SS F	N	MS, LS P int in F SS
	347.3	MS/ST	R Br		N	S Mot. GnGy; Mod. L S P
	363.0	SS	L Gy	VF-F	S	Gradational to ST above VA Gn Gy MS P SM int
	367.6	MS/ST	RBrGnGy		N	
	397.0	SS	L Gy	VF-F	M	SA int SM P Gn Gy MS
	398.1	MS	RBrGnGy		N	
	415.5	SS	LR Br			
			Ly Br	VF-F	N	A int R Br MS
	441.8	MS/ST/ SS	R Br Gn Gy	SS F	N	A int R, Gn, MS
	444.2	CS	LGnGy		N	Ground up; S R Br
	470.3	SS	L R Br	F	N	A int R Br MS
	473.0	MS	R Br		N	
	474.5	SS	L Y Br	F	N	A Bk OP
	476.5	MS	R Br		N	
	497.1	SS	LRBr/ LGyBr	F	N	A int SM R Br MS; LGy lower 5'
	524.0	MS/ST	RBrGnGy		N	L Gn Gy LS 519-520

γ-Ray Log 0 1000

SAMPLE BASE	SAMPLE THICK	LAB ASSAY (%) U_3O_8	LAB ASSAY (%) V_2O_5	FIELD EST. (%) U_3O_8	FIELD EST. (%) V_2O_5
	Barren				

Abbreviations

Wh—white	CG—conglomerate
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Gy—gray	ST—siltstone
Bl—blue	F—fine
Gn—green	M—medium
Yw—yellow	C—coarse
Bk—black	N—none
Pp—purple	S—sparse
Cbn—carbon	A—abundant
OBSS—ore bearing sandstone	

Hole No. DV 108

Summary of drilling by U.S. Geological Survey

No.	Total Depth	Thickness-OBSS	TD and Elev. Base of OBSS		Salt Wash - Mineralization
DV-4A	202	18	171	5350	Mineralized
11	340	57	286	5301	.34-.03, .3'-.02
12	332	69	254	5409	N
15	444	55	347	5307	N
16A	312	42	258	5239	N
3A	434	63	374	5126	.9'-.01, .9'-.014
17	289	29	215	5343	N
48	358	51	304	5498	N
18	609	73	280	5541	N
19	338	24	300	5410	N
22	310	68	276	5639	N
23	435	20	400	5151	N
24	470	28	440	5325	N
25	496	124	456	5365	N
26	478	40	443	5313	N
51	278	102	253	5513	N
106	424	39	389	5582	N
107	459	69	391	5462	N
108	524	74	397	5312	N

AVERY & JOHNSTON DRILLING CO.
633 24-Road
Grand Junction, Colorado

December 6, 1957

Raymond C. Robeck
Hilary Minerals Corp.
535 Orchard Ave.
Grand Junction, Colo.

Dear Mr. Robeck:

Thank you for giving us the opportunity to bid on your proposed drilling operations in the Slick Rock Mining District, San Miguel County, Colorado. Our bid is:

Plug bit drilling:

0 to 200' at $1.50 Per Ft.
200' to 400' at $1.80 " "
400' to 550' at $2.15 " "

Coring:

0 to 200' at $3.50 Per Ft.
200' to 400' at $4.75 " "
400 to 550 at $5.25 " "

Sincerely,

(Ralph Avery) (signed)

AVERY & JOHNSTON DRILLING CO.

Dec.16,195[illegible]
Grand Jut. Colo

Dear Sir:

In reply of your letter requesting bids on Hilary Minerals Corp. in the Slick Rock Mining Area we submit the following bid.

Depth	Plug	Core
0.00-200 ft.	$2.35	$3.35
200-400 Ft.	$2.60	$4.20
400-500 ft.	$3.25	$5.00

We will drill Bx core and request permission to reduce to Ax in case of trouble with hole. $12.50 per hour standby for probing holes, waiting for drill sites, There will be a charge of $500.00 for move in time, if the drilling exceeds 3000 ft. this will be returned.

This bid may be raised or lowered upon inspection of the property.

Thank you

(signed)

Louis Ausmus
V + A Drilling Corp.
2837 N. Ave.
Grand Junction, Colo

December 10, 1957

Mr. Raymond C. Robeck
Hilary Minerals Corporation
535 Orchard Avenue
Grand Junction, Colorado

Dear Sir:

In reply to your letter dated December 2, 1957, please accept the following quotations as our preliminary bid for your D.M.E.A. loan proposal for a minimum total fottage of 16,000 feet to a maximum depth per hole of 500 feet on your Philura group of claims in Sections 32 and 33, Township 44 North, Range 18 West, and in Sections 4 and 9, Township 43 North, Range 18 West, taking a minimum of 70 feet of BX core per hole:

	Price per Foot	
Depth	Plug Bit	Core
0-100 Feet	$ 2.50	$ 3.25
100-200 feet	2.75	3.75
200-300 feet	3.00	4.50
300-400 feet	3.50	5.25
400-500 feet	4.00	6.00

Standby time would be charged at the rate of $15 per hour. You would be expected to construct the drill sites and do any road work necessary to the drill sites.

We would plan on plugging size 3-7/8" to 4-1/4" and core BX size and would plan on an estimated 75 feet of plug bit drilling and 50 feet of core per shift per drill and would run two drills.

Very truly yours,

MINERALS ENGINEERING COMPANY

(Signed) Edson Foster
Drill Superintendent

EF/k

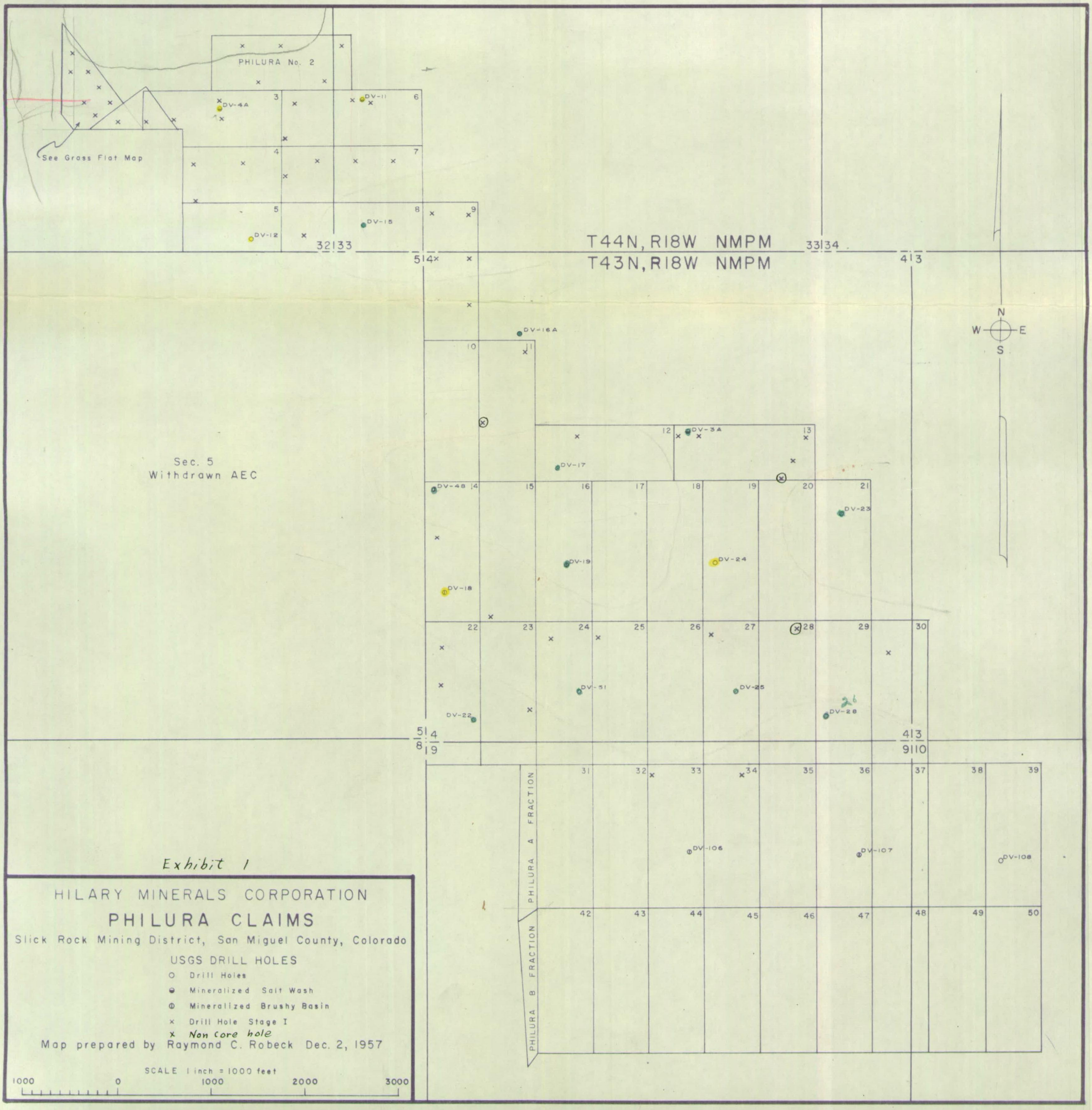


Exhibit 1

HILARY MINERALS CORPORATION

PHILURA CLAIMS

Slick Rock Mining District, San Miguel County, Colorado

USGS DRILL HOLES

- ○ Drill Holes
- ◒ Mineralized Salt Wash
- ⦶ Mineralized Brushy Basin
- × Drill Hole Stage I
- x Non core hole

Map prepared by Raymond C. Robeck Dec. 2, 1957

SCALE 1 inch = 1000 feet

1000 0 1000 2000 3000

Exhibit 1

MAP C

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

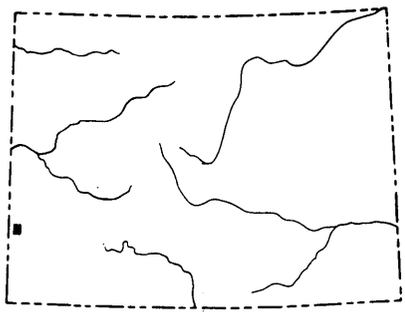
Hilary

Exhibits 1, 3, 5.

GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

GEOLOGY OF THE HORSE RANGE MESA QUADRANGLE COLORADO

By
Fred W. Cater, Jr.

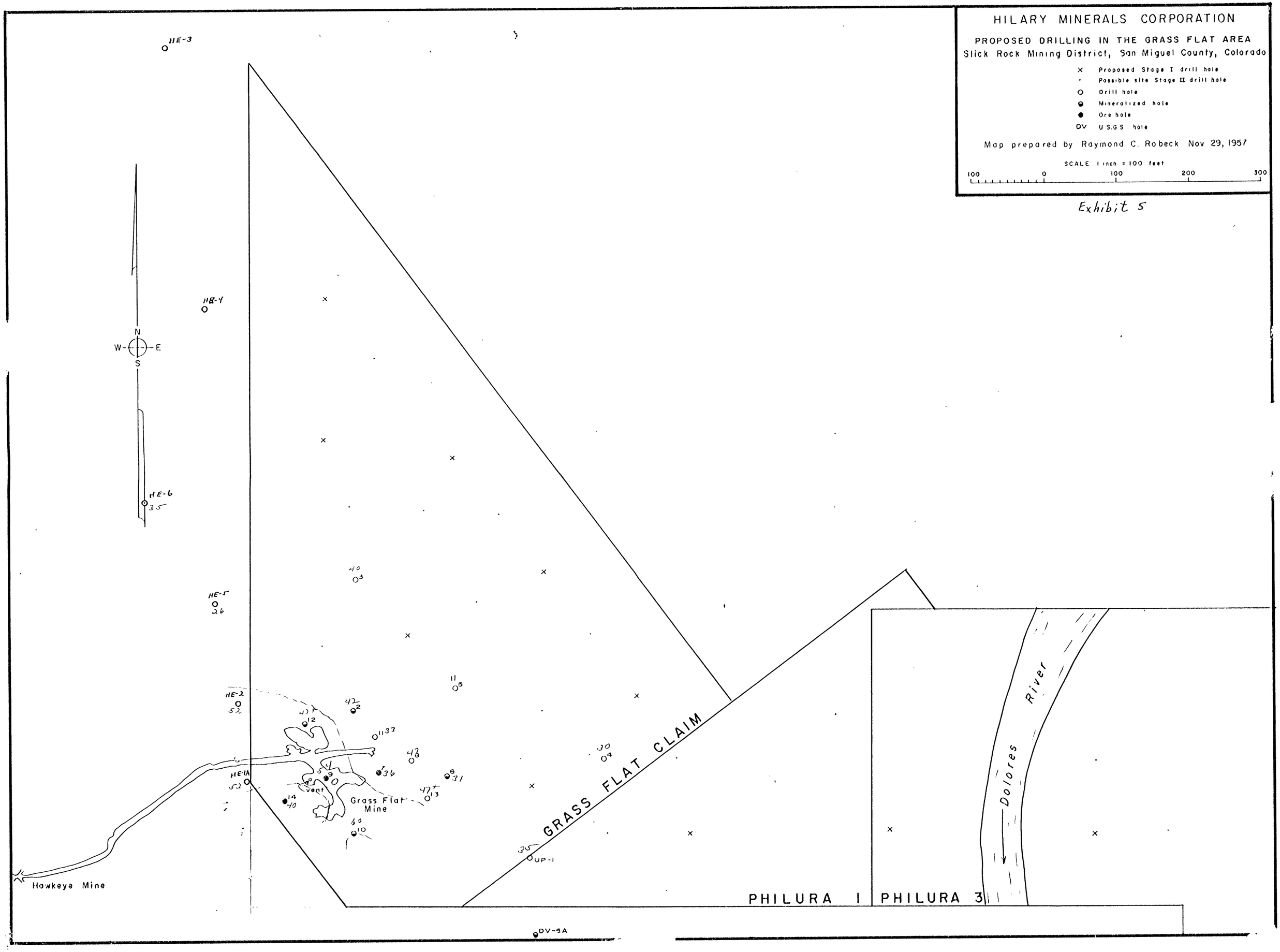


INDEX MAP OF COLORADO

PUBLISHED BY THE U. S. GEOLOGICAL SURVEY
WASHINGTON, D. C.
1955

The series of Ge gic Quadrangle Maps of the United States continues the series of quadrangle maps begun wit . Geologi Atlas of the United States, which were published from 1894 to 1945. The present series consists of geologic maps, suppleme possible by structure sections, columnar sections, and other graphic means of presenting geologic data, and accompanied by a brief explanatory ake the maps useful for general scientific and economic purposes. Full description and interpretation of the geology of the areas shown on t ps are reserved for publication in other channels, such as the Bulletins and Professional Papers of the Geological Survey. Separate maps of th areas, covering bedrock, surficial, engineering, and other phases of geology, may be published in the geologic quadrangle map s. Each edition is issued in flat form, 25 x 30 inches, and folded, 9¼ x 11¾ inches.

These maps may be obtained from the U. S. Geological Survey,) , as listed in "Publications of t Geological Survey." Prepayment is required and may b or the U. S. Geological Survey, or in cas exact amount—at sender's risk. Posta tac should specify whether flat or folded desired.


HILARY MINERALS CORPORATION
PROPOSED DRILLING IN THE GRASS FLAT AREA
Slick Rock Mining District, San Miguel County, Colorado
Proposed Stage I drill hole
Possible site Stage II drill hole
Drill hole
Mineralized hole
Ore hole
DV U.S.G.S hole
Map prepared by Raymond C. Robeck Nov 29, 1957
SCALE 1 inch = 100 feet
100 0 100 200 300
Exhibit 5
HE-3
HE-4
HE-6
HE-5
HE-2
HE-1A
UP-1
DV-5A
N
W
E
S
Vent
Grass Flat Mine
Hawkeye Mine
GRASS FLAT CLAIM
PHILURA 1
PHILURA 3
Dolores River

Hilary — Slick Rock
Philura
Exhibit 3

GEOLOGY OF THE HORSE RANGE MESA QUADRANGLE, COLORADO

By
Fred W. Cater, Jr.

INTRODUCTION

The U. S. Geological Survey mapped the geology of the Horse Range Mesa quadrangle, Colo., as part of a comprehensive study of carnotite deposits. The study, covering the principal carnotite-producing area in southwestern Colorado, included detailed examination of mines and geologic mapping of eighteen 7½-minute quadrangles, of which the Horse Range Mesa quadrangle (fig. 1) is one. Parts of the text accompanying these maps have been standardized; these parts comprise some descriptions of geologic formations and general descriptions of regional structural setting, geologic history, and ore deposits. A comprehensive report presenting in greater detail the geologic features of the entire area and interpretations of these features is in preparation. Work was started in the area in 1939 with the cooperation of The Colorado State Geological Survey Board and the Colorado Metal Mining Fund Board and continued through 1945 as a wartime strategic-minerals project. Since 1947 the Geological Survey has been continuing this geologic study on behalf of the Division of Raw Materials of the Atomic Energy Commission. The Horse Range Mesa quadrangle was mapped in 1945, and some revisions were made in 1949.

The Horse Range Mesa quadrangle covers about 59 square miles in San Miguel County, Colo., and lies in the Canyon Lands division of the Colorado Plateau physiographic province. The quadrangle is a rugged area of mesas and canyons. Total relief within the quadrangle is about 2,205 feet; altitudes range from about 5,360 feet in the canyon of the Dolores River to 7,565 feet on Summit Point. The Dolores River and its tributaries drain the area.

No accurate information on rainfall is available, but the annual precipitation is probably between 10 and 15 inches; the area is semiarid and supports a moderate growth of juniper and piñon on rocky terrain and abundant sagebrush where soils are thick. Cactus and sparse grass are widely distributed. The south half of the quadrangle is accessible over a system of dry-weather roads and State Highway 80, but the north half is accessible only by horseback or by foot.

REGIONAL GEOLOGY

Rocks exposed in the 18 quadrangles mapped consist of crystalline pre-Cambrian rocks and sedimentary rocks that range from late Paleozoic to Quaternary. Crystalline rocks crop out only in the northeastern part of the area along the flanks of the Uncompahgre Plateau; the rest of the area is underlain by sedimentary rocks. The latest Paleozoic and earliest Mesozoic units wedge out northeastward against the crystalline pre-Cambrian rocks, but later Mesozoic units were deposited on top of the pre-Cambrian rocks. Over most of the region the sedimentary beds are flat lying, but in places they are disrupted by high-angle faults or are folded into northwest-trending monoclines, shallow synclines, and strongly developed anticlines. The largest of the folds is the Uncompahgre Plateau uplift, a fold nearly 100 miles long that traverses the northeastern part of the area (fig. 1). Well-developed anticlines having intrusive cores of salt and gypsum underlie Sinbad Valley, Paradox Valley, and Gypsum Valley in the central part of the area; the Dolores anticline in the southwestern part of the area probably has a salt-gypsum core, although it is not exposed (fig. 1).

The Horse Range Mesa quadrangle lies in the southern part of the 18-quadrangle area between the Gypsum Valley anticline on the northeast and the Dolores anticline on the southwest.

STRATIGRAPHY

The oldest rocks exposed in the Horse Range Mesa quadrangle are the Upper Triassic rocks that crop out in Summit Canyon. Jurassic rocks crop out in the canyon walls and on the benches and slopes below the mesas; the Jurassic rocks are exposed in more than three-quarters of the total area of the quadrangle. Cretaceous rocks cap the mesas. Recent deposits of windblown material and sheet wash are widely distributed on top of the mesas and along the benches, and considerable alluvium has been deposited along the Dolores River.

The stratigraphic sequence is similar to that studied by Baker (1933) and Dane (1935) in nearby areas in Utah; most of the formations can be traced continuously from the Horse Range Mesa quadrangle into Utah.

CHINLE FORMATION

The Upper Triassic Chinle formation consists of red to orange-red siltstone, with interbedded red fine-grained sandstone, shale, and limestone-pebble and clay-pellet conglomerate. These lithologic units are lenticular and discontinuous. The lower part of the formation contains numerous lenses of a distinctive limestone-pebble and clay-pellet conglomerate; in places the lowermost lenses contain quartz pebbles or consist of a relatively clean quartz grit. These quartz-bearing lenses are probably the stratigraphic equivalent of the Shinarump conglomerate, which is widely distributed in eastern Utah and northern Arizona. Much of the Chinle formation consists of indistinctly bedded red siltstone that breaks into angular fragments. Evenly bedded shale is rare. The sandstone layers differ in bedding characteristics; some layers are massive, whereas others are crossbedded, and still others are conspicuously ripple bedded. Almost everywhere the formation crops out as a steep slope broken in places by more resistant ledges of sandstone and conglomerate.

The base of the Chinle formation is not exposed in the Horse Range Mesa quadrangle. The formation, as projected from adjoining quadrangles, probably ranges from 475 feet to 525 feet in thickness.

GLEN CANYON GROUP

The Glen Canyon group, of Jurassic(?) age, comprises, in ascending order, the Wingate sandstone, the Kayenta formation, and the Navajo sandstone.

Wingate sandstone.—The Wingate sandstone conformably overlies the Chinle formation. The sandstone is a massive, fine-grained rock composed of clean, well-sorted quartz sand. It typically crops out as an impressive red or dark-brown wall, stained and streaked in places with a surficial red and black desert varnish. Vertical joints cut the sandstone from top to bottom; the spalling of vertically jointed slabs largely causes the recession of the cliff. The sandstone is divided into horizontal layers by extensive bedding planes spaced 2 to 50 feet apart. Within each horizontal layer the sandstone is crossbedded on a magnificent scale; great sweeping tangential crossbeds of eolian type, in places extending across the entire thickness of the horizontal layer, are disposed in all directions. The sandstone is rather poorly cemented and crumbles easily; this quality probably accounts for the readiness with which the rock disintegrates in faulted areas.

In the Horse Range Mesa quadrangle the Wingate sandstone is about 275 feet thick.

Kayenta formation.—The Kayenta formation conformably overlies the Wingate sandstone; the contact between the two formations is gradational in most places. The formation is notable for its variety of rock types. Sandstone, red, buff, gray, and lavender in color, is the most abundant type; but the formation also contains considerable quantities of red siltstone, thin-bedded shale, and conglomerate. The conglomerate contains pebbles of sandstone, shale, and limestone. The sandstone is composed of rounded to subrounded quartz grains and minor quantities of mica, feldspar, and dark minerals. Most of the sandstone is thin bedded, crossbedded in part, and flaggy; some is massive. Individual sandstone beds are lenticular and discontinuous and interfinger with shale and, in places, with conglomerate. The Kayenta typically crops out in a series of benches and ledges. The ledges in many places overhang recesses where softer beds have eroded back. The lower part of the formation is more firmly cemented and forms resistant, thick ledges that protect the underlying Wingate sandstone from erosion.

The Kayenta formation in the Horse Range Mesa quadrangle ranges in thickness from 180 to 210 feet. Abrupt local changes in thickness of 10 to 20 feet are common. The irregular bedding, channel filling, and range of thickness all indicate a fluvial origin.

Navajo sandstone.—The Navajo sandstone conformably overlies the Kayenta formation. The Navajo is a gray to buff massive fine-grained clean quartz sandstone. Tangential crossbeds of tremendous size leave little doubt of the eolian origin of the sandstone. The sandstone weathers by disintegration; it tends to develop rounded topographic forms where exposed on slopes or benches and vertical cliffs where protected by overlying rocks.

The thickness of the Navajo sandstone in the Horse Range Mesa quadrangle ranges within wide limits; in McIntyre Canyon an incomplete section nearly 300 feet thick is exposed, whereas in Summit Canyon a complete section is only about 50 feet thick.

Carmel formation and Entrada sandstone.—The Carmel formation consists largely of red to buff, nonresistant, horizontally bedded siltstone, mudstone, and sandstone. In most localities the basal beds consist of reworked Navajo sandstone. Pebbles and angular fragments of white and gray chert, as much as an inch in diameter, are scattered rather abundantly through the lower part of the formation and less abundantly through the upper part. These chert pebbles and angular fragments are sufficiently abundant locally to form layers of conglomerate. In many places the upper part of the formation contains scattered barite nodules as much as an inch in diameter.

The Carmel formation ranges from 20 feet to 50 feet in thickness in the Horse Range Mesa quadrangle. This range appears to be due chiefly to deposition on an irregular, eroded surface of Navajo sandstone. No definite evidence indicates that the Carmel formation of this area is of marine origin as is the Carmel of central Utah, but the probabilities are that the Carmel of southwestern Colorado was deposited in shallow water marginal to a sea.

The Carmel formation grades upward, in most places without prominent breaks, into the Entrada sandstone. The Entrada sandstone, known locally as the "slick rim" because of its appearance, is perhaps the most picturesque of all the formations in the plateau region of Colorado. The smoothly rounded, in places bulging, orange, buff, and white cliffs formed by this sandstone are a distinctive and scenic feature of the region. Horizontal rows of pits resulting from differential weathering and ranging from a few inches to a foot or more across are characteristic of these cliffs. The Entrada consists of alternating horizontally bedded units and sweeping, eolian-type crossbedded units. The horizontally bedded units are most common in the basal part and in the uppermost, lighter colored part of the Entrada, whereas the crossbedded units are dominant in the middle part. The Entrada sandstone differs from the somewhat similar Wingate sandstone and Navajo sandstone by the sorting of sand into two distinct grain sizes. Subrounded to subangular quartz grains mostly less than 0.15 mm in diameter make up the bulk of the sandstone. The sandstone also contains larger grains, which are well rounded, have frosted surfaces, and range from 0.4 to 0.8 mm in diameter; most of these grains are quartz, but grains of chert are scattered among them. Most of the larger grains are distributed in thin layers along bedding planes.

The Entrada sandstone is 75 to 150 feet thick in the Horse Range Mesa quadrangle.

Summerville formation.—The Summerville formation generally crops out as a steep, debris-covered slope, with very few good exposures. Where exposed the Summerville exhibits a remarkably even, thin, horizontal bedding. Beds are predominantly red of various shades, although some beds are green, brown, light yellow, or nearly white. Sandy and silty shales are the most abundant kinds of rock, but all gradations from claystone to clean, fine-grained sandstone are interbedded with them. Well-rounded amber-colored quartz grains with frosted or matte surfaces are disseminated throughout most of the formation, including beds consisting almost entirely of claystone. Thin beds of authigenic red and green chert are widespread. A thin discontinuous bed of dark-gray dense fresh-water limestone occurs in the upper part of the formation. Sandstone beds are thicker and sandstone is more abundant in the lower part of the formation than in the upper part. Commonly the sandstone beds are ripple marked, and in places they show small-scale low-angle crossbedding.

The Summerville formation rests conformably on the Entrada sandstone, and, although a sharp lithologic change marks the contact, no cessation of deposition separated the two formations. The upper contact of the Summerville is uneven and channeled, and the channels are filled by the overlying basal sandstone beds of the Morrison formation. Locally, however, the contact is difficult to determine, because the overlying beds of shale and mudstone of the Morrison formation are similar to beds of the Summerville.

The Summerville formation in the Horse Range Mesa quadrangle ranges in thickness from 70 feet to 195 feet.

MORRISON FORMATION

The Morrison formation of Late Jurassic age is of special interest economically because of the uranium- and vanadium-bearing deposits it contains. The formation comprises two members in this area; the lower is the Salt Wash sandstone member, and the upper is the Brushy Basin shale member. In the Horse Range Mesa quadrangle the Morrison formation ranges in thickness from 625 to 775 feet. The Salt Wash sandstone member and the Brushy Basin shale member in general are of approximately equal thickness. In some areas, however, their thicknesses vary independently, whereas in other areas a thinning in one member is accompanied by a thickening in the other.

Salt Wash sandstone member.—The Salt Wash sandstone member ordinarily crops out above the slope-forming Summerville formation as a series of thick, resistant ledges and benches. Sandstone predominates and ranges in color from nearly white to gray, light buff, and rusty red. Interbedded with the sandstone are red shale and mudstone and locally a few thin lenses of dense gray limestone. Sandstone commonly occurs as strata traceable as ledges for considerable distances along the outcrop, but within each stratum individual beds are lenticular and discontinuous; beds wedge out laterally, and other beds occupying essentially the same stratigraphic position wedge in. Thus, any relatively continuous sandstone stratum ordinarily consists of numerous interfingering lenses, with superposed lenses in many places filling channels carved in underlying beds. Lenses are separated in places by mudstone and contain mudstone seams. Most of the sandstone is fine to medium fine grained, crossbedded, and massive; single beds or lenses may attain a maximum thickness of 120 feet. Ripple marks, current lineations, rill marks, and cut-and-fill structures indicate that the Salt Wash was deposited under fluvial conditions.

The sandstone consists largely of subangular to subrounded quartz grains; but orthoclase, microcline, and albite grains occur in combined amounts of 10 to 15 percent. Chert and heavy-mineral grains are accessory. Considerable quantities of interstitial clay and numerous clay pellets occur in places, especially near the base of some of the sandstone lenses. Fossil wood, carbonaceous matter, and saurian bones occur locally.

The Salt Wash sandstone member ranges from 28 to 370 feet in thickness. Local changes in thickness of as much as 30 feet are common.

Brushy Basin shale member.—The Brushy Basin shale member contrasts strongly in overall appearance with the underlying Salt Wash sandstone member. Although the lithologic differences are marked, the contact between the two members is gradational. The mapped contact, taken as the base of the lowermost layer of conglomerate lenses, is arbitrary in many respects and probably does not mark an identical stratigraphic horizon in all localities.

The Brushy Basin shale member consists predominantly of varicolored bentonitic shale and mudstone, with intercalated beds and lenses of conglomerate and sandstone, and a few thin layers of limestone. Because of its high proportion of soft, easily eroded bentonitic shale and mudstone, the Brushy Basin member forms smooth slopes covered with blocks and boulders weathered from the more resistant layers of the member and from the overlying formations. The shale and mudstone are thin bedded and range in color from pure white to pastel tints of red, blue, and green. Exposed surfaces of the rock are covered with a loose, fluffy layer of material several inches thick, caused by the swelling of the bentonitic material during periods of wet weather. Scattered through the shale and mudstone are thin beds of fine-grained hard silicified rock that breaks with a conchoidal fracture. The silica impregnating these beds may have been released during the devitrification of volcanic debris in adjacent beds. Beds of chert-pebble conglomerate a few inches to 25 feet thick occur at intervals throughout the member. These conglomerate beds are commonly dark rusty red and form conspicuous resistant ledges. Silicified saurian bones and wood are much more abundant in the Brushy Basin shale member than in the Salt Wash sandstone member, especially in some of the conglomerate beds.

The Brushy Basin shale member, like the Salt Wash sandstone member, undoubtedly was deposited under fluvial conditions. The conglomerate and sandstone lenses mark stream channels that crossed flood plains on which were deposited the fine-grained sediments now represented by the mudstone and shale.

The Brushy Basin shale member ranges from 330 to 425 feet in thickness in the Horse Range Mesa quadrangle; local variations in thickness of 20 to 30 feet are common throughout the quadrangle.

BURRO CANYON FORMATION

The name Burro Canyon formation was proposed by Stokes and Phoenix (1948) for the heterogeneous sequence of Lower Cretaceous conglomerate, sandstone, shale, and thin lenses of limestone that overlies the Morrison formation. The Burro Canyon characteristically crops out as a cliff or a series of thick, resistant ledges. The bulk of the formation consists of white, gray, and red sandstone and conglomerate that form beds up to 100 feet thick. These beds are massive, irregular, and lenticular. Crossbedding and festoon bedding are prevalent throughout the formation. The sandstone is poorly sorted and consists of quartz and lesser amounts of chert. The conglomerate consists largely of chert pebbles, but intermixed are pebbles of quartz, silicified limestone, quartzite, sandstone, and shale. In places the beds are highly silicified. A considerable part of the formation consists of bright-green mudstone and shale, and locally these predominate over the sandstone and conglomerate. Thin, discontinuous beds of dense gray limestone crop out in a few scattered localities. The formation was undoubtedly deposited under fluvial conditions. The lower contact is indistinct in many places and the formation appears to interfinger with the upper part of the Brushy Basin shale member; elsewhere local erosion surfaces intervene and the contact is sharp. The upper contact is an erosion surface of regional extent.

The Burro Canyon formation in the Horse Range Mesa quadrangle ranges from 90 to 230 feet in thickness; in general the formation thins toward the southwest corner of the quadrangle. Abrupt local variations in thickness of 10 to 30 feet are common.

DAKOTA SANDSTONE

The Dakota sandstone, of Early and Late Cretaceous age, consists principally of gray, yellow, and buff flaggy sandstone; less abundant are conglomerate, carbonaceous shale, and impure coal. Some of the sandstone is fine grained and thin bedded, but much of it is coarse grained and crossbedded. Scattered through the sandstone are irregular, discontinuous beds and lenses of conglomerate containing chert and quartz pebbles as much as 2 inches across. Interfingering with the sandstone beds are thin-bedded gray and black carbonaceous shales and thin coal seams and beds. Plant impressions abound in both the sandstone and the shale.

The Dakota sandstone crops out in this quadrangle as the capping beds on the mesa back of Summit Point and on Horse Range Mesa.

The entire thickness of the Dakota sandstone is not exposed in the quadrangle; the upper beds have been stripped off by erosion; but the beds that remain attain a thickness of about 50 feet.

QUATERNARY DEPOSITS

The deposits of Quaternary age consist of terrace gravel, wind-deposited material, alluvium, talus, and landslides. Extensive deposits of light-red sandy and silty material mantle the benches and mesa tops. This material appears to be mostly wind deposited, although much of it has been reworked by water and intermixed with sheet wash. These deposits have not been mapped where they are unusually spotty, discontinuous, or less than a foot thick; the greatest observed thickness in some dry washes on mesa tops is about 10 feet. Gravel and alluvium occur along the Dolores River. Considerable talus covers many of the steeper slopes. Because these various deposits, except for the terrace gravel, are difficult to differentiate in places, they have not been separated on the geologic map. Large landslides, consisting mostly of debris of the Brushy Basin, cover considerable areas in the north half of the quadrangle.

STRUCTURE

REGIONAL SETTING

Many geologic structures on the Colorado Plateau are so large that a 7½-minute quadrangle covers only a small part of any complete structural unit. The larger structural units consist of salt anticlines, 25 to 65 miles long (fig. 1); uplifted blocks, 50 to 125 miles long, bounded by monoclinal folds; and domical uplifts, 8 to 20 miles across, around stocklike and laccolithic intrusions.

The salt anticlines trend northwest and lie in a group between eastward-dipping monoclines on the west side of the Plateau and westward-dipping monoclines on the east side of the Plateau. The cores of these anticlines consist of relatively plastic salt and gypsum, derived from the Paradox member of the Pennsylvanian Hermosa formation and intruded into overlying late Paleozoic and early Mesozoic rocks. All the anticlines are structurally similar in many respects, but each exhibits structural peculiarities not common to the rest; furthermore, all are more complex than their seemingly simple forms would suggest. Faults, grabens, and collapse and slump structures alter the forms of the anticlines. Erosion has removed much of the axial parts of these anticlines, leaving exposed large intrusive masses of the Paradox member and forming valleys such as Sinbad Valley, Paradox Valley, and Gypsum Valley in Colorado and similar valleys in Utah. Alternating with these anticlines are broad, shallow, simple synclines.

STRUCTURE IN HORSE RANGE MESA QUADRANGLE

Parts of three large structural features extend across the Horse Range Mesa quadrangle; these are the southwest flank of the Gypsum Valley salt anticline, the Disappointment syncline, and the Dolores anticline. The crest of the Gypsum Valley salt anticline has collapsed, owing to the removal of much salt by solution and flowage. The southwest edge of this collapsed area is marked by the faults and the relatively sharp narrow anticline and syncline at the northeast end of Steamboat Hill. From the edge of this collapsed area the beds dip southwestward to the trough of the Disappointment syncline, a broad, shallow downwarp that plunges southeast and flattens out to the northwest. The Dolores anticline is an asymmetrical northwest-plunging fold. The northeast limb of this anticline dips much more steeply than does the southwest limb. The anticline probably has an intrusive core of salt as does the Gypsum Valley anticline, but unlike the Gypsum Valley anticline this core is nowhere exposed. Two systems of faults cut the northeast flank of the anticline, an east-trending system in the vicinity of Horse Range Mesa and a northwest-trending system in the area between Summit Canyon and Bush Canyon. A set of transverse northeast-trending faults cut the rocks in the vicinity of Cape Horn.

STRUCTURAL HISTORY

In order to understand the structural history of the Horse Range Mesa quadrangle, it is necessary to understand the structural history of the adjoining part of southwestern Colorado. Parts of this history are still in doubt, because no clear record remains of some events; the record of other events, although legible, is subject to different interpretations. All the events described in the following discussion affected the Horse Range Mesa quadrangle either directly or indirectly, although the evidence for some of them is not visible within the boundaries of the quadrangle.

Weak compressive forces, which probably began in early Pennsylvanian times, gently warped the region. This warping gave rise to the ancestral Uncompahgre highland, an element of the ancestral Rocky Mountains, and to the basin in which the Paradox member of the Hermosa formation of Pennsylvanian age was deposited. These major structural features controlled the pattern and the prevailing northwest-trending grain of the smaller structures later superimposed on them. The boundary between the highland and the basin, which is closely followed by the southwest margin of the present-day Uncompahgre Plateau, was a steep northwest-trending front, possibly a fault scarp, along which were deposited arkosic fanglomerates during late Pennsylvanian and Permian time. The older fanglomerates interfinger with Pennsylvanian marine sedimentary rocks of the Hermosa formation. The bulk of the fanglomerates probably is of Permian age and belongs to the Cutler formation. Intrusion of salt from the Paradox member, probably initiated by gentle regional deformation, began sometime during deposition of the Permian Cutler formation. Isostatic rise of salt ruptured the overlying Hermosa and Cutler formations, and at the end of Cutler deposition salt broke through to the surface. From then until flowage ceased, late in the Jurassic period, the elongate salt intrusions such as those in Paradox Valley and Gypsum Valley stood as actual topographic highs at one place or another along their lengths. The rate of upwelling of additional salt, perhaps accelerated by the increase of the static load of sediments accumulating in the surrounding areas, balanced or slightly exceeded the rate of removal of salt by solution and erosion at the surface. Consequently, all the Mesozoic formations below the Morrison formation wedge out against the flanks of the salt intrusions. Salt flowage was not everywhere continuous or at a uniform rate; rather, in many places it progressed spasmodically. Local surges of comparatively rapid intrusion gave rise to cupolas at different times and in different places along the salt masses. At the beginning of deposition of the Morrison, sediments finally covered the salt intrusions, perhaps because the supply of salt underlying the areas between the intrusions was exhausted. Relative quiescence prevailed throughout the remainder of the Mesozoic and probably through the early part of the Tertiary.

The second major period of deformation occurred in the Tertiary—probably during the Eocene (Hunt, written communication), but the date cannot be determined accurately. The region of the salt intrusions was compressed into a series of broad folds, guided and localized by the preexisting salt intrusions. Although salt flowage was renewed, it seems unlikely that any considerable amount of new salt was forced into the intrusions; flowage probably consisted largely of redistribution of the salt already present. By the end of this period of deformation these folds had attained approximately their present structural form, except for modifications imposed by later collapse of the anticlines overlying the salt intrusions. Owing to the mobility of the rocks in the cores of the anticlines, normal faulting took place along the crests of the anticlines, probably during relaxation of compressive stresses after folding ceased. At this time the crests of the anticlines in places were dropped, as grabens, several hundred to a few thousand feet. A period of crustal quiescence followed, during which the highlands overlying the anticlines and domes were reduced by erosion and topographic relief became low throughout the area.

During the middle Tertiary the entire Colorado Plateau was uplifted. This uplift rejuvenated the streams and increased ground-water circulation. The crests of the anticlines were breached, and the underlying salt was exposed to rapid solution and removal. With the abstraction of salt, renewed collapse of the anticlines began. Although much of the collapse was due directly to removal of salt by solution, it seems unlikely that all the collapse can be attributed to this process, as was believed by earlier workers in the area. Rather, much of the collapse apparently was caused by flowage of salt from the parts of the anticlines still overlain by thick layers of sediments to the parts from which the overlying sediments had been removed. Once the crests of the anticlines had been breached, the relatively plastic salt offered little support for the beds overlying the Paradox member of the Hermosa formation in the flanks of the anticlines; consequently these essentially unsupported beds slumped, probably along fractures and joints formed during earlier flexures. Small faults and folds in Quaternary deposits may indicate that collapse and local readjustments are still continuing.

MINERAL DEPOSITS

The only commercially important mineral deposits in the Horse Range Mesa quadrangle are those that contain uranium, vanadium, and radium. Although deposits containing these metals were discovered in 1899 near Roc Creek, about 22 miles north of the Horse Range Mesa quadrangle, intensive mining of these ores did not begin in the Colorado Plateau region until 1911. Thereafter the ores were mined primarily for their radium content until 1923, when the Belgian Congo pitchblende deposits began to supply radium. The mines were mostly idle from 1923 until 1937, but since 1937 they again have been exploited intensively, first for vanadium and in more recent years for both vanadium and uranium.

Most of the deposits are restricted to the upper layer of sandstone lenses in the Salt Wash sandstone member of the Morrison formation, but within this layer the deposits have a spotty distribution. Ore bodies range from small irregular masses containing only a few tons of ore to large tabular masses containing several thousands of tons; but most ore bodies are relatively small and contain only a few hundred tons. The ore consists mainly of sandstone impregnated with uranium- and vanadium-bearing minerals.

MINERALOGY

The most common ore minerals are carnotite and a fine-grained, vanadium-bearing micaceous mineral. Carnotite [$K_2(UO_2)_2(VO_4)_2\cdot 3H_2O$] is a yellow, fine-grained, earthy or powdery material. Tyuyamunite [$Ca(UO_2)_2(VO_4)_2\cdot nH_2O$], the calcium analogue of carnotite, is also present and is nearly indistinguishable from carnotite. The micaceous vanadium mineral, which formerly was thought to be roscoelite, is now considered to be related to the nontronite or montmorillonite group of clay minerals. It forms aggregates of minute flakes coating or partly replacing sand grains and filling pore spaces in the sandstone. It colors the rock gray. Other vanadium ore minerals present are montroseite [$nFeO\cdot nV_2O_4\cdot nV_2O_3\cdot nH_2O$], corvusite [$V_2O_4\cdot 6V_2O_5\cdot nH_2O$], and hewettite [$CaO\cdot 3V_2O_5\cdot 9H_2O$]. Corvusite and montroseite occur together, forming compact masses of bluish-black ore, whereas hewettite commonly forms stringers and veinlets along joints and fractures. Recent deeper drilling and mining in the Plateau have indicated that below the zone of oxidation black oxides of uranium and vanadium, accompanied by pyrite and perhaps other sulfides, are more abundant, and uranyl vanadates are scarce or absent.

ORE BODIES

The ore consists mostly of sandstone selectively impregnated and in part replaced by uranium and vanadium minerals; but rich concentrations of carnotite and the micaceous vanadium clay mineral are also associated with thin mudstone partings, beds of mudstone pebbles, and carbonized fossil plant material. Many fossil logs replaced by nearly pure carnotite have been found. In general the ore minerals were deposited in irregular layers that roughly followed the sandstone beds. In most deposits the highest-grade concentrations of ore minerals occur in sharply bounded, elongate concretionary structures, called "rolls" by the miners. These rolls are encompassed by rich, veinlike concentrations of the micaceous vanadium-bearing clay mineral that curve across bedding planes. Within these rolls this mineral generally is distributed as diffusion layers, the richer layers commonly lying nearer the margins of the rolls; the distribution of carnotite in the rolls is less systematic. Margins of ore bodies may be vaguely or sharply defined. Vaguely defined margins may have mineralized sandstone extending well beyond the limits of commercial ore; on the other hand, sharply defined margins, such as occur along the surfaces of rolls, ordinarily mark the limits of both the mineralized sandstone and the commercial ore.

Although many rolls are small and irregular, the larger rolls are elongate and may extend with little change of direction for more than 100 feet. The elongate rolls in an ore body or group of ore bodies in a given area generally have a common orientation. This orientation is roughly parallel to the elongation of the ore bodies.

ORIGIN OF ORE

The origin of the uranium-vanadium ores in the Morrison formation is uncertain. In some respects the deposits are unique, and much of the evidence concerning the genesis of the ore is either not conclusive or appears to be contradictory. In this brief account only a small amount of evidence can be presented and the hypothesis can only be summarized.

Most of the deposits are closely associated with certain sedimentary features. Layers of ore lie essentially parallel to the bedding; most of the deposits occur in the thicker parts and commonly near the base of the sandstone lenses; the trend of the long direction of the deposits and the trend of the ore rolls in the sandstone are roughly parallel to the trend of the fossil logs in the sandstone and to the average or resultant dip of the cross-bedding in the sandstone. These relations strongly suggest that primary structures in the sediments were instrumental in localizing most of the ore deposits.

Recent investigations have revealed new data bearing on the origin of the ores (Waters and Granger, 1953). Below the zone of oxidation some of the ore consists chiefly of oxides, such as pitchblende and low-valent oxides of vanadium, and small quantities of sulfides such as pyrite, bornite, galena, and chalcopyrite; fully oxidized and fully hydrated minerals are either rare or nonexistent. A hard variety of uraninite, previously reported only from hydrothermal deposits, has been found in the Gray Daun mine in San Juan County, Utah (Rasor, 1952), and in the Happy Jack mine in White Canyon, Utah. Studies of lead-uranium ratios in ores from the Colorado Plateau indicate that, regardless of where or in what formation found, all the ores are of roughly the same age, and this age is no older than latest Cretaceous (Stieff and Stern, 1952). Some geologists believe that field relations in pre-Morrison formations at White Canyon (Benson et al., 1952) and Temple Mountain in Utah indicate that the deposits may be genetically related to faults and fractures. At the Rajah mine near Roc Creek, in Colorado, ore occurs along a fault and horsetails out into the wall rock.

Two main hypotheses have arisen to explain the origin of the ores. The oldest and probably the most widely held is the hypothesis that the ores are penesyngenetic and were formed soon after the enclosing rocks were deposited (Coffin, 1921; Hess, 1933; Fischer, 1937, 1942, 1950; and Fischer and Hilpert, 1952). Later movements of ground water may have dissolved and reprecipitated the ore constituents, but the essential materials were already present in the host rocks or in the waters permeating them. Although this hypothesis offers a reasonable explanation for the relation of ores to sedimentary features, it faces some difficulty in explaining: (1) the discrepancy between the age of the uranium and the age of the enclosing rock; (2) the broad stratigraphic distribution of uranium occurrences and association of ores with fractures in a few localities; and (3) the hydrothermal aspect of the mineral suites in some ores. The second hypothesis, and the one the author favors, is essentially a telethermal hypothesis and assumes the ore to have originated from a hypogene source. Proponents of this hypothesis believe that ore-bearing solutions originated at depth from an igneous source and ascended along fractures. After these solutions mingled with circulating ground waters the minerals precipitated in favorable beds as much as several miles from fractures. This hypothesis explains more readily the difficulties inherent in the penesyngenetic hypothesis, but it poses two other difficulties: (1) the hypothetical location of igneous source rocks, and (2) the difficulty of proving the connection between fractures and faults and the ore deposits. A third hypothesis, advanced by some geologists, suggests that the source of the ore metals was the volcanic material in the beds overlying the ore-bearing sandstones and that these metals were subsequently leached and redeposited in the beds that now contain the ore. This hypothesis encounters not only most of the difficulties in the penesyngenetic hypothesis but it presents some additional ones of its own.

SUGGESTIONS FOR PROSPECTING

Regardless of the origin of the deposits, certain habits of the deposits—habits that have been recognized through geologic mapping and exploration experience—are useful as guides for finding ore (Weir, 1952). In southwestern Colorado most of the deposits are in the uppermost sandstone stratum in the Salt Wash sandstone member of the Morrison formation. Generally the central or thicker parts of the sandstone lenses are more favorable—many deposits are in sandstone that is 40 feet or more thick; few deposits are in sandstone less than 20 feet thick. Cross-bedded, relatively coarse grained sandstone is more favorable than thinly or evenly bedded, fine-grained sandstone. Light yellow-brown sandstone speckled with limonite stain is more favorable than red or reddish-brown sandstone. Sandstone that contains considerable amounts of gray, altered mudstone or is underlain by a considerable thickness of this rock, is more favorable than sandstone containing and underlain by red, unaltered mudstone—this guide is perhaps the most useful in diamond-drill exploration. If the deposits have a hypogene origin then localities where favorable host rocks are near or coextensive with areas of more intense deformation may be especially favorable for finding ore.

The southern part of the Horse Range Mesa quadrangle is the most likely area for finding ore because of the presence of favorable rocks. Although many of the mines are 2 or 3 miles from known faults, the presence of considerable faulting and fracturing in the general area may have some bearing on the unusual concentration of deposits in this part of the quadrangle.

THE MINES

By A. L. Bush, Henry Bell III, and C. F. Withington

Most of the deposits in the Horse Range Mesa quadrangle are in lenticular sandstone beds in the upper part of the Salt Wash sandstone member of the Morrison formation. Generally the deposits are in sandstone beds 30 to 60 feet thick. However, the deposits in a belt along the Dolores River in the southeastern part of the quadrangle are in sandstone beds 60 to 90 feet thick.

Radium group of mines.—The major deposits of the Radium group of mines, the Radium Nos. 2, 5, 6, 7, and 8 mines, have been collectively the most productive mines in the quadrangle. The Radium No. 7 mine has yielded ore measurable in tens of thousands of tons, almost twice as much as from the next largest mine.

The ore minerals, carnotite and a micaceous vanadium clay mineral, mainly impregnate the sandstone. In places fossil plant remains and mudstone pebbles in the ore are richly mineralized. Small amounts of copper are present in and near the ore, mostly as stains of the carbonates azurite and malachite; subordinately as copper-uranium and copper-vanadium minerals disseminated in the sandstone. Copper sulfide (chalcocite) nodules, about half an inch across, are also present but are rare.

The ore deposits are irregularly tabular layers that in general parallel the bedding of the sandstone but in places cut across it. Most of the deposits are rudely oval in plan, ranging in size from a few tens of feet to several hundreds of feet across. The largest deposit (at the Radium No. 7 mine) is about 800 feet long by 400 feet wide. Ore bodies within the deposits consist both of rolls, with well-defined limits, and of more gradual thickenings of the tabular layers, with less well-defined or poorly defined limits. The ore bodies are commonly podlike or crescent-shaped masses that are several feet across and range from 10 to 100 feet or more in length. A little less than half of the total production probably has come from rolls.

In addition to these deposits in the Salt Wash sandstone member, two small deposits in a conglomeratic lens near the base of the Brushy Basin shale member have been mined. The ore in these deposits is patchy and of lower grade than in the deposits in the Salt Wash.

Lower group of mines.—The Lower group of mines is the second most productive in the Horse Range Mesa quadrangle. The largest deposit in this group has been mined for a distance of 1,200 feet and is essentially continuous along the outcrop for a distance of 2,000 feet. The deposit ranges in thickness from a few inches to several feet. Associated with the micaceous vanadium clay mineral and carnotite are copper carbonate stains, some disseminated copper-vanadium and copper-uranium minerals and, less commonly, nodules of copper sulfide (chalcocite). The copper-silver selenide (eucairite) has been found in small veinlets and in nodules associated with chalcocite.

The deposits in this group are typical of deposits in which rolls are well developed. The deposit consists of an essentially continuous layer of rather low-grade disseminated ore in which are well-developed rolls with sharply defined margins. These rolls may be as much as 200 feet long and 5 to 40 feet wide and are oriented in a predominantly southeast direction. Most of the production has come from these rolls, although rich concentrations of carnotite have been found in fossil logs. These fossil logs have an orientation similar to the orientation of the rolls, to the average dip direction of crossbedding, and to the long dimensions of the ore deposits.

Charles T. mines.—Production from the Charles T. mines ranks third in importance within the quadrangle. Carnotite and the micaceous vanadium clay mineral are the common ore minerals. In their most common association the ore minerals impregnate the sandstone. Many mudstone seams, pebbles, and galls, in or adjacent to the ore deposits, have a high vanadium content. Fossil logs and other carbonaceous material are richly mineralized. The ore deposits are irregularly tabular layers, rudely oval in plan. Overlapping tabular layers, generally parallel to the bedding of the sandstone, are separated by a few inches to several feet of barren sandstone. Most of the ore bodies are rolls; the largest roll is 200 feet or more long, 10 to 25 feet wide, and up to 17 feet thick. The rolls commonly are sinuous in plan, generally with a northerly or northeasterly trend. As much as 70 percent of the total ore production probably has come from rolls. The remainder has come from less well-defined masses of ore.

Georgeto and Veta Mad.—These mines are in the belt along the Dolores River where the upper sandstone beds of the Salt Wash sandstone member are 60 to 90 feet thick. The mines are in ore deposits near the middle of these thick beds. The ore minerals, carnotite and the micaceous vanadium clay mineral, are in the common associations, impregnating sandstone and replacing fossil carbonaceous material. Small amounts of gypsum are present with the replaced fossil logs. In addition, small amounts of copper are present as copper sulfide (chalcocite) nodules surrounded by a halo of copper carbonates (azurite and malachite). A few of these nodules also contain small amounts of a copper-silver selenide (eucairite).

The ore deposits are rudely oval, irregularly tabular layers. Most ore bodies consist of thickenings of the ore layer, with well-defined undulant upper and lower limits. Some rolls and a few richly mineralized fossil logs are present. Two ore layers have been productive at each mine; where these ore layers overlap they are separated by 5 to 20 feet of barren sandstone.

Upper group of mines.—The Upper group of mines lies in the top sandstone bed of the Salt Wash sandstone member. The ore consists mostly of small rolls connected by thin tabular bodies of mineralized material. They range from a few tons to a few hundred tons each. One trend of the rolls ranges from east to slightly south of east. Carbonaceous material in the form of trash and fossil logs is present. The ore consists of carnotite and the micaceous vanadium-bearing mineral. A few small pods of high-grade material have also been found.

Other mines and prospects.—Several other small mines and prospects are present in the southern half of the quadrangle. All of them are in the upper part of the Salt Wash sandstone member. They include the Middle group mines, the Ned group mines, and the Ellison mine. The ore minerals and associations are similar to those in the other mines in the quadrangle. Nearly all the deposits are small tabular layers containing rolls; most of the mining has been of these small rolls.

In the extreme northeast corner of the quadrangle there are a few small mines and prospects. All these lie in the upper part of the Salt Wash sandstone member in blocks downfaulted into Gypsum Valley. The deposits are small tabular bodies that trend northwest. The ore minerals are typical of those of the other mines in the quadrangle.

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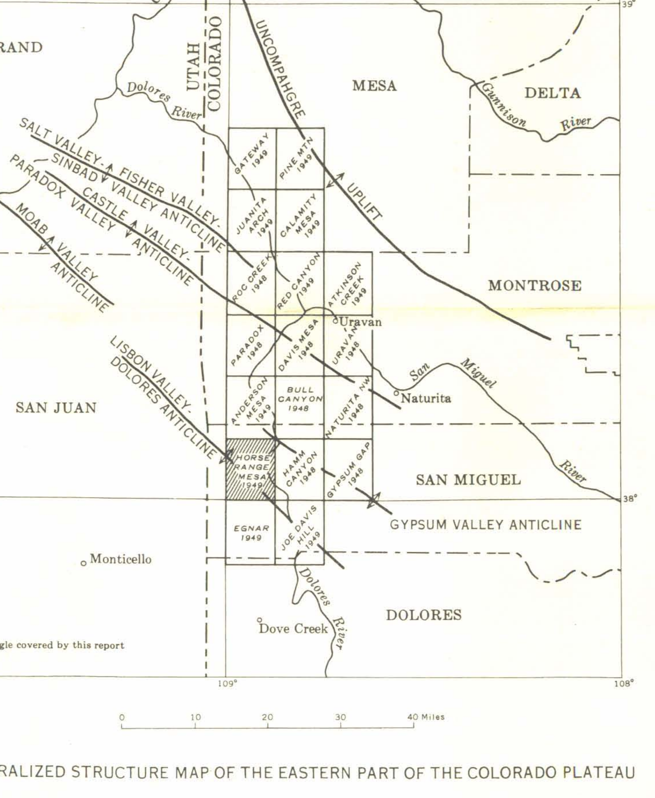
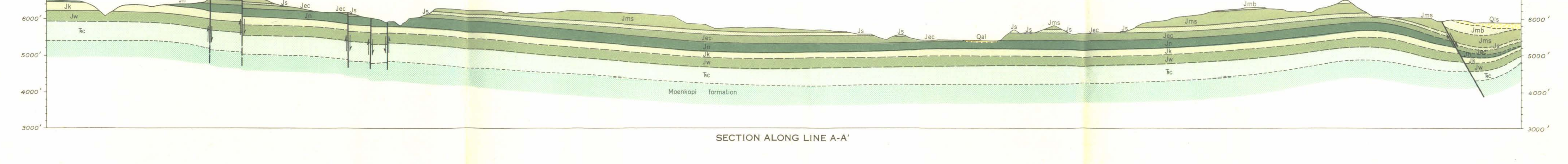


FIG. 1—GENERALIZED STRUCTURE MAP OF THE EASTERN PART OF THE COLORADO PLATEAU

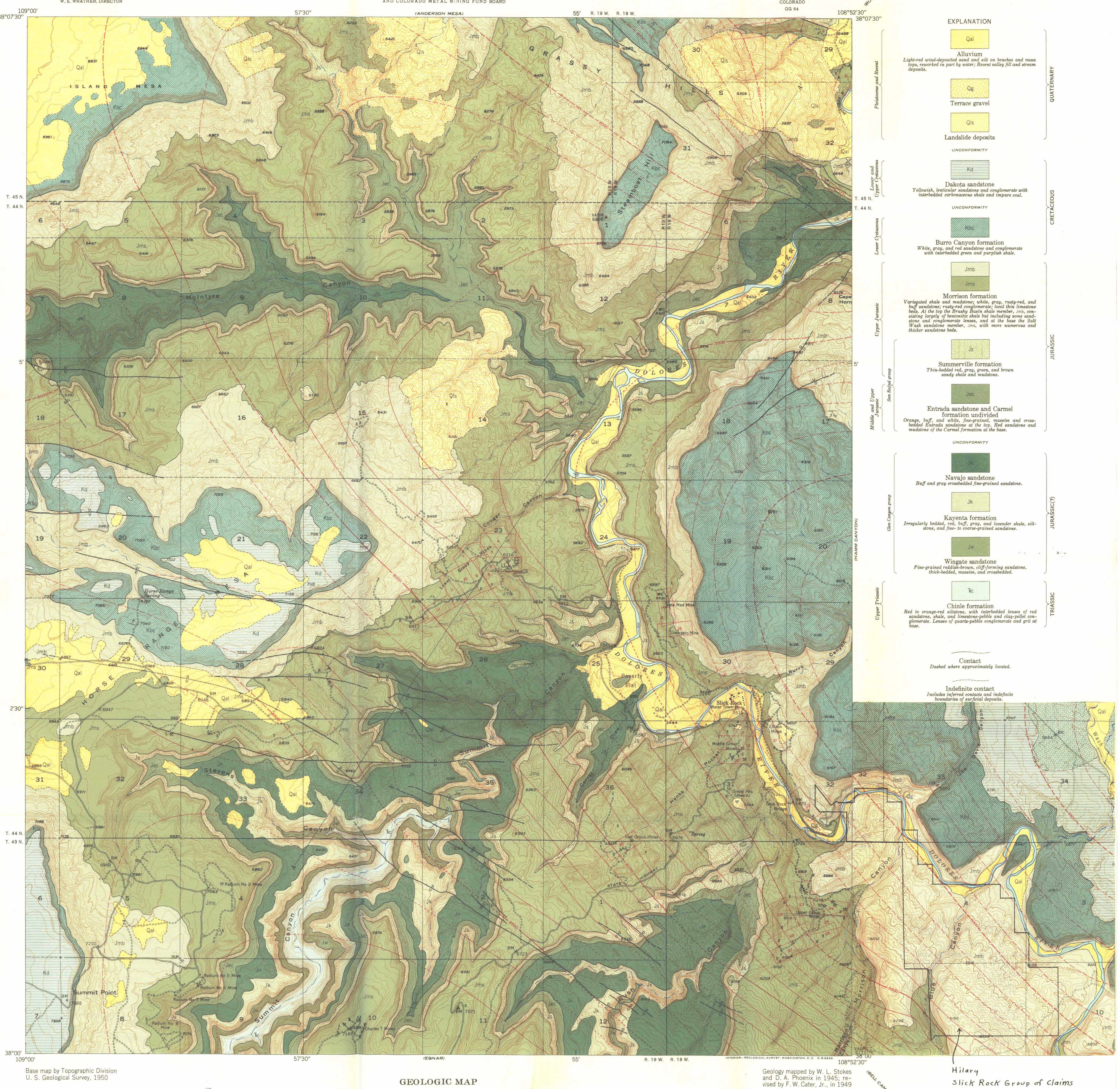


SECTION ALONG LINE A-A'

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
W. E. WRATHER, DIRECTOR

PREPARED IN COOPERATION WITH THE
U. S. ATOMIC ENERGY COMMISSION
COLORADO GEOLOGICAL SURVEY BOARD
AND COLORADO METAL MINING FUND BOARD

GEOLOGY OF THE
HORSE RANGE MESA QUADRANGLE
COLORADO
GQ 64



Base map by Topographic Division
U. S. Geological Survey, 1950

Geology mapped by W. L. Stokes and D. A. Phoenix in 1945; revised by F. W. Cater, Jr., in 1949

(BELL CANYON)

Hilary
Slick Rock Group of Claims

TRUE NORTH
MAGNETIC NORTH
15°
APPROXIMATE MEAN DECLINATION, 1955

GEOLOGIC MAP OF THE HORSE RANGE MESA QUADRANGLE, COLORADO

By
Fred W. Cater, Jr.

Scale 1:24000
1 ½ 0 1 Mile
Contour interval 20 feet
Datum is mean sea level
1955