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BOISE BASIN MONAZITE PLACERS, BOISE COUNTY, IDAHO

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INTRODUCTION

In October 1948, U. S. Bureau of Mines engineers made a preliminary investigation of the Boise Basin placers in Boise County, Idaho, for radioactive minerals. Shortly thereafter, an exploration project was started on behalf of the U. S. Atomic Energy Commission.

The objectives of the program were: (1) To determine the quantity of monazite and other commercial minerals per cubic yard of gravel, and (2) to determine the size and extent of gravel deposits having those minerals.

Monazite had been identified in the Boise Basin more than fifty years ago. Some attempts were made in past years to market monazite from this area, but producers became discouraged with the difficulties encountered in producing clean concentrates and with the low market value of their product. Since the gold in those gravels offered an immediate and profitable source of income, little consideration was given to any secondary or byproduct minerals.

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SUMMARY AND CONCLUSIONS

The exploration of the Boise Basin monazite-bearing placers, which consisted of churn drilling, shafting, and trenching, was started on August 23, 1949 and completed on November 10. Thirty-seven churn-drill holes were drilled; 17 trenches excavated; and 12 shafts were sunk during this exploration work for monazite. A total of 404 samples was taken which consisted of 291 from churn-drill holes, 62 from trenches, 34 from shafts, 14 from old cuts and shafts, and 3 from dredging.

The most extensive reserves of monazite-bearing gravels were found to be tailings from early operations for gold on Moores Creek, Grimes Creek, Granite Creek, and Elk Creek. The virgin ground reserves of monazite-bearing gravel were found to be located in the areas of Wolf Creek, Grassy Flats, Moores Creek, and Fall Creek.

Since radioactive and chemical analyses fail to distinguish between monazite and other radioactive minerals which might be present, petrographic determinations were also made of each sample. A highly radioactive mineral believed to be samarskite was noted to occur in large amounts in the placer concentrates from Elk Creek and its tributaries.

Other heavy minerals found in the black-sand concentrates were ilmenite, magnetite, garnet, zircon, and gold.

DESCRIPTION OF DEPOSITS

Location and Physical Features

The Boise Basin occupies the central part of Boise County, Idaho, and is near the southwestern edge of the mountainous region that covers the northern half of the state. Idaho City, the county seat and largest town in the Basin, is forty-two miles north of the city of Boise on a hard-surfaced road, State Highway 21. Secondary roads connect the Basin with Horseshoe Bend to the west and with Garden Valley and Lowman to the north.

The settlements of Centerville and Placerville, in the western portion of the Basin, are eleven and sixteen miles, respectively, by dirt road west of Idaho City. This road is kept open for travel all year. The aggregate population of the Basin is about 500. An ample supply of cheap electrical energy is available in the district. The nearest railroad shipping point is Boise which is served by the Union Pacific Railroad.

The rolling hills between the many stream deposits and the gentle slopes to the surrounding mountains are covered with second-growth trees which are mostly pine. Previous logging operations and forest fires have destroyed the great stands of timber which once covered the entire Basin.

The climate is quite severe, with cool summers, cold winters, and a heavy snowfall of from four to seven feet. Temperatures reaching 20° below zero are common during December, January, and February. Dredging is generally discontinued for a month or longer during the severest weather.

Geology

The Boise Basin occupies a small marginal portion of the southwest part of the Idaho batholith, a large granitic body encompassing over 20,000 square miles. This granitic mass is of late Cretaceous or early Eocene age. 3/ The rocks of the Idaho batholith vary from granite through quartz-monzonite, grandiorite, and diorite.

These granitic rocks of the Idaho batholith are the oldest and most prevalent exposed in the Boise Basin. In this area, they are chiefly a true biotite granite with less abundant amounts of granodiorite. 4/ Within these older rocks are enclosed later intrusive porphyritic rocks, lamprophyres, pegmatites, and small areas of lavas and lake beds. 5/ The "porphyry belt" is the principal structural feature that has controlled the distribution of gold-bearing veins in the Boise Basin. 6/ It is a zone of structural weakness, deformation, and intrusion, a few hundred feet to a mile wide which trends about N 55° E from a point two miles southwest of Quartzburg and extends northeastward from the Basin across the state.

3/ Lindgren, Waldemar, Mining Districts of the Idaho Basin and Boise Ridge, Idaho: Extracts from 18th Annual Report, Geological Survey.

4/ Ballard, S. M., Geology and Gold Resources of the Boise Basin, Boise County, Idaho: Idaho Bureau of Mines and Geology Bull. 9, 1924.

5/ Jones, E. L., Lode Mining in the Quartzburg and Grimes Pass Porphyry Belt, Boise Basin, Idaho: U. S. Geological Survey Bull. 640-E, 1916.

6/ Anderson, Alfred L., The Boise Basin, Idaho: Ore Deposits as Related to Structural Features - Page 132, edited by W. H. Newhouse, 1942.

The two most productive lode districts in the Basin, Quartzburg and Grimes Pass, are associated with this later intrusion which is believed to be of Miocene age. The lodes are not genetically related to the enclosing Idaho batholith but to those younger magmas which found this zone of structural weakness especially favorable for intrusion. Successive injections from a differentiating magma chamber produced a series of porphyries of diverse composition. These successive injections of partly-crystalline, differentiating magma into longitudinal and transverse faults accounts for the complicated system of porphyritic dikes and stocks. Readjustment during the closing stages of this igneous activity produced fissures and fracture zones that controlled the movement of ore-bearing fluids. In the probable order of intrusion, the younger dike rocks range from dacite porphyry through quartz-monzonite porphyry, rhyolite, and granophyre porphyry, to rhyolite, and finally to basic dikes. The lodes cut all but the basic dikes. The lodes are not uniformly distributed along the "porphyry belt" but are mostly concentrated in and near Quartzburg and Grimes Pass which appear to be the loci of maximum disturbance, also the places of greatest permeability which apparently facilitated the movement of ore-bearing fluids and the deposition of ores.

Mineral deposition took place in three stages, the first characterized by base-metal sulphides, the second by gold and silver, the third by small amounts of calcite. The ore shoots were formed during the second stage when fissures filled with the brittle sulphides during the first stage were reopened allowing the later gold-bearing solutions to ascend. It has been noted that the percentage of monazite concentrated in the placer gravels is higher in the vicinity of these mineralized belts than in non-mineralized portions of the Idaho batholith which indicates that the monazite is genetically related to the younger intrusive magma and/or the still younger metal-bearing solutions.

The lowland areas of the Basin are underlain to a great extent by lake deposits composed of partially consolidated clay and fine sand. They have been correlated with the Payette formation and, therefore, are of middle or upper Miocene age. 7/ Near Idaho City, drilling proved these lake beds to have a thickness of about 850 feet. These beds are also known to exist on Muddy Creek, a tributary of Grimes Creek, and beneath the recent stream gravels on Granite and Wolf Creeks.

The youngest igneous rocks in the Basin are the basalts of which there are small patches associated with the lake beds near Idaho City. Near Placerville, Pioneerville, and northwest of Quartzburg, basalt lavas cover the older lake beds. A considerable area of basalt occurs high on Boise Ridge, northwest of Quartzburg, and attains its maximum thickness of 200 feet.

7/ Reed, John C., Geology and Ore Deposits of the Warren Mining District, Idaho County, Idaho: Idaho Bureau of Mines and Geology Pamphlet 45, 1937.

Physiography

The Boise Basin is an intermontane depression fifteen miles long and twelve miles wide enclosed on all sides, except to the north, by high mountains. The elevation ranges from 4,000 feet above sea level to 8,300 feet at its northeastern limits. The average elevation of the valley floors is approximately 4,300 feet. The area is traversed by flat-topped and gently sloping ridges that rise but a few hundred feet above the stream levels. These ridges, though outliers of the enclosing mountains, are separated from them by abrupt slopes several hundred feet high. 8/ The physiographic features of the Basin could not have been formed by stream erosion alone and is believed to be due to faulting by which a block of granitic rock was sunk far below the surrounding upland surface. 9/ The high ridge to the west of Placerville suggests an ancient and considerably eroded fault scarp.

The divide between Moores and Grimes Creeks in reality separates the Basin into two distinct valleys, each drained by one of the creeks named. These two streams, upon leaving the Basin, enter deep canyons through which they flow for several miles before uniting to flow onward as Moores Creek. From this junction, Moores Creek flows southerly for about ten miles and empties into the Boise River. Within the Basin, these streams flow in broad, gravel-filled channels with grades as low as twenty feet to the mile, but their

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8/ Reference cited in footnote 5.

9/ Reference cited in footnote 3.

upper courses in the surrounding mountains and their courses below the Basin have steeper grades and narrow valleys. The flat bottom lands or dredgeable areas, drained by Grimes and Moores Creeks constitute about five percent of the entire Basin.

Before the uplift that differentiated the Snake River plains from the mountainous area to the east, the granitic rocks were extensively eroded, and the higher summits are thought to be a part of the old surface thus produced. The structure of the Basin is due to the faulting of a block of granitic rock which sank far below the surrounding upland surface. At this time, an earlier drainage system was patterned, and the streams within the Basin eroded channels nearly to their present levels. Later, during Miocene time, the Snake River was dammed by causes ascribed to crustal movement, and the plains area was occupied by a lake whose high-level mark, as recorded on the mountains near Boise, was at 4,200 feet. This lake extended up Boise River and its tributary, Moores Creek, and occupied much of the Basin. Beds of clay and fine and coarse granitic sands were deposited in the lake, and gravel deposits were laid down at the mouths of tributary streams. The beds were rapidly accumulated in the bay then occupying much of the Basin, and since no concentration of the material took place, the gold content was small. Further crustal movement caused the draining of the Tertiary lake, and the streams within the Basin resumed their erosion. Large parts of the gravel and lake beds within the Basin were removed, but further faulting occurred and some blocks of lake deposits were sunk and

and others tilted to altitudes above that of their original deposition. In Eocene time came the eruption of the Snake River basalt. On lower Moores Creek, lava of this age that probably flowed through a vent along the stream forms a level floor whose top is about 100 feet above the creek. When this lava was poured out, it effectively dammed the creek and caused the deposition of gravel along the main streams of the Boise Basin. As the lava barrier was gradually cut through, the streams resumed their work of cutting down. The base of the lava flow is now well above the stream level. The recent stream gravels were then deposited chiefly by the reconcentration of the older, auriferous gravels.

Gravels

The gravel deposits of the Boise Basin are composed entirely of the type rocks of the area; chiefly granitic rocks, the various porphyries, and to a lesser extent, basalt. No evidence of rocks from distant sources was noted in the present stream gravels nor in the old, higher channels of earlier age.

Stream gravels and high-level gravels occur extensively along the creeks and tributaries in all parts of the area. Lindgren 10/ describes two types of high-level gravels, Neocene (Miocene and Pliocene) stream gravels and more recent (Pleistocene) bench gravels. In general, the Neocene gravels are thicker and more firmly consolidated than later deposits.

10/ Reference cited in footnote 3.

They have been regarded by Lindgren as having been deposited soon after the deposition of the lake beds by major stream courses which were established as the lake receded. These streams, which headed near quartz veins, concentrated their gold on bedrock. In places, the bedrock of these old channels is the soft, granitic rock of the Idaho batholith. These old channels show evidence of having undergone disturbances since their deposition. The low terrace separating Muddy and Grimes creeks, and covered by later bench gravels, is partly made up of granitic rock; partly of old-channel gravels. The gravel abuts against the granitic rock on the northern side indicating that they are separated by a fault. The cemented gravel is evidently an old channel sunk down along a fault line. An old-channel deposit east of Placerville is suddenly cut off by the ridge north of Ophir Creek. Furthermore, the nature of the pebbles indicate that the stream came from some point to the northwest, whereas the present grade of the bedrock is in the opposite direction. It is concluded that the old channel has been cut off by a fault and its grade reversed. These deposits have been extensively mined by the hydraulic method. The gravel deposit of Gold Hill, one-half mile above Idaho City, and the one near Placerville are examples of these old-channel deposits.

The more recent bench gravels are similar in many respects to the old-channel deposits, but in general, are thinner and not as firmly consolidated. They have been eroded less extensively and extend more regularly along the creek valleys. They are regarded by

Lindgren as having been deposited when lower Moores Creek was dammed by a basalt flow and as a rule are not more than twenty-five feet thick. These bench deposits were extremely rich in spots and have and have been extensively mined. Little of the original deposit remains. West of Placerville, between Fall and Canyon creeks, these gravels were, in places, 200 feet above the stream levels. This position was due, according to Lindgren, to displacement along the steep eastern fault scarp of Boise Ridge. The bench gravels on the right limit of Moores Creek below Idaho City, and those above Old Centerville at Bummer Hill which were of unusual richness, are examples of this type of deposit.

The virgin gravels remaining on Fall Creek and Grassy Flat can be classified as bench gravels. They contain a high percentage of heavy brown to grey clay and the lack of stratification indicates that little hydraulic sorting or classification took place. Evidently their deposition was very rapid, possibly by mud flows down the narrow gorges of Canyon and Fall creeks. On Fall Creek, later streams cutting across the original deposit at almost 90° have concentrated the gold in narrow, rich channels. The lower part of Grassy Flat is underlain by the lake beds which were shown to be from ten to twenty feet thick by the drilling in 1949. They feather out against the granitic bedrock, which has a steeper slope to the east, at the upper end of the flat. Occasional narrow channels containing good gold values are found beneath the lake beds immediately above the granitic bedrock.

The stream gravels that occupy the creek bottoms are the most recent and, in part, are reconcentrated older stream and bench gravels. Most of the dredging operations of the past and present are on creek placers formerly worked by hand, then covered by later tailings. The early miners were unable to work all of the lower stream channels due to lack of drainage, and their recovery was by no means 100 percent in the gravels they did wash. These factors played a large part in the successful operation of the later dredges.

There is little doubt that the gold-quartz veins of this area are the source of the placer gold found in the different types of auriferous gravels in the Basin. It has been shown by Lindgren that even the older lake beds contain some gold although the conditions of deposition were unfavorable for the concentration of the gold in paying quantities. It was a fortunate succession of geologic events which allowed the reconcentration of the older, leaner gravels by the more recent streams, thus forming the rich placers of the Boise Basin.

Mineralogy and Screen Tests

The black sands contained in the stream gravels of the Boise Basin are composed entirely of the heavy, component minerals released from the disintegrated rock formations of this area. The granitic rocks of the Idaho batholith, except near the prophyry belt, appear to contain only a small amount of the heavy, constituent minerals. In the vicinity of the mineralized zones, and especially in association with pegmatite dikes, the granitic rocks contain an appreciable amount of ilmenite, garnet, zircon, monazite, and to a lesser extent, magnetite. The high percentage of magnetite contained in the black sands from certain areas is believed to be derived from the basic dikes and associated segregation deposits occurring in the porphyry belt. Concentrates from the lake sediments contain ilmenite, zircon, and monazite, but little or no magnetite. The content of black sands in the lake sediments probably does not exceed one pound per cubic yard as conditions were unfavorable for concentration. The absence of magnetite indicates that the lake sediments were deposited before the intrusion of the basic dikes.

The heavy minerals which constitute approximately 96 percent of the black sands are ilmenite, magnetite, garnet, monazite, and zircon. Minor amounts of hematite, pyrite, rutile, and a grey sulphide, which has been identified as a bismuth mineral 11/, were noted. A narrow band of greenish minerals, between the black sands and quartz-feldspar fraction, was noted on the concentrating tables from certain samples obtained from near the porphyry belt. These are believed to be ferro-magnesium minerals derived from the basic dikes. A highly radioactive mineral, believed to be samarskite, was noted to occur in considerable amounts in placer concentrates from Elk Creek and its tributaries. This mineral has also been reported as occurring in a small tributary gulch of Grimes Creek 1-1/2 miles southwest of Pioneerville. 12/ Field Geiger checks indicated that this mineral from Elk Creek contains between 10 and 20 percent U_3O_8.

11/ Reference cited in footnote 6.
12/ Metzger, O. H., Reconnaissance of Placer Mining in Boise County, Idaho: U. S. Bureau of Mines Information Circular 7028, 1938

The quantity of black sands per cubic yard of gravel and the mineral contents of the black sands are estimated as follows for each area:

Summary of the Mineral Content of Black Sands from Each Basin Area

Area	Pounds Black Sand Per Cu. Yd. of Gravel	Field Estimates of the Mineral Content in Percent				
		Magnetite	Ilmenite	Garnet	Monazite	Zircon
Grassy Plats	4.32	39	40	3	8	10
Wolf Creek	7.45	16	42	8	11	23
Fall Creek	8.84	54	27	4	7	8
Granite Creek	8.13	27	37	9	12	15
Grimes Creek	4.78	26	38	10	13	13
Elk - Moores Creek	2.71	3	17	54	7	19

The following screen analyses of dredge cleaner-jig concentrates show the size ranges of the monazite and zircon in the sands, as determined by field estimates.

Screen Test of Cleaner-Jig Concentrates

Screen Size, Mesh	Idaho-Canadian Dredge			Baumhoff-Marshall Dredge		
	Sample, Pounds	Percent Monazite	Percent Zircon	Sample, Pounds	Percent Monazite	Percent Zircon
+ 20	0	0	0	0.429	0	0
- 20 + 28	0.150	0	5	1.410	1	0
- 28 + 35	2.312	0	4	3.450	11	0
- 35 + 48	4.460	0	5	2.954	21	1
- 48 + 65	2.051	0	15	1.246	34	3
- 65 + 100	0.852	10	19	0.437	48	12
-100 + 150	0.125	18	36	0.037	47	25
-150 + 200	0.005	14	57	---	--	--
-200	0.001	--	--	---	--	--

A screen analysis showing the distribution of particle size in relatively pure monazite, obtained by magnetic separation and tabling, follows:

Screen Test of Monazite
Baumhoff-Marshall Dredge on Granite Creek

Screen Size, Mesh	Wt., Lbs.	Percent	Cumulative Percent
+ 20	0	0	0
- 20 + 28	0.024	0.6	0.6
- 28 + 35	0.932	23.3	23.9
- 35 + 48	1.926	48.2	72.1
- 48 + 65	0.759	19.0	91.1
- 65 + 100	0.275	6.9	98.0
- 100 + 150	0.064	1.6	99.6
- 150 + 200	0.014	0.3	99.9
- 200	0.006	0.1	100.0
	4.000	100.0	

Screen analyses of black-sand concentrates from two representative drill holes are shown on the following page:

Black Sand Screen Analyses

Drill Hole BOB-12 - Virgin Ground on Grassy Flats

Screen Size, Mesh	Weight: Sample Pounds	Weight: Table Conc. Lbs.	Weight: Pounds Black Sand Per Cu. Yd.	Weight: Amount Test Grams	Percent Minerals Present (Field Estimates): Magnetite	Ilmenite	Garnet	Monazite	Zircon	Quartz Feldspar
+ 20	447.0	Trace	--	--	--	--	--	--	--	--
- 20 + 28	36.0	0.007	0.5	3	50	42	1	5	1	1
- 28 + 35	49.0	0.032	1.8	10	35	55	1	7	1	1
- 35 + 48	35.0	0.048	3.7	10	35	37	7	14	6	1
- 48 + 65	19.0	0.066	9.4	10	30	35	8	11	8	8
- 65 +100	10.0	0.077	20.8	10	20	30	15	12	10	13
-100 +150	5.0	0.048	25.9	10	15	20	10	16	20	19
-150 +200	4.0	0.024	16.2	10	20	16	8	20	28	8
-200	5.0	0.018	9.7	5	20	14	6	15	32	13

Drill Hole BOB-34 - Dredge Tailings on Grimes Creek

Screen Size, Mesh	Sample Pounds	Table Conc. Lbs.	Pounds Black Sand Per Cu. Yd.	Amount Test Grams	Magnetite	Ilmenite	Garnet	Monazite	Zircon	Quartz Feldspar
+ 20	249.0	Trace	--	--	--	--	--	--	--	--
- 20 + 28	21.5	0.015	1.9	7	13	65	21	0	1	0
- 28 + 35	35.0	0.060	4.6	10	10	63	25	1	1	0
- 35 + 48	30.5	0.117	10.4	10	10	54	6	3	9	18
- 48 + 65	20.0	0.150	20.3	10	15	34	9	8	9	25
- 65 +100	15.0	0.112	20.2	10	15	26	4	8	13	34
-100 +150	7.5	0.054	19.4	10	20	24	4	16	16	20
-150 +200	5.5	0.026	12.8	10	25	23	3	23	23	3
-200	7.0	0.012	4.6	5	25	9	22	20	20	4

HISTORY

The presence of rich placer-gold deposits in the Boise Basin area was reported as early as 1861. In the spring of 1862, Moses Splawn and George Grimes both led prospecting parties into the Boise Basin area.

After considerable delay and difficulty, the combined parties reached the Basin in August, 1862, and discovered gold in the first pan taken from the stream gravels near the present site of Old Centerville. After several days of work and with provisions running low, the men became discouraged by the constant threat of danger from hostile Indians in the area and decided to leave the Basin. George Grimes, while doing some advance scouting, was presumably ambushed and killed by the Indians; however, it is commonly believed by pioneers of the Basin that he was killed by his own men over some dispute. In any event, his grave on a low divide, now known as Grimes Pass, is one of the historical landmarks of the Basin.

Splawn made his way to Walla Walla, Washington, where he organized a larger and better-equipped party. They returned to the Basin and located the ground which was subsequently worked with great profit. By the fall of 1863, from 15,000 to 20,000 men had arrived in the Basin and the towns of Pioneerville, Centerville, Placerville, and Idaho City had been built. The Basin soon became one of the famous placer mining districts of the early West.

The activity for the next few years followed much the pattern of the gold-rush days. In many places the rich placer ground was traced to the outcrops of decomposed quartz veins and, though these veins were exploited first, the production from quartz mines has been less than that of the placers. The first operations consisted of hand shoveling into sluice boxes. Because of the flat gradient of the streams within the Basin, it was difficult to handle the seepage water from the creek channels which made it impossible to work the creek gravels to a depth of more than 6 to 8 feet. 13/ By 1870, most of the rich surface deposits were worked out, and as white labor was too expensive to work the lower-grade deposits, Chinese labor was imported.

The first hydraulic mine was started at Bishop's Hill, above Placerville, in 1864. The method was introduced from California as most of the early operators were experienced miners from that state. Numerous ditches, some 8 to 10 miles long, were built for the washing of the gravel banks at various locations immediately above the main stream channels. These high gravels were well adapted to hydraulic mining as they were well above the creek beds and the bedrock had sufficient slope for the disposal of tailings. Most of the hydraulic operations have long been abandoned. The one exception was the operation of the Gold Hill placer mines near Idaho City which last produced in 1939 when the problem of available tailing disposal area forced it to close.

13/ Reference cited in footnote 7.

Dredging operations were started on Wolf Creek, near Placerville, in 1898, and at two different locations on Grimes Creek, near Old Centerville, in 1899. The Wolf Creek dredge started working on ground that was used as a dump for hydraulic tailings and after a few months of unsuccessful operation, due chiefly to faulty construction of the dredge, it was shut down and abandoned. The two dredges on Grimes Creek operated intermittently for about seven years. The operating costs were high, and these ventures were never entirely successful. About 1900, the Boston and Idaho Gold Dredging Company constructed a 2-1/2-cubic-foot, steam-operated dredge near Warm Springs, about 2 miles below Idaho City, on Moores Creek. This dredge was operated continuously until it sank in 1905. In 1908, Mr. F. W. Estabrook assumed the controlling interest in the above company and constructed a hydroelectric plant on the Payette River north of Grimes Pass. Transmission lines were built to Idaho City, Centerville, and Quartzburg. A 4-cubic-foot dredge erected on Moores Creek, 6 miles below Idaho City, commenced digging in the summer of 1909 and continued operation until the spring of 1914, handling from 40,000 to 100,000 cubic yards of gravel per month. In 1910, a 16-cubic-foot dredge was built for this company on Elk Creek about 1/2 mile above Idaho City. This dredge worked down Elk Creek and then down Moores Creek to Hot Springs whence it was turned around and worked back up Moores Creek for about three miles above Idaho City. The gravels above Idaho City decreased gradually in gold content, and the dredge finally ceased operating in 1918. The maximum capacity of this dredge for any one month was about 200,000 cubic yards.

Dredging operations were conducted by the Moline Mining Company on Fall Creek, about 2 miles southwest of Placerville, from 1902 to 1911. A steam-shovel dredge used by the company until 1905 was replaced by a 5-foot dredge with a capacity of 50,000 cubic yards per month. About 1 mile of the Fall Creek channel was worked which produced about $450,000 with a ratio of gold to silver of six to one.

In 1934, a 7-1/2-foot dredge was erected by the Moores Creek Dredging Company near Idaho City to rework the tailings left by the Estabrook dredge and small patches of virgin ground left on the sides of Moores Creek valley. This dredge was taken over by the Idaho-Canadian Dredging Company in 1939 and operated until the enactment of the War Production Board's gold mine closing order in October, 1942. This dredge resumed production in September,, 1945, and was replaced by a 6-foot dredge in 1946 which operated until late fall of 1949. At this time, the 6-foot dredge was dismantled and moved from a point 2 miles above Idaho City to a new location 5 miles down Moores Creek, where it commenced dredging old tailings in March, 1950.

The Fisher-Baumhoff Company, later Baumhoff and Marshall, Inc., started dredging operations in the Basin in 1935. A 6-foot dredge was erected on Grimes Creek and commenced operation July 15, 1935. A 2-foot dredge was moved from Warren, Idaho, by the same company and started on Granite Creek in August 1936. Both boats operated until shut down by the closing order in 1942. They resumed operations in 1946 and worked until April, 1949. A fourth dredge, equipped with 3-1/2-foot buckets, operated by the Grimes Company near Pioneerville on Grimes Creek produced from 1936 until June, 1940. In addition to the bucket dredges, the period 1936 to 1942 saw the operation of several dragline dredges in the Basin.

The amount of gold and silver produced from the placers in the Boise Basin has long been the subject of dispute, as the records of production for the early years are very incomplete and unreliable. The best available figures are as follows:

From 1863 to 1902---Lode and placer combined	$47,000,000
From 1903 to 1936---Placer production	5,000,000
From 1937 to 1949---Placer production	6,000,000
	$58,000,000

An attempt was made to effect an economical recovery of the monazite contained in the black sands of the placers in 1909 by the Centerville Mining and Milling Company. A mill using gravity concentration followed by electro-magnetic separation was built near Centerville. The plant was destroyed by a forest fire a year after its erection, and no authentic production figures of monazite from this organization are available.

From 1946 through 1948, the dredges of Baumhoff-Marshall and Idaho-Canadian saved part of their jig concentrates which were pumped ashore and stock-piled. A part of those black-sand concentrates were trucked to McCall, Idaho, where the monazite was separated on a magnetic separator. One carload of 40 tons of monazite was sold from this operation.

EXPLORATION

The sampling of the placer gravels in the Boise Basin by churn drilling, shafting, and trenching was initiated August 23, 1949, by the U. S. Bureau of Mines, and was completed November 10, 1949.

Churn Drilling

The drilling was performed on Contract No. Im-5670 awarded on July 26, 1949. Thirty-seven holes, totaling 1207 feet in depth, were completed to bedrock. From these holes, 291 samples were taken and concentrated in the Boise laboratory during the winter months. Six-inch casing with a 7-1/2-inch drive shoe was used. Samples were cut for each five feet of depth, and the core was removed after each 2-1/2-foot drive. All samples were dried and weighed at the drill and screened to minus 1/8-inch. The plus 1/8-inch material was weighed and discarded, and the minus 1/8-inch was sacked for concentration and analysis. A measured fraction of the total slimes from each hole was also saved and concentrated. The actual recovery of core compared to the theoretical volume averaged 70.0 percent for all the holes drilled.

All computations are based on the assumption that one cubic yard of gravel in place weighs 2700 pounds. Several tests with a one-cubic-foot box were made to determine the weight of the gravels and it was found that the dry weight of in place gravels of this area does not exceed 2700 pounds per cubic yard.

Shafting

Twelve shafts were put down by a Bureau of Mines crew, using telescoping, steel caissons. Three of the shafts could not be completed to bedrock due to an excessive seepage of water. A total depth of 137 feet of shaft was sunk from which 34 samples were taken. The shafting equipment was rented.

A representative fraction was cut from each 5-foot section of shaft, and this material was transported to a central location where it was dried, screened, and weighed. After screening, the minus 1/8-inch material was sacked and concentrated in the Boise laboratory.

Three of the shafts were sunk around drill holes to determine the comparative recoveries. The amount of black sands in the drill holes was considerably higher. These checks were made in ground that contained numerous large boulders, and it is believed that the churning action of the drill released some heavy minerals from around the boulders thus increasing the recovery of black sand per cubic yard.

Trenching

The trenching was done by a bulldozer on contract. High banks, dredge tailings, and the mouths of small draws emptying into the main valleys were sampled by this method. Seventeen trenches were excavated having a total vertical footage of 335 feet from which 62 samples were taken. It was not possible to complete the trenches in dredge tailings to bedrock because of the high level of the water table. These trenches were completed by the use of a sand-siphon elevator. The pounds of black sand per cubic yard recovered from the dredge tailings by this method checked very closely to the recovery by churn drilling in tailings. The material from the trenches was handled in the same manner as that from the shafts.

Dredge Sampling

The only operating dredge in the Boise Basin during the period of the Bureau of Mines program was the 6-cubic-foot bucket line dredge of the Idaho-Canadian Dredging Company on upper Moores Creek. This dredge was sampled on September 28 and October 18, 1949, at its location 2 miles above Idaho City. Because the principal older channels, from which the present streams have reconcentrated the gravel, cross Moores Creek below the dredge location, the gold and black sand content of the gravels was not truly representative of the average dredgable gravels of the stream.

During the winter of 1949-50 the dredge was dismantled and moved 5 miles down Moores Creek into an area near the center of the old dredge ground. On April 5 and 6, 1950, the dredge was re-sampled, and more representative samples of the gravels were obtained. Four grab samples were also obtained from stock-piles of cleaner jig concentrates saved by the dredges during the period 1946-1949.

Miscellaneous Sampling

Fourteen samples were taken from 6 old cuts and from the spoil of shafts sunk by previous testing crews. The vertical footage represented by these samples was 78 feet. This sampling was done to obtain a more complete picture of black sand content of the area.

A summary of exploration follows:

Summary of Exploration

<u>Drilling</u>

Number of churn-drill holes......................	37	
Total footage drilled............................	1207	ft.
Total drill-hole samples taken...................	291	

<u>Shafting</u>

Number of shafts sunk............................	12	
Total vertical footage sunk......................	137	ft.
Total shaft samples taken........................	34	

<u>Trenching</u>

Number of trenches cut...........................	17	
Total vertical footage cut.......................	335	ft.
Total trench samples taken.......................	62	

<u>Dredge Sampling</u>

One dredge on Moores Creek was sampled three times between September 28, 1949, and April 6, 1950, to obtain....................................3 samples

<u>Miscellaneous</u>

Old cuts and shafts sampled.....................	6	
Total vertical footage sampled..................	78	ft.
Total samples taken.............................	14	

Total samples taken in the Boise Basin....................	404
Total vertical footage sampled in Boise Basin.............	1757

The location of exploration follows:

Location of Exploration

Area	Kind of Exploration	
Virgin Ground		
1. Grassy Flats	Drill Holes	10 to 21 inclusive
2. Wolf Creek	Drill Holes	22 to 31 inclusive
3. Fall Creek	Drill Holes	5 to 9 inclusive
Dredge Tailings		
4. Granite Creek	Drill Hole	32
	Shafts	1, 4, and 5
	Trenches	1, 2, and 3
5. Grimes Creek	Drill Holes	1, 2, 3, 4, 33, and 34
	Shaft	9
	Trenches	7 to 12 and 14 to 16 inclusive
6. Moores Creek - Elk Creek	Dredge Samples	BOD 1 to 3

Note: Shafts 2 and 3 on Wolf Creek hit quicksand and could not be completed. Shafts 6 to 8 and 10 to 12, and drill holes 35 to 37 were put down to try to prove areas of virgin ground but the areas proved small and not commercially workable.

Trenches 4 to 6 were excavated to determine if the older channels were the source of the monazite, and trenches 17 to 19 were excavated in old cut banks of previous hydraulic operations in older channels. In some areas, the older channels contained nearly as much monazite as the stream gravels. Near Idaho City, these same channels contained almost no monazite.

ANALYSES

Field Estimates

All placer gravel samples obtained from the Boise Basin during the fall of 1949 were concentrated in the Bureau of Mines laboratory in Boise, Idaho. In all, 404 samples from the Boise Basin were tested.

The samples which previously had been dried and screened to minus one-eighth inch in the field were treated on the vibrating screen. At the laboratory the minus 1/8-inch plus 20-mesh size was weighed and discarded. (Tests were made of all sands coarser than 20-mesh and almost no monazite was found, and no field Geiger count was detected in these coarse concentrates.) The minus 20-mesh material was then treated on the large laboratory table, cutting the concentrate band wide enough to recover all of the heavy minerals. This cut of heavy minerals was then further concentrated by treatment on the small laboratory table. Periodic examinations of the tailings from the tables indicated that the recovery of the heavy minerals was plus 98 percent. The final concentrate, which generally contained more than 90 percent heavy minerals or black sands, was shipped to the Mt. Weather laboratory for analysis.

A summary of field estimates follow:

Summary of Field Estimates

Drill Hole No.	Depth Interval, Feet	Pounds Per Cubic Yard of Gravel Magnetite	Ilmenite	Garnet	Monazite	Zircon
BOB-1	15	1.00	1.00	0.33	0.52	0.41
BOB-2	15	1.38	2.03	.26	.53	.39
BOB-3	13	.62	.99	.34	.50	.30
BOB-4	15	.83	.66	.29	.29	.51
BOB-5	45	4.63	2.56	.41	.72	.72
BOB-6	45	5.47	1.90	.56	.78	1.00
BOB-7	40	3.35	1.25	.21	.35	.63
BOB-8	51.5	6.10	3.05	.37	.73	.73
BOB-9	33.5	3.36	3.34	.08	.50	.42
BOB-10	44	2.11	4.59	.18	.93	.55
BOB-11	26.5	1.89	2.35	.11	.35	.46
BOB-12	35	.37	.45	.14	.18	.18
BOB-13	42.5	1.69	2.33	.37	.27	.27
BOB-14	37	1.51	2.02	.09	.28	.46
BOB-15	50	1.38	1.06	.13	.16	.29
BOB-16	40	1.79	3.17	.18	.18	.48
BOB-17	50	1.04	1.21	.08	.11	.20
BOB-18	40	3.68	1.23	.06	.43	.61
BOB-19	35	.73	.43	.10	.30	.30
BOB-20	35	1.49	.66	.17	.37	.53
BOB-21	40	2.27	.99	.20	.49	.84
BOB-22	25.5	.68	2.11	.31	.52	1.30
BOB-23	27.5	.77	2.27	.33	.39	1.49
BOB-24	30	2.30	5.21	.73	1.57	1.82
BOB-25	30	.80	3.13	.47	.33	1.46
BOB-26	40	.78	2.99	.52	.33	1.43
BOB-27	58	1.10	3.30	.92	1.10	2.29
BOB-28	27.5	1.75	3.40	.52	1.96	2.27
BOB-29	32.5	.84	1.82	.44	.44	.94
BOB-30	17.5	2.16	4.43	.87	.62	1.65
BOB-31	12.5	1.27	3.13	.76	1.10	1.86
BOB-32	27.5	1.12	2.58	.77	.70	1.57
BOB-33	25	.62	1.10	.46	.51	1.22
BOB-34	30	0.53	1.47	0.30	0.30	0.42

Trench Samples

Trench No.						
BOT-1	10	5.20	4.03	0.65	1.69	0.39
BOT-10	27	3.23	4.23	1.12	1.34	0.67

3 Dredge Samples, Average

0.08	0.45	1.47	0.19	0.52

Radiometric, Chemical, and Petrographic Analyses

Samples of the Boise Basin, upon being received at Mt. Weather, were reduced by splitting to a size (usually a few ounces) sufficient for the various analytical tests. Radiometric determinations were made on all samples, and as a check, random samples were chemically analyzed for U_3O_8 and ThO_2. The chemical analyses were also useful in the identification of the various radioactive minerals and in determining their correlation with the radioactive results.

The chemical analyses of relatively pure monazite from the Boise Basin were used as a basis for the interpretation of all radiometric results. The analyses of these monazites follow:

Sample No.	Percent ThO_2	Percent U_3O_8	ThO_2 to U_3O_8 Ratio
Sample 1	2.98	.100	30 : 1
Sample 2	3.06	.105	29 : 1
Sample 3	2.9		
Sample 4	4.0		
Average	3.2		

Based upon the above, the average 3.2 percent ThO_2 content and the ThO_2-to-U_3O_8 ratio of approximately 30 : 1 have been accepted as a factor for determining the theoretical monazite content of all Boise Basin samples. Higher uranium percentages with a resultant decrease in the thoria-to-uranium oxide ratio, may be noted in most of the areas, and is attributed to the presence of other radioactive minerals in addition to the monazite. Zircon, which is usually present in these samples, increases the uranium content.

As the radiometric and chemical analyses fail to distinguish between monazite and any other radioactive minerals which might be present, petrographic determinations were also made of each sample. Radiometric, chemical, and petrographic analyses follow:

Summary of Radiometric, Chemical, and Petrographic Analyses

			Percent of Black Sand			Lbs. Monazite Per Cu. Yd. of Gravel	
Drill Hole No.	Depth, Feet	Black-Sand Lbs/Cu. Yd.	Radio-metric ThO_2 Equiv.	Chemical ThO_2	Chemical U_3O_8	Radio-metric	Petro-graphic
BOB-1	15	3.71	0.553			0.64	0.52
2	15	6.56	.326	0.172	0.030	.67	.59
3	13	3.09	.444			.43	.28
4	15	3.18	.412			.41	.10
5	45	10.44	.211			.69	.73
6	45	10.85	.287	.226	.016	.97	.54
7	40	6.80	.131			.28	.27
8	51.5	12.25	.097	.073	.005	.37	.49
9	33.5	8.38	.116			.30	.34
10	44	8.89	.448	.360	.012	1.24	.98
11	26.5	5.74	.346			.62	.34
12	35	1.39	.638	.599	.019	.28	.18
13	42.5	5.40	.254			.43	.27
14	37	4.61	.265			.38	.31
15	50	3.21	.257			.26	.16
16	40	5.96	.394			.73	.18
17	50	2.52	.364			.29	.10
18	40	6.12	.229			.44	.43
19	35	1.97	.395			.24	.14
20	35	3.31	.202	.181	.007	.21	.11
21	40	5.04	.206			.32	.25
22	25.5	5.20	.187			.30	.26
23	27.5	5.53	.168			.29	.39
24	30	12.11	.403	.356	.013	1.53	1.09
25	30	6.66	.205			.43	.33
26	40	6.64	.237			.49	.27
27	58	9.21	.223			.64	.41
28	27.5	10.30	.236			.76	.52
29	32.5	4.93	.123			.19	.44
30	17.5	10.30	.207			.67	.62
31	12.5	8.47	.230			.61	.41
32	27.5	6.98	.288			.63	.35
33	25	4.22	.434			.57	.42
BOB-34	30	3.77	0.411			0.48	0.23

Summary of Radiometric, Chemical, and Petrographic Analyses (Contd.)

Trench No.	Depth, Feet	Black-Sand Lbs/Cu. Yd.	Percent of Black Sand: Radio-metric ThO_2 Equiv.	Percent of Black Sand: Chemical ThO_2	Percent of Black Sand: Chemical U_3O_8	Lbs. Monazite Per Cu. Yd. of Gravel: Radio-metric	Lbs. Monazite Per Cu. Yd. of Gravel: Petro-graphic
BOT-1	10	13.00	0.415			1.69	1.78
2	7	2.70	.576			.49	.19
3	0-5	13.02	.761	0.690	0.020	3.10	1.37
3	5-13	4.08	.624			.80	.38
7	12	8.20	.184			.47	.21
8	16	2.62	.317			.26	.17
9	15	1.25	.676			.26	.11
10	0-10	10.22	.393			1.26	1.23
10	10-15	17.55	.430			2.36	1.93
10	15-22	9.52	.268			.80	1.05
11	10	9.40	1.04	0.929	0.037	3.06	2.30
12	27	2.05	.612			.39	.13
BOT-14	12	3.37	0.418			0.44	0.32
Dredge Sample No.							
BOD-1		1.90	0.444	0.124	0.077	0.26	0.09
2		1.60	.386	.173	.049	.19	.05
BOD-3		3.03	0.396	0.222	0.040	0.37	0.09
Shaft No.							
BOS-1	16.5	2.55	0.550	0.523	0.016	0.44	0.22
4	22	3.42	.331			.35	.24
5	16	5.14	.389			.62	.36
BOS-9	7	2.51	0.411	0.324	0.026	0.32	0.16

RESERVES

Dredge Tailings

The greatest reserves of monazite-bearing gravels are contained in the enormous volume of gold-dredge tailings in the Basin along Moores Creek, Grimes Creek, Granite Creek, and Elk Creek. The material is typical of central Idaho dredge tailings; uneven, cone-shaped piles of coarse, washed gravel on top and underlain by sand and silt. The bedrock of the area is generally soft, decomposed, coarse-grained granitic rock traversed by an occasional reef of harder granite.

Virgin Gravels

Much of the monazite-bearing virgin gravels remaining in the Boise Basin that may be suitable for dredging are on the tributaries of Granite Creek; namely, Canyon, Fall, and Wolf Creeks. There are also some small patches of virgin ground covered by tailings from the bench deposits and from dredges in Moores Creek valley.

BENEFICIATION AND ECONOMICS

Some monazite has been produced and marketed from the black-sand concentrates in the Boise Basin, so the recovery of monazite from the placer gravels is not entirely new. The stockpiled concentrates, from which this mineral was obtained, were recovered as a byproduct from the gold dredging operations.

In addition to monazite, the black-sand concentrates in the gravel contain variable amounts of magnetite, ilmenite, granet, zircon, gold, and other minerals including uranium-bearing minerals.

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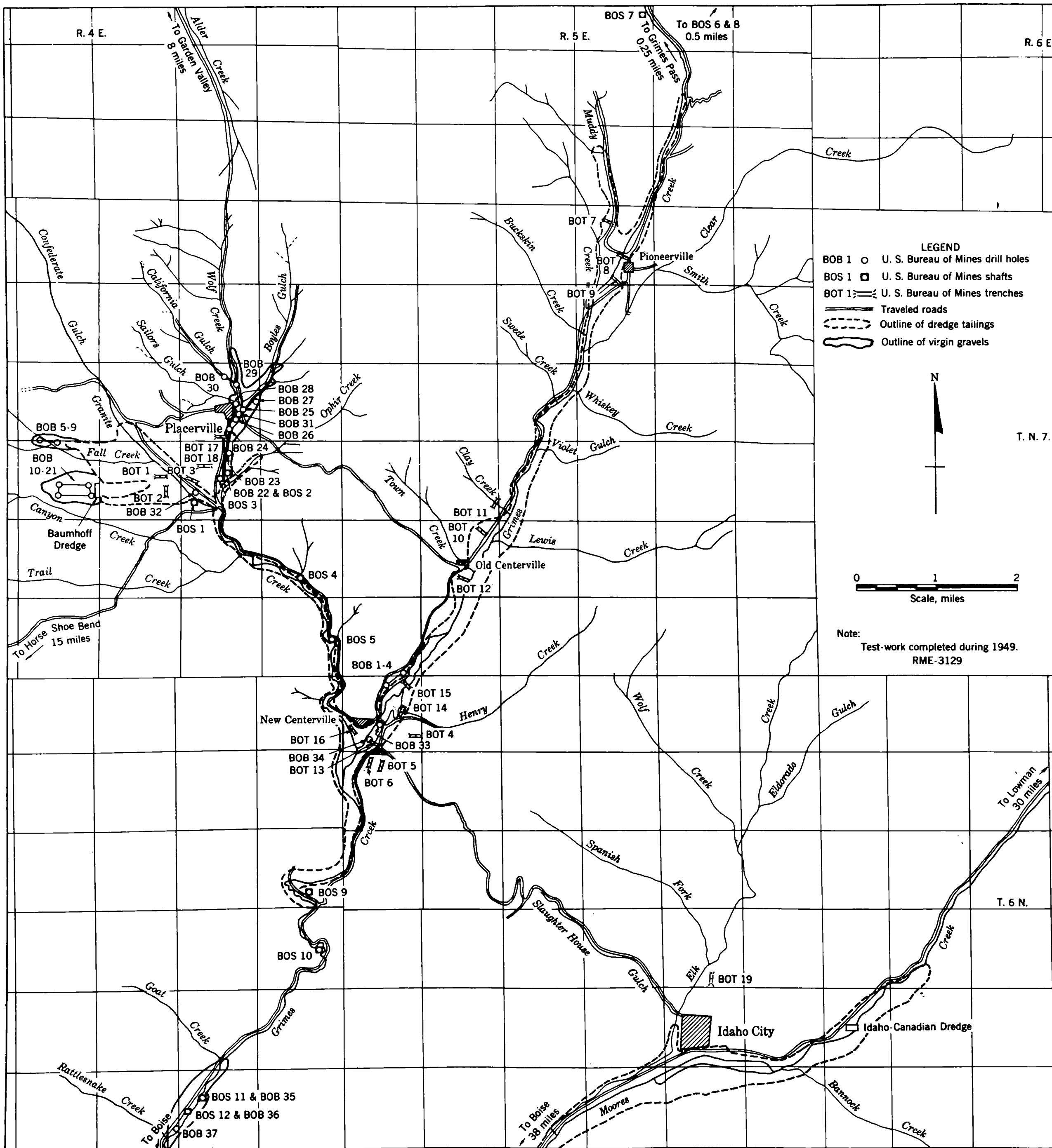

Plate 1. Boise Basin area map.

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