MISCELLANEOUS FIELD STUDIES
MAP MF-1596-A
PAMPHLET

MINERAL RESOURCE POTENTIAL OF THE SNOWY RANGE WILDERNESS, ALBANY AND CARBON COUNTIES, WYOMING

By

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STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and related acts, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Snowy Range Wilderness in the Medicine Bow National Forest, Albany and Carbon Counties, Wyoming. The area was established as a wilderness by Public Law 95-237 in February 1978.

MINERAL RESOURCE POTENTIAL SUMMARY STATEMENT

The U.S. Bureau of Mines and U.S. Geological Survey made a mineral and geological survey of the Snowy Range Wilderness, southern Wyoming. The area is part of a dissected Laramide uplift ranging in elevation from 8,000 to 12,000 ft and is underlain by metasedimentary and metavolcanic rocks of Late Archean and Early Proterozoic age. The Early Proterozoic Deep Lake Group consists chiefly of quartzite of fluvial origin and has a radioactive conglomerate at its base. This conglomerate was considered to possibly contain resources because its stratigraphic setting and geologic characteristics are like those of the productive uranium-bearing conglomerate of the Blind River area of Canada.

Neither surface nor subsurface investigations in the Snowy Range Wilderness and vicinity revealed uranium, thorium, or gold resources; however, some exceptionally high radon anomalies suggest uranium may be present at depth. On the basis of information available by spring 1981, the northern part of the Snowy Range Wilderness has a low to moderate potential for uranium, thorium, or gold resources. The conglomerate at the base of the Deep Lake Group would have to be tested by closely spaced drilling before it could be ruled out as a source of these metals.

INTRODUCTION

The Snowy Range Wilderness, located at the crest of the Medicine Bow Mountains of southeastern Wyoming, covers about 53 sq mi (fig. 1). Elevations range from approximately 10,000 ft in the northeastern part of the area to 12,013 ft at Medicine Bow Peak, the highest point in southeastern Wyoming. The area is largely above timberline and is characterized by alpine meadows with numerous glacial lakes.

The study area is readily accessible by both paved and gravel roads. The southern border is approximately parallel to Wyoming Highway 130, and the eastern and northern borders are accessible from dirt logging roads that connect with the Forest Service's graded Sand Lake Road. The western border of the area is less accessible but can be reached by jeep trails that lead to Twin Lakes and the inactive Gold Hill mining district.

The U.S. Geological Survey and U.S. Bureau of Mines conducted field studies in the wilderness in 1976, 1977, and 1978. The wilderness and parts of the Medicine Bow Mountains to the west and north were recognized as possible areas for uranium- and gold-bearing conglomerate of the Blind River type (Miller and others, 1977; Houston and others, 1977). For this reason, it was determined that additional geological and geochemical studies both within and outside the study area were needed in order to evaluate the mineral resource potential. Additional work was sponsored by the National Uranium Resource Evaluation Program of the U.S. Geological Survey (Houston and others, 1978) and by the U.S. Department of Energy (Houston and Karlstrom, 1979; Karlstrom and others, 1981a, b; Borgman and others, 1981).

Table 1.--Stratigraphic succession of the Medicine Bow Mountains, Wyo.

Age	Group	Formation	Thickness (ft)
Early Proterozoic (2,000-1,700 m.y.).	Upper unit of Libby Creek Group.	French Slate--------------------	2,000
		Towner Greenstone----------------	1,100
		Nash Fork Formation--------------	6,500
Early Proterozoic (2,200-2,000 m.y.).	Lower unit of Libby Creek Group.	Sugarloaf Quartzite--------------	1,800
		Lookout Schist-------------------	1,000
		Medicine Peak Quartzite----------	5,600
		Heart Formation------------------	2,100
		Headquarters Formation-----------	2,060
		Rock Knoll Formation-------------	1,250
Early Proterozoic (2,200-2,400 m.y.).	Deep Lake Group-------	Vagner Formation-----------------	1,500
		Cascade Quartzite----------------	2,000
		Campbell Lake Formation----------	223
		Lindsey Quartzite----------------	1,450
		Magnolia Formation---------------	2,600
Archean (2,500 m.y.).	Phantom Lake Metamorphic Suite.	Conical Peak Quartzite-----------	2,080
		Colberg Metavolcanics------------	5,700
		Bow Quartzite--------------------	1,250
		Rock Mountain Conglomerate-------	650
		Stud Creek Metavolcaniclastics---	1,300

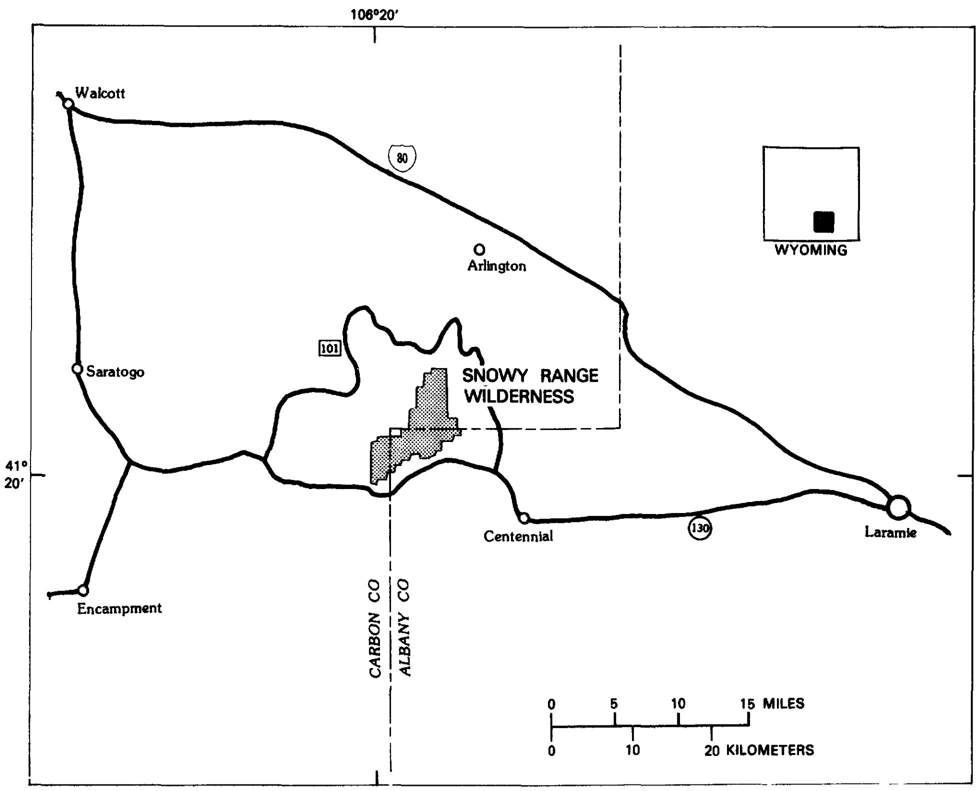


Figure 1.—Index map showing location of the Snowy Range Wilderness, Wyo. (light stipple).

The U.S. Department of Energy study included a diamond-drilling program. In the years 1977-80, 28 holes were drilled at localities in the northern Medicine Bow Mountains both north and west of the study area. Twelve holes were drilled under contract to the U.S. Department of Energy and 16 by companies in the private sector. These holes were drilled to determine the uranium, thorium, and gold content of radioactive conglomerate present at the base of the Magnolia Formation. A detailed report on the results of these drilling programs is in Karlstrom and others (1981b).

One hole (MB-11, fig. 2) was drilled within the study area at a locality in the E1/2 sec. 22, T. 17 N., R. 79 W., and two holes were drilled within 2 mi of the western border of the area (GH-1 and PL-1, fig. 2) in secs. 3 and 10, T. 16 N., R. 80 W.

GEOLOGY

The area is underlain entirely by rocks of Precambrian age, which are covered in about half of the area by a relatively thin veneer of glacial ground moraine of Pleistocene age (Houston and others, 1968, pl. 1). Exposures of the Precambrian rocks are adequate to make reasonable geologic interpretations of their distribution beneath the glacial deposits, and the geologic map shows bedrock only. The potential for mineral resources in the wilderness exists only in the Precambrian rocks.

Precambrian units are composed chiefly of metasedimentary and metavolcanic rocks that are 43,000 ft thick and range in age from Late Archean (about 2,900-2,700 m.y. old) to Early Proterozoic (about 2,500-1,700 m.y.). These metasedimentary and metavolcanic rocks are folded and displaced by faults and are cut by sills and dikes of gabbroic composition and a single felsic intrusion, the Gaps Intrusion. All intrusive rocks are phacoliths or linear bodies along faults or shear zones. Details of the stratigraphy and structure may be found in other reports (Houston and others, 1968 and in press; Houston and Miller, 1984; Karlstrom and others, 1981a). Metasedimentary and metavolcanic successions include the Late Archean Phantom Lake Metamorphic Suite, the Early Proterozoic Deep Lake Group, and the Early Proterozoic Libby Creek Group of Karlstrom and others (1981a) (table 1).

Late Archean metasedimentary and metavolcanic rocks are part of the Phantom Lake Metamorphic Suite of Karlstrom and others (1981a). Three units of the Phantom Lake Metamorphic Suite are exposed in this area: the Bow Quartzite, Colberg Metavolcanics, and Conical Peak Quartzite (table 1). These rocks occur in the cores of anticlines located in the northeastern and southwestern parts of the mapped area. The rocks are overlain unconformably by rocks of the Early Proterozoic Deep Lake Group of Karlstrom and Houston (1979), which in order of increasing age consists of the Magnolia Formation, Lindsey Quartzite, Campbell Lake Formation, Cascade Quartzite, and Vagner Formation (table 1). Deep Lake Group rocks are chiefly fluviatile quartzites at the base (Magnolia Formation and Lindsey Quartzite) and marine quartzites (Cascade Quartzite) and glaciomarine formations (Campbell Lake Formation and Vagner Formation) at the top. The Magnolia Formation is of particular interest because it contains radioactive fluviatile conglomerates similar to the uranium- and gold-bearing conglomerates of the Witwatersrand of South Africa and Blind River area of Canada (Houston and others, 1979; Karlstrom and others, 1981a).

The Libby Creek Group of Houston and others (1968) is divided into lower and upper parts (table 1). From oldest to youngest, the lower Libby Creek Group consists of the Rock Knoll Formation, Headquarters Formation, Heart Formation, Medicine Peak Quartzite, Lookout Schist, and Sugarloaf Quartzite (table 1). Rocks of the lower Libby Creek Group are lithologically very similar to rocks of the Huronian Supergroup of Canada (Houston and others, 1977; Karlstrom and others, 1981a). In fact, the entire succession from the base of the Deep Lake Group to the Sugarloaf Quartzite of the lower Libby Creek Group can be correlated on lithologic grounds (Karlstrom and others, 1981a) and by age (Hedge, in Karlstrom and others, 1981a, p. 96, 277, 300) with rocks of the Huronian Supergroup. Inasmuch as the Huronian Supergroup contains the productive uranium-bearing conglomerates of the Blind River type, this correlation has a bearing on resource potential.

Rocks of the upper Libby Creek Group are in fault contact with units both below and above them. The upper Libby Creek Group is thrust over units of the lower Libby Creek Group. This thrust fault probably is developed at a major unconformity. The younger beds of the upper Libby Creek Group are cut out by a steeply dipping shear zone exposed in the southeastern part of the map area which brings a Proterozoic eugeosynclinal rock succession against the Early Proterozoic miogeosynclinal succession discussed above (Hills and Houston, 1969). This shear zone may have negative resource significance because rocks of the upper Libby Creek Group, which includes, from oldest to youngest, the Nash Fork Formation (stromatolitic dolomite and graphitic phyllite), Towner Greenstone (marine(?) mafic igneous and volcanic rocks), and French Slate are lithologically and chronologically similar to the Marquette Range Supergroup (2.1-1.9 m.y.) of the Lake Superior region. The upper formations of the Marquette Range Supergroup contain a productive iron-formation (Bayley and James, 1973; Sims, 1976); if our correlation is correct (Houston and others, 1977; Karlstrom and others, 1981a), it is the upper, iron-bearing part of this Marquette Range Supergroup-type succession that is removed by the shear zone.

Sills and dikes of gabbroic composition are common in the Early Proterozoic rock succession. Thick sills (as much as 1,640 ft) are predominant in the Deep Lake Group, and dikes are more common in rocks of the Libby Creek Group. These mafic intrusions are of tholeiitic composition (Houston and others, 1968). The only mapped felsic intrusion is a small elongate body, the Gaps Intrusion, which is emplaced in a fault zone in the S1/2 sec. 8, N1/2 sec. 11, T. 16 N., R. 79 W. The Gaps Intrusion is sheared and brecciated and contains many inclusions of country rock.

GEOCHEMISTRY

A total of 270 stream-sediment and rock samples from the study area and vicinity area were collected by R. S. Houston, K. E. Karlstrom, and L. R. Lanthier. Seventeen stream-sediment samples,

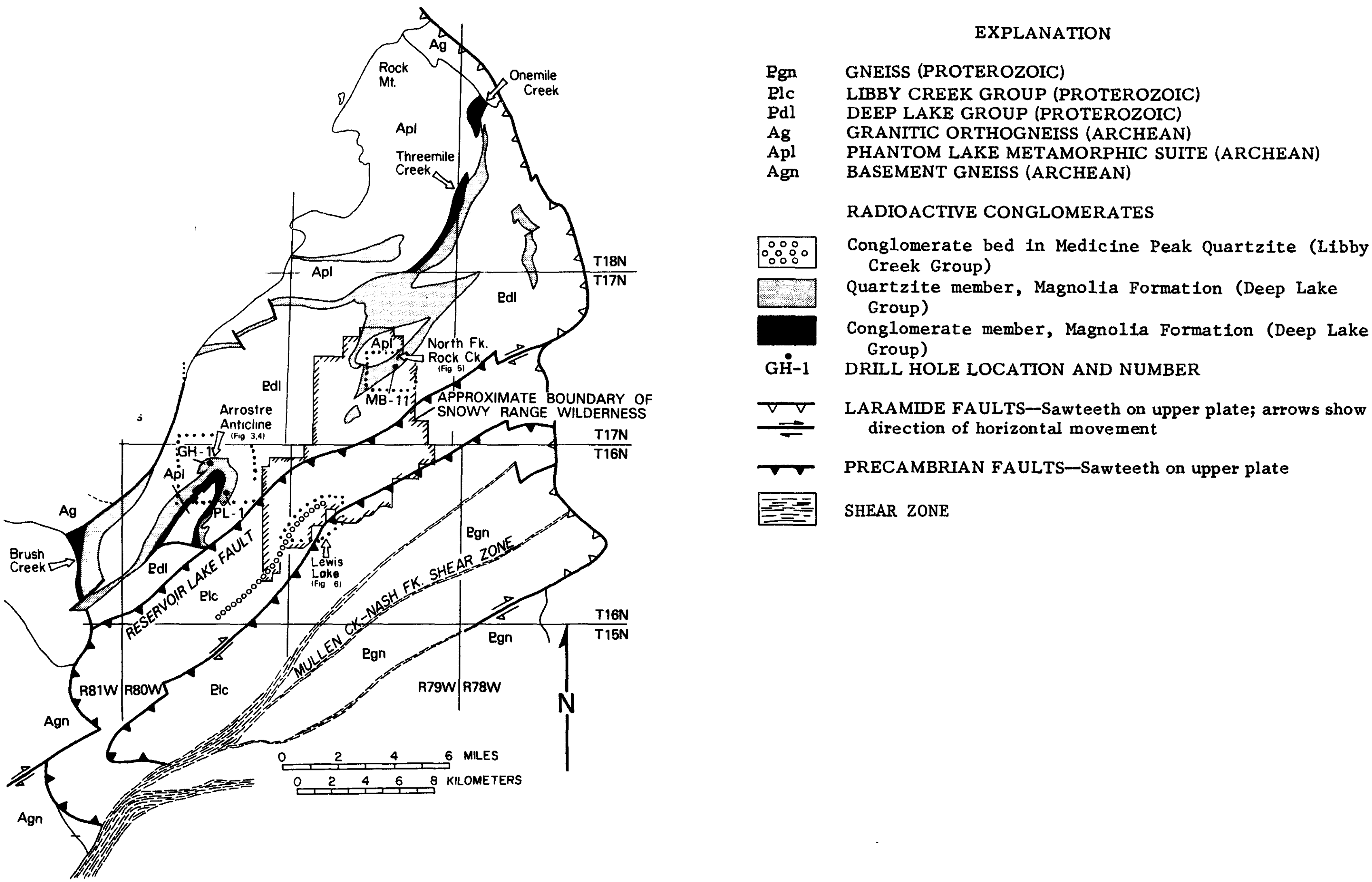


Figure 2.—Generalized geologic map of the Medicine Bow Mountains showing the location of radioactive conglomerates, drill holes, and area of resource potential (dotted).

averaging about 1 1/2 pounds each, were collected along flowing streams. In addition, 123 water samples were collected from streams, springs, and seeps by W. R. Miller, W. H. Ficklin, and J. B. McHugh.

All 17 stream-sediment samples and 203 of the rock samples were analyzed in U.S. Geological Survey laboratories by J. Motooka, R. T. Hopkins, S. J. Sutley, and J. M. Domenico using a six-step semiquantitative spectrographic method for 30 elements (Au, Ag, As, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mg, Mn, No, Nb, Ni, Pb, Sb, Sc, Sn, Sr, Ti, V, W, Y, Zn, and Zr). The spectrographic data were reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, and so forth, which represent approximate midpoints of grouped data on a geometric scale. The same 203 rock samples and 17 stream-sediment samples were analyzed by D. M. Hopkins for Au (using atomic-absorption technique), for Th (using M. A. spectrometry technique), and for U (using fluorimetric technique). Water samples collected from streams, springs, and seeps were analyzed for radon, pH and specific conductance. Temperature and pH were determined at the sample site. The methods of collection and chemical analyses are described by Miller and others (1977). The data for all samples are stored in the rock analysis and storage system (RASS) files of the U.S. Geological Survey.

Fifty samples (nos. <160,000) were analyzed by the Oak Ridge gaseous diffusion plant of the U.S. Department of Energy for U, Au, Ag, Al, B, Ba, Be, Ca, Ce, Co, Cr, Cu, Fe, Hf, K, La, Li, Mg, Mr, Mo, Na, Nb, Ni, P, Pb, Sc, Sr, Th, Ti, V, Y, Zn, and Zr by a combination of neutron activation, fluorimetry, and plasma-source emission spectroscopy. Analytical methods, detection limits, and quality control information for these samples are in Karlstrom and others (1981b, table 3), and the data for all samples are in Karlstrom and others (1981b, p. 503-581).

MINING DISTRICTS AND MINERALIZED AREAS

The Snowy Range Wilderness does not lie within an organized mining district. As of January 1978 mining claims were confined to the southern, eastern, and western borders of the area, and most were filed in the period between 1878 and 1939. These claims were located on gold prospects and are largely confined to quartz veins and veinlets that proved to be too thin and discontinuous to mine at the time. Since 1970 numerous claims for uranium, thorium, and gold have been located west and north of the study area in regions underlain by the Magnolia Formation. Although no such claims have been located within the study area the entire northern half of it, north of Reservoir and Arrowhead Lakes, is underlain by the Magnolia Formation.

No formal record exists of mineral production within the study area, except some green fuchsite-bearing quartzite was sold as a decorative stone. This material was found near the upper contact of the Medicine Peak Quartzite and was mined in 1967 and 1968 from a locality south of Browns Peak and west of Telephone Lakes. Total production was about 1,000 tons. Verbal reports of citizens of Laramie suggest that enough gold was mined from prospects north of Lewis Lake, both inside and outside of the study area, to keep one prospector solvent during the 1920's-1930's.

URANIUM, THORIUM, AND GOLD MINERALIZATION

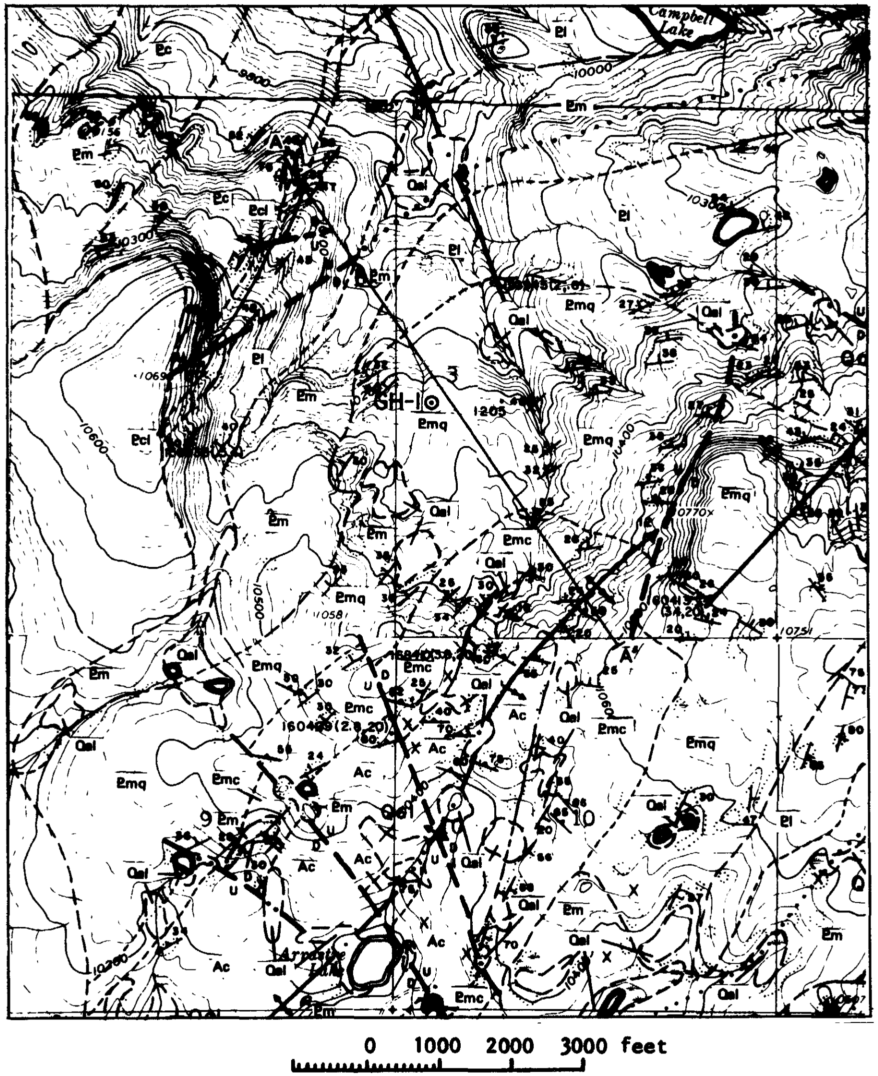
Early Proterozoic quartz pebble conglomerate

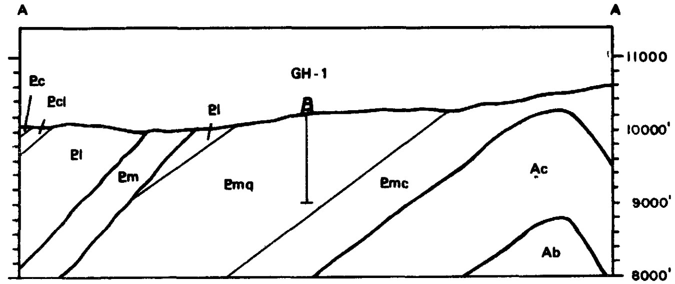
Uranium and thorium

The northern half of the Snowy Range Wilderness is underlain by uranium-, thorium-, and gold-bearing quartz-pebble conglomerate which is at and near the base of the Magnolia Formation, the basal formation of the Deep Lake Group (fig. 2, table 1). In and adjacent to the study area all outcrops of the Magnolia Formation were examined with hand-held spectrometers, and radioactive conglomerate was found at localities on the northeast limb of Arrastre anticline (fig. 2) about 1 1/2 mi west of the study area border; radioactive conglomerate was also found at a locality within the study area near the head of the North Fork Rock Creek (fig. 2). On the northeast limb of Arrastre anticline lenticular beds of radioactive quartz-pebble conglomerate are within a thick sequence of arkosic paraconglomerate. These paraconglomerates can be traced for about 3,300 ft on the east limb of the Arrastre anticline. The maximum uranium value in surface samples was 8 ppm and the maximum thorium value was 32 ppm. These surface values for uranium and thorium were not high, but the radon content of ground water from springs, seeps, and bogs was found to be significantly higher than could be accounted for by surface rocks (Miller and others, 1977). Because surface samples of conglomerate are readily leached of their uranium content, exploration companies drilled two holes in the Arrastre area to determine if higher uranium values might be encountered at depth. Hole GH-1 was drilled in W1/2 sec. 3, T. 16 N., R. 80 W. (fig. 3) and was spudded in the upper Magnolia Formation where beds dipped 35^{o} NW. The hole was drilled vertically 1,205 ft but did not penetrate the lower conglomerate of the Magnolia Formation. Radioactivity was uniformly low; maximum values were 32 ppm uranium and 48 ppm thorium at 660 ft (Karlstrom and others, 1981a).

A second hole (PL-1), drilled by private interests, was located in E1/2 sec. 10, T. 16 N., R. 80 W. (fig. 4). The hole was spudded east of outcrops of radioactive conglomerate on the northeast limb of the Arrastre anticline in beds of the upper Magnolia Formation that dipped southeast. The hole was drilled at an angle of 50^{o} to intersect these beds perpendicular to bedding. It encountered 599 ft of quartzite of the upper Magnolia Formation followed by arkosic polymictic paraconglomerate of the basal Magnolia Formation to 1,232 ft, where basalt of the Colberg Metavolcanics of the Archean Phantom Lake Metamorphic Suite was encountered. Conglomerates were only mildly radioactive; and maximum uranium values were 11 ppm and maximum thorium values were 30 ppm at 1,134 ft (Karlstrom and others, 1981a).

The conglomerate of the Magnolia Formation in the Arrastre Lake area was considered a promising target for uranium on the basis of radon in water surveys (Miller and others, 1977), but these initial surface and subsurface studies failed to verify the radon results. We must emphasize that a very small sample of the radioactive conglomerate was tested in the subsurface, and the radon results cannot be

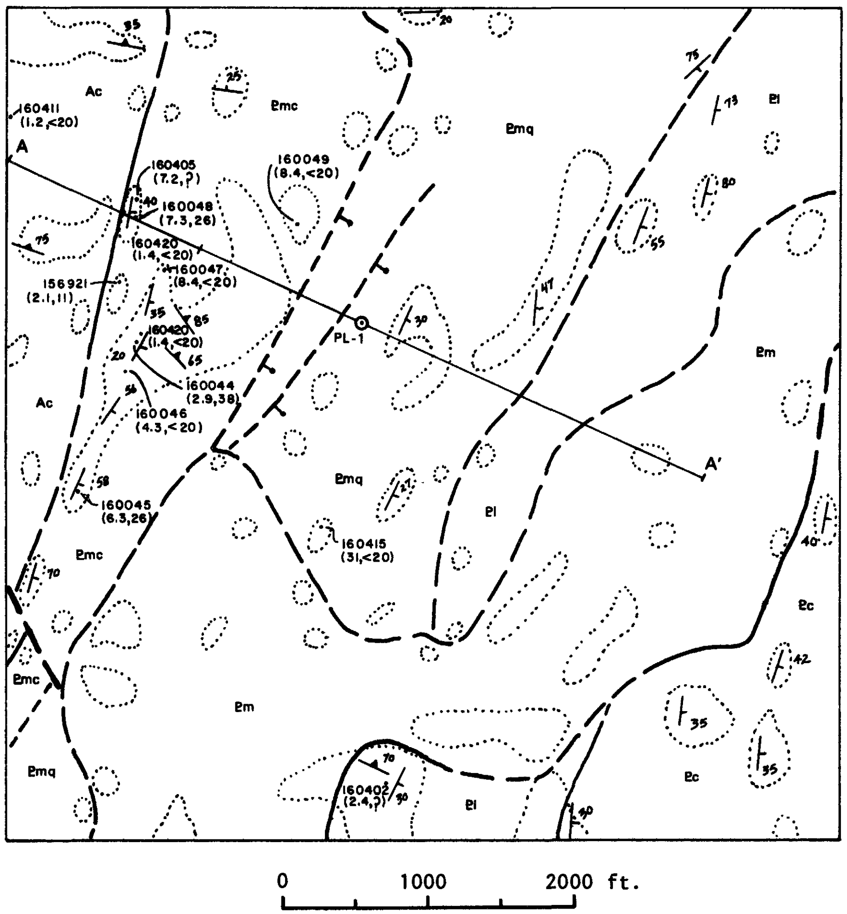


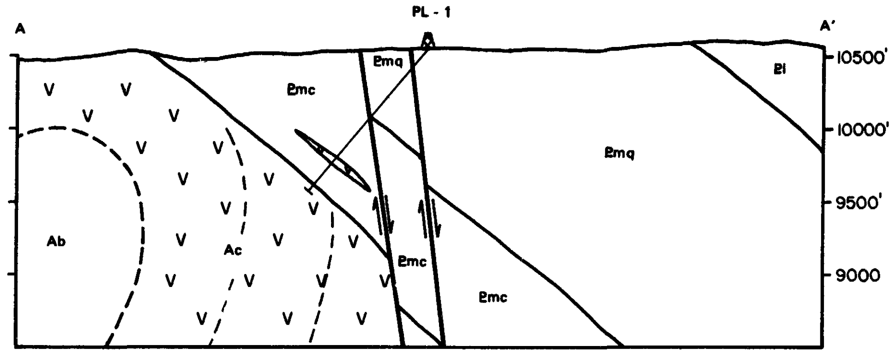


EXPLANATION

Qal	ALLUVIAL DEPOSITS (QUATERNARY)
Pm	MAFIC INTRUSIVE ROCK (PROTEROZOIC)
Pc	CASCADE QUARTZITE (PROTEROZOIC)
Pcl	CAMPBELL LAKE FORMATION (PROTEROZOIC)
Pl	LINDSEY QUARTZITE (PROTEROZOIC)
	MAGNOLIA FORMATION (PROTEROZOIC)
Pmq	Quartzite member
Pmc	Conglomerate member
	Unconformity
Ac	COLBERG METAVOLCANICS (ARCHEAN)
Ab	BOW QUARTZITE (ARCHEAN)
	OUTCROP BOUNDARY
	CONTACT—Dashed where inferred
U / D	FAULT—Dashed where inferred; dotted where concealed; U on upthrown side
	ANTICLINE—Showing direction of plunge
32	STRIKE AND DIP OF BEDDING
50	STRIKE AND DIP OF FOLIATION
1604B 3.4,20)	SAMPLE LOCALITY AND NUMBER—With assay (U, Th)
GH-1 1205'	VERTICAL DRILL HOLE—Showing total depth

Figure 3.—Geologic map of drill site GH-1, Medicine Bow Mountains, Turpin Reservoir quadrangle, sec. 3, T. 16 N., R. 80 W., Carbon County, Wyo. (Karlstrom and others, 1981b).





EXPLANATION

Em MAFIC INTRUSIVE ROCKS (PROTEROZOIC)
Ec CASCADE QUARTZITE (PROTEROZOIC)—Pebbly quartzite
El LINDSEY QUARTZITE (PROTEROZOIC)—Medium-grained quartzite
MAGNOLIA FORMATION (PROTEROZOIC)
Emq Quartzite member—Quartz-granule conglomerate
Emc Conglomerate member—Arkosic paraconglomerate
Unconformity
Ac COLBERG METAVOLCANICS (ARCHEAN)—Mafic volcanics
Ab BOW QUARTZITE (ARCHEAN)—Fine-grained quartzite

OUTCROP BOUNDARY

CONTACT—Dashed where approximately located

INFERRED FAULT—Bar and ball on downthrown side

42 STRIKE AND DIP OF BEDDING

65 STRIKE AND DIP OF FOLIATION

160207 (16,27) SAMPLE LOCALITY AND NUMBER—With assay (U, Th), if available

DRILL HOLE—Showing bearing and total length

Figure 4.—Geologic map of drill site PL-1, Arrastre anticline area, Medicine Bow Peak quadrangle, sec. 10, T. 16 N., R. 80 W. (Karlstrom and others, 1981b).

discounted on the basis of geologic and geochemical surveys done as of 1982.

Near the head of the North Fork of Rock Creek (sec. 22, T. 17 N., R. 79 W., fig. 5), which is within the wilderness, radioactive quartz-pebble conglomerate of the basal Magnolia Formation lies unconformably on basalt of the Archean Phantom Lake Metamorphic Suite. Surface samples contained as much as 3.2 ppm uranium and 13 ppm thorium and had about 3 times background radioactivity. Samples of water from springs, seeps, and bogs showed that this area has exceptionally high radon values, as high as 20,605 picocuries per liter in SE1/4 N1/4 sec. 22, T. 17 N., R. 79 W. (Houston and Miller, 1984). The presence of radioactive quartz-pebble conglomerate and the extraordinarily high radon values suggested that this area was a promising target for uranium, and one drill hole hole (MB-11) was drilled by Bendix Corporation for the U.S. Department of Energy (fig. 5). Drill hole MB-11 was located 1,010 ft from the east line, 2,860 ft from the south line, sec. 22, T. 17 N., R. 79 W. (fig. 5) and was spudded in beds of the upper Magnolia Formation that dipped 30° SE. The hole was drilled at an angle of 70° to encounter beds of the basal Magnolia Formation (Karlstrom and others, 1981a). It encountered quartzites and quartz-granule conglomerate of the basal Magnolia Formation, but did not intersect radioactive quartz-pebble conglomerate. Hole MB-11 was terminated at 680 ft, where fine-grained quartzite that was interpreted as part of the Archean Phantom Lake Metamorphic Suite was encountered. Maximum uranium values were 14 ppm and maximum thorium values were 36 ppm in drill hole MB-11.

Several other formations of the Deep Lake Group and of the lower Libby Creek Group in the wilderness and adjacent areas contain quartz-pebble conglomerate. The most important of these in terms of extent and thickness are in the Cascade Quartzite of the Deep Lake Group and the Medicine Peak Quartzite of the lower Libby Creek Group. The Cascade Quartzite contains persistent conglomerate layers commonly 2.5-4 in. thick but as much as 60 ft thick in an area northeast of North Twin Lake, sec. 4, T. 16 N., R. 80 W. These conglomerate layers are well sorted and consist of pebbles of quartz, quartzite, black chert, and, locally, pink granite. Pyrite was identified in the Cascade conglomerate in several areas, and overall field characteristics suggested it was a good target for uranium and thorium exploration. However, no surface outcrop of conglomerate in the Cascade Quartzite was radioactive, and of 14 surface samples of conglomerate from the Cascade Quartzite in the wilderness and adjacent areas only three had detectable uranium and thorium; the highest uranium value was less than 1 ppm and the highest thorium value was less than 5 ppm.

The Medicine Peak Quartzite of the Libby Creek Group contains well-developed and persistent layers of quartz-pebble conglomerate near the middle of the formation (fig. 2). One of these quartz-pebble conglomerate layers was traced from a roadcut north of Silver Lake to outcrops east of Lewis Lake, a distance of over 5 mi. Quartz-pebble conglomerate of the Medicine Peak Quartzite is well sorted and consists of well-rounded pebbles of quartz and black and red chert. Unlike quartz-pebble conglomerate of the Deep Lake Group, quartz-pebble conglomerate of the Medicine Peak Quartzite has hematitic cement. The presence of hematitic cement suggests an oxidizing environment and is unfavorable for uranium mineralization (Houston and Karlstrom, 1979). Radiometric surveys of outcrops of Medicine Peak Quartzite quartz-pebble conglomerate were negative for the most part. Several beds of quartz-pebble conglomerate from the area north of Lewis Lake were slightly radioactive (2 times background), and one bed of conglomerate in a glacial boulder located in the Gaps area was strongly radioactive (6 times background). Forty-nine samples of the quartz-pebble conglomerate of the Medicine Peak Quartzite from within the study area were analyzed for uranium and thorium. Forty-eight of these samples contained uranium, but the average uranium content was less than 1.7 ppm; one sample from north of Lewis Lake contained 7.4 ppm uranium and the radioactive bed in the glacial boulder contained 28.3 ppm uranium. Thirty-four samples of quartz-pebble conglomerate of the Medicine Peak Quarzite contained thorium and the average thorium content was 21.3 ppm. One sample from a locality north of Lewis Lake contained 328 ppm thorium. Despite the fact that quartz-pebble conglomerate of the Medicine Peak Quartzite has local beds containing moderate amounts of uranium and thorium, we do not consider it a good exploration target because of the oxidation state of the conglomerate matrix. We assume that the hematitic matrix is primary, but if this is not the case, and the fact that a glacial boulder contained more uranium than surface outcrop suggests it is not the case, then drilling to intersect conglomerate beds of Medicine Peak Quartzite might be warranted.

Gold

Twenty surface samples of quartz-pebble conglomerate from the basal Magnolia Formation were analyzed for gold. Gold was detected in 10 of these samples, but the maximum content was only 0.08 ppm.

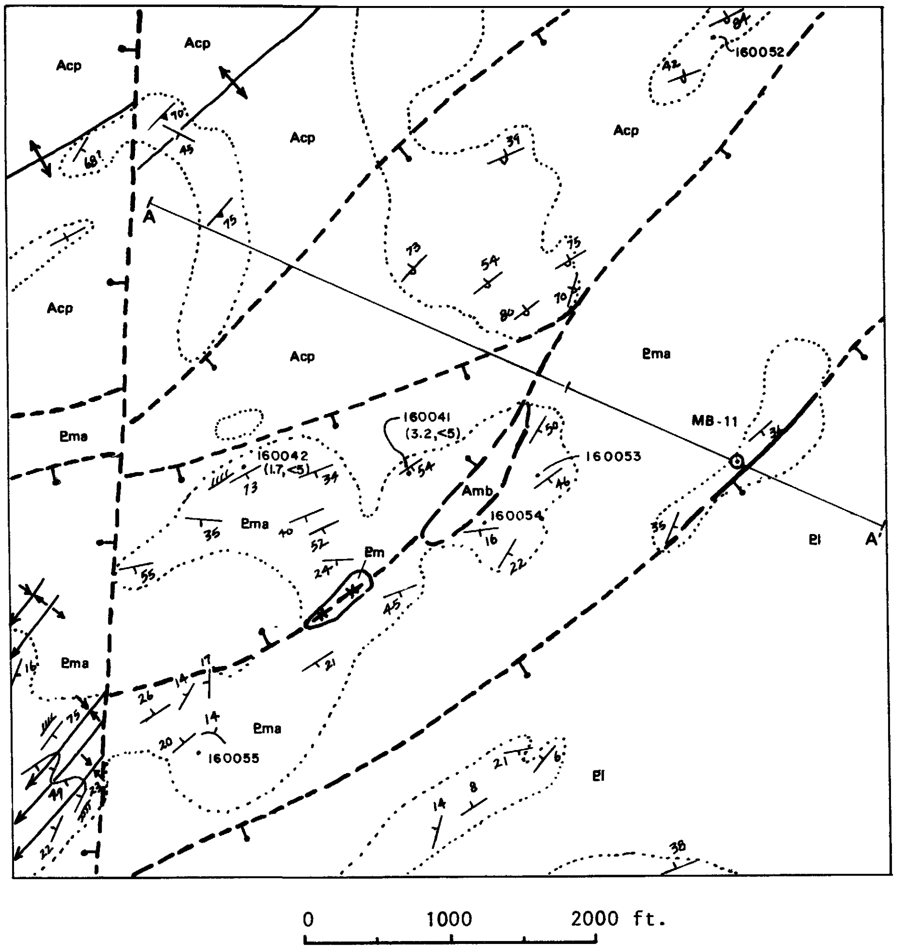
Forty-nine surface samples from the quartz-pebble conglomerate of the Medicine Peak Quartzite were analyzed for gold. Gold was not detected in any of these samples.

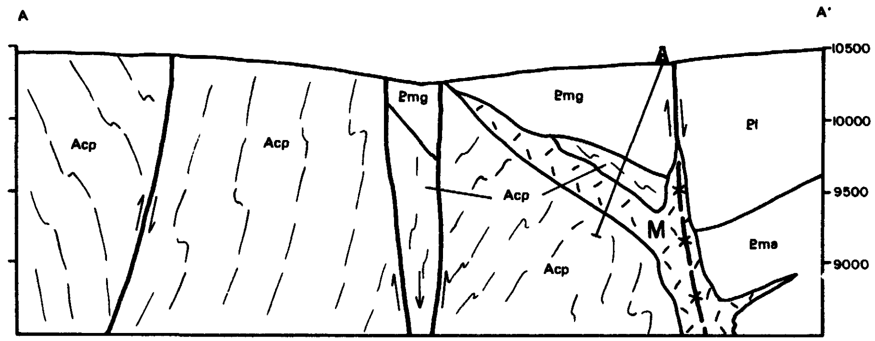
Fourteen samples of the Cascade Quartzite were analyzed for gold; one contained 0.02 ppm and another 0.08 ppm. Gold was not detected in 12 of the samples.

Samples analyzed for gold were collected from the base of the quartz-pebble conglomerate beds, but these samples were not large enough to be statistically meaningful (Clifton and others, 1969). Samples collected were approximately 5X3X3 in. It was not possible to obtain panned concentrates from the well-lithified samples so we do not consider the gold sampling program adequate to test the conglomerate fully. Further testing of quartz-pebble conglomerate of the Cascade Quartzite and Magnolia Formation might be warranted.

Veins of Precambrian age

Discontinuous quartz veins ranging in width from a few inches to 2 ft and traceable along strike for tens of feet maximum are common in the Snowy Range Wilderness. These quartz veins are most common near contacts between mafic intrusive rocks and the various





EXPLANATION

Pm	MAFIC INTRUSIVE ROCKS (PROTEROZOIC)
Pl	LINDSEY QUARTZITE (PROTEROZOIC)—Medium-grained quartzite
Pma	MAGNOLIA FORMATION (PROTEROZOIC)—Quartz-granule; conglomerate
	Unconformity
Amb	AMYGDALOIDAL METABASALT (ARCHEAN)
Acp	CONICAL PEAK QUARTZITE (ARCHEAN)—Fine-grained quartzite
	OUTCROP BOUNDARY
	CONTACT--Short dashed where inferred
	INFERRED FAULT—Ball on downthrown side
	ANTICLINE—Showing direction of plunge
	SYNCLINE—Showing direction of plunge
34, 54	STRIKE AND DIP OF BEDDING Inclined Overturned
70	STRIKE AND DIP OF FOLIATION
	TRUNCATED FORESET BEDDING
160052	SAMPLE LOCALITY AND NUMBER—With assay (U, Th), if available
	DRILL HOLE--Showing bearing and total length

Figure 5.—Geologic map of drill site MB-11, North Fork of Rock Creek, Sand Lake quadrangle, sec. 22, T. 17 N., R. 79 W. (Karlstrom and others, 1981b).

metasedimentary rocks. They are also present in the Gaps Intrusion (fig. 6).

Most quartz veins are oxidized and have poorly developed limonitic gossans. Pyrrhotite, chalcopyrite, and pyrite can be recognized in some veins exposed in prospect pits.

Fifteen samples of vein quartz that contained sulfide minerals were analyzed, and several shear zones containing visible sulfide minerals were also analyzed. Most of the quartz veins and shear zones were not radioactive, but veins and shear zones in and adjacent to the Gaps Intrusion were radioactive and one mineralized quartz vein cutting Gaps Intrusion exposed in a prospect pit on the southwest shore of Lewis Lake contained 1,000 ppm uranium and 1,655 ppm thorium (fig. 6). Another shear zone in the Gaps Intrusion contained 19.6 ppm uranium and 52.5 ppm thorium.

Other quartz veins were either in or near contacts with mafic intrusions and these veins all contained uranium, averaging 4.03 ppm, and having a maximum of 31.20 ppm in sec. 10, T. 16 N., R. 80 W. This vein quartz containing 31.20 ppm uranium is in a mafic intrusion that cuts the upper Magnolia Formation about 1/4 mi east of outcrops of radioactive conglomerate at the base of the Magnolia Formation. The thorium content of veins in and associated with the mafic intrusive averages 27.4 ppm. Both thorium and uranium are present in amounts greater than crustal abundances in mafic intrusive rocks and associated quartz veins of this area. These elements must have been assimilated from uranium-bearing rocks during emplacement of the mafic intrusions.

It may be significant, however, that the highest uranium and thorium values in any igneous rocks and associated veins are in the same general area. These rocks are the Gaps Intrusion of the Gaps area and the gabbroic intrusion about 3/4 mi southwest of the Gaps Intrusion near Lookout Lake (fig. 6). The Gaps Intrusion is emplaced in a major fault system that may be mineralized at depth, and both intrusions are near a faulted major unconformity between the lower and upper parts of the Libby Creek Group.

Gold was detected in 5 of 14 veins that were analyzed, but the average gold content was 0.13 ppm and the highest value detected was 0.70 ppm.

Fractures showing hematitic alteration

Hematitic alteration often accompanies uranium mineralization and is regarded as a guide in exploration for vein-type uranium deposits (Rich and others, 1977). Fault zones and shear zones that displayed hematitic alteration were sampled in several parts of the study area. Major dip-slip faults south of Lake Marie contain breccia zones cemented by hematite. None were radioactive, and two samples averaged only 0.9 ppm uranium and 1.00 ppm thorium. In the Lewis Lake area (fig. 6), however, where greater than normal values for uranium and thorium are present in quartz veins, shear zones, and igneous rocks, hematitically altered breccia in fractures is radioactive (5-10 times local background). Three samples from both dip- and strike-slip faults averaged 69.3 ppm uranium and 122.7 ppm thorium. Only one of the samples contained gold, and that value was 0.05 ppm.

The uranium and thorium values in veins, fractures, and igneous rocks in the vicinity of Lewis Lake are indicative of a potential for uranium and thorium resources. Particular attention should be directed to major faults with hematitic alteration.

Proterozoic unconformities

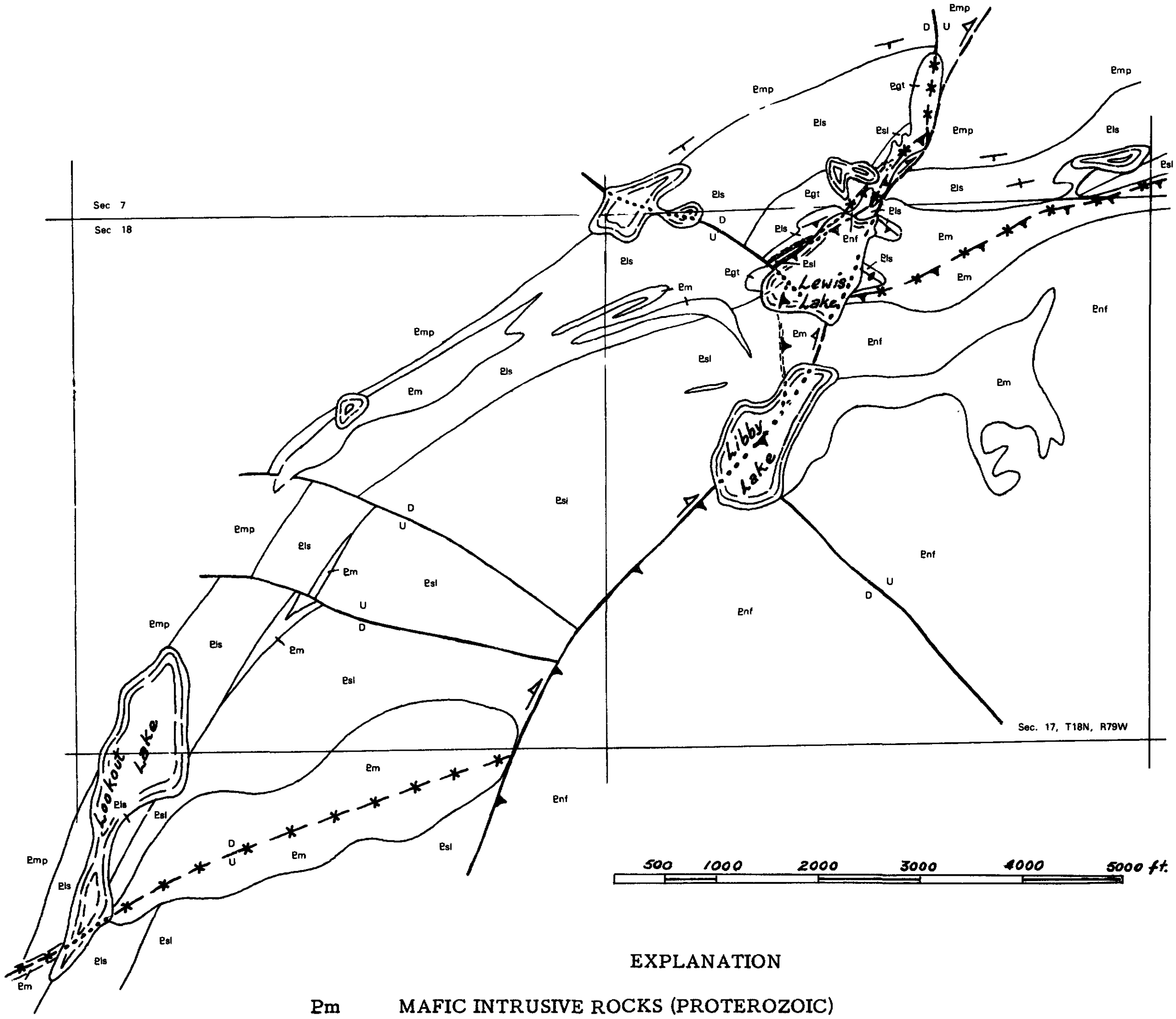
The contact between the Sugarloaf Quartzite and Nash Fork Formation of the Libby Creek Group is interpreted to be a faulted unconformity (Karlstrom and others, 1981a, b; fig. 6). Major uranium deposits are known to occur in fractures below Proterozoic unconformities (Kalliokoski and others, 1978). These unconformity-type uranium deposits are best developed where a fluvial succession of sedimentary rocks lies on an old regolith or peneplain surface. These deposits are around 1,700 m.y. old, for the most part, and are thought to have developed after the time when oxygen became abundant enough in the Precambrian atmosphere so that uranium was readily soluble in surface and ground waters. Uranium is transported by ground water along the unconformity, and when uranium-bearing ground water seeps into the underlying regolith and enters a fault system that contains a suitable reductant, uranium is precipitated.

The unconformity between the Sugarloaf and Nash Fork fits some of the above criteria. It is about the right age, provided we are correct in our assumption that the upper part of the Libby Creek Group correlates with the Marquette Range Supergroup of the Lake Superior region, but the basal fluvial succession is missing and this may be critical for formation of the unconformity-type uranium deposit. In addition, some veins and shear zones near Lewis Lake contain thorium as well as uranium, and thorium would not be present in major amounts in the unconformity-type deposit. Nonetheless, some of the most radioactive and uranium-rich veins of the study area and adjacent areas are near this unconformity.

Another unconformity within the wilderness is that between the rocks of the Archean Phantom Lake Metamorphic Suite and Early Proterozoic Deep Lake Group. This unconformity does have a fluvial succession at its base, but it is reasonable to assume the Precambrian atmosphere was still reducing when the fluvial beds were deposited.

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

Despite positive results from radon surveys and the presence of radioactive quartz-pebble conglomerate in outcrops, no conglomerate or any other rock type sampled in the surface or subsurface in the Snowy Range Wilderness contained appreciable uranium, thorium, or gold. These results were surprising because the basal conglomerate of the Magnolia Formation in the study area is similar in many respects to the uranium ore-bearing quartz-pebble conglomerate of the Matinenda Formation near Elliot Lake in Canada (Houston and others, 1977; Karlstrom and others, 1981b). Furthermore, interesting amounts of uranium (local beds of uranium-bearing conglomerate containing as much as 1,380 ppm uranium over a thickness of 2 ft (Karlstrom and others, 1981a)) were found in the basal conglomerate of the Magnolia Formation at the Onemile Creek locality



EXPLANATION

Pm	MAFIC INTRUSIVE ROCKS (PROTEROZOIC)
Pgt	GAPS INTRUSION (PROTEROZOIC)
Pnf	NASH FORK FORMATION (PROTEROZOIC)
Psl	SUGARLOAF QUARTZITE
Pls	LOOKOUT SCHIST (PROTEROZOIC)
Pmp	MEDICINE PEAK QUARTZITE (PROTEROZOIC)

STRIKE OF BEDDING
- Inclined
- Vertical

STRIKE OF FOLIATION
- Inclined
- Vertical

REVERSE FAULT OF PRECAMBRIAN AGE—Dashed where inferred; dotted where concealed; sawteeth on upper plate; open arrows indicate inferred Laramide or post-Laramide movement

U/D FAULT—U on upthrown side

DIKE—Intruding fault

Figure 6.—Geologic sketch map of Lewis Lake area, central Medicine Bow Mountains, Wyo.

about 8 mi northeast of the Snowy Range (fig. 2). Metamorphic rocks of the Onemile Creek area are upper amphibolite grade metamorphism; where metamorphic grade is this high, uranium could be mobilized and removed from the conglomerate, thus reducing the uranium values. The metamorphic grade of the Magnolia Formation conglomerate in the study area is greenschist and the conglomerate is less deformed than at Onemile Creek. The low grade, lack of severe deformation, and resemblance to the Canadian ore-bearing conglomerate all suggested that the conglomerate of the Magnolia Formation of the study area should contain ore-grade uranium, but this has not been demonstrated by work to date.

We believe that the Magnolia Formation of the study area has not been adequately tested for uranium or thorium, and, in the absence of closely-spaced drilling, we cannot rule out the presence of significant uranium and thorium deposits. The exceptionally high radon values in this area remain unexplained and suggest uranium may be present at ore grade at depth. On the basis of information available by spring 1981, the northern part of the Snowy Range Wilderness Study Area has low to moderate potential for uranium, thorium, and gold resources in the Magnolia Formation.

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