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Environments favorable for the occurrence of uranium within the Mount Belknap caldera, Beaver Valley and Sevier River Valley, west-central, Utah

By

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

Contents

	Page
Ring fracture zone of the Mount Belknap caldera	7
Gold Mountain breccia pipe	8
Blue Lake area	12
North Fork of North Creek	12
Beaver Valley and Sevier River Valley areas	13
References cited	15

Illustrations

	Page
Figure 1. Index map showing areas discussed in text	2
2. Geologic map of the Delano Peak NW quadrangle, west-central Utah	3

Table

	Page
Table 1. Sample analyses	9

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In studying the economic mineral potential of the Tushar Mountains and adjacent areas in west-central Utah (fig. 1), members of the U.S. Geological Survey have delineated several geologic environments that seem favorable for the occurrence of uranium deposits. This report is concerned primarily with three areas: (1) the ring fracture zone of the Mount Belknap caldera, (2) the Beaver Valley, and (3) the Sevier River Valley near Marysvale. The data and interpretations presented are tentative and will be revised as work in the area continues. Other environments containing uranium exist, but are not discussed here. This report presents preliminary geologic data and interpretations to assist in uranium resource evaluation by the U.S. Department of Energy, and to aid in exploration programs by private industry.

The regional geology is summarized by Steven and others (1977), and the relationship of the geology to mineralization is described by Callaghan (1973) and by Steven and others (1978). The origin of the Mount Belknap and Red Hills calderas is discussed by Cunningham and Steven (1977) and most of the interior of the Mount Belknap caldera was mapped by Cunningham and Steven (1978a); the latter map embraces the area shown on figure 2 of this report, but is at a scale of 1:24,000.

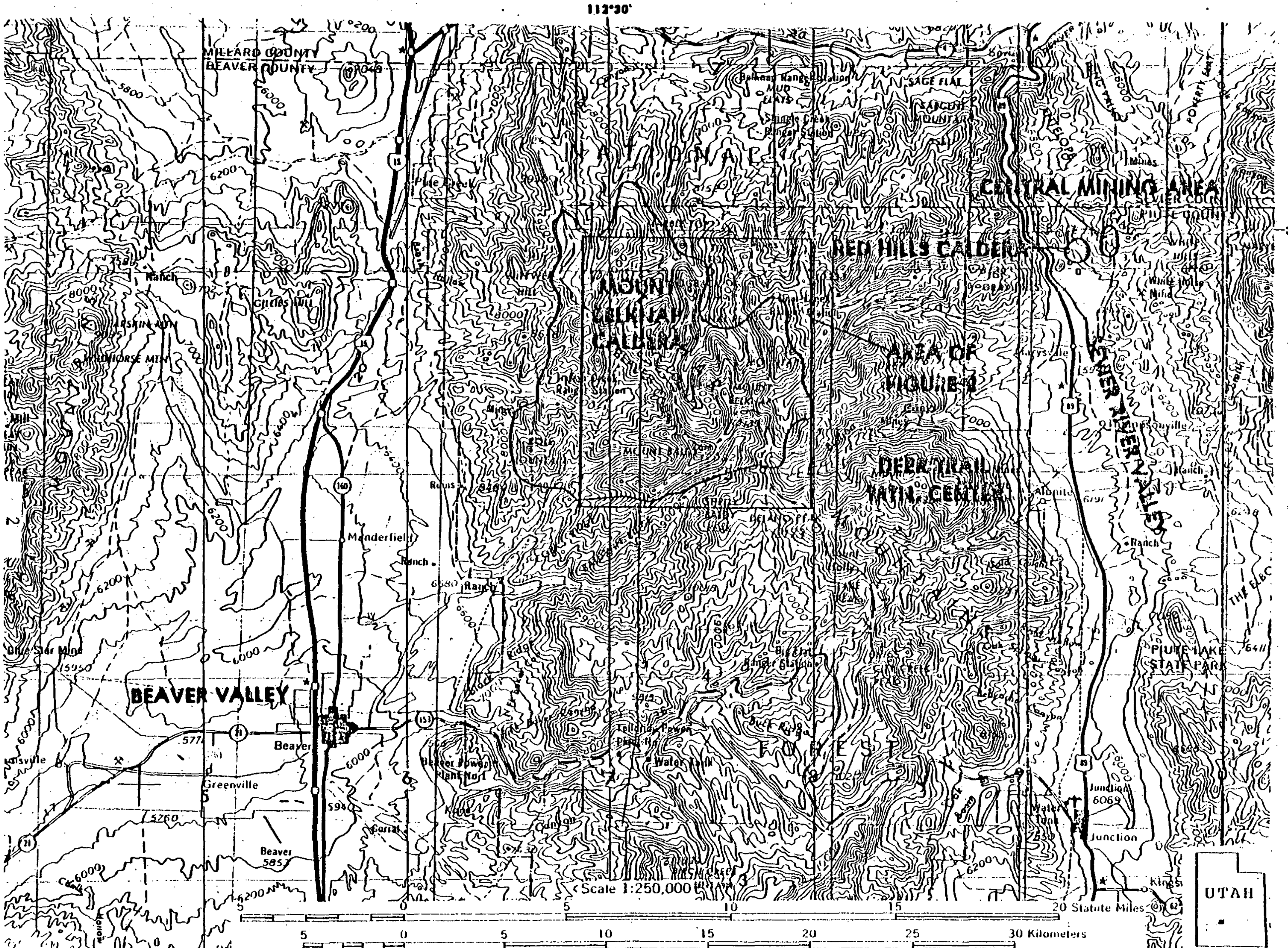


Figure 1--Index map showing areas discussed in text.

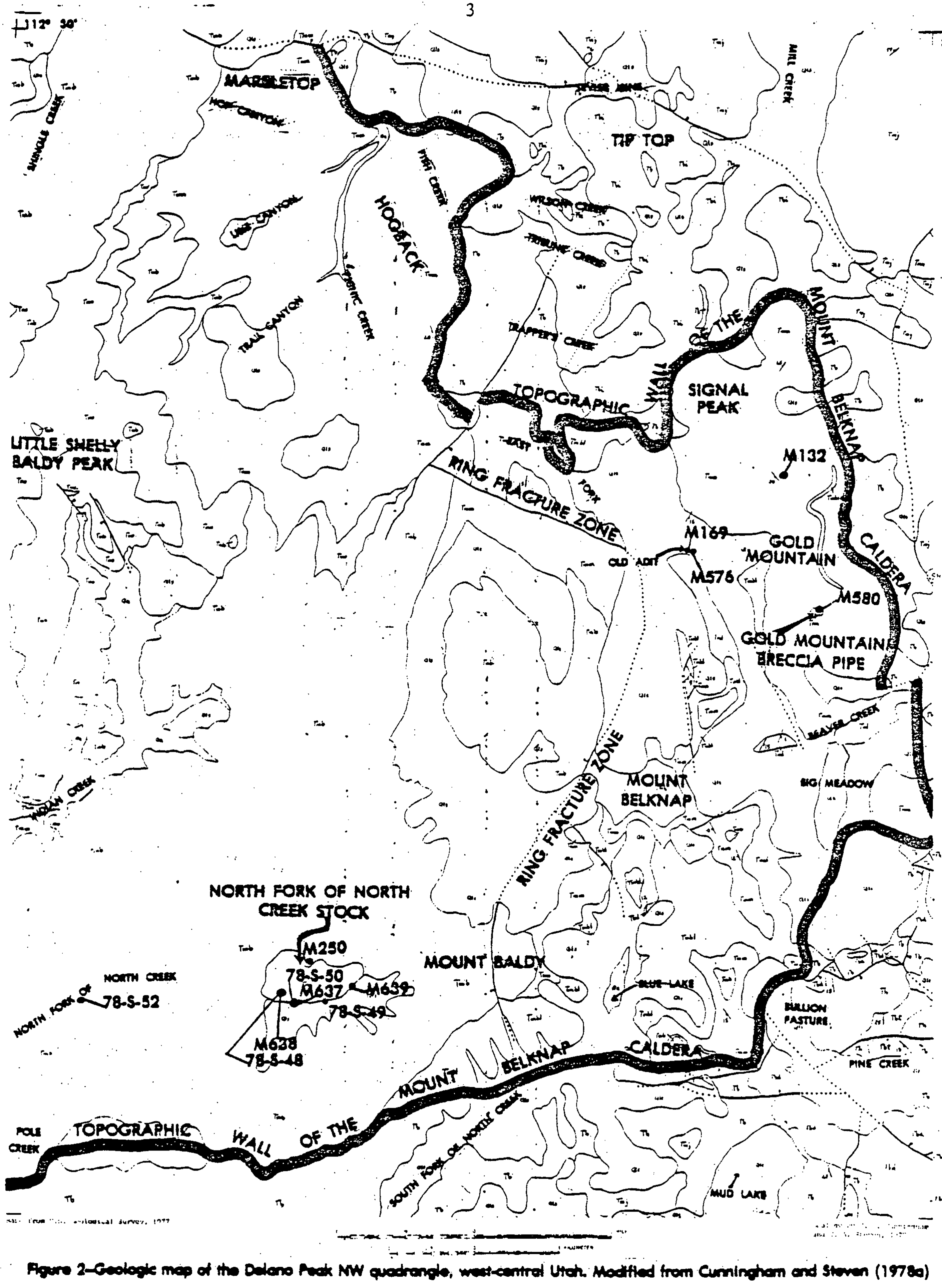
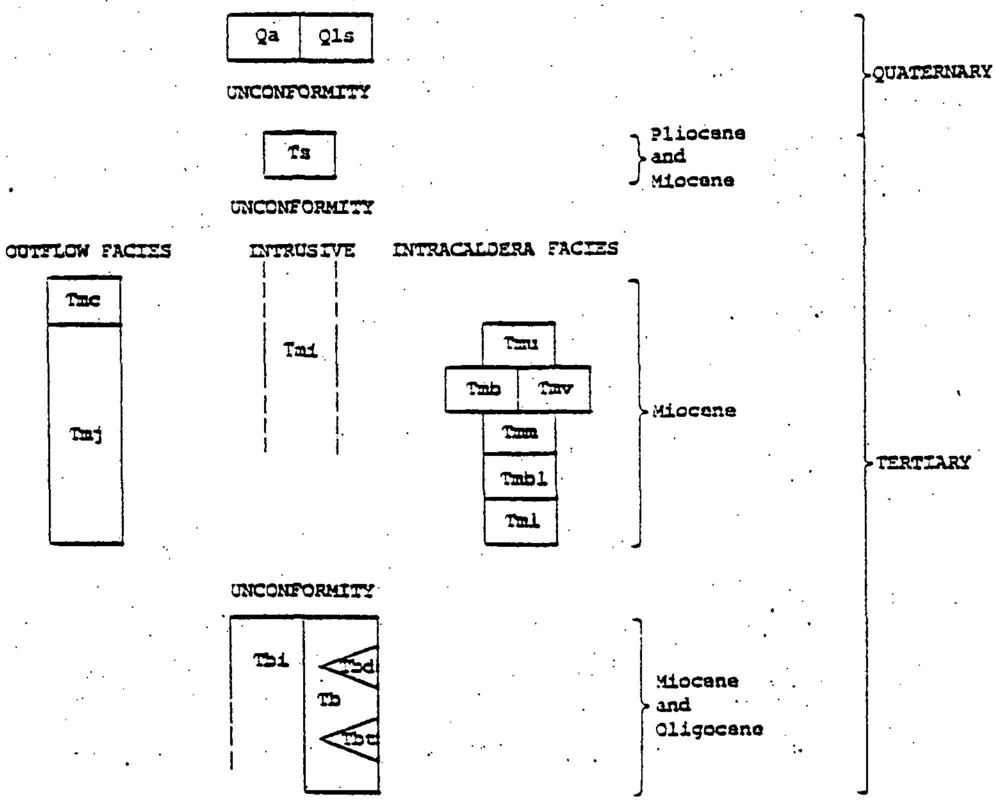


Figure 2—Geologic map of the Delano Peak NW quadrangle, west-central Utah. Modified from Cunningham and Steven (1978a)

EXPLANATION FOR FIGURE 2

CORRELATION OF MAP UNITS



DESCRIPTIONS OF MAP UNITS

Qa ALLUVIAL DEPOSITS (QUATERNARY)

Qls LANDSLIDE DEBRIS (QUATERNARY)—Locally contains significant quantities of glacial drift, rock glaciers, talus, and other deposits

Ts SEVIER RIVER FORMATION, LOWER PART (PLIOCENE AND MIOCENE)—One small area of coarse gravel composed predominantly of rhyolite clasts along the north margin of the quadrangle

MOUNT BELKNAP VOLCANICS (MIOCENE)

Tmi Intrusive rocks—Several small porphyritic quartz latitic to rhyolitic stocks containing scattered phenocrysts of quartz, plagioclase, and sanidine in a finely granular mosaic of alkali feldspar and quartz

Tmc Crystal-rich member--Welded alkali rhyolite ash-flow tuff containing 30 percent phenocrysts of the following: quartz (3 percent), anorthoclase (24 percent), plagioclase (2 percent), and biotite (1 percent). Age is 19.0±1.2 m.y. as determined by K-Ar dates (Steven and others, 1977)

Tmj Joe Lott Tuff Member--Crystal-poor welded alkali rhyolite ash-flow tuff containing about 1.5 percent phenocrysts of quartz, plagioclase, and sanidine, with traces of biotite

Tmu Upper tuff member--Crystal-poor rhyolite welded ash-flow tuff closely similar to that of the Joe Lott Tuff Member (Tmj)

Tmb Mount Baldy Rhyolite Member--Crystal-poor rhyolite lava flows consisting largely of a fine granular mosaic of quartz and alkali feldspar, and minor plagioclase, biotite, and hematite. Contorted flow layers are common

Tmv Volcaniclastic rocks--Dominantly laharic mud-flow breccias from nearby lava flows of the Mount Baldy Rhyolite Member (Tmb). Some landslide debris and fluviatile sands and gravels are included

Tmm Middle tuff member--Crystal-poor rhyolitic welded ash-flow tuff closely similar to that in the outflow Joe Lott Tuff Member (Tmj)

Tmbl Blue Lake Rhyolite Member--Crystal-poor rhyolite flows closely similar to those in the Mount Baldy Rhyolite Member (Tmb)

Tml Lower tuff member--Crystal-poor rhyolitic welded ash-flow tuff closely similar to that in the outflow Joe Lott Tuff Member (Tmj)

BULLION CANYON VOLCANICS (MIOCENE AND OLIGOCENE)

Tbi Intrusive rocks--Porphyritic to equigranular, fine- to medium-grained quartz monzonite containing approximately equal proportions of plagioclase and orthoclase, as much as 20 percent quartz, plus augite, hornblende, and biotite. Accessory minerals are apatite, zircon, and Fe-Ti oxide minerals

Tb Heterogeneous lava flows and volcanic breccias--Range from thick porphyritic rhyodacite and quartz latite flows containing phenocrysts of plagioclase, biotite, and clinopyroxene, to fine-grained dark lava flows and breccias of intermediate composition, that contain small phenocrysts of plagioclase and clinopyroxene

Tbd Delano Peak Tuff Member--Densely welded crystal-rich quartz latite ash-flow tuff containing phenocrysts of plagioclase (32 percent), hornblende (9 percent), Fe-Ti oxide minerals (4 percent), and less than 1 percent each of quartz, biotite, and apatite

Tbt Three Creeks Tuff Member--Densely welded crystal-rich quartz latite ash-flow tuff containing phenocrysts of plagioclase (30 percent), hornblende (12 percent), biotite (2 percent), and quartz (2 percent). Fe-Ti oxide minerals, sanidine, and other accessory minerals are trace constituents. Age is 27 m.y. as determined by K-Ar dates (Steven and others, 1977)

SAMPLE LOCATION

CONTACT—Dotted where covered

FAULT—Dotted where covered. Bar and ball on downthrown side

STRIKE AND DIP OF COMPACTION FOLIATION

STRIKE AND DIP OF SEDIMENTARY BEDS OR LAVA FLOWS

TRACE OF TOPOGRAPHIC WALL OF CALDERA

RING FRACTURE ZONE OF THE MOUNT BELKNAP CALDERA

The Mount Belknap caldera, in the Tushar Mountains of west-central Utah, formed 19 m.y. ago in the western source area of the Mount Belknap Volcanics (Cunningham and Steven, 1977). Volcanic eruptions here and in the eastern source area of the Mount Belknap Volcanics, near the Red Hills caldera, were largely of high-silica alkali rhyolite belonging to the bimodal basalt-rhyolite igneous suite that was erupted widely in the Basin-Range Province during late Cenozoic extensional tectonism.

The Mount Belknap caldera formed in response to eruption of the rhyolitic ash flows of the Joe Lott Tuff Member of the Mount Belknap Volcanics. The caldera is filled with a cogenetic suite of ash-flow tuffs, lava flows, volcanic domes, and volcanic breccias. Small stocks cut the caldera fill above the ring fracture zone along the southern and eastern peripheries of the caldera. Recent discoveries of uranium, mercury, and lithium deposits in caldera fill adjacent to the ring fracture zone of the McDermitt caldera (Rytuba and Glanzman, 1978) indicate that the similar geologic environments of the Mount Belknap caldera should be examined for resources of these metals.

Unaltered rocks in the Mount Belknap Volcanics contain anomalous concentrations of uranium, but the fill in the Mount Belknap caldera is widely bleached and altered, and some of the uranium has been moved. About 3 ppm (parts per million) of the uranium in the caldera fill appears to have been mobilized as a result of leaching following devitrification (Carmony, 1977; Cunningham and Steven, unpub. data). Some of this mobile uranium was redeposited in permeable channelways within the caldera fill; flow margins, lahar breccia beds, and talus-landslide tongues along the topographic wall were favored environments for this redeposition. Epigenetic uranium derived either directly from young stocks that cut the caldera fill or by the secondary processes mentioned above was deposited in fractures cutting older volcanic rocks in the walls of the caldera. Small uranium deposits of this type have been prospected and mined (Callaghan, 1973), and there may be a significant potential for undiscovered deposits. A principal requisite would have been a local reducing environment to precipitate uranium from solution.

The ring fracture zone of the Mount Belknap Volcanics and the overlying caldera fill contain several local environments in which uranium may have been precipitated. Three of these will be discussed below.

Gold Mountain breccia pipe

A rhyolitic breccia pipe, cutting welded ash-flow tuffs of the caldera fill, is located at the southern end of Gold Mountain (fig. 2), above and outside (east) the main ring fracture zone of the Mount Belknap caldera. A caved adit approximately 650 m lower in elevation than the breccia pipe and slightly over one kilometer to the northwest, extends southeast in the general direction of the breccia pipe. The size of the dump suggests that the adit extended as much as 200 m into the hill. The dump and sediments from Fish Creek, which drains the area, contain anomalous metals. Selected vein samples from the dump contain as much as 5,000 ppm molybdenum (table 1) as molybdenite. North of the breccia pipe, along the crest of Gold Mountain, a small quartz vein contains 150 ppm beryllium (sample M132C, fig. 2). The breccia pipe could

Table 1.—Sample analyses

[Uranium and thorium by delayed neutron methods. All other data by semiquantitative 6-step spectrographic analysis. Data reported in parts per million. Symbols used: L = Detected, but below limit of determination or below value shown; N = Not detected at limit of detection or at value shown; — = Not looked for. Spectrographic analysts: (A) Leon A. Bradley, (B) Nancy Conklin, (C) Mollie Jane Malcolm. Uranium and thorium analysts: H. T. Millard, Jr., R. B. Vaughn, M. F. Coughlin, M. W. Solt, C. Bliss, C. McFee.]

Field No.	M132C	M169C	M576A	M576B	M576C	M576D	M576G	M576H	M576J	M250	M637B	M638	M639	M580A	M580B	M580C
Analysts	A	A	B	B	C	B	C	B	C	A	B	B	B	B	B	B
Mn	5,000	50	300	700	300	300	500	700	500	150	500	300	200	500	700	700
Ag	N	N	70	15	50	7	50	7	10	N	N	N	N	N	N	N
As	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
B	L	L	N	N	N	N	N	N	N	L	N	N	N	N	N	L
Ba	50	70	150	150	100	70	70	500	300	70	300	15	150	1,500	1,500	50
Be	150	5	2	3	5	1	1.5	2	1.5	3	3	15	15	3	3	1.5
Bi	N	N	30	N	N	N	15	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Co	L	N	15	L	N	N	15	3	5	N	N	N	N	3	3	N
Cr	L	2	30	15	15	15	30	30	50	L	20	7	7	7	10	15
Cu	5	1,500	150	150	3,000	20	200	30	200	7	15	7	3	3	7	7
La	N	N	70	N	N	N	N	150	70	70	70	100	70	150	150	70
Mo	3	3	3,000	15	7	30	5,000	10	30	7	7	7	5	3	7	5
Nb	15	N	30	15	N	N	10	30	L	50	70	70	70	30	50	70
Ni	L	L	70	30	20	15	50	30	30	L	30	7	15	7	15	15
Pb	N	30	150	15	N	30	100	30	30	15	30	15	15	30	30	30
Pd	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sc	L	N	15	N	N	N	15	7	5	L	7	L	7	10	7	N
Sn	N	N	N	N	N	N	N	N	N	N	N	L	N	N	N	N
Sr	10	15	7	15	7	70	5	150	70	30	70	N	70	300	300	15
Te	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
U	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
V	N	L	30	7	N	N	50	70	30	L	15	7	7	30	30	N
W	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Y	15	N	30	N	N	10	L	30	10	30	70	50	30	50	50	50
Zn	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Zr	15	30	300	30	10	N	200	300	100	300	300	300	300	300	300	300
Ce	N	L	150	N	N	N	N	200	L	L	100	200	N	200	200	150
Ga	L	7	N	7	7	N	N	30	10	15	30	30	30	30	30	15
Ge	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Hf	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
In	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Li	L	150	L	150	100	150	N	N	L	N	N	N	N	N	N	L
Re	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ta	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Th	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Tl	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Yb	1	N	3	N	N	N	1.5	3	1	3	7	5	3	5	5	7
Pr	—	—	N	—	—	—	—	N	N	N	N	N	N	N	N	N
Nd	—	—	70	—	—	—	—	70	N	L	70	100	70	150	150	N
Sm	—	—	N	—	—	—	—	N	N	N	N	N	N	N	N	N
Eu	—	—	—	—	—	—	—	—	N	N	—	—	—	—	—	—
Gd	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dy	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Er	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	—	—	10.0	2.0	—	1.7	—	12.8	—	—	33.2	15.6	11,5	7.9	9.1	13.4
Th	—	—	22.4	3.1	—	16.5	—	25.1	—	—	48.6	39.9	34.6	19.3	20.1	34.4

Table 1.—Sample analyses—Continued

Field No.	M580D	78-S-48A	78-S-49A	78-S-50A	78-S-51A	78-S-52A	78-S-48B	78-S-49B	78-S-50B	78-S-51B	78-S-52B
Analysts	B	C	C	C	C	C	B	B	B	B	B
Mn	1,500	1,500	2,000	2,000	2,000	2,000	3,000	30,000	30,000	15,000	7,000
Ag	N	N	N	N	N	N	N	N	N	N	N
As	N	N	N	N	N	N	N	N	N	N	N
Au	N	N	N	N	N	N	N	N	N	N	N
B	N	N	N	N	N	N	L	N	N	15	15
Ba	30	200	200	200	200	150	150	150	150	150	150
Be	1.5	7	10	7	7	7	15	30	15	15	15
Bi	N	N	N	N	N	N	N	N	N	N	N
Cd	N	N	N	N	N	N	N	N	N	N	N
Co	3	L	L	L	L	L	7	7	15	7	3
Cr	70	150	10	5	5	2	15	20	15	15	7
Cu	30	10	7	7	7	5	15	15	15	15	7
La	30	150	150	100	100	50	700	500	300	300	150
Mo	30	15	10	15	15	10	10	30	20	15	15
Nb	70	15	15	20	20	20	30	30	50	70	70
Ni	150	5	5	5	7	5	7	15	15	7	7
Pb	20	50	50	50	50	50	70	50	70	70	70
Pd	N	N	N	N	N	N	N	N	N	N	N
Pt	N	N	N	N	N	N	N	N	N	N	N
Sb	N	N	N	N	N	N	N	N	N	N	N
Sc	N	L	L	L	L	L	7	7	7	7	7
Sn	N	N	N	N	N	N	N	N	N	N	N
Sr	15	70	100	70	50	30	70	30	70	70	70
Te	N	N	N	N	N	N	N	N	N	N	N
U	N	N	N	N	N	N	N	N	N	500	N
V	N	20	20	20	10	10	30	15	30	30	15
W	N	N	N	N	N	N	N	N	N	N	N
Y	50	70	50	50	50	30	300	300	300	300	150
Zn	N	L	L	L	L	N	300	700	700	300	300
Zr	300	300	300	500	700	700	300	300	300	700	700
Ce	N	200	L	L	L	L	700	700	700	500	200
Ga	30	20	30	20	20	15	30	15	20	30	30
Ge	N	N	N	N	N	N	N	N	N	N	N
Hf	N	N	N	N	N	N	N	N	N	N	N
In	N	N	N	N	N	N	N	N	N	N	N
Li	150	N	N	N	N	N	N	N	N	N	N
Re	N	N	N	N	N	N	N	N	N	N	N
Ta	N	N	N	N	N	N	N	N	N	N	N
Th	N	N	N	N	N	N	N	N	N	N	N
Tl	N	N	N	N	N	N	N	N	N	N	N
Yb	5	[illegible]	5	5	5	5	20	20	15	15	10
Pr	N	N	N	N	N	N	150	150	150	150	N
Nd	N	150	100	100	100	L	700	500	500	300	200
Sm	N	N	N	N	N	N	150	150	100	100	N
Eu	—	N	N	N	N	N	—	—	—	—	—
Gd	—	—	—	—	—	—	100	100	70	70	N
Dy	—	—	—	—	—	—	70	70	70	70	N
Er	—	—	—	—	—	—	N	N	N	N	N
U	11.3	—	—	—	—	—	72.2	183	132	103	55.8
Th	29.4	—	—	—	—	—	94.2	209	133	112	66.0

SAMPLE DESCRIPTIONS AND LOCATIONS. Samples with letter suffixes are from the same locality.

Sample Number	Description and Location
M132	Vein containing Mn-oxides and quartz crystals, and cutting altered tuff. Near old cabin in saddle between Gold Mountain and Signal Peak.
M169, M576A-J	Dump samples from caved adit on East Fork of Fish Creek. On the west side of Gold Mountain. Some samples appear to be intrusive rock. Pyrite and fluorite are commonly present.
M580A-D	Gold Mountain breccia pipe in rhyolite, on the southern end of Gold Mountain. Samples A and B are from the north and south side of the pipe; C and D are from the west and south margin of the enclosing rhyolite.
M250, M637B, M639, M638	North fork of North Creek stock. Sample locations as indicated on figure 2. Sample M250 from the hood zone of the stock. M637B is altered and contains fresh pyrite. M639 is fresh rock.
78-S-48, 49, 50, 51, 52	Stream-sediment samples from along the North Fork of North Creek. Locations shown on figure 2. Samples with an A suffix are Wilfley table concentrates. Samples with a B suffix are -170 mesh.

represent a high level of exposure over a hydrothermal system similar to the one that formed the molybdenum-bearing uranium-fluorite veins in the Central Mining Area near Marysvale (Cunningham and Steven, 1978b).

Blue Lake area

The canyon of the South Fork of North Creek in the Blue Lake area provides some of the deepest known exposures of the Mount Belknap caldera fill. The area is located above the buried ring fracture zone and is near the source of many of the intracaldera lava flows. Rocks in the area are highly altered and iron staining may indicate the presence of sulfides. Tongues of talus, landslide breccias, and laharic breccias extend from the topographic wall of the caldera into the adjacent caldera fill. These permeable breccia deposits could have provided pathways for uranium-bearing fluids of either primary or secondary origin, and may host uranium deposits. Some similar breccias exposed elsewhere along the caldera wall are mineralized.

North Fork of North Creek

The largest exposed intrusive cutting the caldera fill within the Mount Belknap caldera is located in the headwaters of the North Fork of North Creek, above the buried ring fracture zone (fig. 2). The stock is anomalously radioactive and part of it is highly altered. A gossan derived from the altered rocks is exposed along the south side of the creek near the middle of the stock. Stream-sediment samples collected within and downstream from the stock contain anomalous concentrations of rare earths, uranium, and thorium. This anomalously radioactive intrusive could contain epigenetic concentrations of uranium within it, or it could have supplied uranium-bearing solutions to the adjacent caldera fill.

BEAVER VALLEY AND SEVIER RIVER VALLEY AREAS

The Tushar Mountains are flanked by the Beaver Valley on the west and the Sevier River Valley on the east. The mountains and the valleys are the result of basin-range block faulting in late Cenozoic time, and erosion of the uplands and deposition in the basins took place concurrently with tectonism. Deformation began shortly after eruption of the Mount Belknap Volcanics, and has continued to the present. Details of the structural history are still poorly known because investigations of the basins are just beginning. Nevertheless, considering that sedimentation has been taking place in the basins from middle Miocene to the present, and that waters responsible for transporting and depositing the sediments probably leached uranium from anomalously radioactive rhyolites in adjacent uplands, a good potential may exist for significant uranium deposits within the basin sediments.

Uplift of the Mineral Mountains west of the Beaver Valley probably resulted in the Beaver Valley having a closed basin environment periodically during basin-range tectonism, with lacustrine deposits in the center of the basin intertonguing marginally with fluvial deposits. Most of the drainage from the Mount Belknap caldera area probably was westward toward this basin. Effluent hydrothermal solutions originating from late stages of caldera development probably preceded major sedimentation, but uranium leached from the Mount Belknap Volcanics within and around the caldera during the last 15 million years would have been directed toward the Beaver Valley basin. Complexly intertongued lacustrine and fluvial facies sediments could well have provided a variety of reducing chemical environments suitable for depositing uranium.

The Sevier River Valley east of the Tushar Mountains also may have been a sump for uranium-bearing waters from the highlands. The whole eastern part of the rhyolitic Mount Belknap Volcanics was subject to erosion and leaching within the tributary area. In addition, areas of uranium-bearing hydrothermal systems centered in the Deer Trail Mountain-Alunite Ridge area (Cunningham and Steven, 1978a) and in the Central Mining Area north of Marysvale (Cunningham and Steven, 1978b) would have contributed uranium-bearing waters to the local hydrologic environment.

The bedrock configuration, basin-fill stratigraphy, and facies distribution within the valleys need careful study before the possible resource potential of this environment can be assessed. A regional study of the whole structural and sedimentational history would be especially helpful.

References cited

Callaghan, Eugene, 1973, Mineral resource potential of Piute County, Utah and adjoining area: Utah Geological and Mineralogical Survey Bulletin 102, 135 p.

Carmony, J. R., 1977, Stratigraphy and geochemistry of the Mount Belknap series, Tushar Mountains, Utah: Unpublished M.S. thesis, The Pennsylvania State University, 153 p.

Cunningham, C. G., and Steven, T. A., 1977, Mount Belknap and Red Hills calderas and associated rocks, Marysvale volcanic field, west-central Utah: U.S. Geological Survey Open-File Report 77-568, 40 p.

______1978a, Geologic map of the Delano Peak NW quadrangle, west-central Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-967.

______1978b, Postulated model of uranium occurrence in the Central Mining Area, Marysvale District, west-central Utah: U.S. Geological Survey Open-File Report 78-1093, 19 p.

Rytuba, J. J., and Glanzman, R. K., 1978, Relation of mercury, uranium, and lithium deposits to the McDermitt caldera complex, Nevada-Oregon: U.S. Geological Survey Open-File Report 78-926, 28 p.

Steven, T. A., Cunningham, C. G., Naeser, C. W., and Mehnert, H. H., 1977, Revised stratigraphy and radiometric ages of volcanic rocks in the Marysvale area, west-central Utah: U.S. Geological Survey Open-File Report 77-569, 45 p.

Steven, T. A., Cunningham, C. G., and Rowley, P. D., 1978, Geology and mineralization in the Marysvale mining area, west-central Utah, <u>in</u> Guidebook to mineral deposits of southwestern Utah: Utah Geological Association Publication 7, p. 67-70.