SOME THORIUM PROSPECTS,

LEMHI PASS AREA,

BEAVERHEAD COUNTY, MONTANA

By Frank C. Armstrong

Trace Elements Memorandum Report 918

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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SOME THORIUM PROSPECTS, LEMHI PASS AREA, BEAVERHEAD COUNTY, MONTANA*

By

Frank C. Armstrong

June 1955

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*This report concerns work done on behalf of the Defense Minerals Exploration Administration and the Division of Raw Materials of the U. S. Atomic Energy Commission.

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By Frank C. Armstrong

ABSTRACT

The Last Chance group, Brown Bear, and Shady Tree claims in Beaverhead County, Mont., were explored for thorium under a Defense Minerals Exploration Administration Contract in 1951 and 1952.

The project was undertaken to explore northwest-trending, moderately to steeply dipping, thorite-bearing quartz-barite-hematite veins. The veins are wall-rock replacements and fissure fillings in faults and shears that cut rocks of the Precambrian Belt series. Recurrent movement along the faults has intensely fractured the veins. Quartz, iron-oxide minerals, and thorite have been deposited in these fractures. The iron oxides and thorite are intimately associated and were among the last minerals deposited. Because no rare earth or uranium minerals have been found in the veins, it is thought that the small amounts of these elements reported in the analyses must substitute for thorium in the thorite.

Under the D. M. E. A. contract the Last Chance vein was traced on surface for a distance of about 1,300 feet; the thickness ranges from about 35 feet to a few inches. Two diamond drill holes cut the vein 240 and 290 feet below the outcrop.

INTRODUCTION

The Last Chance group, Brown Bear, and Shady Tree claims are in the $N\frac{1}{2}$ sec. 28, sec. 29, and $S\frac{1}{2}$ sec. 20, T. 10 S., R. 15 W., in the unorganized Frying Pan mining district of western Beaverhead County, Mont., which is just east of the McDevitt mining district in Lemhi County, Idaho (fig. 1). The property consists of seven contiguous, unpatented lode claims and one tunnel site claim (fig. 2). The property is about 2 3/4 miles south of a point on the Lemhi Pass road that is about 10 miles east of Tendoy, Idaho, and 30 miles west of Armstead, Mont. The road between Tendoy and Armstead is a graded dirt road and is open to ordinary vehicles about 6 or 7 months of the year. Access to the property from the Lemhi Pass road is over a poorly defined sheep camp trail that runs south from where the Lemhi Pass road crosses the Continental Divide on the Idaho-Montana state line. Both the Union Pacific Railroad and U. S. Highway 91 pass through Armstead. The nearest source of mining supplies is 51 miles distant at Dillon, the county seat of Beaverhead County.

The Geological Survey first examined the Lemhi Pass area for thorium in 1950 (Trites and Tooker, 1953); and in 1952 Sharp and Cavender (written communication) made a more detailed geologic study of the area. In the spring of 1951, the Elkhorn Mining Co., Boulder, Mont., applied for a Defense Minerals Exploration Administration contract to explore the Last Chance group, Brown Bear, and Shady Tree claims for thorium. Assays taken from veins on the property justified a limited exploration program for thorium, consequently DMEA Contract Idm-E144,

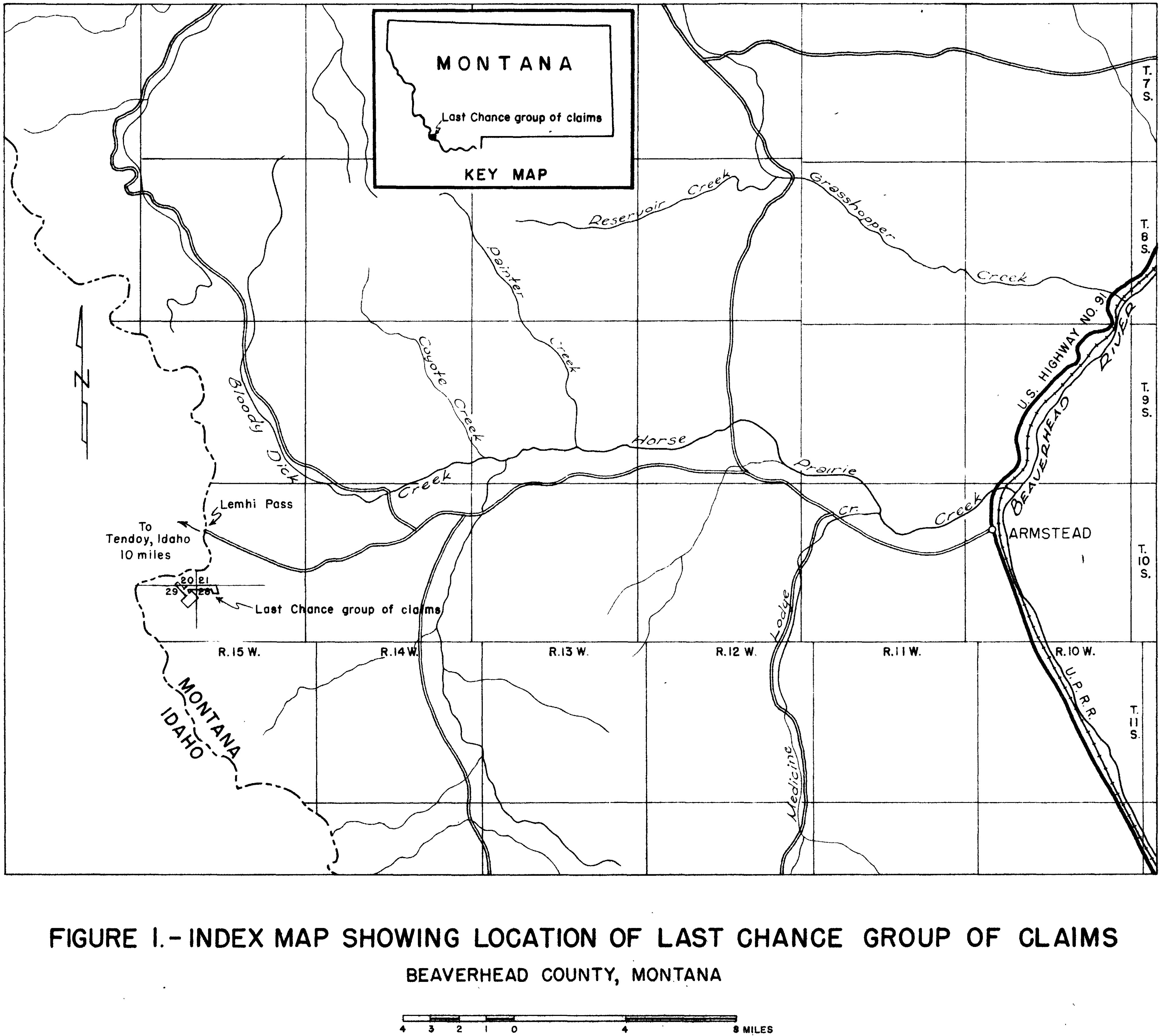
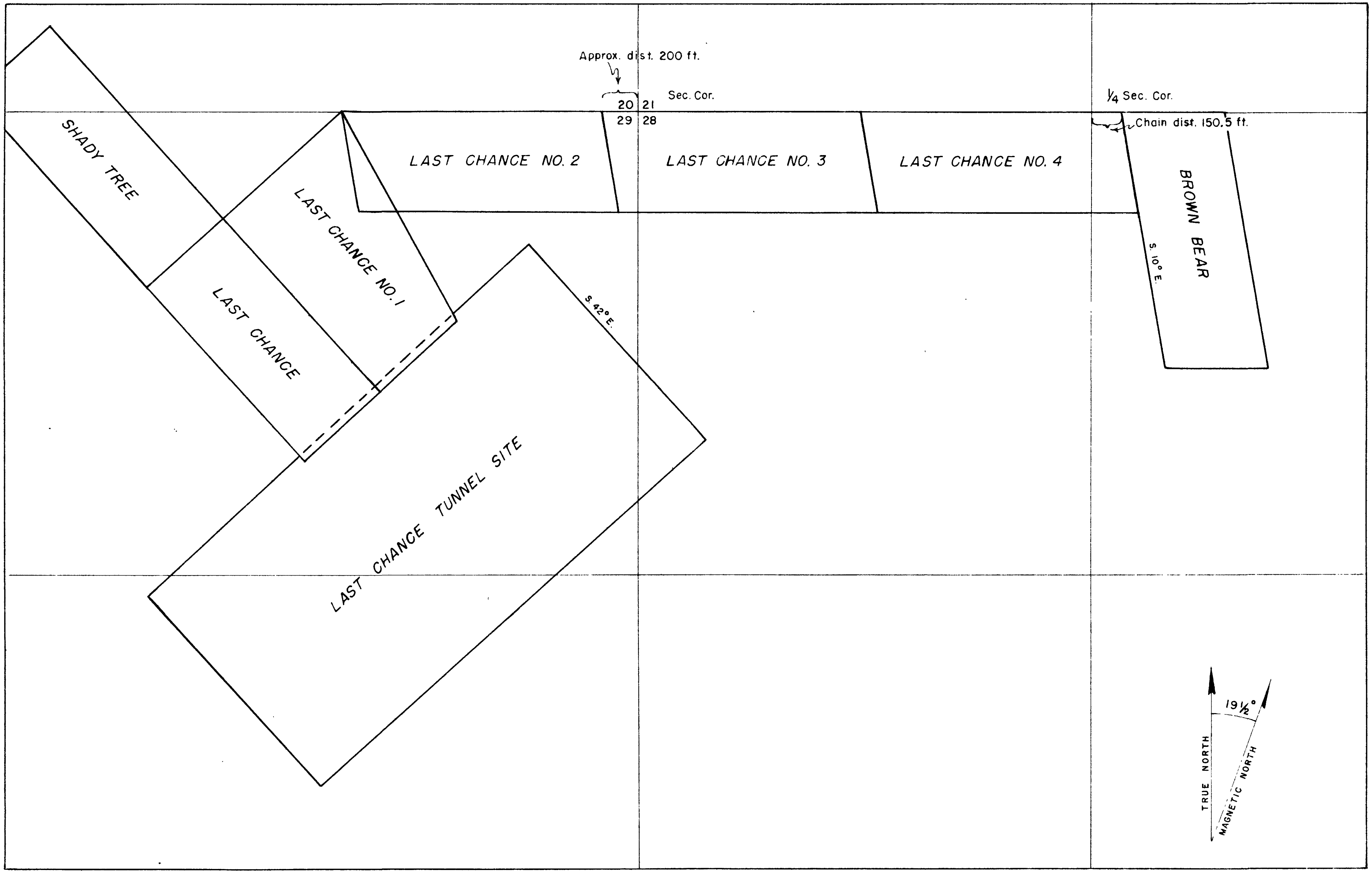


FIGURE 1.- INDEX MAP SHOWING LOCATION OF LAST CHANCE GROUP OF CLAIMS

BEAVERHEAD COUNTY, MONTANA



Modified from a map furnished by the Elkhorn Mining Company

D M E A Docket No. 1186

FIGURE 2. - LAST CHANCE GROUP OF CLAIMS

BEAVERHEAD COUNTY, MONTANA

DMEA Docket No. 1186, was granted the applicant September 14, 1951. Under the contract 700 feet of bulldozer trenching was done, most of it on the Last Chance claim where trenching exposed the main vein in several places. Small bulldozer cuts on the Shady Tree and Brown Bear claims exposed a few narrow veins. In addition, the main vein on the Last Chance claim was cut by 2 diamond drill holes (fig. 3). The contract was terminated by mutual agreement in June 1953, without completing the drilling allowed in the contract.

This report relates to the results obtained by the exploration work done primarily under the Defense Minerals Exploration Administration contract. It was also prepared partly on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

GEOLOGY

Regional geology

The Beaverhead Mountains in the vicinity of Lemhi Pass are underlain by light- to dark-gray, micaceous quartzite, dark-gray argillite, and argillaceous quartzite of the late Precambrian Belt series. These rocks are intricately folded, but because of poor exposures, the pattern of the folds has not been worked out.

The veins in the area occur in faults that trend northwest. The veins are wall-rock replacements and fissure fillings along faults and shears and are composed dominantly of quartz with some barite, iron oxides and hydroxides, and lesser amounts of thorite.

Geology of the Last Chance and Shady Tree claims

Figure 3/ is a geologic map of a part of the Last Chance and Shady

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/ Modified after unpublished map by W. N. Sharp and W. S. Cavender.

Tree claims. The area is underlain by gently dipping quartzite, argillaceous quartzite, and quartzitic sandstone of the Belt series. Because of poor outcrops the different rock types were not mapped separately.

The southern part of the Last Chance vein strikes about N. 45° W., and the north end strikes about N. 60° W. (fig. 3). The results of the diamond drilling indicate that the south third of the vein dips about 45° SW.; a dip of 64° NE. was observed on surface near the north end of the vein. The vein crops out for a distance of 500 feet and has been traced on the surface for a total distance of about 1,300 feet; it extends at least 290 feet down the dip (Sec. A-A'). Over the southern two-thirds of its length the thickness of the vein is between 10 and 15 feet; near the south end the vein has a maximum thickness of about 35 feet. The northern third of the vein progressively narrows and finally the vein dies out entirely. Several smaller veins, parallel or subparallel to the major vein, occur in the wall rocks. The largest of these, located about 35 feet northeast of the foot wall of the Last Chance vein, is 4 feet thick and is about midway between the ends of the major vein.

The Last Chance vein occupies a fault and has been emplaced by replacement of the brecciated wall rock and to a lesser extent by fissure filling. Even though replacement has played a large part in its formation, the contact of the vein with the wall rocks is sharp. The wall rocks have been intensely bleached for a distance of 3 to 5 feet from the vein, and locally they appear to be highly silicified. Numerous silicified breccia fragments of wall rock occur in and near the margins of the vein. The vein is intensely fractured from recurrent movement along the fault after the emplacement of the vein. Fracturing of the vein is most intense at points where abrupt changes in its strike occur.

The vein consists of milky quartz and subordinate barite; barite is only locally abundant and in most places is much less abundant than quartz. The wide part of the vein about 550 feet from its north end (fig.3), however, is dominantly barite with only sparse quartz. Barite in white, finely crystalline masses and in pink veinlets replaces some of the quartz. The quartz and barite have been intensely fractured and later quartz and barite, and goethite, lepidocrocite, specular and earthy hematite have been deposited in the fractures as veinlets from less than an inch to several inches thick. In the barite-rich part of the vein a banding parallel to the vein walls results from alternate layers of barite and dark-red, hematite-impregnated layers of barite. A little malachite was also noted in the vein. The presence of iron oxides and hydroxides in the numerous fractures colors almost the entire vein red.

The only mineral of economic importance in the vein, thorite ($ThO_2.SiO_2$), was identified by the Geological Survey Laboratory at Washington, D. C., by X-ray diffraction patterns. The thorite and its alteration products are dark red-brown, and the presence of abundant similarly colored iron compounds in the vein makes the megascopic identification of thorite difficult. The thorite occurs as irregular to rounded masses, and as irregular streaks and blebs smeared along fracture surfaces according to Sharp and Cavender (written communication), but Sharp and Cavender (written communication) and Trites and Tooker (1953) also report that thorite crystals occur throughout the vein and disseminated in quartz. Trites and Tooker (1953) also observed that the thorite crystals appear to be associated with red hematite.

The author visited the property on September 3, 1953 but did not observe the disseminated thorite crystals reported by the previous workers. Most, if not all, of the thorite seems to occur along fractures in the quartz or barite, and possibly is genetically associated with specular hematite-earthy hematite mineralization.

Microscopic examination of two thin sections of material cut in Diamond Drill Hole no. 2 shows the vein material to be severely crushed and finely ground, so that in places the vein has the texture of mylonite. Strain shadows in the quartz are abundant. Several generations of quartz filling the fractures are evident, and locally the quartz is recrystallized. Almost without exception any mineral that might be thorite is in a healed fracture, and the great majority of material that looks like thorite is in prominent iron oxide-filled fractures. The iron oxides appear to have been among the last minerals to have been deposited in the vein.

The well-fractured parts of the vein should, therefore, generally be richest in thorite and iron-oxide veinlets.

Rare earths have been reported in analyses of samples from the vein, but no rare-earth minerals have been identified. The amount of rare earths reported in the analyses is such that all of it can be accounted for as substituting for thorium in the mineral thorite, and, therefore, rare-earth minerals need not be present. Analyses show that there is very little uranium in the vein. What uranium is present could also be accommodated by substitution for thorium in the thorite.

Geology of the Brown Bear claim

In the northwest corner of the Brown Bear claim one cut exposed a vein that is traceable for about 250 feet. Near its south end the vein is $1\frac{1}{2}$ feet thick, and at its north end, beyond the north boundary of the Brown Bear claim, it is 3 feet thick. Its strike and dip change from N. 50° W., 49° SW. at the south end, to N. 15°-20° W., 54° SW. at the north end. A smaller parallel vein is also exposed in the bulldozer cut.

In the northeast corner of the Brown Bear claim four veins are exposed in one cut. The two larger veins, each paralleled for a short distance by a smaller vein, have been traced 200 to 250 feet to the southeast. One pair of veins strikes N. 65° W. and dips 87° SW.; the other pair strikes N. 25°-30° W., and dips 25° SW. Both of the larger veins are 6 to 8 inches thick.

All of the veins on the Brown Bear claim are like those on the Last Chance and Shady Tree claims. They are thorite-bearing quartz-barite-specular hematite-earthy hematite veins in which the thorite is associated with the iron oxides.

RESULTS OF DIAMOND DRILLING

Three diamond drill holes were drilled on the Last Chance claim, but only two of them cut the Last Chance vein. Detailed geologic logs of the holes showing recovery, size of hole, and description of material are given in Appendix A.

Hole no. 1 was drilled 239 feet bearing N. 43° E. and inclined 45 degrees from the horizontal (fig. 3). The drill hole cut vein material at 223.5 feet. The hanging wall rocks showed strong bleaching for several feet above the vein. From 223.5 to 231.0 feet the core consists of brecciated, iron-stained quartz veined by specular hematite and other reddish iron compounds. About 60 percent of the core was recovered from that 7.5-foot interval; no sludge was saved. From 231 to 239 feet only 2 inches of core consisting of vein material similar to that from 223.5 to 231 feet was recovered. The drillers reported good water return going through the vein zone, and a sandy sludge was recovered from the interval 231 to 239 feet. When this sludge was examined with a Geiger counter, the needle went off its most sensitive scale. Inasmuch as the sludge was the most radioactive material recovered, it appears that hole no. 1 may not have penetrated the entire vein zone. Personnel of the U. S. Atomic Energy Commission tried to log this hole radiometrically but could not do so because it had caved.

Diamond drill hole no. 2 was drilled 303 feet bearing N. 40° E. and inclined 45 degrees from the horizontal (fig. 3). The hanging wall of the vein cut by hole no. 2 is silicified and strongly bleached. The hole cut vein material at 264.6 feet, and there was vein material and silicified wall rock in the core from that point to the bottom of the hole. Although the hole bottomed in mineralized material, it is thought that the footwall of the main vein zone is at 284.6 feet. The most radioactive part of the core, as shown by examination with a Geiger counter, is from 264.6 to 269 feet. The core below 269 feet is not very radioactive. Personnel of the Atomic Energy Commission's Butte suboffice made a radiometric log (see Appendix A) of the hole. This log shows the most radioactive part of the hole to be at about 280 feet and the second most radioactive part to be about 266 feet. Radioactivity was not detected in the core at 280 feet, probably because in the interval 277.6 to 284.6 feet core recovery was only 24 percent, whereas from 264.6 to 269 feet it was 100 percent. The radiometric log shows the start of another radiometric high at the bottom of the hole, and it is possible that the hole has not cut the full thickness of the vein zone.

Diamond drill hole no. 3 was drilled 95 feet bearing N. 50° E. and inclined 45 degrees from the horizontal (fig. 3). The drilling was recessed for the winter before the hole cut the vein; because the project was terminated the following June, the hole was not completed.

SAMPLES

During the course of an investigation of the thorium deposits in the Lemhi Pass area by the Geological Survey sixteen surface samples were taken from the Last Chance claim and two from the Brown Bear claim. The analyses of the samples are listed in table 1 and the sample locations are plotted on figure 3.

Diamond drill core samples were assayed by both the Lindsay Chemical Company and by the Geological Survey. A comparison of these analyses is given in table 2. Semiquantitative spectrographic analyses of the samples were also made by the Geological Survey and are listed in table 3. If uranium and thorium are present in a sample in quantities less than 0.1 percent, they are not ordinarily detected spectrographically. This fact accounts for the absence of uranium in table 3 and the absence of thorium in some of the samples of table 3.

Table 1.--Surface sample data, Last Chance and Brown Bear claims, Beaverhead County, Montana (from Sharp and Cavender, written communication)

Sample Number	eU (percent)	U (percent)	ThO_2 (percent)	ThO_2 + RE_2O_3 (percent	Ra (gr/gr)	Location	Remarks	
Last Chance vein								
LC-B	0.008	0.001	0.05	0.06		Pit on satellite vein NW of road cut	Chip sample across 3- to 4-ft. vein	
LC-E	.021	.001	.05	.06		Prominent enlargement of vein NW of road cut	Chip sample across 20-ft. vein outcrop	
LC-G	.19	.005	.93	1.70		First trench NW of "E" location	Chip sample across 3- to 4-ft. vein	
LC-H	.017	.001	.05	.05		Second trench NW of "E" location	Chip sample across 4-ft. vein	
KW-LC-1	.059	.001	.31		$3x10^{-12}$		Chip samples east to west across 10-ft. vein	3 ft.
-2	.10	.002	.53		$7x10^{-12}$	Road cut across vein		3 ft.
-3	.41	.003	2.1		$1.4x10^{-11}$			4 ft.
-5	.36	.002	1.8		$2.0x10^{-11}$	Outcrop, 30 ft. SE of road cut	Channel sample 8-ft. outcrop	
-6	.32	.003	1.7		$2.5x10^{-11}$	Small pit on prominent outcrop; 210 ft. SE of road cut	Grab sample from pit	
AFT-S24-50	.10	.003	.5*			Small pit on prominent outcrop; 210 ft. SE of road cut	Grab sample from cherty lens	

* Calculated

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Table 1.--Surface sample data, Last Chance and Brown Bear claims, Beaverhead County, Montana--Continued (from Sharp and Cavender, written communication)

Sample Number	eU (percent)	U (percent)	ThO_2 (percent)	ThO_2 + RE_2O_3 (percent)	Ra (gr/gr)	Location	Remarks
AFT-S25-50	0.43	0.005	2.4*		1.5×10^{-11}	Small pit on prominent outcrop; 210 ft. SE of road cut	Chip sample across 1-ft. of vein
-S26	.44	.004	2.4*			Outcrop of vein 60 ft. SE of road cut	Chip sample across 1 ft. of vein
-S32	.15	.002	.8*		4×10^{-12}	Road cut across vein	Chip sample across 5 ft. of footwall side of vein
-S33	.041	.001	.2*			Road cut across vein	Chip sample across 5 ft. hanging wall side
-S34	.009	.001	.04*			Prominent enlargement of vein NW of road cut	Chip sample across 25 ft. of vein
S-35	.014	.001	.07*			SE end of vein outcrop	Chip sample across 40 ft. of vein
Brown Bear claim							
AFT-S30-30	0.017	0.001	0.09*			Outcrop of vein 150 ft. NW of NW trench	Chip sample across 3 ft. of vein
AFT -S19-50	1.25		7.0*			NE trench	Selected composite sample of 6-in. vein

* Calculated

Table 2.--Assays of diamond drill holes No. 1 and 2, Last Chance claim, Beaverhead County, Montana

Diamond Drill Hole No. 1

	U. S. Geological Survey Analyses 1/				Lindsay Chemical Company Analyses	
Footage	Equivalent U Percent	Equivalent ThO_2 Percent	U_3O_8 Percent	ThO_2 Percent	RE_2O_3 + ThO_2 Percent	ThO_2 Percent
	0.069	0.26				
224.0-226.4	.068	.26	0.001	0.37	0.5	0.3
226.4-227.1	.013	.049	.001	.05	.07	
227.1-229.2	.012	.046	< .001	.06	N.D. 2/	N.D.
229.2-231.2	.009	.034	< .001	.05	N.D.	N.D.
	.050	.19	.001			
231.2-239.0 3/	.048	.18		.30	0.5	0.3
	Weighted average			.233		

Diamond Drill Hole No. 2

264.6-266.2	0.035	0.13	0.001	0.12	0.4	0.4
266.2-267.5	.039	.15	.001	.15	.3	.2
267.5-269.0	.019	.072	.001	.07	.2	N.D.
269.0-271.2	.006	.023	< .001	.01	N.D.	
271.2-273.0	.003	.011	.001	< .01	N.D.	
273.0-274.6	.006	.023	< .001	.01	N.D.	
274.6-275.3	.004	.015	< .001	.01	N.D.	
275.3-277.0	.003	.011	< .001	.01	N.D.	
277.0-277.6	.007	.027	< .001	.02	N.D.	
277.6-284.6	.023	.087	.001	.10	0.2.	N.D.
		Weighted average		.064		

1/ Total RE_2O_3 was not run because the spectrographic report(table 3) showed that they were not **significantly** high. Analysts Audrey Smith and Harry Levine, U. S. Geological Survey, Washington Laboratory

2/ Not detected.

3/ Sludge sample.

Table 3.--Semiquantitative spectrographic analyses of samples from diamond drill holes Nos. 1 and 2, Last Chance claim, Beaverhead County, Montana.

Diamond Drill Hole No. 1

Footage	Over 10%	1-10%	0.1-1.0%	0.01-0.1%	0.001-0.01%	0.0001-0.001%
224.0-226.4	Si	Fe	Al Ba Mg Th	Ce Pb Ti Mn Gd Cu Nd Sm Eu Sr	Dy Ni Y La Co Cr Sn V Zr	Yb Be Ag
226.4-227.1	Si	Al Fe K	Ba Mg	Th Na Ti Mn Cu Pb Ni Sr	Co Cr Ga Y V Zr Mo Sn	Ag Be Yb
227.1-229.2	Si	Al Fe K	Ba Mg	Na Th Ti Mn Cu Pb Sr Ni	Co Cr Y V Sn Zr Mo	Yb
229.2-231.2	Si	Fe	Al Ba	Zn Mn Cu Pb Mg Th Ti Ni Sr	Cr Y V Mo	Ag Yb
231.2-239.0	Si	Al Fe K	Ca Na Ba Mg Ti Th	Ce Nd Gd Y Cu Sr Mn Eu Sm Ni Pb	La Dy Co Cr Ga Zr V	Yb Be

Diamond Drill Hole No. 2

Footage	Over 10%	1-10%	0.1-1.0%	0.01-0.1%	0.001-0.01%	0.0001-0.001%
264.6-266.2	Si	Fe	Ba Al K Th Ca	Sm Co Pb Mn Ce Ti Sr Gd Cu Mg Ni Nd	Eu Y La Cr Yb V Mo Zr	-----
266.2-267.5	Si	Fe	Th Al Ba	Mg As Cu Ti Pb Sr Gd Mn Ni	Sm Nd Eu Co Y Cr V Yb Ga	Be
267.5-269.0	Si	Fe Al	Ba K Ca Th Mg	Na Ti Cu Mn Sr Ni	Pb Nd Cr Mo V Y Ga	-----
269.0-271.2	Si	Al K Fe	Na Mg Ca	Ba Ti Mn Ni	Sr Pb Cu Ga Cr V Zr	-----

Table 3.--Semiquantitative spectrographic analyses of samples from diamond drill holes Nos. 1 and 2, Last Chance claim, Beaverhead County, Montana--Continued

Diamond Drill Hole No. 2

Footage	Over 10%	1-10%	0.1-1.0%	0.01-0.1%	0.001-0.01%	0.0001-0.001%
271.2-273.0	Si	Al K Fe	Na Mg Ca	Ba Ti Mn Ni	Sr Cu Ga Cr V Zr	-----
273.0-274.6	Si	Al K Fe	Na Ca Ti Mg Ba	Mn Ni	Sr Co Cu Ga Cr Zr V Y	Be
274.6-275.3	Si	Al K Fe	Na Mg Ca Ti	Ba Pb Mn Cu Ni	Sr Co Ga Cr Zr V Y	Be Ag
275.3-277.0	Si	Al K Fe	Na Ca Mg Ba Ti	Pb Mn Sr Ni	Cu Ga Cr Co V Y Zr Mo	Be
277.0-277.6	Si	Al K Fe	Ca Na Ba Ti	Mg Mn Sr Ni	Co Pb Cu Ga Cr V Zr Mo	-----
277.6-284.6	Si	Al K Fe	Ba Na Ca Ti	Th Mg Mn Ce Gd Cu Sr Ni Sm	Nd Co Eu Pb Cr Ga V Y Mo Zr	-----

Spectrographers, Charles Annell and Joseph Haffty, U. S. Geological Survey, Washington Laboratory.

A semiquantitative spectrographic analysis of a selected radioactive sample from the southern part of the Last Chance vein also was made by the Geological Survey. The results of the analysis are as follows:

Th	>2.0 percent	Y	0.0X percent
Nd	0.1-1.0 percent	La	0.05-0.1 percent
Ba	0.X percent	Ca	0.0X percent
Ce	0.5-1.0 percent	Sr	0.00X percent

Spectrographer, Tennyson Myers, U. S. Geological Survey, Denver Laboratory

LITERATURE CITED

Trites, A. F., Jr., and Tooker, E. W., 1953, Uranium and thorium deposits in east-central Idaho and southwestern Montana: U. S. Geol. Survey Bull. 988 - H, p. 157-209.

APPENDIX A

DRILL HOLE #1 LAST CHANCE CLAIM, BEAVERHEAD COUNTY, MONTANA- DMEA-1186X

Direction - N. 43 E. at 45° inclination NE, Drillers: Carlson & Son,

logged by Sharp and Cavender, USGS, 8-52

Depth interval		Core recovery in feet
0 - 11	Soil, overburden	
11 - 26	Fine-grained gray argillite. Fractures parallel to hole. Brown staining in fractures. Bedding 60° to hole.	3.5
26 - 30	Missing, Lost core and water.	
30 - 31	Slightly schistose gray argillite. Brown gouge.	0.8
31 - 35.3	Upper 0.5' ditto. Then gray to light green, fine-grained sandstone. Bedding 55° to hole. Bedding shown by biotite layers. Brown stained fractures across and parallel to bedding.	3.0
35.3 - 40.8	Ditto	3.6
40.8 - 45.6	Ditto. Fractures cut core at 30° to hole. More fractured at base.	5.3
45.6 - 50.6	Upper 3'-fine-grained sandstone, then gray-green argillaceous sandstone. Fractures cemented by limonite. Minor biotite in sediments. Base sandy, micaceous.	5.0
50.6 - 52.7	Gray-green quartz sandstone. Bleached, fractures stained. Darker at base.	2.0
52.7 - 54	Light gray-green quartz sandstone. Fractures 35° to hole. Broken.	1.0
54 - 60	Mottled greenish-gray argillaceous sandstone. Broken. Iron-stained fractures. ½" quartz vein at 56.6' at 30°, ½" quartz vein at 57'. Darker and micaceous at base.	3.5
60 - 66	Fractured, gray sandy argillite.	0.1
66 - 70	White quartz vein with chlorite and black iron staining in upper part. Lower part dark gray-green sandstone. Beds 75° to hole.	2.5
70 - 80	No recovery	

Depth interval		Core recovery in feet
80 - 90.5	Fine-grained gray argillaceous sandstone. Beds 70° to hole. At 85', $\frac{1}{2}$" quartz vein. At 87', coarser-grained gray-green sandstone, with muscovite. At 90', $\frac{1}{2}$" quartz vein at 35° to hole.	10.5
90.5 - 100	Green argillite. $\frac{1}{2}$" quartz vein at top. Then fine-grained, gray-green argillite. Biotite on bedding and at 65° (good core) to core. At 92', quartz and limonite seam. Below quartz fine-grained gray sandstone, with muscovite. At 96', $1\frac{1}{2}$" quartz vein. $\frac{1}{2}$" quartz veins at 96.5', 98'. Bedding 55° to hole.	9.5
100 - 110	Fine gray-green sandstone. Poor bedding. At 102', 2' broken, iron-stained zone. Minor bleaching. Below, fine-grained gray sandstone.	10.0
110 - 119.5	Dark gray sandstone, some muscovite. Few fractures. Poor bedding. Iron-stained fractures. Quartz vein at 114'. Some 1/8" quartz seams at base.	9.5
119.5 - 120	Fine-grained, gray argillaceous sandstone.	0.5
120 - 125	Gray argillite and sandstone, fractured. Sandy at base. Beds 55° to hole. Occasional 1/8" quartz veins.	5.0
125 - 132	Light gray to gray-green, micaceous, fine-grained sandstone. Good bedding. Iron-stained fractures. Argillite at base.	6.3
132 - 135	Gray to gray-green micaceous sandstone. Thin fractures.	2.0
135 - 145	Broken gray to gray-green micaceous sandstone. Hematite streaks at 138' and 140'.	4.0
145 - 150	Broken, gray to light pinkish-gray argillaceous sandstone. Thin gouge seams. Iron-stained fractures.	3.0
150 - 157	Pinkish-green argillite. Broken, iron stained. Occasional 1/4" vein of quartz. Mica on bedding at 55° to hole.	2.3
157 - 163	Highly broken, fine-grained, light-gray argillite. Clay at base.	2.0

Depth interval		Core recovery in feet
163 - 164.5	Rubble of fine, iron-stained, light-gray argillite.	1.0
164.5 - 166.5	Rubble of gray-green argillite and vein quartz.	0.2
166.5 - 167.5	Ditto	0.2
167.5 - 172	Rubble of gray to gray-green argillite. Thin quartz veins.	1.0
172 - 180	Light gray-green micaceous sandstone. Biotite on bedding at 50° to hole. Highly fractured and iron stained	2.6
180 - 190	Light gray-green micaceous sandstone. Broken	0.7
190 - 191	Light-gray argillite. Highly fractured	0.9
191 - 192.5	Whitish mottled, highly fractured argillite. Iron oxides in fractures.	2.0
192.5 - 193.5	Ditto. Contorted bedding.	1.0
193.5 - 204	White fine-grained sandstone.	2.0
204 - 214	White to buff, iron-stained, fine-grained sandstone, 1/8" quartz veins from 209'-214', mostly white. Highly broken. Thin quartz at 213'.	3.0
214 - 216.2	Gray, iron-stained sandstone. 2" quartz vein.	0.5
216.2 - 224	White to buff sandstone. At 223.5', quartz vein. Probably narrow contact zone of sheering. (4" quartz recovered). Silicified belt of various colors and brown quartz.	1.25
224 - 226.4	Highly broken, red-stained quartz.	0.4
226.4 - 227.1	Broken gray quartz. Some red and brown quartz.	0.6
227.1 - 229.2	Ditto, but more highly stained. Shows evidence of faulting and cementing of rubble.	1.0
229.2 - 231.2	Rubble of gray, brown, and red quartz.	0.8
231.2 -239	Quartz vein. At 231.5' out of quartz and into soft material. No core bit resistance. No core, but sludge of stained sand grains. Did not lose water in hole.	0.1
	TOTAL CORE RECOVERED	114.2

Total cored hole--223'
Total core recovered--114.2' Recovery--51%

Hole bottomed at 239.0 on August 31, 1952.

0 - 26 drilled NX, cased BX
26 - 70 drilled BX, cased AX
70 -239 drilled AX

DRILL HOLE #2 LAST CHANCE CLAIM, BEAVERHEAD COUNTY, MONTANA

Direction---N 40° E, 45° inclination NE Drillers: Carlson & Son, logged by Sharp and Cavender, USGS, 9, 10-52

Depth interval		Core recovery in feet
0 - 26	Overburden, soil and Belt quartzite float	
26 - 40	Light gray to buff, fine-grained sandstone. Iron stained, weathered, friable. Mica on bedding at 35° to hole.	2.3
40 - 50.5	Upper 0.5'-ditto. Then--fine-grained, bleached, micaceous, lightly iron-stained sandstone. Zone of gray argillite and fine-grained sandstone. Beds are 30° to hole. Cleavage is 50° to hole.	2.0
50.5 - 61	Soft, gray argillite; iron-stained fractures at base. Beds 40° to hole. Cleavage 45-50° to hole. Bottom of BX	2.2
61 - 71	Weathered, light-gray, fine-grained friable sandstone. Iron stained and broken at top. Bedding 30° to hole.	1.2
71 - 81	Fine, light-gray, micaceous sandstone. Bedding 33° (top) and 30° (base) and 40° (middle) to hole. Graded bedding -upright	2.4
81 - 96	Ditto. Thin quartz-hematite vein at base.	0.6
96 -97.5	Interlayered sandstone and argillite. Beds at 35° to hole. Cleavage in argillite is 47° to hole.	1.4
97.5 -109.5	Upper part is ditto. Center is thin-bedded, micaceous sandstone. Base is bleached sandstone.	1.3
109.5 -112.1	Upper 1' is fine-grained, gray poorly bedded sandstone. Then 0.75' of coarser-grained sandstone with bedding 40° to hole. Then 0.3' of dark-gray argillite. Below is dark gray, poorly bedded, coarse-grained sandstone.	2.7

Depth interval		Core recovery in feet
112.1 -117.7	Fine-grained, gray sandstone with reddish tinge due to hematite. Bedding 35° to hole. At 113.3', 1/4" quartz seam, crosses bedding at 30°. Associated 2" fractured zone. At 114.7', 1/4" quartz-hematite vein, cuts hole at 45° to bedding. Sandstone stained red for 6" across veinlet. Staining trends across hole at 35°. Sandstone highly fractured, more micaceous at base.	5.3
117.7 -119.9	Sandstone as above. Fractures normal to hole. At base, rubble zone of fault material, highly iron stained, probably where core was lost.	1.3
119.9 -121.2	Sandstone as above. Fractured.	1.0
121.2 -129.7	Same as above. Darker, more micaceous at center. Near top, 2--1/4" quartz veins and a 1" shear zone recemented with Fe_2O_3. Shears nearly normal to hole. Veins as previously stated. Less fracturing in lower 3', bleached along fractures.	4.1
129.7 -136	Sandstone, coarse-grained at top and base. Bedding at top 50° to hole. In center, bleaching along fractures. Hematite-filled fractures about 134.5'.	4.7
136 -145.2	Very fine- to coarse-grained, gray sandstone. Thin quartz vein at 137'. Beds 30° to hole.	4.4
145.2 -149.3	Ditto, with some very fine-grained, some very coarse-grained, micaceous sandstone. 2--1/8" altered hematite seams along bedding at base. Cleavage, rotated 45° from bedding, is 40° to hole.	3.4
149.3 -157.5	Gray, thin-bedded sandstone. Bedding at 30° to hole. Fractures at 40° to hole and red stained for 1/2".	2.3
157.5 -160	Ditto. 1/2" quartz vein at top, at 30° to hole contains specular hematite.	2.5
160 -169.5	Gray sandstone. Fractures cemented with iron oxides. 1/2" quartz, hematite, chlorite vein at 163.8', 30° to hole. Another vein at 165.3'. Bedding 27° to hole.	6.2
169.5 -179.5	Ditto. More fractures near top.	3.6
179.5 -186.4	Ditto. Mica on bedding distinct at top, 25° to hole. Fractures parallel core.	2.8

Depth interval			Core recovery in feet
186.4	-199.7	Sandstone. Bedding indistinct. 1/8" quartz vein at top. Pinkish cast for 1' below. Core is rubble at base. Quartz veinlet at base.	3.4
199.7	-200	Ditto. Cleavage is at 40° to hole.	0.3
200	-210	Fine- to coarse-grained, highly broken sandstone. Upper part cemented by iron oxides.	1.8
210	-215	Sandstone of light gray color, with mica on bedding 30° to hole. Highly broken core.	1.5
215	-222.1	Light gray to gray, argillaceous sandstone and quartzose sandstone. Fractures every 3", cutting 70° to core. At 219.5', 2 or 3 small quartz veins. Small fault offsets veins.	7.3
222.1	-222.8	Ditto. Highly broken, rubble. Evidence of small quartz vein.	0.6
222.8	-229.6	Coarser-grained, bedded sandstone and gray argillite. Broken.	1.0
229.6	-239.6	Argillaceous sandstone, light gray, bleached, mottled, irregularly bedded. Two small quartz veins. Cleavage is 40° to hole, bedding is 20° to hole.	2.0
239.6	-249.6	Fine-grained, gray sandstone, bleached at base. Center zone is buff to pink silicified Belt. One or two quartz veinlets.	1.4
249.6	-253.5	Bleached white sandstone, friable, highly broken. Upper part probably in fault zone.	3.9
253.5	-253.8	Ditto.	0.3
253.8	-255	Ditto, less broken. 1/4" quartz-hematite vein, altered to porous limonite.	1.0
255	-264.6	Ditto at top. Bedding 35° to hole. Silicification in lower foot. Interbed of 4" of bleached sandstone, then quartz vein of pinkish-white color. Red hematite staining.	1.9
264.6	-266.2	Quartz vein at top. Core shows highly broken quartz vein recemented with specular hematite and limonite. Brown to red to gray, mottled and highly "veined'. Breccia structure appears 40° to the hole.	1.8

Depth interval			Core recovery in feet
266.2	-267.5	Ditto. Very rubbly at top. Heavy red iron staining. Bottom is more quartzose.	1.3
267.5	-269	White vuggy quartz and specular hematite with red splotches. Base has pieces of unreplaced Belt, further down alters to white-brown soft sand.	1.5
269	-271.2	Zone of quartz vein. Much bleaching, much replaced Belt. Quartz is 60° to hole. Vugs trend at small angle to the hole and follow center of quartz trend.	2.2
271.2	-273	Ditto. Much red iron staining.	2.0
273	-274.6	Ditto, with base mostly rubble of Belt sandstone.	1.2
274.6	-275.3	Mostly rubbly sandstone and quartz "pebbles".	0.8
275.3	-277	White, glassy quartz and relict sandstone. Specular hematite in vugs in quartz. Hematite veinlets cut the core at various angles.	0.5
277	-277.6	Quartz vein rubble, highly broken. Shear zone at top cemented with red iron oxide.	0.5
277.6	-284.6	Quartz vein, specular hematite rich. Less relict Belt than above. Vuggy, mottled color. Rubbly at base. Out of hard rock at 279'. No core below 279. Probably soft sandstone.	1.7
284.6	-285.6	Quartz vein as above (4"). Rest of core is light gray-green argillite, highly veined with brown limonite-stained fractures.	0.9
285.6	-294.5	At top is 5" quartz vein, similar to that above—vuggy, contains specular hematite. Some unreplaced Belt. Below is bleached light gray, semi-silicified, and friable sandstone. Limonite-stained fractures.	1.8
294.5	-298.5	Some white, bleached, friable sandstone, limonite veined. 3/4" quartz veinlet near top.	2.1
298.5	-301	Bleached Belt sandstone, with limonite veining. Poorer core.	2.5
301	-303	Bleached white, friable Belt, cut and partially replaced by silica, red to white.	2.0
		TOTAL CORE RECOVERED	106.9

Total hole cored _/ -277'
Total core recovered - 106.9'   Recovery--39%

BX casing - 0-26'; AX casing - 26'-61'; drilled AX - 61'-303'
Hole bottomed at 303' on or about Sept. 29, 1952.

U. S. ATOMIC ENERGY COMMISSION

Radiometric DDH Log

U 302

Date: 10-2-52

Property: Last Chance

State: Montana

Dist.: Beaverhead

DDH no. 2

Location:

Strike: N. 40° E

Dip: 44° NE

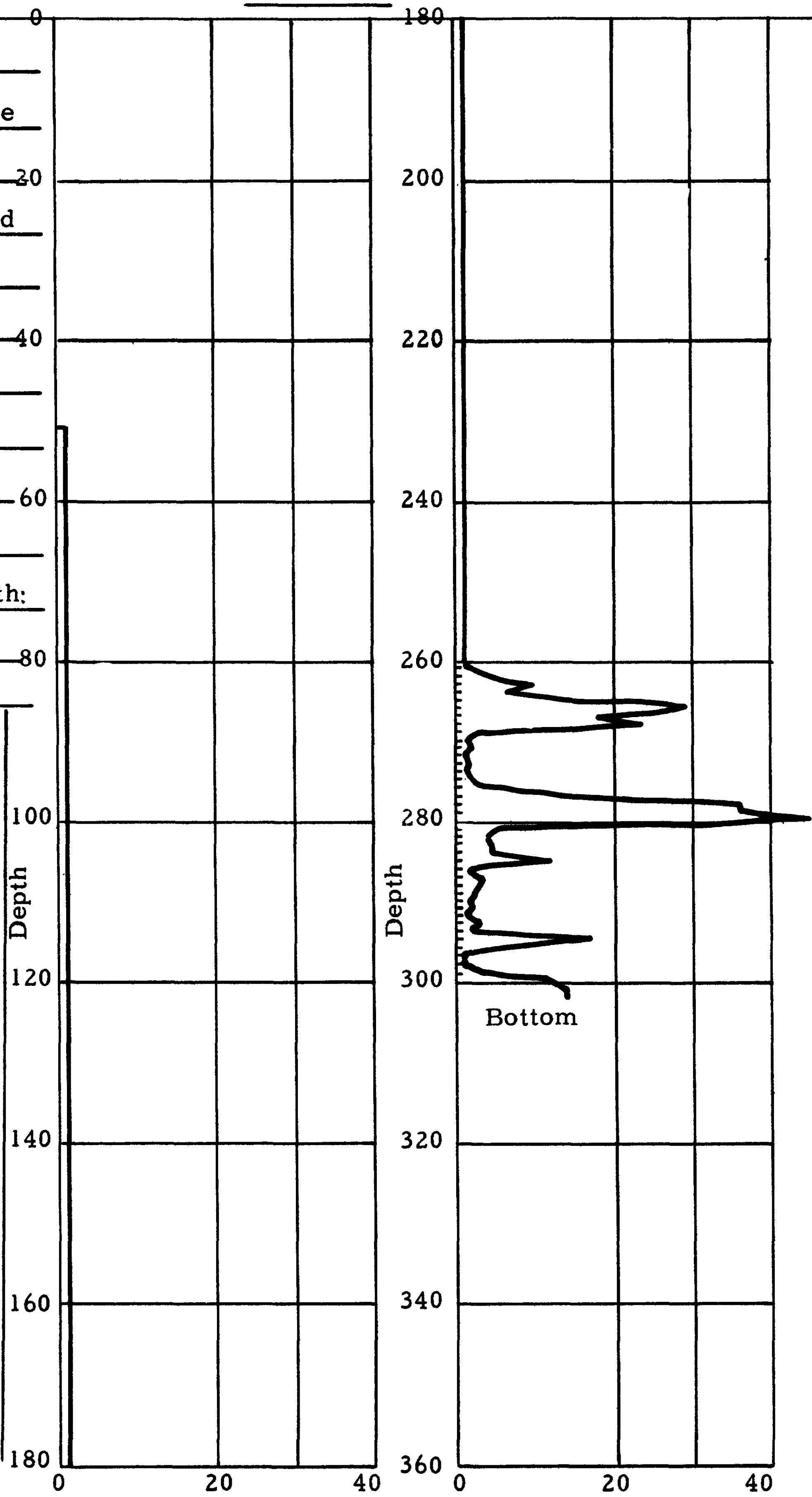
Depth: 302'

Water Table Depth:

Log by: Hetland Jarrard

Driller: Carlson

Remarks: Armored cable probe was used - Hole was Bx cased to 51.0'. No cave was encountered - Rate of descent 5' intervals to 262' - 1' intervals 262'-302' at 1 interval per 20 seconds.



Meter Reading in Milli Amperes

92757

DRILL HOLE # 3 - LAST CHANCE CLAIM, BEAVERHEAD COUNTY, MONTANA

Direction-- N. 50° E., inclination 45° NE

Drillers: Carlson & Son, Logged by Sharp and Cavender, USGS, 10-20-52

0 - 26 Soil and overburden

26 - 95 Soft, fine-grained, gray-white bleached sandstone. Lost water at 54', never recovered circulation. Pressure lost again at 95'.

BX casing 0-26'; AX casing 26' - 60'.

Drilling discontinued for the winter at depth of 95'. Was to have been resumed in spring of 1953.