ABSTRACTS of PUBLICATIONS of the IDAHO BUREAU of MINES and GEOLOGY
1920 - 1975

Second Edition

1920-1967 compiled by Sylvia H. Ross
1968-1975 compiled by Carl N. Savage

Idaho Bureau of Mines and Geology
Moscow, Idaho

Maynard M. Miller . Chief
FOREWORD

Abstracts of Idaho Bureau of Mines and Geology publications were compiled by Sylvia H. Ross, former Bureau groundwater geologist, in 1967 and published in February 1968 as Information Circular no. 19. The demand has exceeded supply and because of its demonstrated usefulness the decision was made to bring the printing up-to-date through 1975, in a second edition. Older publications dating from 1920, are out-of-print, but a new list of available materials may be obtained from the Idaho Bureau of Mines and Geology. Many of the older publications may be consulted in larger libraries and sister state agencies in other states. The State of Idaho Historical Society has also scheduled the microfilming of all Bureau publications as a part of its program to preserve materials that often have long term value for public use.

The Bureau and its personnel are always concerned with helping both Idaho citizens and other people from outside the state whenever they can be of service. Our area of expertise has been expanded in recent years and as more sophisticated laboratory and field equipment is obtained, our endeavors have expanded, and it is hoped that our qualitative and quantitative data have improved in accuracy. We encourage questions on subject matter ranging from minerals and the mining industry and resources, through matters relating to ground water, natural sources of energy, and a broad spectrum of geological subject matter and geologically-oriented environmental problems of mankind.

The preparation of abstracts and their compilation, from late 1967 through 1975, is my responsibility alone. I sincerely trust that not too many errors have been made, and that the value of this updated work will prove as useful and popular as the original 1968 publication.

Carl N. Savage
Associate Chief
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**Bulletin 1**


The rocks of the Seven Devils district include andesites and small amounts of rhyolites, limestones, granodiorite related to the Idaho batholith, and Columbia River Basalt. Ore deposits occur as (1) mineralized shear zones, (2) fissure veins, (3) large disseminated deposits, and (4) contact metamorphic deposits. In addition to the deposits in this district, copper occurs at the Heath district in Washington County, at the Hoodoo district in northern Latah County, and at the Deer Creek district in Lewis County.

**Bulletin 2**

A PRELIMINARY REPORT ON THE CLAYS OF IDAHO. By Frank H. Skeels, 1920, 74 p. (9 figs.)

Idaho clays range from whiteware and high refractory clays through the buff-burning stoneware and terra cotta clays to the common red brick varieties. Potential deposits occur in Benewah, Cassia, Idaho, Kootenai, Latah, Lewis, Power, Shoshone, and Washington Counties.

**Bulletin 3**

A RECONNAISSANCE IN SOUTH CENTRAL IDAHO EMBRACING THE THUNDER MOUNTAIN, BIG CREEK, STANLEY BASIN, SHEEP MOUNTAIN, AND SEAFOAM DISTRICTS. By J. B. Umpleby and D. C. Livingston, 1920, 22 p. (5 plates, map)

Precambrian metasedimentary rocks occur as roof pendants in the granitic rocks of the Idaho batholith. These rocks are overlain by silicic flows and tuffs of Middle Tertiary age. Minor amounts of alluvium and glacial debris fill the valleys. Two periods of mineralization have occurred. The older one, which formed base metal deposits and one gold deposit, is related to the Idaho batholith and is represented at most of the districts. The younger deposits, which occur at Thunder Mountain, are gold-silver veins in volcanic rocks.

*Indicates out-of-print.
PETROLEUM POSSIBILITIES OF CERTAIN ANTICLINES IN SOUTHEASTERN IDAHO.
By Virgil R. D. Kirkham, 1922, 36 p. (9 plates)

Three areas of eastern Idaho, one in Teton County and two in Caribou County, are the least unlikely for the production of oil and natural gas. Mesozoic and Carboniferous sediments, correlative with producing petroleum horizons to the east have been folded and faulted into anticlines and synclines in these three areas. Although no oil seeps are present, salt springs and sulphur springs do occur and some rocks yield a petriferous odor when fractured.

GEOLOGY AND ORE DEPOSITS OF ALTURAS QUADRANGLE, BLAINE COUNTY, IDAHO.
By S. M. Ballard, 1922, 36 p. (8 figs., 10 plates)

Granitic rocks of the Idaho batholith crop out over three-fourths of the Alturas quadrangle. Irregular areas of silicic volcanic flows cover the foot-hills in Sawtooth Valley. Dikes cutting these rocks are either extremely acid or extremely basic. The principal ores, associated with quartz veins, are arsenical or antimonial sulfides of silver. The district is considered one of considerable promise.

GEOLOGY AND WATER RESOURCES OF THE GOOSE CREEK BASIN, CASSIA COUNTY, IDAHO. By Arthur M. Piper, 1923, 78 p. (6 plates)

Granite, related to the Idaho batholith, has intruded a thick sequence of Paleozoic metasediments. These rocks are overlain by Miocene (?) rhyolite, lake beds of sediments and volcanic ash, and Pliocene (?) basalt. Quaternary stream and wind deposits mantle the valley floor. The Paleozoic rocks are gently folded and extensively faulted. Younger, normal faulting was extensive in the Late Miocene. Ground water is stored in large amounts in the lake beds and rhyolites and in moderate amounts in the Quaternary valley fill. Thermal springs issue from the Paleozoic rocks. The artesian water supply in the basin, although not large, is worthy of developing for irrigation use.

GEOLOGY AND GOLD RESOURCES OF NORTH CENTRAL IDAHO. By Francis A. Thompson and Samuel M. Ballard, 1924, 127 p. (15 figs., 27 plates)

The basement rocks of the mining districts of north-central Idaho are either Precambrian metasedimentary roof pendants or granitic rocks of the Idaho batholith. The mining districts in this region are the Elk City, Dixie, Florence, Orogrande, Golden (Tennille), Buffalo Hump, and Pierce City districts. The principal ore deposits are steeply-dipping fissure veins carrying mainly gold and silver in quartz gangue. These veins are associated with dikes of all compositions. Placer mining, once extensive in the region, is now relatively unimportant.
The sedimentary rocks of the area include 27,000 feet of formations ranging in age from Carboniferous to Cretaceous and valley fill of Tertiary age. Tertiary dikes, sills, and stocks intrude the older rocks, and the northwest portion of the area is overlain by basalt and silicic volcanic flows. Parallel anticlines are broken up into oval-shaped domes by undulations along the axes of the folds. Four overthrust faults and a number of normal faults cut the area. The region is underlain by formations correlative with productive oil and gas series in Wyoming and Montana; the area may be rated as a prospective or "wildcat" one.

The rocks within the Boise Basin are, in decreasing age, granite of the Idaho batholih, dikes that range from pegmatite to diabase and lamprophyre, older (Miocene?) lacustrine sediments, basalt, gravels, and younger lacustrine sediments. Regional shearing occurred in the Miocene, and local block-faulting occurred sometime after the gravels were deposited. Lode deposits generally occur in veins related to the Miocene shearing. Primary mineralization formed ores of gold and silver with some lead, zinc and copper. Later, placer gold was concentrated in the gravels.

Metasedimentary and volcanic rocks of the Belt Series are the oldest rocks in Boundary County. These rocks have been invaded by granitic rocks which are related to the Nelson batholith of Canada. Pleistocene lake sediments fill most of the valleys. Several large faults, including one overthrust fault, traverse the County. Only two folds of major importance occur. Lead and silver are the important lode minerals of the County; molybdenum is potentially important. Gold occurs in placer deposits. The lodes include replacement ore bodies in metamorphic rocks, shear-zone deposits in quartzite, and veins cutting or paralleling all types of pre-Tertiary rocks.

*Indicates out-of-print.
**Bulletin 11**

GEOLOGY AND METALLIFEROUS RESOURCES OF THE REGION ABOUT SILVER CITY, IDAHO. By Arthur M. Piper and Francis B. Laney, 1926, 165 p. (6 figs., 13 plates)

The oldest rocks in the Silver City region are metamorphosed sedimentary blocks in a granitic intrusive. The whole is overlain by basalt and a thick series of rhyolite flows. Three major periods of deformation, each represented by distinct sets of fractures, have influenced regional structure. Placer gold was discovered in 1863 and lode mining began before 1865. In the first 60 years, more than $40,000,000 worth of gold and silver was mined. Three types of veins occur: (1) fissures filled with massive ore-bearing white or milky quartz, (2) fissures filled with laminar pseudomorphic quartz, and (3) silicified and mineralized shear zones.

**Bulletin 12**

GEOLOGY AND ORE DEPOSITS OF THE CLARK FORK DISTRICT, IDAHO. By Alfred L. Anderson, 1930, 132 p. (2 figs., 14 plates)

A large part of the Clark Fork district is underlain by metasedimentary rocks of the Belt Series. These rocks and a Paleozoic (?) conglomerate have been intruded by granodiorite. Pleistocene glacial and stream deposits occur in the valleys. The east-west trending Hope fault is the dominant structural feature. Many smaller faults are associated with igneous intrusions. The ore deposits are primarily lead-silver replacement veins, formed at moderate temperatures and pressures.

**Bulletin 13**

CRATERS OF THE MOON NATIONAL MONUMENT, IDAHO. By Harold T. Stearns, 1928, 57 p. (21 plates)

The Monument includes the most recent part of a vast lava field that covers hundreds of square miles of the Snake River plain. Crater pits, volcanic cones and lava flows are massed along the northwest-trending Great Rift Zone. Two distinct types of basalt—aa and pahoehoe, and three types of cones—cinder, spatter, and lava—occur in the area. Other features include volcanic bombs, tree molds, water holes, and caves.

**Bulletin 14**

GEOLOGY AND MINERAL RESOURCES OF EASTERN CASSIA COUNTY, IDAHO. By Alfred L. Anderson, 1931, 169 p. (1 fig., 19 plates)

The rocks of the region include sedimentary beds of Precambrian, Cambrian, Carboniferous, Permian, Miocene(?), and Quaternary age; granitic rocks intruded in Late Cretaceous or early Eocene time; flows of quartz latite and locally basalt intercalated in and lying above the tuffs and other strata of Miocene (?) age; and flows of Quaternary Snake River basalt. The mountains in the area are faulted blocks separated by down-dropped valleys. Two types of metallic ore deposits exist: (1) silver and zinc deposits as irregular replacements in limestone, and (2) quartz-galena fillings in fissure veins. Other mineral resources include limestone, marble, quartzite, volcanic ash, mica, feldspar, clay, and road metal.
OUTLINE OF THE GEOLOGY OF IDAHO. By Clyde P. Ross and J. Donald Forrester, 1958, 74 p. (10 figs., glossary)

Stratified rocks of Idaho range in age from Precambrian to Recent. Intrusive rocks are Precambrian, Late Mesozoic, or Tertiary. Parts of 4 geomorphic provinces — the Northern Rocky Mountains, the Middle Rocky Mountains, the Basin and Range, and the Columbia Plateau — lie within Idaho's boundaries. Metallic minerals, such as gold, silver, lead, copper, and zinc, occur in lodes; and some of these minerals also occur in placer. Non-metallic minerals include phosphate, barite, sand and gravel, diatomaceous earth, gemstones, and gypsum. Idaho is deficient in mineral fuels.


Although this guidebook was prepared initially for use during a Coeur d'Alene District field trip, the material provides a source of general information on the district. The first 6 papers treat aspects of the district's history and general geology. Five additional articles discuss the geology of the Bunker Hill, Dayrock, Galena, Lucky Friday, and Sunshine mines.

ECONOMIC GEOLOGY OF CENTRAL IDAHO BLACKSAND PLACERS. By C. N. Savage, 1961, 160 p. (35 figs.)

Idaho placer deposits yield moderate to high percentages of blacksand, including 50 or more detrital minerals. Source rocks are mainly quartz monzonite, granodiorite, diorite, aplitic, pegmatite, and metasedimentary rocks. The geologic history of blacksands from the Precambrian to the present seems to be one of ancient placer concentration, metasomatic recrystallization and dispersal, erosion, and reconcentration in Cenozoic placers. The major placer areas of Idaho include Boise Basin, Wood River-Camas Creek, Bear Valley, Deadwood River, Dismal Swamp, Cascade Valley, Stanley Basin-Yankee Fork, Salmon City, Burgdorf-Warren, Florence, Elk City-Newsome-Dixie, and the Clearwater watershed.

*Indicates out-of-print.
Bulletin 18


Mining is Idaho's third most important industry in terms of dollar value of production. The authors of this publication discuss the importance of minerals in everyday life, the history of mining in Idaho, the changes that are occurring in the industry, modern mining, milling, and smelting methods, mineral economics, and the political and social aspects of mining.

*Bulletin 19

RUSH TO IDAHO. By Merle W. Wells, 1961, 57 p. (1 map, 7 photographs)

Gold was discovered on Orofino Creek in late 1860 and by summer 1861, Oro Fino City and Pierce were well established. But before the end of 1861, many men had moved south to Elk City and Florence. More than 10,000 miners worked the Florence district in 1862, and perhaps $6,000,000 worth of gold was recovered; by the end of 1863, only about 50 men remained. Cost of food and supplies at Pierce during the height of the boom was approximately 4 times that at Portland. It is further estimated that at Florence less than 13 percent of the gold recovered was profit.

*Bulletin 20

PROSPECTING AND DEVELOPING A SMALL MINE. By W. W. Staley, 1961, 106 p. (4 figs.)

Prospecting and developing a small mine requires varied knowledge. Some of the things an operator of a small mine should know include: a working knowledge of mineralogy and rock-type associations, economic locations of surface openings, treatment of mine-run ore, drilling and blasting, timbering of shafts and drifts, and how to estimate costs. A comprehensive bibliography on information of interest to the prospector or operator of a small mine.

*Bulletin 21

TIMBERING AND SUPPORT OF UNDERGROUND WORKINGS FOR SMALL MINES. By W. W. Staley, 1962, 54 p. (28 figs.)

No matter how limited their extent, few underground workings can progress very far without some sort of timber, concrete, or steel for support. Timber, treated to prolong its life, satisfies most requirements for supporting drifts, raises, shafts, and stopes. Timber can also be used to construct headframes and ore bins. Rock bolts are commonly used to supplement timber for support. In areas where timber is scarce or expensive, reinforced concrete sets should be used.

Gold and silver mining in southern Idaho from 1862 through 1869 went on in several prominent mining districts, as well as in a number of others whose importance lay in the future. Those 8 seasons saw rushes to Boise Basin, South Boise districts, Owyhee district, Deadwood, Volcano, Little Smoky, Banner, Atlanta, the Hailey gold belt, Leesburg, Pearl, South Mountain, Loon Creek, and placers on the Snake River. Most production was from placers, although some lode production came from Owyhee. In some districts stamp mills were brought in, only to fail, primarily because of poor technology and lack of good rail transportation.

DISTIBUTION AND ECONOMIC POTENTIAL OF CARBONATE ROCKS IN IDAHO.
By C.N. Savage, 1969, 100 p. (49 figs., 8 tables, 10 maps, appendix)

Idaho has widespread and abundant calcium and magnesium carbonate rocks differing in quality and geologic age. The largest reserves occur in south Idaho marine, Paleozoic and Mesozoic strata. Permian and Triassic marine limestones are plentiful in western Idaho but are contaminated with fragmental volcanic material. Smaller occurrences of Cambrian limestones in north Idaho have been used for lime and cement. Precambrian carbonate-bearing rock is widely dispersed. Those found near Orofino have been used for cement. Small to relatively large deposits of Cenozoic travertine occur associated with warm or hot springs in southeastern Idaho. Premium trimstone has been quarried from these deposits. A comprehensive appendix gives field and laboratory data including sample locations by sections, township, range and analyses.

*Indicates out-of-print
Also available from the Idaho Historical Society, Boise, Idaho 83706
PAMPHLETS

*Pamphlet 1
INTERFACIAL TENSION MEASUREMENTS AND SOME APPLICATIONS TO FLOTATION.
By Robert B. Elder, 1921, 33 p. (8 figs.)

At least six methods may be employed to measure the surface tension of liquids (water, oil, and aqueous solutions). Of these, the method of using a knife-edge gravity balance is especially valuable because it can be readily used as a method of studying flotation phenomena.

*Pamphlet 2
SIZE OF MINERAL PARTICLE IN RELATION TO FLOTATION CONCENTRATION. By A. W. Fahrenwald, 1921, 8 p.

Maximum flotation efficiency is obtained by treating the largest particle that can be floated; however, when the particle is so large that it is caught and dropped many times before it is finally removed, finer grading would result in greater recovery and higher efficiency. Factors controlling the size of a particle that can be floated include: (1) shape, (2) specific gravity, (3) cleanliness of the surface, (4) degrees of adsorption, and (5) the swirl of the pulp.

*Pamphlet 3
TESTING ORES FOR FLOTATION. By A. W. Fahrenwald, 1921, 22 p. (8 figs.)

If testing is done with care, 95 percent of small scale tests can be duplicated in the mill. Complete notes should be taken on every test. Ores to be tested should be both dry and wet crushed, and the size of the particles should be determined. The shape and mechanism of the flotation-testing machine is important to obtaining accurate results.

*Pamphlet 4
DIFFERENTIAL FLOTATION. By A. W. Fahrenwald, 1921, 23 p. (7 figs.)

The term differential flotation should be used to designate the flotation of one flotable mineral in the presence of a second one. Success in differential flotation lies in adjustment of the following controlling factors: (1) nature and amount of pre-agitation, (2) material and design of the machine, (3) temperature, (4) amount of reagent or reagents used, and (5) amount and nature of aeration.

*Indicates out-of-print.
Pamphlet 5


The rocks to the north of the area investigated are dominantly granitic and those to the south are metamorphosed Paleozoic sediments. The area is underlain by Tertiary lavas and interbedded sediments. Wells drilled at Payette, Weiser, and near Boise showed marsh gas, but do not have true oil seeps associated with them. Stratigraphic and structural evidence show little chance of any major production of oil or gas.

Pamphlet 6


Assay samples from Kootenai County properties reported to contain platinum were sent to 12 assay laboratories throughout the country. Extra precautions were taken against contamination. Of the 142 samples tested, only two showed even traces of platinum group minerals.

Pamphlet 7

NOTES ON THE GEOLOGY OF EASTERN BEAR LAKE COUNTY, IDAHO, WITH REFERENCE TO OIL POSSIBILITIES. By Virgil R. K. Kirkham, 1923, 6 p.

The area studied is underlain by folded sedimentary rocks that range in age from Permian through Jurassic. Insufficient work has been done to determine the structure of the area. The rocks do not seem to be oil bearing, although they are correlative with oil producing formations in Wyoming.

Pamphlet 8

GROUND WATER SUPPLY AT MOSCOW, IDAHO. By F. B. Laney, V. R. D. Kirkham, and A. M. Piper, 1923, 13 p. (3 plates)

Moscow is situated in a basin of granite and quartzite basement rock overlain by basalt and interbedded sediments. The basalt flows are essentially horizontal. At least 3, and perhaps more, aquifers are present. Since 1880 water levels have declined approximately 44 feet. A recent rapid drop has been caused by intensive pumping of shallow aquifers and by silting of the wells. Annual pumpage is about 230 million gallons, or about one-half the estimated recharge.
The mountains in the area are composed of Precambrian and Paleozoic meta-sedimentary rocks and various igneous rocks. The valleys are filled with Tertiary volcanic and sedimentary rocks capped by terraced alluvial fans. The mountains have been glaciated. Precipitation averages 10 inches per year at low elevations. Water in the streams is completely claimed. The gravels on the alluvial fans are porous and the water table is more than 50 feet below the surface. Much of the surface run-off is absorbed into this gravel. Seepage losses of diverted water are higher than the amount applied. Careful development of ground-water resources could augment the amount of irrigation practiced.

The Horseshoe Basin coal field of Cretaceous age contains possibly 11,000,000 tons of high-grade sub-bituminous coal, low in ash and moisture. The coal is somewhat friable and the seams stand at a high angle; both conditions tend to increase the cost of producing lump coal.

The rocks of the Bruneau River drainage area comprise a basement of Cretaceous or Early Eocene granitic rocks intruded into metamorphosed Paleozoic sediments. These rocks are overlain by Tertiary and Quaternary volcanic and sedimentary rocks. Surface water is not plentiful; 65 percent of the runoff occurs in April and May. Two irrigation companies divert surface water and irrigate approximately 10,000 acres. Ground-water circulation is determined mainly by rock structure. Both cold springs and hot springs occur in the region. Some of the spring water is not suitable for irrigation because of the high salt content.

In Power and Oneida Counties, parallel mountain ranges are separated by wide, flat-bottomed valleys. The rocks of the mountains are folded and faulted blocks of Cambrian through Pennsylvanian sedimentary rocks. The valleys are filled with Late Tertiary basalt and alluvium. The areas contain neither the proper rocks nor the proper structures for the accumulation of oil. The older rocks are somewhat metamorphosed and the younger are mostly igneous; faulting has destroyed the continuity of folds within the mountain ranges.

*Indicates out-of-print.
Silicic volcanic and sedimentary Permian and Triassic rocks occur as a roof pendant in the Idaho batholith. The batholith is cut by dikes and is overlain by flows of the Columbia River Group. Mineral deposits are of 4 types: (1) disseminated pyrite, chalcopyrite, and pyrrhotite in granodiorite, (2) segregations of minerals associated with quartz porphyry dikes, (3) contact metamorphic deposits in Triassic limestone, and (4) replacement deposits containing silver in andesite and rhyolite.

Muscovite occurs at the Avon district in pegmatite dikes intruded into quartz monzonite-granodiorite of the Idaho batholith. The main minerals are feldspar, quartz, and mica. Tourmaline, garnet, and beryl occur as accessory minerals.

Granitic rocks of the Idaho batholith intruded into Paleozoic sedimentary rocks form an impermeable basement complex in the Camas Prairie area. Silicic volcanics and basalt flows cover the older rocks. Glacial outwash and alluvium cover the present valleys to depths approaching 1,000 feet. Most streams are intermittent and feed water to the basin. Springs are common; those in older rocks are often thermal. Flowing artesian wells occur in the alluvial fill.

Aquifers less than 100 feet in depth in the Idaho Falls area are discontinuous and small. The main aquifer, at about 125 feet, should be sufficient to supply large amounts of water if wells are constructed properly. Quality of the water should be checked before use. Drilling to even deeper levels should give an even larger amount of water.

Valleys eroded into Belt metasediments are filled with Columbia River Basalt and Recent and Pleistocene alluvium in the St. Maries area. Although 3 inches of precipitation (a total of 247 million gallons) enters the ground annually, most of this water is discharged into rivers by springs. Thus, ground water is not a practical source of water for the town.
*Pamphlet 18

SOME MIocene AND PLEISTOCENE DRAINAGE CHANGES IN NORTHERN IDAHO. By Alfred L. Anderson, 1927, 29 p. (2 maps)

In pre-Miocene time, the major rivers of northern Idaho flowed southward and westward. During the Miocene, flows of basalt from the west caused a reversal of the system, with the entire drainage passing through the Purcell Trench into Canada. Subsequent erosion has removed much of the basalt from St. Joe and Rathdrum valleys. In Pleistocene time, ice advanced twice from the north, blocking drainage in that direction. Meltwater streams from these glaciers helped establish new drainage patterns, primarily westward.

*Pamphlet 19

A GEOLOGIC RECONNAISSANCE OF CLARK AND JEFFERSON AND PARTS OF BUTTE, CUSTER, FREMONT, LEHII, AND MADISON COUNTIES, IDAHO. By Virgil R. D. Kirkham, 1927, 47 p. (4 plates)

Nearly 20,500 feet of Paleozoic and 6,000 feet of Mesozoic sedimentary rocks occur in the mapped area. These rocks are folded and broken by normal and thrust faulting. Four regional overthrust belts are present. At lower elevations, Middle Tertiary lake beds are overlain by silicic volcanics and Late Tertiary basalt flows. Quaternary gravels and alluvium are widespread. Coal occurs within the region, but chances of finding oil are small. Bentonite beds occur near Mackey. Other resources of the region include building stone and water.

*Pamphlet 20

A DISSEMINATED LEAD PROSPECT IN NORTHERN BOISE COUNTY, IDAHO. By Clyde P. Ross, 1926, 7 p.

Disseminated lead occurs in altered granodiorite of the Idaho batholith about 70 miles northeast of Boise. Mineralization consists of scattered galena, sphalerite, pyrite, and chalcopyrite. The only gangue mineral is quartz. There is no indication of leaching or secondary enrichment.

*Pamphlet 21

THE VIENNA DISTRICT, BLAINE COUNTY, IDAHO. By Clyde P. Ross, 1927, 17 p. (3 plates)

The lodes of the district are in shear zones in hydrothermally-altered Cretaceous granite cut by dikes. Paleozoic (?) sedimentary rocks and Miocene (?) silicic volcanics are also present. The most important mineral is silver, but lead and zinc are also important; the gangue consists of quartz and altered granite with some siderite. The district was active in the 1880's and may have produced as much as $1,000,000 worth of ore.

*Indicates out-of-print.

A lens-shaped belt of schists, quartzites, and limestones is a roof pendant in a granodiorite intrusive. The metasediments are folded, and faults displace both the metasediments and the igneous body. Three types of ore deposits are present: (1) contact metamorphic deposits, rich in copper and zinc; (2) vein-replacements, rich in lead and zinc; and (3) gold-bearing quartz veins. The deposits are related to the granodiorite, but seem to be confined largely to recrystallized limestone areas.

GROUND WATER FOR MUNICIPAL SUPPLY AT POTLATCH, IDAHO. By Virgil R. D. Kirkham, 1927, 12 p. (2 plates)

Miocene lava flows are the rocks most affecting the ground-water supply of the area. These rocks overlie a complex of Belt metasediments and granitic intrusives. Approximately 3.5 inches of precipitation is available annually for recharge. The logs of 4 wells at the Potlatch Lumber Company show such differences over short distances that no accurate predictions can be made on quantity of water available at a given site.

UNDERGROUND WATER RESOURCES IN THE VICINITY OF OROFINO, IDAHO AND OF LAPWAI, IDAHO. By Virgil R. D. Kirkham, 1927, 17 p. (3 plates)

The oldest rocks in the area are Precambrian metasediments intruded by granitic rocks. Covering this basement complex are lava flows and interbedded sediments. Approximately 2 inches of precipitation annually enters the ground-water reserves in a catchment area of 77,000 acres. A well east of Orofino would be the best source of water for that community. A well in the valley flat near Lapwai should strike an adequate water supply.

ORE DEPOSITS IN TERTIARY LAVA IN THE SALMON RIVER MOUNTAINS, IDAHO. By Clyde P. Ross, 1927, 20 p. (1 fig.)

The lode deposits of the Musgrove, Thunder Mountain, Parker Mountain, Gravel Range (Singiser), and Yankee Fork districts are in or closely related to Miocene (?) lava and tuff. The major minerals are gold and silver, but in some deposits copper, lead, or antimony are also important. Placers contain gold, silver, tin, and opal. The rocks in the Salmon River Mountains include Precambrian metasediments, Permian (?) volcanics, and Miocene (?) lavas. Granitic rocks in the area are both older and younger than the Miocene (?) lavas. Glacial debris and alluvium are present in some stream valleys.
Pamphlet 26

GEOLOGY AND ORE DEPOSITS OF THE ROCKY BAR QUADRANGLE. By S. M. Ballard, 1928, 41 p. (1 plate)

The country rock in the Rocky Bar area is granodiorite of the Idaho batholith; composition of the rock is variable. Aplitic, rhyolite porphyry, diorite, lamprophyre, and basalt dikes cut the area. Ore deposits of the Pine district are mainly auriferous pyrite with some arsenopyrite and minor galena and sphalerite. Auriferous pyrite and arsenopyrite are the main ores of the Rocky Bar district. Two types of veins are present: relatively barren quartz veins and younger, mineralized veins following zones of major fracturing.

Pamphlet 27

GEOLOGY AND ORE DEPOSITS OF THE BIRCH CREEK DISTRICT, IDAHO. By P. J. Shenon, 25 p. (5 plates)

The mountainous parts of the district are underlain by Paleozoic quartzites, limestones, dolomites, and shales. These rocks have been intensely folded and faulted and are cut by a few porphyry dikes. Birch Creek valley is underlain by gravels and basalt flows. Two types of ore deposits occur: one contains mostly copper minerals and the other mostly lead and silver. Ore occurs as replacement veins in limestone and quartzite and as irregular replacements along bedding planes in the limestone.

Pamphlet 28

PORTLAND CEMENT MATERIALS NEAR POCATELLO, IDAHO. By Alfred L. Anderson, 1928, 15 p. (2 plates)

Large bodies of Cambrian limestone and shale are available near Portneuf siding and Inkom. Chemical and physical analyses indicate that these rocks are suitable for use in cement. The deposits are well located with respect to transportation, and the decision to build a cement plant in the area depends on the availability of markets.

Pamphlet 29


Four papers include the following: (1) A brief preliminary report on the possibilities of an underground water supply for the city of Weiser, Idaho. (The alternation of plunging synclines and anticlines provides favorable conditions for artesian wells.); (2) Coal and oil possibilities in Clark County, Idaho. (The area cannot be recommended until the structure in Montana is known.); (3) Subsurface water supply in Big Lost River valley. (Abnormal rises in the surface of the water table are caused by projecting promontaries that lie close to the valley surface.); (4) An examination of coal prospects on Willow and Fall Creeks, Bonneville County, Idaho. (The coal is of small amount and poor quality and does not justify development.)

*Indicates out-of-print.
Pamphlet 30


Most of the area is underlain by Precambrian Beltian formations. The Prichard, the oldest formation, is at least 8,000 feet thick. The Wallace Formation consists of over 6,000 feet of thin-bedded calcareous rocks. Quartz diorite and diabase dikes and sills cut the Belt rocks and are in turn cut by other dikes and a stock. Early Tertiary gravels and Columbia River basalts blanket the lower valleys. Recent alluvium occupies the valley flats of major rivers. Ore deposits are lead-zinc or gold veins along fissures. Copper is a minor constituent.

Pamphlet 31

GEOLGY AND SILVER ORE DEPOSITS OF THE PEND OREILLE DISTRICT, IDAHO. By Edward Sampson, 1928, 25 p. (4 plates, 1 fig.)

The sedimentary rocks of the Pend Oreille District include those of the Belt Supergroup and 3 formations of Cambrian age. Several granodiorite stocks cut the igneous rock. Faults, most of which dip vertically and strike north or northeast cut the area. Most ore deposits are simple fissure veins and mineralized shear zones. Silver is the most important mineral, but some lead and minor amounts of zinc and gold are present.

Pamphlet 32

GEOLGY AND ORE DEPOSITS OF THE LAVA CREEK DISTRICT, IDAHO. By Alfred L. Anderson, 1929, 70 p. (1 fig., 4 plates)

Nearly half of the rocks in the Lava Creek district are Mississippian sandstones, shales, and limestones. Most of the remainder are silicic volcanic flows and tuffs of Tertiary age. Tertiary granitic rock and Quaternary basalt flows are also present. Lodes occur as fissure veins or brecciated zones in which replacement has been the dominant process. The most common minerals are argentiferous galena, zinc sulfides, and some silver minerals.

Pamphlet 33

GEOLGY AND ORE DEPOSITS OF THE SEAFOAM, ALDER CREEK, LITTLE SMOKY AND WILLOW CREEK MINING DISTRICTS, CUSTER AND CAMAS COUNTIES, IDAHO. By Clyde P. Ross, 1930 (reprinted 1956), 26 p. (9 figs.)

The Seafoam district is underlain by the Idaho batholith and by blocks of dolomitic limestone. Ore deposits containing silver occur in shear zones in igneous rocks and as replacements in the dolomite. The Alder Creek district rocks are folded Mississippian limestone, intrusive igneous rocks, and the Challis Volcanics. The copper ore deposits are related to contact metamorphism around the stock. The Willow Creek and Little Smoky districts are largely underlain by granitic rock of the Idaho batholith and Paleozoic quartzites and limestones. The ore deposits, containing galena, sphalerite, and pyrite, are along shear zones.
Pamphlet 34

THE GEOLOGY AND MINERAL RESOURCES OF THE REGION ABOUT OROFINO, IDAHO.
By Alfred L. Anderson, 1930 (reprinted 1956), 63 p. (7 plates)

The oldest rocks in this 6,400 square mile area of north-central Idaho are those of the Belt Supergroup. Permian and Triassic Seven Devils Volcanics occur in the southern part of the region; rocks of the Idaho batholith cover much of the area. Columbia River Basalt has flooded the area from the west. Gold and copper are the two metallic minerals of importance, while asbestos, clay, feldspar, garnet, marble, mica, monazite, and crushed rock are important non-metallic resources.

Pamphlet 35

ELEMENTARY METHODS OF PLACER MINING. By W. W. Staley, 1931 (reprinted 12 times), 28 p. (10 figs., 1 map)

Alluvial mining is one of the earliest-used methods of abstracting gold and other heavy minerals from gravels. Little or no drilling or blasting is needed. Gold and other minerals are deposited along the lower portions of the streams and gullies with coarser ore nearest to the lode deposit. Simple devices for gold recovery include pans, rockers, and sluices. Gold may be recovered with mercury or cyanide.

Pamphlet 36

PROSPECTING FOR GOLD ORES. By John W. Finch, 1932 (reprinted 4 times), 29 p. (5 figs., 1 map)

Before going into relatively primitive areas to prospect for gold, one should have maps, adequate food supplies, and camping and prospecting equipment. Gold lodes are generally found in areas that are near to igneous rocks and where erosion has not been excessive. At least 62 districts in Idaho have produced gold ore.

Pamphlet 37

THE RECOVERY OF GOLD FROM ITS ORES. By A. W. Fahrenwald, 1932 (reprinted 3 times), 28 p. (7 figs.)

Gold occurs as native gold in placers or lodes, or alloyed with small percentages of other minerals. Gold is recovered from its ores by one, or a combination, of the following methods: (1) amalgamation, (2) cyanidation, (3) concentration, and (4) smelting. Gold, pure or impure, can be sold at any U. S. mint or government assay office.

Pamphlet 38


In 1931-1932, the Idaho Bureau of Mines and Geology was involved in 8 cooperative projects with Federal agencies and was working on 6 projects by itself. Several future studies were being planned. (This paper was presented to the State legislature.)
THE DOME MINING DISTRICT, BUTTE COUNTY, IDAHO. By Clyde P. Ross, 12 p. (3 plates)

The ore deposits of the Dome district, mainly lead and silver, are the result of replacement of Ordovician dolomitic beds. Mineralization was controlled by thrust faults and other structural features. Ore deposition may be related to altered dikes of Miocene (?) age.

GOLD-BEARING GRAVEL OF THE NEZPERCE NATIONAL FOREST, IDAHO COUNTY, IDAHO. By John C. Reed, 1934, 26 p. (8 figs., 1 plate)

The Clearwater Mountains of north-central Idaho have yielded nearly $50,000,000 in placer gold. The main districts are the Elk City, Tenmile, and Castle Creek districts. Both high-level and recent-valley type placers are present. The outlook seems favorable for continued production, but most of the gold will probably come from large-scale operation of low-grade deposits.

GEOLOGY OF THE PEARL-HORSESHOE BEND GOLD BELT, IDAHO. By Alfred L. Anderson, 1934, 36 p. (2 figs., 3 plates)

The rocks of the district include granitic rocks of the Idaho batholith and Columbia River basalts and related sediments. Gold-bearing lodes are distributed along a prominent fracture and dike zone or "porphyry belt" in the batholithic rock. The lodes are of great length and composed of complex sulphide seams, lenses, and stringers averaging from 0.25 to 0.50 oz. of gold per ton. Lodes were formed under moderate conditions of temperature and pressure, and should extend to much greater depths than have been mined. Mines closed in the early 1900's, not because of ore exhaustion, but because of metallurgical problems.

APPLICATION OF THE DIESEL ENGINE TO SMALL MINES. By W. W. Staley, 1935, 30 p. (3 figs.)

A diesel engine powerplant may be the most economical source of power for some small mining operations. The most useful size of engine is generally 180-200 HP. In computing requirements for the engine, the following should be known: elevation of mine, ore hoisted per day, waste per day, number of mine and mill shifts per day, days worked per year, tonnage of mill, estimated life of the mine, and rated HP requirements of all mine equipment.
Granitic rocks of the Idaho batholith are the most common rocks in the district. One large roof pendant of Paleozoic (?) quartzite, schist, and limestone is present. Intermediate to basic dikes cut both granitic and sedimentary rocks. Three major fault zones cut the area. Gold and antimony ores occupy shear zones in the Idaho batholith. The low grade of the gold ores make it probable that large scale operations would be necessary for successful mining. Mercury deposits are restricted to a small area at the heads of Fern and Cinnabar Creeks.

The Idaho batholith, which underlies most of the region, has intruded remnants of Belt rocks. Paleozoic sedimentary beds, and Permian volcanics. Challis Volcanics overlie these older rocks, and Tertiary dikes cut many of them. Placer deposits in the area have not yet been developed extensively. Lode deposits in the Challis Volcanics are irregular replacement deposits, mostly of broad lateral but small vertical extent. Lodes in pre-Tertiary rocks are mineralized shear zones, some of which are large and can be traced long distances. Average tenor of the ore is low. The main ore is gold, although some copper and mercury are present.

The oldest rocks in the district, chiefly Beltian (?) quartzites, have limited distribution. These rocks have been intruded by quartz monzonite of the Idaho batholith. Lamprophyre dikes cut the older rocks. Unconsolidated sediments include older gravel, younger gravel, glacial moraine, and alluvium. The Warren district, discovered in 1862, has produced about $17,000,000 worth of precious metals, mostly in gold; all but about $2,000,000 worth has come from placers. The older gravel has only been worked locally, and may produce more gold. Some forty fissure veins, trending to the east, are known in the district.
The most extensive rock in the Florence district is quartz diorite of the Idaho batholith. The igneous rock intrudes Precambrian quartzite and is overlain in a few places by Columbia River Basalt. Late Tertiary gravel mantles some areas, and the valley floors are covered with arkosic sand and peat. Placer gold was discovered in 1861, and has been mined off and on. Quartz mining was active in the 1890's. The district has produced about $15,000,000 to $30,000,000 worth of gold, of which less than $225,000 has come from lodes.

Most of the Murray district is underlain by the Prichard Formation (Belt Supergroup), although younger Belt rocks also occur in the district. Unconsolidated deposits of sand, silt, and gravel occur along stream valleys and on terraces several hundred feet above the streams. Placer deposits have produced gold and silver worth more than $4,000,000, and lodes have produced over $2,000,000, mostly in gold. Gold occurs in lodes in quartz veins along bedding planes in the Prichard Formation; lead and zinc may also occur in these veins. Large volumes of low-grade placer ground still remain unworked.

The prevailing bedrock of the Dixie area, Idaho County, includes granitic rocks of the Idaho batholith, and older (Belt?) gneisses and schists. The Dixie basin is part of an old erosion surface which was faulted or warped below the general level of the surface, and which was partly covered to a depth of more than 700 ft. by an ancient valley fill. The placer deposits are of two types: (1) residual placers, and (2) recombinations along the entrenched valleys. Placer mining began in 1864 and some lodes were mined beginning in the 1890's. During the 1930's, revaluation of gold and improvement in transportation has stimulated new interest in the placer gold.
*Pamphlet 49

GEOL OGY AND ORE DEPOSITS OF THE ATLANTA DISTRICT, ELMORE COUNTY, IDAHO.

By Alfred L. Anderson, 1939, 71 p. (7 figs., 6 plates)

The gold and silver deposits of the Atlanta district lie along a zone of shearing and fracturing that extends northeasterly through the Idaho batholith. Ore occurs in shoots 200 to 800 feet long, from 400 to 800 feet high, and ranging from 4 to 6 feet thick. Deposition was epithermal and accompanied by extensive silicification of the country rock. Ore probably does not occur at greater depths. Mineralization is probably early Tertiary in age.

*Pamphlet 50

THE SILVER BELT OF THE COEUR D'ALENE DISTRICT, IDAHO. By P. J. Shenon and R. H. McConnel, 1939, 9 p. (geologic map)

The rocks in the area around Osburn, Idaho, are (1) Precambrian Belt rocks, (2) intrusive diabase or lamprophyre dikes, and (3) small areas of unconsolidated sand, gravel and silt. Complex folding and faulting have greatly deformed the Belt rocks. Ore occurs in veins and small shear zones and consists of sulfides, mainly tetrahedrite. The main gangue mineral is siderite, which sometimes makes up the entire vein filling. Ore bodies are often zoned. In the vicinity of the veins the country rock has been "bleached".

*Pamphlet 51


Thirteen samples of placer gravel, including nine of flour gold along the Snake River, were studied in the laboratory. Determination for each sample included: screen analysis, gold content, fineness of the gold, and size of the gold "colors". To recover fine gold, panning may be used, but the method is slow. Screening, addition of small amounts of cyanide, and flotation will recover a large amount of placer gold.

*Pamphlet 52

GOLD PLACERS OF THE SECESH BASIN, IDAHO COUNTY, IDAHO. By Stephen R. Capps, 43 p. (4 figs., 13 plates)

The area of the Secesh Basin is underlain by granitic rocks of the Idaho batholith containing roof pendants of quartzite, gneiss, and schist. Small areas of tilted Tertiary sediments are preserved where they have been faulted down into structural depressions. Unconformably overlying the older rocks are extensive deposits of Pleistocene and Recent materials that include 2 ages of moraines, 2 or 3 ages of terrace gravel, and recent alluvium. Large volumes of gold-bearing gravel remain in the district, but most are of low grade and efficient methods and prudent management will be required to exploit them profitably.

*Indicates out-of-print.
GEOLOGY AND METALLIFEROUS DEPOSITS OF KOOTENAI COUNTY, IDAHO. By Alfred L. Anderson, 1940, 67 p. (18 figs., 2 plates)

The most common rocks in the mountains of Kootenai County are the Precambrian Belt Series and granite gneisses formed during batholith intrusion. The Belt rocks have been intruded by dikes, sills, and a small stock. Other rocks in the county are flows and sediments of the Columbia River Group, Tertiary terrace gravels, Pleistocene glacial deposits, and alluvium. The Belt rocks have been warped into a broad, much faulted north-northwest-trending anticline. Mineral deposits are of two types: (1) groups of fissure veins filled with quartz and small amounts of sulfides and (2) replacement deposits.

MINING ACTIVITY IN THE NORTH FORK OF THE CLEARWATER RIVER AREA. By W. W. Staley, 1940, 6 p. (map)

Although the area studied is one of the oldest gold mining areas in the State, only recently has the area been opened up with good roads and other facilities. Improvements in mining and metallurgy have made it possible to mine types and grades of ore unthought of in previous years. Two main areas -- the Vanderbilt Gulch-Dill Creek area and Stocking Meadows southeast to Eldorado Creek -- have been the most heavily worked. A large amount of ground between these two areas needs detailed and systematic prospecting.

GEOLOGY OF THE IDAHO ALMADEN QUICKSILVER MINE NEAR WEISER, IDAHO. By Alfred L. Anderson, 1941, 9 p. (2 figs., 3 plates)

The mercury deposit at the Idaho Almaden mine is in a downwarped part of the crest of a long anticline in the Fayette Formation. The originally permeable sandstone has been cemented with opal, chalcedony, cinnabar, and some pyrite. Mineralized ground extends over more than 100 acres, but most is probably too low grade to be of importance. The main ore body averaged 250 x 175 x 18 feet. In 1939, a considerable part of it had been mined; quicksilver content was reported at 5 to 15 pounds to the ton.

FAULTING IN WESTERN IDAHO AND ITS RELATION TO THE HIGH PLACER DEPOSITS. By Stephen R. Capps, 1941, 19 p. (1 plate)

West-central Idaho was subjected to extensive normal block faulting, probably in Pliocene time. The faults have a prevailing north to northwest trend and displacements of from a few hundred to 3,500 feet. Major streams are antecedent where they cross the faults, but tributaries were diverted to the troughs. There is no evidence that a mature erosion surface has developed since the faulting. Many of the high placer areas lie in the down-faulted valleys. Three stages of Pleistocene glaciation had an important influence on the distribution of certain placer deposits.

Idaho includes nearly 200 recognized mining districts. Brief descriptions of each of these mining districts plus descriptions of coal, mineral fuel and other non-metallic resources are included. Essentially all publications of value through 1941 regarding the geologic features of Idaho have been included. In general, material in the text is listed under mining districts arranged alphabetically by counties. Valuable as a research document.

MICA AND BERYL OCCURRENCE IN EASTERN LATAH COUNTY. By J. Donald Forrester, 1942, 16 p. (4 plates)

Beryl and muscovite mica occur as variable and sporadic constituent minerals in pegmatite dikes that have invaded mica schists and gneisses of Beltian age. The mica is highly disseminated and generally has many internal structural imperfections. Beryllium content, in relatively minor amounts, is restricted to the major dike structures at one property.

A SILLIMANITE DEPOSIT NEAR TROY, LATAH COUNTY, IDAHO. By J. Donald Forrester, 1942, 10 p. (3 maps)

Sillimanite has been concentrated locally in Beltian biotite schists and quartzitic gneisses. These rocks show the effects of dynamic metamorphism and also metasomatism from fluids from the nearby Idaho batholith. The only other type of rock in the area is the Columbia River Basalt. Sillimanite zones are broken by faulting, but the structure is obscure. The sillimanite can be concentrated by flotation.

COPPER MINERALIZATION NEAR SALMON, LEMHI COUNTY, IDAHO. By Alfred L. Anderson, 1943, 15 p. (4 figs.)

The country rock in the mineralized area is impure quartzite and quartzitic argillite of the Belt Supergroup. The mineral deposits are in shear zones that cut the bedding and schist planes. The deposits are of deep-seated origin and are genetically related to the Idaho batholith. The main mine in the area, the Pope-Shenon, has yielded 2,400,000 pounds of copper and has possibilities for the future.

*Indicates out-of-print.
A PRELIMINARY REPORT ON THE COBALT DEPOSITS OF THE BLACKBIRD DISTRICT, LEMHI COUNTY, IDAHO. By Alfred L. Anderson, 1943, 34 p. (5 plates)

Cobalt occurs in Precambrian Beltian quartzite and schist. Cobalt deposits are related to granitic rocks of the Idaho batholith which occur nearby. The deposits include both gold-copper-cobalt and simple cobalt lodes. Both types were formed at high temperatures and at considerable depths. Mineralization is widespread and known lodes are numerous. Some lodes carry 1 to 2 percent cobalt over widths of 20 feet or more.

THE ANTIMONY AND FLUORSPAR DEPOSITS NEAR MEYERS COVE, LEMHI COUNTY, IDAHO. By Alfred L. Anderson, 1943, 20 p. (2 figs., 1 plate)

One antimony and several fluorspar deposits occur as fillings and replacements along complicated fissure and fracture zones in tuffaceous beds of the Casto and Challis Volcanics. The antimony deposit consists of barite with minor quantities of stibnite, fluorite, and chalcedony. The fluorspar deposits are composed largely of fluorite with variable amounts of barite and chalcedony. Some range up to 20 feet wide and several hundred feet long.

FLOTATION TESTS ON FLUORITE ORE FROM LEMHI COUNTY, IDAHO. By Lewis S. Prater, 1943, 8 p. (1 fig.)

Run-of-mill fluorspar from the deposits at Meyers Cove contains too much silica to meet the specifications for "acid spar". Batch flotation tests on a sample gave the following information: Grinding to 100 mesh was required to obtain mineral liberation. A satisfactory product can be made using a conventional fatty acid collector in a pulp conditioned with soda ash and sodium silicate. Heating the pulp increases the rate of flotation and decreases the amount of acid required.

THE AERATING CAPACITY OF FLOTATION MACHINES. By A. W. Fahrenwald, 1943, 4 p.

Two methods may be used to determine the amount of "air" produced by a flotation machine. The first method, although precise, is complex and is limited to use with small experimental units. A second, more practical method, consists of displacing fluid in a flask with bubbled air given off by the machine.
GEOLOGY OF THE GOLD-BEARING LODES OF THE ROCKY BAR DISTRICT, ELMORE COUNTY, IDAHO. By Alfred L. Anderson, 1943, 39 p. (4 figs., 4 plates)

Gold-quartz lodes and veins of the Rocky Bar district seem to be associated with prophyritic dikes intruded into the Idaho batholith. Mineralized faults and fault zones trend N70°—80°E. Veins are about 2 feet wide and lodes are 8 to 10 feet wide; both are up to several thousand feet long. Ore shoots are commonly 20 to 30 feet long, but may be as much as 300 feet long. The deposits are complex, were formed at moderate depths, and show 3 stages of quartz deposition; the gold was introduced with the youngest quartz.

BENEFICIATION TESTS ON LATAH COUNTY CLAYS. By Lewis S. Prater, 1943, 8 p.

Latah County clays have been considered as possible sources of aluminum. Preliminary tests on samples of these clays indicated that only residual clays containing significant amounts of sand are appreciably beneficiated by washing and classification. Washing was found to be superior to air classification as a means of beneficiation. Calcining the clay before washing aided in thickening, but lowered the grade of the product.

SOME PHYSICAL FACTORS AFFECTING FLOTATION MACHINE PERFORMANCE. By A. W. Fahrenwald, 1944, 19 p. (10 figs.)

Flotation machines may be classified as (1) those employing pneumatic means of effecting agitation and aeration and (2) those employing mechanical means (impellers). Of these, impeller-type machines, particularly those using gravity flow, are much more popular. The physical factors affecting flotation, particularly the gravity-flow units include: (1) mechanism of the gravity-flow principal, (2) impeller speed, (3) depth and number of impeller blades, (4) power and aeration variations with cell depth, (5) power and aeration variations with pulp density, and (6) frothers and their effects on power, aeration and bubble size.

GOLD IN IDAHO. By W. W. Staley, 1946, 32 p. (24 figs., 2 plates)

Gold was first discovered in 1860 at Pierce, Clearwater County, and many of the districts now known were discovered soon after. Estimates of gold production before 1900 disagree, but since 1900 production has been about 2½ million oz., slightly less than half of which is from placers. The main gold-producing areas of the State are: (1) Boundary Co., (2) Murray district, (3) the area around Avery, (4) much of Clearwater Co., (5) Edwarsburg and vicinity, (6) Lemhi Co., (7) northern Custer Co., (8) the Sawtooth area, (9) Hailey area, (10) Rocky Bar district, (11) Boise Basin, (12) the Boise quadrangle area, (13) the Silver City district, and (14) placers along the Snake River.
THE SIZE, NUMBER, AND MINERAL-CARRYING EFICACY OF BUBBLES IN FLOTA-
TION. By A. W. Fahrenwald and Lewis S. Prater, 1944, 20 p.

This study is an attempt (1) to define the relationship between bubble dia-
meter and particle size of material carried and (2) to determine where
optimum flotation conditions could be expected. Parallel experiments, using
mixtures of magnesite and galena in one series and mixtures of magnesite
and sphalerite in the other, determined percentage loading and flotation
efficiency. Actual recoveries indicated that mineral loading of the bubble
in a flotation cell is extremely low, perhaps in the vicinity of 1 percent
of the theoretical capacity of the bubbles to carry solid particles to the
surface.

LEAD-ZINC-COPPER DEPOSITS OF THE BIRCH CREEK DISTRICT, CLARK AND LEMHI
COUNTIES, IDAHO. By Alfred L. Anderson and Warren R. Wagner, 43 p.
(10 figs., 2 plates)

The lead-zinc-copper deposits of the Birch Creek district form irregular and
pipelike replacements in complexly folded and faulted Paleozoic limestone
and quartzite. The production has been estimated at between 2½ and 5
million dollars. Production since the 1880's has been small, but the out-
look is for continued small production of base metals for some time to come.
The Paleozoic rocks range from Ordovician to Pennsylvanian. Tertiary sed-
iments lie on an irregularly eroded surface and a variety of igneous rocks
are present.

BRINE LEACHING TESTS ON OXIDIZED ORES OF LEAD. By Lewis S. Prater,
1944, 15 p. (3 figs.)

Because most oxidized ores of lead do not respond to conventional methods of
beneficiation, only those that are of high enough grade for direct smelting
or leaching have any economic value. Preliminary tests on two ores from
south-central Idaho to explore the possibility of recovering the lead by
leaching with an acidified brine solution show recoveries in excess of 85
percent of the lead. However, acid consumption was high enough to make
the economic application of the process unattractive.

FINE GOLD OF SNAKE RIVER AND LOWER SALMON RIVER, IDAHO. By W. W. Staley,
1945, 11 p.

The presence of gold along the Snake and Salmon Rivers was recognized early,
but mining did not begin until 1871. Almost the whole length of the Snake
River has been placered at various times. Most activity along the Salmon
River has been between Riggins and Whitebird. The placer gold along the
Salmon has a fineness of 850 or less; that of the Snake averages about 950.
Old auriferous channels may be buried by the Snake River basalt flows and could
be sought by geophysical methods.
Recently discovered lead-zinc deposits near Bonners Ferry, similar to those of the Coeur d'Alene Region, are in high-angle reverse faults of the Nelson (Kamiskiu) batholith. The presence of gold and arsenopyrite distinguishes the deposits from many in the Coeur d'Alene region. The fault pattern is similar to that in the Clark Fork district and is of Early Tertiary age, unrelated to the intrusion of the Nelson batholith. An east-west zone of structural weakness along Meadow Creek valley may have influenced localization of the ore deposits.

The area contains Permian Seven Devils Volcanics, the Pittsburg Formation, the Triassic Lucile "Series" Columbia River Basalt, the Latah Formation, and Quaternary deposits. Some of the numerous granitic bodies can be correlated with the Idaho batholith. The Seven Devils Volcanics were folded at the end of the Paleozoic, and much post-Paleozoic folding and faulting occurred. Copper deposits are few and widely separated. All are lodes developed along complex zones of shearing in the Seven Devils Volcanics.

The district is underlain by folded and faulted Paleozoic sedimentary rocks of the Wood River (?) Formation which are in fault contact with the Challis Volcanics and are cut by 2 small stocks of quartz monzonite and dikes of diverse composition. The silver-lead deposits are replacements along bedding planes and strike-slip faults in the sedimentary rocks. Ore bodies are small, but of good grade. The deposits were formed at moderate temperatures and at moderate depths, but development has not shown the vertical range of the ore.

The Hailey gold belt contains numerous mesothermal gold-quartz veins in rocks of the Idaho batholith, capped by Tertiary (?) basalt. The veins, in reverse faults, are fissure fillings, 300-1,000 feet long and up to 15 and locally 40 feet wide. The ore shoots are 200-400 feet long and 3-8 feet wide. The veins are associated with lamprophyre dikes and are probably of early Tertiary age. The future outlook for the district is good.
*Pamphlet 77

BENEFICIATION TESTS ON GYPSUM ROCK FROM WASHINGTON COUNTY, IDAHO. By Lewis S. Prater, 1947, 6 p.

Gypsum ore was subjected to selective grinding and screening to determine if siliceous material in the rock could be rejected by this process. Depending on the method of grinding and the cut-off screen size, the grade of the product and the recovery of the gypsum can be balanced against each other in almost any proportion. Under optimum conditions, slightly less than half the acid insoluble could be rejected with a recovery of 70 percent of the gypsum. Poor results were obtained in attempts to upgrade the product by flotation.

*Pamphlet 78

METALLURGICAL TESTS ON MANGANESE BEARING SANDS OF PAYETTE COUNTY, IDAHO. By Lewis S. Prater, 1947, 11 p. (1 fig.)

Leaching tests were run in order to determine the possibilities of extracting manganese from a deposit of sandstone cemented by manganese oxide. The tests indicate that leaching of raw ore with sulfuric acid is superior to leaching pretreated ore with sulfuric acid.

*Pamphlet 79

REACTION RATES IN THE ACIDULATION OF IDAHO PHOSPHATE ROCK WITH SULFURIC ACID. By Lewis S. Prater, 1948, 8 p. (1 fig.)

Raw phosphate rock is reacted with sulfuric acid in the manufacture of commercial phosphate fertilizer. Considerable time is required to "cure" the product to a form in which it can be handled conveniently for shipping and application. Laboratory tests show that under optimum conditions, somewhat more than 75 minutes is required for the acid-phosphate reaction to reach equilibrium. This length of time excludes any plan to mix rock and acid slurry at the time of application to the soil.

*Pamphlet 80

RECONNAISSANCE SURVEY OF THE GEOLOGY AND ORE DEPOSITS OF THE SOUTHWESTERN PORTION OF LEMHI RANGE, IDAHO. By Roy A. Anderson, 1948, 18 p. (6 figs., 3 plates)

The rocks of the southwestern portion of the Lemhi Range consist of Paleozoic sediments (Ordovician to Mississippian) which lie unconformably on a series of Precambrian (?) metamorphic rocks. A small basaltic flow occurs at the crest of the range. Cenozoic valley fill is widespread in the valley bottoms. The sedimentary rocks are intensely folded and thrust faulted. Block faulting is responsible for uplift of the present mountain range. Mineral deposits, primarily lead, occur mainly in Paleozoic quartzite and dolomite.
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BENEFICIATION TESTS ON ORE FROM THE SUN VALLEY BARITE MINE, BLAINE COUNTY, IDAHO. By Lewis S. Frater, 1948, 11 p. (3 figs.)

Barite used in compounding the heavy muds used for oil well drilling must have a minimum specific gravity of 4.5. The material recovered from some portions of this deposit is slightly below S.G. 4.2 and careful control must be maintained in mining to meet specifications. Laboratory studies indicate that grinding to minus 48 mesh is required to free the barite from the light weight constituents. Products concentrated by flotation had gravities ranging up to 4.4 or 4.5.

Pamphlet 82


The Precambrian sedimentary rocks include the Burke, Revett, Wallace, and Striped Peak Formations. Diorite and gabbro sills and a quartz monzonite stock intrude these older rocks. Some Columbia River Basalt is present. The Belt rocks, in general mildly metamorphosed, have been affected by 3 periods of folding and by complex faulting. The principal mineral deposits are in areas of major deformation. The Wallace Formation, not regarded as favorable to ore deposition farther north, covers much of the area. Although the mineral deposits are similar in character to many in the Coeur d'Alene region, no mines are present in the area and the potential does not seem encouraging.

Pamphlet 83

SILVER-GOLD DEPOSITS OF THE YANKEE FORK DISTRICT, CUSTER COUNTY, IDAHO. By Alfred L. Anderson, 1949, 37 p. (17 illustrations)

The Yankee Fork district produced about $12,000,000 of silver and gold in the 19th Century. Recurrent activity since 1900 has produced about $1,000,000 more. The deposits are in the Challis Volcanics which overlie Paleozoic and Mesozoic stratified rocks and the Idaho batholith, all cut locally by dikes. The deposits follow some half dozen zones of fractured and altered volcanic rock and are mostly breccia veins and lodes. The metallic minerals are sparse and fine grained and are of irregular distribution. The deposits have nowhere been found to extend downward more than a few hundred feet.

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MINERAL AND BENEFICIATION BY GRAVITY CONCENTRATION, A FUNDAMENTAL STUDY. By Robert D. Carpenter, 1949, 15 p. (3 figs.)

Experimental studies of gravity concentration using a rotary pan concentrator were compared with the results obtained from a standard Wilfley laboratory table. Materials tested were (1) an artificial mixture of magnesite and magnetite, and (2) a sulfide ore of copper and cobalt. The rotary pan not only had the greater capacity, but also gave better metallurgical results.

*Indicates out-of-print.
Most of the mineralized deposits -- largely base-metal ores -- occur either within or adjacent to contacts between the Purcell sills and Belt metamorphosed sedimentary rocks. Most deposits occur in structurally-weak fracture openings at the sill-sedimentary rock contact. Although mineral production from the various properties in the area has been slight, occurrence of ore deposits over a wide lateral and vertical range suggests extensive mineralization.

The lead-zinc ores of the Pine Creek district, Shoshone County, are difficult to mill because the minerals, especially galena and sphalerite, are finely intergrown. Several mill products that were sized, briquetted, and polished for microscope study show that some of the galena blebs are only a few microns in diameter.

The minerals of commercial value in Idaho black sands include monazite, zircon, ilmenite, and magnetite. All of these black sand minerals will float with oleic or other fatty acids without conditioning, but further separation by flotation is not practical. A combination of screening, gravity methods, and magnetic separation was used to separate the minerals completely.

Silver-lead deposits, in which the main ore mineral is jamesonite, occur in the Boulder Creek district. In the Livingston, the principal mine, the ore is a replacement of a rhyolite porphyry dikes, cut by the Livingston fault which directed the flow of mineralizing solutions. The ores are mesothermal and should persist to depths greater than those reached by mining. The district includes part of the Idaho batholith, Paleozoic sedimentary rocks (mainly Milligen), numerous dikes, and areas covered by Challis Volcanics.
STUDIES ON THE PRODUCTION OF ANTIMONY OXIDES. By Joseph Newton and Willard Dean Wilde, 1949, 52 p. (39 figs.)

Antimony oxide was produced experimentally by blowing air on the surface of commercially pure molten antimony, quenching the vapor in a blast of cold air, and collecting the oxide fume in a bag filter. The product, similar to commercially produced $\text{Sb}_2\text{O}_3$, consisted almost entirely of cubic crystals. A white pigment, without discoloration, can be formed only under certain conditions of temperature and air volume.

DETAILED GEOLOGY OF CERTAIN AREAS IN THE MINERAL HILL AND WARM SPRINGS MINING DISTRICTS, BLAINE COUNTY, IDAHO. By A. L. Anderson, T. H. Kilsgaard, and V. C. Fryklund, Jr., 1950, 73 p. (27 figs., 6 plates)

The districts are underlain by Pennsylvanian and Mississippian sedimentary rocks, Quaternary deposits, and varied Cretaceous and Tertiary intrusives. The Paleozoic rocks are folded into a broad anticline, but faulting is the dominant structural feature. The principal ore deposits are lead-silver veins and lodes in complex fracture zones; in other veins, gold or zinc predominates. The veins are related to andesite and lamprophyre dikes. The deposits are mesothermal and formed largely by replacement along fractures, with little wallrock alteration.

A RECONNAISSANCE OF SOME IDAHO FELDSPAR DEPOSITS, WITH A NOTE ON THE OCCURRENCE OF COLUMBITE AND SMARSKITE. By Verne C. Fryklund, Jr., 30 p. (6 figs.)

Potentially valuable feldspar in Idaho is in zoned pegmatite dikes, but distance from markets has hampered development. Prospects are in Adams, Boise, Cassia, Clearwater, Elmore, Idaho, and Latah Counties, but the most important areas are the Avon district (Latah Co.); the Allison Creek district (Idaho Co.); and the Moulton district (Cassia Co.). The pegmatites of Garden Valley (Boise Co.) contain columbium and uranium.

THE GEOLOGY AND COAL OF THE HORSESHOE CREEK DISTRICT, TETON COUNTY, IDAHO. By Thor H. Kilsgaard, 1951, 42 p. (3 figs.)

The Horseshoe Creek district contains Mississippian through Cretaceous sedimentary rocks overlain by Tertiary volcanic rocks. Subbituminous to high-grade bituminous coal occurs in the Upper Cretaceous Frontier Formation. Seven commercial coal beds, minimum thickness 2 feet each, occur in the district. Past production was roughly 100,000 tons with more than 4.5 million tons still available.

*Indicates out-of-print.
Gypsum deposits along the Snake River, where it borders Oregon, have long been known, but those in Idaho have not become productive. The deposits are banded lenses of varying thicknesses up to 30 feet. They may have formed by replacement of limestone rather than by sedimentary deposition, but proof is scanty. Locally, the deposits may have slid downhill. The total tonnage is not predictable without an extensive drilling program.

The Yellowjacket district is underlain by Precambrian argillaceous and calcereous quartzite of the Yellowjacket Formation and by the Hoodoo Quartzite. These rocks are cut by Cretaceous and Tertiary intrusives and by Miocene dikes. Locally the rocks are covered by Challis Volcanics. The mineral deposits are primarily lodes, with the ore filling fractures, fissures, and breccias, augmented by replacement of altered country rock. Future base-metal production must depend on development of large, low-grade ore bodies; gold will contribute materially to the value of the ore.

The Mineral district has produced more than a million ounces of silver and appreciable amounts of copper and lead. Production has come from silver-bearing lodes which occur along zones of complexly fractured rock and which contain fine-grained sulfide minerals in a calcite gangue. The lodes, which have a restricted vertical range, are the product of shallow, low-temperature Tertiary mineralization. The most common rocks in the district are metamorphosed Permian (?) to Jurassic volcanic and sedimentary rocks. These rocks are intruded by Cretaceous quartz diorite and Miocene basaltic dikes. Two prominent fault systems -- one trending ENE; the other trending NNW -- cut the area.

The Seafoam district is underlain mainly by rocks of the Idaho batholith. Included with the granitic rocks are bodies of Precambrian schist and Ordovician (?) dolomitic limestone, quartzite, and shale. The major structures trend northwest. The mineral deposits occur in shear zones in granitic rock or as replacement deposits in limestone. Value of production of gold, silver, copper, lead, and zinc from 1933 to 1950 is estimated at $127,904.
MINING GEOLOGY OF THE SEVEN DEVILS REGION. By Earl Ferguson Cook, 1954, 22 p. (6 figs., 2 plates)

The principal rocks of the Seven Devils region are the metamorphosed Seven Devils Volcanics and related sedimentary rocks overlain by Columbia River Basalt. The ore deposits and placers have been worked intermittently since 1888 and have an estimated production of $1,000,000, mostly in copper with some lead, tungsten, gold, and silver. Disseminated deposits of copper in the Seven Devils Volcanics are as yet unproductive but show promise.

FLUORSPAR DEPOSITS NEAR MEYERS COVE, LEMHI COUNTY, IDAHO. By Alfred L. Anderson, 1954, 34 p. (16 figs., 6 plates)

Fluorspar deposits near Meyers Cove occur as fillings and replacements along zones of complex fissuring and fracturing in the Challis Volcanics and other Tertiary extrusive rocks. The fluorite is somewhat spotty in its distribution, but tends to form lenticular shoots up to 16 feet thick and several hundreds of feet long. The known vertical topographic range is at least 2,000 feet. The deposits yielded about 12,000 tons of spar from June 1951 to April 1953.

MONAZITE DEPOSITS IN CALCAREOUS ROCKS IN NORTHERN LEMHI COUNTY, IDAHO. By Agatin T. Abbott, 1954, 24 p. (4 illustrations)

Between North Fork and Shoup, immediately north of the Salmon River, several thin beds of marble of the Belt Supergroup contain scattered crystals of the radioactive phosphate mineral monazite. These crystals were probably formed during metamorphism when rare-earth elements migrated from sandy, argillaceous sediments into a more compatible environment of phosphatic limestone.

THE GEOLOGY OF KYANITE, ANDALUSITE DEPOSITS, GOAT MOUNTAIN, IDAHO AND PRELIMINARY BENEFICIATION TESTS ON THE ORE. By Agatin T. Abbott and Lewis S. Frater, 1954, 27 p. (7 illustrations)

Kyanite and andalusite occur in a biotite schist (Prichard Formation?) in Shoshone County near the Shoshone-Clearwater County boundary. Total tonnage of aluminum silicate minerals is estimated at 341,000 tons; the deposits can be worked by open-cut methods. Laboratory tests to determine if the aluminum silicate minerals could be concentrated into a marketable product for use in the ceramic industry indicated that a reasonably clean product could be recovered and that mica might be recovered as a byproduct.

*Indicates out-of-print.
A PRELIMINARY REPORT ON THE FLUORSPAR MINERALIZATION NEAR CHALLIS, CUSTER COUNTY, IDAHO. By Alfred L. Anderson, 1954, 13 p. (8 illustrations)

The fluorspar deposits near Challis occur as fissure and breccia fillings in the fractured and faulted Bayhorse Dolomite. Although exact evaluation must await more extensive underground exploration, surface indications are that many of them are relatively large.

PROSPECTING FOR URANIUM, THORIUM, AND TUNGSTEN IN IDAHO. By Earl Ferguson Cook, 1955, 52 p. (8 figs.)

Uranium is in veins in the Coeur d'Alene and Gibbonsville districts, and in Boundary and Blaine Counties; it occurs in sedimentary rocks of the Phosphoria, the Salt Lake, and the Bear River Formations. Uranium minerals occur in pegmatites in Garden Valley and near Deary, and in placers in several locations. Thorium is present in various placers and in lodes in Lemhi County. Tungsten occurs in deposits of widely different kinds throughout Idaho. The mineralogy and mode of occurrence of these minerals, as well as suggestions as to prospecting and staking claims are described.

A SURVEY OF GROUND WATER OF THE STATE OF IDAHO. By Philip T. Kinnison, 1955, 40 p. (7 figs.)

The principal ground water environments of Idaho are: (1) valley-fill sands and gravels, (2) basalt, (3) sand and gravel intercalated with basalt, and (4) lacustrine sands and gravels. Although surface water is used extensively in the Northern Rocky Mountain province, some water has been developed from valley fill. Rathdrum Prairie is underlain by highly permeable glacial deposits. In the Craig Mt., Palouse, and Seven Devils sections, water comes from basalt and intercalated sediments. In the Bruneau Basin and in the Basin and Range sections, ground water occurs in lacustrine and valley-fill sediments. Ground water is developed from all major environments in the Snake River plain and in the Middle Rocky Mountain province.

FLOATATION TESTS ON AN OXIDIZED LEAD-ZINC ORE FROM THE COEUR D'ALENE DISTRICT, IDAHO. By Lewis S. Prater, 1955, 12 p. (3 plates)

A partially oxidized sulfide ore from the Coeur d'Alene district was subjected to various laboratory flotation tests. The best overall results were obtained with the conventional practice to recover first a lead sulfide concentrate and then a zinc sulfide concentrate, followed by a third step to recover the lead carbonate. Depression of the zinc minerals during collection of the lead sulfide concentrate was the principal difficulty. Photomicrographs indicate that the problem is partially one of grinding.

Gold-mining began in 1860 and until 1870 placer mining was Idaho's main industry. Later gold-silver lodes, lead-silver, and lead-zinc lodes, in succession attracted attention. About 1900 lead led in values, zinc came later but was of importance during both World Wars. Silver has recently markedly increased in importance. Recently, industrial minerals, notably phosphate rock, have become significant. In 1951 Idaho ranked first in production of silver, second in lead and zinc, and sixth in production of metallic minerals. The report contains a brief summary of 49 mineral resources. (Some of the mineral locations are based upon unauthenticated reports).

GEOLOGY AND MINERAL RESOURCES OF THE SALMON QUADRANGLE. By Alfred L. Anderson, 1956, 102 p. (9 figs., geologic map)

In the Salmon quadrangle a thick assemblage of Belt quartzitic rocks are in part covered by the Challis Volcanics and by Miocene sedimentary rocks. Intrusive rocks include Precambrian metagabbro, outliers of the Idaho batholith, dikes related to the Challis Volcanics, and dikes and small stocks of dacite and quartz latite porphyry (Miocene). Glacial deposits of two stages, alluvium, and landslide debris are also present. Deformation is evident in all but the youngest surficial deposits. Mineral resources include copper, gold, lead, possible radioactive minerals, coal, building stone, bentonite, clay, and gravel. One hot spring is present. Gold mining was active in the early days, but copper is the only mineral resource important at the moment.

GEOLOGY OF THE SOUTHEAST PORTION OF THE PRESTON QUADRANGLE, IDAHO. By Henry W. Coulter, 1953, 48 p. (3 figs., geologic map)

A thick section of Paleozoic sedimentary rocks exposed in the Bear River Range includes 12 formations ranging in age from Cambrian through Devonian with an aggregate measured thickness of approximately 11,700 feet. Small down-faulted blocks of the Devonian Jefferson Formation and the Mississippian Madison Limestone crop out. On the west flank of the range about 1,500 feet of the Cenozoic Salt Lake Formation, succeeded by Lake Bonneville sediments and late alluvial and colluvial deposits, are exposed. The Paleozoic rocks are in a N 10°E syncline cut by branching, steep, normal faults.

TUNGSTEN DEPOSITS OF SOUTH-CENTRAL IDAHO. By Earl Ferguson Cook, 1956, 40 p. (11 figs.)

About 20 tungsten occurrences in south-central Idaho are concentrated in a north-west-trending zone which cuts obliquely across the margin of the Idaho batholith. Most deposits are in areas where limy sediments have been converted to tactite near contacts with igneous rock; mineralization was, in part, controlled by structures of Laramide age. Most of the deposits that have produced ore contain scheelite, but a few wolframite group deposits have also been mined.

*Indicates out-of-print.
Pamphlet 109

CLAY DEPOSITS OF NORTH IDAHO. By Charles R. Hubbard, 1956, 36 p. (5 figs.)

Although clay deposits occur in Benewah, NezPerce, Clearwater, Lewis, Idaho, Kootenai, and Latah Counties, deposits of economic interest are mainly in Latah and Kootenai Counties. The clay reserves in the eight major deposits as tabulated total more than 4½ million dry tons.

Pamphlet 110

GEOLOGICAL RECONNAISSANCE OF THE CASSIA MOUNTAIN REGION, TWIN FALLS AND CASSIA COUNTIES, IDAHO. By Walter Youngquist and Jerald R. Haegerle, 1956, 18 p. (2 figs.)

The Cassia Mountains consist chiefly of silicified limestone and orthoquartzites of late Paleozoic age, largely Permian. Total thickness exceeds 10,000 feet. Fossiliferous Ordovician limestone and quartzite crop out on the northwest flanks of the mountains. Pyroclastic silicic volcanic rocks of Tertiary age cap most of the peaks.

Pamphlet 111

ECONOMIC EVALUATION OF PHOSPHATE AND OTHER MINERALS IN SOUTHERN IDAHO. By James F. McDivitt, 1956, 48 p.

Economic factors influencing exploitation of phosphate and other southern and central Idaho mineral commodities include: geology, mining and production costs, distance to markets, power costs, availability of water supplies, and varying governmental policies. Brief case studies of cobalt; lead, zinc, and copper; barite; and pumice are appended.

Pamphlet 112

GEOLOGY AND MINERAL RESOURCES OF THE BAKER QUADRANGLE, LEHII COUNTY, IDAHO. By Alfred L. Anderson, 1957, 71 p. (7 figs., geologic map)

Complexly folded and faulted Belt rocks comprise the mountain ranges; the Lemhi Valley is underlain by Challis Volcanics and Tertiary sedimentary formations. Locally, glacial till and outwash cover older rocks. Mineral resources include: gold and copper deposits; minor silver, lead, radioactive minerals, bentonite, and lignite coal; some building stone, and abundant gravels. One hot spring occurs in the area.
Pamphlet 113

RECONNAISSANCE GEOLOGY OF THE LEESBURG QUADRANGLE, LEMHI COUNTY, IDAHO. By Philip N. Shockey, 1957, 42 p. (13 figs., geologic map)

About 35,000 feet of Belt metasedimentary rocks overlie unformably by 4,000 feet of Ordovician (?) quartzite underlie two-thirds of the Leesburg quadrangle. During the late Mesozoic the older rocks were deformed as the Idaho batholith was emplaced. Tertiary rocks include the Challis Volcanics and continental sediments. Quaternary deposits include pre-Wisconsin and Wisconsin drift. Deposits of cobalt, copper, rare-earth elements, gold, tungsten, and lead-silver are present; opalized fossil wood is an important nonmetallic product.

Pamphlet 114

PETROGRAPHY, MINERALOGY AND ORIGIN OF PHOSPHATE PELLETS IN THE PHOSPHORIA FORMATION. By G. Donald Emigh, 1958, 58 p. (13 figs.)

Petrographic examination of sedimentary phosphate pellets from Idaho (Permian), Tennessee (Ordovician), Arkansas (Pennsylvanian), and the sea floor off the coast of California shows the phosphate to be similar in physical form and mineralogy in all the formations. The pellets are microcrystalline aggregates of what appears to be the carbonate-fluorapatite mineral francolite. It is proposed that the pellets are replaced calcium carbonate pellets and that the phosphate was derived from normal sea water.

Pamphlet 115

URANIUM, THORIUM, COLUMBIUM, AND RARE EARTH DEPOSITS IN THE SALMON REGION, LEMHI COUNTY, IDAHO. By Alfred L. Anderson, 1958, 81 p. (6 figs., 2 plates)

Uranium deposits are widely scattered through the Salmon region with the greatest concentration in the Gibbonsville area. Lode deposits in metamorphosed sedimentary and in volcanic rocks offer the greatest promise. Monazite and columbium-bearing rutile deposits occur as structurally-controlled replacements along a WNW-trending belt of the border zone of the Idaho batholith. Most deposits are small and show an irregular distribution of minerals. Thorite-rare earth vein deposits are confined to the Lemhi Pass region and a small area on Diamond Creek, NWW of Salmon.

Pamphlet 116

GOLD-BEARING GRAVELS NEAR MURRAY, IDAHO. By Wakefield Dort, Jr., 1958, 21 p. (5 figs.)

Placer gold occurs in Quaternary bench gravels and valley-floor alluvium along creeks in the Murray area. The source of the gold is quartz veins in mineralized shear zones in slightly metamorphosed Belt rocks. Recovery of placer gold began in 1883, and has continued at varying rates to the present, when there is only scattered work by individuals. Great amounts of unworked bench gravels contain small amounts of gold. Concentrated pockets of gold, generally along bedrock floors, are uneconomical to mine at present-day prices and mining costs.
Pamphlet 117

GEOLOGY OF THE URANIUM DEPOSITS NEAR STANLEY, CUSTER COUNTY, IDAHO.
By B. F. Kern, 1959, 40 p. (8 plates, geologic map)

The dominantly quartz monzonite Idaho batholith is overlain nonconformably by the Challis Formation in the Stanley area. Uranium, of hydrothermal origin, occurs in: (1) steeply dipping fractures in batholithic rocks and silicic intrusive rocks, and (2) disseminated in beds of arkosic conglomerate at the base of the Challis Formation. Known deposits are distributed in a NW-trending belt; fractures are the primary control. Sixteen groups of claims, described in the text, have been staked, totaling over 230 claims.

Pamphlet 118

GEOLOGY AND MINERAL RESOURCES OF THE NORTH FORK QUADRANGLE, LEMHI COUNTY, IDAHO. By A. L. Anderson, 1959. (14 figs., geologic map)

Within the North Fork quadrangle, the mountains are carved largely in complexly folded and faulted Belt rocks; although two small granitic stocks exist. The northern end of the Salmon basin is floored by the Challis Volcanics and related Tertiary sedimentary formations. Pleistocene glaciation occurred in the highest mountains. Mineral resources include small gold-quartz veins and lodes; large low-grade, galena-bearing quartz lodes; small thorite replacement lodes; and extensive gravel deposits.

Pamphlet 119

ANNOTATED BIBLIOGRAPHY OF PAPERS RELATED TO THE GEOLOGY OF IDAHO, 1941-1957. By Clyde F. Ross, 1959, 219 p., index.

The bibliography lists not only formally published reports and books, but also abstracts, reports, and maps on open file by the U. S. Geological Survey, some engineering reports that include data on the history and production record of Idaho mining districts, and student theses, where these are so filed in universities as to be accessible to interested persons. Each item is abstracted. Publications have been cross-indexed primarily under county headings. Excellent research reference.

*Pamphlet 120

RECONNAISSANCE GEOLOGY OF THE ELK CITY REGION. By Rolland R. Reid, 1959, 74 p. (65 figs.)

Belt equivalent (?) northwest-trending gneisses, quartzites, and schists contain three sets of major superposed folds and four lineation sets representing four postulated metamorphic episodes. Three episodes are pre-Idaho batholith and the fourth is perhaps Laramide. Non-folded dikes, related to the batholith cut the folded metamorphic rocks. High-angle faulting and deposition of coarse-grained sediments in fault-produced basins characterize the Tertiary. Essentially a study of metamorphic petrology.
Pamphlet 121

PLACER DEPOSITS OF THE ELK CITY REGION. By Rolland R. Reid, 1960, 26 p. (8 figs.)

Potentially valuable heavy minerals in 15 samples of the 55 million cubic yards of stream placers in the Elk City region average 27 pounds per cubic yard; ilmenite and magnetite constitute 23.7 pounds per cubic yard. In addition, four small grab samples of the 100 million cubic yards of Tertiary basin gravels averaged 1.6 pounds monazite, 0.3 pounds rutile, 0.3 pounds brookite, and 1.5 pounds zircon per cubic yard. Biotite gneiss, underlying the region, is probably the source of the placer minerals.

Pamphlet 122


Thorite lode deposits occur on Hall Mountain, Boundary County, and in Lemhi Pass area, Lemhi County. A marketable product, containing up to 53.5 percent REO, may be formed by gravity concentration methods. Flotation and hydraulic classification tests on Lemhi Pass ore were deemed unsuitable as commercial methods for concentrating this ore; instead, leaching was determined as a possible method of recovery.

Pamphlet 123

GLACIAL GEOLOGY OF STANLEY BASIN. By Paul L. Williams, 1961, 29 p. (14 figs., 1 plate)

Extensive glacial deposits and evidence of glacial erosion indicate that two major glaciations -- Bull Lake (Early Wisconsin) and Pinedale (Late Wisconsin) -- occurred in the mountains surrounding Stanley Basin. There is also evidence of pre-Wisconsin glaciation, and small cirque moraines in some of the higher peaks represent a minor glacial advance of Recent age. The major glacial advances indirectly caused the accumulation of potential placer deposits containing thorium and rare earth minerals in some of the non-glaciated drainages east of the Salmon River.

Pamphlet 124

GEOLOGY AND MINERAL RESOURCES OF THE LEMHI QUADRANGLE, LEMHI COUNTY. By Alfred L. Anderson, 111 p. (7 figs.)

The rocks of the Lemhi quadrangle include three units of the Belt Supergroup, five Paleozoic formations, the Tertiary Challis Volcanics, four Tertiary sedimentary formations, and seven kinds of surficial deposits. Major deformation occurred during the Laramide orogeny, but later Tertiary faulting produced structural basins. Mineral resources are thorium, iron, copper, dolomite, and gravel.

*Indicates out-of-print.
*Pamphlet 125

STRATIFIED ROCKS OF SOUTH-CENTRAL IDAHO. By Clyde P. Ross, 1962, 126 p. (9 figs.)

The stratified rocks of the mountains north of the Snake River Plain and south of the westward-flowing Salmon River range in age from Precambrian to Recent. Precambrian rocks are widespread but correlations are not practicable. All Paleozoic systems are represented, but with many gaps in the record. Mesozoic strata occupy small, isolated areas close to the eastern and western margins of the region. Cenozoic strata are dominantly volcanic, but continental sedimentary deposits are intercalated with, and may locally overlie, the volcanic rock.

*Pamphlet 126

GEOLOGY AND ORE DEPOSITS OF THE STANLEY AREA. By Raoul Choate, 1962, 122 p. (50 figs.)

The main rock units of the Stanley area are the Pennsylvanian Wood River Formation, the Cretaceous Idaho batholith, and the Oligocene Challis Volcanics. Uranium is being mined from (1) pitchblende-bearing veins in the batholith and (2) younger, bedded deposits in carbon-rich, arkosic sandstone and conglomerate. In addition, vein gold and silver have been mined from the Yankee Fork district and placer gold taken from many of the streams. Potentially economic minerals in the area are scheelite, molybdenite, stibnite, and black sand placer minerals.

Pamphlet 127


The Idaho batholith is the largest geologic unit exposed in the Cartwright Canyon quadrangle of southwestern Idaho. The two other major units are the Columbia River Basalt and the Payette Formation. Landslides, a major problem in the area, include both rotational and planar-type failures. Most failures were attributed to oversteepening of slopes and to overloading critical areas containing montmorillonite. Relocation of the highway and installation of drainage devices are the remedies most commonly recommended. Although a wide variety of construction materials exists in the area, good materials are not abundant.

*Pamphlet 128


The Clearwater Embayment, an irregular prism of basalt covering over 4,000 square miles, was created in mid-Tertiary time by flows of the Columbia River Group which spread eastward into west-central Idaho and covered the valleys and foothills of the Clearwater Mountains to a maximum depth of 3,700 feet. Two formations, the "Lower" and "Upper" Basalts are correlative with the Picture Gorge and Yakima Basalts, respectively. Locally, early Pleistocene basalt flows cover the older flows. The formations are distinguishable in the field by lithology and topographic expression and under the microscope by slight mineralogic variations.
The Idaho batholith is the major rock unit in the Sawtooth Range. Older rock units are the Precambrian (?) Thompson Peak and Pennsylvanian Wood River Formations. Rock units younger than the Idaho batholith include four ages of Tertiary intrusive rocks and Quaternary glacial deposits. The range was uplifted along two N20–30°W Faults, probably during Late Pliocene–Early Pleistocene time. Small, widely scattered occurrences of aquamarine (beryl) are known over a broad area of the range.

Road logs and three-color strip maps (1:250,000) depict the geologic, topographic, and cultural features along U. S. Highways 93 and 93A. The average width of the maps represents about 20 miles on the ground. U. S. 93 serves numerous mines. The rocks along the highway range in age from Precambrian to Recent. Cretaceous and Tertiary plutonic rocks have intruded Precambrian and all ages of Paleozoic sedimentary rocks. Cenozoic volcanic rocks are widespread, ranging from Tertiary rhyolitic welded tuff to Quaternary olivine basalt.

Trappers noted gold in south-central Idaho as early as 1844 and mining began in 1862. The resulting 10-year placer boom yielded over $30 million, largely from Boise Basin. Base metal mining began to prosper in the 1880's after branch railroads reached the mountain borders. The region yielded about $20 million in the early 1900's, mostly in gold, silver, lead, zinc, and copper. Beginning during World War II, tungsten, cobalt, mercury, and antimony have been mined in the region. More recently, the region has been explored for metals such as uranium, beryllium, and columbium. Possible discovery of new ore shoots plus known complex ore bodies, some of grades previously considered uneconomic, should provide much new material for future mining.

A reconnaissance Bouger gravity anomaly map (contour interval 10 mgals) is overprinted on a generalized geologic map of Idaho (1:1,000,000). The Snake River Plain shows a gravity maximum with positive isostatic anomalies as large as 70 mgals. The Idaho batholith is a region of negative Bouger anomalies (as low as -236 mgals), and is approximately in isostatic equilibrium (+20 mgals). The Columbia River plateau in Idaho is an area of gravity maxima with slightly positive isostatic anomalies (+23 mgal). The northern Idaho section is of modest gravity relief.
Pamphlet 133

THE COEUR D'ALENE MINING DISTRICT IN 1963. 1963, 104 p. (15 figs.)

The papers that make up this comprehensive overview of the Great Coeur d'Alene mining district were first presented at the convention held by the Idaho Mining Association at Wallace, Idaho, July 18-20, 1963, to commemorate the Association's 60th anniversary. The 27 papers include discussions on history of the region and individual mines, geologic features of the district, and mining and milling operations of the various companies.

Pamphlet 134

GEOLOGIC HISTORY OF PEND OREILLE LAKE REGION IN NORTH IDAHO. By C. N. Savage, 1965, 18 p. (25 figs.)

The rocks of the Pend Oreille region of north Idaho include metamorphosed Precambrian sediments; Cambrian sediments; the Sandpoint Conglomerate (Cretaceous?); rocks related to the Kaniksu batholith; basalts of the Columbia River Group; and Quaternary glacial, lake, and stream deposits. An economic geology map of Bonner County shows the location of both metallic and nonmetallic mineral resources as well as mines and prospects. Pamphlet 134 is a much condensed and simplified version of County Report No. 6.

Pamphlet 135

VOLCANIC CONSTRUCTION MATERIALS IN IDAHO. By R. R. Asher, 1965, 150 p. (86 figs.)

Commercial deposits of pumice, pumicite, volcanic cinders, perlite, and bentonite are restricted to areas of late Tertiary and Quaternary volcanism in southern Idaho. Pumice, the most important commodity in terms of value, comes from the Idaho Falls area and Oneida County. Pumicite deposits, with large potentials for development, are in Goose Creek basin (Cassia County) and at other locations along the margin of the Snake River plain. Volcanic cinders are abundant and are extensively exploited for road metal. Deposits of perlite (Oneida County) and bentonite (Owyhee County) are relatively insignificant.

Pamphlet 136


The oxbow of the Snake River, the site of a recently completed dam and power plant, is carved in a thick succession of complexly deformed Permian metavolcanics and sedimentary rocks (Seven Devils Volcanics) overlain unconformably by flows and pyroclastics of the Columbia River Group. Surficial stream, river, and talus deposits of Quaternary age cover some of the older rocks. A large northeast trending post-basalt fault and northeast structures in the older rocks control the shape of the oxbow loop.
Pamphlet 137

INTERPRETATION OF SHORT TERM WATER LEVEL FLUCTUATIONS IN THE MOSCOW BASIN, LATAH COUNTY, IDAHO. By Daniel Sokol, 1966, 27 p. (15 figs.)

Moscow basin is underlain by a sequence of basalt and intercalated sediments (Columbia River Group) containing at least five aquifers separated by rocks with such low permeability that hydraulic connection among aquifers is extremely poor. Water levels in wells respond to changes in barometric pressure, pumping in other wells, earthquakes, and wind, as well as seasonal recharge.

Pamphlet 138

GEOLOGY AND MINERAL RESOURCES OF A PORTION OF THE SILVER CITY REGION. By R. R. Asher, 1968, 106 p. (46 figs., maps, tables)

Two important fracture systems trend northeast and north-northwest intersecting near Silver City. Economic minerals were emplaced along faults related to these systems especially at major intersections during at least two periods of hydrothermal activity. Mineralized areas near Silver City yielded approximately $30,000,000 in silver–gold from 1865 to 1914. Antimony–silver veins are found in the Silver City granites and silver–gold veins occur in pre-Pliocene igneous rocks. Associated minerals include mercury, auriferous pyrite and traces of copper.

Structures unfavorable for mineralization occur in the northern mapped area. To the south, a zone of structural intersections caused localization of metalliferous veins near Silver City.

A fracture system oriented N. 75° W. apparently controls mineralization near DeLamar. High-grade silver ore probably occurs in deeper zones in the DeLamar district.

Prospects also appear favorable for development of open-pit mining on Florida Mountain.

Pamphlet 139


A product-flow table is used to show the interrelations of the minerals industry with other industries in the state. Sales and purchase dollars are used as a unit of measurement to represent the flow of goods and services among industries. Transactions in a flow table are arranged so that sales from one industry to another can be read horizontally across the table, while purchases by a specific industry shown at the top of the table can be read vertically down the column. Such a table provides information on: (1) the flow of goods and services associated with Idaho’s minerals industry, both to other sectors within the state as well as exports from the state; (2) the contribution of the minerals industry to Idaho’s economy; and (3) the measurement of income and employment effects.

*Indicates out-of-print.
Three formations of basalt flows and interbedded sedimentary rocks have been mapped in the county and are termed Unit A, Unit B, and Unit C (youngest). Units A and B are correlated with the Yakima Basalt of eastern Washington and Unit C is a Late Pliocene (?) olivine-rich basalt of local origin.

Outcrops of Units A and B are restricted to deeper stream valleys; Unit C underlies a much broader area up to an elevation of about 3200 feet in central Benewah County. The formations and individual flows are distinguished by their primary structures, weathering habit, thickness, rock color, hand specimen petrography, and stratigraphic position. Units A and B are composed of plagioclase, titanaugite, basaltic glass, and usually less than 2 percent olivine. Unit C is composed of plagioclase, pigeonite, basaltic glass, and up to 10 percent olivine.

Selected references suggest that sites of accumulation of non-marine evaporite minerals are discharge zones for poor quality water from regional ground-water flow systems. Comparison of observed spatial variations of ground-water quality with pertinent solutions to flow equations under specified boundary conditions reveals that quality of ground water is a function of flow path length, flow path route, and flow velocity.

Studies of isotope ratios in oil field brines and standard mean ocean water indicate that water in some deep brines is of local meteoric origin; therefore, the brines are part of a ground-water flow system. Observed distribution of fluid potential in the saline portion of some ground-water flow systems on the Atlantic Coast of the United States reveals that saline ground-water discharges toward the ocean floor. Therefore, ground-water may also act as a transport medium for dissolved solids which may be precipitated, under appropriate conditions, as marine evaporite deposits.
Three major units of crystalline rocks form the autochthonous core of the Pioneer Mountains. The lowest structural unit, the oldest rocks in the area, is composed of heterogeneous migmatites of predominantly sedimentary derivation, which form two domes of gneiss. About 7000 feet of metasedimentary rocks, of possible Late Precambrian to Early Paleozoic age and overlying the migmatites, have undergone regional, synkinematic, isochronal metamorphism in the upper amande-amphibolite facies. A Middle Cretaceous intrusive sheet ranging from gneissose quartz diorite and granodiorite to porphyritic quartz monzonite, separates the above two metamorphic units. Field and optical petrographic studies indicate that the pluton was intruded during a waning stage of intense, orogenic metamorphism that affected the metasedimentary wallrocks. The crystalline core of the range is exposed in a window, modified by high-angle faults in low rank Paleozoic rocks.

Studies indicate waste water could be a potential source of fertilization, irrigation and ground-water recharge. Under appropriate hydrogeologic conditions, renovated wastewater can meet U.S. Public Health Service safe drinking water standards. Appropriate hydrogeologic conditions include: the presence of nonconsolidated porous media such as sand, through which the wastewater can move an appreciable distance, before entering a potential water supply; the absence of surficial, jointed rocks through which the wastewater might move without appreciable adsorption of dissolved solids; and a water table at least five feet below the ground surface. A major source of nutrient rich wastewater in Idaho is located within the Snake River Basin upstream from Brownlee Dam.

A growing interest in the use of dynamic ground water as a prospecting tool has accentuated the need for a conceptual framework within which such studies can be placed. A number of such studies have utilized mathematical models as a means of analyzing patterns of ground-water flow. The flow systems depicted by these prepared models provide insight into the source areas for geochemical anomalies observed in ground water. The general procedure proposed consists of the identification of geochemically anomalous ground-water discharge zones by a basin-wide sampling program. The recharge areas from which the anomalous, discharging ground-water emanates are determined by the construction of mathematical models of the ground-water flow system in the basin in which the discharge area occurs. The criteria on which the mathematical models are based must be determined by hydrogeologic investigation.
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Hydrogeological environments commonly considered safe for refuse disposal are those with materials of low permeability and those that are well above the water table. Sites can be engineered (hydrogeologically protective sites) to prevent migration of undesirable leachate.

Major communities in Idaho are placed within an appropriate geomorphic unit for purposes of broad recommendations regarding the selection of safe refuse disposal sites.

The authors explain their support of the Idaho Department of Health's regulations and standards for solid waste control.

Pamphlet 146

GEOLOGY AND GEOCHEMICAL EXPLORATION OF THE VIENNA DISTRICT, BLAINE AND CAMAS COUNTIES, IDAHO. By Spencer S. Shannon, Jr., 1971, 45 p. (fig., table, 4 plates, appendix)

From 1879 to 1889 silver ores valued at two million dollars were recovered from the Vienna district of the Sawtooth Mountains. Since then only small and irregular ore recoveries have been reported. Several types of cold extraction tests were applied on samples taken from the mouths of first and second order tributaries in the district. Some anomalies were masked by contamination from old working sites, but it was concluded that no new, large ore deposits are likely to be discovered in the Vienna district.

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EVALUATION OF MINERALS AND MINERAL POTENTIAL OF THE SALMON RIVER DRAINAGE BASIN IN IDAHO. By C. N. Savage, 1970, 64 p. (8 tables, 15 figs.)

The main Salmon River from the town of North Fork downstream to the mouth of the river has been provisionally designated for inclusion in the Wild and Scenic Rivers Act. Because written criteria for inclusion is minimal and because such a designation would potentially have wide-ranging affects on the Salmon River Drainage Basin, this study was initiated as a pilot project to create a framework of criteria for studying other river systems that are essentially primitive and relatively unpolluted.

The main stem of a river has tributaries branching out into an elaborate drainage network. The Salmon River Basin covers an area of 14,000 square miles. Included in this area are known and potential reserves of valuable mineral deposits. Locations are designated on maps and briefly considered in the text.

*Indicates out-of-print.
The question is asked: how can multiple use be made of these public lands without endangering either the beauty of the Salmon River or the mining industry?

Recommendations include: Proper staking of claims with responsible enforcement of environmental principles to prevent secondary pollution problems, while developing worthwhile mineral deposits where feasible.

Built-in safeguards for the Salmon River proposal to protect and permit growth of the minerals industry in the basin.

Examination of all river systems on their own merits and examination of entire watersheds for other systems being considered for Wild and Scenic designation.

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A drain well or waste disposal well is a natural or man-made hole, crevice, fissure, or opening which extends down into the ground until a water-accepting zone is located. Wells which extend down into the fractured basalt aquifers of the Snake River Plain are being used for the disposal of sewage, street drainage, irrigation excess water, and industrial wastes.

Based on a field inventory of drain wells in 1969 and 1970, it is estimated that there are approximately 5000 drain wells in the Snake River Plain. Of these 5000 wells, approximately 3000 drain wells are concentrated in Lincoln, Jerome, and Gooding Counties.

As the principal domestic water supply resource in southeastern Idaho, it is concluded that a bacterial pollution problem exists on a local scale and corrective measures are needed immediately to protect the public health in several areas. Alternatives to the use of drain wells exist. Sewage, street drainage, and industrial waste drain wells can be eliminated if municipal sewage, above-ground and subsurface soil adsorption systems, and sedimentation-recirculation systems are implemented.
EFFECT OF INDUSTRIAL AND DOMESTIC EFFLUENTS OF THE WATER QUALITY OF THE COEUR D'ALENE RIVER BASIN. By Leland L. Mink, Roy E. Williams and Alfred T. Wallace, 1971, 83 p. (Appendix I, 17 figs., maps and graphs; Appendix II, 8 tables; Appendix III - water quality data)

The Coeur d'Alene River system of northern Idaho includes the North Fork with a healthy aquatic community; the South Fork which has received mining and domestic wastes for over 80 years and during which time has been devoid of aquatic life; and the downstream main river which has been affected by the adverse condition of the South Fork.

Water samples collected from 34 stations on the Coeur d'Alene River system over a sixteen-month period indicate zinc and cadmium concentrations above toxic limits for fish survival occur over much of the South Fork and main stem of the Coeur d'Alene River. With the exception of fluoride, which is high at two stations during low flow, concentrations of most other elements are comparable to or slightly greater than concentrations observed in the North Fork.

Baseline installation of settling ponds for mill wastes in 1968 greatly improved the quality of water, by lowering suspended solids. Macroinvertebrates recently have been discovered in the South Fork and a greater number of species are returning to the main downstream river.

Raw sewage is discharged into the South Fork, and although there is adequate assimilative capacity to handle the present organic load, the effect of the raw sewage on the bacteriological quality is evident.

GEO THERMAL POTENTIAL OF IDAHO. By Sylvia H. Ross, 1971, 72 p. (Appendix I, 13 plates, 2 tables)

Inventory and evaluation of thermal ground water in the state of Idaho shows that such water can be expected in wells and springs almost anywhere along the margins of the Snake River Plain or in valleys south of the Plain. About one-half of the approximately 200 thermal springs in the state emerge from granitic rocks or silicic volcanic rocks adjacent to the Idaho batholith margins north of the Snake River Plain.

Surprisingly, thermal springs and wells are non-existent in the area of Idaho bordering Yellowstone National Park. Here, although ground-water temperatures are commonly as much as 20° F above the mean annual temperature of 3°F, lack of higher temperatures is caused by high rock permeabilities and large volumes of diluting non-thermal water.

Sodium and bicarbonate are the dominant ions in most water, although a few highly-mineralized springs are of the sodium-chloride type. Much of the water is high in silica and fluoride; concentrations of other minerals are low.

*Indicates out-of-print.
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CENOZOIC GEOLOGY OF THE REYNOLDS CREEK EXPERIMENTAL WATERSHED, OWYHEE COUNTY, IDAHO. By David H. McIntyre, 1972, 115 p. (Appendix 6 stratigraphic sections)

The drainage basin of Reynolds Creek and its tributaries, located north of Silver City, Idaho is underlain by volcanic and sedimentary rocks of late Tertiary age and rests upon an erosion surface of considerable relief cut into granitic rocks of probable Cretaceous age. The volcanic and sedimentary rocks may be divided into three sequences separated by unconformities.

Structural relations within the second sequence, tentatively dated Late Miocene or Early Pliocene, show that deformation was more or less continuous during the time interval represented by the sequence. This crustal disturbance probably was a direct result of deformation occurring to the east along the modern Snake River Plain.

The silver-gold mineralization in the Silver City Mining district is the same age as part of the Late Miocene or Early Pliocene sedimentary sequence in the Reynolds Basin.

A sequence of recognizable erosion surfaces, include two rolling uplands at 6,100 and 5,900 feet elevation, terraces along Reynolds Creek, and pediments in the Reynolds Basin.

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COMMUNITY PERCEPTION IN THE COEUR D'ALENE MINING DISTRICT. By Lawrence E. Ellsworth, 1972, 43 p. (10 figs., 14 tables)

Residents of the Coeur d'Alene mining district were surveyed by random selection techniques to determine their perception of their everyday environment. Controls such as age, sex, family size, income adequacy, place of residence, length of residence, birthplace, civic pride, and other factors were used to determine attitudes.

Analysis of these data show air pollution to be the dominant concern. Other significant problems are housing conditions, water quality, and indoor recreation opportunities.

Evaluation of the underground mining environment reveals 19% of the miners fear the occurrence of rock bursts, while 12% are concerned with operation of hoists or possible cable breakage. Respondents with no underground experience imagine the overall hazards to be great, fearing rock caving and claustrophobia.

Regional planning agencies will use this study to implement programs designated to attract more miners to work in the Coeur d'Alene district.
MOSCOW BASIN GROUND WATER STUDIES. By Robert W. Jones and Sylvia H. Ross, 1972, 95 p. (11 figs., 14 tables)

The principal aquifers of the Moscow Basin are three artesian zones in the sedimentary interbeds of the Columbia River Group (Miocene age).

Pumping of the upper artesian zone resulted in declining water levels in wells in 1960-1965, at which time wells drilled into the middle and lower artesian zones began to provide nearly all water for the City of Moscow.

Investigations indicate that pumage of the upper artesian zone was not in excess of recharge during the period 1896 – 1960. A mathematical model aquifer utilizing the theory of image wells, and assuming no recharge to the basin, indicated that the decline in water levels in the upper artesian zone was much less than it would have been if pumage was greatly in excess of recharge. Long-term records suggest that the decline of water levels in the upper artesian zone resulted from barrier boundary effects not from lack of recharge.

The mathematical model suggests that the middle and lower artesian zones can supply the anticipated pumage needs into the 21st century even with a no-recharge assumption. Artificial recharge could supply additional water if needed.

RECONNAISSANCE GEOLOGY OF THE SELWAY-BITTERROOT WILDERNESS AREA. By William R. Greenwood and Donald A. Morrison, 1973, 30 p. (4 tables, 1 fig., 1 plate)

Reconnaissance geologic mapping of about 3,000 square miles in and around the Selway-Bitterroot Wilderness Area was instigated in order to gain at least minimal knowledge of its mineral potential.

The most extensive rocks, are those of the Idaho batholith, a complex of igneous rocks with different structural characteristics, yielding different radiometric ages.

Quartz monzonite is a predominant rock type. The batholith cuts metasediments of the Belt Supergroup and metamorphosed igneous bodies of several ages. Tertiary granitic batholiths intrude the quartz monzonite. All these rock types are cut by numerous aphanitic dikes.

The metasediments were deformed by four regionally penetrative fold events prior to intrusion by the quartz monzonite. Separate phases of igneous intrusion preceded or accompanied each folding and metamorphic event. At least two periods of pro-grade metamorphism appear to have occurred with a maximum in the sillimanite-almandine sub-facies of the amphibolite facies. A third crystallization event, under retrograde conditions, changed the higher grade mineral assemblages.
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Since 1945, Idaho's phosphate industry has progressed from a single underground mine producing somewhat over 100,000 tons of phosphate rock per year to four large surface mines yielding about 4,000,000 tons of rock per year. Ninety percent of this ore is converted into fertilizer and elemental phosphate within the state. The estimated annual value of these phosphorus products exceeds the combined value of metals produced in the famous Coeur d'Alene mining district of northern Idaho.

Rapid growth of the phosphate industry was made possible principally by large reserves amenable to low-cost surface mining; success in penetrating the West North Central States phosphate fertilizer market during its most rapid growth; establishment of an elemental phosphorus industry as the market for phosphate detergents began its explosive growth; and very low electric power rates of critical importance to the industry.

Growth in the fertilizer segment of Idaho's phosphate industry ceased in the late 1960's apparently due to increases in fertilizer production in the southern and midwestern states. However, fertilizer production again turned upward in 1972 as consumption again began to increase rapidly.

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GEOLOGY AND MINERAL RESOURCES OF THE LAKEVIEW MINING DISTRICT. By Peter Kun, 1974, 47 p. (6 plates, 22 figs.)

Precambrian and Cambrian rocks underlying the Lakeview Mining district are cut by Cretaceous intrusives related to the Kaniksu batholith. High-grade thermal metamorphism present around the intrusives resulted in chloritization and seritization of bedrock around veins and shear zones.

The major structural feature of the area is the Packsaddle fault, a northeast-trending, west-dipping normal fault. Sulfide ore-bodies are located in east-trending faults and shear zones, at structural intersections with north-trending, normally barren faults. The ore-bodies occur as high-grade shoots, formed chiefly by fracture filling and replacement of older minerals or bedrock.

Minerals of all stages of emplacement include early arsenopyrite, quartz, pyrite, rhodochrosite, siderite, sphalerite, galena and tetrahedrite. Later emplacements include cerussite, anglesite and secondary silver-bearing minerals. Previous mining was restricted to upper portions of the ore bodies.

Two hypogene and one supergene stage of mineralization can be recognized in the district. Economic potential exists in previously unreported oxidized veins, as well as deeper extensions of the ore shoots previously mined.

*Indicates out-of-print.

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Several techniques of air photography and satellite image interpretation were applied to portions of Owyhee County, Idaho. The principal purpose of this work was comparison of the methods as a goal for geologic reconnaissance with respect to mineral potential evaluation and regional land-use decision making. Geologic interpretation in this area was concerned with major structural trends plotted as "lines".

ERTS-1 Satellite MSS imagery is best applied to rapid analysis of regional geologic relationships. Little actual geologic mapping can be done with MSS imagery. The color composite 1:250,000 scale enlargement of MSS bands 4, 5, 7 is the single most useful ERTS image for geologic evaluation. For rapid reconnaissance studies, 1:120,000-1:70,000 scale conventional vertical stereo airphotos are the most valuable and economical remote-sensing product. The Color Oblique Stereo Airphoto (COSA) technique is excellent for high interest of problem areas due to its low cost, flexibility, and accuracy.

Because each technique provides unique information, a combination of the three methods is optimum for reconnaissance studies.

The problem of ground-water management under the legal code of Idaho was investigated from the viewpoints of hydrology, engineering, economics, and law. Several general conclusions were derived from the combined study.

The legal guidelines for ground-water management are subject to a wide range of interpretation which in turn may provide a wide range of possible administrative actions. It is believed that the range of alternatives available under the Idaho code will allow efficient ground-water management in a wide range of physical situations.

The legal and physical definition of the concept of "reasonably anticipated average rate of future natural recharge" is the greatest problem for re-

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A PRELIMINARY EVALUATION OF GROUND WATER IN UPPER DRY VALLEY AND LITTLE LONG VALLEY CARIBOU COUNTY, IDAHO. By Kenneth Albert Sylvester, 1975, 97 p. (26 figs., 1 table)

Little Long Valley is characterized by a relatively large ground-water flow system on the east ridge and by a smaller ground-water flow system on the west ridge. Preliminary interpretations suggest that surface mining along the west ridge of the valley would not intercept the major ground-water flow system. Upper Dry Valley is characterized by an extensive alluvial-colluvial valley fill. Tests show higher hydraulic conductivities in this material than in bedrock aquifers in Little Long Valley. Surface mining in the valley fill material might require some dewatering.

Existing geologic data with the aid of remote sensing and field reconnaissance were used in this study. Oblique color and infrared aerial photography was particularly useful in delineating geologic control on ground water movement. Data from test drilling substantiate the results of surface studies. Theoretical models were used to develop ground-water flow systems.

Pamphlet 160

GEOLOGIC FIELD GUIDE TO THE QUATERINARY VOLCANICS OF THE SOUTH-CENTRAL SNAKE RIVER PLAIN, IDAHO. By Ronald Greeley and John S. King, 1975, 49 p. (41 figs., road log)

Quaternary volcanic landforms of the south central Snake River Plain are described and discussed in a broad regional and structural framework of the Snake River Plain province. Specific volcanic features at King's Bowl near Crystal Ice Cave are documented and a detailed description and reconstructed geologic history of Split Butte, a maar crater is provided. The morphology of Split Butte is compared and contrasted with Sand Crater and China Cap, two other volcanic constructs in the same region. A discussion of lava tubes is presented and brief comparisons between Snake River Plain features and analogous extraterrestrial volcanic and impact phenomena is considered. A detailed road log for the trip from American Falls to Split Butte and the Crystal Ice Cave — King's Bowl area is included.
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GEOLoGY AND ORE DEPOSITS OF THE SILVER CITY - DELAMAR - FLINT REGION
OWYHEE COUNTY, IDAHO. By Arthur J. Fainshe, Jr., 1975, 80 p. (2 plates,
22 maps, figs. and sketches, 4 tables)

The Silver City - DeLamar - Flint region is in the Owyhee volcanic field in
southwestern Idaho.

Volcanic activity began in Middle Miocene with fissure eruptions. A series
of alkali, olivine basalt general flows, were followed by local flows, flow
breccias, tuff breccias, dikes and domes of silicic quartz latite and rhyo-
lite. Eruptive centers are domes localized on a north-northwest fault sys-
tem. This faulting and the bimodal basalt-rhyolite volcanic assemblage are
attributed to major Early Miocene tectonic rifting in the adjacent Snake
River Plain, and crustal extension in the Basin and Range province to the
south.

During and after late stages of silicic volcanism, thermal fluids ascended
favorable structures, altering adjacent rocks, depositing epithermal gold-
silver-quartz veins, and occasionally surfacing to form silicious hot-springs.

Field mapping and K-Ar radiometric ages demonstrate that the veins (14.6-
15.2± 0.6 m.y. on andularis) are closely associated in time and space with
the late rhyolitic volcanism (15.6-15.7± 0.3 m.y.). Interpretation of min-
erals and alteration assemblages indicate that the ore fluids were of the
sodium-chloride type. The mineralization postdates most or all of the vol-
canic activity.

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RECONNAISSANCE GEOLOGY AND GEOCHEMISTRY OF THE SILVER CITY-SOUTH MOUN-
TAIN REGION, Owyhee County, IDAHO. By Earl H. Bennet II and James
Galbraith, 1975, 88 p. (1 plate, 23 figs., 3 tables)

During the Late Cretaceous, folded and faulted metamorphic rocks in the
Silver City-South Mountain area were intruded by a granodiorite-quartz mon-
zonite magma, probably part of the Idaho batholith-Nevada intrusive complex.
In Lower to Middle Miocene time, a sequence of basalt flows and sedimentary,
fossiliferous interbeds accumulated. The intrusion and extrusion of quartz
latite domes and flows were followed by several minor volcanic phases cli-
maxing with the emplacement of the Silver City rhyolites in Middle Miocene
time. An eruptive stage of Pliocene tuffaceous basalt and pyroclastic sed-
iments appear to have late completed volcanic history of the area, however,
faulting appears to have continued throughout the Tertiary and Quaternary
Periods.

Analysis of various trace-elements associated with mineralization such as
silver, gold, lead, zinc, and molybdenum, and their distribution, indicates
that the best targets for future work are in the Trout Creek, Pickett Creek,
Saddle Hart Creek and Rose Ridge areas. Also promising is the NW-SE trend-
ing silver anomalous belt.
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RECONNAISSANCE GEOLOGY AND GEOCHEMISTRY OF THE MT. PEND OREILLE QUADRANGLE AND SURROUNDING AREAS. By Earl H. Bennett II, Richard S. Kopp, and James H. Galbraith, 1975, 80 p. (2 plates, 23 figs., 4 tables)

Analysis of the 246 stream-sediment samples, collected for this project, for eight elements, resulted in certain summary conclusions. The distribution of anomalous samples is apparently related to the location of major fault systems which trend NNE to NE or to a band of diorite sill/dike outcrops, that have a similar trend across the entire quadrangle. Also, the distribution of chromium and nickel is closely related to the position of the sill/dikes which contain more chromium and nickel than the surrounding Precambrian Pritchard Formation or local granodiorite outcrops.

While copper and zinc are poor indicators, lead and silver are the best indicators of mineralized zones in this area. High lead areas may be low silver areas and vice versa, or both elements may be anomalous in the same area, depending on the type of rock or rock material. Also, gold is a good indicator of mineralization and may be indicative of gold/silver deposits or gold/quartz vein systems. Manganese may be a useful indicator because high values commonly occur in areas anomalous in other metallic elements.

Four target areas which merit further attention are recommended: Lake Darling region at the head of Lightning Creek; Head waters area of Porcupine Creek; the upper end of Char Creek; and the area in and around Auxor Basin.

In addition to these four areas the entire ridge from Round Top Mountain to Mt. Pend Oreille may have localities containing potential economic mineralization.

Pamphlet 164

SETTLING PONDS AS A MINING WASTEWATER TREATMENT FACILITY. By Roy E. Williams and Leland L. Mink, 1975, 41 p. (14 figs., 3 tables)

Temperature, acidity, conductivity, suspended solids, and 13 elements were analyzed from inflow(s), outflow(s), and seepages in and around settling basins installed by the major mining companies in the Coeur d'Alene district.

Results show that settling ponds receiving effluent from concentrating processes were effective in stabilizing temperature and reducing suspended solids, acidity, electrical conductivity, potassium and magnesium, to acceptable levels in pond outflow.

Settling basins receiving effluent from mine drainage, smelting, or refining operations create conditions within the settling basin which result in effluent which is unacceptable in natural stream systems. A method of treatment other than, or in addition to a settling basin, is required for non-concentrator type wastes.
The mine drainage from the Kellogg Tunnel of the Bunker Hill Mine averages about 2,000-2,500 gallons per minute with a pH of about 4 to 4.7. The mine discharge is a major pollution problem because of its acidity, heavy metals load, and suspended solids load contributed by sand-filling.

The delineation of the potential recharge areas provides alternatives to the treatment of the mine discharge. Recharge to the mine has been identified in four areas. The first is an area of subsidence and related fractures resulting from mining by caving. The second is a drift and stope which intersect the stream bed of Milo Creek. The third and fourth areas are in close proximity to stopes extending to the land surface which have induced surface fractures due to subsidence or which have intersected previously faulted areas.

Drainage facilities may be designed to bypass the surface runoff from the recharge areas and sealants may reduce direct infiltration.

The mineralogy of the mine has an important impact on the production of acid water in the mine. Ore samples collected from various locations within the mine showed that the ratio of pyrite to calcite in the samples strongly controlled the resultant pH values.
**Information Circular 1**

BLACK SANDS. By Lewis S. Prater, 1957, 16 p. (2 figs., table showing properties of black sand minerals)

Black sands is a common name for heavy, resistant minerals that accumulate in alluvial deposits when the rocks in which they originally occur are weathered and eroded. Common black sand minerals include magnetite, hematite, ilmenite, garnet, zircon, and monazite. Minor amounts of other minerals may also be present. Churn drilling or shaft sinking are needed to sample adequately potential large-scale placer operations. Metallurgical treatment of the black sand to produce a marketable product must also be considered before mining is begun.

**Information Circular 2**


Theses which have been written in the College of Mines are divided into the 3 fields of geology, metallurgy, and mining, and under each heading are listed by year of completion. Each year the circular is updated by adding newly-completed theses to the list. Titles preceded by (UI) are in the University library; titles preceded by (BM) are in the Idaho Bureau of Mines and Geology library in the College of Mines Building.

**Information Circular 3**

AGRICULTURAL MINERALS. By Lewis S. Prater, 1958, 17 p. (2 figs.)

Soils, particularly those under cultivation, become depleted of the elements required to maintain good plant growth. With the exception of nitrogen, which can be recovered from the atmosphere, all compounds that must be added to overcome soil deficiencies are of mineral origin. Phosphate rock is by far the most important Idaho industrial mineral useful to agriculture; this state has the largest reserve of phosphate-bearing rock in the United States. Nitrates, potash, sulphur, gypsum, and limestone are also important to agriculture.

*Indicates out-of-print.
*Information Circular 4
IGNIMBRITE BIBLIOGRAPHY. By E. F. Cook, 1959, 30 p.

Ignimbrite as used herein means "a nonsorted pyroclastic deposit of probable Pelean or nuee ardente origin". It is used as a rock unit and not as a rock type. An ignimbrite may be composed of tuff or tuff-breccia, and it may be welded, partially welded, or entirely nonwelded. The early publications on such rocks were all of foreign origin; the 1930's were the pioneer decade of ignimbrite study in the western United States. Since the 1930's Pelean deposits ranging in age from Precambrian to Recent have been found in every continent except Antarctica. The bibliography contains 19 pages of references, listed by author.

*Information Circular 5
CLAY, ITS COMPOSITION, PROPERTIES AND USES. By Joseph Newton, 1960, 35 p. (3 figs.)

Clay deposits are formed by alteration of siliceous rocks. Clays are made of one or more complex clay minerals, which may be either amorphous or crystalline. Clay minerals contain from 6 to 25 percent water, which gives clay many of its useful properties. Clay minerals are difficult to identify from chemical analysis only; thus, differential thermal analysis, x-ray analysis, dehydration curves, and electron microscopy may all be needed to identify a clay mineral. Industrial types of clay include fire clay, china clay, bentonite, pottery clay, and Fuller's earth, and miscellaneous clays.

*Information Circular 6

The opening up of Idaho to large numbers of people began with the placer mining rushes in the 1860's. The mines influenced the development of river navigation, railroads, and wagon roads. The mines also influenced the development of agriculture; because of the great demand for food, many miners took up farming. Then, in 1880, the discovery of galena marked the transition point in Idaho from small-scale isolated mining to organized, large scale-capitalistic mining and added even more stability to Idaho's economy. (Also included is an excerpt from an 1885 publication by J. L. Onderdonk, Territorial Controller.)

*Information Circular 7
PROSPECTING FOR BERYLLIUM IN IDAHO. By R. R. Reid and Raoul Choate, 1960, 19 p. (2 figs.)

In Idaho, beryllium as beryl occurs in the Sawtooth Mts., near Cobalt (Lemhi County), near Deary (Latah County), and near the Middle Fork of the Boise River (Elmore County). Favorable locations for prospecting include portions of the Idaho batholith (especially those near tungsten mineralization, iron mineralization, or metasomatic mineralization) and parts of the Challis Volcanics. Samples of rocks thought to contain beryllium should be checked by a beryllometer, chemical, or spectrographic tests. Two U. S. companies extract and process beryllium, although 16 other companies are also potential buyers.
Information Circular 8


From 1954 to 1958, Congress passed 5 laws that are important to the mining industry: Public Law 585 provides for validation of claims located between July 31, 1939 and February 10, 1954. Public Law 167 provides for multiple use of the surface of a tract of land. Public Law 359 permits development of the mineral resources on public land withdrawn or reserved for power development. Public Law 85-701 provides for Federal financial assistance to exploration for additional mineral reserves. Public Law 85-876 changes the definition of "labor" required for assessment work to include geological, geochemical, and geophysical surveys.

Information Circular 9


Each of the four northwestern states has its own set of regulations dealing with alluvial mining (dredging, placering, and washing of gravel). The subcommittee recommends: that permits be required for future alluvial operations; that water quality be controlled; and that when mining is completed, disturbed water courses and land along streams be restored. The committee further recommends, where needed, that existing state laws be amended to conform to their suggestions.

Information Circular 10

METALS FROM BLACKSANDS: SELECTED TECHNOLOGIC AND ECONOMIC DATA. By C. N. Savage, 1961, 34 p.

The exact amount of blacksand minerals in Idaho placers is not definitely known, but their quantity and potential value are known to be fairly high. Research and development will determine the proportions of future exploitation. New uses are being developed for some of these metals, while unit prices are being reduced. The outlook for thorium, scandium, yttrium, and the rare earths is uncertain at present; zirconium and hafnium, titanium, niobium and tantalum should develop moderately expanding markets.

Information Circular 11

IDAHO'S MINERAL FRONTIERS. By E. F. Cook, 1961, 11 p.

The value of mineral production in Idaho dropped from $70 million in 1959 to $56 million in 1960. Both government and industry are increasing research efforts to find and develop structural minerals, almost all of mineral origin, with which to build a great variety of new objects and machines. Most of the dollars invested in new mineral facilities in Idaho in 1960 went into nonmetallics. In 1961, a nonmetallic mineral, phosphate was for the first time in a position of equality among the metals.

*Indicates out-of-print.
*Information Circular 12


Production of mineral wealth in Idaho in 1961 increased more than 20% (from $57 million to $69 million) over 1960. Among other news that affected Idaho's mineral industry was the news of a halt in sales of silver by the U.S. Treasury, and news of increases in exploration and development at mines in the Coeur d'Alene district as well as elsewhere. Four appendices are attached: 1961 EMG&G publications; mineral aspects of the Wilderness bill; metal production and employment in Idaho 1947-1961; and value of Idaho's mineral production, 1861-1961.

*Information Circular 13

IGNIMBRITE BIBLIOGRAPHY AND REVIEW. By E. F. Cook, 1962, 64 p.

Most students of ignimbrites believe them to have been formed by deposition from a hot, rapidly expanding, turbulent, highly mobile, magmatic gas cloud (density current) which carries with it intratelluric crystals, liquid droplets of the exploding magma and the resultant glass shards, as well as rock fragments torn from the walls of the vent or picked up from the ground. This expanded edition of Information Circular 4 includes an additional 200 references on ignimbrites.

*Information Circular 14

PRIMITIVE MAN ON BROWNS BENCH. By Alfred W. Bowers and C. N. Savage, 1962, 23 p. (12 figs.)

Geological and archeological studies of the Dean site on Brown's Bench southwest of Twin Falls, show that terrain, bedrock types, and climate were important reasons for the presence of small migrant bands or primitive man, probably as early as 10,000 years ago. Including the oldest crudely-chipped tools, a total of 22,159 archeologically useful specimens of stone and pottery were obtained at the site.

*Information Circular 15

GEOMAGNETICS AND GEOLOGIC INTERPRETATION OF A MAP OF EASTERN BONNER COUNTY. By C. N. Savage, 1962, 16 p. (3 figs., including aeromagnetic map)

The included magnetic map of eastern Bonner County was released in open file by the U.S. Geological Survey in 1962. Although known mineralized locations in the vicinity of Clark Fork and near Lakeview appear to exert little control over the general pattern of measured anomalies the pattern does appear to reflect the configuration of the Kaniksu batholith and the larger dioritic dikes and sills underlying much of the region. In general, magnetic highs appears over areas where Belt rocks exhibit a slightly higher than normal metamorphism, suggesting the presence of plutonic masses at depth.

Location of each placer or lode claim, not to exceed 20 acres, on State-owned land, must conform to legal subdivisions on surveyed land. The locator must immediately post conspicuously a dated notice of his intent; within 20 days he must file a certificate of location with the State Board of Land Commissioners. Within 90 days from date of location, the locator must make an excavation or dig a discovery shaft. To hold his claim for 2 years the locator must perform $100 worth of work during each year for each claim. After 2 years the locator is eligible to lease the land from the State.


Mean-dip maps are graphic displays of the relative dip of bedding or other planar elements through the map areas. Such maps show the relative intensity of deformation of each upright fold event and make possible delineation of tectonic boundaries. Construction of a mean-dip map consists of: (1) subdivision of a structure map into subareas which are reasonably homogeneous with respect to the strike of the planar element; (2) calculation of the arithmetic mean of the dips within each subarea; (3) plotting each mean-dip value at the median areal center of its subarea; and (4) contouring of the resulting distribution of mean dips.


The most extensive rock unit in the area, the Idaho batholith, is composed of coarse-grained quartz monzonite. This rock unit cuts Belt metasediments that have been deformed by 3 episodes of metamorphism and igneous bodies of several ages. Small granite stocks cut the Idaho batholith. Numerous dikes cut all other rocks. Near Meadow Creek lookout, malachite and chrysocolla occur in a highly-fractured white quartzite in a zone that may trend N-S. Assay of a selected sample indicates a copper content of 1%.

*Indicates out-of-print.
Information Circular 19 (2nd Ed.)


Abstracts of Idaho Bureau of Mines and Geology publications from 1920 through 1975 replaces the first edition of Information circular 19 published in 1968. This edition has been revised and updated and provides useful, quick reference to subject matter covered by out-of-print documents as well as currently available publications.

Information Circular 20


Accepted usage of formal and informal names, through 1967, as applied to Idaho rock units. Alphabetized for rapid use, the information lists the source of the name, thickness of sedimentary units, lithology, location of the type section, stratigraphic position, names of units above and below (when applicable), chronologic position in geologic time, and selected references to literature relative to original name and section.

Information Circular 21

COMPUTER ANALYSIS OF ZIRCON MORPHOLOGY DATA. By Marion R. Hedberg and William R. Greenwood, 1970, 15 p. (5 figs., appendix)

Zircon morphology data can be rapidly processed using the IBM 360/40 computer. Crystal length and width can be used to calculate statistical data, including the means of length and width, the standard deviations of these means, and the linear regression coefficients of the relation of crystal axial ratios versus crystal length.

Sample statistics can be calculated for a facet or faceting, rounding, and color subclasses to reveal possible differences in crystal shape within a given sample, or for comparison of shape for a given subclass between samples from different rocks. These calculations are useful in distinguishing zircons from metasomatic granitic rocks and zircons from plutons of magmatic origin. Such data may also serve in correlating comagmatic igneous plutons.

Information Circular 22

DELINEATION OF MINERAL BELTS OF NORTHERN AND CENTRAL IDAHO. By William R. Green, 1972, 8p. (4 figs.)

Five linear, mineralized belts are delineated and described for northern Idaho. The belts represent probable occurrences of gold, silver, lead, zinc, and copper resources and known reserves. The data indicate that mineralized ground tends to parallel regional fracture and other structural patterns.

Four composite belts occurring in central Idaho are notable. Relationship of these latter belts to regional structure is less certain, indicating a need for more detailed geologic studies in this region. Since these belts suggest where future mineral exploration might be profitable, classification for land-use should include mineral potential.
Information Circular 23

GUIDE FOR THE LOCATION OF WATER WELLS IN LATAH COUNTY, IDAHO. By Dale R. Ralston, 1972, 14 p. (12 figs., maps and sketches)

Primary factors influencing well location are ground-water geology, topography, potential pollution sources and accessibility. The major geologic, rock units of Latah County include metamorphosed sedimentary rocks of the Precambrian Belt Supergroup; granitic intrusive rocks of Cretaceous age; basalt flows and interbedded sediments of the Miocene Columbia River Group; surficial sediments consisting of the Palouse Formation; and younger aeolian loess and stream deposited alluvium. For purposes of well location, the county is divided into five subareas. In all subareas, known artesian zones in the Columbia River Group are the primary aquifers.

Information Circular 24


605 streams are entered alphabetically, and located in four ways.
1. relationship of the stream to a major drainage system
2. township, range and section
3. ranger district
4. county

Of special interest are historical notes and comments relating to name origins.

Information Circular 25

EVALUATION OF PHOSPHATE RESOURCES IN SOUTHEASTERN IDAHO. By J. Dan Powell, 1974, 33 p. (2 tables, 7 figs.)

Previous estimates of phosphate rock potential in southeastern Idaho are considered volumetrically accurate, but impractical relative to projection of mining activity in Idaho over the next 50 years. Much published information on the geology and mining of phosphate-bearing rocks is already available. This information, together with new raw data from mining companies, on-site measurements, and projected increased demands and costs, comprise the basis of revised tonnage estimates of phosphate rock potentially and feasibly mineable. A conservative estimate indicates 450 million short tons of ore-grade phosphate rock can be mined before the year 2025.

Information Circular 26

RECONNAISSANCE GEOCHEMISTRY OF THE BIGHORN CRAGS. By Charles Knowles, 1975, 24 p. (13 figs., 14 tables, 8 maps)

The Bighorn Crags in Lemhi County contain many cirque lakes that are the headwaters of numerous streams dissecting a rugged terrain of about 120,000 acres. Fine fraction sediments were collected from all first and second order streams at one-half mile intervals. The samples were analyzed on an atomic absorption spectrophotometer for trace amounts of silver, gold, cobalt, copper, molybdenum, lead and zinc. Areas around Goat Lake, Cathedral Lake and Cant Ridge show anomalies in silver, cobalt and copper.
Information Circular 27

GEOCHEMICAL PROCESSING AT THE IDAHO BUREAU OF MINES AND GEOLOGY. By James Galbraith, 1975, 28 p. (10 tables)

Numerous computer techniques for the compilation and interpretation of geochemical data are being used at the Idaho Bureau of Mines and Geology. There are programs to calculate the basic statistics of data wherein the type of distribution of a variable may be tested parametrically, tests to make comparisons between pairs of variables (elements); programs for analysis of variance and covariance; regression programs such as step-wise discriminant analysis and R-mode factor analysis. For map preparation, a program is available which creates grid data sets from random data sets and makes use of an off-line Cal-Comp plotter to contour the results.

Information Circular 28 (Two field trip guides prepared for the 28th annual meeting of the Geological Society of America, Rocky Mountain section, in Boise, Idaho, May, 1975)


Field trip 7 presents a correlation between rock units and fossil plants from eleven localities in the Weiser area. Three floral stages indicate a trend towards more pronounced climatic barriers in western North America in which winters became more severe and summers drier.

GEOLOGY AND SCENERY OF THE SNAKE RIVER ON THE IDAHO-OREGON BORDER FROM BROWNLEE DAM TO HELLS CANYON DAM. By Patsy J.B. Miller, 1975, 11 p. (1 fig., 1 map)

Field trip 8 is a 34-mile geologic roadlog along the Snake River. In this 300-foot drop in river elevation, the exposed rock suite represents more than 180 million years in time. Miocene basalt flows are exposed at Brownlee with older Permian and Triassic metavolcanic units exposed toward Hells Canyon Dam. Included with the roadlog is a list of selected references used in the geologic compilation of the area.

Information Circular 29

A BRIEF GEOLOGICAL SURVEY OF THE EAST THUNDER MOUNTAIN MINING DISTRICT VALLEY COUNTY, IDAHO. By Spencer S. Shannon, Jr., Stephen J. Reynolds, 1975, 13 p. (1 map)

The geology of the eastern part of the Thunder Mountain mining district was mapped in the summer of 1973. A brief explanation accompanies the map and covers the stratigraphy, structural geology, geomorphology, mineralization and genesis.
Information Circular 30

DISTRIBUTION OF PRECIPITATION IN LITTLE LONG VALLEY AND DRY VALLEY, CARIBOU COUNTY, IDAHO. By Dale R. Ralston and E. Woody Trihey, 1975, 13 p. (8 figs., 1 table)

Nineteen storage-type precipitation gages were installed in the Little Long Valley-Dry Valley portion of a phosphate mining area in southeastern Idaho in September, 1974. Results from the first year of gage operation indicate a range in precipitation of an average of 18 inches on the valley floors to an average of 21 inches on the ridges. Long term precipitation records at a nearby station indicate that the 1975 water year was near the long term average. Provides basic data needed to assess open pit mine planning, its relation to environmental problems and possible guidelines leading to compatibility and balance between surface mining and the ecosystem.
GEOLOGY AND MINERAL RESOURCES OF NEZ PERCE COUNTY. By Charles R. Hubbard, 1956, 17 p. (geologic map)

Much of Nez Perce County is underlain by basalt and intercalated sediments of the Columbia River Group. Belt rocks and Seven Devil Volcanics, intruded by granitic stocks and dikes are exposed in places through the basalt cover. Placers and some gold and copper lodes are known; nonmetallic mineral deposits of interest include limestone, gravel, stone, sand, and clay.

MINEAL RESOURCES OF LATAH COUNTY. By Charles R. Hubbard, 1957, 27 p. (geologic map)

The more rugged areas of Latah County are underlain by Belt rocks and by outliers of the Idaho batholith. About a third of the County is underlain by basalt flows and intercalated sediments of the Columbia River Group. About 99% of metallic mineral production has been in gold; the major potential mineral wealth is in industrial minerals, especially high-grade fireclay and high-alumina clay. Mica, beryl, and other nonmetallic minerals are also present.

GEOLOGY AND MINERAL RESOURCES OF ADA AND CANYON COUNTIES. By C. N. Savage, 1958, 94 p. (27 figs., geologic maps)

The oldest rock unit in Ada and Canyon Counties is the Idaho batholith. Basalt flows and pyroclastics of the Columbia River and Snake River Groups represent several episodes of Tertiary and Quaternary volcanism. Widespread sedimentary rocks are largely of fluviatile and lacustrine origin. The older rocks belong to the Fayette and Idaho Formations; Quaternary deposits include clays, silts, sands, and gravels. Post-Paleozoic tectonic history consists of a series of uplifts with attendant faulting and erosion. Gold, in small amounts, is the only metallic mineral of economic value; the most abundant mineral deposits are sand and gravel and water. Significant quantities of mineral fuels seem to be absent.

GEOLOGY AND MINERAL RESOURCES OF GEM AND PAYETTE COUNTIES. By C. N. Savage, 1961, 50 p. (13 figs., geologic map)

Much of Gem and Payette Counties is underlain by the Idaho batholith or by flows of Columbia River Basalt overlain by silicic volcanic rocks of Pliocene to Recent age. Sedimentary materials range in age from Miocene to Recent. Important mineral commodities are silica sand and sand and gravel. Sandstone, arkose, and basalt are available as dimension stone. The Pearl district contains minor amounts of gold, silver, copper, lead, and zinc. Ground and surface water supplies are reasonably plentiful. Neither natural gas nor oil seems to be present in commercial amounts.

*Indicates out-of-print.
Sedimentary rocks in Bonneville County include folded, block-faulted and over-thrust Paleozoic, Mesozoic, and Cenozoic strata. Igneous rocks are primarily extrusive, including basalt, rhyolite, and pyroclastics; although intrusive rocks occur on Caribou Mountain. Nonmetallic minerals — clays, sands, gravels, and pumice — are the most important commodities, although gold was relatively important in the past. Attempts to produce oil, gas, radioactive minerals, and coal have met with failure. Future exploration should consider the vast limestone resources and possible economic deposits of salt, gas, oil, copper and vanadium.

Rocks in Bonner County include Precambrian metasedimentary rocks, Cambrian and post-Cambrian sedimentary and metamorphic rocks, igneous rocks related to the Kaniksu batholith, dikes, and sills of several ages, and Quaternary glacial drift and fluviatile deposits. Major wrench faults are bounded by mosaic, bedded plane, and mineralized block faults. Of past and potential value are sand and gravel, dimension stone, limestone, silica, and peat; and minerals containing gold, silver, lead, zinc, and copper. The outlook for mineral production is good; intensified exploration and development by technically and financially qualified persons are justifiable. Water resources are generally plentiful.
MINERAL RESOURCES REPORTS

*Mineral Resources Report 1
COAL IN IDAHO. By W. W. Staley, 1945, 4 p. (geologic map)
Although most coal reserves are in the Driggs area, Teton County, some are in the Wilson Creek-Caribou district, 25 miles south of Idaho Falls, and the Continental Divide district near Kilgore, Clark County. In all three areas coal occurs in the Cretaceous Frontier Formation. The field near Driggs has been called the St. Anthony, Teton Basin, and Horseshoe Basin field, but the last name is preferred. The coal beds are one to nine feet thick, of bituminous rank, and estimated to be able to yield 11,000,000 tons. The coal is friable, but with modern methods of use, this is not a serious disadvantage.

*Mineral Resources Report 2
SULPHUR IN IDAHO. By W. W. Staley and Lewis S. Prater, 1945, 7 p. (index map)
Native sulphur occurs in 5 sections southeast of Soda Springs in Caribou County. The sulphur is associated with gypsum in a cemented fault breccia zone. It is estimated that the deposits contain 1,000,000 tons running 10 percent sulphur. Preliminary flotation tests to determine the quantity of sulphur that can be recovered and the grade of the product show the deposit to be amenable to this treatment with satisfactory recovery.

*Mineral Resources Report 3
BENEFICIATION OF IDAHO PHOSPHATE ROCK. By Joseph Newton and Oscar C. Finkelnburg, 1947, 22 p. (7 figs.)
Low-grade phosphatic shales from the Fort Hall and Montpelier deposits were concentrated in the laboratory. The principal method used was selective grinding followed by removal of fine "slime" from the coarser phosphatic oolites. Head samples contained 24 to 26 percent P₂O₅. It was possible to produce acid-grade (P₂O₅ = 31.5%) phosphate with recoveries of 85 percent from the Fort Hall shale and 70 percent from the Montpelier shale.

*Mineral Resources Report 4
DIATOMITE DEPOSITS OF SOUTHWESTERN IDAHO. By Harold Auburn Powers, 1947, 27 p. (32 figs.)
Sixty-three samples of diatomite from 20 localities in Adams, Washington, Gem, Ada, Boise, Owyhee, Elmore, Camas, and Twin Falls Counties are Tertiary accumulations of diatom frustules. Laboratory analysis shows that most of the diatomite is fair to excellent for filters, insulation, or abrasives. Total reserves on the basis of geologic mapping, are conservatively estimated at 4,615,000 tons dry weight.

*Indicates out-of-print.
*Mineral Resources Report 5

DISTRIBUTION OF HEAVY ALLUVIAL MINERALS IN IDAHO. By W. W. Staley, 1948, 12 p. (location map)

Minerals in alluvial deposits of central Idaho include gold, ilmenite, garnet, zircon, chromite, hematite, amalgam, pyrite, monazite, rutile, titanite, cinnabar, cassiterite, corundum, columbite-tantalite, and various uranium minerals. Most of these have been recognized in recently-collected samples, but the quantity of some are small; a large prospective tonnage of monazite, zircon, and ilmenite is available.

*Mineral Resources Report 6

PUMICE AND PERRLITE IN IDAHO. By W. W. Staley, 1950, 10 p.

Plants for the manufacture of light-weight aggregate blocks using pumice and perlite are in Idaho Falls, Jerome, and Boise; many individuals make small numbers of blocks. The bulk of the pumice comes from the Idaho Falls area, although potential commercial deposits occur in Owyhee County, near Fairfield (Camas County), Hollister (Twin Falls County), Rockland (Power County), Tetonia (Teton County), and north of Magic Reservoir (Blaine County). Deposits of perlite have been little more than prospected yet. Technical problems confronting manufacturers include: (1) the proper aggregate mixture, (2) the slowness of curing, and (3) the development of shrinkage cracks.

*Mineral Resources Report 7

URANIUM AND THORIUM-BEARING MINERALS IN PLACER DEPOSITS IN IDAHO. By J. Hoover Mackin and Dwight L. Schmidt, 1957, 9 p.

Uranium and thorium-bearing placer deposits sufficient to be worked by dredges occur in 3 areas in central Idaho. The main minerals are: euxenite at Bear Valley, uranathorite in the Hailey area, and monazite in Cascade-Long Valley. The radioactive placer minerals were derived from segregations of accessory minerals weathered out of quartz monzonite of the Idaho batholith. The grade of the placer deposits depends largely on the number and size of these segregations and on the physiographic history of the drainage basin. (This report has been reprinted from pages 375-380 of U.S.G.S. Prof. Paper 300.)

*Mineral Resources Report 8

RADIOACTIVE MINERALS IN IDAHO. By E. F. Cook, 1957, 5 p.

Uranium occurs in the Coeur d'Alene region, the Gibbonsville district, the Hailey area, Stanley Basin, Garden Valley, and in Permian phosphate rock. It also occurs in lignite coal and in the Challis Volcanics (particularly in tuff containing organic matter). Thorium is known in veins and replacements in Lemhi County and both uranium and thorium are present in placers. Major uranium reserves are in the phosphate rock.

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Mineral Resources Report 9

THE ONEIDA PELITE DEPOSIT. By W. W. Staley, 1962, 7 p. (3 photos)

Expanded perlite, because of its outstanding insulating properties and light weight (about 8 pounds per cubic foot), is widely used in construction, industry, and agriculture. About 6,200,000 tons of easily-minable perlite occur in northern Oneida County. The Oneida Perlite Corporation recovers this material from an open-pit mine about 25 miles north of Malad City. The perlite is crushed and screened, then taken to Malad City to the company's expanding plant.

Mineral Resources Report 10

ECONOMIC GEOLOGY OF CARBONATE ROCKS ADJACENT TO THE SNAKE RIVER SOUTH OF LEWISTON, IDAHO. By C. N. Savage, 1965, 26 p. (8 figs., geologic map)

Permian and Triassic rocks containing a high percentage of calcareous rocks crop out about 22 miles south of Lewiston at Lime Point. Younger granitic intrusive and basaltic extrusive rocks are also present. The Lime Point area has a probable reserve of over 626 million short tons of commercial-grade carbonate rock suitable for production of Portland cement, agricultural and commercial lime, and other purposes. CaCO₃ averages 95%; most impurities are negligible. If finished lime products or raw materials could be shipped by water from Lewiston, they could become competitive with existing lime rock sources in the region.

Mineral Resources Report 11


The Lemhi Pass thorium and rare-earth deposits in Idaho and Montana are the largest known in the United States. The deposits are Tertiary (?) veins and replacements in quartzites, phyllites, schists, and gneisses of the Precambrian Belt Supergroup. Quartz-hematite-thorite veins with yttrium-group (rare earths) dominate the southern portion of the district; whereas, monazite replacements with cerium-group (rare earths) dominate the northern part. Base and precious metals are present in some of the thorium-rare earths and in other veins of the district including border zones. More than 70 mineral species have been reported from the area. Grid patterns in quartz resemble carbonate cleavage. This suggests that carbonate mineralization may have been replaced by silica in many of the veins. The dominant thorium mineral is thorogummite or auerlite, concentrated in limonitic zones by supergene processes. Mobilization by acid solutions from oxidizing pyrite is believed to have been the most important method of emplacement.

*Indicates out-of-print.
Special Report 1

MINERAL AND WATER RESOURCES OF IDAHO. Compiled by U.S. Geological Survey in cooperation with the Idaho Bureau of Mines and Geology, Idaho Department of Highways and the Idaho Department of Reclamation, 1964, 335 p. (56 figs.)

The mineral industry, with a total historical production of over $3.6 billion and a production in 1962 of $82.6 million, forms an important segment of Idaho's economy. Mineral commodities within the State include: antimony, barite, beryllium, clays, coal, cobalt and nickel, copper, diatomite, fluorite, garnet, gems, gold, gypsum and anhydrite, iron, limestone, manganese, mercury, mica, molybdenum, niobium and tantalum, peat, petroleum and natural gas, phosphate rock, refractories, salt, sand, gravel and quarry rock, silica, silver, lead, and zinc, stone and construction materials, thorium and rare earths, titanium, zirconium, and hafnium, tungsten, uranium, and vanadium. Water is one of the most important renewable resources in the State. The supply exceeds the need in the northern counties, but in the southern part of the State, areas of serious shortage exist. Large amounts of ground water are used, principally on the Snake River Plain.

Special Report 2

BELT SYMPOSIUM, 1973

Volume 1, 322 p. (contributions by 18 authors, 60 figs., 7 tables)

Volume 2, 138 p. (contributions by 5 authors, 34 figs., 16 tables)

The geology of the Precambrian Belt terrain in two volumes. These 22 papers and 4 field-trip guides are those presented at the "Belt Symposium" of September 17-22, 1973, at Moscow, Idaho, sponsored by the Idaho Bureau of Mines and Geology and the Department of Geology at the University of Idaho.

Papers discuss Beltian geochronology, geochemistry, orogenies, stratigraphy, sedimentary environments, mineralization and petrology. The rocks of particular concern are those of northwestern United States and southwestern Canada. Comparisons are made with similar Precambrian units elsewhere.

Field trip guides offer directions to and discussions of selected exposures of Belt Supergroup rocks in Idaho, Montana, Washington and British Columbia.
Rocks of all ages from Precambrian to Recent occur in Idaho. Many of the sedimentary ones contain fossils. Precambrian structural features are strong in north Idaho; the Idaho batholith dominates central Idaho; and folded and faulted Paleozoic rocks and the Snake River plain are important in south Idaho. The state has both metallic and nonmetallic mineral resources, but mineral fuels are scarce. Idaho has adequate water, although much of it is poorly distributed in space and time. The state includes portions of the Northern and Middle Rocky Mountains, the Great Basin, and the Columbia Intermontane provinces. Landforms and geology typical of these areas may be studied with maps. The varying climates of Idaho depend on latitude, altitude, winds, and mountain barriers. Nine great soil groups and more than 600 soils have been recognized within the state. For professional and nonprofessional persons interested in Idaho.

Caves are of interest to many persons for diverse reasons; the two most common being recreation and scientific study. Records of more than 200 Idaho caves are on file, four of which have been commercialized.

Most of these caves are lava tubes, lava blisters, or fissure caves in the basalts of the Snake River Plain. Concentrations of known caves occur near Mountain Home, north of Bliss, in the Black Butte lava flow north of Shoshone, in the southern end of the Great Rift Zone northwest of American Falls, at Craters of the Moon National Monument, and in the northeastern corner of the Plain.

Only a relatively few solution-formed limestone caves occur in the state. Most are in southeastern Idaho, but the largest solution cavern, Papoose Cave, is near Riggins in the west-central part of the state.

Idaho caves and rockshelters are also important for archeological studies. More than a dozen shelters have been excavated and studied in the search for man’s past. For the novice the practices of safety and courtesy, the wearing of proper clothing, and the use of adequate equipment are emphasized.
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| P = Pamphlet |
| C = County Report |
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