MME Form 9
Rev. Nov. 65

UNITED STATES
DEPARTMENT OF THE INTERIOR
Geological Survey

OFFICIAL DOCKET FILE Contract No. _____ Docket No. 6830

Application
- [ ] Denied
- [ ] Withdrawn

Contract
- [ ] Terminated - Not Certified
- [ ] Terminated - Certified
- [ ] Cancelled
- [ ] Royalty Agreement

The records contained in this file are marked (x) and arranged in this order:

Folder No. 1:

Left Side

- [ ] Royalty Audits
- [ ] Certification of Discovery
- [ ] Closing Letter
- [ ] Cost Audits
- [ ] Termination Notice or Agreement
- [ ] Recision Notice
- [ ] Assignment of Contract
- [ ] Contract Amendments
- [ ] Contract with all exhibits and annexes
- [x] Owner's Consent to Lien and Subordination Agreement
- [x] Application and Attachments

Right Side

- [ ] Project Summary (final)
- [ ] Work Completed Analysis (final)

All other material filed in chronological order including the following reports if checked:

- [ ] Field Team Semiannual Report for Certified Project
- [ ] Final Field Team Report (Tab)
- [ ] Operator's Final Report (Tab)
- [ ] Interim Field Team Reports
- [ ] Operator's monthly reports and all attachments
- [ ] On-site Exam. Report (Tab)
- [ ] Settlement Sheets
- [ ] Drill Logs

Additional Folders:

Left Side

Folders No. _____: Reports

- [ ] Analysis of Semiannual Inspection Reports
- [ ] Project Summary (Interim) by MME Engineers

Right Side

- [ ] Field Team Semiannual Report for Certified Project
- [ ] Field Team Interim Reports
- [ ] Operator's Monthly Reports with Transmittal, Narrative and Maps

Folders No. _____: Maps (Use pocket folder or envelope)

Folders No. _____: Settlement Sheets

Folders No. _____: Drill Logs

Folders No. _____: Royalty Material

72195-65

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
FEDERAL CENTER, DENVER, COLORADO 80225
Office of Minerals Exploration
Building 53 Room 200

October 27, 1970

OFFICIAL COPY
O. M. E.
RECEIVED
OCT 30 1970

INITIALS	CODE

Memorandum

To: Chief, Office of Minerals Exploration

From: Field Officer, Region III

Subject: Application for financial assistance to explore for uranium and vanadium on the Little Bob, Red Bird, and Sunset Claim, Vixen Mines District near Uravan, Colorado.

Mr. Ralph Madden, Rural Route 1, P. O. Box 106, Palisade, Colorado has applied to the Office of Minerals Exploration to explore for uranium and vanadium on the subject property that lies near the Uravan mineral belt southeast of Long Park, in Montrose County, Colorado. His estimate totals some $128,160.00; however, his geologist's costs total an estimated $70,000.00. Enclosed is Mr. Madden's application.

Mr. Madden's costs are spread over a 24-month period; however, the 50 Stage I holes proposed could easily be drilled in a one-month period if most road work and sites were already prepared, and both a Stage I and Stage II should not take much more than two months, unless there is an excessive amount of road work that needs to be completed before most of the drilling can be started. The applicant's cost figures indicates that this is so, as his Supervisor, Travel expense, Road construction and Improvement appear to be excessive. The quoted rate of drilling per foot is $3.00 whereas a recent application for uranium, OME-Docket 6813, quotes only $1.20 per foot. Mr. Madden is apparently intending to do his own drilling; however, the costs of the two programs should be comparable.

The Little Bob, Red Bird and Sunset groups of claims that lie in secs. 5 and 8, T. 46 N., R. 16 W., sec 29-32, T. 47 N., R. 16 W., and sections 24 and 25, T. 47 N., R. 17 W., are in ground that is classified as semifavorable and unfavorable with small patches of favorable ground, according to the U. S. Geological Survey's Trace Element Memorandum Report 885, Figures 3a and 3b.

The applicant's consulting geologist, Dr. Robert Young, presently professor of geology, Mesa Junior College, Grand Junction, Colorado, formerly geologist with the Atomic Energy Commission shows in his report accompanying the application that the subject claims lie outside of the Uravan mineral belt. Professor Young, I believe, gives the property a fair appraisal and says that there may be a chance of finding a few ore bodies in the 15,000 ton range. Some drilling may be justified but not if excessive road building is required. The subject grooups of claims are marginal in my estimation, insofaras the chances of discovering new reserves of uranium are concerned.

The applicant's geologist should be requested to locate approximately where the wide spaced drilling should be with respect to the proposed trends of ore bodies, or where mineralized material may be, in another words, his target areas.

A limited drilling program may be justified, but not under the present circumstances.

J. William Hasler

J. William Hasler,
Field Officer, Region III
Office of Minerals Exploration

Enclosures

0
v. 68)

Budget Bureau No. 42-R1368
Approval expires Dec. 1971

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

APPLICATION FOR FINANCIAL ASSISTANCE IN MINERALS EXPLORATION

Pursuant to Public Law 85—701 (72 Stat. 700; 30 U.S.C. 641)

NAME OF APPLICANT *(Full legal name and mailing address as they should appear on contract if one is executed.)*	APPLICANT DO NOT USE THIS BLOCK
Madden and Bell RR 1 Box 106 Palisade, Colo 81526	DOCKET NUMBER 6830 DATE RECEIVED 10/30/70 REGION III DIVISION CODE

BUSINESS ORGANIZATION *(Check one)*	LIST CORPORATE OFFICERS OR PARTNERS HERE, IF APPLICABLE — NAME / ADDRESS / TITLE
INDIVIDUAL [ ] CORPORATION [ ] PARTNERSHIP [X] OTHER *(Specify)* [ ]	Ralph R. Madden RR1 Box 106 Palisade, Colo, 81526 — partner Albert W. and Billie W. Bell Box 144 Nucla, Colo 81424 — partners
STATE IN WHICH FIRM IS ORGANIZED	

MINERAL(S) FOR WHICH YOU WISH TO EXPLORE	PROPERTY NAME	LOCATION COUNTY	STATE
Vandium and Uranium	Little Bob Sun Set Red Bird	Montrose Co.	Colo.
ESTIMATED COST OF PROJECT $128,160.00			

GENERAL INSTRUCTIONS

Before filling out this application, please read the *OME Regulations for Obtaining Federal Assistance in Financing Explorations for Mineral Reserves* (30 CFR Chap. II). 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 two 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 2, existing mine workings and geology in item 3, and the proposed exploration work in item 5. 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 3(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 Department of the Interior, U.S. Geological Survey, Office of Minerals Exploration, Washington, D. C., 20242, or with the nearest OME 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, and that he would not ordinarily undertake the proposed exploration under current conditions and circumstances at his sole expense.

5/21/70
DATED

Ralph R. Madden
Albert L. Bell
Billie L. Bell
BY *(Signature)*

owners
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. Financial Eligibility:

(a) Submit evidence of efforts made within 90 days preceding the filing of this application to obtain credit from your bank of account and at least one other banking institution or other private source of credit. Such evidence shall include (1) true copies of your letters to credit sources which show date of loan request, amount and terms requested, and proposed use of loan funds and (2) true copies of replies from credit sources. If the loan was offered under terms which you consider unreasonable, state why you consider them so.

(b) List names and addresses of affiliated, parent, or controlling companies or organizations and state extent and nature of their interest.

(c) State how you propose to furnish your share of the cost of the exploration work.

2. Applicant's Rights in Land:

(a) State your interest in the land and mineral rights, whether owner, lessee, purchaser under contract, or other. If you are not the owner, submit one true copy of the lease, contract, or other document (with address of owner) under which you control the property. Describe all liens, mortgages, or other encumbrances on the land and state book and page number and official place where recorded.

(b) 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 adjacent land which you own or control. Describe any part of the land or workings which should not be subject to Government royalty and liens. If the land consists of unpatented claims, state book and page number for each recorded location notice, including amended locations, and official place where recorded. State all the names by which you know the property.

(c) For all land or mineral rights encumbered or not owned, submit five copies of Lien and Subordination Agreements signed by owner on MME Form 52. If the agreements cannot be obtained, state reasons and whether you can furnish a performance bond.

3. 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 land. Include existing mine workings and all production facilities.

(b) State your interest, if any, in operations described in (a)

(c) State, if 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, giving quantities and grades.

(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) 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. State your reasons for expecting to find ore.

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

4. Accessibility of Property:

(a) To aid the OME representative who may examine the property state name, address, and telephone number of person who will meet him; give directions for reaching the property; and describe accessibility of property and of any mine workings.

(b) Name the shipping and supply points and state the distances to the property.

5. Exploration Work:

(a) Describe fully the proposed exploration work giving individual footages and sizes of openings *for each item of work.* Use narrative, maps, plans, and sections as necessary. Show 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 *land boundaries* or to the closest identifiable corner.

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

(c) If an OME contract is executed, state how soon thereafter work would be started and finished. State your anticipated average daily or monthly rate of progress for each type of work.

6. Experience:

State your operating experience and background to conduct this exploration work and also that of the person who will supervise the work.

7. Estimate of Costs:

Furnish detailed estimates of the necessary costs for time and materials *for each item of the work proposed in 5(a)* under the headings listed below with a total for each heading and the estimated total cost of the work. Costs for any work to be performed by an independent contractor should be listed separately under category (a) below. Costs for any work that is not to be performed by an independent contractor should be listed under categories (b) through (g).

(a) Independent contracts. State the total cost of any proposed independent contract for all or any part of the work, and the number of units and the unit cost for each type of work, such as per foot of drilling, per foot of drifting, per hour of bulldozer operations, or 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. The cost of supervision, engineering and geological services, outside consultants, and labor should be itemized by numbers and classes of employees; rates of wages, salaries or fees; and periods of employment. State whether these services are available.

(c) Operating materials and supplies. List items of material and supplies giving quantity and price of each. 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 equipment and tools costing $50 or more per unit. Give specifications and indicate how each item is to be acquired—i. e., rented, purchased or provided by the applicant. If rented or purchased, state the estimated rental or purchase price. If furnished by the applicant, state condition and present fair market value.

(e) Initial rehabilitation and repairs. Describe the type and the cost of *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 in the exploration work.

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

(g) Miscellaneous. Describe the type and estimate the cost of repairs and maintenance of the operating equipment listed in 7(d). Do not repeat initial repairs listed in 7(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*—The Government will not contribute to costs incurred before the date of the contract, or to costs of or incident to: (1) acquiring, using, or possessing land and any existing improvements, facilities, buildings, installations, and appurtenances, or the depreciation and depletion thereof; (2) general overhead, corporate management, interest and taxes (other than payroll and sales taxes); (3) insurance (other than employees' liability insurance); and (4) damages to persons or property (other than authorized repair to or replacement of equipment or other property used in the work).]

May 27th 1970

Fruita State Bank
Fruita, Colo.

Gentlemen:

I would like to formally request a loan in the amount of $128,160.00 to be used for exploration purposes on fiftyseven claims that I control in the Uravan Mining District.

Yours truly,

Ralph R Headden

FRUITA STATE BANK

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

FRUITA, COLORADO

DONALD A. TURNER
EXECUTIVE VICE PRESIDENT & CASHIER

May 27, 1970

Mr. Ralph R. Madden
Route 1, Box 106
Palisade, Colorado

Dear Mr. Madden:

Thank you for your letter of May 27, 1970 for application for a loan in the amount of $128,160.00 for exploration. The time period of pay off and our requirements of security would not comply to grant this loan. I am sorry we cannot be of service to you.

Sincerely,

Donald A. Turner
Exec. Vice Pres. & Cashier

DAT:mb

Co-owner of the claims, Ralph R. Madden, will supervise all construction and exploration.work. Mr. Madden has had 19 years experience in the building and construction supply business where he served in a supervisory and management capacity. Mr. Madden has successfully owned and operated a building construction and contracting business for the past 15 years. During this time, he has also been actively involved in the minerals exploration and mining industry. Due to his positions and on the job experience, Mr. Madden has had a working knowledge of machinery operation and business and labor management all of his life.

Half of the total cost of the exploration project will be furnished by the co-owners in the form of the labor for the project and the use of their equipment to carry out the project. The operation will be carried out on a twenty-four month basis commencing upon the approval of this application. A project total cost estimate and monthly breakdown is as follows:

Twenty-four Mo. Project

Drill Sight Const.	$ 2560.00
Geology	2000.00
Drilling	60000.00
Gamma Ray	5000.00
Supervision	21600.00
Travel Expense	4800.00
Road Const. & Improvement	4000.00
Office Blds. Const.	1800.00
Total-	$128160.00

The monthly portion of the total cost will average approximately $5340.00 per month. This figure will vary considerably due to increased costs at the beginning of the project, poor working conditions in winter months due to weather, and the speed with which the project is carried out.

May 27th 1970

First National Bank
5th & Main
Grand Junction, Colo.

Gentlemen:

I would like to formally request a loan in the amount of $128,160.00 to be used for exploration purposes on fiftyseven claims that I control in the Uravan Mining District.

Yours truly,

Ralph R. Hadden

FIRST NATIONAL BANK in Grand Junction . . . .

GRAND JUNCTION, COLORADO

May 27, 1970

Ralph R. Madden
Route 1, Box 106
Palisade, Colorado 81526

Dear Mr. Madden:

In answer to your request for a loan of $128,160.00 today to develop mining property, we are not making this type of loan, and therefore, deny your request.

Very truly yours,

R. G. Youngerman
Vice President

RGY/lrh

No. 90. MINING LEASE—Short[illegible]n. —Bradford-Robinson Printing Company, 1824-46 Sto[illegible]eet, Denver, Colorado

THIS INDENTURE, Made this 3rd day of June, 19 70, between Norman L. Smith and Otis C. Madden

parties

of the first part, and Ralph R. Madden, Partner and Albert L. Bell and Billie L. Bell Partners

of the second part, WITNESSETH, that the said parties of the first part, for and in consideration of the rents, covenants and agreements hereinafter expressed to be paid, kept and performed by the said parties of the second part, have leased, let and demised, and by these presents do lease, let and demise unto the said parties of the second part, the following described premises, situate, lying and being in Vixen Mining District, in the County of Montrose and State of Colorado, to-wit:

Red	Bird	#1	as	recorded	on	page	564	in	Book	571
"	"	#2	"	"	"	"	565	"	"	"
"	"	#3	"	"	"	"	566	"	"	"
"	"	#4	"	"	"	"	567	"	"	"
"	"	#5	"	"	"	"	568	"	"	"
"	"	#6	"	"	"	"	569	"	"	"
"	"	#7	"	"	"	"	570	"	"	"
"	"	#8	"	"	"	"	571	"	"	"
"	"	#9	"	"	"	"	572	"	"	"
"	"	#10	"	"	"	"	573	"	"	"
"	"	#11	"	"	"	"	574	"	"	"
"	"	#12	"	"	"	"	575	"	"	"
"	"	#13	"	"	"	"	576	"	"	"
"	"	#14	"	"	"	"	577	"	"	"
"	"	#15	"	"	"	"	578	"	"	"

TO HAVE AND TO HOLD THE SAME, for the purpose of mining, for the term of twentyfive (25) years from the date hereof, unless sooner terminated under any of the provisions herein contained, with no power to assign this lease or any interest thereunder, or to sublet the whole or any part of said premises except upon the written consent of the parties of the first part.

And the said parties of the second part, for and in consideration of the leasing of said premises, covenant and agree with said parties of the first part to commence work on said premises on or before August 1, 1971 OCM RRM ALB - BLB NLS and thereafter to work the same continuously, in a thorough and workmanlike manner, ~~employing at least [illegible] men underground~~

and working at least twenty (20) shifts each calendar month; to keep the same securely timbered, drained and clear of loose rock and rubbish; to keep accurate accounts, and to render statements to the said parties of the first part, their agent or attorney, showing the amount and character of work done, and to pay to said part of the first part, agent, or attorney, as rental for said premises royalty upon all ore taken and sold therefrom as follows, to-wit:

5% on all ore ~~xxxxxxxxx~~ shipped o sold up to $.40 and OCM M L L RRM. BLB ALB
6% on all ore shipped or sold from $.40 to $.50 and OCM M L L RRM BLB ALB
7% on all ore shipped or sold above $.50 OCM M L L RRM. ALB BLB

And it is expressly understood and agreed by and between the parties hereto, that the said part of the first part reserves the property and right of property in and to all ores extracted from said premises during the term hereof, and that all settlements for royalty shall be made upon the assay value of the mineral in the ore that may be taken from said premises less the actual cost of railroad transportation and treatment; and the sampling works, mill, smelter, or ore buyer purchasing any such ore shall retain the amount of the royalty herein stated and shall pay the same to the parties of the first part at each settlement for ore purchased.

And the said parties of the second part furthermore covenant.....and agree.....that the said parties of the first part, ...their.....agent or attorney, shall have the right at any and all times to enter upon and descend into any and all parts of said premises to inspect the same, make surveys thereof, or take samples therefrom, and that the said parties of the second part will render to.....them..... all the assistance in.....their.....power in so doing. And the said parties of the second part furthermore covenant.....and agree.....to occupy and hold all side veins, spurs, feeders, cross-lodes, parallel lodes, or mineral deposits of any kind which may be discovered by the said parties of the second part or by any person working under.....them.....in any manner, by working within or from the aforesaid premises, as the property of the said parties of the first part and as part of the premises demised, and to not allow any person not in privity with the parties hereto to take or hold possession of said premises or any part thereof under any pretense whatever, and to pay in due season all taxes and assessments levied against said demised premises on account of the production of ore under this lease.

And the said parties of the second part furthermore covenant.....and agree.....that in case....they fail.....in any respect to keep and fulfill any one or more of the covenants or agreements herein expressed or implied, then, and in that case it shall be lawful for the said parties of the first part, ...their..... agent or attorney, to declare said term ended, and with or without process of law to enter upon and take possession of said premises, and in such case, and also at the expiration of this lease by limitation, said parties of the second part agree.....to surrender, yield and deliver to said parties of the first part quiet and peaceable possession of said premises in good condition, and that time shall be of the essence hereof, and that all of the covenants and agreements herein contained shall extend to and be binding upon the heirs, executors, administrators, successors and lawful assigns of the respective parties hereto.

IN WITNESS WHEREOF, The parties hereto have executed these presents the day and year first above written.

Norman L. Smith .....[SEAL]

Otis C. Madden .....[SEAL]

Ralph R. Madden .....[SEAL]

Albert F. Bell .....[SEAL]

Billie L. Bell .....[SEAL]

.....[SEAL]

MINING LEASE

FROM

.....

TO

.....

STATE OF COLORADO,
County of ..... } ss.

I hereby certify that this instrument was filed for record in my office, at..... o'clock.....M., on the.....day of ....., A. D. 19....., and is duly recorded in book....., page.....

.....
Recorder.

By.....
Deputy.

Fees, $.....

5-65 BRADFORD-ROBINSON PTG. CO., DENVER

Little Bob Group

No.	Book	Page
1	559	485
2	559	774
3	559	775
4	559	776
5	559	486
6	559	777
7	559	778
8	559	779
9	559	487
10	559	780
11	559	781
12	559	782
13	559	783
14	559	784
15	559	785
16	559	786
17	559	488
18	559	787
19	561	997
20	561	998
21	565	956
22	565	957
23	565	958
24	565	959
25	565	960
26	565	961
27	565	962
28	565	963
29	565	964
30	565	965
31	565	966
32	577	386
33	577	387
34	577	388
35	577	389
36	577	390

SUNSET GROUP

No.	Book	Page
1	577	382
2	577	383
3	577	384
4	577	385
5	577	386

RED BIRD GROUP

No.	Book	Page
1	571	564
2		565
3		566
4		567
5		568
6		569
7		570
8		571
9		572
10		573
11		574
12		575
13		576
14		577
15		578

Maps, reports, etc.

Maps, reports, etc.

INSTRUCTIONS FOR USE

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3. Write Clearly
4. Send Surplus Envelopes to Supply Room for Reissue

Standard Form No. 65
November 1961
General Services Administration
FPMR (41 CFR) 101-11.6

U.S. Government Messenger Envelope

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~~U. S. GEOLOGICAL SURVEY BRANCH OF MAP REPRODUCTION TYPE COMPOSITION SECTION GSA BUILDING, ROOM B-13 WASHINGTON 25, D. C.~~	STOP		STOP
~~BMR NEGATIVE ENGRAV. SECT. RM. 1219-C, GS Bldg.~~	STOP		STOP
[redacted]	STOP		STOP
~~RT A Nelson Va.~~	STOP		STOP
~~Mr. D. Goodwyn Bldg 69 GSA~~	STOP		STOP
~~Branch of Budget & Finance Yellowstone Nat'l Park Room 3356 GSA Bldg~~	STOP		STOP
~~Property Control Sect. Rm. 1321 Int Bldg~~	STOP		STOP
~~Emmett Brown Room B-208 GS Bldg~~	STOP		STOP
~~Bob Weeks Bldg 70~~	STOP		STOP

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65-107

NAME (OR TITLE) OF ADDRESSEE, AGENCY, ORGANIZATIONAL UNIT, ADDRESS, AND ROOM		NAME (OR TITLE) OF ADDRESSEE, AGENCY, ORGANIZATIONAL UNIT, ADDRESS, AND ROOM	
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Use other side first

☆ U. S. GOVERNMENT PRINTING OFFICE: 1964 — 0:231-900

Kirk. 10/27/70

Sheet 2 of 2 has
sections outlined on
them concerning the Madden
application.

Bill

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
U. S. ATOMIC ENERGY COMMISSION

GEOLOGY, STRUCTURE, AND URANIUM DEPOSITS OF THE MOAB QUADRANGLE COLORADO AND UTAH

Compiled by

Paul L. Williams

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-360

PUBLISHED BY THE U. S. GEOLOGICAL SURVEY
WASHINGTON, D.C.
1964

MAP I-360

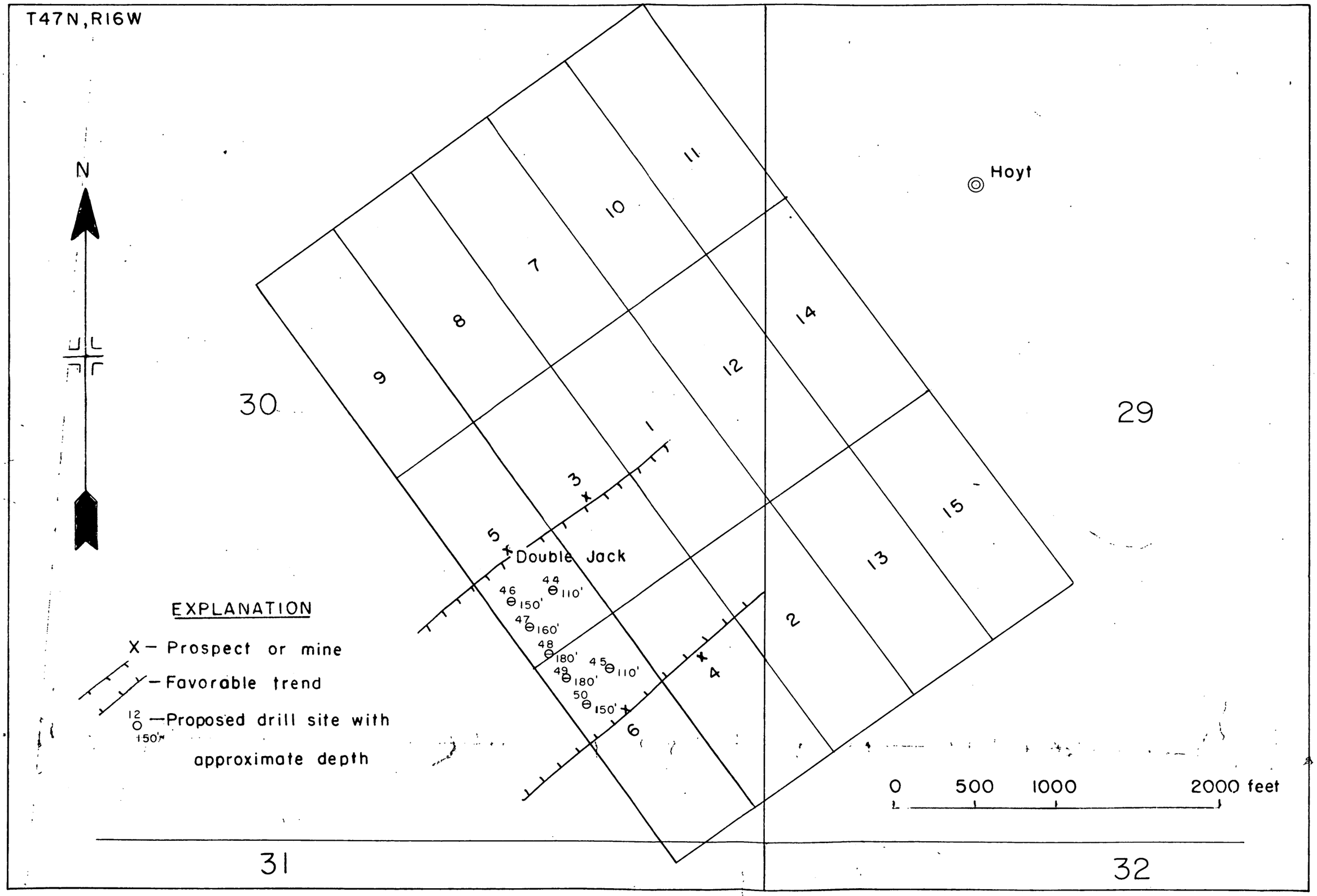

Fig. 5 — Red Bird claim map

CONTROLLED
COPY
O. No. 7
RECEIVED
OCT 30 1970
CONTROLS CODE

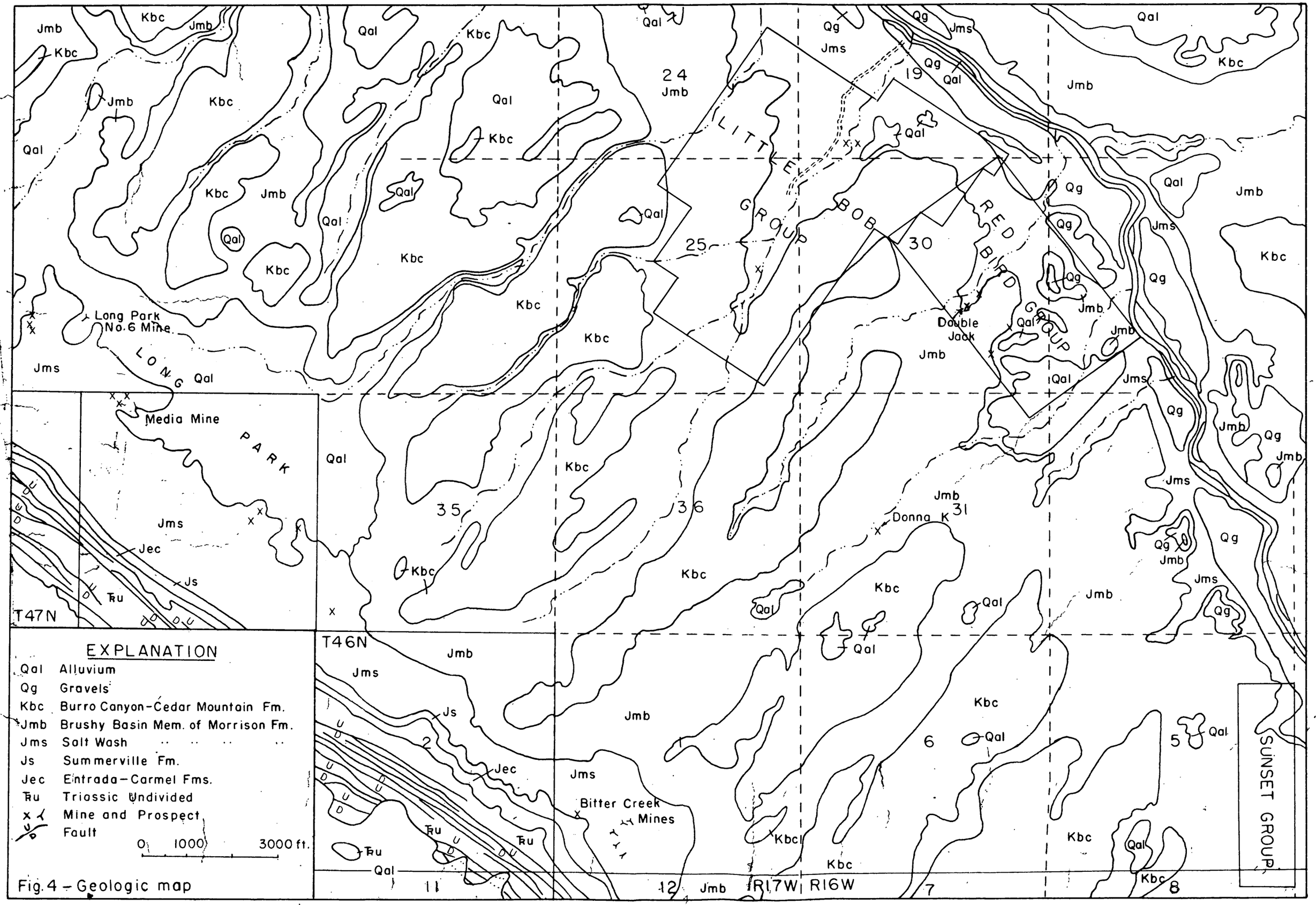

Fig. 4 – Geologic map

STATEMENT

Report on: AN EVALUATION PROGRAM FOR LITTLE BOB, RED BIRD AND SUNSET GROUPS, MONTROSE CO., COLORADO

Feb. 21	Field examination of property including per diem)	$ 92.00
	Preparation of report. (4 3/4 days at $76./day)	$361.00
	Total:	$453.00

AN EVALUATION PROGRAM FOR LITTLE BOB, RED BIRD AND SUNSET GROUPS, MONTROSE CO., COLORADO

April 27, 1970

Dr. Robert G. Young
Engineering Geologist

Robert G. Young

SUMMARY

The Little Bob, Red Bird and Sunset Groups consist of 57 uranium claims located in the Vixen Mining District near Uravam, Colorado. They are about two miles down the northeast flank of Paradox Anticline from the very productive Long Park Mining District. Here ore has been mined from the second and third rims of the Salt Wash Member of the Jurassic Morrison Formation.

Ground covered by these claims has been only partially investigated. Surface exploration resulted in the discovery of a small ore pod yielding about 20 tons of uranium-vanadium on the Little Bob Claims and an unknown amount on the Sunset Claims. A total of about 22 holes have been drilled here but no additional ore has been found.

Recent developments suggest that mineable ore bodies may exist on these properties. A reported ore trend on claims to the south appears to lead onto the Little Bob Claims. Elsewhere, favorable channel trends appear to cross the claims but have been essentially neglected in previous exploration.

A study of all the favorable trends indicates that they may have a potential of 75,000 tons or ore containing 375,000 pounds of uranium and 4,500,000 pounds of vanadium with a present gross value of about $3.5 million.

To develop this potential a two stage drilling program is proposed. The first consists of wide spaced holes to delineate mineralized areas to be explored by close spaced drilling in the second phase. Total cost of drilling the proposed 100 holes is about $60,000. Additional costs include $2,080 for road and drill-site construction and $2,000 for geologic supervision.

INTRODUCTION

Location:-

The Little Bob, Red Bird and Sunset Groups consist of 57 lode mining claims in the Vixen Mining District near Uravan, Montrose County, Colorado(fig. 1). More specifically they are located in Secs. 5 and 8, T. 46 N., R. 16 W.; Secs. 29-32, T. 47 N., R. 16 W.; and Sec. 24 and 25, T. 47 N, R. 17 W. as shown in figure 2.

These uranium claims, now either owned or controlled by Ralph Madden of Palisade, Colorado were staked at various times from 1967 to 1970. They are all well marked and are apparently free of any encumberances.

Topography:-

These claims lie along the partially dissected northeast flank of the Paradox Anticline, a northwest trending uplift produced by movement of Pennsylvanian salt. Intermittent consequent streams flowing down the flank of the fold have removed most of the strata which normally overlie the ore-bearing Salt Wash Member of the Jurassic Morrison Formation, and along the deeper valleys has cut through the Salt Wash and into still older strata. High flat-topped erosional remnants, capped by the Dakota Group of Cretaceous age, separate drainages.

Elevations on the claims range from a low of about 5300 feet at the lower end of Horsethief Draw to a maximum of about 6100 feet on some of the higher erosional remnants. These

claims lie almost entirely in stream drainage basins beneath the high resistant "Dakota" rim. Because these stream valleys are still extremely youthful, they consist mostly of steep slopes with a few gently sloping sandstone benches.

Climate and Vegetation:-

The climate of the subject area can be described as sub-arid to arid. Rainfall varies from seven to ten inches per year with most of it occuring as thundershowers in July and August. Light snows generally blanket the area from December to March but seldom hinder mining activities. Temperatures commonly drop below zero for short periods during the winter and may exceed 100°F. for a few days in summer but otherwise are generally mild.

Because of the low rainfall, vegetation is sparse on the claims. Scattered low juniper and pinyon trees are the most conspicuous plants but among them occur clumps of Indian Rice Grass, rabbitbrush, cactus and a few annual and perennial grasses and wild flowers.

Access:-

To reach the claims one should travel southeast from Uravan on Colorado Highway 141 for approximately seven miles. At this point an unimproved dirt road, usable only by truck or 4 wheel-drive vehicle, leads westward to the claims. This trail is passable in dry weather but will need some improvement before

any major developments are undertaken on the property.

In the event ore is developed on the property, a ready market is available at the Uravan Mill operated by Union Carbide. At such a time a new road could be built to allow access from the north end of the claims.

Purpose of Report:-

The purpose of this report is to describe the geology of the area around the Little Bob, Red Bird and Sunset claims, and to indicate the uranium possibilities of these properties. It is also designed to indicate a means of locating any uranium reserves by use of a limited drilling program. The estimated cost of such a program is included.

STRATIGRAPHY

Strata exposed within a few miles of the claims range in age from Pennyslvanian to Cretaceous and total about 8,000 feet in thickness. Most of these are exposed in the sheer cliffs forming the inward facing escarpments of the eroded axis of the Paradox Anticline just west of the property. The generalized section for this area is shown in figure 3 and the local geology is illustrated in figure 4.

As indicated in figure 3, the oldest outcropping unit is the Hermosa Formation of Pennsylvanian age. It is represented by a thousand feet or so of limestone, gypsum and black shale exposed in the core of the anticline. Conformably overlying the

Hermosa is the Permian Cutler Formation which here consist of about 3500 feet of fluvial red beds; conglomerates, arkoses and sandy mudstones.

Resting unconformably on the Cutler is the moenkopi Formation of Early Triassic age. It ranges from 350 to 450 feet in thickness and consists of conglomerate, arkose and reddish brown silty sandstones and sandy siltstones of fluvial and tidal flat origin. Unconformably overlying the Moenkopi is a sequence of fluvial red beds referred to the Chinle Formation of Late Triassic age. It is composed largely of variegated mudstones with a few scattered lenses of channel-fill sandstone. Total thickness of the unit is about 500 feet.

Disconformably overlying the Chinle is the eolian Wingate Sandstone which is also of Late Triassic age and has an average thickness of about 350 feet. The Wingate is a massive orange-brown unit which generally forms high fluted cliffs. This cliff-forming habit is largely due to the resistive nature of the overlying Kayenta Formation which is composed of better cemented fluvial sandstones and lesser amounts of red shale. This unit is also of Late Triassic age and ranges in thickness from 35 to 320 feet.

Overlying the Kayenta with slight unconformity is a thin wedge of the Triassic-Jurassic(?) Navajo Sandstone. This massive, highly cross-bedded eolian sandstone is seen here near its eastern pinchout. Its average thickness is this area is about 30 feet.

In some areas the Navajo is overlain by a few feet of

red mudstone, siltstone or silty sandstone of the Jurassic Carmel Formation but in other places is succeeded directly by the Entrada Sandstone, an eolian unit which averages about 150 feet in thickness throughout the area. This unit, the "Slick Rim" of this area, is of Late Jurassic age.

Resting conformably on the Entrada is a 50 foot thick unit of marginal marine shales and sandstones. This is the Summerville Formation of Late Jurassic age.

Disconformably overlying the Summerville is the Morrison Formation of Late Jurassic age. This fluvial unit is the principal uranium-bearing formation in this region and thus will here be treated in more detail. In this area it consists of two members - the Salt Wash and Brushy Basin Members. The Salt Wash rests with slight disconformity on the Summerville and is composed of about 350 feet of interbedded red to green mudstone and massive channel-fill sandstones. In this area the lower hundred feet is primarily red mudstone whereas the upper portion commonly is composed of two or three distinct ledges or "rims" formed by channel-fill sandstone complexes separated by mudstone beds. The sandstones are defined as orogenic sandstones and they represent the deposits of ancient braided-channel river systems devoted to transporting great volumes of clastics northward from a highland area which lay to the south and southwest in southern California and southern Arizona. The sandstone ledges vary in thickness up to more than 100 feet and consist of innumerable scour-and-fill channel

segments(sometimes separated by thin mudstone partings) which reflect the composite nature of the units. Maximum thicknesses generally occur high on the salt anticlines where they coincide with "rim synclines" related to growth of the old salt structures. Some channel segments are very short whereas others can be traced for nearly a mile before losing their identity by shaling out or by being cut off by other scours. Thickness of sandstone in these segments ranges up to 40 feet.

In the vicinity of the claims, only the two upper ledges of sandstone(2nd and 3rd rims) are present. Channel trends in these two sands differ considerably--those in the second or middle rim trend N. 80° - 90° E. and those in the third or upper rim trend N. 50° - 60° E.

The Salt Wash Sandstones range in color from white to gray to pale orange and are generally fine to medium grained. They are composed largely of subangular to subrounded quartz grains with some fragments of chert and blebs of kaolin, probably representing kaolinized feldspar or impure chert. Cement is generally calcitic. In many scours, considerable carbon trash is present and has served as the locus of uranium deposition.

The upper part of the Morrison in this area is referred to as the Brushy Basin Member and consists of about 300 feet of variegated bentonitic mudstone with an occasional lens of channel-fill sandstone. This is the outcropping unit over most of the claims.

Unconformably overlying the Brushy Basin is the Cedar Mountain Formation of Early Cretaceous age. It consists of 50

to 150 feet of fluvial channel-fill sandstone and bentonitic mudstone. It is overlain by the Naturita Formation(Dakota Sandstone) which consists of 50 to 200 feet of fluvial conglomeratic sandstone, paludal carbonaceous shale and coal, and littoral marine sandstone. It, too, is of Early Cretaceous age.

Disconformably overlying the Dakota in areas a few miles east of the claims is the basal portion of the Mancos Shale, a unit of thin bedded gray marine shale. This unit is of Late Cretaceous age.

STRUCTURE

As noted above, the claims lie on the northeast flank of the Paradox Anticline, a northwest trending piercement type salt ridge. This anticline is just one of several such ridges which have developed in southwestern Colorado and southeastern Utah within the old Paradox Basin, a Permo-Pennsylvanian structural depression. During the Pennsylvanian, thousands of feet of salt, gypsum and black shale accumulated in the basin and were subsequently buried by thick Permian strata. Simultaneous with Permian deposition the salt began to migrate toward places of lower stress, apparently areas of thicker evaporite deposition in long narrow northwest trending deeps overlying graben-like structures. As it entered these lower stress areas the salt began to uparch the overlying Permian sediment which caused the crest of the structure to be partially eroded. As deposition continued in Triassic, Jurassic, Cretaceous and Tertiary time there was discontinuous uplift

and alternating deposition and erosion on the crest of the Paradox Anticline. In Late Tertiary time circulating ground water removed much of the salt from the crest of the structure allowing it to collapse. Multitudes of faults occur along the collapsed crest but very few are present on the flanks.

On the Little Bob, Red Bird and Sunset claims dips average about 2° northeast but flatten slightly to the east. Jointing is pronounced in the resistant sandstone ledges, but no faults have been noted on the property.

ECONOMIC GEOLOGY

Nature of Uranium Occurrences in District:-

The Little Bob, Red Bird and Sunset Claims are in the Vixen Mining District, an eastward extension of the Long Park District; and both districts lie within the Uravan Mineral Belt. This belt embraces a large number of small mining districts extending in an arcuate trend from Egnar on the south to Polar Mesa on the north, as shown in figure 4.

Throughout the belt uranium is mined or has been mined primarily from channel-fill sandstones in the Salt Wash Member of the Morrison Formation. Major deposits occur on the flanks of breached salt anticlines where subsiding "rim-synclines" allowed thicker accumulation of sand in Salt Wash channels. The Salt Wash commonly exhibits two or three major benches or rims at the outcrop but about 95% of the uranium occurs in the

upper rim. The largest ore bodies are found at the base of this rim.

Host sandstones are generally gray to white, or tan with brown specks, fine to medium grained, well sorted and contain abundant carbonaceous material including fossil logs. The more favorable channels are up to 40 feet thick interbedded with and underlain by gray-green mudstone.

Ore has been shipped from approximately 1500 deposits in the mineral belt. These deposits range in size from a few tons to more than 200,000 tons with more than half of the production of the belt coming from ore bodies larger than 25,000 tons. Nearly all ore bodies are tabular bedded masses with irregular outlines in plan view. They may range up to 30 feet in thickness and 1,250 feet in length, but the average body is about four feet thick, 75 feet long and 20 feet wide. Carbonaceous debris, which furnished a reducing environment, and local mudstone lenses, which served as permeability barriers, apparently were agents in localizing such ore bodies. Smaller but higher grade ore bodies are found as haloes around fossil trees or as "c"-shaped rolls marking the position of an ancient solution interface.

Primary ore minerals in these deposits include uraninite, coffinite and montroseite. All tend to replace cement, sand grains or carbonaceous material. Secondary ore minerals are corvusite, tyuyamunite, carnotite, and others. Gangue minerals include barite, sulfides, and carbonates. The average uranium: vanadium ratio is about 1:5 and most ores are essentially in

radioactive equilibrium.

Uranium Occurrences on Little Bob Claims:-

Very little exploration has been done on the Little Bob Claims. Outcrops have been thoroughly checked with the discovery of one small ore pod in the second rim and a mineralized tree in the third rim. A total of about 22 holes have been drilled on the property. Most were drilled in 1968 for Lowell Stotts and the remainder in 1969 for Hank Clark. Owen Story was driller for both. A few gamma-ray logs are available. Some holes reportedly encountered low-grade ore but this has not been confirmed. However, a close-spaced drilling program conducted last year by Reed and Williams, operators on the adjoining property to the south, reportedly outlined an ore body in the third rim trending onto the Little Bob Claims. Each of these occurrences is treated below.

The small ore pod noted above was mined from two small adits in a channel-fill sandstone which crops out on both sides of the drawn on Claim No. 9. It consisted of about 20 tons of ore averaging about 0.12% U_3O_8 and 2.36% V_2O_5. It occurred at the base of a N. 85° E. trending sandstone-filled channel which has a width of 75 feet and a thickness of six feet. The channel is truncated a short distance updip but appears to thicken downdip(eastward). No concerted effort has been made to follow this channel downdip, but mineralization, reported in a few holes drilled updip, may be in this channel.

The mineralized tree was mined from a thick N. 20° E.

trending channel sandstone in the third rim along the west side of the draw near the east end of Little Bob No. 6 Claim. Eight of the holes drilled on the property were located to the west of this show apparently with the intent of evaluating this favorable appearing sandstone updip from the wash. Results of the drilling done by Lowell Stotts in 1968 are unknown but the few logs available give no sign of ore. The locations of these and other holes on the property are shown in figure 2.

Little is known about the drilling by Reed and Williams on the adjoining claims to the south of the Little Bob group but a large number of closely spaced holes are visible in upper Horsethief Draw and lead about N. 60° E. directly to the boundary of the Little Bob claims. Results of the drilling have not been released but reportedly they were following an ore body in the third rim which averaged about 16 feet in thickness.

Potential of Little Bob Claims:-

It is always a difficult task to ascertain the potential of a mining property, especially one on the fringe of a mining district where little information is available. The Little Bob claims are no exception.

From the data presented above it is apparent that there is ore present on the property in one or more areas but that previous exploration has not been conducted in such a manner as to evaluate possible ore trends. The three most likely areas for discovery of mineable ore are all east of Horsethief Draw(fig. 2).

They are the northeast continuation of the third rim mineralized channel at the south end of the claims, the northeast projection of the third rim sandstone containing the mineralized log near the center of the claims, and the eastward extension of the second rim channel from which the 20 tons of ore have been mined. This channel is of interest in that it is trending nearly due east. Across the San Miguel River one and a third miles due east is a small mine from which Woodrow Gripe has mined about $600 worth of ore. It is possible that this is the same channel.

In this report it is postulated that the three favorable channel trends could contain a total of four ore bodies of the 15,000 ton variety for a total potential of about 60,000 tons at 0.25% U_3O_8 and 3.00% V_2O_5 (300,000 pounds U_3O_8 and 3,600,000 pounds V_2O_5).

Uranium Occurrences and Potential of Red Bird Claims:-

The Red Bird claims, which lie just east of the Little Bob Claims, have been subjected to a limited amount of exploration. The only evidences of investigation are four small mines or prospect pits in the third rim from which a small amount of ore was reportedly mined by Climax Uranium. Most of this probably came from the Double Jack Mine indicated in figures 4 and 5.

All of the prospects on the Red Bird appear to lie in a belt which trends about N. 35° E. from the Bitter Creek Mines on the rim slightly more than two miles to the southwest. The Donna K., a prospect in the Brushy Basin Member, also appears

to lie along this trend. Its uranium may represent material carried up along fractures from an underlying ore body in the Salt Wash.

From the limited information available it is postulated that a favorable channel trend about 1000 feet wide crosses the claims in a southwest to northeast direction as shown in figure 5. Much of the third rim has been eroded from these claims but it is postulated that in the remaining portion covered by the channel there could be at least one body totaling about 15,000 tons @ 0.25% U_3O_8 and 3.00% V_2O_5 (75,000 pounds U_3O_8 and 900,000 pounds V_2O_5).

Uranium Occurrences and Potential of Sunset Claims:-

There are no known uranium occurrences on the Sunset Claims, but the outcropping Salt Wash Member exhibits relatively favorable lithologic characteristics. Considerable ore could be present on this property but no potential is assigned to it at this time.

It is proposed that several holes be drilled on these claims behind outcrops of favorable sandstone. Sites will be selected by the geologist after further field investigations.

PROPOSED EXPLORATION PROGRAM

In order to evaluate these uranium claims it will be necessary to regrade some existing roads, construct a new access road, build drill sites, and drill a relatively large number of holes.

Road and Drillsite Construction:-

About three miles of existing road will have to be improved before exploration can be undertaken on the claims. Repairs, consisting primarily of grading will require about three days of bulldozer work.

Approximately one mile of new road will have to be constructed at the north end of the Little Bob claims to permit freer access to the property. It is estimated that this road can be constructed in four days. Location of this new segment is shown in figures 2 and 4.

An additional ten days will be required to build new drill roads and drillsites for the initial drilling program. Most of these will be constructed on the Little Bob Claims.

Estimates of these construction costs are based on the generally accepted figure of $20.00 per hour for bulldozer work. Thus the sixteen days of road and site construction should total about $2560.00.

Drilling and Logging:-

It is proposed that a two-stage drilling program be initiated on these claims. The first stage of 50 holes would be

relatively wide spaced holes(3 and seven-eights to 4 and one-fourth inches diameter) drilled to an average depth of about 200 feet on the four favorable trends shown on the maps. If ore or mineralized ground is encountered, the second stage, consisting of close-space drilling will be undertaken. It is estimated that the number of holes necessary in the second stage will also be about 50 and that depths will average about 200 feet. At an average cost of $3.00 per foot, total drilling costs will be about $60,000.

In such a project as this, all holes should be logged with reliable logging equipment. In order to limit expenditures on such logging, I recommend the purchase of a hand logging device consisting of a probe, several hundred feet of cable on a drum and a sensitive recording geiger or scintillation counter such as that offered by Urinco in Grand Junction. These do not yield a continuous record of hole radioactivity, but if read and recorded every one-half foot the resulting information will suffice for rough ore calculations. If more accurate records are desired a commercial logging company can be contracted to produce a continuous gamma log for specific holes.

Geologic Supervision:-

It is recommended that an engineering geologist be employed to supervise the drilling project. He would not be needed on the project continuously but should be available to log the holes, make changes in hole locations and do other tasks which involve geologic decisions. In order to properly

supervise the project the geologist would have to spend about 18 days on the property. Payment for this work based on $75.00 per day would total $1350. Per diem for the 18 days @ $16.00 per day would total $288.00 and travel would total about $360.00 giving a grand total of $1998.00.

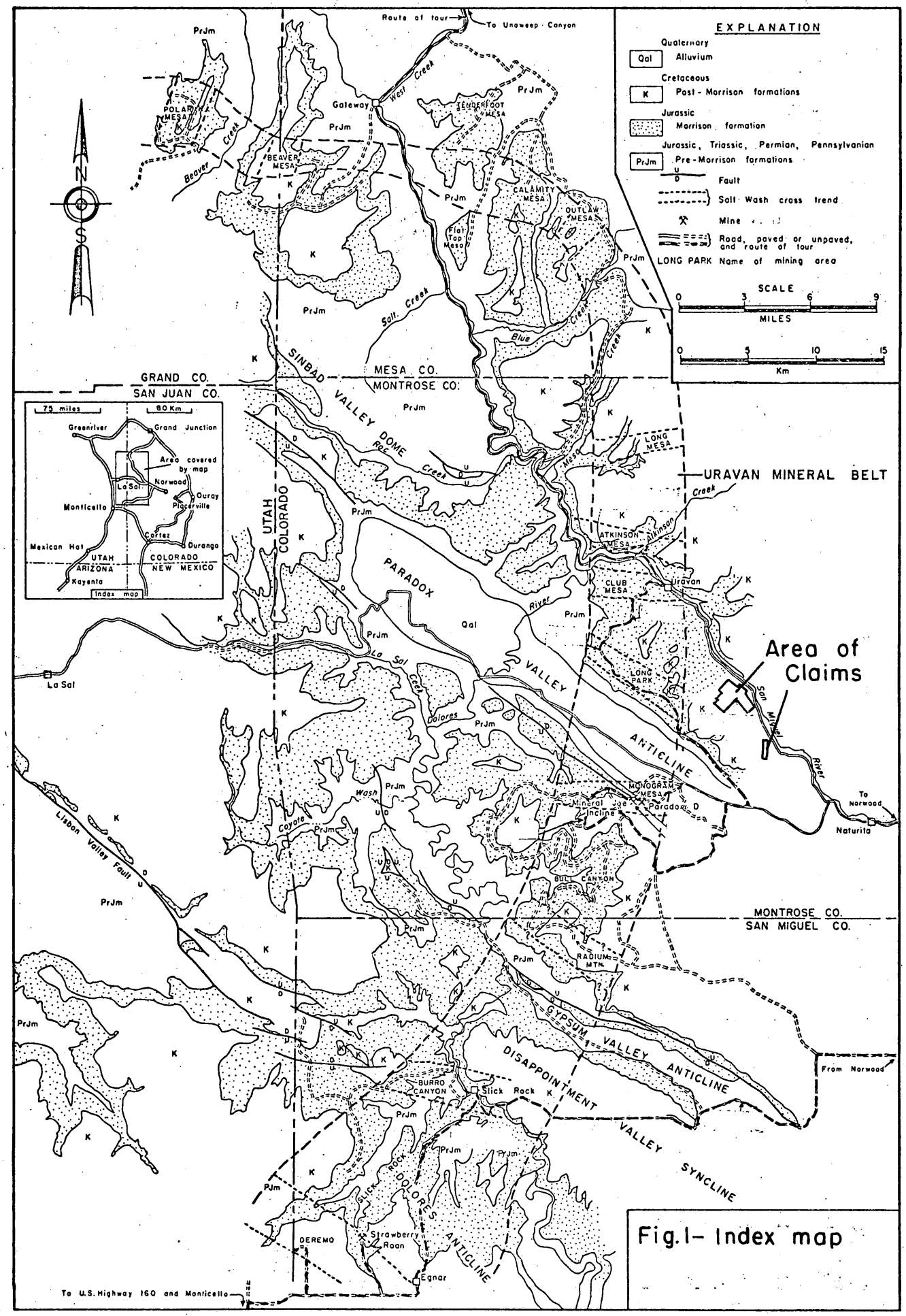

Fig. 1- Index map

Fig. 2

See envelope for
Map 1-360

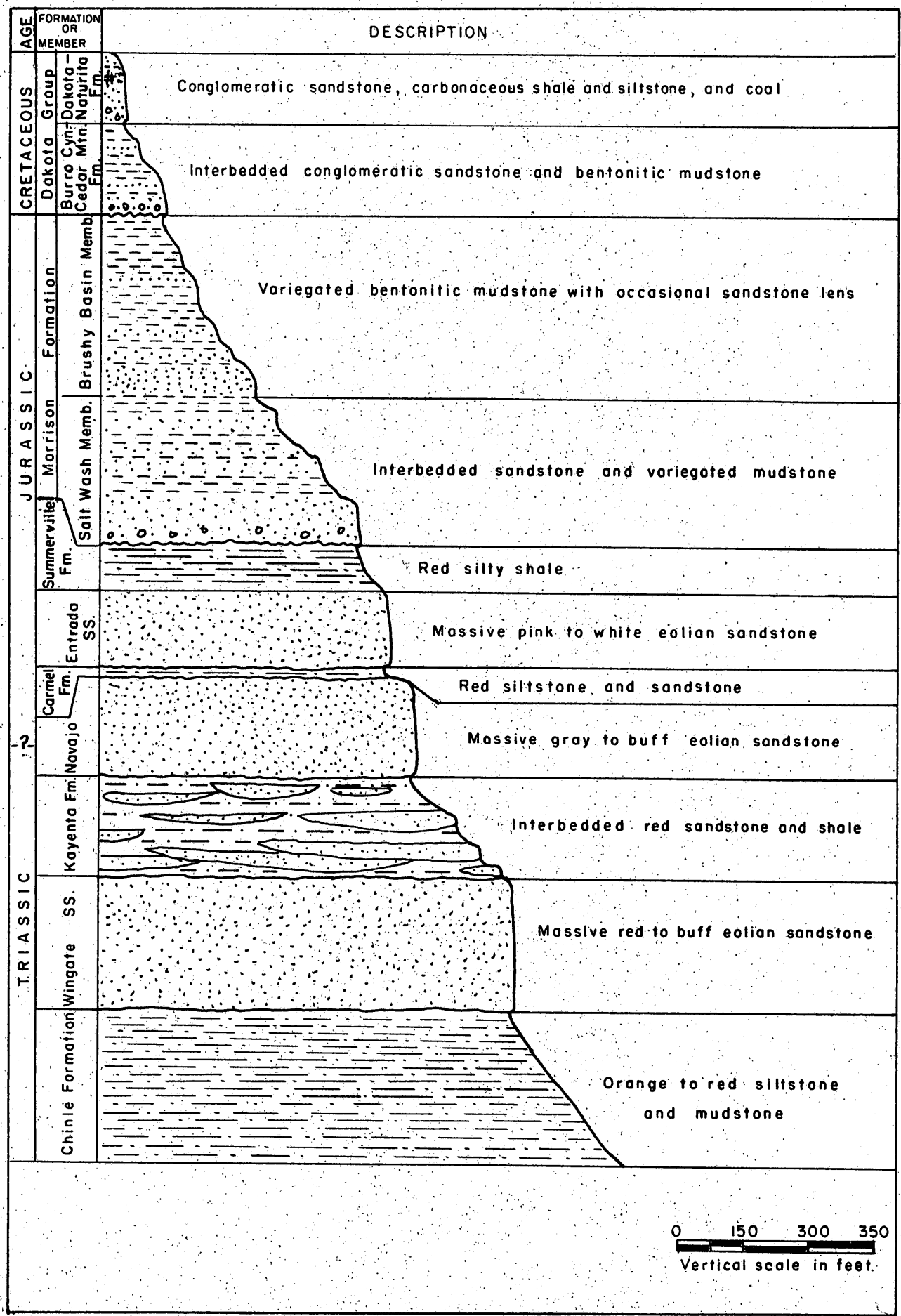

Fig. 3 – Stratigraphic section

Figures 4 & 5

See envelope for
Map I-360

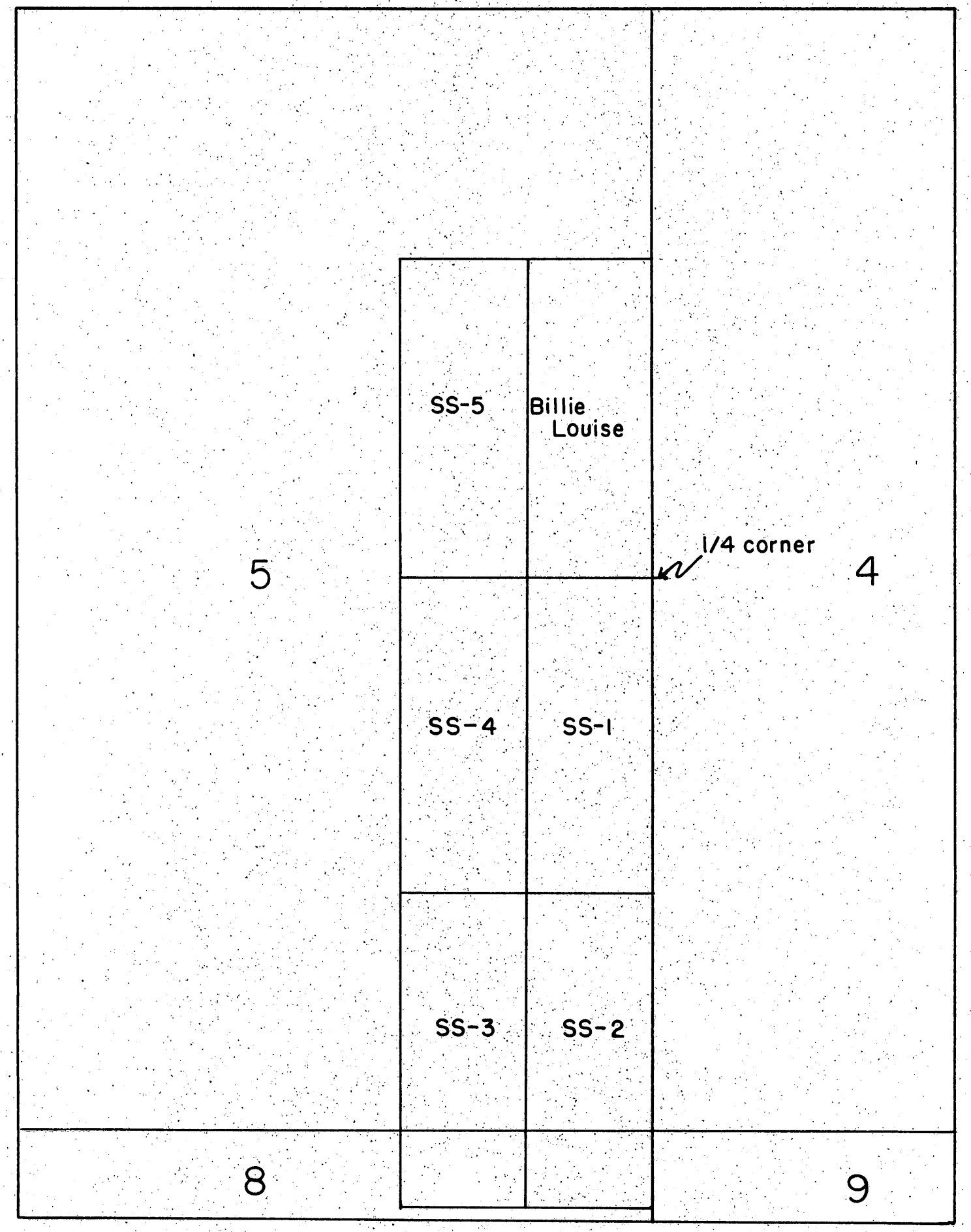

Fig. 6— Sunset claims

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5-23	Weeks	
5/23/72	Kirkemo	
5/24	Gar	

MAY 25 1972

Madden and Bell
R. R. 1, Box 106
Palisade, Colorado 81526

Re: OME-6830 (Uranium Vanadium)
Madden and Bell
Little Bob, et al., Claims
Montrose County, Colorado

Gentlemen:

Careful study of your application for financial assistance in exploring your Little Bob, Red Bird and Sunset groups of claims and of other information available to us indicates the probability of disclosing significant uranium - vanadium ore reserves is not sufficiently promising to justify Government participation in the proposed exploration. Accordingly, we regret to inform you that your application is denied.

We wish to thank you for your interest in the minerals exploration program.

Sincerely yours,

Harold Kirkemo

Harold Kirkemo
Chief, Office of
Minerals Exploration

cc: DRF
Mineral Resources
OME reading file
Region III
Mr. Kirkemo
Mr. Weeks
130

RWeeks:cac 5/23/72

MME Form 7
(2/63)

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Date	Surname	Code
5-23	Weeks	
5/23/72	Kirkbemo	

May 23, 1972

Memorandum

To: The File

From: Robert A. Weeks

Subject: OME-6830 (Uranium-Vanadium)
Madden and Bell
Little Bob, Sunset, Red Bird Claims
Montrose County, Colorado

Justification for Denial of Application

The applicant proposed to explore at depth for uranium-vanadium ore bodies in the Salt Wash Member of the Morrison Formation by rotary drilling some 50 holes in four areas. Estimated cost of the project, as originally requested by the applicant totalled $128,160, but was subsequently reduced to $64,080.

The applicant's property lies east of the favorable area known as the Uravan Mineral Belt, within which the majority of the more than 1,500 known uranium-vanadium ore bodies in the region have been found. Some 22 exploration holes have been drilled within the limits of the applicant's ground, three by the Geological Survey and the rest by various companies and private interests. None of these are known to have intersected high grade material, some are reported to have cut low grade ore and records are not available for some of them. Limited production of 20 tons of relatively low grade ore has been made from a single small deposit, and even more limited production from a single mineralized log from a second location. The area was generally classified on the basis of Geological Survey drilling and mapping as being semifavorable to unfavorable with small patches of favorable ground. The sparse mining activity and modest exploration effort that has been attempted has not resulted in viable mining operations thus far. Exploration on an adjacent property is reported to have outlined an ore body in 1969, but no mining has yet been attempted on it.

The Field Examiner concluded on the basis of an on-site study of the surface geology and examination of two small adits, a review of the available records and published data, and discussions with geologists familiar with the region that there is little likelihood of finding an ore body of sufficient size and grade to repay the costs of exploration as proposed. He indicates that grade of the ore as mined in the one small body found thus far would be about equal in value ($22.98 per ton at May, 1972 prices) to the cost of mining. He recommended that the application be denied.

In view of the absence of data that would indicate a favorable target the geologic probability of finding an ore body of significant size and grade is too small to justify the amount of exploration proposed. I concur with the Field Examiners recommendation to deny the application.

Robert A. Weeks

cc: DRF
Mineral Resources
OME reading file
Region III
Mr. Kirkemo
Mr. Weeks

RAWeeks:cac 5/23/72

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
FEDERAL CENTER, DENVER, COLORADO 80225

Office of Minerals Exploration
Building 53 Room 28

May 18, 1972

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Memorandum

To: Chief, Office of Minerals Exploration

From: Field Officer, Region III

Subject: OME-6830 (Uranium-Vanadium)
Madden and Bell
(Little Bob, Sunset, Red Bird Claims)
Montrose County, Colorado

Transmitted herewith is a Report of Examination with accompanying illustrations on the subject property recommending that the application be denied.

J. William Hasler

J. William Hasler,
Field Officer, Region III
Office of Minerals Exploration

Enclosures

UNITED STATES

DEPARTMENT OF THE INTERIOR

ROGERS C. B. MORTON, SECRETARY

U. S. GEOLOGICAL SURVEY

OFFICE OF MINERALS EXPLORATION

REPORT OF EXAMINATION

REGION III

OME-6830 (Uranium-Vanadium)

MADDEN & BELL

(Little Bob, Sunset, and Red Bird)

Montrose County, Colorado

By

J. William Hasler

Geologist

May 1972

cation Report

ILLUSTRATIONS

Figure 1. Index Map, showing area of claims and Uravan Mineral Belt, Colorado.

2. Little Bob claim map showing proposed drilling areas.

3. Stratigraphic section.

4. Geologic map of claim areas.

5. Red Bird claim map showing proposed drilling.

Introduction and Summary

The applicants, Mr. Ralph Madden and Mr. Albert Bell, applied to the Office of Minerals Exploration for financial assistance in minerals exploration to explore for uranium-vanadium ore deposits in the Jurassic Morrison Formation just east of the Uravan Mineral Belt some seven miles south of Uravan, Montrose County, Colorado. The applicant has applied to explore by rotary drilling in some fifty holes in four areas that appear to be possible extensions of ore-bearing channel-filled sandstone on the Little Bob, and Red Bird Claim groups. The estimated total cost of the proposed exploration is $64,080.00.

A field examination and a subsequent detailed study of the applicant's property shows that the area under consideration herein lies considerably east of the so-called Uravan Mineral Belt in Jurassic Morrison sandstones that are classified as being semifavorable, unfavorable with small patches of favorable ground. Additional drilling has been done in the area by private mining companies with apparent poor and unfavorable results as very little mining activities have been attempted except for the small tonnage mined by the applicant. The grade of material mined is not too good, even though the vanadium assay was well above the average grade mined from the Uravan Mineral Belt. An average grade of 1.5% V_2O_5 is considered good for overall mining in the Colorado Plateau. Additional mining and exploration work should be performed by the applicant on his own account, to further prove the property before obtaining assistance from the Office of Minerals Exploration. Because of the unfavorableness of the property in general, it is recommended that the application be

denied, as the likelihood of discovering significant reserves of uranium and vanadium at this time are not promising.

Recommendations

Results of a field examination and subsequent detailed study of the applicant's property shows that there has not been enough mining and exploration work done to thoroughly test the ground. Drilling that has been completed indicates that the property generally is semifavorable to unfavorable and contains only small patches of favorable ground and that the chances of discovering significantly large ore bodies of uranium-vanadium are not good. It is therefore recommended that the application be denied at this time.

Location Accessibility

The applicant's Little Bob, Red Bird, and Sunset Groups of claims consist of 57 uranium claims located in the Vixen Mining District, near Uravan, Montrose County, Colorado (Fig. 1). The claims are located in Secs. 5 and 8, T. 46 N., R. 16 W., Secs. 29-32, T. 47 N., R. 16 W., Secs. 24 and 25, T. 47 N., R. 17 W., Figure 2. The claims are either owned or leased by Mr. Ralph Madden, Palisade, Colorado. The claims may be reached from Grand Junction, Colorado, by travelling 9 miles southeastward on U. S. Highway 50 to Whitewater, Colorado, then proceed southwestward on Colorado State Highway 141 through Gateway, Colorado to Uravan, Colorado a distance of 81 miles. Proceed seven miles south of Uravan, Colorado then turn right on an unimproved dirt road that is usable only by trucks or 4-wheel drive vehicle for some 3 miles to

the claims. The road is passable only in dry weather. Should the property be further developed an access road to the claims up Horsethief Draw would be a shorter and more accessible route to the claims. The applicant proposed such a road in his original application.

History, Production and Ownership

The claims, either owned or leased by Mr. Ralph Madden, have been staked by him, purchased or leased at various times from 1967 to 1970. The claims and the general area of the claims have been drilled in times past, as a part of the U. S. Geological Survey's exploration drilling program in the Long Park area, and by private mining companies and individuals, such as Union Carbide Mining Corporation, King Resources, Henry Clark and Lowell Stotts. Some 22 holes have been drilled on the property. Most of them were drilled for Lowell Stotts in 1968, and Hank Clark drilled some holes in 1969.

According to the applicant's consulting geologist, it is reported that some of the holes penetrated low grade ore; however, this has not been confirmed. Close-spaced drilling in 1969 by Reed and Williams, on the property adjoining the applicant's claim on the south reportedly outlined an ore body in the third rim trending into the Little Bob claims. A small pod of ore was mined from the second rim and a mineralized tree in the third rim. The ore pod lies in a channel-fill sandstone on Claim No. 9 in Horsethief Draw. Some 20 tons of ore was mined from this pod that averaged about 0.12% U_3O_8 and 2.36% V_2O_5. The pod occurred at the base of a N. 85° E. trending sandstone-filled channel that has

a width of about 75 feet and a thickness of about six feet--the channel is truncated a short distance updip but appears to thicken downdip (eastward). No concerted effort has been made as yet to follow the channel downdip, due largely to a general lack of funds available to the applicant.

A mineralized tree was mined from a thick N. 20° E. trending channel in the third rim along the west side of Horsethief Draw near the east end of the Little Bob No. 6 claim.

Eight of the holes drilled on the property were located to the west of this show apparently in an attempt to evaluate this favorable appearing sandstone updip from the draw. Reports of the driling done by Lowell Stotts in 1968 are unknown but the few logs that were available gave no sign of ore grade material. Little is known about the drilling completed by Reed and Williams on the adjoining claims to the south of the Little Bob group. However, a large number of closely-spaced holes are visible in upper Horsethief Draw and trend about N. 60° E. directly to the boundary of the Little Bob claims. Results of the drilling have not been released but they were reportedly following an ore body in the third rim that averaged 16 feet in thickness.

The exploration drilling done by the U. S. Geological Survey (Holes LP-520, LP 1352, LP-1357) in the sections on which the applicant's claims lie indicates that the claims are in ground classified as semi-favorable and unfavorable with small patches of favorable ground. The majority of the holes drilled are barren. Thickness of the ore-bearing sandstone ranges from 12 feet to as thick as 90 feet but average (numerical) about 44 feet in thickness. The ore-bearing sandstone

ranges from light brown, light brown gray to light gray, the mudstone is mostly gray-green, there is very sparse to sparse carbon shown as logged. Gamma-ray logs show the eU_3O_8 is spotty and is usually less than 0.008. The applicant's map (Fig. 1, Index Map) shows the location of the claims in relation to the Uravan Mineral Belt. The claims lie a considerable distance east of the Uravan Mineral Belt.

Financial Eligibility

The applicant, Mr. Madden, owns the drilling equipment and proposes to provide his share (50%) of the costs of an OME contract for uranium, by using his equipment, and labor. The estimated, revised costs for the exploration program total $64,080.00. The applicant's share of the total, should a contract be executed, would be $32,040.00 or 50% of the total. Even though the revised program is small, it is doubtful that the applicant's labor and use of his equipment would adequately cover the 50% participation figure. The applicant states he can finance his share of the proposed program from his own personal funds, a bank loan, plus the labor and use of the equipment, should he be offered a contract.

Geology

General

The rocks exposed in the Long Park area of the Uravan district are marine and terrestrial formations ranging in age from late Paleozoic to late Mesozoic. Quaternary alluvium and landslide material

are present locally.

All known uranium-vanadium deposits in the area are in the Morrison formation of late Jurassic age except for one small prospect in a conglomeratic bed in the overlying Burro Canyon formation of Cretaceous age. The Morrison formation is divided into two members, the Salt Wash member, and the overlying Brushy Basin member. This report is concerned with proposed exploration for ore deposits in the sandstone units of the Salt Wash member of the Morrison formation. A generalized stratigraphic section for the area in the vicinity of the claims is given in figure 3, and a detailed description of individual formations is presented below.

The ore-bearing Salt Wash member of the Morrison formation averages about 300 feet in thickness and is made up of terrestrial sandstone, siltstone, and mudstone beds. About 50 percent of the Salt Wash is made up of sandstone units, although the ratio of sandstone to siltstone and mudstone varies considerably within short distances. Generally three to five sandstone units, each 20 or more feet thick, are present along the outcrop of the Salt Wash. Such sandstone units are a few hundred feet to several thousand feet in horizontal extent.

Most uranium-vanadium deposits in the Long Park area are contained in the upper 100 feet of the Salt Wash member. The sandstone units in this stratigraphic zone are crossbedded and medium- to medium-fine-grained. Locally they are quartzitic and are brown, light

gray, light red or white and contain varying amounts of limonite, disseminated pyrite and carbonaceous material. Cut and fill structures, ripple marks, current lineations and rill marks suggest that the Salt Wash was deposited under fluvial conditions. Mudstone and siltstone in contact with upper sandstone units of the Salt Wash are generally red, reddish brown, green and gray. Interstitial clay, clay pellets and thin seams of mudstone are included in the sandstone units. Disseminated pyrite and carbonaceous material are found in some mudstone and siltstone beds. The contact of the Salt Wash member with the overlying Brushy Basin member is gradational, although there is a marked contrast in the overall appearance of the two members.

The Brushy Basin member, which is about 400 feet thick in the Long Park area, is made up of variegated shale, claystone and mudstone beds, that range in color from pure white to pastel shades of red, blue, and green. These fine-grained rocks are interbedded with sandstone and conglomeratic units. A few thin layers of quartzitic sandstone and siliceous limestone are also present. The shale and mudstone beds are bentonitic and form smooth rounded slopes covered with a loose, fluffy layer of material caused by swelling of the bentonite.

The Burro Canyon formation is a hetergeneous sequence of lower Cretaceous conglomerate, sandstone, shale and thin lenses of limestone that overlies the Brushy Basin member of the Morrison formation. Crossbedding and festoon structures indicate a fluvial origin. The

lower contact is indistinct and the formation appears to interfinger with the upper part of the Morrison formation. The upper contact is an erosional surface of regional extent. In the vicinity of the subject property the Burro Canyon averages from 50 to 125 feet in thickness.

The Long Park area lies on the northeast flank of the Paradox salt anticline which trends in a northwesterly direction. The beds dip from 2° to 9° but high on the flank of the Paradox anticline, the dip steepens to as much as 15°. The strike of the bed is generally N. 45° W. High angle faults and intensely jointed strata are common along the sides of Paradox valley. The best developed joint system in the Long Park area parallel the strike of the northwest trending Paradox anticline, and another set of joints strikes essentially normal to the trend of the major structure.

Ore Deposits

Most of the uranium-vanadium deposits in the Long Park area are found in sandstone units in the upper 100 feet of the Salt Wash member of the Morrison formation. Mineralized rock consists principally of sandstone impregnated with uranium and vanadium minerals in a ratio of 1 to 6. Small amounts of uranium and vanadium are contained in mudstone pebbles and seams or replace carbonaceous material. Ore bodies range from small irregular masses containing a few tons of ore to large tubular masses containing thousands of tons of ore. Mineralized rock lies essentially parallel to the sandstone beds but

does not follow the beds in detail. In some deposits the highest grade of ore occurs in sharply bounded elongate concretionary structures or "rolls" which cross bedding planes.

Mineralized rock at or near the surface is sandstone impregnated with carnotite and its calcium analogue tyuyamunite. Metatyuyamunite, rauvite, pascoite, hewettite and hummerite have also been identified in the oxidized ores. Less oxidized minerals including uraninite, coffinite, corvusite, and montroseite are found at greater depths. Copper minerals are rare in the upper sandstone units of the Salt Wash. A few small but high-grade deposits, present in lower sandstone units of the Salt Wash member, contain substantial amounts of secondary copper minerals associated with uranium-vanadium minerals.

The origin of the ore and factors that controlled its localization are little understood. Primary sedimentary structures in the ore-bearing sandstone units apparently are closely related to localization of ore. Trends of sedimentary structures are generally easterly to southeasterly. The strike of mineralized logs and the long axes of ore bodies are nearly parallel to the strike of primary sedimentary structures. En echelon arrangement of ore bodies is probably caused by en echelon arrangement of these structure.

It does not appear that origin and localization of uranium and vanadium deposits are related to fractures. Apparently fractures served as avenues for secondary migration of small amounts of uranium-vanadium leached from early ore minerals by ground water solutions. Known faults that cross ore deposits in the area displace ore layers and some faults contain breccia derived from ore layers.

Geologic features and habits of ore bodies useful in exploring for uranium and vanadium deposits have been recognized through drilling experience and geologic studies. The following geologic guides (Weir 1952) were used by the Geological Survey in exploring for ore deposits in the Long Park area:

1. The ore-bearing sandstones are 25 feet or more thick in the vicinity of ore deposits.

2. The ore-bearing sandstones are dominantly light brown or light gray and have no reddish cast in the vicinity of ore deposits.

3. Mudstone and siltstone in contact with ore-bearing sandstone is green or gray near ore deposits instead of red or reddish brown.

4. The ore-bearing sandstone commonly contains abundant limonite stains or disseminated pyrite near ore deposits.

5. Carbonized plant remains are abundant in or near ore deposits.

No single one of the foregoing guides is persistent enough to be used alone in appriasing favorable ground.

Ore Reserves

There are no known ore reserves on the property.

By U. S. G. S. standards indicated and inferred reserves of class I material found by Geological Survey drilling in the Long Park area total about 250,800 short tons averaging 0.31 percent U_3O_8 and 2.04 percent V_2O_5.

Class I reserves are 1 foot or more thick and contain 0.10 percent

U_3O_8 or 1.0 percent V_2O_5 in accordance with the Atomic Energy Commission purchase price and the mill cutoff for vanadium.

Geology

Areal

In the area of the claims the Morrison Formation consists of two members -- the Salt Wash Member and the overlying Brushy Basin Member. The Salt Wash member lies with a slight unconformity on the underlying Summerville, and is composed of about 350 feet of interbedded red to green mudstone and massive channel-fill sandstones. The lower hundred feet is primarily red mudstone whereas the upper portion commonly is composed of two or three distinct ledges or "rims" formed by channel-filled sandstone complexes separated by mudstone beds. The sandstones are considered orogenic and represent deposits of an ancient braided-channel system devoted to transporting great volumes of clastic sediments. The sandstone ledges vary in thickness up to more than 100 feet and consist of innumberable scour-and-fill channel segments, (sometimes separated by thin mudstone partings) which reflect the composite nature of the units. Maximum thicknesses generally occur high on the salt anticlines where they coincide with "Rim synclines" related to the old salt structures. Some channel segments are very short whereas others can be traced for nearly a mile before losing their identity by shallowing out or by being cut off by other scours. Thickness of sandstone in these segments range up to 40 feet. In the vicinity of the claims,

only the two upper ledges of sandstone (2nd and 3rd rims) are present. Channel trends in these two sands differ considerably -- those in the second or middle rim trend N. 80° to due E., and those in the 3rd rim trend 50° - 60° E. (Figs. 2, 4 and 5).

The beds on the Little Bob, Red Bird and Sunset claims dip about 2° northeastward. Jointing is quite pronounced in the resistant sandstone ledges, but no faults were noted on the property.

The consulting geologist reviews the geology and the occurrence of ore deposits in the Uravan Mineral Belt, Figure 1, stating, of course, that throughout the belt uranium and vanadium has been mined primarily from channel-fill sandstones in Salt Wash Members of the Morrison Formation, and that the major ore deposits occurred on the flanks of the breached salt anticlines where subsiding "rim synclines" allowed thicker accumulation of sand in Salt Wash channels, and that the uranium deposits occur in two or three rims and/or benches with some 95% of the uranium occurring in the upper rim. The host sandstones are generally gray to white, or tan with brown specks, fine to medium grained, well sorted and contain abundant carbonaceous material including fossil logs. The more favorable channels are up to 40 feet thick interbedded with and underlain by gray-green mudstone.

Ore has been shipped from approximately 1500 deposits in the mineral belt from deposits ranging in size from a few tons to more than 200,000 tons with more than half of the production coming from ore bodies larger than 25,000 tons.

Nearly all of the ore bodies are tabular, irregularly bedded masses, and they may range up to 30 feet in thickness and 1,250 feet in length, but the average ore body is about four feet thick, 75 feet long and 20 feet wide. Carbonaceous debris, which furnished a reducing environment, and local mudstone lenses which served as permeability barriers apparently were agents in localizing such ore bodies. Smaller but higher grade bodies are found as halos around fossil trees or as "C"=shaped rolls marking the position of a solution interface.

Primary ore minerals include uraninite, coffinite and montroseite. All tend to replace cement, sand grains or carbonaceous material. Secondary ore minerals are corvusite, tyuyamunite, carnotite, and others. Gangue minerals include barite, sulfides and carbonates. The average uranium vanadium rate is about 1:5 and most ores are essentially in radioactive equilibrium.

It might be noted here that the applicant's property lies east of the Uravan mineral belt as shown on Figure 1 and maps of the area, (geologic, and mine location maps available to us) show considerably fewer mines and/or prospects throughout the property than occur within the mineral belt, even though some of the ore channels may trend into the applicant's property. There is little evidence of much production having come from this immediate area.

Applicant's Proposal

The applicant's original proposal consisted of rehabilitating some existing roads into the claim area as well as to build a mile of new road from the highway up Horsethief Draw to the Little Bob claims. The new road would shorten the distance to the property by some 2 miles or more. A proposed two stage drilling program consisting of 50 relatively wide-spaced holes, in the first stage and 50 more closely-spaced holes on Stage II. Average depths of hole would be 200 feet, at an average cost of $3.00/foot or $60,000.00 for the drilling. The original application was a request for a total of $128,160.00, to be expended in minerals exploration.

During the processing of the application, the applicant was requested to scale down the size of his request for a more modest and realistic exploration program, as well as one that would suit his own financial means. Consequently, he revised his exploration program and has submitted one that would total some $64,080.00. The applicant proposes to drill a total of 50 holes in three areas on the Little Bob claims and in one area on the Red Bird claims. Total estimated footage is 9,175 feet a total of $64,080.00 is nearly $7.00/foot of drilling, including supervision, labor, and use of equipment. The applicant intends to explore along three possible channels on the Little Bob Claims as shown on Figure 2, accompanying the application, and to explore on a possible northeast trending channel on the Red Bird claims.

Examiner's Evaluation

The property was examined by J. W. Hasler, geologist, U. S. Geological Survey, on April 14 and 15, 1972 in company with Mr. Ralph Madden, the applicant. Results of the field examination indicates that the chances of discovering significant new ore bodies of uranium and vanadium are not too promising on the applicant's claims at this time, for the following reasons:

The applicant has mined from only two small adits in a channel-fill sandstone that outcrops on the Little Bob Claim No. 9. As was pointed out by the applicant's consultant only 20 tons of ore had been mined that averaged about 0.12% U_3O_8 and 2.36% V_2O_5. The channel fill sandstone appears to be truncated a short distance updip, but does appear to thicken downdip. The applicant has made no concerted effort to drill, largely due to lack of financial support. Some drilling should be done here, however, it is unlikely that there would be any large ore bodies discovered here as the material mined to date is not very high grade and it is doubtful that an ore body as large as 15,000 tons would be found. The Woodrow Gripe property across the San Miguel River east of the property only produced $600.00 worth of ore.

Considerable drilling has been done in the area by the U. S. Geological Survey, as well as by several private individuals. The Survey classified the ground as being semifavorable and unfavorable with small patches of favorable ground. Results from private drilling were undoubtedly unfavorable as no further exploration drilling or mining has been done since the drilling was completed. It is reported that King Resources drilled a series of holes northeast of the

proposed trend off the Little Bob claim Nos. 4 and 22, however, in a recent discussion with Mr. Ed Pinnick, Geologist, Union Carbide, Grand Junction, Colorado who is assigned to the Uravan area, he indicated that the drilling completed by King Resources was not encouraging and that the area of the applicant's claims were much less promising than areas within, or even along the edges of the Uravan Mineral Belt. He concurred with my conclusions that the area appeared to be considerably less favorable than some adjacent areas and that the potential for the occurrences of large ore bodies of significant grade and size are not good. The purchase price for uranium is lower than it was a year ago. The cost of mining at present, including the exploration allowance is between $18.00 - $20.00 per ton, however, some leasing operations can mine for about $10.00 per ton, but this is the exception rather than the rule. Uranium assaying about 0.12 percent U_3O_8 ore would bring about $3.50 per lb. Vanadium will bring about $6.60 per unit. The 2.36 percent V_2O_5 would bring about $13.20. However, it is very doubtful that this grade of vanadium could be maintained, as a 1.5% vanadium assay is considered good for overall mining in the Uravan area. The 20 tons of ore mined at the grade reported would gross approximately $17.00 per ton at current prices. The ore mined is unusually high in vanadium but is low in uranium.

Union Carbide at Uravan May 1972 value
$1.51 per lb. = 3.62 U_3O_8
0.41 per lb = 19.38 V_2O_5
22.98

Note: Figures penciled in were obtained 5/23/72 from A.E.C. RAW.

It is advisable that the applicant do some more definitive drilling and some additional mining on his own account along the channel on the Little Bob claims No. 9 to more thoroughly explore the pod of ore mined there.

It appears that the area within the claim group lies too far down the flank of the Paradox Valley anticline for the occurrence and development of large ore bodies. Because of these unfavorable circumstances it is recommended that the application for financial assistance in minerals exploration be denied, as the possibilities of discovering significant new ore bodies of uranium and vanadium on the applicant's claims are not good at the present time.

OME 6830

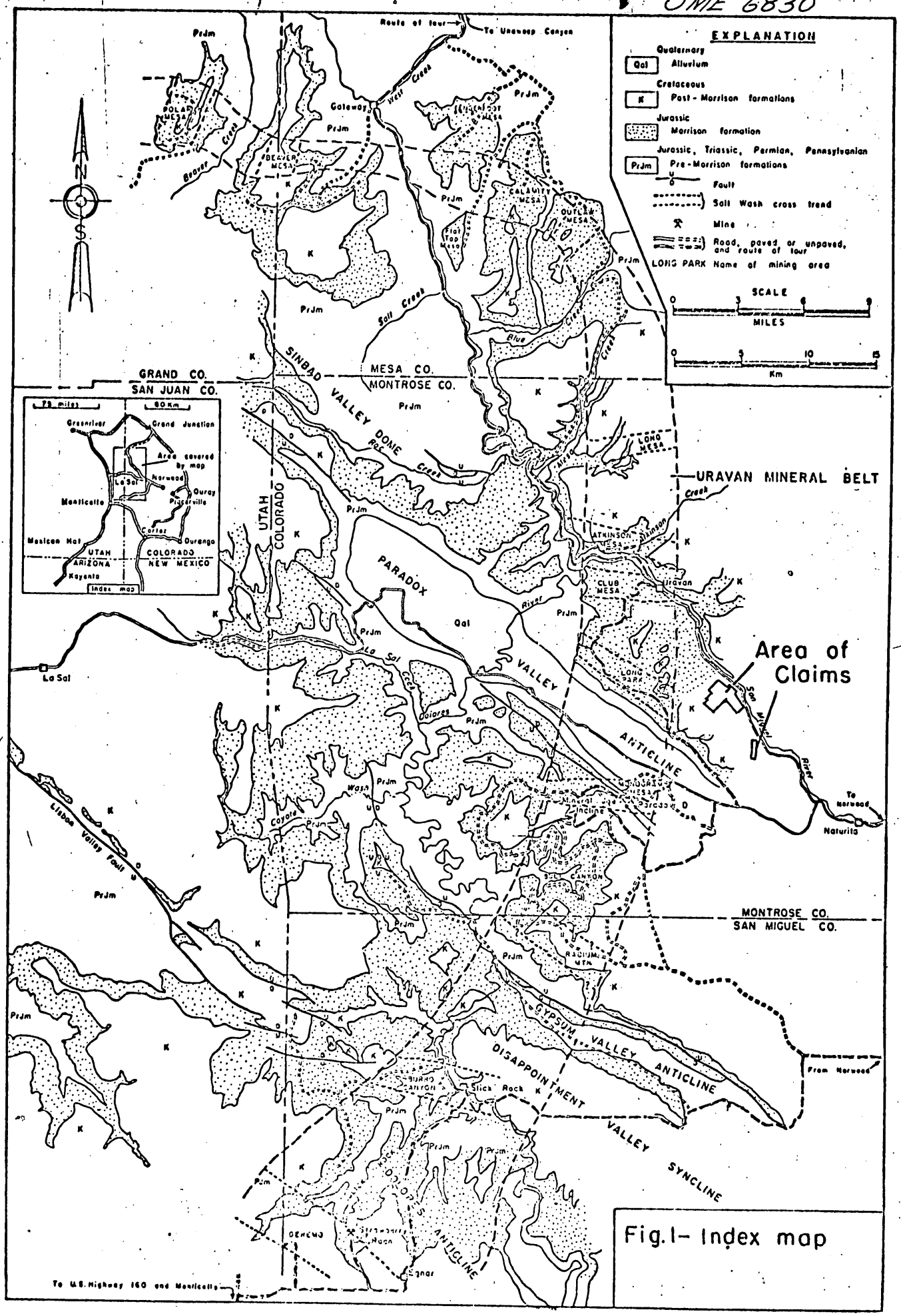

Fig. I- Index map

OME 6830

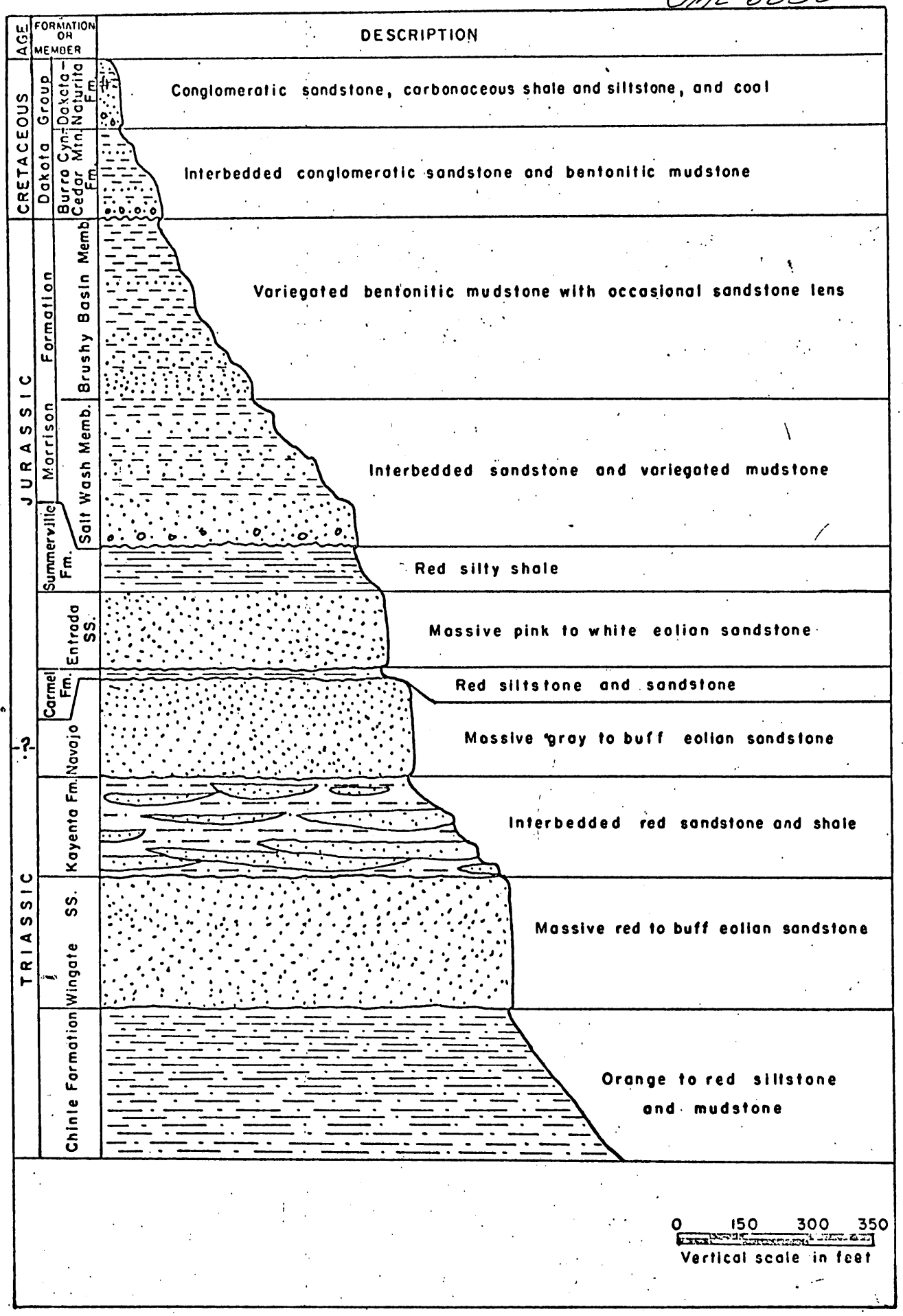

Fig. 3 – Stratigraphic section

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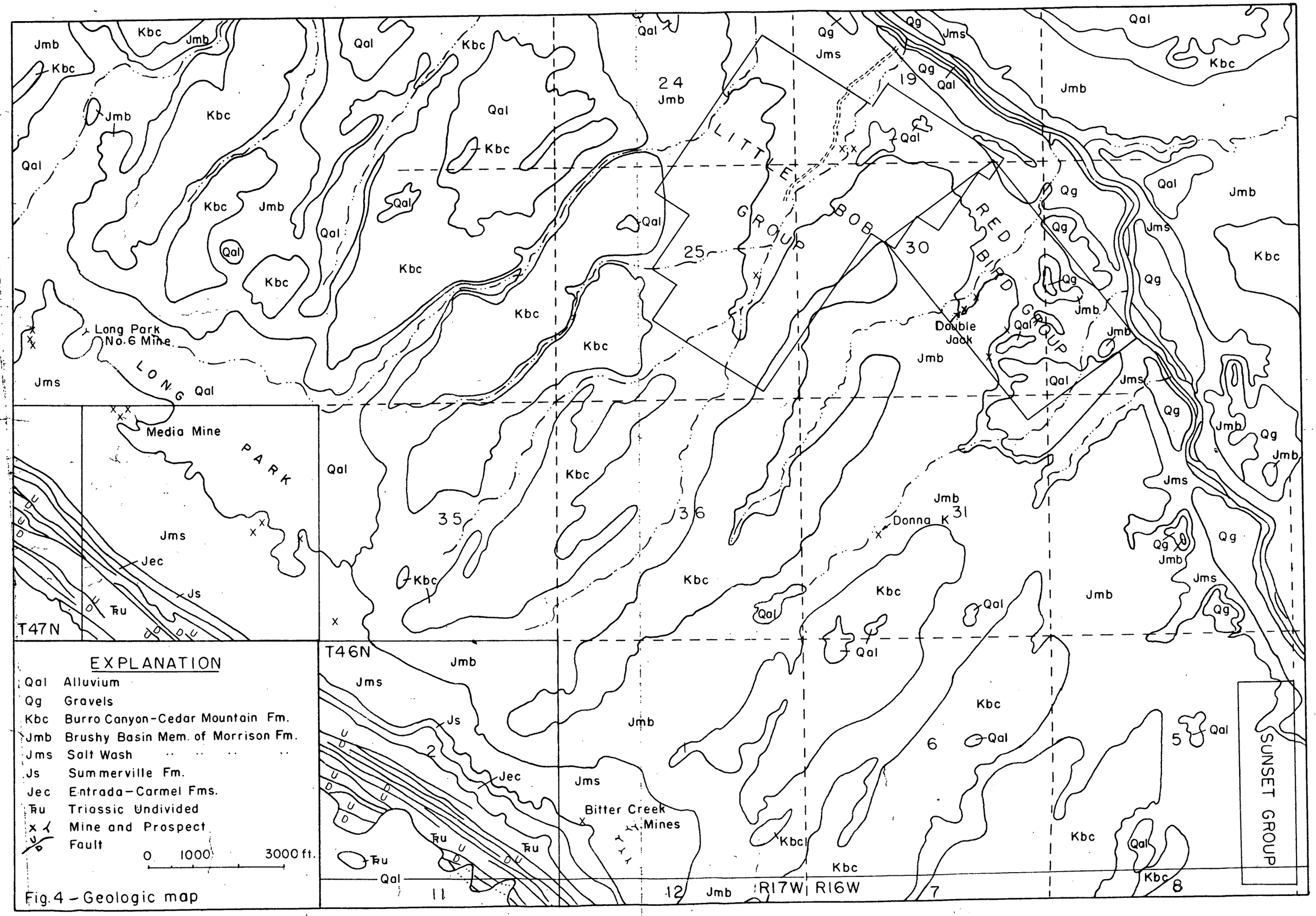

Fig. 4 – Geologic map

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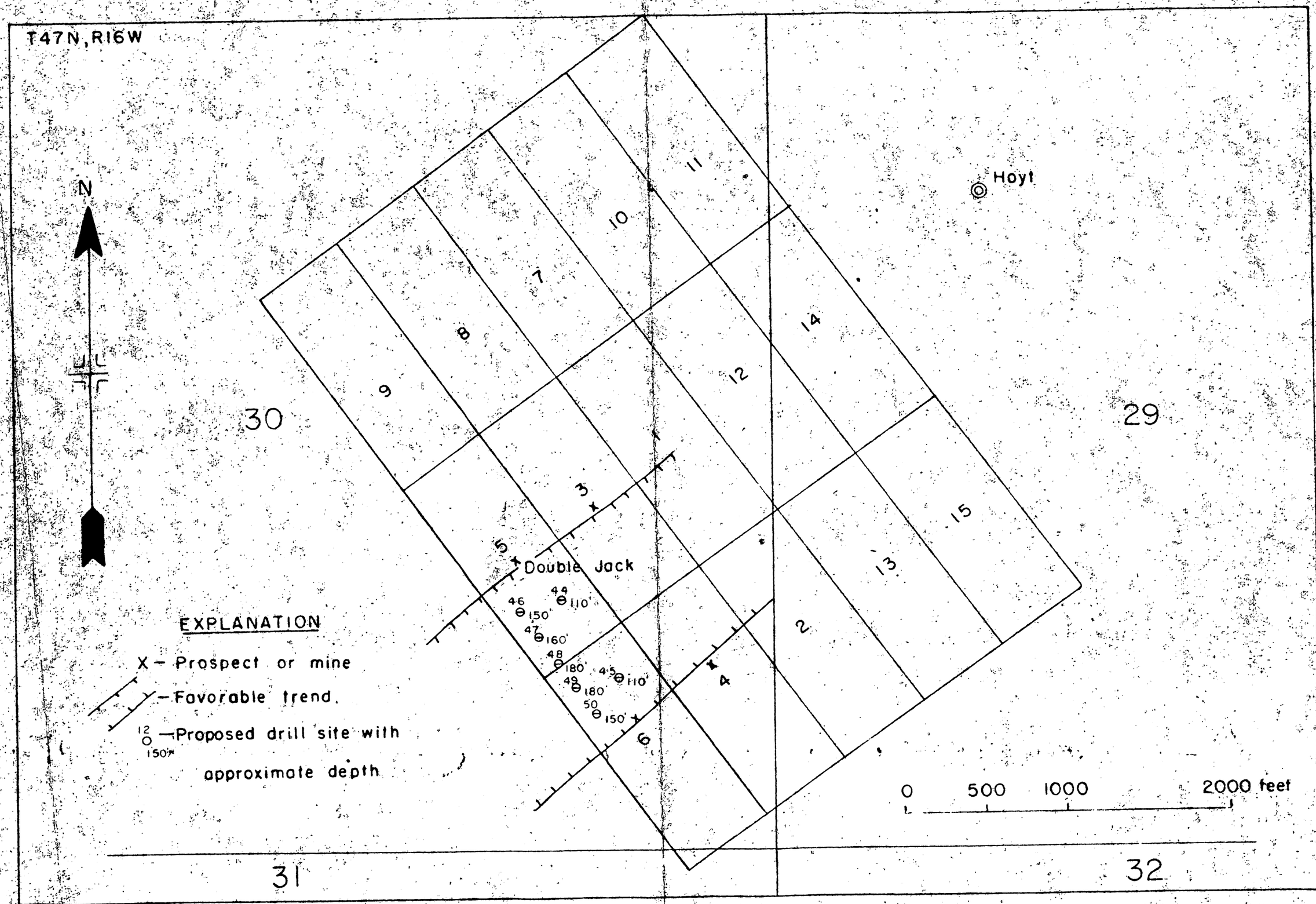

Fig.5— Red Bird claim map

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
FEDERAL CENTER, DENVER, COLORADO 80225

Office of Minerals Exploration
Building 53 Room 28

COPY
O. M. E.
RECEIVED
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March 7, 1972

Memorandum

To: Chief, Office of Minerals Exploration

Through: Assistant Chief, Office of Minerals Exploration

From: Field Officer, Region III

Subject: OME-6830 (U, V)
Madden and Bell
Little Bob, Sunset and Red Bird
Montrose County, Colorado

Mr. Ralph Madden contacted this office today, via telephone, informing us that he was obtaining new letters from two banking institutions concerning his application for financial assistance in minerals exploration. Copies of his letters should arrive in this office this week or next.

J. William Hasler

J. William Hasler,
Field Officer, Region III
Office of Minerals Exploration

MME Form 7
(2/63)

OFFICIAL FILE COPY

Date	Surname	Code
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AIRMAIL

JUN 30 1971

Madden and Bell
R. R. 1, Box 106
Palisade, Colorado 81526

Re: OME-6830 (Uranium-Vanadium)
Madden and Bell
Little Bob, et al., Claims
Montrose County, Colorado

Gentlemen:

On March 10, 1971, Mr. J. W. Hasler, Field Officer, OME Region III, requested additional information which is necessary to complete your application, but to date you have not furnished this.

If you need additional time to prepare this information, please let us know. If we do not hear from you within 30 days from the date of this letter, we must assume that you are no longer interested in proceeding with your application and we shall consider it as having been withdrawn.

We should mention that OME funds for fiscal year 1972, beginning July 1, 1971, will be much less than were available when your application was submitted. This will restrict the OME program to the point where only modest assistance will be available to a very few of the more promising proposals. Under the circumstances, we regret that we cannot consider your application for the full amount originally requested. Perhaps you could consider a less extensive exploration project if you decide to continue with your application.

Sincerely yours,

Harold Kirkemo
for

Harold Kirkemo
Chief, Office of
Minerals Exploration

cc: Director's reading file
Mineral Resources
OME reading file
Region III
Mr. Kirkemo

HKirkemo/cac 6/30/71

Office of Minerals Exploration
Building 53 Room 200

March 10, 1971

R 15 1971

INITIALS	CODE
	130
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HK	120
NE	120

Mr. Ralph R. Madden
Rural Route 1, Box 106
Palisade, Colorado 81526

Subject: OME-6830 (Uranium-Vanadium)
Madden and Bell
Little Bob et al Claims
Montrose County, Colorado

Dear Mr. Madden:

Although we discussed a number of items concerning your application during your visit here I shall indicate the items needed to complete your application as follows:

1. Financial Eligibility

(a) Your letters of request to the banks were for the full amount of the estimated cost ($128,160.00) rather than the Government's share ($64,080.00). Any new requests should be for the amount of the Government's share of the total estimated costs of the exploration project.

(c) You stated that your share of the costs of the project would be furnished in the form of labor and use of your own equipment. As we discussed here, it is likely that these contributions would not be sufficient to cover your share of a project especially if the total estimated costs were as much as $128,160.00. Under an OME contract, depreciation on an Operator's equipment is an allowable cost to the extent of 1/60 of the fair value or the book value, whichever is less, for each month actually used on the project. The Operator's share of the cost of an exploration project may be contributed entirely in cash or partly in cash and partly through depreciation of necessary equipment owned by the Operator and used on the project. The Government pays its share of the costs at the end of each month after a voucher for the costs incurred has been submitted and approved. As it usually takes two or three weeks to process a voucher, an applicant should have sufficient funds on hand to pay for all costs of the project for the first two or three months.

2. Applicant's Rights in Land:

(a) The Mining Lease dated June 30, 1970 between H. L. Smith, O. C. Madden, and R. R. Madden, A. L. and B. L. Bell does not state that N. L. Smith and O. C. Madden are sole owners of the property. The lease was not certified or recorded. It covers only the Red Bird 1 through 15 claims. Who owns the Little Bob group and where are the appropriate documents.

(c) The incomplete Lien and Subordination Agreements were given to you to correct, and/or to obtain new, correctly executed Lien and Subordination Agreements.

We discussed in detail how you should submit your exploration costs relative to the time you expect the exploration project may take for completion. I may be in the Grand Junction area within the next week or two and will contact you at that time.

Sincerely yours,

J. William Hasler

J. William Hasler,
Field Officer, Region III
Office of Minerals Exploration

cc: Chief, OME
OME-6830
OME chron
Mr. Hasler

MME Form 7
(2/63)

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Date	Surname	Code
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		120M

AIRMAIL

NOV 5 1970

Memorandum

To: Field Officer, Region III

From: Chief, Office of Minerals Exploration

Subject: OME-6830 (Uranium-Vanadium)
Madden and Bell
Little Bob, et al., Claims
Montrose County, Colorado

The subject application is referred to you for further study, a field examination if warranted, and your recommendations.

In the event you recommend a contract, the following deficiencies in the application would have to be corrected, probably under your direction, before a contract could be drafted. You will note that we do not mention the deficiencies in our letter to the Applicant informing him of the field referral because you have stated that he would be unable to furnish the information without undue delay. The comments apply to the numbered items on the reverse side of MME Form 40.

1. Financial Eligibility:

(a) The Applicant asked the banks for a loan in the full amount of the estimated cost ($128,160.00) rather than the Government's share ($64,080.00). No doubt the banks' replies would be negative any way, but the request should have been for the smaller amount.

(c) The Applicant states that its share of the cost of the project would be furnished in the form of labor and use of its own equipment. As you know, this is not sufficient to cover the Applicant's share.

2. Applicant's Rights in Land:

(a) The Mining Lease, dated June 30, 1970, between N. L. Smith, O. C. Madden, and R. R. Madden, A. L. and B. L. Bell does not state that N. L. Smith and O. C. Madden are sole owners of the property. The lease was not certified or recorded. It covers only the Red Bird 1 through 15 claims. Who owns the Little Bob group and where are the appropriate documents?

(c) The Lien and Subordination Agreements are incomplete. The land descriptions are inadequate--see options under footnote 2/, then follow one of the instructions exactly as requested. The entries on the line ending with footnote 3/ are incorrect. The entries should be Madden and Bell as stated on the front of the MME Form 40. The Lien and Subordination

Agreements for the Little Bob group suggest that the partners are the owners, but this is not mentioned in the application. Five copies of each Lien and Subordination Agreements are required, but only two were received. These are enclosed for your attention if you should recommend a contract.

Items 3 through 7:

Dr. Young's report on the property furnishes most of the information requested under these items. We note that the Geological Survey drilled a hole (LP-1357) on Little Bob Claim No. 20 and another (LP-520) on Little Bob No. 8 Claim. No information is furnished as to the results of these holes.

In your referral memorandum, dated October 27, 1970, you mention that Dr. Young should be asked to locate the exploration target areas. Perhaps these are the narrow belts shown on Figures 2 and 5 accompanying his report. The pattern of proposed holes within the belts may be more prospecting than exploration of specific targets, except perhaps those on Little Bob No. 9 Claim.

The Applicant's estimates greater costs for all items of work except drilling than Dr. Young estimates in his report. As you noted, the Applicant estimates a much longer time period for the project than is necessary. No bids were submitted for any of the work.

In conclusion, the primary question is the geologic probability of discovering a significant uranium-vanadium deposit on this property. There would be no need for the Applicant to prepare the information necessary to complete the application if geologic conditions are not favorable to justify expenditure of Government funds. Perhaps a field examination could be made when you are in the district on another examination or an interim inspection of a current contract.

Harold Kirkemo (gla)

Harold Kirkemo

Enclosures

cc: Director's Reading File
Mineral Resources
OME docket
OME Reading File
Mr. Kirkemo
130

HKirkemo/gla 11-5-70

MME Form 7
(2/63)

OFFICIAL FILE COPY

Date	Surname	Code
11/5/70		120
		220
		120M

AIRMAIL

NOV 5 1970

Madden and Bell
R. R. 1, Box 106,
Palisade, Colorado 81526

Re: OME-6830 (Uranium-Vanadium)
Madden and Bell
Little Bob, et al., Claims
Montrose County, Colorado

Gentlemen:

The application for assistance in exploring the subject property has been reviewed by the Washington Office and referred to Mr. J. William Hasler, Field Officer, Region III, Office of Minerals Exploration, U. S. Geological Survey, Room 203, Building 53, Denver Federal Center, Denver, Colorado 80225.

The Regional Office will notify you if additional information concerning the application is needed.

Sincerely yours,

Harold Kirkemo (gla)

Harold Kirkemo
Chief, Office of
Minerals Exploration

cc: Director's Reading File
Mineral Resources
OME docket
OME Region III
OME Reading File
Mr. Kirkemo

GLAult/a 11-5-70

October 30, 1970

Madden and Bell
R. R. 1 Box 106
Palisade, Colorado 81526

Subject: OME-6830

Gentlemen:

Your application for exploration assistance, dated May 21, 1970, submitted to our office at Denver, Colorado, has been assigned Docket No. OME-6830.

Please identify all future correspondence relating to your application by this docket number.

Sincerely yours,

Harold Kirkemo
Chief, Office of
Minerals Exploration

Copy to Region III

OME 6830

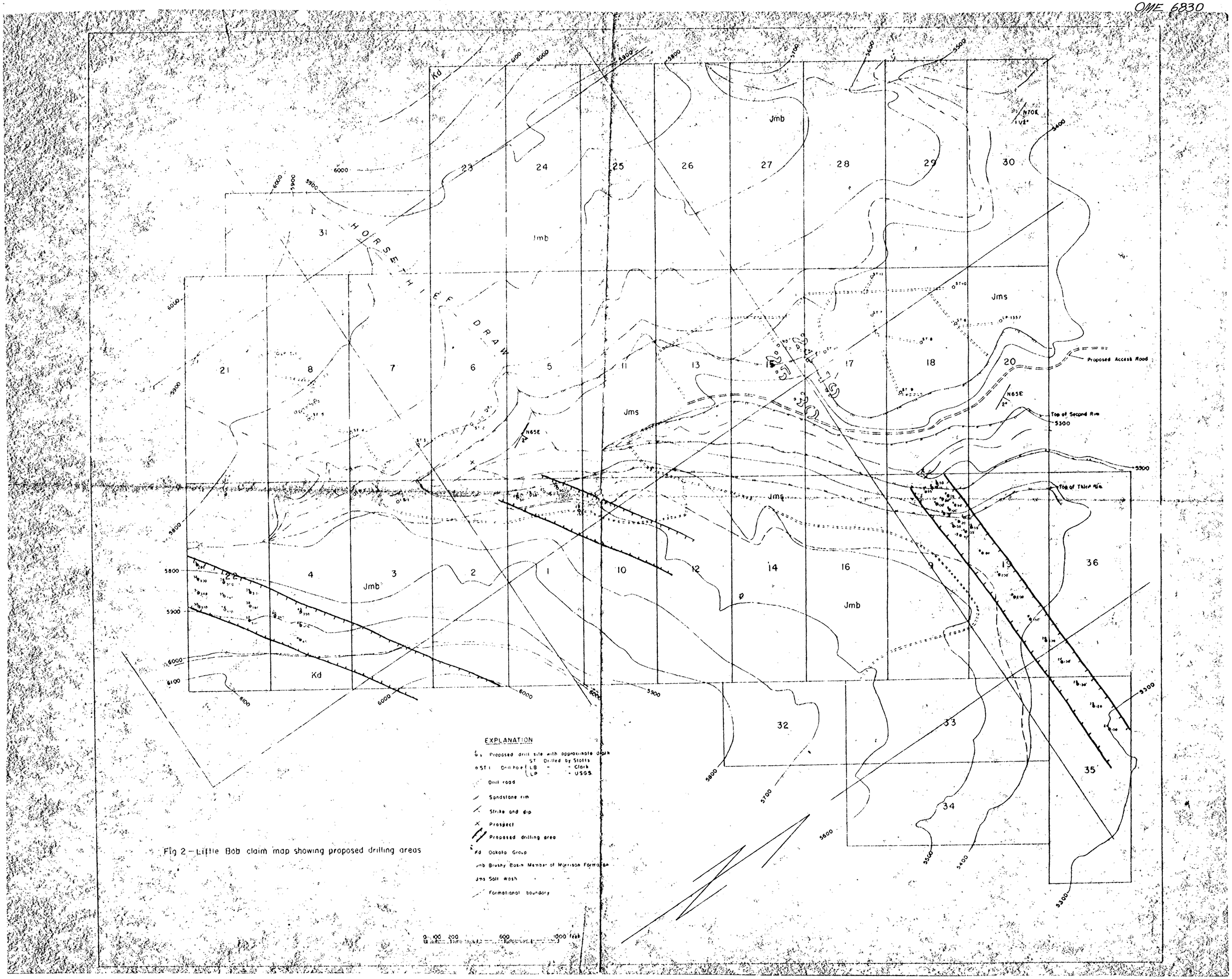

Fig 2 – Little Bob claim map showing proposed drilling areas

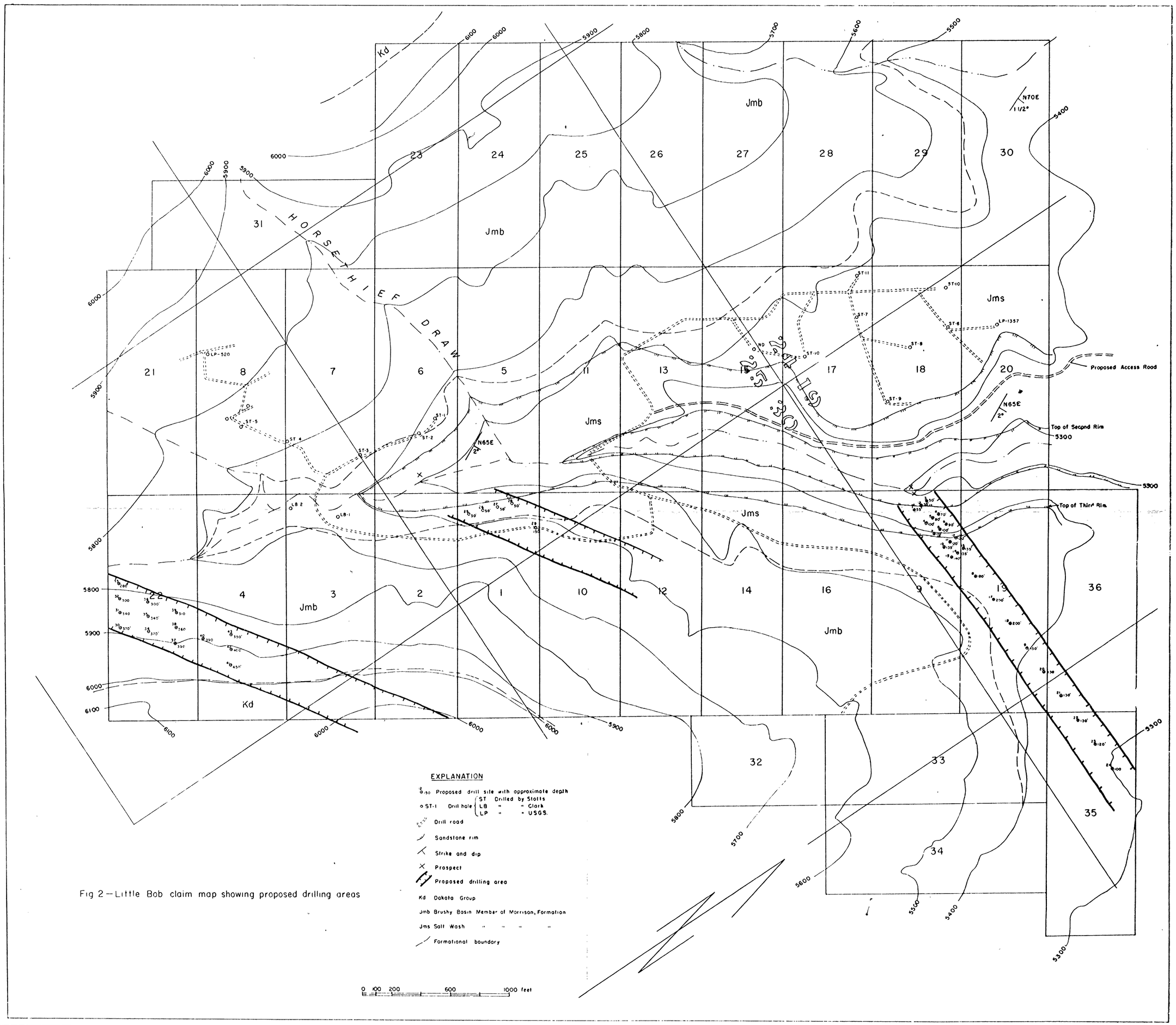

Fig 2 — Little Bob claim map showing proposed drilling areas

Base from Army Map Service Moab sheet, 1957

Geology compiled 1958–62

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
DATUM IS MEAN SEA LEVEL

EXPLANATION

Uranium deposit
Limits plotted at map scale

Uranium ore deposit
Limits cannot be plotted at map scale: triangle where production totals more than 200,000 pounds U_3O_8; circle where production totals more than 20,000 and less than 200,000 pounds U_3O_8; dot where production totals less than 20,000 pounds U_3O_8 (20,000 pounds U_3O_8 = 10 short tons U_3O_8 = 8.43 short tons U). Production totals are to January 1959

Uranium prospect
Rocks contain 0.01 percent or more U_3O_8 or a uranium mineral, but no ore is known to have been produced; prospects are not shown in areas of numerous deposits

Area underlain by uranium-bearing rocks of ore grade or less
Determined by U.S. Geological Survey drilling

Approximate area of uranium-bearing rock of less than ore grade
Solid line where boundary of area is exposed; dashed where buried

Note: Host rocks for uranium deposits are the following stratigraphic units, listed in order of number of deposits:
- Jms, Salt Wash Sandstone Member of Morrision Formation
- Ꞧcb, Moss Back Member of Chinle Formation
- Jmb, Brushy Basin Shale Member of Morrison Formation
- Pca, arkosic member of Cutler Formation
- Ꞧc, Chinle Formation, undifferentiated
- Pc, Cutler Formation, undifferentiated
- Je, Entrada Sandstone
- ₽hu, upper member of Hermosa Formation
- Ꞧw, Wingate Sandstone
- Kbc, Burro Canyon Formation

East of longitude 109°30′, uranium deposits occur in Salt Wash Sandstone Member of Morrison Formation unless otherwise indicated by letter symbol; west of longitude 109°30′, deposits occur in formation on which deposit symbol lies, unless otherwise indicated by letter symbol

Structure contours
Drawn on base of Dakota Sandstone. Solid where accuracy within 125 feet; long dashed where accuracy between 125 and 250 feet; short dashed where accuracy not within 250 feet. Arrow shows direction of dip. Contours dropped where structure unknown or too complex to show at map scale. Contour interval 250 feet. Datum is mean sea level

Strike and dip of beds

Horizontal beds

Anticline
Showing direction of plunge

Syncline

Monocline
Showing direction of dip

Fault
Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

Horizontal projection of inclined fault
Showing horizontal separation of datum surface

Collapse structure

Data on uranium deposits by U.S. Atomic Energy Commission, Grand Junction, Colorado

See geologic map (sheet 1) for explanation of letter symbols

INDEX MAP SHOWING SOURCES OF STRUCTURE DATA

STRUCTURE SOURCES

1. Structure compiled directly from geologic-topographic map. Elevations of several datum surfaces are corrected by isopaching to base of the Dakota.
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INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1964—G62250

GEOLOGY, STRUCTURE, AND URANIUM DEPOSITS OF THE MOAB QUADRANGLE, COLORADO AND UTAH

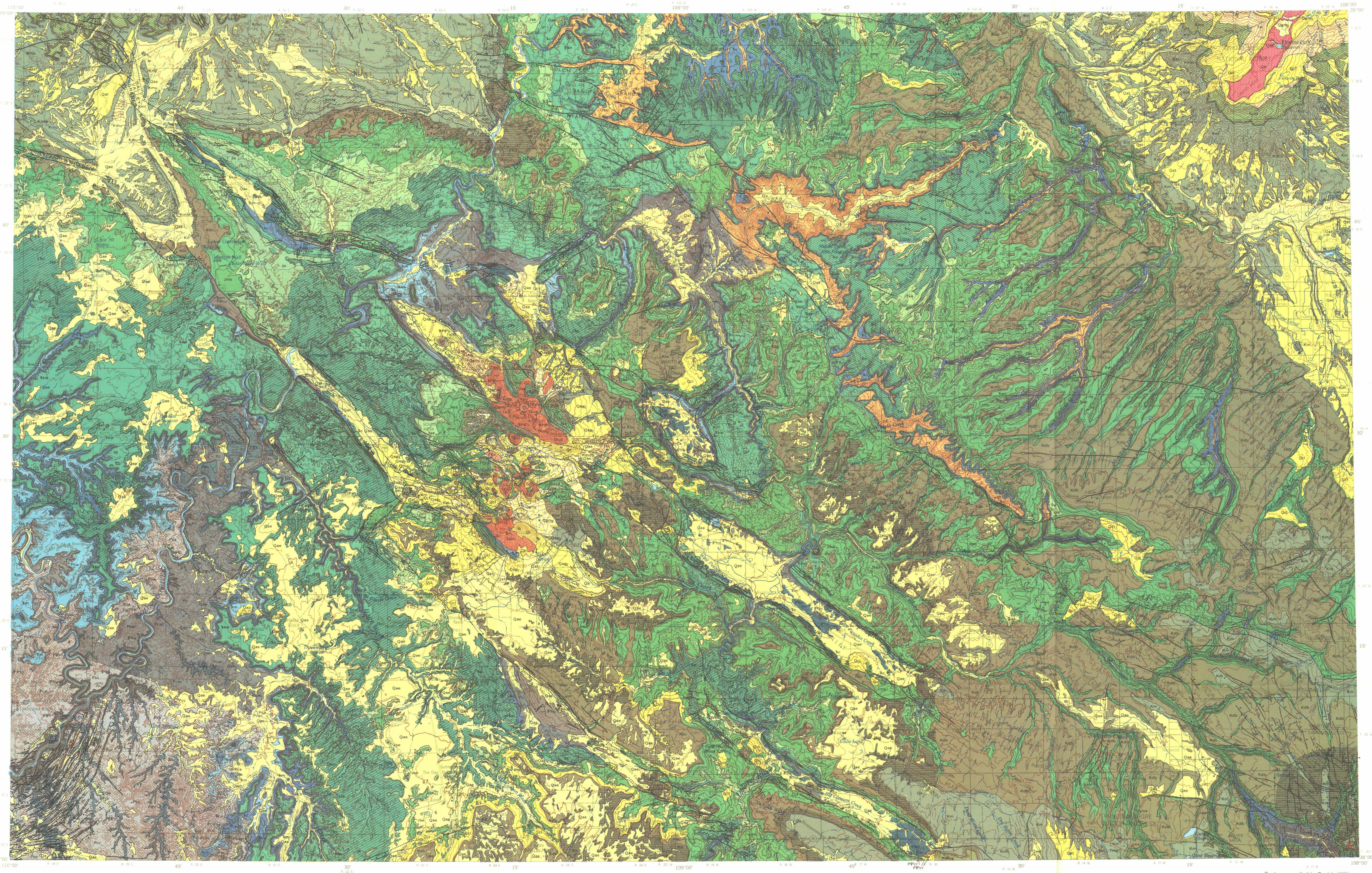
Compiled by
Paul L. Williams
1964

For sale by U. S. Geological Survey, price $1.75 per set

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
U.S. ATOMIC ENERGY COMMISSION

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-360 (SHEET 1 OF 2—GEOLOGY)



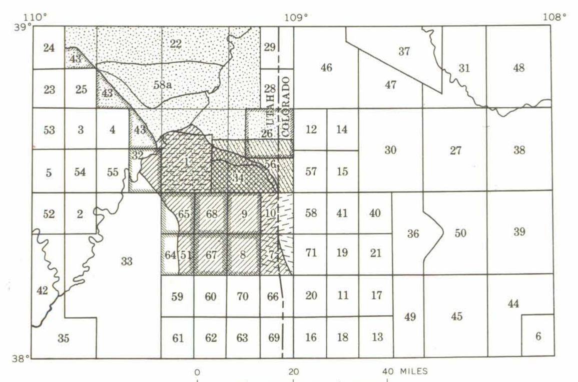
Base from Army Map Service Moab sheet, 1957

Geology compiled by Paul L. Williams

APPROXIMATE MEAN DECLINATION, 1964

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
DATUM IS MEAN SEA LEVEL



INDEX MAP SHOWING SOURCES OF GEOLOGIC DATA

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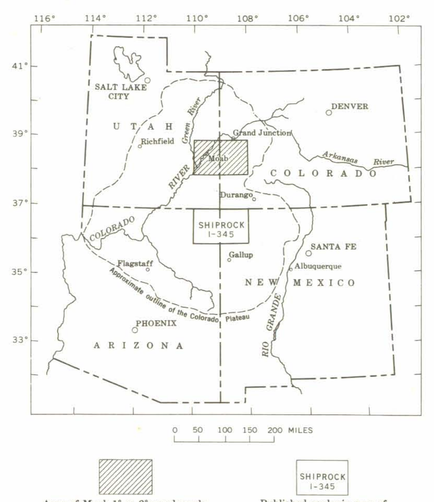


Area of Moab 1° × 2° quadrangle

Published geologic map of other 1° × 2° quadrangles

INDEX MAP SHOWING AREA OF MOAB QUADRANGLE

EXPLANATION

QUATERNARY

Pleistocene and (or) Recent

Alluvium and eolian deposits (Qae, Qa, Qap)
Qae, alluvium and eolian deposits, undifferentiated; mostly wind-deposited silt and sand on mesa tops, benches, and in broad valleys, reworked in part by running water.
Qa, alluvial deposits, chiefly sand, gravel, and silt of Recent age in flood plains of streams.
Qap, pediment gravels; limited to deposits veneering pediment surfaces in the present cycle of erosion

Colluvial deposits (Qc, Qct, Qcl)
Qc, colluvial deposits, undifferentiated; includes talus, slope wash, block rubble, and rock glaciers.
Qct, talus; deposits of angular blocks at base of cliffs.
Qcl, landslide deposits; angular, unsorted debris, occurring chiefly below steep outcrops of Morrison Formation

Terrace gravels (Qat)
Includes gravels along larger streams and pediment gravels of earlier cycles of erosion, occurring principally near Grand Mesa and south of Book Cliffs

Pleistocene

Alluvial fan gravels in the La Sal Mountains (Qaf, Qaf₃, Qaf₂, Qaf₁)
Locally derived, poorly sorted angular to subangular sand, silt, and gravel.
Qaf, undifferentiated as to age.
Qaf_3, of Pinedale age.
Qaf_2, of Bull Lake age.
Qaf_1, of pre-Bull Lake age

Alluvial gravels in the La Sal Mountains (Qag)
Well-rounded and well-sorted deposits, mostly of glacial outwash origin.
Qag, undifferentiated as to age.
Qag_3, of Pinedale age.
Qag_2, of Bull Lake age.
Qag_1, of pre-Bull Lake age

Glacial till (Qgm)
Unsorted, unstratified deposits occurring in moraines on Grand Mesa and in the La Sal Mountains.
Qgm, undifferentiated as to age.
Qgm_3, of Pinedale age.
Qgm_2, of Bull Lake age.
Qgm_1, of pre-Bull Lake age

Conglomerate in Fisher Valley (Qfc)
Partly consolidated; of uncertain age

Basalt (Qb)
Extrusive scoriaceous and vesicular basalt capping Grand Mesa. Includes intercalated volcanic ash and breccia

UNCONFORMITY

TERTIARY

Pliocene

Conglomerate in Castle Valley and Geyser Creek (Tcc)
Chiefly pebbles and cobbles of igneous rock derived from North Mountain

Miocene(?)

Clastic dike (Tcd)
Consists of fragments of gneiss, schist, limestone, granitic rocks, and eruptive rocks of intermediate composition; in Placerville area

Monchiquite (Tmq)
Dikes, chiefly biotite and augite, and carbonates derived during alteration; in Placerville area

Diorite and andesite (Tda)
Dikes and sills of diorite, diorite porphyry, and andesite, chiefly plagioclase, hornblende, and biotite; in Placerville area

Microgranogabbro (Tmg)
Basaltic dike, chiefly plagioclase and augite, and biotite partly altered to chlorite; between Gypsum Valley and Placerville

Eocene

Green River Formation (Tgr)
White friable sandstone and gray to gray-green lacustrine shale. Poorly exposed near top of Grand Mesa

Wasatch Formation (Tw)
Variegated clay shale, in part sandy. Sparse beds of massive fluvial sandstone, numerous thin sandy lenses, and some fresh-water limestone. Locally conglomeratic at base. Maximum thickness is about 1,500 feet. Occurs only in Grand Mesa area

CRETACEOUS AND (OR) TERTIARY

LA SAL MOUNTAINS AREA

Vent breccia (TKvb)
Chiefly fragments of aegirine granite porphyry and altered diorite porphyry

Soda syenite porphyry (TKs)
Small intrusive bodies, consisting of coarse phenocrysts of microperthite and augite in groundmass of aegirine-augite and anorthoclase

Syenite porphyry (TKdi)
Dikes consisting chiefly of perthite, sodic plagioclase, and aegirine-augite.
TKdi, dike swarm.
d, individual dikes

Monzonite porphyry (TKmp)
Closely spaced dikes. Chiefly plagioclase, potassium feldspar, hornblende, and pyroxene

Diorite porphyry (TKds, TKdl)
Chiefly phenocrysts of plagioclase and hornblende in groundmass of orthoclase, albite-oligoclase, and quartz.
TKds, stocks.
TKdl, laccoliths

CRETACEOUS

Upper Cretaceous

GYPSUM VALLEY

Mesaverde Group (Kmvg)
Yellowish-gray, thick-bedded marine and nonmarine sandstone beds separated by light-gray marine and nonmarine shale. Total exposed thickness about 1,200 feet

BOOK CLIFFS

Mesaverde Group [1]

Upper part of Mesaverde Group (Kmvu)
Alternating light-colored nonmarine sandstone and shale containing some coal

Castlegate Sandstone (Kc)
Buff-weathering, coarse- to fine-grained, massive cliff-forming marine sandstone

Upper member of Blackhawk Formation (Kb)
An upper cliff-forming sandstone and a lower shale; locally coal-bearing

Buck Tongue of the Mancos Shale (Kmb)
Similar in lithology to the Mancos Shale to the south; occurs in the Book Cliffs

GRAND MESA

Mesaverde Formation (Kmv, Kmvr)
Kmv, similar in lithology to upper part of Mesaverde Group (Kmvu).
Kmvr, Rollins Sandstone Member; white, coarse-grained, massive sandstone

Mancos Shale [1]

Mancos Shale (Km, Kmu, Kmfe, Kml)
Dark-gray to black soft, fissile marine shale with thin sandstone beds at various horizons. The upper beds intertongue with, and grade vertically into, the lower part of the Mesaverde Group (Kc, Kb). Maximum thickness about 4,000 feet.
Km, Mancos Shale, undifferentiated.
Kmu, upper shale member.
Kmfe, Ferron Sandstone Member. Fine-grained, thin-bedded sandstone and sandy shale; thin and persistent; occurs near base of Mancos Shale.
Kml, lower shale member

Mancos Shale, Dakota Sandstone, and Burro Canyon Formation (Kmdb)

Lower Cretaceous

Dakota Sandstone (Kd)
Yellowish-brown and gray friable to quartzitic fluvial sandstone and conglomeratic sandstone with interbedded gray to black carbonaceous nonmarine shale. Plant impressions are common; a coarse basal conglomerate is locally present. Ranges in thickness from a few feet to about 200 feet

UNCONFORMITY

Burro Canyon Formation (Kbc)
White, gray, and light-brown fluvial sandstone and conglomerate interbedded with green and purplish lacustrine siltstone, shale, and mudstone, and thin beds of impure limestone. Thickness ranges from 0 to 200 feet. Forms discontinuous lenses in the Placerville area, and is not differentiated from the Dakota Sandstone (Kd) there

Dakota Sandstone and Burro Canyon Formation (Kdb)

JURASSIC

Upper Jurassic

Morrison Formation (Jm, Jmb, Jms)
Variegated fluvial and lacustrine shale, mudstone, and sandstone; local thin limestone beds. Total thickness ranges from 450 to 950 feet.
Jm, Morrison Formation, undifferentiated.
Jmb, Brushy Basin Shale Member. Chiefly gray, pale-green, red, and light-purple bentonitic mudstone, fluvial sandstone and conglomerate lenses, some of which contain uranium and vanadium deposits. Thickness ranges from 250 to 500 feet.
Jms, Salt Wash Sandstone Member. White, gray, rusty-red, and buff fluvial sandstone interbedded with red, gray, and green fluvial mudstone, with thin limestone beds near base. Uppermost continuous sandstone beds contain major uranium-vanadium deposits through much of the area. Thickness ranges from 190 feet in the north to a maximum of 490 feet in the south

San Rafael Group [2]

Summerville Formation (Js)
Red, gray, green, and brown sandy shale and mudstone of terrestrial origin; masses of red and white chert occur in places near top. Thickness ranges from 60 to 150 feet and varies irregularly from place to place

Entrada Sandstone (Jem, Je)
Jem, Moab Sandstone Member; light-colored, medium-grained, massive, and crossbedded sandstone at top of formation in western two-thirds of area.
Je, Entrada Sandstone; orange, buff, and white, fine- to medium-grained, massive and crossbedded eolian sandstone. Basal few feet of Entrada, consisting of red siltstone and fine-grained sandstone, has been termed Carmel Formation by some workers. In southeasternmost part of area the Entrada contains tabular vanadium-uranium deposits. Total thickness, including Moab Tongue, ranges from 550 to 60 feet, decreasing from west to east

Summerville Formation and Moab Sandstone Member of Entrada Sandstone (Jsem)

Summerville Formation and Entrada Sandstone (Jse)

Wanakah Formation and Entrada Sandstone (Jwe)
Wanakah Formation is the lateral equivalent of Summerville Formation in the southeasternmost part of area; it is greenish-gray limy siltstone and sandstone at top, underlain by light-colored, friable, fine-grained sandstone of the Bilk Creek Sandstone Member; at base of Wanakah is the Pony Express Limestone Member, a dark-gray to black bituminous limestone. Total thickness about 80 feet

Summerville Formation, Entrada Sandstone, and Navajo Sandstone (JŦsen)

TRIASSIC

Upper Triassic

Navajo Sandstone (JŦn)
White, grayish-yellow, gray, and pale orange-pink, fine-grained, crossbedded eolian sandstone; prominent vertical joints in most outcrops; absent in most of eastern half of area; attains thickness of 400 feet in western half

Glen Canyon Group (JŦgc)
Includes Navajo Sandstone, Kayenta Formation, and Wingate Sandstone

Kayenta Formation (Ŧk)
Irregularly interbedded fluvial red, buff, gray, and lavender shale, siltstone, and fine- to coarse-grained sandstone. Thin beds of limestone and of shale-pellet conglomerate locally present. Thickness ranges from 0 in east to maximum of 240 feet in west

Kayenta Formation and Wingate Sandstone (Ŧkw)

Wingate Sandstone (Ŧw)
Reddish-brown, buff, and grayish-orange, fine-grained, massive, thick-bedded, and prominently crossbedded eolian sandstone. In most exposures forms vertical cliffs and exhibits dark-brown desert varnish on weathered surfaces. Thickness ranges from 0 at east edge to about 350 feet throughout most of western half

Chinle Formation (Ŧc, Ŧcu, Ŧcb)
Ŧc, Chinle Formation, undifferentiated. Terrestrial sedimentary rocks, including red, reddish-brown, and orange-red siltstone interbedded with lenses of red sandstone and shale, limestone-pebble and shale-pellet conglomerate, with lenses of grit and quartz-pebble conglomerate near base. Thickness ranges from 0 to 600 feet, increasing from north to south.
Ŧcu, upper part of Chinle Formation in parts of area between Green and Colorado Rivers.
Ŧcb, Moss Back Member. Gray, brown, and pale gray-green, calcareous, fluvial sandstone and grit, with red, purplish, and gray-green mudstone; carbonaceous plant fragments locally abundant; occurs in parts of area between Green and Colorado Rivers. Contains uranium deposits in western quarter of map; in Lisbon Valley its stratigraphic equivalent contains large uranium deposits

Wingate Sandstone and Chinle Formation (Ŧwc)

Dolores Formation (Ŧd)
Approximate lateral equivalent to parts of Wingate Sandstone and Chinle Formation in southeasternmost part of area. Consists of fluvial red siltstone sandstone, and shale, with a few limestone-pebble conglomerate lenses; a quartz-pebble conglomerate or grit occurs at base; locally contains a thin Wingate Sandstone equivalent at the top. Total thickness about 575 feet

Chinle and Moenkopi Formations (Ŧcm)

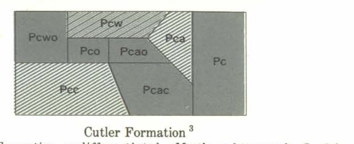
UNCONFORMITY

Lower and Middle(?) Triassic

Moenkopi Formation (Ŧm)
Chocolate-brown, ripple-bedded shale; brick-red sandy mudstone; reddish-brown and chocolate-brown sandstone; purple and reddish-brown arkosic conglomerate; and local gypsum beds. Thickness ranges from 0 to more than 1,000 feet

Rocks of Triassic, Permian, and Pennsylvanian ages, undifferentiated, in La Sal Mountains (ŦPPu)
May contain some or all of the Chinle, Moenkopi, Cutler, Rico, and Hermosa Formations

PERMIAN



Cutler Formation [3] (Pc, Pca, Pcw, Pco, Pcc, Pcwo, Pcao, Pcac)
Pc, Cutler Formation, undifferentiated. Mostly red to purple, fluvial arkose and arkosic conglomerate. Total thickness ranges from 0 to about 3,000 feet; locally attains thickness of 8,000 feet at west edge of Uncompahgre uplift.
Pca, unnamed arkose and arkosic conglomerate in western part of map. Reddish-brown, red, and purple, medium- to coarse-grained, crossbedded, fluvial arkose and arkosic conglomerate. Contains small copper-uranium deposits in Lisbon Valley area and in area between Green and Colorado Rivers. Interfingers complexly with other members.
Pcw, White Rim Sandstone Member. White, gray, and buff, medium- to coarse-grained, crossbedded, eolian, quartzose sandstone.
Pco, Organ Rock Tongue. Reddish-brown siltstone and thin-bedded, fine-grained sandstone.
Pcc, Cedar Mesa Sandstone Member. Yellowish-gray, reddish-orange, and reddish-brown, fine-grained, thickly crossbedded, eolian sandstone.
Pcwo, White Rim Sandstone Member and Organ Rock Tongue, undivided.
Pcao, transition zone where arkosic beds interfinger with Organ Rock Tongue.
Pcac, transition zone where arkosic beds interfinger with Cedar Mesa Sandstone Member

Cutler and Rico Formations (PPcr)

PENNSYLVANIAN

Rico Formation (PPr)
Reddish-brown and greenish-gray, fine- to medium-grained, crossbedded fluvial sandstone; gray thin- to thick-bedded, cherty, fossiliferous marine limestone; red micaceous siltstone. Distinguished from overlying Cutler Formation chiefly by presence of limestone beds. Exposed thickness ranges from 0 on Uncompahgre uplift to about 650 feet near west border

Middle Pennsylvanian

Hermosa Formation (Ph, Phu, Php)
Ph, Hermosa Formation, undifferentiated.
Phu, upper member. Blue and gray, thin- to thick-bedded fossiliferous marine limestone; gray fine-grained, micaceous, crossbedded sandstone and siltstone; red sandy shale and sandstone; gray arkose and conglomerate. Ranges in thickness from 0 to 1,800 feet.
Php, Paradox Member. Salt, gypsum, anhydrite, black shale, gray sandstone and limestone. Thickness ranges from 0 in Uncompahgre uplift to more than 11,000 feet under salt anticlines

UNCONFORMITY

PRECAMBRIAN

Precambrian rocks (p€)
Rock types not differentiated on map. Includes gneiss, schist, granite, and pegmatite, occurring in two main groups. Younger group, a granitic intrusive complex, consists chiefly of granite with coarse microcline phenocrysts, minor amounts of gneissic granite, pegmatite dikes, and a few lamprophyre dikes; crops out extensively in Ryan Creek area and at east and west ends of Unaweep Canyon. Granitic complex has intrusive relations with older sequence of quartz-biotite and quartz-feldspar schists and gneisses, with minor amounts of slate and injection gneiss

Contact

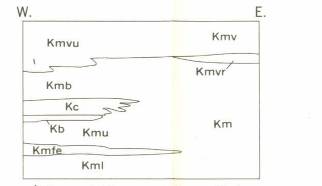
Fault
Dashed where approximately located; dotted where concealed. Bar and ball on downthrown side

Strike and dip of beds

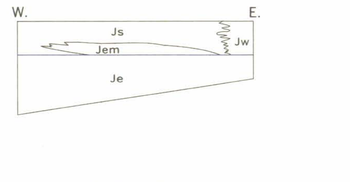
Horizontal beds

Limit of deposition of a formation or member, in this case the Kayenta Formation

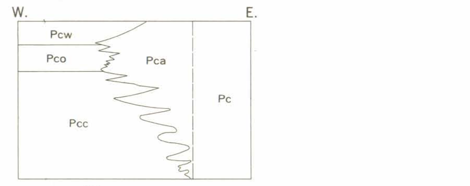
Collapse structures
Small vertical pipelike bodies of breccia, bounded by circular faults, occurring on northeast side of Spanish Valley; contain blocks of rock from all formations from Navajo Sandstone through Dakota Sandstone. Age of collapse unknown, possibly Tertiary



[1] Mesaverde Group and Mancos Shale



[2] San Rafael Group



[3] Cutler Formation

GEOLOGY, STRUCTURE, AND URANIUM DEPOSITS OF THE MOAB QUADRANGLE, COLORADO AND UTAH

Compiled by
Paul L. Williams
1964

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-360 (SHEET 1 OF 2—GEOLOGY)

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1969—G62250

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