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Dave Rohrs

Clay Identification Procedure

In order to produce a randomly oriented clay fraction for identification purposes, the clays were peptized by the addition of calgon to the water - sediment mixture and then centrifuged to separate a particle size of about two microns. For each sample three slides were prepared and x-rayed by the x-ray diffractometer at a scanning rate of one degree per minute. These slides included an air dried, a slide treated with ethylene glycol, and a slide heated to 250°C. Since no seven angstrom peaks, corresponding to either kaolinite or chlorite, were present in any air dried slide, there was no need to heat the clays to 550°C, the temperature at which kaolinite decomposes. For the air dried slides, the samples were scanned from two degrees to twenty-two degrees, while the latter two were scanned from two degrees to fifteen degrees. The results of these runs are tabulated below.

For the search for Uranium minerals, a sample of the powdered rock was scanned at two degrees per minute from five degrees to fifty-five degrees. This procedure did not provide a positive identification of any uranium minerals, probably because their percentage was low in the rock. I would recommend a heavy liquid separation in order to concentrate the uranium-vanadium minerals if there should be a future need for their identification.

Clay Data

Sample	Phases present in clay fraction	Smectite/K-mica ratio
AM-51-C		
401	smectite K-mica	8/1
473-474	smectite K-mica	2/1
454	interstratified clay K-mica	2/1
434	smectite clinoptilolite	-
AM-79-C		
57	interstratified clay	-
63	interstratified clay	-
AM-135-C		
299	trace smectite (?) trace K-mica	
382	smectite K-mica clinoptilolite	4/1
396	interstratified clay K-mica trace clinoptilolite (?)	9/1

Note: I would suspect that the interstratified clay probably consists of K-mica and smectite.

Uranium Minerals -- AM-51-C-446

Minerals present
- smectite
- K-mica
- quartz
- cristobalite
- feldspar

No indication of Uranium minerals.

Bob Rogers

Union Oil Samples

The nine samples were X-rayed with a diffractometer at a scanning speed of 2 degrees per minute. The results are tabulated below. The zeolite clinoptilolite was detected in four of the samples. It was the only zeolite found. (Zeolites present in amounts of less than 5-10 wt. % would probably not have been detected.) The other rock constituents are listed below by sample in order of relative abundance based on X-ray peak heights. The plagioclase probably has a composition in the oligoclase-andesine range judging from the diffractometer data.

AM-51-C

454
guartz
cristobalite
plagioclase
mica
interstratified clay
(no zeolites)

434
montmorillonite
plagioclase
quartz
clinoptilolite
mica

401
quartz
plagioclase
mica
montmorillonite
cristobalite (minor)
(no zeolites)

473-474
quartz
cristobalite
plagioclase
mica
montmorillonite
amphibole
(no zeolites)

AM-79-C

57
calcite
montmorillonite (minor)
mica ? (minor)
(no zeolites)

63
quartz
cristobalite
calcite
mica (minor)
interstratified clays (minor)
(no zeolites)

AM-135-C

299
calcite
quartz
cristobalite
plagioclase
clinoptilolite
mica
amphibole

396
quartz
plagioclase
montmorillonite
clinoptilolite
cristobalite
mica
amphibole (minor)

382
quartz
plagioclase
cristobalite
mica
montmorillonite
clinoptilolite (minor)

HAZEN RESEARCH, INC.

4601 INDIANA STREET
GOLDEN, COLORADO • 80401
TELEPHONE 303/279-4501

November 15, 1977

Mr. Terry S. Hellinger, Geologist
Minerals Exploration Company
P.O. Box 2674
Casper, Wyoming 82602

Re: HRI Project 003-105

Dear Terry,

Enclosed are the results of a mineralogical study of the four uranium ore samples referred to in your letter of October 11, 1977 as (I) AM-51c, 465.5 - 466.0, (II) AM-51c, 440.0 - 440.3, (III) AM-1c, 100.0 - 100.5, and (IV) Surface Sample.

As already discussed over the phone, Electron microprobe analyses and microscopic study show that the uranium mineralization ~~in the three drill core samples~~ consists of a uranium silicate, with a highly variable uranium to silicon ratio, apparently occurring in intimate association with carbonaceous matter. The chemical composition of this material suggests the mineral coffinite and, ~~in an attempt to confirm this by~~ x-ray diffraction analysis, a sample ~~of black, sooty material (with a high uranium content as determined microchemically)~~ was ~~hand~~ picked from the highly mineralized, carbonaceous, tuffaceous mudstone sample. The x-ray diffraction film of this sample showed no evidence for any uranium mineral, and therefore it is concluded that this material is either very poorly crystallized or amorphous. For this reason, ~~we prefer to refer to it~~ it is referred to as a uranium silicate rather than coffinite.

No x-ray diffraction analyses were attempted on the other two drill core samples since autoradiographs showed that the radioactive mineralization is too finely disseminated to obtain a suitable sample for x-ray analysis. The uranium silicate-carbonaceous material occurs either very finely disseminated in the cementing matrix constituents of the rocks or as distinct, independent, sometimes highly contorted veinlets and irregular patches. Under the microscope, using high power oil immersion objectives, the more distinct veinlets are seen to be composed of at least two separate phases which are distinguishable by differences in reflectivity. It could not be determined whether these differences in reflectivity are due to segregated discrete uranium silicate within carbonaceous matter or not.

The data for each individual sample together with autoradiographs, photomicrographs and oscilloscope scanning images is attached.

Mineralogy

1. Primary min. – ~~absot. of carbon~~
~~uranium silicate similar to offerite~~
~~a. micro X ray analyses~~
~~Min. ident. of core sample 465.5-466 from core hole 2~~
~~has recited th~~ by Hazen (1977)

Sample from core hole 2

a. See Roland Schmidt – Hazen report ~~#~~ 2
   1. Fig (scan & photo micrograph)
   2. Brega 197_ and ~~Haji-Vassil~~
      Haji-Vassilion 1969 – discuss non-xray pattern w/respect to uran. min.
   3. general the min. is too fine grained & for dessim. for ~~a~~ identif.

b. min. assoc. w/ carbon –
   1. Carbon ~~occurs as~~ which is min. occurs as blk sooty mat. ~~both~~ which displays rem. cellular structure recon. in thin section. Megascopic carbaneous plant remains are v. rare in the min. zone.
   2. sooty blk. carb. mat. is observed to be filling possible ~~decomposition~~ minor fractures in the sed. and is locally ~~non~~ silicified.

2. Secondary min.
   a. Carnotite – occurs as ~~pulv~~ pulverulent coatings and fibrous fracture fillings, bedding planes, comm. assoc. w/ ~~surface~~ chalced. and opal
   b. surface sample – (Fig. ___ Geol. Map X)
   c. Confined to near surface & surface sl/stn, tuffs & ls.

Mineralogy

Electron microprobe analysis of

Primary uranium mineral in from core hole 2 (interval 148.8-223 m)

has revealed the presence of uranium oxide in the mineral

which displays an extremely varied morphotype (Schmidt, 1977). The

chemical composition supports the mineral coffinite. However,

an attempt to confirm this by x-ray diffraction analysis revealed

no evident uranium pattern.

For Sherborne & Buckovic

Criteria for uranium deposition in the Date Creek Basin and adjacent areas, west-central Arizona

By

James K. Otton
U.S. Geological Survey, Denver, Colorado 80225

Uranium in the Date Creek Basin occurs principally in carbonaceous, tuffaceous lacustrine rocks of Eocene(?) and Miocene(?) age, the Miocene(?) occurrences being the more important. Thinly bedded lacustrine siltstones and sandstones near the base of the Artillery Formation near Artillery Peak and in Ester Basin are the Eocene(?) host. They are underlain by red-brown arkosic fluvial sandstones and overlain by siliceous algal limestones also of the Artillery. No uranium minerals can be observed at the surface; however, drilling has intercepted uranium minerals in the subsurface. A second anomalous zone occurs beneath another algal limestone in the upper middle part of the formation.

A basal, commonly tuffaceous, lacustrine or fluvial-lacustrine facies of the Miocene(?) Chapin Wash Formation is the host for mineralization at the Anderson mine, at Lincoln Ranch Basin, and possibly at Black Butte. At the Anderson mine the Chapin Wash rocks include a lower lacustrine and lacustrine-delta facies comprised of tuffaceous mudstone, locally carbonaceous, locally silicified; micaceous siltstone; silicified tuffaceous siltstone, locally jasperized; bioturbated tuffaceous marl; and tuffaceous limestone. The basal facies unconformably overlies a volcanic terrane.

This basal facies of the Chapin Wash grades rapidly upward into a fluvial facies comprised of calcareous siltstone, sandstone, and sandy conglomerate. Plant remains are abundant: root casts, palm logs, Ruppia(?) mats, leaf trash beds, and thin seams of lignite. These features show varying degrees of silicification.

Two end-member types of ore can be recognized at the Anderson mine: highly silicified, oxidized tuffaceous siltstone with abundant plant debris and carbonaceous siltstone and mudstone with minor silicification. In the highly silicified ore, U occurs as very fine grained carnotite and hematite in jasper and as uraniferous silica in massive jasper or in silica veins. In less silicified ore it occurs as carnotite cement. It also occurs as carnotite fracture coatings or disseminations in the tuffaceous mudstones adjacent to the silicified ore. In the carbonaceous ore, U occurs as a urano-silica complex, close to coffinite in composition, either in micro-veinlets or disseminated in organic-rich siltstone (J. Sherbourne, oral commun., 1977).

The lacustrine section at the Anderson mine is generally enriched in U, Li, V, B, Co, Cr, Cu, F, La, Mo, Ni, Sc, Yb, Ce, and Nd compared to an "average" granite (Levinson, 1974). Li and F are highly enriched in the altered tuffaceous lacustrine mudstone. Ag, As, B, Be, Cu, Y, W, Ga, Ge, Ti, and Mo, in addition to U, are enriched in the carbonaceous rocks. The trace-metal suite observed in the section may have two sources: the underlying bedrock, especially the andesitic volcanic rocks, and the air-fall tuff.

The host rocks at Black Butte resemble those at the Anderson mine; however, the tuffaceous lacustrine section is not as thick; plant remains are sparse; and the lake was probably more saline, as evidenced by abundant gypsum. Carnotite occurs in thin seams of black organic-rich siltstone in a section of greenish-gray tuffaceous mudstone and siltstone.

In the Lincoln Ranch Basin, lacustrine rocks intertongue with coarse fluvial Mn-rich sandstones. Plant remains are abundant but are largely silicified. Uranium occurs as carnotite in fractures and as uraniferous silica in bedded chert. Tuffaceous siltstone and mudstone beds are present, but generally are not very thick or continuous. The host rocks are faulted and folded and lie with low-angle fault contact on older crystalline rocks.

These observations, coupled with observations of other unmineralized lacustrine sections in west-central Arizona, suggest several criteria important for the formation of significant uranium orebodies in lacustrine sections: (1) the lake waters must have been sufficiently fresh to allow the growth and preservation of abundant organic material, (2) the lake must be provided with uranium--tuffaceous debris appears to be the best source, (3) the basin must persist long enough, and (4) the chemistry and movement of ground water must allow the mobilization, transportation, and fixation of the uranium. The conditions necessary for the formation of uranium orebodies in the fluvial parts of the Tertiary section apparently did not occur in the Date Creek Basin.

STRUCTURE

Five periods of Tertiary deformation are recognized in the region. The first evidence of strong differential uplift in the region is the sub "Arrastra" unconformity of the Upper (?) Eocene. The greatest uplift occurred along a west northwest trend that nearly parallels the present Arrastra Mountains.

The second period of uplift and erosion followed the eruption of the "Arrastra" volcanics in the latest Oligocene or earliest Miocene time. During this period, local enclosed basins were formed by block faulting +/or erosion in the vicinity of Anderson Mine. These basins nearly parallel the present erosional limits of the Miocene Anderson Mine sediments ~~, and current faults~~ in the area.

The third period of deformation occurred following the infilling of the Miocene basins and prior to the eruption of the upper Miocene basalt. Over 200' of offset occurred in the immediate Anderson Mine area along a series of northwest trending normal faults. The greatest amount of displacement is along individual zones ~~is~~ in the southern part of the mine area. One zone ~~Fig. 16~~ has over 70 m of displacement in the southern mine area, and only 15 m of displacement along the same zone 2,000 feet to the northwest. The increasing displacement to the south is mirrored north of the Santa Maria River where displacements are reversed in a sizzors like fashion ~~and increase to the north~~. The aver. dip of the AM sur. is ~ 7° north + only exists to local faulting. Local rotational slumpg + the bowing of bds along

The fourth period of deformation ~~faulting~~ which follows the eruption of the upper Miocene basalt is probably a continuation of faulting from the previous episode. The general trend and displacement in analogous to the previous period. In places over 70 m of offset occurs during this period. However, in the immediate mine area, except for the west-bounding fault (Fig.), displacements are less than 10m.

The last period of deformation is evidenced by only regional tilting + ~~of~~ incision of younger streams into the Plio-Pleistocene "older" alluvium. The older Mio-Pliocene faults do not appear to cut these younger gravels.

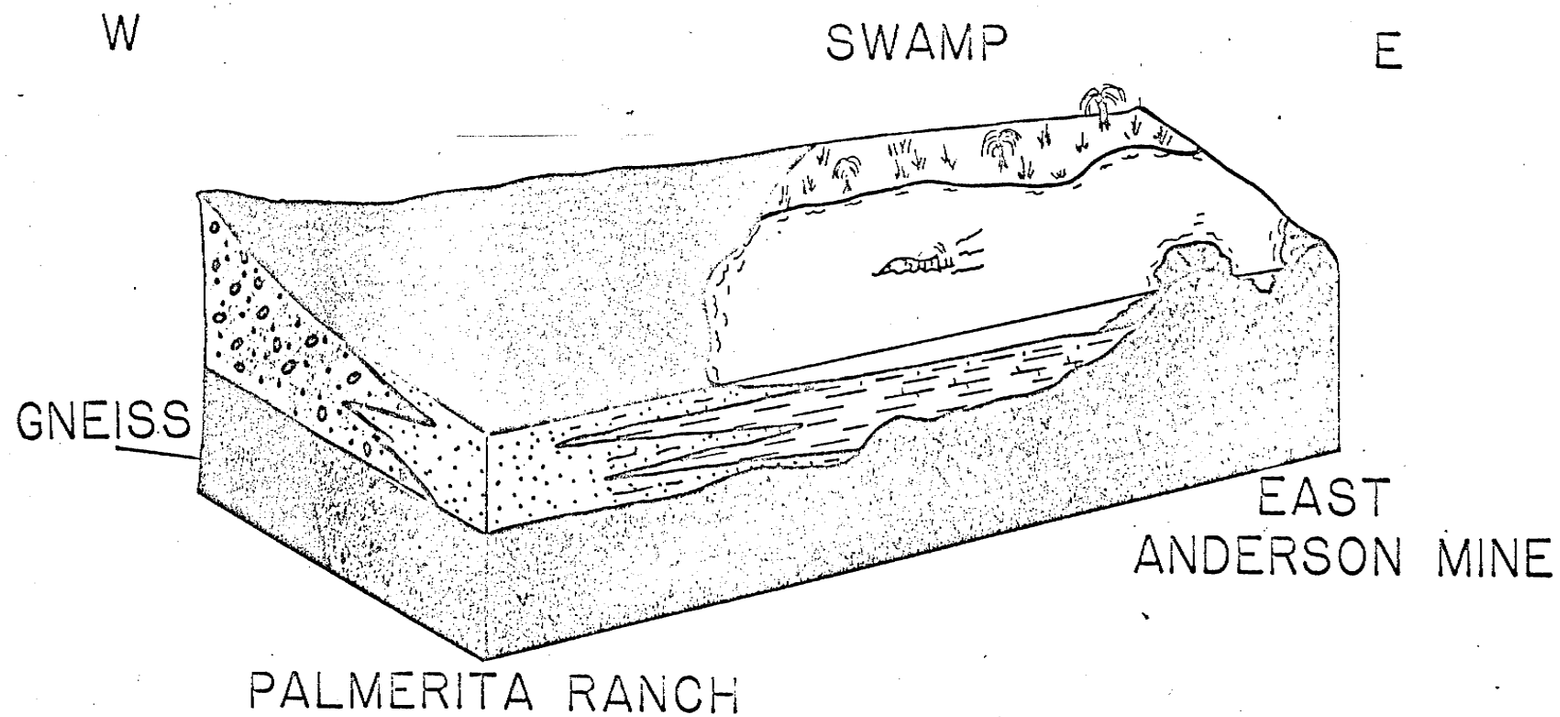
Well for Arrastra dips in the area

CRITERIA FOR URANIUM DEPOSITION IN THE DATE CREEK BASIN,

WEST-CENTRAL ARIZONA

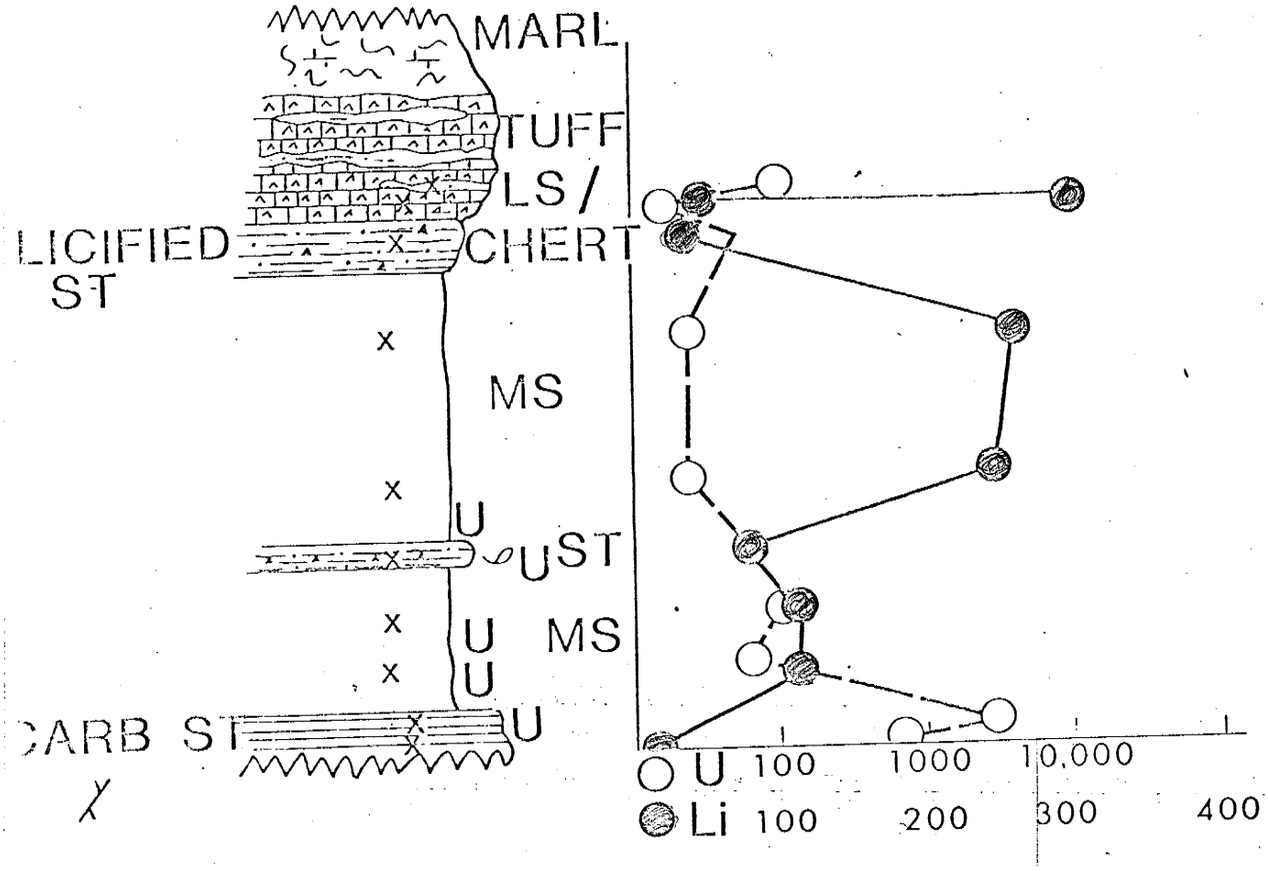
List of non-pictorial slides

1. Location map
2. Map of basin area
3. Artillery Formation schematic section
4. Schematic stratigraphy of the Date Creek Basin
5. Uranium host rock section - Anderson mine
6. Anderson mine section - lithology-geochem composite - U,Li
7. Inferred Anderson mine paleogeography



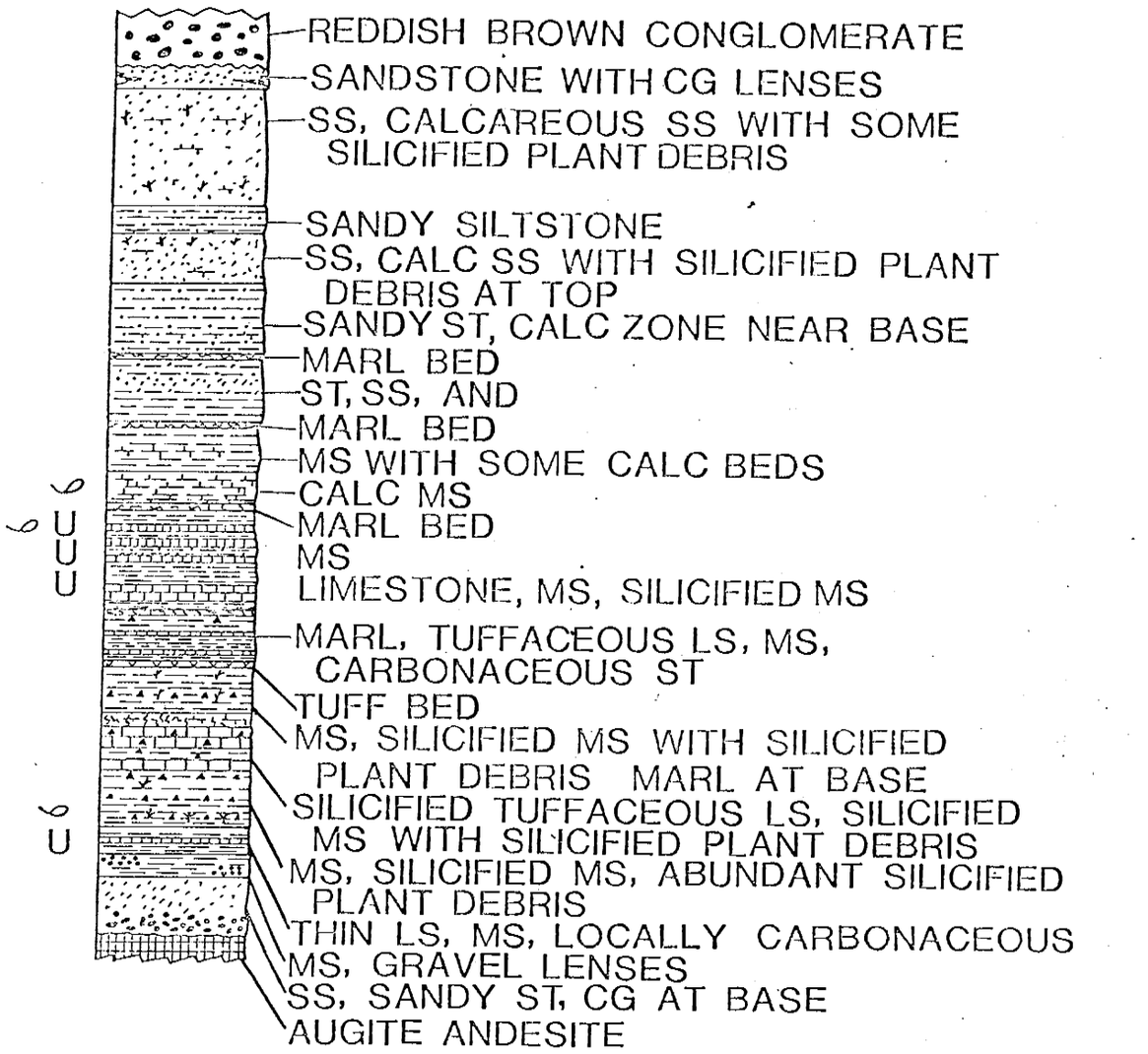
INFERRED ANDERSON MINE PALEOGEOGRAPHY

ANDERSON MINE SECTION
LITHOLOGY–GEOCHEM COMPOSITE



U URANIUM
GASTROPODS, PELECYPODS, OSTRACODS
PLANT DEBRIS
SAMPLE LOCATIONS

URANIUM HOST ROCK SECTION
ANDERSON MINE



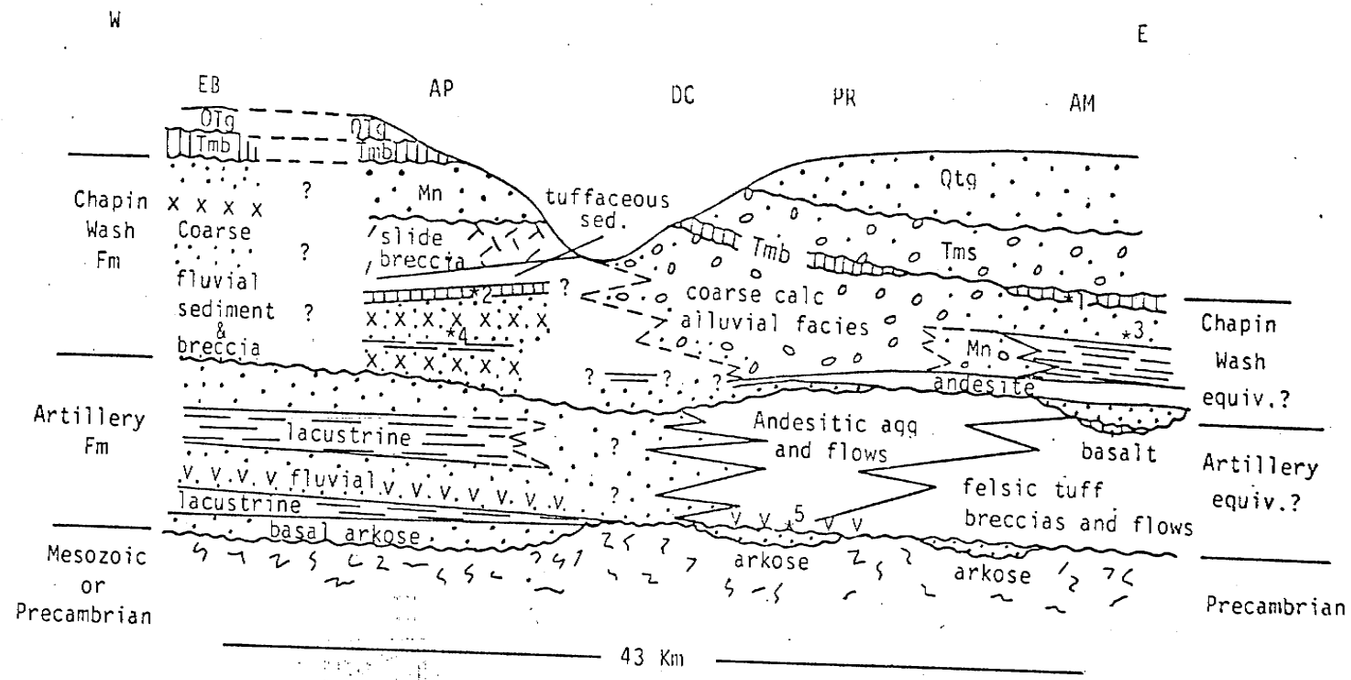
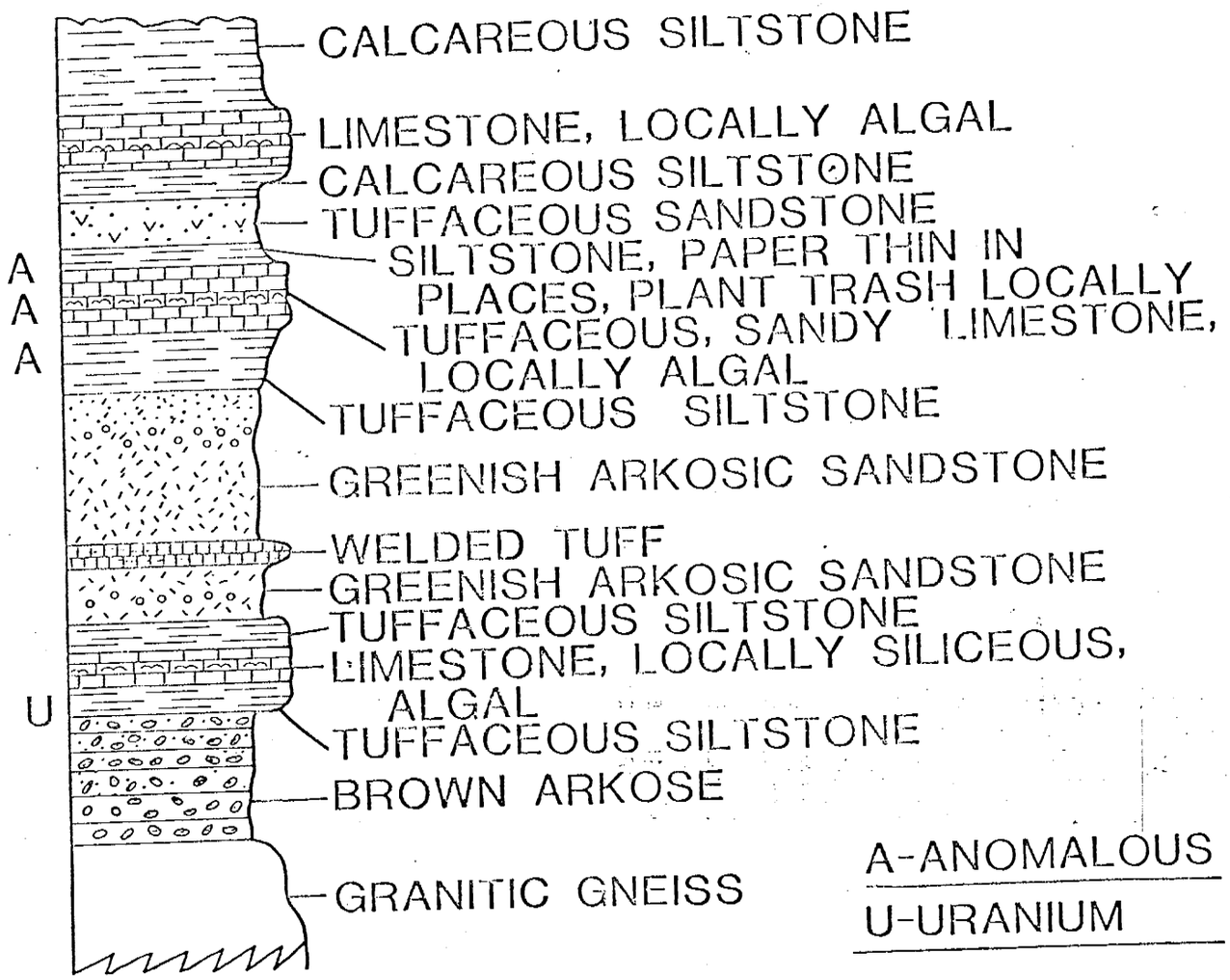


Figure - Schematic stratigraphy of the Date Creek basin. QTg - Plio-Pleistocene gravels; Tms-Miocene sedimentary rocks; Tmb-Miocene basalt; Mn-manganese facies; vvvv-rhyolitic welded tuff, xxx-sedimentary breccia.

1. K-Ar ages on basalt flow between AM & DC - 11.0, 12.8, 12.1, 12.9m.y. (this paper).
2. K-Ar age on basalt flow - 15.9m.y. (Shackelford, 1976).
3. Land mammal age - Hemingfordian (21-17 m.y.) (Lindsay & Tessman, 1974).
4. K-Ar age on basalt - 43.3 m.y. (probably not in place) (Gassaway, 1977): Tentative lower Miocene camel track, 75' below basalt.
5. K-Ar age on biotite in welded tuff - 41.5 m.y. (Gassaway, 1977)

ARTILLERY FORMATION

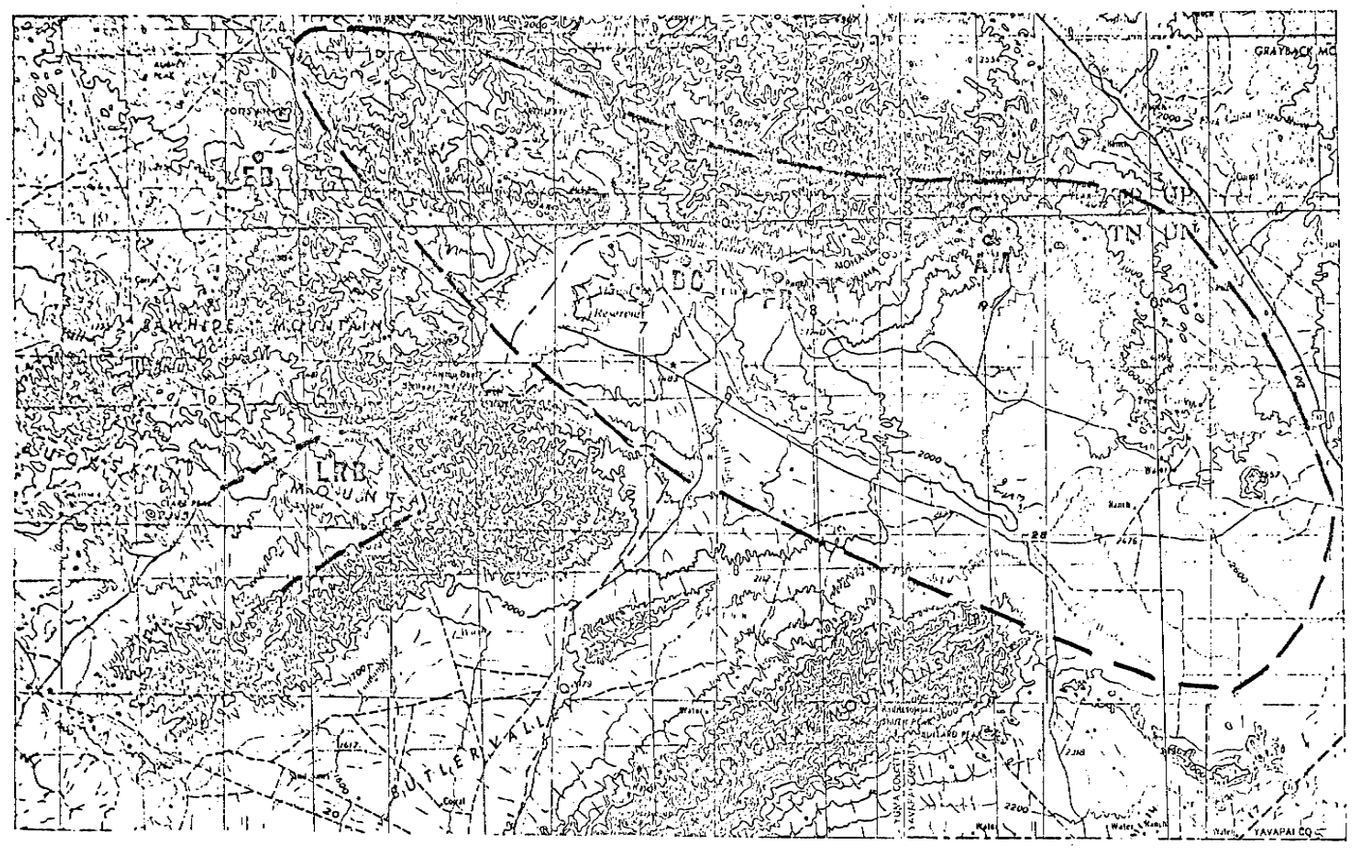
SCHEMATIC SECTION



A-ANOMALOUS

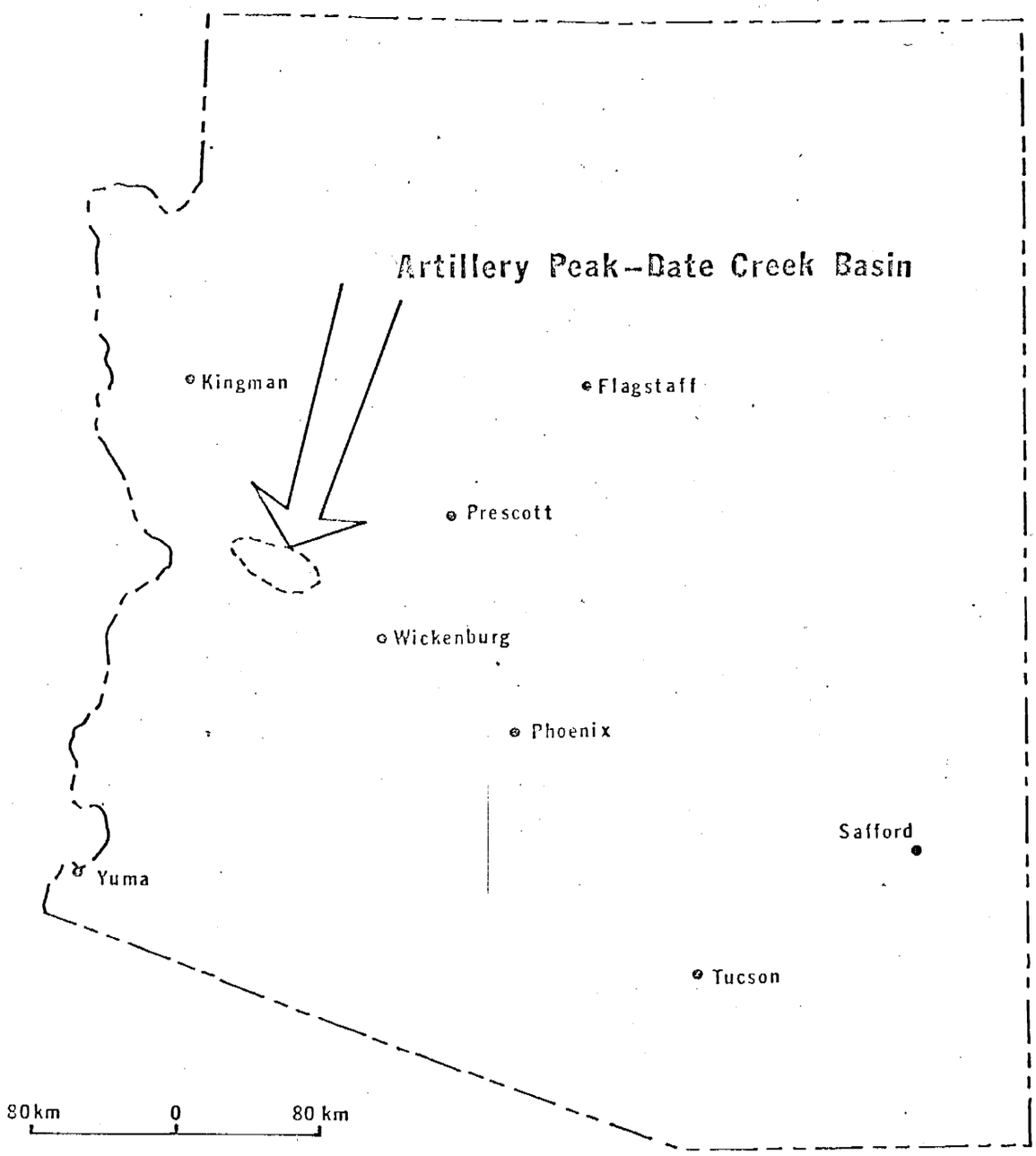
U-URANIUM

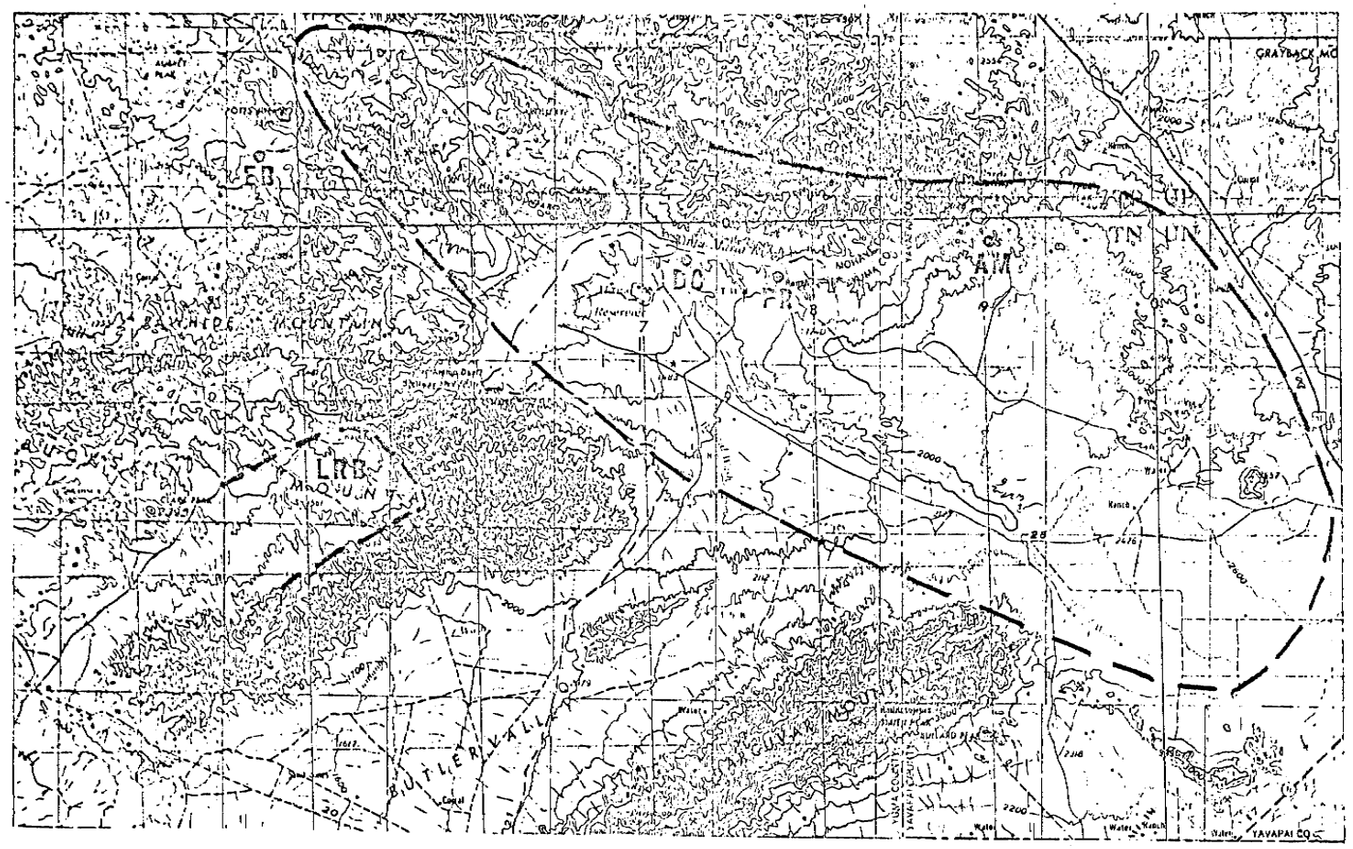
AGGREGATE THICKNESS
700-800 METERS



Map of basin area - AM-Anderson mine; PR-Palmerita Ranch; DC-Date Creek; AP-Artillery Peak; EB-Ester Basin; LBR-Lincoln Ranch Basin

Location Map





Map of basin area - AM-Anderson mine; PR-Palmerita Ranch; DC-Date Creek; AP-Artillery Peak; EB-Ester Basin; LBR-Lincoln Ranch Basin

CMSI INC.

CHEMICAL & MINERALOGICAL SERVICES • 445 WEST 2700 SOUTH • SALT LAKE CITY, UTAH 84115 • (801) 485-0711

ANALYTICAL REPORT FOR:

Mineral Exploration Company	OUR NUMBER 8930
P. O. Box 2674	DATE Nov 18, 1977
Casper, Wyoming 82602	CUSTOMER'S ORDER NO.

Semi-quantitative spectrographic analyses

< = less than

	AM-26C(726-727)	AM-26C(735-736)	AM-26C(740-741)	AM-49C(630-631)	AM-113C(298-299)
Fe %	3.0	2.0	2.0	1.5	1.5
Ca %	1.5	1.5	5.0	3.5	1.5
Mg %	.4	.02	.02	.02	< .02
Al %	5.0	4.0	4.0	4.5	4.5
Ti %	.2	.2	.2	.3	.4
Ag ppm	< 1	< 1	< 1	< 1	< 1
Au	< 10	< 10	< 10	< 10	< 10
As	< 500	< 500	< 500	< 500	< 500
B	< 10	< 10	< 10	< 10	< 10
Ba	< 200	< 200	< 200	< 200	< 200
Be	2	< 2	< 2	< 2	< 2
Bi	< 30	< 30	< 30	< 30	< 30
Cd	< 100	< 100	< 100	< 100	< 100
Co	30	10	10	20	20
Cr	80	20	20	10	20
Cu	70	200	200	400	200
Ga	10	10	< 10	< 10	< 10
Ge	< 20	< 20	< 20	< 20	< 20
La	80	< 50	< 50	< 50	< 50
Mn	300	100	100	100	100
Mo	< 10	< 10	< 10	250	200
Nb	< 50	< 50	< 50	< 50	< 50
Ni	40	30	20	40	40
Pb	20	30	20	20	10
Sb	< 100	< 100	< 100	< 100	< 100
Sc	< 30	< 30	< 30	< 30	< 30
Sn	< 10	< 10	< 10	< 10	< 10
Sr	< 100	200	400	200	100
Tl	see above				
V	30	150	100	300	400
W	< 100	< 100	< 100	< 100	< 100
Y	30	< 10	< 10	< 10	< 10
Zn	< 200	< 200	< 200	< 200	< 200
Zr	100	100	200	200	300

CMSI*

	AM-1130(299-300)	AM-1130(339-340)	AM-1130(340-341)	AM-1190(118-119)
Fe %	1.5	4.0	2.0	.6
Ca %	1.0	4.0	2.0	>10.0
Mg %	.02	.05	< .02	.03
Al %	4.0	7.0	3.0	1.0
Ti %	.4	.7	.4	.3
Ag ppm	< 1	< 1	< 1	< 1
Au	< 10	< 10	< 10	< 10
As	< 500	< 500	< 500	< 500
B	< 10	20	20	20
Ba	< 200	< 200	< 200	< 200
Be	< 2	< 2	< 222	< 2
Bi	< 30	< 30	< 30	< 30
Cd	< 100	< 100	< 100	< 100
Co	10	20	10	20
Cr	30	100	30	20
Cu	300	400	200	300
Ga	< 10	10	< 10	< 10
Ge	< 20	< 20	< 20	< 20
La	< 50	< 50	< 50	< 50
Mn	80	500	150	50
Mo	< 10	150	10	200
Nb	< 50	< 50	< 50	< 50
Ni	40	50	40	20
Pb	10	10	10	10
Sb	< 100	< 100	< 100	< 100
Sc	< 30	< 30	< 30	< 30
Sn	< 10	< 10	< 10	< 10
Sr	200	500	100	500
V	400	300	250	200
W	< 100	< 100	< 100	< 100
Y	< 10	< 10	< 10	< 10
Zn	< 200	< 200	< 200	< 200
Zr	200	500	300	300

CMSI*

	AN-1350(384-385)	AN-1490(381-382)	AN-1490(392-393)
Fe %	1.5	5.0	3.0
Ca %	5.0	2.0	2.5
Mg %	.02	.06	.06
Al %	2.0	7.0	4.0
Ti %	.15	.2	.15
Ag ppm	< 1	< 1	< 1
Au	< 10	< 10	< 10
As	< 500	< 500	< 500
B	< 10	< 10	< 10
Ba	< 200	< 200	< 200
Be	< 2	< 2	< 2
Bi	< 30	< 30	< 30
Cd	< 100	< 100	< 100
Co	10	20	10
Cr	20	40	30
Cu	200	100	100
Ga	< 10	10	< 10
Ge	< 20	< 20	< 20
La	< 50	< 50	< 50
Mn	60	200	100
Mo	< 10	< 10	50
Nb	< 50	< 50	< 50
Ni	20	30	20
Pb	15	20	20
Sb	< 100	< 100	< 100
Sc	< 30	< 30	< 30
Sn	< 10	< 10	< 10
Sr	100	200	100
V	600	150	250
W	< 100	< 100	< 100
Y	< 10	< 10	< 10
Zn	< 200	< 200	< 200
Zr	100	200	100

Ray Broadhurst

CMSI INC.

CHEMICAL & MINERALOGICAL SERVICES • 445 WEST 2700 SOUTH • SALT LAKE CITY, UTAH 84115 • (801) 485-0711

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Semi-quantitative spectrographic analyses

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	SS AM-26C(726-727)	sub mud AM-26C(735-736)	marl AM-26C(740-741)	lignite AM-49C(630-631)	carbon shale AM-113C(298-299)
Fe %	3.0	2.0	2.0	1.5	1.5
Ca %	1.5	1.5	5.0	3.5	1.5
Mg %	.4	.02	.02	.02	< .02
Al %	5.0	4.0	4.0	4.5	4.5
Ti %	.2	.2	.2	.3	.4
Ag ppm	< 1	< 1	< 1	< 1	< 1
Au	< 10	< 10	< 10	< 10	< 10
As	< 500	< 500	< 500	< 500	< 500
B	< 10	< 10	< 10	< 10	< 10
Ba	< 200	< 200	< 200	< 200	< 200
Be	2	< 2	< 2	< 2	< 2
Bi	< 30	< 30	< 30	< 30	< 30
Cd	< 100	< 100	< 100	< 100	< 100
Co	30	10	10	20	20
Cr	80	20	20	10	20
Cu	70	200	200	400	200
Ga	10	10	< 10	< 10	< 10
Ge	< 20	< 20	< 20	< 20	< 20
La	80	< 50	< 50	< 50	< 50
Mn	300	100	100	100	100
Mo	< 10	< 10	< 10	250	200
Nb	< 50	< 50	< 50	< 50	< 50
Ni	40	30	20	40	40
Pb	20	30	20	20	10
Sb	< 100	< 100	< 100	< 100	< 100
Sc	< 30	< 30	< 30	< 30	< 30
Sn	< 10	< 10	< 10	< 10	< 10
Sr	< 100	200	400	200	100
Ti	see above				
V	30	150	100	300	400
W	< 100	< 100	< 100	< 100	< 100
Y	30	< 10	< 10	< 10	< 10
Zn	< 200	< 200	< 200	< 200	< 200
Zr	100	100	200	200	300

CMS

	Carbon. sitst AM-113C(299-300)	carb. sitst AM-113C(339-340)	carb sit (mig) AM-113C(340-341)	marl (above [illegible]) AM-119C(118-119)
Fe %	1.5	4.0	2.0	.6
Ca %	1.0	4.0	2.0	>10.0
Mg %	.02	.05	< .02	.03
Al %	4.0	7.0	3.0	1.0
Ti %	.4	.7	.4	.3
Ag ppm	< 1	< 1	< 1	< 1
Au	< 10	< 10	< 10	< 10
As	< 500	< 500	< 500	< 500
B	< 10	20	20	20
Ba	< 200	< 200	< 200	< 200
Be	< 2	< 2	< 222	< 2
Bi	< 30	< 30	< 30	< 30
Cd	< 100	< 100	< 100	< 100
Co	10	20	10	20
Cr	30	100	30	20
Cu	300	400	200	300
Ga	< 10	10	< 10	< 10
Ce	< 20	< 20	< 20	< 20
La	< 50	< 50	< 50	< 50
Mn	80	500	150	50
Mo	< 10	150	10	200
Nb	< 50	< 50	< 50	< 50
Ni	40	50	40	20
Pb	10	10	10	10
Sb	< 100	< 100	< 100	< 100
Sc	< 30	< 30	< 30	< 30
Sn	< 10	< 10	< 10	< 10
Sr	200	500	100	500
V	400	300	250	200
W	< 100	< 100	< 100	< 100
Y	< 10	< 10	< 10	< 10
Zn	< 200	< 200	< 200	< 200
Zr	200	500	300	300

CMSI

	mydet. AM-135C(384-385)	heavist (min. below) AM-149C(381-382)	Earth 3H st. AM-149C(392-393)
Fe %	1.5	5.0	3.0
Ca %	5.0	2.0	2.5
Mg %	.02	.06	.06
Al %	2.0	7.0	4.0
Ti %	.15	.2	.15
Ag ppm	< 1	< 1	< 1
Au	< 10	< 10	< 10
As	< 500	< 500	< 500
B	< 10	< 10	< 10
Ba	< 200	< 200	< 200
Be	< 2	< 2	< 2
Bi	< 30	< 30	< 30
Cd	< 100	< 100	< 100
Co	10	20	10
Cr	20	40	30
Cu	200	100	100
Ga	< 10	10	< 10
Ge	< 20	< 20	< 20
La	< 50	< 50	< 50
Mn	60	200	100
Mo	< 10	< 10	50
Nb	< 50	< 50	< 50
Ni	20	30	20
Pb	15	20	20
Sb	< 100	< 100	< 100
Sc	< 30	< 30	< 30
Sn	< 10	< 10	< 10
Sr	100	200	100
V	600	150	250
W	< 100	< 100	< 100
Y	< 10	< 10	< 10
Zn	< 200	< 200	< 200
Zr	100	200	100

Ray Broadhead

Andersen Mine (✓) = completed

✓ Abstract

✓ Introduction

✓ General Geol

✓ Regional Strat

" Struct

Andersen Mine

Paleo reconstruction

Structure

Mineralogy & Mineralization

Mineralogy

Occurances

Stratigraphic

Secondary

Disequilibrium

Alteration & Secondary mineralization (clay + zeolite min.)

Genesis

Summary

Conclusion

References Cited

Figures + Plates

1) location map
2) Regional Geol. of NE Date Cr. Basin
3) Geol. map Anderson Mine
4) Idealized X-section - Anderson Mine
5) High Oblique Air photo of Anderson Mine
6) GT map
7) Isopach map of carbonaceous material
8) Pre-Anderson topog (paleotopography) map
9) lower time line map
10) middle " " " (upper Carb. interval)
11) upper " " " Marlstone
12) photo micrographs
13) 51-C geochem strip-log figures } → appendices
14) 135-C " " " }

1st WK Nov:

Plates + Figs for Strat. Anderson Mine - incl any structuctere

- Strip chart for Geochem.

2nd WK Nov:

6-12 Strating + Struct completed (if thin-sections + other in)

Start Geochem. plots

Begin Writting Geochem

3rd WK Nov.

13-19 Continue Geochem.

Begin writting Genesis

4th WK Nov.

20-28 Review + Compile

5th WK Nov.

27-36 continue the above

15th Decem. to

Minerals Exploration Company

P.O. Box 2674
Casper, Wyoming 82602
Telephone: (307) 234-7331

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MINERALS

September 8, 1977

Head Office:
P.O. Box 54945
Los Angeles, California 90054
(213) 486-6929

Mr. R. J. Broadhead
Chemical and Mineralogical Services
445 West 2700 South
Salt Lake City, Utah 84115

Dear Ray,

Enclosed are twenty-three samples to be analyzed as designated on the accompanying sheet. Please return to me all pulps and rejects which remain after analysis. If you have any questions, please feel free to contact me.

Sincerely,

Terry S. Hellinger

Terry S. Hellinger
Geologist

TSH:ct
Encl.

CMSI* INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM:

T.S. HELLINGER	CUSTOMER NUMBER
MINERALS EXPLORATION CO.	CMS NUMBER
P.O. BOX 2674	DATE SHIPPED 8-8-77
CASPER, WY 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-49c (620-621)	Li, U_3O_8	C		✓	
AM-135c (383-385)	Li, U_3O_8, em. spec.	C		✓	30+ elements on emission spec. scan
AM-17c (130-131)	Li, U_3O_8, em. spec.	C		✓	"
AM-26c (735-738)	Li, U_3O_8, em. spec.	C		✓	"
AM-26c (638-639)	Li, U_3O_8, em. ~~spp~~ spec.	C		✓	"
AM-26c (639-640)	Li, U_3O_8	C		✓	
AM-149c (381-382)	Li, U_3O_8, em. spec.	C		✓	30+ elements on emission spec. scan
AM-149c (382-383)	Li, U_3O_8	C		✓	
AM-149c (392-393)	Li, U_3O_8, em. spec.	C		✓	30+ elements on emission spec. scan
AM-113c (298-299)	Li, U_3O_8, em. spec.	C		✓	"
AM-113c (299-300)	Li, U_3O_8, em. spec.	C		✓	"
AM-113c (300-301)	Li, U_3O_8	C		✓	
AM-113c (339-340)	Li, U_3O_8, em. spec.	C		✓	30+ elements on emission spec. scan
AM-113c (340-341)	Li, U_3O_8, em. spec.	C		✓	"
AM-49c (630-631)	Li, U_3O_8, em. spec.	C		✓	"
AM-49c (631-632)	Li, U_3O_8	C		✓	
AM-18c (286-287)	Li, U_3O_8, em. spec.	C		✓	30+ elements on emission spec. scan
AM-26c (726-727)	Li, U_3O_8, em. spec.	C		✓	"
AM-26c (721-721.3)	Li, U_3O_8	C		✓	
AM-119c (118-119)	Li, U_3O_8, em. spec.	C		✓	30+ elements on emission spec. scan.

REJECTS SAVE ☒ DISCARD ☐

PULPS SAVE ☒ DISCARD ☐

R = rock
C = core (crushed)
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

T.S. Hellinger
Minerals Expl. Co
P.O. Box 2674
Casper, WY 82602

(RETURN PULPS & REJECTS AFTER COMPLETION)

GEOLOGIST: Terry S Hellinger

CMSI* INC.

Page 2

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM:

T. S. Hellinger	CUSTOMER NUMBER
c/o Minerals Exploration Co.	CMS NUMBER
P.O. Box 2674	DATE SHIPPED 8-8-77
Casper, WY 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
	~~Li, U_3O_8~~	~~C~~		~~Li, U_3O_8~~	
AM-119c (119-120)	Li, U_3O_8	C			
AM-26c (740-741)	Li, U_3O_8, em. spec.	C			30 elements on emission spec. scan
AM-135c (385-386)	Li, U_3O_8	C			

REJECTS SAVE ☒ DISCARD ☐

PULPS SAVE ☒ DISCARD ☐

R = rock
C = core - (crushed)
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES 23

SEND RESULTS TO:

~~T. S. Hellinger~~

(RETURN REJECTS & PULPS AFTER COMPLETION OF ANALYSES)

GEOLOGIST: Terry S. Hellinger

CMS INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM:

TERRY S. HELLINGER	CUSTOMER NUMBER
MINERALS EXPLORATION CO.	CMS NUMBER
P.O. Box 2674	DATE SHIPPED 10-17-77
CASPER, WY 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-51c 377-378	U_3O_8, V_2O_5, Mn, Li, Mo, $S_{(total)}$, $C_{(organic)}$	C			
AM-51c 378-379	as above	"			
AM-51c 379-380	" "	"			
AM-51c 380-381	" "	"			
AM-51c 381-382	" "	"			
AM-51c 382-383	" "	"			
AM-51c 383-384	" "	"			
AM-51c 384-385	" "	"			
AM-51c 385-386	" "	"			
AM-51c 386-387	" "	"			
AM-51c 387-388	" "	"			
AM-51c 388-389	" "	"			
AM-51c 389-390	" "	"			
AM-51c 390-391	" "	"			
AM-51c 391-392	" "	"			
AM-51c 392-393	" "	"			
AM-51c 393-394	" "	"			
AM-51c 394-395	Mn, Li, Mo, $C_{(organic)}$	"			
AM-51c 395-396	as above	"			
AM-51c 396-397	" "	"			

REJECTS SAVE ☒ DISCARD ☐
PULPS SAVE ☒ DISCARD ☐
} please return

R = rock
C = core
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

Minerals Exploration Co.
P.O. Box 2674
Casper, Wy 82602
Attn. T.S. Hellinger

GEOLOGIST: Terry S. Hellinger

CMS* INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM:

Page 2

T. S. HELLINGER	CUSTOMER NUMBER
Minerals Expl. Co.	CMS NUMBER
P. O. Box 2674	DATE SHIPPED 10-17-77
Casper, WY 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-51c (377-398)	Mn, Li, Mo, C(organic)	C			
AM-51c 398-399	as above	"			
AM-51c 399-400	" "	"			
AM-51c 400-401	" "	"			
AM-51c 401-402	" "	"			
AM-51c 402-403	" "	"			
AM-51c 403-404	" "	"			
AM-51c 404-405	" "	"			
AM-51c 405-406	" "	"			
AM-51c 406-407	" "	"			
AM-51c 407-408	" "	"			
AM-51c 408-409	" "	"			
AM-51c 409-410	" "	"			
AM-51c 410-411	" "	"			
AM-51c 411-412	" "	"			
AM-51c 412-413	" "	"			
AM-51c 413-414	U_3O_8, V_2O_5, Mn, Li, Mo, S (total)) C (organic)	"			
AM-51c 414-415	as above	"			
AM-51c 415-416	" "	"			
AM-51c 416-417	" "	"			

REJECTS SAVE ☒ DISCARD ☐
PULPS SAVE ☒ DISCARD ☐
} PLEASE RETURN

R = rock
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SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

above address

Terry S. Hellinger

GEOLOGIST:

CMS* INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

PAGE 3

SAMPLES FROM:

TERRY S. HELLINGER	CUSTOMER NUMBER
MINERALS EXPLORATION CO.	CMS NUMBER
P.O. BOX 2674	DATE SHIPPED 10-17-77
CASPER, WY 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-51c 417-418	U_3O_8, V_2O_5, Mn, Li, Mo, $S_{(total)}$, $C_{(organic)}$	C			
AM-51c 430-431	as above	"			
AM-51c 431-432	" "	"			
AM-51c 432-433	" "	"			
AM-51c 433-434	" "	"			
AM-51c 434-435	" "	"			
AM-51c 435-436	" "	"			
AM-51c 436-437	" "	"			
AM-51c 437-438	" "	"			
AM-51c 438-439	Mn, Li, Mo, $C_{(organic)}$	"			
AM-51c 439-440	as above	"			
AM-51c 440-441	U_3O_8, V_2O_5, Mn, Li, Mo, $S_{(total)}$, $C_{(organic)}$	"			
AM-51c 441-442	as above	"			
AM-51c 442-443	Mn, Li, Mo, $C_{(organic)}$	"			
AM-51c 443-444	as above	"			
AM-51c 444-445	" "	"			
AM-51c 445-446	" "	"			
AM-51c 446-447	" "	"			
AM-51c 447-448	" "	"			
AM-51c 448-449	U_3O_8, V_2O_5, Mn, Li, Mo, $S_{(total)}$, $C_{(organic)}$	"			

REJECTS SAVE ☒ DISCARD ☐
PULPS SAVE ☒ DISCARD ☐
} Please return

R = rock
C = core
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

above address

GEOLOGIST: Terry S. Hellinger

CMS* INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM:

PAGE 4

TERRY S. HELLINGER	CUSTOMER NUMBER
MINERALS EXPLORATION CO.	CMS NUMBER
P.O. BOX 2674	DATE SHIPPED 10-17-77
CASPER, WY	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-51c 449-450	U_3O_8, V_2O_5, Li, Mn, Mo, S (total), C (organic)	C			
AM-51c 450-451	as above	"			
AM-51c 451-452	" "	"			
AM-51c 452-453	" "	"			
AM-51c 453-454	" "	"			
AM-51c 454-455	" "	"			
AM-51c 455-456	" "	"			
AM-51c 456-457	" "	"			
AM-51c 457-458	" "	"			
AM-51c 458-459	" "	"			
AM-51c 459-460	" "	"			
AM-51c 460-461	" "	"			
AM-51c 461-462	" "	"			
AM-51c 462-463	" "	"			
AM-51c 463-464	Mn, Li, Mo, C (organic)	"			
AM-51c 464-465	as above	"			
AM-51c 465-466	U_3O_8, V_2O_5, Li, Mn, Mo, S (total), C (organic)	"			
AM-51c 466-467	as above	"			
AM-51c 467-468	" "	"			
AM-51c 468-469	" "	"			

REJECTS SAVE ☒ DISCARD ☐
PULPS SAVE ☒ DISCARD ☐
} Please return

R = rock
C = core
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

Same as above

GEOLOGIST: Terry S. Hellinger

CMSI* INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM:

Page 5

TERRY S. HELLINGER	CUSTOMER NUMBER
MINERALS EXPLORATION CO.	CMS NUMBER
P.O. BOX 2674	DATE SHIPPED 10-17-77
CASPER, WY 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-51c 469-470	Mn, Li, Mo, C (organic)				
AM51c 470-471	as above				
AM-51c 471-472	U_3O_8, V_2O_5, Mn, Li, Mo, S (total), C (organic)				
AM-51c 472-473	as above				
AM-51c 473-474	" "				
AM-51c 474-475	" "				
AM-135c 452-453	U_3O_8, V_2O_5, Mn, Li, Mo, S (total), C (organic)				
AM-135c 453-454	as above				
AM-135c 454-455	" "				
AM-135c 455-456	" "				
AM-135c 456-457	" "				
AM-135c 457-458	" "				
AM-135c 458-459	" "				
AM-135c 459-460	" "				
AM-135c 460-461	" "				
AM-135c 461-462	" "				
AM-135c 462-463	" "				
AM-135c 463-464	" "				
AM-135c 464-465	" "				

REJECTS SAVE ☒ DISCARD ☐
PULPS SAVE ☒ DISCARD ☐
} Please return

R = rock
C = core
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

Same as above

Terry S. Hellinger

GEOLOGIST:

CMS* INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

SAMPLES FROM: Page 6

TERRY S. HELLINGER	CUSTOMER NUMBER
Minerals Exploration Co.	CMS NUMBER
P.O. Box 2674	DATE SHIPPED 10-17-77
Casper, Wy 82602	DATE RECEIVED

SAMPLE NUMBERS	ANALYSE FOR:	SAMPLE TYPE*	ASSAY	GEOCHEM	REMARKS
AM-135c 465-466	Mn, Li, Mo, C (organic)	C			
AM-135c 466-467	as above	"			
AM-135c 467-468	" "	"			
AM-135c 468-469	" "	"			
AM-135c 469-470	" "	"			
AM-135c 470-471	" "	"			
AM-135c 471-472	" "	"			
AM-135c 472-473	" "	"			
AM-135c 473-474	" "	"			
AM-135c 474-475	" "	"			
AM-135c 475-476	" "	"			
AM-135c 476-477	" "	"			
AM-135c 477-478	U_3O_8, V_2O_5, Mn, Li, Mo, S (total), C (organic)	"			
AM-135c 478-479	as above	"			
AM-135c 479-480	" "	"			
AM-135c 480-481	" "	"			
AM-135c 481-482	" "	"			
AM-135c 482-483	" "	"			
AM-135c 483-484	" "	"			

REJECTS SAVE ☒ DISCARD ☐
PULPS SAVE ☒ DISCARD ☐
} Please return

R = rock
C = core
DC = drill cuttings
S = soil
SS = stream sed.
Other

TOTAL NO. OF SAMPLES

SEND RESULTS TO:

Same as above

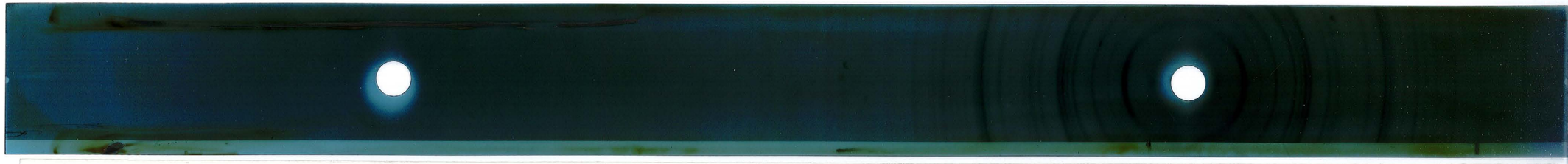
Terry S. Hellinger
GEOLOGIST:

Film No. 1
Specimen No.
Spindle No.
Date
rad. filter
KVP ma
Hr. exposure
Dev. min @ °F

Mineral(s) Carnotite
Locality
For 003-105 Yellow Urau

hkl	dÅ	I/I1

Chemistry
Optics
Other data

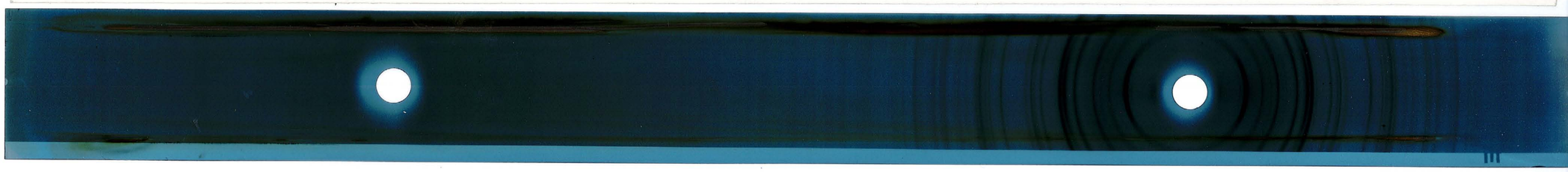


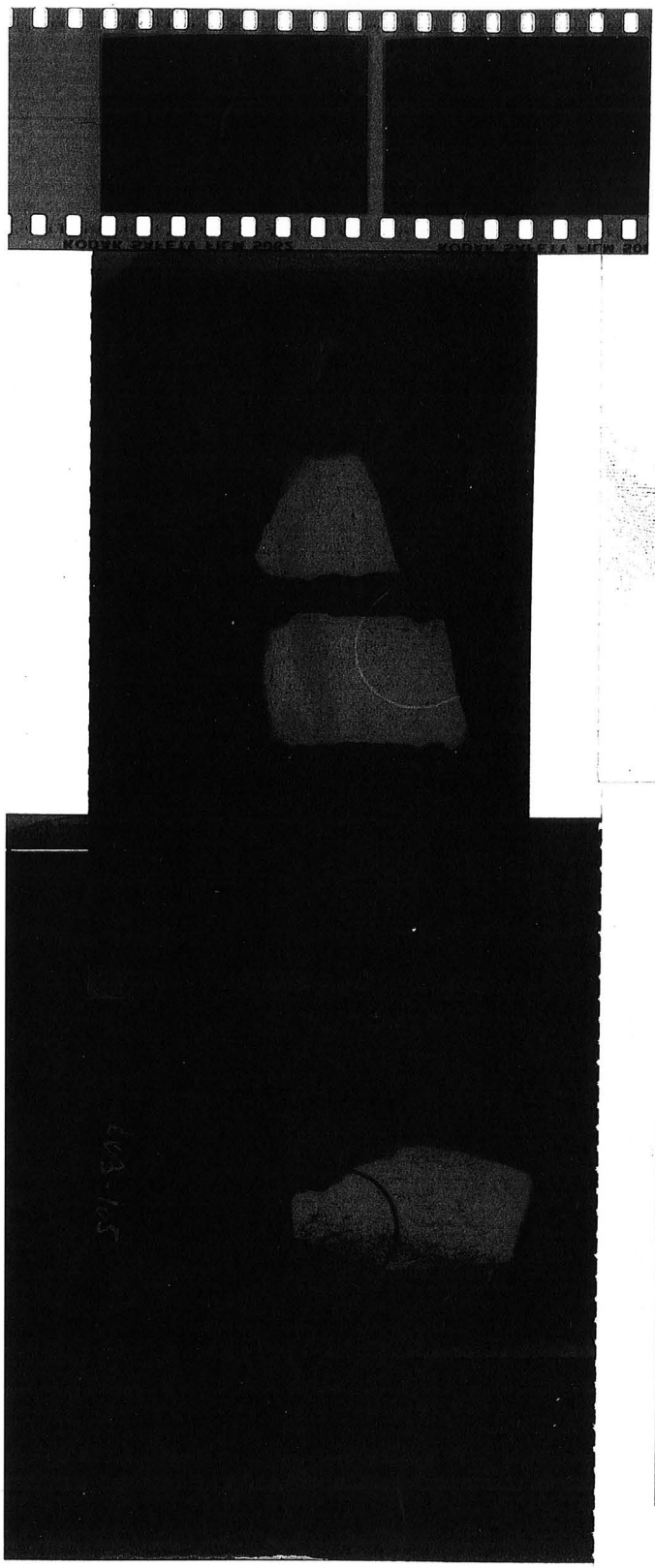
Film No. 3
Specimen No.
Spindle No.
Date
rad. filter
KVP ma
Hr. exposure
Dev. min @ °F

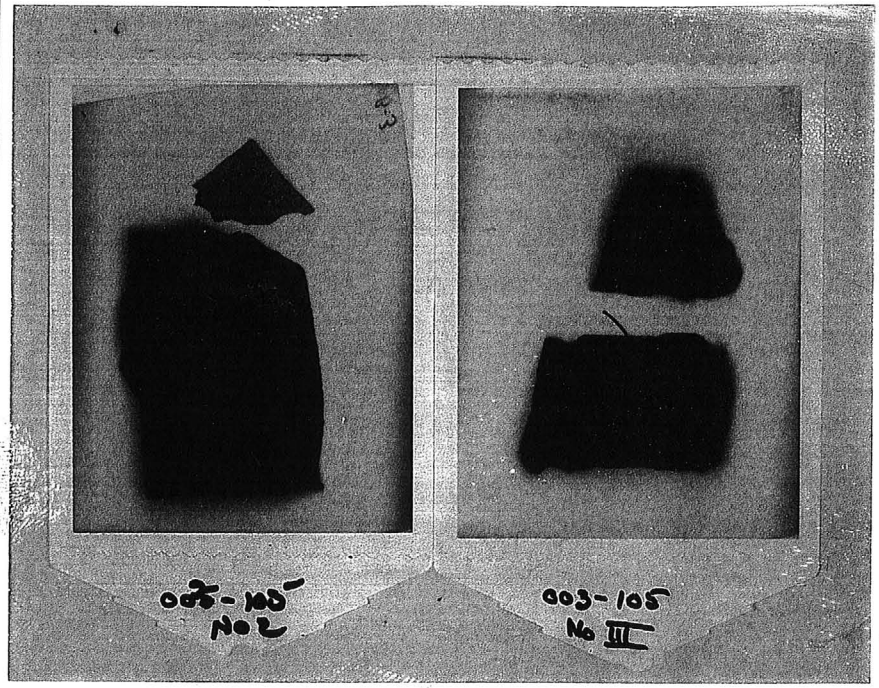
Mineral(s) Carnotite
Locality
For 003-IV/105-Yellow Coatings

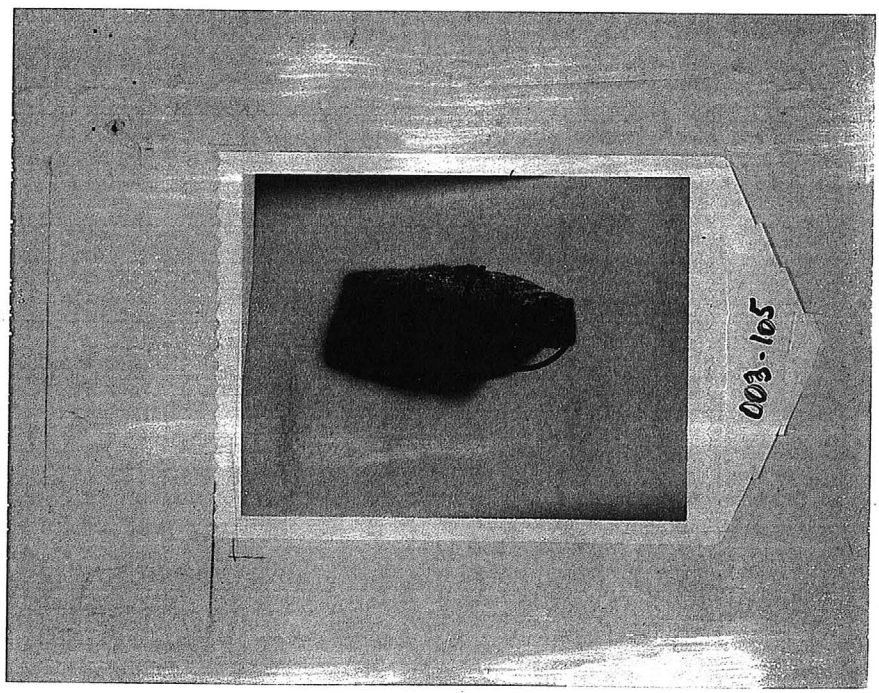
hkl	dÅ	I/I1

Chemistry
Optics
Other data









photos/neg in photo cabinet

Minerals Exploration Company

P.O. Box 2674
Casper, Wyoming 82602
Telephone: (307) 234-7331

union 76 MINERALS

October 11, 1977

Head Office:
P.O. Box 54945
Los Angeles, California 90054
(213) 486-6929

Mr. Roland Schmidt
Hazen Research, Inc.
4601 Indiana St.
Golden, Co. 80401

Dear Roland:

Enclosed are four samples for radioactive mineral identification. The following is a very brief description of the samples. Beta and gamma values were obtained from our GEOCO Beta-Gamma scaler.

(I) AM-51c, 465.5-4666.0, blk. carbonaceous "tuffaceous" mudstone;
beta = 4794, gamma = 502

(II) AM-f1c, 440.0-440.3, gry-buff calcareous "tuffaceous" mudstone;
beta = 845, gamma = 252

(III) AM-1c, 100.0-100.5, buff "water laid tuff";
beta = 676, gamma = 228

(IV) Surface sample, gry-grn silicified tuffaceous mudstone with secondary yellow oxide "uranium" mineralization;
beta = 3446, gamma = 564

At this time we only need the radioactive minerals identified by the most rapid and inexpensive method readily available. If there are any questions, please feel free to contact Jack Sherborne or myself.

The information obtained from this study will be incorporated into a paper written for the annual AAPG meeting. Therefore, we would appreciate a pnone call as soon as the results are available.

Thank you.

Sincerely,

Terry S. Hellinger

Terry S. Hellinger
Geologist

TSH:ct
Encls.

Minerals Exploration Company

P.O. Box 2674
Casper, Wyoming 82602
Telephone: (307) 234-7331

union 76
MINERALS

October 17, 1977

d Office:
. Box 54945
Angeles, California 90054
3) 486-6929

Mr. Ray Broakhead
CMS Inc.
445 West 2700 South
Salt Lake City, Utah 84115

Dear Ray,

Enclosed are the 118 samples requiring analysis indicated on the accompanying sheets. These samples are critical for a uranium paper to be presented at the AAPG annual meeting. We therefore need the results as soon as possible (i.e. mid Nov.). If you have any problems or questions, please feel free to contact me. We would also like any of the remaining samples returned upon completion of the analysis.

I hope you are not too busy to fit these samples in. I do realize that it has been a very busy field season for most companies. Thanks again.

Sincerely,

Terry Hellinger

Terry S. Hellinger
Geologist

P.S. Two boxes were sent via U.P.S. containing
box 1- AM 51C samples
box 2- AM 135C samples

tele. 801-485-0711

Calculation Record
Union Oil Company of California
union 76

Prepared by	Checked by	Date	Sheet
		/ /	of

Title

W.O. / A.F.E. no.

(86 samples) AM-51c (disequilibrium 1.06)

										* cost
I	U_3O_8	V_2O_5	Mo	Li	MnO					$ 1064.00
II	"	"	"	"	"	C				1580.00
III	"	"	"	"	"	S	CO_2			1682.00
IV	"	"	"	"	"	"	"	C		2198.00
V	"	"	"	"	"	C	CaO			2053.00
VI	"	"	"	"	"	"	"	MgO		2483.00
VII	"	"	"	"	"	"	"	"	S	2671.00
VIII	"	"	"	"	"	"	"	S		2241.00
IX	"	"	"	"	"	"	S			

(* does not include sample prep. @ .75/sample or 10% discount)

Cost break down:

✓ U_3O_8	3.00
✓ V_2O_5	5.00
✓ Mo	1.50
✓ Li	5.00
✓ MnO	1.50
✓ C (organic)	6.00
✓ S (total)	4.00
CO_2	5.00
CaO	5.50
MgO	5.00

86 total samples
39 of the total already have U_3O_8, V_2O_5, CO_2, S(total) analyses

Calculation Record
Union Oil Company of California
union 76

Pg. 2 of 6
AM 135C

Prepared by	Checked by	Date	Sheet
		/ /	of

Title

W.O. / A.F.E. no.

AM-135c (cont.)

(analysis of lower interval only)

										* Costs
I	U_3O_8	V_2O_5	Mo	Li	MnO					96.00
II	"	"	"	"	"	C				352.00
III	"	"	"	"	"	S	CO_2			204.00
IV	"	"	"	"	"	"	"	C		396.00
V	"	"	"	"	"	C	CaO			464.00
VI	"	"	"	"	"	"	"	MgO		624.00
VII	"	"	"	"	"	"	"	"	S	672.00
VIII	"	"	"	"	"	"	"	S		512.00
IX	"	"	"	"	"	"	S			

(* does not include sample prep. @ .75/sample or 10% discount)

Cost breakdown

See other sheets

32 total samples
20 samples of this total already have U_3O_8, V_2O_5, CO_2, S analyses

Calculation Record
Union Oil Company of California
union 76

Prepared by	Checked by	Date	Sheet
		/ /	of

Title

W.O. / A.F.E. no.

(55 samples) AM-149c (disequilibrium .709)

										* cost
I.	U_3O_8	V_2O_5	Mo	Li	MnO					600.00
II	"	"	"	"	"	C				930.00
III	"	"	"	"	"	S	CO_2			780.00
IV	"	"	"	"	"	"	"	C		1100.00
V	"	"	"	"	"	C	CaO			1232.00
VI	"	"	"	"	"	"	"	MgO		1507.00
VII	"	"	"	"	"	"	"	"	S	1587.00
VIII	"	"	"	"	"	"	"	S		1312.00

(* does not include sample prep. @ .75/sample or 10% discount)

Cost breakdown

U_3O_8	3.00
V_2O_5	5.00
Mo	1.50
Li	5.00
MnO	1.50
C (organic)	6.00
S (total)	4.00
CO_2	5.00
CaO	5.50
MgO	5.00

55 total samples
35 of the total already have U_3O_8, V_2O_5, CO_2, S (total) analyses

Calculation Record
Union Oil Company of California
union 76

Prepared by	Checked by	Date	Sheet
		/ /	of

Title

W.O. / A.F.E. no.

AM-135c

(disequilibrium .762)

										*Cost
I	U_3O_8	V_2O_5	Mo	Li	MnO					688.00
II	"	"	"	"	"	C				1036.00
III	"	"	"	"	"	S	CO_2			940.00
IV	"	"	"	"	"	"	"	C		1288.00
V	"	"	"	"	"	C	CaO			1355.00
VI	"	"	"	"	"	"	"	MgO		1645.00
VII	"	"	"	"	"	"	"	"	S	1757.00
VIII	"	"	"	"	"	"	"	S		1467.00

(* does not include sample prep. @ .75/sample or 10% discount)

Cost breakdown

U_3O_8	3.00
V_2O_5	5.00
Mo	1.50
Li	5.00
MnO	1.50
C(organic)	6.00
S(total)	4.00
CaO	5.50
MgO	5.00

58 total samples
30 samples of the total already have U_3O_8, V_2O_5, CO_2, S analyses

NOTE:
Can save money on this study if we only study lower interval which has 32 total samples
20 samples of this total already have U_3O_8, V_2O_5, CO_2, S analyses
see pg. 2

AM-51c

intervals: 377-418 430-475

41 ft. 45 ft. = 86 ft.

39 samples already w/ U_3O_8, V_2O_5, CO_2, and total S

47 samples requiring @ least U_3O_8, V_2O_5, @ 8.00/sample

376.00

86 samples requiring Mo, Li, MnO @ 8.00/sample

688.00

47 samples requiring total S @ 4.00/sample

188.00

86 samples requiring C (organic) @ 6.00/sample

516.00

86 samples for CaO @ 5.50/sample

473.00

86 samples for MgO @ 5.00/sample

430.00

47 samples for CO_2 @ 5.00/sample

430.00

86 samples for em. spec. @ 12.00/sample

1032.00

AM-135c (disequilibrium .762)

intervals: 373-399 452-484

26 ft. 32 ft 58 ft

30 samples already w/ U_3O_8, V_2O_5, CO_2, and total S

28 samples for U_3O_8, V_2O_5 @ 8.00/sample lower interval

224.00 (96.00)

58 samples for Mo, Li, MnO @ 8.00/sample

464.00 (256.)

28 samples for total S @ 4.00/sample

112.00 (48.00)

58 samples for C (organic) @ 6.00/sample

348.00 (192.0)

58 samples for CaO @ 5.50/sample

319.00 (176.00)

58 samples for MgO @ 5.00/sample

290.00 (160.00)

28 samples for CO_2 @ 5.00/sample (60.00)

140.00

AM-149c

(diseq.(.709)

intervals: 340-355 380-420

15 ft 40 ft = 55 ft.

35 samples already w/ U_3O_8, V_2O_5, CO_2, and total S

20 samples for @ least U_3O_8, V_2O_5 @ 8.00/sample

160.00

55 samples for Mo, Li, MnO @ 8.00/sample

440.00

20 samples for total S @ 4.00/sample

80.00

55 samples for C(organic) @ 6.00/sample

330.00

55 samples for CaO @ 5.50/sample

302.00

55 samples for MgO @ 5.00/sample

275.00

20 samples for CO_2 @ 5.00/sample

100.00

55 sample for em. spec. @ 12.00/sample

660.00

correlated with part of Lasky and Webbers, (p. ___, 1949) Artillery Formation in the Artillery Mountains (Fig. 1).

"Arrastra Volcanics"

Northwest of Anderson Mine the "Arrastra Volcanics" rest with up to 35 degrees of discordance on the basal Tertiary rocks in section 30, T. 12 N., R. 10 W., (Fig. 2). Further east the volcanics lie ~~rest directly~~ on pre-Cambrian rocks. The "Arrastra" succession consists chiefly ~~largely~~ of coarse andesitic flows, agglomerates and volcanic breccias, with locally developed ~~clastic, but~~ volcanic conglomerates, sandstones, basaltic flows, and dacitic tuffs ~~(are also common in parts of the region)~~ An eastward thickening ~~of the succession~~, associated with an increase in the abundance of flows suggests a local source most of the succession ~~for part of the volcanics~~. Three dacitic domes located between Anderson Mine and the Santa Maria River contributed large quantities of light gray tuffs and agglomerate to the "Arrastra" volcanics ~~section (Fig. 2)~~. To the west, the section contains more reworked volcaniclastics and fewer flows. An upper Eocene or Oligocene age is suggested for the "Arrastra Volcanics" based on their relative stratigraphic position.

Following "Arrastra" volcanism over 120 m of ~~local~~ relief was developed in the vicinity of Anderson Mine, prior to the deposition of the lower Miocene sequence. The resistent andesitic volcanics formed local ~~contributed by upholding~~ topographic heights ~~topography~~ near volcanic centers, ~~but~~ normal faulting and tilting of the section ~~basin~~ may have contributed to the development of local paleo-depressions in the eastern part of the Date Creek Basin. The coincidence of local paleo-channels and enclosed paleo-depressions with younger faulting, and the association of lower Miocene depositional patterns suggests that the post-Miocene faults were also active prior to the lower Miocene. Following pre-Miocene deformation thick paleosals and colluvial fill developed on this post "Arrastra" surface.

The Tertiary section in the northeastern Date Creek Basin includes more than 1100 m of a complex succession of volcanic ~~rocks~~ based arkosic and volcaniclastic sediments.

GENERAL GEOLOGY

The lower Miocene section at Anderson Mine forms about one-sixth of the of the Tertiary succession in the northeastern Date Creek Basin. Over 1100 m of volcanic and arkosic material form this complex succession. The intricate facies, associated volcanism, and numerous unconformities reflect the tectonic instability of the region during this period. Two similar ~~sequences, an~~ Eocene and ~~a~~ Miocene sequences begin with arkosic sedimentation and ~~are~~ continued with ~~silic~~ silicic volcanism ~~in the northeastern Date Creek Basin~~. Andesitic and basaltic volcanism follow these two respective sequences after periods of deformation and erosion ~~in the basin~~.

STRATIGRAPHY

Five informal stratigraphic units are recognized in the Arrastra Mountains and the northeastern Date Creek Basin. In ascending order They include the basal Tertiary rocks; the upper Paleogene "Arrastra" volcanics; ~~the~~ lower Miocene Anderson Mine sediments; ~~the~~ upper Miocene basalt and agglomerate; and ~~the~~ "~~younger~~ older" alluvium.

Basal Tertiary Rocks

The basal Tertiary rocks consists predominately poorly sorted ~~largely~~ of reddish arkosic (sandstones and congl ~~sediments~~ overlain by varicolored an ignimbrite and air-laid and reworked vitric tuffs ~~silicic volcanics~~. These rocks ~~which~~ are preserved in a series of tilted and down-dropped fault blocks in the Arrastra Mountains (Fig. 2). ~~The section is formed of over 90 m of coarse, poorly sorted, reddish, arkosic sandstones and conglomerates, that are overlain by reworked vitric tuffs, and a silicic ignimbrite~~. The contact between the red beds and the volcanics is gradtional to disconformable. In places the an ignimbrite rests on the Precambrian older metamorphic complex, but elesewhere it rests either on red beds or tuffaceous sediments. ~~The ignimbrite, which is an important key unit that is recognized over large parts of the region~~. An Eocene age (41.5±1.2 m.y.) was obtained by ~~J.~~ Gassaway (197_) for this ignimbrite ~~(Otton, 1977)~~. The basal Tertiary unit is tentatively

Water = 62.428 lbs / cu ft

Bucyrus Erie 70 yd dragline can move 18 million yards of earth per year.

RANK	Sp. Gr	Tons/Acre Ft	Tons/cu ft	Tons/Square mile-foot
Anthracite - Semi anthracite	1.47	1999	1.240	1280000
Bituminous	1.32	2000	1.116	1152000
Subbituminous	1.30	1794	1.098	1132800
Lignite	1.29	1800	1.084	1120000
		1767		
		1770		
		1754		
		1750		

Source: U.S. Geological Survey. Published in Bull 1242-B and others

1 Ton Coal = 25 cu ft at 1.28 sp.
1 yd³ coal = 1.08 Tons.

"bone" - carbonaceous mud

1 cu foot = 43560 cu.ft. = 1613.33 cu. yds.
1 btu = 252 calories = heat required to raise 1 pound of water from 62° to 63° F.

Fuel Ratio = Fixed Carbon / Volatiles. If less than 1 then Cannel Coal

$$\text{Dry mineral-matter-free fixed carbon} = \frac{FC}{100-(M+1.1A+0.1S)} \times 100$$

where: FC = percentage of fixed carbon,
M = percentage of moisture,
A = percentage of ash, and
S = percentage of sulfur.

Classification of coals by rank [1]

[Symbols: FC, fixed carbon; VM, volatile matter; Btu, British thermal units. From American Society for Testing Materials (1939, p. 2)]

Class	Group	Limits of fixed carbon or Btu mineral-matter-free basis	Requisite physical properties
I. Anthracitic	1. Meta-anthracite	Dry FC, 98 percent or more (dry VM, 2 percent or less).	
	2. Anthracite	Dry FC, 92 percent or more and less than 98 percent (dry VM, 8 percent or less and more than 2 percent).	
	3. Semianthracite	Dry FC, 86 percent or more and less than 92 percent (dry VM, 14 percent or less and more than 8 percent).	Nonagglomerating.[2]
II. Bituminous [3]	1. Low-volatile bituminous coal.	Dry FC, 78 percent or more and less than 86 percent (dry VM, 22 percent or less and more than 14 percent).	
	2. Medium-volatile bituminous coal.	Dry FC, 69 percent or more and less than 78 percent (dry VM, 31 percent or less and more than 22 percent).	
	3. High-volatile A bituminous coal.	Dry FC, less than 69 percent (dry VM, more than 31 percent); and moist [4] Btu, 14,000 [5] or more.	
	4. High-volatile B bituminous coal.	Moist [4] Btu, 13,000 or more and less than 14,000.[5]	
	5. High-volatile C bituminous coal.	Moist Btu, 11,000 or more and less than 13,000.[5]	Either agglomerating or nonweathering [6]
III. Subbituminous	1. Subbituminous A coal.	Moist Btu, 11,000 or more and less than 13,000.[5]	Both weathering and nonagglomerating.
	2. Subbituminous B coal.	Moist Btu, 9,500 or more and less than 11,000.[5]	
	3. Subbituminous C coal.	Moist Btu, 8,300 or more and less than 9,500.[5]	
IV. Lignitic	1. Lignite	Moist Btu, less than 8,300	Consolidated.
	2. Brown coal	Moist Btu, less than 8,300	Unconsolidated.

[1] This classification does not include a few coals which have unusual physical and chemical properties and which come within the limits of fixed carbon or Btu of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48 percent dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu.

[2] If agglomerating, classify in low-volatile group of the bituminous class.

[3] It is recognized that there may be noncaking varieties in each group of the bituminous class.

[4] Moist Btu refers to coal containing its natural bed moisture but not including visible water on the surface of the coal.

[5] Coals having 69 percent or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of Btu.

[6] There are three varieties of coal in the high-volatile C bituminous coal group, namely, Variety 1, agglomerating and nonweathering; Variety 2, agglomerating and weathering; Variety 3, nonagglomerating and nonweathering.

1.25 sp gr = 1700 tons/cu ft
1.35 sp gr = 1835 tons/cu ft

F

a.) F correl. w/ U_3O_8 & General F values

1. no good correl. F (Table —) ~~surprisingly enough show~~ displays ~~little variation w/ respect to lith. throughout the cores~~ studied

2. values range in min zone

a. from ~~425 1500 ppm~~ ~~540~~ 120 to 1320 ppm

3. values range from 425 to 1550 ppm in un min. zone

4. more than 70% of the F values for both min. & min. zones are greater than 750 ppm

b.) F vs. lith

1. no displayed v. little v. w/ respect to lith. however ~~did show~~ the lower F values correlated w/ the calcareous units (Fig 135c)

2. no cor. w/ organic C (Table —)

c.) Insuff. infor. to determine if F ~~is anom~~ more than just locally anom. @ AM.

1.) Fleisher & Robinson (1963) aver. conc. of F in vol. ash & bent. ≅ 750 ppm

2. @ this time is not considered a reliable indicator for AM type min.

* 3. the gen. high uniform F values for the AM probably reflect the acid volcanic origin of the sediments, F was prob. released during sedimentation and diagenesis of the tuffs

15-25
30

Li

a.) ~~E~~ Li compared w/ U_3O_8

1. Li ranges from 9 to 280 in min. zone w/only 40 % ~~only~~ less than 60 ppm
2. Li ranges from 25 to 560 in non.min. zone w/ approx 40 ~~60~~ % ~~less than~~ less than 60 ppm
3. ~~no~~ U. poor correl. w/ U_3O_8 (Table ___) Cor. Coef.

b.) lith vs. Li

1. poor cor. w/ organic C (Table ___) Cor. Coef.

* Values are gen. higher outside of the min. zone
use ranges

Mn

a.) Mn compared w/ U_3O_8

1. Mn ranges in min. zone 125 to 2300 ppm w/ %
2. Mn ranges in unmin. zone to ppm w/ %

b.) lith vs. Mn.

1. fair-poor corr. w/ organic C (Table ___) Cor. Coef.
2.

In general Mn has been only locally conc. in the higher grade U_3O_8 min. assoc. w/ organic carbon.
Outside of the min. zone Mn ~~is~~ generally displays values of 100 - 200 ppm
Rather poor correlation - however higher background in min. zone probably due to carbon

As — $\boxed{\text{compare As-S}}$

a.) ~~in min. zone~~ compared to U_3O_8:

1. As is anom. ranges from 5-315 ppm, values are gen. greater than 10 ppm
2. As ranges from ~~from~~ 1-115 ppm outside min. zone
   however values are generally less than 10 ppm
3. Good-fair correlation w/ U_3O_8 (Table ___ . ___ Cor. Coef.

b.) lithology & As (Figs. ___ ~~and~~ ___)

1. good correlation w/ organic C. (Table ___)
2. not assoc. w/ tuff or tuffaceous units
   a. except Core hole 2 (Fig ___). however this unit ~~lies between~~ is overlain and & underlain by a carb. unit

c.) As assoc. w/ other ~~or~~ uran. deposits

1. Min. @ Runge Mine, S.D. - in Inyan Kara has anom. high As values 10-60 ppm (PP 763)
2. also anom. values reported in Tx U_3O_8 dep. (Weeks & Eargle)

Mo

a) compared to U_3O_8

1. Mo is v. anom. in min. zone ranging from less than 1 to 915 ppm
   however 50% of the values are ~~gen.~~ greater than ~~10~~ 15 ppm
2. Mo is not anom. outside of min. zone ranges 1 to 35 ppm
   however ~~most values~~ appr. 80% of the are less than 3 ppm which is considered
3. Good to fair cor. coef. w/ U_3O_8 (Table ___)

b) lith vs. Mo (Figs. ___)

1. similar to As in ~~most~~ all respects
2. not assoc. w/ tuffs and highly tuffaceous ~~units~~ sediments
   a) except Core hole 2 (Fig ___) See As b).2.

c.) As assoc. w/ other uran. dep.

1. Min @ Runge Mine, S.D. 10-900 ppm (PP 763)
2. also anom. values reported in Tx U_3O_8 dep. (Weeks & Eargle)

V_2O_5

a) compared to U_3O_8

1. although a ~~[illegible]~~ $U_3O_8 : V_2O_5$ of exists in the ore zone (Hellinger, 1972), no distinct enrichment in the min. zone has been observed in the ore zone.

   a. V_2O_5 values range 100 ppm to 9060 ppm w/ ~~most~~ more than 70% of values greater than 500 ppm

2. As outside of min. zone ranges from 120 ppm to 7100 ppm w/ more than 70% of ~~[illegible]~~ values greater than 500 ppm

3. Poor corr. w/ U_3O_8 (Table ___) Cor. Coef.

b) lith vs. V_2O_5 (Figs. ___)

1. ~~[illegible]~~ poor correlation w/ organic C (Table ___)
2. ~~[illegible]~~ gen. not assoc. w/ ~~[illegible]~~ calcareous units (Fig. ___) however ~~no real~~ other patterns have ~~[illegible]~~ developed. i.e. V_2O_5 is anom. in almost all of the ~~lith.~~ ~~units in~~ fine grained ~~[illegible]~~ lith. units in the AM Sed.

c.) V_2O_5 general as compared to other areas

1. Waterlaid tuffs of W. Utah Be belt are gen. less than 15 ~~[illegible]~~ ppm (Lindsey 818 B & C?)
2. In general the V_2O_5 is anom. throughout the sequence. — entire sequence has been enriched in V_2O_5 as opposed to sim. sed. outside of the AM area

   a.) Love (PP474-E) Grn R. Fm. 30-150 ppm

   b.) PP 463 M. tuff rks Williston Basin 10-100 ppm

   c.) vanadium values are more similar to the vanadium sh in Nv.

Lith vs. Geochem

U_3O_8

AM 135c:

a.) assoc. w/ carb. lut. & silty mdstn, lignitic slstn
min. units are typically mod. silicified or have calcite cement

b) not assoc. w/ tuff. siltstone immed. below min. or non carb. slty mdstn immed. overlying

AM 51c: upper interval

a.) assoc. w/ carb. mat.; tuff. carb. lutites, carb. mdstns. and assoc. w/ tuff sltstn.

b.) not assoc. w/ tuff mdstn w/ pumice frag immed overlying
not assoc. w/ tuff sltstn which has secondary silica immed underlying

AM 51c: lower interval

a) assoc. w/ carb. mdstn & sltstn; ~~sltst~~ slty tuff, micaceous sltstn, and types, es ~~Calcite cmt. tuff~~

b.) not assoc. w/ tuff mdstn, ~~tuff sltstn~~ above ~~are~~ 1st min. zone, tuff sltstn. both sep. min. zones, tuff sltstn immed. below lower min. zone.

coherence exists between these elements (Rankama and Sahama, 1950). ~~The correlation is more sig. when one~~ ~~It~~ It is interesting ~~that~~ to note ~~that even~~ though ~~several rock types are involved in the ore zone~~, It is also apparent from Figures _____ and Table ___ that organic carbon displays an ~~remarkable~~ excellent correlation with ~~the~~ respect ~~mostly~~ As, Mo, and U_3O_8.

In fact close inspection of the mineralized zones (Figs ___) indicates an affinity to zones containing carbonaceous material. Uranium, ~~and~~ As, and Mo values are ~~typically~~ generally lower ~~absent~~ in ~~from~~ the tuffs and highly tuffaceous sediments in the unoxidized zone. ~~The~~ A noteable exception is ~~Core~~ Fig interval 140-145m where a tuffaceous siltstone ~~has been~~ displays ~~anom~~ ~~Mineral~~ high values of U_3O_8, As, and Mo. However the presence of carbonaceous units above and below this siltstone probably created a reduction barrier ~~impeded the migration of these elements~~ inhibiting the migration of these elements during diagenesis.

C. Other trace elements of less significance ~~importance~~ which display a direct or indirect relationship with respect to the mineralized zone is Mn and Li. Manganese displays a low ~~fair~~ correlation with organic carbon and uranium (Table ___). However manganese ~~has~~ been locally conc. ~~in the higher grade uran. min.~~ up to 2300 ppm ~~in the higher grade~~ has been observed locally associated with the higher ~~high grade~~ grade (>.20% U_3O_8) uranium ~~ore~~ mineralization. Outside of the mineralized zone Mn generally displays values between 100-200 ppm. Lithium ~~is~~, which has a very low correlation coefficient with respect to uranium and carbon, ~~appears to be~~ generally has lower values within the mineralized zone (10-280 ppm) than in the ~~non~~ unmineralized zones (25 ~~pp~~ 560 ppm). This is similar to results obtained by Otton (1977) ~~on~~ for Lithium values elsewhere in the Anderson Mine area.

As vs. Lith

135c

low ~~back~~ values in brn-gry tuff sltstn.
highest values in carb. zones
low values in silicified mdstn - ~~no carbon~~ also drop in carbon

51c upper

low in tuff, tuff mdstn, & sltstn @ top
highest values in carb. zones
low in opalized tuff @ bttm

51c lwr

a) assoc. w/ tuff ~~which has $CaCO_3$ cement~~ es & high Carbo
carb sltstn, tuff ststn

b.) not assoc. w/
opaline sltstn @ top, tuff sltstn @ middle,
Sil. tuff sltstn @ base

---

assoc. w/ carbon. ~~zones~~ intervals - ~~tuffs, mds~~
gen not assoc. w/ distinctly tuff units except in
Core hole 2 interval btwn 140-145. however
this unit is overlain & underlain by min. carb. units.

Geochem

I Introduction

A. Source of data

1. Quant. analyses were preformed on .3 (1ft) interval throughout the min. portion of ___ core holes

2. In addition, two core holes (Fig ___ and ___) were chose for a more detailed geochem. study. Particular attention was given to the unmineralized portions of the core ~~adjacent to~~ overlying and underlying the min. zones. Total 118ft. of core ~~was~~ used ~~stored~~ through three min. zones in this latter study

3. This latter study has been primarily concerned w/ the unox. ore. A total of 118ft taken from 3 min. zones was analyzed for this phase of the study

B. Two commercial analytical laboratories were ~~used~~ employed during various phases of the research to cross check analyses. (C.M.S. Lab., Salt Lake City, Ut, and Chem. and Geol. Lab., Casper, Wy)

II. Ore zone geochem.

A. Disequilibrium studies were undertaken to ascertain the relationship between chemical uranium ~~U_3O_8~~ and radiometric (equivalent) uranium. Chem. and radiomet. ~~Analysis~~ analys from 13 wide spaced core holes were plotted as in Fig ___, and disequilib. values were calculated. Values ranged from .48 to 1.18, ~~However~~ with a weighted average diseq. factor approaching 1.00 for the entire deposit. Sample from the Oxidized mineralization generally displays the lowest diseq. factor.

B. Associated elements

1. The unoxidized ore zone is characterized by anomalously high values of As and Mo (Fig. ___ and ___)

a. Maximum ~~Values~~ for As and Mo of 315 ppm and 915 ppm respectively were obtained from the mineralized ~~URAN~~ mineralized ~~ore~~ zones. Outside of the ~~Thus is~~ ore zones values were generally less than 10 ppm ~~ppm~~ for As and 3 ppm for Mo

b. ~~Table~~ The correlation coefficient for As and Mo with respect to U_3O_8 indicates a Table ___, which displays the corr. coefficient for As and Mo with respect to U_3O_8, indicates that a fair geochem

Mo

135c

a) excellent assoc. w/ carbon
lith is ditto w/ As

51c

a) excellent correlation w/ Carbon
carb. lutites, & sltstn

b.) ~~does not~~ not assoc. w/ tuffs, tuff sltstns,
tuff mdstns where distinct volcanic features
are evident i.e. pumice frag. etc.

51c

a) assoc. w/ ~~tuff w/ calcite cmt~~ tuffs & carb. mdstn
carb. sltstn & tuff sltstn w/ only minor pumice
- v. close assoc. w/ carbon

b.) not assoc. tuff mdstn, tuff sltstn &
sltstn

---

assoc. w/ carb. zones

V_2O_5

135c

a) fair assoc. w/ Carbon
also w/ silty mdstn, carb. lutite, lignitic sltstn

b.) not. assoc. w/ ~~tuff mdstn~~ tuff mdstn & tuff sltstn

51c upr.

a) fair assoc. w/ carbon
also w/ tuff - tuff sltstn, tuff mdstn,

b.) not assoc. w/ sandy ~~tuf~~ tuff sltstn
or tuff mdstn

51c lwr

a) fair to poor assoc w/ carbon
~~also~~ also w/ tuff sltstn, carb. mdstn, ~~tuf~~ carb. sltstn,

b) not assoc. w/ ~~calcite cmt tuff~~ tuff ls or
tuff mdstn

F vs lith

135c

a) fair to poor assoc. w/ carbon, ~~F is more in the min. zone~~ shows v. little variation throughout core

b) not assoc. w/ ~~lo~~ & mrlstn - lowest values

51c upr

a) insuff. variation throughout

51c lwr

a) insufficient variation

U, V, Mn, Li, Mo, As, C, S,

Geochem study

~~I. Detailed study~~ ~~Two premises~~

~~A.~~

1. U_3O_8 assoc. w/ organic C

2. Min. zones also v. anom. in ~~V_2O_5~~, As, Mo, total S

3. entire seg. ~~possibly~~ ~~has high~~ enriched in V_2O_5,

4. Mn - is not anomalous

5. Li, F possibly anom.

6. As, Mo, total S prob. assoc. w/ organic C rather than U_3O_8, however U_3O_8, As, & Mo may have similar origin i.e. altered tuff

7. Diagrams — a) U_3O_8 - C - Mo - As

b) As - V_2O_5 - U_3O_8

8. ~~B~~ ~~A~~ Alkaline waters rich in SiO_2 and buffered w/ $CaCO_3$ transported U_3O_8

9. Min. assoc. w/ lith —

Mineralogy

1. Coffinite like mineral -
   a. no x-ray pattern for U from hand picked sample
   b. ∴ either v. poorly xltzd or amorphous (see Breger 1974 p.109 IAEA.)

2. Carnotite - yellow min.
   a. x ray pattern verified
   b. secondary min. ~~filling~~ occurring as fibrous fillings and pulverulent coatings assoc w/ chalcedony &/or qtz

1 & 2 done by Hazen research

, cc

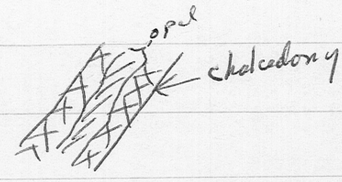
#1

Silicification - all different colors i.e. clear, wh, brn, rd, pnk, or.

1. qtz - fn grn, replacement of: fossils, micritic calite
   also cementing agent (post calcite)

2. Chalcedony - void filling i.e. fossil molds, fractures
   replacement of micritic calcite
   (cristobalite)

3. opal - vein fillings - ~~usually~~
   & white in color



Calcification

1. rextlzn of arag. → calcite
2. ~~replacement~~ rextlzn of micritic ls
3. vein filling & void fillings
4. replacing primary feldspars

* 5. What is calcite - silica relationship

Argillic Alteration : i.e. Montmorillonite, illite, and K mica

1. waxy clays (lt. grn) –

2. mont.

3. illite – K mica – layered clays?
   a. replacement of feldspars
   b. coarser fraction of the clays – in matrix – i.e. rexHzta

Zeolites –

Five informal formational units are recognized in the Arrastra

Rankama

Love, J.P., P.P. 474-E, Uran. phosphatic lake beds of Eocene age (1964)

Pine Mtn. MnO: 5400 - 1600 ppm, C: 1000 - 5000 ppm

Lysite Mtn MnO: 200 - 2700 ppm, C: 11000 - 1000 ppm

Green River Fm:

		Semi Quant.	
MnO:	700 - 1900 ppm;	300 - 1500 ppm	median 700 ppm
V:		30 - 150 ppm	median 150 ppm
Mo:		>3 - 7 ppm	median >3 ppm
Li:	lower detection limits ~~are too low~~ inadequate		

range in non. min.

Average for AM corehole 39ppm
median = >10ppm

As

PP 820 :

2ppm igneous rks (Onishi & Sandell, 1955)

4ppm deep Marine sed.

esp. assoc. w/ sed. containing large quant. of Fe & Mn oxides

forms S minerals readily

assoc. w/ PO_4 deposits, forms AsO_4 which is isomorphous w/ PO_4 anion

PP 763

Inyan Kara in min. ss

As ≡ 20 - 60ppm (U_3O_8 ≡ 300 - 900ppm)

As ≡ 10ppm (U_3O_8 ≡ 1800ppm)

PP 463 Williston Basin

none detected in tuff. rks ∴ >100ppm

in min. zone : range 5 - 315 ppm

~~av. median~~

non min. : range >1 - 115ppm

Values outside of min. zone are gen. <10ppm whereas w/in min. zone are gen > 10ppm

56 acre 7900
39

F in AM cores
average - 855
~~median~~
no U_3O_8 correlation or Lith correlation

F

PP 820:

Fleischer and Robinson (1963) mean F content of following rks
basalts 360, andesite 210, rhyolite 480, phonolite 930,
gabbro & diabase 420, granite & granodiorite 870, alkalic rks 1000
ls 220, dol 260, ss & graywacke 180, sh 800, oceanic sed 730, soil 28

F is conc. in sed. environ. by ppt of CaF_2 or
Fapatite during sed accum. or diagenesis

Sed. groups which contain F deposits: a) volcaniclastic, b) lacustrine
c.) evaporite d.) marine carb. e.) marine phosphate

F in volcaniclastic & lacustrine rks (Shepard & Gude, 1969) PP 650D

PP 933 (*order for library*)

Basalt	510 ppm	extrusive
Andesite	630 ppm	
Rhyolite	780 ppm	

~~F~~ tends to increase w/ silica in glassy vol. rks
however an inverse rel. exists w/ respect to
silica-F rel. in vol. tuffs i.e. high SiO_2 lower F

(from Fleisher and Robinson, 1963)

ss & grywke ≡ 200 ppm
sh ≡ 940 ppm
vol. ash & bent ≡ 750 ppm
Coal ≡ 50-190

in recent fresh water lakes 450 - 1,100 ppm

W. Spar Mtn area (Lindsey 818-B)
1500 ppm mean (approx)

9 $80\overline{)30.0}$ .3

$40\overline{)9.0}$ .25

Li in AM core
average 78 ppm
~~median 50-60~~ ppm median btwn 50-59

Li

PP 820 :

Li commonly attains levels of several hundred ppm in mont. clay esp. in saline environments

C 673 :

Vinogradov (1959) average Li in soils 30 ppm
Hawkes & Webb (1962) Li range 5-200 ppm

PP 463

Li in tuff rks generally none detected however
~~vef~~ 5 sample av. 100 ppm, doubtful sign.
detection limits 100 ppm

Turek. & Wedepohl

Basalt	17 ppm
Granitic	24-40 ppm
sh	28 ppm
ss	15 ppm
deep sea clay	57 ppm

W. Spor Mtn Lith values (Lindsey PP 818B
geometric mean 60 ppm

60%
80) 30.0

~~40~~
40) 15.

60%

1
4/77 500

Mn in AM cores
aver. 290
~~median~~

Mn

Degen et. al 1957 AAPG:

fresh water sh (Freeport sh in Pa - Penn. age)
200 - 3000 ppm av. 1000 ppm ?

~~PP~~ PP 820
mafic rks 1600 ppm
granitic rks 600 ppm

Turik. & Wedephole; AAPG

sh - 850 ppm
clay - 6700 ppm (deep sea sed.)

PP 463 Williston Basin
Mn in tuff rks 500 - 700 ppm
Lignite ash 400 ppm

Lindsey (PP. 818 B) Thomas Range ~~sed.~~ water laid tuffs
500 ppm - geometric mean

Mo

Turek. & Wedepohl:

sh - 3 ppm

carb. - .4 ppm

granites - 1 ppm

clay - 27 ppm (deep sea)

PP 820

pos. correl. btwn Mo and organic content

av. crustal abundance is 1-2 ppm

higher Mo in assoc. w/ U_3O_8 deposits in Tx

ss i.e. Tx, Az, Wy, S.D., N.M., Ut

PP 763

Inyan Kara in U_3O_8 min. portion from Runge Mine

Mo - 20 ppm to 900 ppm (U_3O_8 = 900-300 ppm)

Mo 10 ppm (U_3O_8 = 1800 ppm)

PP 463

Tuffaceous rks 1-6 ppm Williston Basin

Lignite ash 2800 ppm

min zone

range <1 to 915 ppm

gen. averages > 20 ppm

non min. zone

range <1 to 35 ppm

gen. averages <10

17

23 ∪ 13

40 | 24.

62

17

79

.8

90 | 68.0

V_2O_5

PP463 Williston Basin

tuff. rks 10-100 ppm, 90 ppm in Miocene Rks

Lignite ash 200 ppm

PP820

crustal abund. 100-150 ppm

mafic ign. ≡ 200 ppm

ultra mafic & intermed. rks ≡ 50 ppm

silicic rks ≡ 25 ppm

magmatic mt esp. titanif. ≡ 1000 - 5000 ppm

laterites & bauxites ≡ 500 ppm

argillaceous sed. com. contain about as much V_2O_5 as igneous rks

ss ≡ 20 ppm

sed. Fe ores ≡ 500 ppm

conc. by red. in presence of organic material and/or biogenetically generated H_2S

Waterlaid tuff W. Utah Be-U Belt

Lindsey PP 818B, PP 818?

less than 10 ppm

15 ppm

12 40) 12. .3

80) 16.

118
40
78

Alteration

(1.) Silica : (clear, white, red, buff, no color prim. assoc. w/ min.)

a. secondary silicification of :

mdstn, sltstn, marls, et.

b. filling veins

appears to be continuous throughout the min. period including form. of secondary U_3O_8 min.

** is carnotite post SiO_2 ? (check hand sample)

carnotite is post silicification in hand sample

(2.) zeolites : clinoptilolite

a. diagentic processes

b. assoc. w/ what is interp. to be tuff. material

** what elements are released during the formation of ~~clinoptilolite~~ clinoptilolite ?

H_2O, SiO_2

(3) Clay : alteration of vol. mat.

a. interstrat. clays i.e. illite + K micas

b montmorillonite & K micas (possibly celadonite?)

** what elements are needed to form these clays — which elements are released? Is celadonite present?

Alterations (cont)

(4) calcification:

a. secondary - esp. w/ respect to mdstns, etc.

** — is this post dep. or during diagenesis?

b. possible indication for chem. of min. fluids i.e. uranyl tricarbonate (Bregin IAEA 1974)

~~Grade~~

Mineralization

① Uran. min. assoc. w/ selected Elements

a. U_2O_5 diagrams of AM 135c & AM 5k

b. MnO_2 diagrams of AM 135c & AM 5k

c. C (organic) diagrams

d. S (total) diagrams

Mineralization (cont.)

e. other elements – diagrams

(2) U_3O_8 assoc w/ lithology see diagrams

Mode of deposition of ore

Dist. of U_3O_8 deposit

Ore controls

Genesis

Relationship to alteration ?

I. Ore Body Design.

A. tabular blanket type config.

1. 1500 - 1000 m

2. S. extent is not know as it continues ~~into~~ off of the property @ depth

B. Ore zone

1. sev. min. beds 1-3m ~~thick~~ thick, up to max 11m

2. stacked min w/ aggregate thickness in excess of 15 m is not unknown

3. Grades range from .03 to .10% UO_3O_8 w/ average grade .06% UO_3O_8

4. Most of the min. is assoc. w/ carb. ~~and~~ and lignites ~~and~~ and it's fat. equivalents

A.

CMSI INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (8

ANALYTICAL REPORT FOR:

Minerals Exploration Company	Terry Hellinger	OUR NUMBER 8951
P. O. Box 2674		DATE Nov. 28, 19
Casper, Wyoming 82602		CUSTOMER'S ORDER NO.

Sample #	organic C%	S %	As ppm
AM-51C 377-378	.0700	1.21	25
378-379	.07	.06	3
379-380	.04	.04	< 1
380-381	.09	< .01	< 1
381-382	.04	< .01	< 1
382-383	.09	.05	< 1
383-384	< .01	< .01	< 1
384-385	.02	<.01	< 1
385-386	.02	< .01	< 1
386-387	.03	.03	< 1
387-388	.03	< .01	< 1
388-389	.06	.03	< 1
389-390	.06	< .01	< 1
390-391	.03	.05	5
391-392	.02	< .01	< 1
392-393	< .01	< .01	4
393-394	.03	< .01	3
394-395	.07	.06	< 1
395-396	.04	.04	6
	.83	1.67	59

CMSI INC.

CHEMICAL & MINERALOGICAL SERVICES · 445 WEST 2700 SOUTH · SALT LAKE CITY, UTAH 84115 · (801) 485-0711

ANALYTICAL REPORT FOR:

Minerals Exploration Company	OUR NUMBER 8913
P. O. Box 2674	DATE Nov. 15, 1977
Casper, Wyoming 82602	CUSTOMER'S ORDER NO.

Sample #	U_3O_8 ppm	Fe ppm	V_2O_5 ppm	Mn ppm	Li ppm	Mo ppm	
AM-51C 377-378	110.0	1210	300	510	85	8	1210
378-379	6.0	535	780	155	45	3	535
379-380	7.5	1000	1320	250	75	< 1	380
380-381	4.5	645	1440	240	40	1	1000
381-382	5.5	990	2440	105	70	1	321
382-383	6.0	795	2800	130	45	< 1	645
383-384	10.0	1020	2750	305	85	< 1	382
384-385	10.5	1110	1950	510	80	< 1	990
385-386	12.0	1180	1850	660	75	< 1	383
386-387	15.0	1190	680	650	70	< 1	795
387-388	16.0	1180	600	510	75	1	384
388-389	13.0	1230	880	265	80	< 1	1020
389-390	19.0	1090	620	300	75	< 1	385
390-391	125.0	1180	860	355	80	< 1	1110
391-392	145.0	1040	600	340	65	< 1	380
392-393	30.0	1030	220	400	65	< 1	480
393-394	38.0	975	360	380	65	< 1	387
394-395	10.0	965	350	405	55	< 1	1090
395-396	40.0	995	380	395	55	< 1	388
	625	19360	21180	6865	1285	28	

CMSI

Sample #	organic C %	S %	As ppm
AM-51C 396-397	.06	.43	35
397-398	.06	.39	20
398-399	.11	.06	13
399-400	.03	.32	14
400-401	.05	.41	20
401-402-	.04	.33	15
402-403	.20	.37	< 1
403-404	.04	.51	20
404-405	.11	1.01	75
405-406	.08	.85	95
406-407	.65	1.39	80
407-408	9.05	2.05	230
408-409	.44	.91	35
409-410	.22	.85	30
410-411	1.61	1.40	120
411-412	1.17	.09	60
412-413	.45	.33	25
413-414	.86	.14	18
414-415	.31	.07	9
415-416	.11	< .01	1
416-417	.16	< .01	< 1
417-418	.07	.03	2
	15.88	11.96	919
Am-51C 430-431	.08	.14	< 1
431-432	.07	< .01	< 1
	.15	.15	2

CMSI*

e #	* U_3O_8 ppm	F ppm	V_2O_5 ppm	Mn ppm	Li ppm	Mo ppm	
C 396-397	400	955	640	410	60	3	881
397-398	130	755	160	275	45	3	1130
398-399	210	815	130	325	40	< 1	343
399-400	80	1100	130	370	60	3	1090
400-401	80	1030	120	390	60	4	391
401-402	90	1130	140	405	55	3	1180
402-403	50	1150	120	405	65	4	392
403-404	120	1040	250	325	55	6	993
404-405	230	817	200	310	45	25	1130
405-406	110	~~878~~ 825	100	380	50	30	394
406-407	110	960	170	400	55	25	975
407-408	1520	945	2540	270	50	35	348
408-409	10	1090	350	360	60	8	965
409-410 ✓	50	1120	200	330	65	6	
410-411	100	1080	450	210	85	20	
411-412	70	915	670	270	60	8	
412-413	10	910	570	210	60	3	
413-414	14.0	655	610	130	30	3	
414-415	15.0	525	760	110	30	6	
415-416	6.0	825	820	230	60	< 1	
416-417	8.5	745	1050	165	55	1	
417-418	9.5	560	580	65	25	1	
	3424	~~21097~~ 19947	10760	6345	1170	199	
C 430-431	4.5	715	1900	120	45	< 1	
431-432	4.5	1010	3400	155	90	< 1	
	10.0	1725	5300	275	135	2	

begin for (5) x (4)

CMSI

Sample #	organic C %	S %	As ppm
AM-51C 432-433	.40	< .01	< 1
433-434	.06	< .01	2
434-435	.09	< .01	3
435-436	.06	< .01	3
436-437	.08	< .01	3
437-438	.11	.07	2
438-439	.20	.03	14
439-440	1.28	.36	60
440-441	2.40	.47 (.44)	80
441-442	.59	.68 (.52)	90
442-443	.56	.23	70
443-444	1.53	.72	75
444-445	2.40	.05	45
445-446	2.81	.05	110
446-447	.68	.02	5
447-448	.45	.65	30
448-449	.29	.03	3
449-450	.31	< .01	1
450-451	.21	< .01	1
451-452	.21	< .01	1
452-453	.17	.02	1
453-454	.17	.01	1
454-455	.21	< .01	< 1
455-456	.16	< .01	< 1
456-457	.15	< .01	< 1
	15.50	3.31	604

CMSI*

Sample #	U_3O_8 ppm	F ppm	V_2O_5 ppm	Mn ppm	Li ppm	Mo ppm
AM-51C 432-433	6.0	1190	2440	185	165	< 1
433-434	4.0	1400	1450	205	400	< 1
434-435	2.5	1510	870	360	560	< 1
435-436	4.5	1050	1020	260	165	< 1
436-437	4.0	840	720	265	70	< 1
437-438	4.5	1040	700	300	80	< 1
438-439	10	1250	1210	325	90	< 1
439-440	440	775	610	750	35	4
440-441	1680.0 (2270)	705	260 (250)	2300	30	6
441-442	995.0 (630)	705	280 (180)	1400	35	12
442-443	200	755	290	690	40	7
443-444	110	1320	890	330	185	10
444-445	240	545	1050	140	35	13
445-446	750	540	1990	125	35	17
446-447	1110	1150	1400	125	125	2
447-448	10	550	2000	100	30	4
448-449	14.0	425	1460	110	25	3
449-450	16.5	1580	3850	130	350	1
450-451	13.0	1000	2000	200	150	< 1
451-452	8.5	1020	6000	150	85	< 1
452-453	7.5	875	4080	175	70	< 1
453-454	10.0	560	3450	125	35	< 1
454-455	7.0	780	3650	180	80	1
455-456	7.0	725	3200	155	75	< 1
456-457	6.5	510	2660	110	35	< 1
	5889	22770	47340	9195	2985	93

CMSI

Sample #		organic C %	S %	As ppm
AM-51C	457-458	.28	.02	< 1
	458-459	.33	.01	< 1
	459-460	.81	.02	1
	460-461	1.09	.05	4
	461-462	.76	.05 (.07)	5
	462-463	.56	.12 (.04)	16
	463-464	.52	.06	25
	464-465	.54	.51	65
	465-466	1.90	2.14 (.59)	200
	466-467	.17	.14 (.71)	15
	467-468	.13	.22 (.55)	45
	468-469	.15	.28 (.08)	45
	469-470	.17	.03	16
	470-471	.13	.03	3
	471-472	.08	.04	< 1
	472-473	.13	.02	2
	473-474	.11	.03	< 1
	474-475	.11	.02	< 1
		7.97	2.94	447
AM-135C	452-453	.25	.25	35
	453-454	.15	.06	5
	454-455	.20	.09	80
	455-456	.18	.04	25
	456-457	1.19	.32	80
	457-458	2.43	.52 (.21)	70
		4.40	.97	295

CMSI*

Sample #		U_3O_8 ppm	F ppm	V_2O_5 ppm	Mn ppm	Li ppm	Mo ppm
AM-51C	457-458	6.0	576	2900	120	40	< 1
	458-459	8.5	655	3400	190	50	1
	459-460	14.0	540	6400	140	50	< 1
	460-461	32.0	610	7100	110	45	3
	461-462	75.0 (80)	695	6000 (4880)	145	35	7
	462-463	115.0 (70)	635	2760 (2810)	145	40	3
	463-464	110	635	3030	150	45	3
	464-465	2590	1000	3120	185	85	2
	465-466	5160.0 (2630)	750	2600 (3850)	200	85	9
	466-467	70.0 (8450)	935	1950 (3820)	215	160	1
	467-468	31.0 (630)	775	1800 (2150)	205	95	< 1
	468-469	88.0 (10)	770	1800 (1560)	210	100	< 1
	469-470	80	930	1590	200	150	< 1
	470-471	20	675	1340	155	55	1
	471-472	7.0	595	1200	130	40	1
	472-473	5.0	645	1350	190	50	< 1
	473-474	9.5	515	840	155	45	3
	474-475	5.0	630	1240	175	45	< 1
		14758	12500	52580	3020	1215	41
AM-135C	452-453	32.0	695	2300	180	70	3
	453-454	6.0	580	2340	145	60	3
	454-455	9.0	660	1700	120	75	3
	455-456	6.0	505	1760	115	50	1
	456-457	42.0	525	3000	115	55	11
	457-458	95.0 (110)	575	3200 (3440)	135	55	7
		205	3540	14540	810	365	28

CMSI

Sample #	organic C %	S %	As ppm
AM-135C 458-459	1.84	.24 (.16)	45
459-460	1.87	.43 (.33)	40
460-461	3.14	.58 (1.57)	50
461-462	5.65	1.65 (.51)	180
462-463	2.81	.80 (.75)	70
463-464	3.11	1.69 (2.42)	155
464-465	.30	1.68 (2.24)	115
465-466	.18	1.32	100
466-467	2.29	2.09	140
467-468	4.00	2.24	130
468-469	6.30	2.24	290
469-470	1.75	.21	115
470-471	1.12	.33	30
471-472	.98	.33	20
472-473	1.27	.21	35
473-474	5.35	.83	65
474-475	3.57	1.10	315
475-476	6.75	2.09	115
476-477	2.63	1.70	135
477-478	.23	.71	55
478-479	.08	.82	18
479-480	.11	.09	4
480-481	.08	.04	1
481-482	.08	.02	< 1
482-483	.07	.02	< 1
483-484	.07	< .01	< 1
	2438		2226

CMSI*

Sample #	Fam	U_3O_8 ppm	Fup	V_2O_5 ppm	Mn ppm	Li ppm	Mo ppm
AM-135C 458-459	460	98.0	(10)	2400 (2640)	65	35	13
459-460	610	540.0	(330)	3650 (4560)	130	50	12
460-461	700	270.0	(1710)	1680 (9060)	160	130	85
461-462	880	650.0	(1760)	2360 (3730)	695	95	140
462-463	955	960.0	(1060)	1120 (2720)	255	60	155
463-464	740	1260.0	(909)	300 (440)	385	90	50
464-465	905	75.0	(80)	220 (240)	410	90	16
465-466	1110	60		180	645	90	90
466-467	1240	530		470	290	60	340
467-468	1050	1380		1170	180	60	915
468-469	975	840		860	165	25	350
469-470	790	450		560	375	13	75
470-471	280	580		140	385	9	85
471-472	140	520		140	310	13	115
472-473	145	3610		670	120	15	230
473-474	225	2730		510	145	145	340
474-475	980	1490		3140	125	85	235
475-476	930	590		710	170	200	50
476-477	1020	110		710	160	280	10
477-478	1160	17.0		1220	190	140	7
478-479	920	14.0		1300	185	95	6
479-480	903	35.0		680	715	75	3
480-481	785	6.5		460	455	65	3
481-482	690	7.0		300	375	55	6
482-483	675	2.5		200	430	60	3
483-484	635	2.0		4100	150	60	2
	19903	18825		41110	7670	2095	3336
						(9250)	