Pamphlet No. 119 August 1959

# ANNOTATED BIBLIOGRAPHY OF PAPERS RELATED TO THE GEOLOGY OF IDAHO

1941-1957

By

Clyde P. Ross

Geologist, U. S. Geological Survey

IDAHO BUREAU OF MINES AND GEOLOGY

MOSCOW, IDAHO

Prepared in cooperation with the Geological Survey
United States Department of the Interior

# ANNOTATED BIBLIOGRAPHY OF PAPERS RELATED TO THE GEOLOGY OF IDAHO, FOR THE YEARS 1941 TO 1957

By

Clyde P. Ross

## FOREWORD

In December 1941, Pamphlet 57 of the Idaho Bureau of Mines and Geology was published. This report was entitled "The metal and coal mining districts of Idaho, with notes on the nonmetallic mineral resources of the state". The major portion of this report was an annotated bibliography by Clyde P. Ross and Martha S. Carr which attempted to include essentially all available publications regarding the geologic features of Idaho through April 15, 1941. It now seems desirable to bring the annotated bibliography up-to-date. However, the descriptions of mining districts and similar items included in Pamphlet 57 are not repeated here. For many districts little new information is available, and the present writer is not in a position to add much to the published record for any of the recent developments. Those interested in these can readily obtain the recent data from reports that have been or are in process of being published.

The present bibliography starts with papers published in 1941 and not included in Pamphlet 57. It goes through 1957 and includes such reports as have been published in the early part of 1958 and have come to the attention of the compiler. A few reports that escaped inclusion in Pamphlet 57 are inserted in the present bibliography. The purpose of the new compilation is to include all reports that appeared during the period indicated above that would be of interest to those concerned with the geology of Idaho and its problems. With this purpose in mind, news notes of ephemeral interest and reports concerned with metallurgical and engineering matters but with little original geologic information in them are omitted. Some engineering reports that include data on the history and production record of districts in Idaho are listed as of possible interest to geologists who might study these districts. The coverage of reports of this nature is not exhaustive. Insofar as possible the bibliography lists not only formally published reports and books, but also abstracts, reports, and maps placed on open file by the U. S. Geological Survey, and student theses where these are so filed in the universities as to be accessible to interested persons. Each item listed, whether a complete report, an abstract, or some other form of record of work done is abstracted. The completeness of the abstracts varies with the character of the items abstracted. The principal geologic reports are abstracted at some length. Reports and books that deal only to a degree with the geology of Idaho are abstracted primarily with matters pertinent to the purpose of the present bibliography in mind. In many such instances matters not pertinent to this purpose are omitted entirely from the abstract, a fact that can be inferred from the title of the publication abstracted. Some purely descriptive articles dealing with particular areas are abstracted briefly, even though they may be of great interest for those who may be concerned with the specific areas involved. To be

really useful, abstracts of some of these articles or reports would be disproportionately long. In addition to papers directly concerning Idaho, a number of publications of interest to anyone concerned with general problems in regard to the geology of the state are listed. These publications give data on such things as broad features of stratigraphy, structure, paleogeography and kindred matters. Where possible, the abstracts of such general papers emphasize those parts that concern problems of the geology of Idaho. Parts not of interest in connection with Idaho are omitted from the abstracts as far as practicable. However, it has not been practicable in all instances to be selective on this basis in abstracting, Thus, abstracts of a few papers of broad scope include data on much of western North America in order to furnish background material and also to suitably indicate the character of the material abstracted.

To facilitate the use of the bibliography, cross indexing has been performed by the staff of the Idaho Bureau of Mines and Geology. Where the character of a publication permits, it has been indexed under the county or counties it covered. Subheads under each county indicate the general character of the reports cited. Those publications that cover large parts of the state or that deal with general geologic features rather than with areas, cannot be indexed under the county headings but are indexed under general headings indicative of the scope of the publication.

## BIBLIOGRAPHY


Abbott, Agatin T.

1. 1954, Monazite deposits in calcareous rocks, northern Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 99, 24 p., incl. geol. map.

Between North Fork and Shoup, Idaho, several thin beds of marble are interbedded in the gneiss and schist derived from the Belt series. These contain monazite and other minerals. The monazite is of potential economic value.

_____ (and Prater, Lewis Seward)

2. 1954, The geology of kyanite-andalusite deposits, Goat Mountain, Idaho, and preliminary beneficiation tests on the ore: Idaho Bur. Mines and Geology Pamph. 100, 27 p., incl. geol. map.

Potentially valuable deposits of kyanite and andalusite are present in T. 42 N., R. 5 E., Shoshone County, Idaho. Anna Hietanen, U. S. Geological Survey, called attention to the deposits in 1951, and fieldwork for the present report was done in 1953.

The country rock is mainly highly metamorphosed rock of the Belt series (Prichard?), including biotite schist and biotite paragneiss plus anorthosite, apparently formed by replacement of lava or tuff and garnet amphibolite, regarded as metamorphosed dike rock. The kyanite and andalusite are in the schist in four restricted zones plus a zone of andalusite gneiss. The aluminum silicates are thought to have been formed during and after regional metamorphism, perhaps more or less contemporaneously with the Idaho batholith, but with little addition of material from igneous sources. The four zones are estimated to contain 341,000 tons of aluminum silicate minerals down to a depth of 50 feet.

Preliminary tests indicate the kyanite would be amenable to flotation concentration and a fairly clean mica concentrate could be obtained by selective flotation.

Adamson, Robert D. (Hardy, Clyde Thomas, and Williams, James Stewart)

1. 1955, Tertiary rocks of Cache Valley, Utah and Idaho, in Tertiary and Quaternary geology of the eastern Bonneville Basin, A. J. Eardley, Ed., Utah Geol. Soc., Guidebook no. 10, p. 1-22.

This paper subdivides sedimentary rocks of Tertiary and Quaternary age in Cache Valley, Utah and Idaho, in comparative detail. It lists "Wasatch" conglomerate (Paleocene and Eocene), Salt Lake group (Miocene and Pliocene) subdivided into Collinston conglomerate, Cache Valley formation, Mink Creek conglomerate (in ascending order) and, in the Pleistocene, the pre- and post-Lake Bonneville groups. The Wasatch outcrops are apparently all in Utah.

Alden, William Clinton

1. 1953, Physiography and glacial geology of western Montana and adjacent areas: U. S. Geol. Survey Prof. Paper 231, 200 p., incl. geol. map.

This paper records many traverses and local studies related to geomorphic features in Montana, plus some in Idaho, terminating in 1938. The major points brought out bearing on the geomorphic history of Idaho include the following: In western Montana the Eocene epoch was one of extensive erosion but erosion surfaces that old are not known. Volcanism and probably also glaciation occurred in Eocene time in Montana. The intermontane valleys there have diverse faulted and tilted sedimentary fill of Oligocene to Pliocene age. The Tertiary fill was deposited in a topography similar to that of today but possibly more subdued. Remnants of gravelly deposits, now deeply eroded, are preserved high on the east front of the Rocky Mountains and farther east. These postdate the valley fill just mentioned and were eroded during regional uplift of late Tertiary and Quaternary date. Perhaps the Clark Fork deepened its valley 800-1,000 feet in Pliocene-early Pleistocene time. Some smooth tracts may be remnants of Pliocene(?) erosion surfaces but the mountains may have been uplifted in one episode of the Laramide orogeny and the continuous, subsequent erosion has not gone beyond maturity. An old alluvial fan on the crest of the Beaverhead Mountains near Bannock Pass is mentioned. Deposits near here contain Miocene(?) bones, but doubt is cast on Atwood's idea that these were laid down in streams tributary to Snake River. Canyon Creek, a tributary of Lemhi River may have pushed the Continental Divide northward 4-5 miles from its position in late Tertiary or early Pleistocene time. In and near northern Idaho the Purcell Trench and adjacent valleys may have been deepened by faulting and erosion in Oligocene and Miocene time. The Latah formation and Columbia River basalt reached far up these northern valleys but were largely removed before the advance of the Rathdrum lobe of the pre-Wisconsin ice. Only scanty evidence of early Pleistocene glaciation and remnants of terraces of similar date are known. The terraces may belong to the Yarmouth interglacial stage. The Wisconsin ice was widespread in British Columbia and may have largely submerged the mountains of northern Idaho, blocking Clark Fork and producing Lake Missoula.

Allen, Rhesa McCoy, Jr.

1. 1952, Geology and mineralization of the Volcano district, Elmore County, Idaho: Econ. Geology, v. 47, no. 8, p. 815-821, incl. geol. sketch map.

The Volcano district is astride the boundary between Elmore and Camas Counties, Idaho, and has veins that have been mined principally for gold although silver and base metals are present. They are in a tilted mountain block along the south boundary of Camas Prairie. They are in the Idaho batholith, in part cutting related aplite dikes and in part cutting granophyre dikes regarded as of early Tertiary age. The lodes are much older than rhyolitic flows (Pliocene) and basalt flows (Pleistocene). They are believed to have developed along one of the east-trending zones of structural weakness developed in the batholith during the Laramide orogeny. There is marked wall-rock alteration. Deposition of vein minerals was in three stages.

Allen, Victor Thomas, (Nichols, Robert Leslie, and Scheid, Vernon Edward)

1. 1944, Cenozoic weathering profiles in the Northwest U. S. (abs): Geol. Soc. America Bull., v. 55, no. 12, p. 1463.

During the Cenozoic, northwestern U. S. was a land area except for a coastal belt that was flooded at times. There was intermittent deposition of continental

sediments and pyroclastic rocks and intermittent extrusion of lava. Successive land surfaces were formed and at most places buried. More than 12 profiles have been recognized and there are undoubtedly others. They were developed on various rocks, mostly igneous, and vary in thickness and in climatic conditions during formation. Kaolinite, halloysite, montmorillonite, beidellite, nontronite, gibbsite, diaspore, bochmite, limonite, garnierite, and other materials were formed in them. Most of the high-alumina clays in the region, plus some nickel and iron deposits, are genetically related to these profiles. These include the Benson, Idaho clay deposits and the sedimentary high-alumina clay deposits at Troy and Moscow, Idaho, all in Latah County, as well as many in other states.

Allen, Victor Thomas (and Scheid, Vernon Edward)

2. 1946, Nontronite in the Columbia River region (abs.): Am. Mineralogist, v. 31, nos. 3-4, p. 189-190.

Investigations of high-alumina clay by the U. S. Geological Survey have resulted in new discoveries of occurrences of nontronite. The nontronite forms from basaltic glass, palagonite, iddingsite, and augite under conditions of poor drainage in the presence of alkalies or alkaline earths. Under opposite conditions kaolinite and halloysite formed from plagioclase and nontronite migrated into vesicles and cracks.

---

3. 1946, Nontronite in the Columbia River region: Am. Mineralogist, v. 31, nos. 5-6, p. 294-312.

Several occurrences of nontronite have been found recently in Washington, Idaho and Oregon. The mineral forms through the weathering of basaltic glass, palagonite, iddingsite, and augite under conditions of poor drainage in the presence of alkalies, magnesium, and probably ferrous iron. Under conditions of through drainage with neutral or slightly acid solutions kaolinite and halloysite are formed from plagioclase and nontronite migrates into vesicles and cracks in the rock.

---

4. 1946, Origin of the Benson clay deposit, Latah County, Idaho (abs): Geol. Soc. America Bull., v. 57, no. 12, pt. 2, p. 1173.

The Benson clay was formed by weathering, not by hydrothermal action. Weathering reached 100 feet or more below the surface. The amount of fresh feldspars and biotite increase downward. No dickite was found. Irregularities in clays of the Benson type depend on the nature of the parent rock, local structures controlling permeability, duration of the weathering, and irregularities in the ground surface.

Anderson, Alfred Leonard

1. 1941, Geology of the Idaho Almaden quicksilver mine near Weiser, Idaho: Idaho Bur. Mines and Geology Pamph. 55, 9 p.

Development of the Idaho Almaden mine began in 1937 and a large production rate

was attained by 1939. Anderson visited the mine in August 1939, at which time 464 flasks of quicksilver had been produced. The sandy and clayey beds containing the deposit are assigned to the Payette formation (Miocene), which is overlain by the Columbia River basalt and this in turn by the Idaho formation (Pliocene and Pleistocene). The deposit is on the crest of one of a series of anticlines of northwest trend at a place where minor faulting and flexure have produced a local structural depression. This depression may be younger than the first of two Pleistocene erosion surfaces inferred by Kirkham to exist in the region.

The deposit is believed by Anderson to have formed from a hot alkaline hydrothermal solution that ascended close to the surface at temperatures of $100^{\circ}$-$150^{\circ}$ C, and at pressures close to atmospheric. The initial solutions are supposed to have permeated and dissolved the rocks and filled the openings with opal. As all voids then formed were not filled, collapse followed. Successive solutions introduced more opal and later, chalcedony, both accompanied by cinnabar.

Anderson, Alfred Leonard

2. 1941, A copper deposit of the Ducktown type near the Coeur d'Alene district, Idaho: Econ. Geology, v. 36, no. 6, p. 641-657.

The Mizpah copper deposit, 40 miles southwest of the Coeur d'Alene mining district, formed hydrothermally under rather intense temperature conditions but possesses many features of pyrometasomatic deposits. It formed by replacement along bedding plane fractures and fissures in quartzite of the Belt series, and its ore consists chiefly of pyrrhotite, chalcopyrite, and cubanite in a silicate (diopside, amphibolite, microcline, etc.) and carbonate gangue. There were three stages of mineralization; some of the quartzite nearby shows incipient granitization.

The mineralizing solutions might well have come from the Idaho batholith. However, the wall-rock alteration resembles that associated with a monzosyenite stock, inferred to be of early Tertiary age, 12 miles west. Anderson, therefore, infers an early Tertiary age for the Mizpah deposits.

---

3. 1941, Physiographic subdivisions of the Columbia Plateau in Idaho: Jour. Geomorphology, v. 4, no. 3, p. 206-222.

Fenneman's five sections of the Columbia Plateau province are reviewed and modifications are proposed on the basis of Anderson's fieldwork in Idaho. He proposes that the Snake River Plain section be redefined to include the whole of that Plain instead of the eastern part alone, which requires abandoning the Payette section of Fenneman. The parts of that section not annexed to the Snake River Plains section are renamed the Owyhee section and the Seven Devils section. Further, Fenneman's Walla Walla section is subdivided into the Craig Mountain section (north of the Seven Devils section) and the Palouse section, still farther north. Brief descriptions of each of the five proposed subdivisions are given.

---

4. 1942, The Boise Basin, Idaho, <u>in</u> Newhouse, W. H., ed., Ore deposits as related to structural features, p. 132-134.

The principal feature that has controlled the distribution of veins in the Boise Basin is the porphyry belt, a zone of structural weakness, deformation, and intrusion, believed to be part of a belt of Tertiary deformation that extends northeast across the state. In the Boise Basin this zone and its two most productive districts are entirely within the Idaho batholith. Disturbances in the porphyry belt were recurrent throughout late Mesozoic and all of Tertiary time and were accompanied by intrusion of various kinds of stocks and dikes and by ore deposition. The lodes, which were deposited after all but the latest of the dikes were intruded, are in two kinds of openings, relatively continuous fissures mainly in granodiorite and groups of closely spaced tension cracks in sheared dikes of rhyolite porphyry. Mineralization took place in three stages, the precious metal ore-minerals being introduced in the second stage. Base metal sulphides came in during the first stage. In the continuous fissures the ore shoots are in areas of relatively low dip. The lodes along the porphyry belt are related, not to the Idaho batholith, but to much younger magmas. The lodes are mostly concentrated in two areas, thought to be loci of maximum disturbance. Early deformation in the porphyry belt was by horizontal shear, later deformation may represent collapse along longitudinal and traverse faults. The structural arrangement of the ore deposits is similar to that of the intrusions. The deposits strike obliquely across the porphyry belt and are more nearly parallel to the rhyolitic bodies to which they are most closely related in time and genesis, than to the other intrusions.

Anderson, Alfred Leonard

5. 1942, Endomorphism of the Idaho batholith: Geol. Soc. America Bull., v. 53, no. 8, p. 1099-1126.

In the broadest sense, the Idaho batholith has two main facies; a broad, marginal and roof zone of relatively calcic rock, and an inner less calcic zone that consolidated when stresses were less intense. In some places calcic rocks fringe the batholith, apparently intruded ahead of the main marginal mass. The main marginal mass is estimated to make up roughly half the mass of the entire batholith.

Much of the marginal facies is quartz diorite but much granodiorite and some quartz monzonite are included. More calcic rocks are present but escaped general endomorphism and are not further discussed here. In the marginal facies the mineral grains are intricately penetrated or irregularly penetrate neighboring grains in a manner that suggests not orderly crystallization, but rather replacement such as that in alteration zones in wall rock bordering high-temperature ore deposits. It is argued that hornblende, biotite, andesine, etc. in the early consolidated rocks have been added to and replaced by biotite, microcline, quartz, and various accessory minerals. The inner facies is calcic quartz monzonite with local variations to granodiorite and granite. The mineral relationships are reported to be similar to those in the marginal facies. Minerals thought to result from normal crystallization from a consolidating magma include biotite, oligoclase, orthoclase, and quartz. Those formed by later replacement include some biotite, orthoclase, microcline, quartz and accessories. Locally aplite is present and is regarded as showing the same two sets of processes as the larger masses. In the pegmatite nearly all the minerals now visible are thought to represent a second generation, formed by replacement of the original rock of the inner and outer facies of the batholith and of the aplite.

6. 1942, Granite and ore: Econ. Geology, v. 37, no. 6, p. 510-519.

This paper favors the concept that "metamorphic" granite has formed through addition of magmatic emanations to such rocks as schist and quartzite rather than by simple recrystallization of these rocks, which is the mode of genesis advocated by Agustus Locke (Econ. Geol. v. 36, p. 445-454, 1941). Anderson cites the "Cassia batholith, the marginal zone of the Idaho batholith, the Nelson batholith," all in Idaho, in support of his concept. He thinks that in spite of earlier ideas to the contrary, no ore bodies were formed by means of the emanations from any of these batholiths. Such ore bodies as do occur are ascribed to much younger intrusive dikes and stocks. Most of the ore deposits examined by him in Idaho, he regards as genetically related to magmas of early Tertiary or of "mid-Tertiary" age, whereas the batholiths are of late Mesozoic age. Nevertheless, some ore deposits are associated with products of local granitizing solutions and these solutions (related to the batholiths) "may possibly be looked upon as the earliest phase of the mineralizing process." He thinks the composition of these solutions was similar to that of the later ore-bearing solutions. The Boise Basin, Blue Wing, and Coeur d'Alene areas are cited as illustrating his concepts. In all these the ore bodies are in or closely associated with granite masses of the kind regarded by him as of Mesozoic age.

---

7. 1943, A preliminary report on the cobalt deposits in the Blackbird district, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 61, 34 p.

This report gives results of a brief visit early in the reopening of the Blackbird district in search of cobalt. The principal rocks belong to the Belt series and show increase in metamorphism northward toward a granitic mass regarded as belonging to the Idaho batholith. There are poorly exposed intrusions of gabbro (pre-mineral) and of lamprophyre (post-mineral). The mineralized fracture zones are diverse in trend. Schistosity is local, parallels bedding, and developed during mineralization. Folding is of pre-batholith age. Some of the faults are pre-batholith; others developed during batholithic emplacement. Lodes dominated by a content of cobalt are widely distributed. Others containing gold, copper, and cobalt occur mainly in the northern and central areas, and many have formed by addition of gold and copper compounds to the cobalt lodes. Lodes in the central part of the district are irregular lenses in broad shear zones. The principal minerals include cobaltite, chalcopyrite, pyrite, quartz, biotite, chlorite, carbonate, and tourmaline. Oxidation has had only minor effect on cobalt distribution but chalcocite and related secondary minerals reach depths of 100-300 feet. The deposits formed at fairly high temperatures and under varying strains in different parts of the district. They are genetically related to the Idaho batholith and, except for the cobalt, resemble those near Salmon formed in deep fracture zones in the final stages of consolidation of the Idaho batholith.

Anderson, Alfred Leonard

8. 1943, Copper mineralization near Salmon, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 60, 15 p.

The report deals mainly with the Pope-Shenon mine, the only copper deposit in the area that had had much work done on it since about 1925. This mine has yielded over 2,400,000 pounds of copper and has possibilities for the future. The mine was developed, at the time of this study, by a series of 6 tunnels and had more than 3,610 feet of drifts and crosscuts with stopes at intervals between the no. 4 and no. 6 tunnels.

The country rock is impure quartzite and quartzitic argillite of the Belt series, somewhat schistose and largely recrystallized. The mineral deposits are in shear zones that cut the bedding and schist planes. The presence of a broad shear zone made up of smaller overlapping and branching zones was not appreciated until the no. 6 tunnel was extended. The mineralogy and structure of the ore shoots are summarized. The deposit differs from those Anderson regards as of Tertiary age and he regards it as related to the Idaho batholith and, therefore, of Cretaceous age.

---

9. 1943, The antimony and fluorspar deposits near Meyers Cove, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 62, 20 p., incl. geol. maps.

One antimony and several fluorspar deposits in tuff in the Casto and Challis volcanics are described. The deposits are fillings and replacements in fissure and fracture zones. 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 in width and several hundred feet in length. The report is based on fieldwork in 1942, before the deposits had received much development.

---

10. 1943, Geology of the gold-bearing lodes of the Rocky Bar district, Elmore County, Idaho: Idaho Bur. Mines and Geol. Pamph. 65, 39 p., incl. geol. sketch maps.

The Rocky Bar district is an old one, started as a placer camp. Lode mining began early but so little has been done in recent years that very little information could be obtained underground during the present investigation. Fieldwork was done in 1938 and 1939 and included a topographic map made by Warren R. Wagner and Rhesa M. Allen, showing the principal lodes.

The district is underlain by the Idaho batholith (Mesozoic) which is reported to show evidence of endomorphism. A few small bodies of porphyritic rock are present. Those interpreted as pre-ore (dacite porphyry, quartz monzonite porphyry, granophyre, etc.) are regarded as of early Tertiary age and the rhyolite is regarded as Miocene. Lamprophyre may have come in at about the time of mineralization.

Mineralized faults and fault zones trend N. 70°-80° E. with a few of other trends. The main faults are roughly parallel to the dikes but some cut dikes. There has been repeated movement in these faults. In addition there are transverse, post-mineral faults. Mainly on geomorphic grounds the suggestion is made that the basinlike area in which the district lies is cut by a fault mosaic and is the result of structural collapse.

The deposits are mainly valued for their gold content. Total production may exceed $3,000,000 mainly from the shallow oxidized zone. The deposits contain quartz (deposited in three stages) with minor amounts of arsenopyrite, pyrite, sphalerite, galena, chalcopyrite, and sericite. Some of the gold is free in the quartz and some is associated with the sulphides. Mineralization is supposed to have taken place early in the Tertiary. Twenty-four properties are described and a number of others are mentioned.

Anderson, Alfred Leonard, (and Wagner, Warren Richard)

11. 1944, Lead-zinc-copper deposits of the Birch Creek district, Clark and Lemhi Counties, Idaho: Idaho Bur. Mines and Geology Pamph. 70, 43 p., incl. geol. maps.

Gives fairly detailed maps and descriptions of the mines. Does not map general geology except in the immediate vicinity of mines where faults are plentiful. The oldest rock is Ordovician quartzite, 600 feet thick with the base hidden. This is best exposed in Skull canyon below the Weimer mine. The lower 400 feet is mainly well-bedded, maroon and pink quartzite, which grades upward into massive white vitreous quartzite, sandy in the upper 75 feet. At the Viola mine dark-gray dolomite overlies the quartzite, apparently conformably. Similar beds are present at other mines but no good section was found. At some mines, especially the Worthing-Kauffman, there are several hundred feet of dark fissile shale and thin-bedded, bluish-gray magnesian limestone, in part with much black chert (supposedly Devonian). Shenon got Upper Devonian fossils. Mississippian limestone with some shale is plentiful, and Pennsylvanian buff sandstone, gray, sandy limestone, and light- and dark-bluish-gray limestone with some intercalated shale is present. Tertiary sediments lie on irregularly eroded surface. There is a variety of igneous rocks.

---

12. 1945, Lead-zinc mineralization in the Moyie Yaak district near Bonners Ferry, Boundary County, Idaho: Idaho Bur. Mines and Geology Pamph. 73, 9 p.

Rather recently discovered lead-zinc deposits in the Moyie Yaak district, Boundary County, are regarded as similar to those of the Coeur d'Alene region. They are in high-angle reverse faults in the Nelson batholith (Cretaceous). The presence of gold and arsenopyrite in them distinguishes the deposits from many in the Coeur d'Alene region. Both of these formed at a late stage. The fault pattern is said to be similar to that in the Clark Fork district and is regarded as of early Tertiary age, unrelated to the intrusion of the Nelson batholith. There may be a zone of structural weakness along the part of the valley of Meadow Creek that trends east, and this zone may have influenced localization of the ore deposits. Production has not been large but further exploration is regarded as warranted.

Anderson, Alfred Leonard (and Wagner, Warren Richard)

13. 1946, A geological reconnaissance in the Little Wood River (Muldoon) district, Blaine County, Idaho: Idaho Bur. Mines and Geology Pamph. 75, 22 p. incl. topog-geol. map.

This is a report of a reconnaissance in the Little Wood River district, Blaine County. The principal rock unit (Wood River(?) formation) consists of massive quartzitic breccia above light-gray limestone and a thick succession of calcareous shale and quartzite. Neither the top nor bottom is exposed but the thickness exceeds 8,000 feet. It is scantily fossiliferous. There are a few dikes and two small bodies of quartz monzonite porphyry (Tertiary), probably post-Idaho batholith. Several thousand feet of flows and tuffs of the Challis volcanics are present. Some alluvial and glacial deposits are noted. The rocks are folded and cut by several groups of faults, of which some of the largest are mapped on topographic evidence.

The principal mining activity was in 1881-1886, with various revivals since then. The principal mine, the Muldoon, has yielded $200,000. The deposits seen are replacements along bedding planes and strike-slip faults in the Wood River(?) formation; with argentiferous galena, arsenopyrite, some sphalerite, and pyrite, and chalcopyrite, with quartz in altered limestone and quartzite. Ore bodies are small. Only two mines could be examined, the Muldoon mine being inaccessible.

Anderson, Alfred Leonard

14. 1946, Lead-silver mineralization in the Clark Fork district, Bonner County, Idaho: Econ. Geology, v. 41, no. 2, p. 105-123.

The lead-silver deposits of the Clark Fork district resemble those in the Coeur d'Alene region, but are mineralogically more complex because of late introduction of silver and antimony minerals. Nine complex and in part rare minerals are identified in this report.

Localization of dikes of diabase, granodiorite, quartz monzonite, granite, rhyolite porphyry, and of the lead-silver deposits along the zone of weakness associated with the Hope fault indicates genetic relationships. Early solutions rich in potash are thought to have reacted strongly with the country rock, sericitizing it. Later solutions carried ferrous iron and carbonates, then silica with a little barium sulphate, and finally came solutions carrying the metals. The early metallization, that resembling that of the Coeur d'Alene, is regarded as mesothermal, and that with the complex metallic minerals as epithermal.

Anderson, Alfred Leonard (and Wagner, Warren Richard)

15. 1946, A geologic reconnaissance of the Hailey gold belt (Camas district), Blaine County, Idaho: Idaho Bur. Mines and Geology Pamph. 76, 26 p. incl. geol. sketch maps.

The Hailey gold belt now little known but formerly productive is in west-central Blaine County. It contains numerous mesothermal gold-quartz veins in rock of the Idaho batholith, in part under Tertiary(?) basalt (apparently older than Snake River basalt and like Columbia River basalt). The veins are in reverse faults apparently related to the Laramide orogeny. They 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 have an early, barren coarse quartz to which a younger coarse comb quartz, with gold, has been added. Sulfides comprise less than two percent of the vein matter. Some veins contain siderite and show transitions into siderite-galena veins like those of the Wood River region. The veins are associated with lamprophyre dikes and probably of early Tertiary age. The outlook for the future is good.

Anderson, Alfred Leonard

16. 1946, Drainage diversion in the northern Rocky Mountains of east-central Idaho (abs.): Geol. Soc. America Bull., v. 57, no. 12, pt. 2, p. 1174.

Piracy and large-scale faulting have had an important role in disrupting a drainage system of Tertiary age in east-central Idaho. The northeast trend of the Salmon River, its main tributaries, and Big Lost River and parallel streams are interpreted as formed in a drainage system of early Tertiary age which extended across the Continental Divide and perhaps to the Missouri River. Diversion of the Salmon River is supposed to have been brought about by headward erosion of a west-flowing stream in late Tertiary time, whereas diversion of the Big Lost River and similar streams is ascribed to block faulting in late Tertiary or early Quaternary time, during which the Continental Divide was shifted about 100 miles eastward.

---

17. 1947, Geology of the lead-silver deposits of the Clark Fork district, Bonner County, Idaho: U. S. Geol. Survey Bull. 944-B, p. 37-118, incl. geol. map.

The deposits resemble those of the Coeur d'Alene region. They are fillings and replacements along minor thrusts and reverse faults, genetically related to the Hope fault, in the Wallace and Striped Peak formations, and are regarded as of early Tertiary age. They are comparatively small but rich. The ore contains galena, siderite, quartz, and sphalerite with pyrite, arsenopyrite, tetrahedrite, and calcite and some is enriched by hypogene lead sulphantimonites and sulpharsenites, copper-lead sulphantimonites and ruby silver. The district has not yet been adequately explored. Over a dozen properties are described.

---

18. 1947, Geology and ore deposits of Boise Basin, Idaho: U. S. Geol. Survey Bull. 944-C, incl. geol. maps.

The report discusses 300 square miles in Boise Basin, Boise County. The basin yielded $59,649,673 in gold from 1863 through 1940, of which $5,966,902 was from lodes in 1900 through 1940. Total production from lodes is estimated at over $10,000,000. The area is underlain by quartz monzonite of the Idaho batholith, then regarded as probably of Late Jurassic or Early Cretaceous age, with marginal masses of quartz diorite. Both have suffered compositional changes through introduction of late-stage fluids. Pyroxene-hornblende diorite and granodiorite are thought to have

come in early in the Tertiary. These are components of the "porphyry belt" that extends diagonally across the basin and includes dacite porphyry, quartz monzonite porphyry, granophyre, etc., all of early Miocene age. Minor areas of lake beds, Columbia River basalt, and Snake River basalt, plus Pleistocene and Recent alluvium remains. The early Tertiary intrusives and related lodes are controlled by fractures (probably reverse faults). Intrusives and lodes of early Miocene age are related to horizontal fractures, perhaps related to collapse over a magma reservoir. Faults not filled by intrusions are difficult to map but may be numerous. There were marked drainage changes prior to the eruption of the Columbia River basalt. Faulting, warping, and uplift produced Boise Basin in the Pleistocene.

Gold-quartz deposits and a few with other metals were formed in the early Tertiary in three stages. Most of the placer gold came from these deposits. More complex fissure fillings and replacements including gold-bismuth, gold-pyrite, and silver-gold deposits formed in the porphyry belt in Miocene time. The first stage of mineralization produced a quartz gangue; a second stage produced also barite, carbonates, and tremolite. The metallic minerals include arsenopyrite, complex sulphobismuth and sulphantimonite minerals, etc. The deposits are more favorable to deep exploration than those here assigned to the early Tertiary but few extend downdip more than 1,000 feet.

Anderson, Alfred Leonard

19. 1947, Cobalt mineralization in the Blackbird district, Lemhi County, Idaho: Econ. Geology, v. 42, no. 1, p. 22-46.

This report includes the results of laboratory studies of collections from the Blackbird district, not available for the writer's earlier report. The general geologic data here are essentially those of the earlier report. The deposits are put into four interrelated classes. The cobalt-tourmaline lodes (with biotite) are typically in the southern part of the district. They are as fine grained and dark as the enclosing quartzite but tend to be more resistant to erosion. They are replacements in fractured and sheared rock. Cobalt-biotite lodes extend through the central into the northern part of the district. They are similar to the first class but are zones of mineralized schist rather than quartzite and less resistant to weathering. The texture is a bit coarser than in the first type. Cobalt-quartz lodes are closely associated with the cobaltiferous schists in the central part of the district and are commonly short and discontinuous. The gold-copper-cobalt lodes are in the central and northerly parts of the district, especially in the area containing the principal cobalt-biotite lodes, some of which they have replaced irregularly. The first three classes of lodes appear to have formed in two stages each while the fourth shows evidence of four stages. The cobalt in the younger lodes was derived by solution from the older ones and redeposited.

The Idaho batholith is inferred to have had nothing to do with the mineralization but the intrusion of gabbro formation of the lodes and the later injection of lamprophyre dikes probably were closely related events.

Anderson, Alfred Leonard

20. 1947, Drainage diversion in the northern Rocky Mountains of east-central Idaho: Jour. Geology, v. 55, no. 2, p. 61-75.

The upper Salmon River and other streams in the southeastern part of Central Idaho flow northeast and then abruptly change direction. The Salmon makes an elbow turn and crosses the state westward. Below the turn it has barbed tributaries and above it has consequent ones in northwest-trending structural basins. Other northeast-trending streams enter northwest-trending basins and are there directed southwest to the Snake River Plain. The interpretation offered is that an early northeast-trending drainage system that extended through wind gaps in block mountains, probably to the Missouri River, has been broken up by piracy and large-scale block faulting. Diversion of the Salmon River westward probably resulted from capture by a stream from the west as a consequence of crustal disturbance in the late Tertiary or early Quaternary time. Diversion of other streams into northwest trending basins probably also took place then. The Continental Divide was shifted about 100 miles east of its location in late Tertiary time. The area of northwest-trending ranges and basins is spoken of as the Basin and Range area and apparently regarded as an extension of the Physiographic Province of that name.

---

21. 1947, Epithermal mineralization of the Last Chance and Horn Silver mines, Lava Creek district, Butte County, Idaho: Geol. Soc. America Bull. v. 58, no. 5, p. 451-482, incl. geol. maps.

The epithermal deposits in the Lava Creek district are in a zone of structural weakness in Tertiary volcanics which facilitated intrusion of Miocene magma and circulation of mineralizing solutions. Early sericite, chalcedony, pyrite, and locally alunite were followed by pyrite, marcasite, sphalerite, wurtzite, galena, and chalcedony. After a more marked structural reopening, quartz, barite, pyrite, stannite, klaprothite, chalcopyrite, tetrahedrite, famatinite, enargite, and dickite were added. Early solutions were alkalic and hot; later ones were acidic and mostly below 135° C. The third stage was acid but hotter.

---

22. 1947, Lead-silver mineralization in the Clark Fork district, Bonner County, Idaho: Econ. Geology, Discussion, v. 42, no. 3, p. 305-306.

This note records the fact that Charles Milton, U. S. Geological Survey, examined Anderson's specimens from the Clark Fork district (See Anderson 194, no. 17 above) by X-ray and other methods and failed to confirm some of the results of Anderson's polished-section work, an illustration of the uncertainties inherent in mineral identification by etch tests alone. Milton confirmed the presence of semseyite, jordanite, and bournonite, but could not verify the meneghinite, geocronite, boulangerite, guitermannite, and freislebenite originally reported.

Anderson, Alfred Leonard

23. 1947, Structural control and wall-rock alteration at the Wilbert mine, Dome district, Butte County, Idaho: Econ. Geology, v. 42, no. 4, p. 368-383.

This gives summary data on history and geologic setting of the Wilbert mine, taken mainly from an earlier paper (Ross, C. P., 1933). The ore is confined to a dolomite member of a quartzite assemblage and is mainly formed by replacement with minor fillings of fissure and breccia openings. Primary ore is composed mainly of fine-grained galena, with sphalerite and pyrite that are commonly visible only under the microscope, in gangue composed of dolomite country rock with added feldspar, calcite, dolomite, chalcedony, quartz, and sericite. There are occasional grains of epidote, chlorite and tourmaline.

At the time of Anderson's examination, ore had been mined almost continuously from the surface to a depth of 800 feet and laterally for about 2,000 feet with a production up to 1931 of about $2,000,000. In the upper levels the ore bodies were in fractures along the crest of an overturned anticline, in the intermediate levels in a fissure in the plane of a curved thrust fault and in the lower levels in a weak fissure along the contact of the dolomite with overlying quartzite. Replacement was the dominant factor in the mineralization but the fractures localized it so as to produce ore bodies of commercial size. Small, much altered igneous dikes are present. Anderson infers that feldspathization of the original dolomite was followed by carbonatization and this in turn by silicification and locally by sericitization and pyritization before the valuable minerals were deposited. The epidote, chlorite, and tourmaline may have formed even later. In line with his general ideas as to periods of mineralization in Idaho, Anderson infers the deposit to be of early Tertiary age. He speaks of the introduction of feldspar as "granitization" at a high temperature but thinks most of the mineralization took place at low temperature and moderate depth. He suggests it may belong to the telethermal zone of Graton (Graton, 1933, p. 547-551).

---

24. 1947, Role of the Idaho batholith during the Laramide orogeny (abs.): Geol. Soc. America Bull., v. 58, no. 12, pt. 2, 1162.

The Idaho batholith is interpreted as emplaced just before the beginning of the Laramide orogeny and forming a part of the hinterland west of the Rocky Mountain syncline. It transmitted orogenic stresses into the sedimentary rocks in the geosynclinal trough. It was itself locally deformed and controlled deformation in the bordering formations. It was broken both by low-angle thrusts and by transverse strike-slip faults. These zones of weakness, according to Anderson's view, influenced igneous intrusion and mineralization both at the end of the Laramide orogeny and also during a mid-Tertiary disturbance. The batholith influenced deformation of the Belt series for scores of miles to the north, forming transverse fault zones of E. to SE. trends.

Anderson, Alfred Leonard

25. 1947, Tungsten mineralization at the Ima mine, Blue Wing district, Lemhi County, Idaho (abs.): Geol. Soc. America Bull., v. 58, no. 12, pt. 2, p. 1162.

The mineralization in the Ima mine is confined to a group of fractures along the crest of an anticline in Belt strata near a small mass of early Tertiary(?) granite. The fractures hold quartz veins; some near to the granite being relatively large. The veins also contain orthoclase, fluorite, muscovite, sericite, rhodochrosite, siderite, and other carbonates, and the metal-bearing minerals molybdenite, pyrite, sphalerite, tetrahedrite, chalcopyrite, galena, gratonite, scheelite, and hubnerite, of which tetrahedrite and pyrite are the most abundant. The scheelite and molybdenite are formed near the granite. The hubnerite is the widest distributed and one of the youngest minerals. The granite may have formed, at least in part, by granitization of quartzite and may have been the initial stage of mineralization.

---

26. 1948, Role of the Idaho batholith during the Laramide orogeny: Econ. Geology, v. 43, no. 2, p. 84-99.

The Idaho batholith, emplaced just before the beginning of the Laramide orogeny, formed a part of the hinterland on the west side of the Rocky Mountain geosyncline. Acting as a strong rigid mass it transmitted orogenic forces into the trough where weaker beds were folded. The batholith was locally deformed and also controlled deformation in the bordering formations. Transverse faults in the batholith localized igneous intrusion and mineralization at the close of the orogeny and again in middle Tertiary time.

---

27. 1948, Tungsten mineralization at the Ima mine, Blue Wing district, Lemhi County, Idaho: Econ. Geology, v. 43, no. 3, p. 181-206.

The mineralization in the Blue Wing district is confined to a group of fractures along the crest of an anticline in quartzitic beds of the Belt series near a small body of granite of supposed early Tertiary age. The veins are mostly quartz but include microcline, fluorite, muscovite, sericite, rhodochrosite, siderite, and calcite, of which the first three are near the granite. The metallic minerals are molybdenite, pyrite, sphalerite, tetrahedrite, chalcopyrite, galena, gratonite, scheelite, and hubnerite. The scheelite and molybdenite are in and near the granite. Hubnerite appears to be one of the youngest minerals. The granite is thought to be at least in part a product of granitization of the quartzite and may represent the initial stage of mineralization.

---

28. 1948, Monzonite intrusion and mineralization in the Coeur d'Alene district, Idaho (abs.): Geol. Soc. America Bull., v. 59, no. 12, pt. 2, p. 1308.

The monzonite, to which the mineralization in the Coeur d'Alene region is thought to be related, apparently was intruded as a hornblende-augite diorite and changed through later introduction of potash-bearing emanations from below. During late stages the emanations became more sodic. The constituents of sphene, apatite, magnetite, and locally other minerals were also introduced in the emanations.

Elsewhere along zones of faulting rocks of the Belt series have been bleached (sericitized), assumed to result from potash-bearing emanations from buried magma, followed later by the ore-bearing solutions from the same source.

Anderson, Alfred Leonard

29. 1949, Silver-gold deposits of the Yankee Fork district, Custer County, Idaho: Idaho Bur. Mines and Geology Pamph. 83, 37 p., incl. geol. maps.

The Yankee Fork district produced about $12,000,000 silver and gold in the 19th Century, principally from the General Custer mine, which closed in 1905. Recurrent activity since then has produced about $1,000,000 more. The deposits are in the Challis volcanics which rest on Paleozoic and Mesozoic stratified rocks and the Idaho batholith, all cut locally by dikes, mostly dacite porphyry. The mineral deposits follow some half dozen zones of fractured and altered volcanic rock, apparently above old lines of weakness in the basement rocks developed in the Laramide revolution. The deposits are mostly breccia veins and lodes with some mineralized fracture zones of the chimney and stockwork type. The fillings include fine and coarse comb and drusy quartz, locally lamellar calcite with minor amounts of chalcedony, adularia, barite, and amethystine quartz. In material now exposed metallic minerals are sparse and fine grained. They include pyrite, chalcopyrite, sphalerite, tetrahedrite, galena, arsenopyrite, enargite, stephanite, myargyrite, pyrargyrite, argentite, electrium, gold, and apparently gold and silver selenides. Most of this ore contains 80-90 times as much silver as gold. The ore minerals are of irregular distribution. Most of the early production was from bonanza pockets. The deposits have nowhere been found to extend downward more than a few hundred feet. Most of the ore is primary. More than 30 properties are described.

---

30. 1949, Monzonite intrusion and mineralization in the Coeur d'Alene district, Idaho: Econ. Geology, v. 44, no. 3, p. 169-185.

The monzonitic (and syenitic) rocks, the zones of bleaching and mineralization in the Coeur d'Alene region, all show an intimate dependence on a deeply seated, differentiating magma. The intrusions are inferred to be of early Tertiary age and not related to the Idaho batholith. Locally portions of the magma, emplaced at high levels, began consolidation as pyroxene-hornblende diorite but during consolidation differentiation below produced potash-rich solutions with subordinate titanium, phosphorous, etc. These solutions replaced much of the consolidating rock above, as well as parts of the bordering sedimentary rock, producing quartz monzonite and syenite. Orthoclase was formed early, followed by microcline during cooling. Sodium freed early, entered the solutions, giving rise to perthitic albite in the microcline. Minor minerals came later. In other parts of the district faults reached to magma depths and served as channelways for the potash-rich solutions, resulting in bleached, sericitic zones in the rocks of the Belt

series. Metallization throughout the district has been more or less closely associated with these zones. Some ore was of contact-metamorphic type and formed at the margin of the largest monzonitic body, but most deposits are in the sedimentary rocks farther from the intrusives.

The intrusive bodies vary widely in composition and texture. Marginal zones are generally finer grained and more calcic than the interior of the intrusive masses.

Anderson, Alfred Leonard

31. 1950, Geology and ore deposits of the Hailey-Bellevue mineral belt, in Anderson, A. L., Kiilsgaard, T. H., and Fryklund, V. C. Jr., Detailed geology of certain areas in the Mineral Hill and Warm Springs mining districts, Blaine County, Idaho: Idaho Bur. Mines and Geology Pamph. 90, 1-37, incl. geol. maps.

The area mapped is 8 miles by 9 miles and most of the mines are tributary to Bellevue. It contains representatives of the Wood River (Pennsylvanian) and Milligen (Mississippian) formations, volcanic and sedimentary rocks of supposed Oligocene age, Quaternary deposits, and varied intrusive rocks, mainly diorite, quartz monzonite, etc., regarded as of Cretaceous age but with a few dikes of andesite and dacite that appear to be pre-ore and of lamprophyre regarded as post-ore. The andesite and dacite tend to fill northeasterly fractures and, hence, are thought to be of early Tertiary (Laramide) age. The Paleozoic rocks are bent into a broad anticline but faulting is the dominant structural feature of the area.

Mining began in the 1870's, was active in 1880-1900 and has never entirely ceased. The total production may be over $12,000,000. The principal deposits are lead-silver veins and lodes with some pyritic gold veins in complex fracture and fissure zones. There are also deposits in which zinc predominates. These seem younger and the gold veins older than the lead deposits, although there is some mingling. All three varieties are thought to be genetically related to the andesitic and lamprophyric dikes rather than to the older diorite and quartz monzonite. The deposits are mesothermal and formed largely by replacement along fractures, with little wallrock alteration. More than 60 properties are described, especially the Minnie Moore, by far the most productive in the area.

---

32. 1951, Metallogenic epochs in Idaho: Econ. Geology, v. 46, no. 6. p. 592-607.

Idaho appears to have had no less than five metallogenic epochs. The earliest of these is associated with the "Purcell sills". The deposits of this epoch are magmatic segregations containing pyrrhotite, gersdorffite, and chalcopyrite but, at present, of small economic value. Minor copper deposits in Precambrian rocks near Pocatello are also inferred to be Precambrian. The second epoch of mineralization is the one commonly regarded as related to the Idaho batholith but here held to be of early Tertiary age and not genetically related to the batholith, largely because the deposits are supposed to be associated with andesitic and dacitic dikes and lamprophyres thought to have been intruded into cold rocks and at comparatively shallow depths. Anderson thinks the Idaho batholith was emplaced in

three stages, two of which were in the late stages of the Sierra Nevada orogeny, the third during the Laramide orogeny (late Cretaceous). The deposits in the Wood River region, even those hitherto regarded as contact metamorphic deposits along granitic contacts, those of the Coeur d'Alene region, where the monzonitic stocks seem petrographically different from the Idaho batholith, also those in the Clark Fork district, and various precious metal deposits, and copper-cobalt, tungsten, and molybdenum deposits are all here regarded as early Tertiary. The third epoch followed the extrusion of the Challis volcanics and is assigned a "mid-Tertiary" age. Its deposits are associated with granitic and porphyritic rocks that cut the volcanics. In this and the early Tertiary epoch mineralization is thought to have just preceded intrusions of lamprophyre. A fourth epoch (late Tertiary) is thought to be illustrated by the Silver City region, Owyhee County, where the deposits are associated with flows of post-Columbia River basalt age. The fifth epoch is reflected in cinnabar and gold deposits that cut sedimentary rocks supposedly belonging to the Payette formation.

Anderson, Alfred Leonard

33. 1952, Multiple emplacement of the Idaho batholith: Jour. Geology, v. 60, no. 3, p. 255-265.

Evidence is offered intended to cast doubt on the long-held view that the Idaho batholith was emplaced essentially as a unit. The batholith is composed of discrete masses of granitic rock, some of which came into place under deep-seated conditions, others at much shallower depths. The deep-seated ones evolved under deformative stresses at the close of the Sierra Nevada orogeny. The others probably come from an unrelated source and are associated with Laramide structures, hence Late Cretaceous. Granodiorite that cuts the main mass of the batholith in Boise Basin and is genetically related to distinctive pyroxene-hornblende-biotite granite that intrudes the batholith in the Basin and at Horseshoe Bend is mentioned. In the Hailey-Bellevue area this kind of diorite is intruded by quartz monzonite that had previously been thought to be a part of the main batholith. The intrusions of "mid-Tertiary" age in the "porphyry belts" are so young as not to be involved in the present discussion. The "marginal facies" of the batholith has been traced from Horseshoe Bend and Boise Basin and thence far to the north. Much is quartz diorite but endomorphic changes have converted some into granodiorite and quartz monzonite. The border zone is older than the main batholith which is cut by aplitic quartz monzonite. The distinctive diorite at Horseshoe Bend is a stock 8 miles long and up to 1-1/4 miles wide and cuts the marginal facies. In Boise Basin several bodies of this rock cut the main batholith. Near Bellevue the distinctive diorite forms a body 5 miles by 2-1/2 miles, is sill-like and intrudes the Milligen. On the west it is cut off by and at depth is underlain by quartz monzonite belonging to the younger batholithic complex. In Boise Basin granodiorite belongs to this younger complex. The irregular quartz monzonite masses in the Casto quadrangle are also regarded as belonging to the complex. There may be others.

---

34. 1952, Magmatic source of Idaho ores: Northwest Science, v. 26, no. 2, p. 55-60.

Except for local granitization as an early intense phase of wallrock alteration, the ore deposits of Idaho show no relation whatsoever to large-scale granitization such as is involved in batholithic emplacements. The Idaho batholith, a notable product of recrystallization-replacement processes, is held to have produced no mineral deposits except pegmatites. The batholith is believed to have been conceived of crustal materials; hence incapable of producing appreciable amounts of ore. The ore deposits of Idaho, on the other hand, show close association with igneous activity and orthomagmatic rocks and appear to have had their source in the basic material beneath the granitic crustal shelf.

Doubt of an ore-batholith association came when Anderson was unable to reconcile shallow (epithermal) characteristics with a deep-seated batholithic environment. Many deposits were on zones of weakness (Laramide) also occupied by early Tertiary intrusions.

Anderson regards the stocks in the Coeur d'Alene as early Tertiary, not related to the Idaho batholith, and says the stocks follow a zone of weakness dominated by the Osburn fault. In developing the stocks, quartz diorite was changed to monzonite and nearby sedimentary rock into syenite. Farther from the stocks the sedimentary rocks were sericitized and bleached zones resulted. The ore deposits are associated with pre-ore diabase and post-ore lamprophyre.

The Blue Wing tungsten district is cited as an instance of ore that originated through granitization. The Dome district is also mentioned.

Anderson, Alfred Leonard (and Wagner, Warren Richard)

35. 1952, Reconnaissance geology and ore deposits of the Mineral district, Washington County, Idaho: Idaho Bur. Mines and Geology Pamph. 95, 26 p., incl. geol. sketch maps.

The Mineral district, in western Washington County near the Snake River, has produced more than 1,000,000 ounces of silver, plus copper and lead, from lodes containing fine-grained pyrite, tetrahedrite, chalcopyrite, galena, sphalerite, marcasite, wurtzite, etc. in a calcite gangue in broad fracture zones in altered Permian(?) rocks. A group of quartz-tourmaline veins with pyrite, chalcopyrite, and sphalerite has not been productive. The silver deposits have a restricted vertical range and appear to have formed at rather low temperatures in Tertiary time. The others may be mesothermal and of late Mesozoic age.

The district contains folded and faulted sedimentary and volcanic rocks, altered and intruded by intrusive rocks of various kinds and ages. The volcanics have been regarded as Permian but their upper beds have Jurassic fossils. The slates, limestone, and gypsum are presumed to be Triassic. A post-Triassic diorite stock is intruded by quartz diorite, regarded as related to the Idaho batholith. Both may be of Cretaceous age. Both are cut by diabase and basalt, lamprophyre and granodiorite porphyry, the first two of which are probably feeders of the Columbia River basalt. There are two prominent fault systems, each of which has directed mineralizing solutions. There may have been several periods of structural disturbance. Fourteen mining properties are described. The district was discovered in the 1870's and at times has had smelters in operation. It has been inactive from 1940 to the time of visit.

Anderson, Alfred Leonard

36. 1952, Magmatic and granitized rocks in the Yellowjacket district, Lemhi County, Idaho (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, P. 1231-1232; Am. Mineralogist, v. 38, nos. 3-4, p. 328, 1953.

The Belt series in the district has been invaded by three unrelated groups of intrusive rocks. The earliest one (pre-Cretaceous) is represented by small bodies of considerably altered gabbro; the second (late Cretaceous or early Tertiary) by dikes and stocks of diabase, olivine gabbro, augite-hornblende-biotite diorite, hornblende-biotite diorite, pegmatite, lamprophyre, and marginal masses of biotite diorite and syenite about the body of hornblende-biotite diorite plus a small pulaskite dike; and the third (Miocene) by dikes, etc., of granophyre, granite porphyry, and vitrophyre. Except for the biotite diorite, syenite, and pulaskite, the rocks are hypabyssal and in part show micrographic and microspherulitic intergrowths. The exceptions are products of alkali-rich fluids from the hornblende-biotite diorite magma with the first two formed by replacement of rocks of the Belt series and the pulaskite by consolidation of the alkali-rich fluids along distant channels. Mineralization accompanied the second group of intrusives, just preceding the injection of lamprophyre. None of the intrusive rocks are regarded as related to the Idaho batholith.

---

37. 1953, Gold-copper-lead deposits of the Yellowjacket district, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 94, 41 p., incl. geol. maps.

This examination was undertaken primarily to look for possible copper and lead ore in this old gold camp. Most of the old workings were inaccessible. Some hope is held out for development of base-metal ore that also carries gold. Two formations of the Belt series, a small amount of Challis volcanics and unconsolidated sand and gravel along stream courses are described briefly. Igneous rock includes altered gabbro (Precambrian), diabase, olivine gabbro, augite-hornblende-biotite diorite, biotite diorite, syenite, pulaskite, pegmatite, and lamprophyre of late Cretaceous or early Tertiary age. All, except the lamprophyre, are regarded as premineral. In addition, granophyre, granite porphyry, and vitrophyre are regarded as Miocene.

The district is along a zone of weakness in which deformation began late in Precambrian time and has continued intermittently to the present. Most mineralized faults and fracture zones are in two zones, one trending east-northeast across Yellowjacket Hill, the other west-northwest from the town across Columbia Hill. Some are scattered elsewhere. Individual fractures are mostly short. Some post-mineral faults are present. Two large (regional) faults are noted. At the close of Pliocene time intermittent uplift is inferred which inaugurated the present canyons. Pauses in uplift are reflected in terraces. The area was glaciated during the Pleistocene. The modern streams have removed much of the glacial debris and are now lowering their floors.

Mining began in 1868 and mostly stopped in the late 90's. Some placer mining was done early in the present century and minor lode and placer mining has continued intermittently. In 1893-1897, the most productive period in the history

of the district, the Yellowjacket mine produced $121,761.56. The total district production up to 1910 was estimated by Umpleby at $450,000. Production figures for 1902-1949, in terms of recovered metals, are tabulated.

The ore deposits include veins, lodes, and stockworks with only sporadic bodies of lead and copper; where minerals of these two metals are present in a single deposit they tend to occur apart from each other. The minerals of the deposits include calcite, quartz, siderite, barite, pyrite, specularite, chalcopyrite, tetrahedrite, galena, and gold. The gold may have been carried to higher levels than the base metals. Anderson puts the ore deposits in his early Tertiary group.

Anderson, Alfred Leonard

38. 1953, Magmatic source of Idaho ores: Northwest Science, reply by author, v. 27, no. 2, p. 77-80.

Anderson in reply to a discussion by Wallace Hobbs and Greggs says he has not stated that the mineralization along the Osborn fault is directly related to the monzonite but, on the contrary, thinks there is a close relation with diabasic and lamprophyric dikes. All these are considered as offspring of a deep-seated magma that differentiated at depth and gave rise to the monzonite, ore deposits, and dikes. The alinement of the monzonitic bodies nearly at right angles to the fault may be related to complementary shears. The challenge to Anderson's statement that alteration in the monzonite resulted from potash-rich emanations is met by the statement (based on earlier papers) that emanations that extended beyond the stocks were so hot they converted the sedimentary rock into syenite instead of producing sericitized bleached zones in it. The positive form of some of the statements challenged is defended on the basis of the brevity of the paper that resulted in the challenge.

---

39. 1954, A preliminary report on the fluorspar mineralization near Challis, Custer County, Idaho: Idaho Bur. Mines and Geology Pamph. 101, 13 p., incl. geol. map.

The fluorspar deposits are in the northern part of the Bayhorse district, mostly in Keystone Mountain, along Daugherty Gulch and near Bayhorse. The presence of fluorspar became known during World War II, although metallic deposits in the region have been mined for many years. The fluorspar deposits are in fissures and breccias in fractured and faulted Bayhorse limestone (Cambrian?) along a major fold here named the Bayhorse anticline. They appear to have formed mostly in open spaces and later than the metallic deposits. The deposits are sufficiently numerous and in part large enough to give promise for the future, although production has been small.

---

40. 1954, Fluorspar deposits near Meyers Cove, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 98, 34 p., incl. geol. sketch maps.

The fluorspar deposits along Camas Creek below Meyers Cove from June 1951 to April 1953 yielded 10,978 tons of acid grade, 998 tons of ceramic grade, and 100

tons of metallurgical grade fluorspar. Known reserves were then mostly used up. Development had started in 1942.

The deposits are in the Casto and Challis volcanics, here regarded as mainly fragmental, with small intrusives in both. They are in zones of fracture and alteration which are complex so that openings filled with fluorspar are commonly not parallel to the northeast strike of the magma zones. Deposition was mainly in open spaces, but, especially at depth, in part by replacement. Dip and stope lengths of the shoots are mostly a few hundred feet but fluorspar is known through a vertical range of over 2,000 feet. Mineralization is of epithermal type and the minerals include banded fluorite with smaller amounts of barite, cryptocrystalline fluorite, and chalcedony. Wall rock alteration is extensive and includes silicification, sericitization, and "argillic alteration". Three kinds of faults are described but none are large enough to show as such on the maps. The outlook for discovery of more ore is regarded as good.

Anderson, Alfred Leonard

41. 1956, Geology and mineral resources of the Salmon quadrangle, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 106, 102 p., incl. geol. map.

The Salmon quadrangle contains a thick assemblage of quartzitic rocks of the Belt series. These are in part covered by flows, tuffs, and ignimbrites of the Challis volcanics (Oligocene) and by shale sandstone, lignite, and clay here assigned to the newly named Carmen formation (lower Miocene). The contained fossils were not studied. The intrusive rocks include metagabbro (late Precambrian) granitic outliers of the Idaho batholith, dikes related to the Challis volcanics, and dikes and small stocks of dacite and quartz latite porphyry, assigned an early Miocene age. There are glacial deposits of two stages, alluvium and landslide debris. Deformation is evident in all but the youngest of the surficial deposits. The earliest may be Precambrian but most of the folding and fracturing is regarded as Nevadan (Late Jurassic). The Challis volcanics were deposited on a hilly erosion surface. Local downwarping produced the basin filled by the Carmen formation. An old erosion surface of Pliocene age was broken and eroded through late Pliocene warping and uplift. The two glacial stages were separated by up to 1,000 feet of downcutting.

The mineral resources include copper, gold, lead, possible radioactive materials, coal, building stone, bentonite, clay, gravel, road metal, and hot springs. Gold mining was active in the early days but the copper deposits of the Pope-Shenon mine are the only mineral resources of importance at the moment.

---

42. 1957, Geology and mineral resources of the Baker quadrangle, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 112, 71 p. with geol. map.

The Baker quadrangle is a 15' quadrangle without a topographic base. The northeastern part is in Montana and is not treated here. The topography resembles that in the Basin and Range province. The mountainous part of the quadrangle is

underlain largely by impure quartzites of the Belt series, metamorphosed in varying degrees. Flows and pyroclastic beds with some intercalated sedimentary beds, assigned to the Challis volcanics, are distributed on both sides of the Lemhi Valley. Three sedimentary units, here treated as post-Challis, are here named, in upward succession, the Kenney, Geertson, and Carmen formations. No fossil identifications are reported, although the presence of fossils is noted. At least two ages of Pleistocene glacial deposits are recognized and alluvium forms three sets of terraces and floors modern valleys. Intrusive rocks regarded as of Jurassic-Cretaceous (diorite or gabbro), (quartz monzonite, known only as float), early Tertiary, and mid-Tertiary ages are represented. All the consolidated rocks are deformed. One major, longitudinal fault near the crest of the Beaverhead Range is occupied by metagabbro inferred to be of Jurassic age. Mineral resources include gold, copper, radioactive materials, gravel, lignitic coal, bentonitic clay, building stone, and thermal waters, but only the gold deposits have been significantly productive. The copper deposits are inferred to be of Jurassic age and older than the Idaho batholith. They have been worked on a small scale only. Three are described. The gold deposits are mostly quartz veins, assigned to the late Cretaceous, and have been fairly productive, but available records include mines outside the quadrangle. Eight lode gold mines and some placers are described. The placers yielded 11,970 ounces of gold and 1,157 ounces of silver. Other mineral resources are described briefly.

Anderson, Roy Arnold

1. 1948, Reconnaissance survey of the geology and ore deposits of the southwestern portion of Lemhi Range, Idaho: Idaho Bur. Mines and Geology Pamph. 80, 18 p., incl. geol. maps.

This is the result of a rapid reconnaissance of 136 square miles in the southern part of the Lemhi Range. The rock units distinguished are metamorphic rock (Cambrian or Precambrian), quartzite, gray dolomite, black shale, coral-bearing limestone, basalt flows, alluvium. The sedimentary rocks are Paleozoic. The dolomite is Ordovician and the coral-bearing limestone is of Brazer age. The sedimentary rocks were intensely folded, with the development of stretch thrusts. One or possibly two periods of block faulting are deduced.

Mineral deposits are found mainly in the quartzite and dolomite. Eleven deposits valued mainly for lead, are briefly described.

Andrews, Henry Nathanial, Jr., (and Kern, Ellen M.)

1. 1946, The Idaho Tempskyas and associated fossil plants (abs.) Am. Jour. Botany, v. 33, no. 3, p. 225.

In two collecting trips into southeastern Idaho during the past four years, Andrews had searched for Tempskyas (Upper Cretaceous). In 1945 he found specimens near Wayan, Idaho associated with conifers, dicotyledons, and cycads.

---

2. 1946, Craters of the Moon (Idaho): Earth Sci. Digest, v. 1, no. 4, p. 3-6.

This is a popular account, giving routes to the National Monument, data on tourist accommodations (now out of date), and summary statements as to the geology, at

least in part, based on H. T. Stearns' Guide to the Craters of the Moon National Monument.

Andrews, Henry Nathanial, Jr.

3. 1946, Some fossil plant localities in Idaho and Wyoming (abs.): Am. Jour. Botany. v. 33, no. 16, supp. p. 833.

In the little studied late-Tertiary beds south of Bruneau a few conifer cones and a sporaphore were collected. Several specimens of Tempskya were found near Wayan and Ammon, Idaho. Other collections were made in Oregon and Wyoming.

_____, (and Lonz, Lee Wayne)

4. 1947, Fossil polypores from Idaho: Mo. Bot. Garden Annals, v. 34, no. 2, p. 113-114.

A collecting trip resulted in finding specimens believed to belong to Fomes idahoensis 10.5 miles south of Mountain Home and 0.5 mile east of State Highway 51, in beds below a horizon yielding abundant fish jaws (Mylocyprimus robustus Leidy).

_____, and Kern, Ellen M.)

5. 1947, The Idaho Tempskyas and associated fossil plants: Mo. Bot. Garden Annals, v. 34, no. 2, p. 119-183.

This is a botanical paper that gives an outline of the history of the study of a Cretaceous tree fern Tempskyas and of the present status of knowledge regarding it. Previous information was based on poorly preserved or fragmentary specimens. In southeastern Idaho, especially near Wayan, excellent and abundant specimens have been found. For example, at one outcrop three hours' digging can be expected to yield 300 pounds of specimens. The plant is supposed to have grown with a vertical trunk, perhaps up to 20 inches in diameter at the base, and with numerous short, leafed branches that would be convenient food for animals. It is inferred from botanical characteristics that the Tempskyas grew in tropical forests covering undulating hills up to 4,000-7,000 feet in altitude. The date was middle Upper Cretaceous. Cycads, Cupressinoxylon and dictoyledons were found sparingly with the Tempskyas.

_____

6. 1948, A note on Fomes idahoensis Brown (Idaho): Missouri Bot. Garden Annals, v. 35, no. 3, p. 207.

Newly acquired specimens of Fomes idahoensis confirm previous identifications.

_____

7. 1948, Fossil tree ferns of Idaho: Archaeology, v. 1, no. 4, p. 190-195.

This report gives a picture of a restored Tempskya, describes this tree fern and methods of studying this and similar fossils. It is based mainly on large collections from the Wayan formation (middle Upper Cretaceous) at Wayan, Idaho.

Andrichuk, John Michael

1. 1954, Regional stratigraphic analysis of the Devonian system in Wyoming, Montana, southern Saskatchewan, and Alberta, revised in Clark, L. M., ed., Western Canada sedimentary basin--a symposium: Am. Assoc. Petroleum Geologists, Ralph Leslie Rutherford Mem. Volume, p. 68-108.

This paper gives a summary of data on Devonian rocks in the region. They are regarded as groupable into (1) a basal unit, (2) a dolomite-evaporite unit, and (3) a post-evaporite unit. The basal unit is characterized by evaporites, including halite in association with dolomitized normal marine to reefoid carbonates. The second unit has dolomitized limestone with bioherms with shale beds increasing northward in Alberta. The third unit contains secondary dolomite, with undolomitized limestone in places, plus evaporites and bioherms. This unit includes normal marine carbonates in southwestern Alberta and varicolored shaly, silty, and sandy beds in other areas. The basal unit is pre-Jefferson.

One of the sections studied was in the Centennial Range in Idaho. Isopach maps extend into Idaho and one of them into southcentral Idaho. This one is erroneous.

Anonymous

1. 1947, Sapphires in Idaho: Mineralogist, v. 15, no. 12, p. 625.

Gem sapphires in Idaho were first announced about 1912 from placers near Meadows. The source is said to be basalt dikes in gneiss.

Anonymous

2. 1949, Western phosphate output soars: Eng. Mineral Jour. v. 150, no. 7, p. 130-133.

This is a news note with almost no geologic data. Has a graph showing a very rapid production rise from 1945 to 1947 compared with slower previous rise. Mentions present and proposed plants at Pocatello, and Anaconda's plant at Conda, plus plants in Montana.

Anonymous

3. 1953, Bibliography, Utah-Idaho thrust belt, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., 1953, p. 95-96.

This is a general reference guide, not necessarily complete.

Anonymous

4. 1956, Anderson Ranch Dam and Power Plant, Arrowrock Div., Boise Project: U. S. Bur. Reclamation, 231 p.

This is primarily an engineering report but has an outline of the geology on p. 9-17 with Fig. 9 showing the geology around the cutoff trench. No scale is

given. Further notes on geology relative to construction are given. In general the bedrock, largely granitic but variable and with numerous dikes, was found to be much more sheared and weathered than was supposed prior to excavation. This necessitated various modifications in construction plans. It produced conditions conducive to landslides.

Armstrong, Frank Clarkson (and Weis, Paul L.)

1. 1955, The Garm-Lamoreaux mine, Lemhi County, Idaho: U. S. Geol. Survey open-file report, 10 p.

Analysis of samples from the Garm-Lamoreaux mine dumps indicates uranium oxides (uraninite and zippeite) in sufficient quantity to warrant re-exploration of the mine as a uranium prospect. The uranium presumably occurs in fractured quartz veins previously mined for gold and sulfides.

_____

2. 1957, Dismal Swamp placer deposit, Elmore County, Idaho: U. S. Geol. Survey Bull. 1042-K, p. 383-392.

The Dismal Swamp placer deposit was explored for niobium-tantalum- and uranium-bearing minerals by the J. R. Simplot Company in 1953. It is underlain by the Idaho batholith and is composed of gravel derived from streams and from slopewash. Columbite and samarskite, presumably from pegmatite, have been identified. Most of the uranium is believed to be in multiple-oxide minerals. The gravel contains 1.40-1.87 pounds of "weakly magnetic" material per cubic yard and this averages 14-20 percent $Nb_2O_5+Ta_2O_5$ and between 0.15 and 0.19 percent $U_3O_8$.

_____, (and Cressman, Earle Ruppert)

3. 1957, Reinterpretation of the Bannock overthrust, southeastern Idaho (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1697.

The Bannock overthrust was originally described as a single folded thrust but it now appears that parts of the supposed large thrust are separate faults and the faults are not folded, except for slight original curvature. The Bannock overthrust is reinterpreted as an imbricated thrust zone possibly several tens of miles wide extending at least from southwestern Montana to northeastern Utah, and should be renamed the southeastern Idaho thrust zone.

_____, (and Weis, Paul L.)

4. 1957, Uranium-bearing minerals in placer deposits of the Red River Valley, Idaho County, Idaho: U. S. Geol. Survey Bull. 1046-C, p. 25-26, geol. sketch map.

In 1951 or 1952 uranium-bearing multiple oxide minerals were recognized in jig concentrates from a gold dredge 10 miles south of Elk City. The gravel in the placer came from the Idaho batholith and a roof pendant of Precambrian rocks. The concentrate contained 0.11 percent uranium. The nonmagnetic radioactive

fractions assayed 0.2 percent niobium. Brannerite, euxenite, davidite, betafite, and samarskite from the placer contain uranium. Euxenite, samarskite, betafite, and perhaps also ilmenite contain niobium. The concentrates are not at present valuable for their uranium and niobium content but under different market conditions recovery should not be a difficult job.

Atwood, Wallace Walter (and Atwood, Wallace Walter, Jr.)

1. 1948, Tertiary-Pleistocene transition at the east margin of the Rocky Mountains, in Colbert, E. H., ed., Pleistocene of the Great Plains (symposium): Geol. Soc. America Bull., v. 59, no. 6, p. 605-608.

This paper barely mentions Idaho but the deductions in it are broad enough to include that state. The major points made are outlined below.

The widespread Rocky Mountain peneplain, probably completed in early or mid-Pliocene time, had several areas of bold relief rising above it. The alluviation east of the mountains during peneplanation buried extensive areas, aided by volcanism. A monotonous old-age landscape resulted. Widespread conglomerates near the close of the period may record rejuvenation of headwaters and perhaps increase in aridity.

Late in the Tertiary, after the mid-Tertiary sediments had accumulated and the great volcanic flows of Colorado, Wyoming, and Idaho, plus their ejectaminta, had formed; just before the opening of the Pleistocene, there was very widespread epeirogenic uplift accompanied by rejuvenation of streams. After a long time the quickening influence reached the mountain areas, and the mountain streams cut into the mid-Tertiary alluvium and the hard rocks, producing superposed streams. The earliest Pleistocene glacial deposits are on high ridges, not related to modern glaciated canyons, and far beyond points reached by late Pleistocene ice. After the widespread late Tertiary uplift there were several minor uplifts, followed by a canyon-cutting period when the present valleys were excavated.

---

2. 1948, Geomorphic relations of the Rocky Mountains (abs.): Geol. Soc. America Bull., v. 59, no. 12, pt. 2, p. 1309.

Studies commenced earlier have been extended into the Canadian Rockies and into physiographic provinces adjoining the Rockies in the U. S. The writers believe definite correlations can be established between the geomorphic history of the mountains and that of the Great Plains to the east and the Plateaus to the west.

---

3. 1953, The geomorphic relations of the Rocky Mountains of western North America: Pacific Sci. Cong., 7th, New Zealand, 1949, Proc., v. 2, p. 18-20, Wellington.

Near the close of the Mesozoic era the Paleozoic and Mesozoic strata of the Rocky Mountain Province were greatly deformed. Long erosion followed and was interrupted by later mountain building uplift, extensive volcanism, and severe mountain glaciation. Two generations of mountains have been removed and a third is now

in the process of being removed, with related changes in the Great Plains to the east and the Plateau provinces to the west. There was at least one period, early in the Pliocene, when widespread peneplanation was completed in the mountains, accompanied by volcanism. After Pliocene uplift of the three provinces, erosion produced extensive superposition of major streams. This was followed by glaciation. There was also Eocene glaciation in Colorado. In the closing stages of the late Tertiary planation, gravel and boulder deposits were spread widely at high levels along the mountain fronts. There may have been a marked and widespread pause in mountain growth in very late Pliocene or early Pleistocene time. After the Pleistocene glaciation, erosion has been renewed but so far has been slight.

Axelrod, Daniel Isaac

1. 1948, Climate and evolution in western North America during middle Pliocene time: Evolution, v. 2, no. 2, p. 127-144.

This paper has no specific reference to Idaho. In the middle Pliocene, western North America south of latitude 42° is inferred to have had a mild, warm, semi-arid climate. This climate initiated grasslands and subdesert environments of subcontinental extent. Evolution was rapid. The final breakup and segregation of major continental Tertiary floras and their evolution into modern plant communities was initiated.

Bailey, Earl Gordon

1. 1956, Index of surface-water records to September 30, 1955, pt. 12, Pacific slope basins in Washington and upper Columbia River basin: U. S. Geol. Survey Circ. 392, 24 p.

This index lists streamflow and reservoir stations in the Pacific slope basins in Washington and upper Columbia River basin where records have been made. Drainage areas and other data are given.

---

2. 1956, Index of surface-water records to September 30, 1955, pt. 13, Snake River basin: U. S. Geol. Survey Circ. 393, 19 p.

This index lists streamflow and reservoir stations in the Snake River basin where records have been made. Drainage areas and other data are given.

Bain, George William

1. 1956, Reconnaissance for uranium in the Phosphoria formation: U. S. Atomic Energy Comm., RME-3141, 59 p.

Studies of a reconnaissance character were made of the literature, field relations, and of laboratory procedure useful in studying the Phosphoria formation with reference to its uranium content. The literature showed the most favorable locality to be near Montpelier, Idaho. This favored area appeared to be a water

depth zone about at the bottom of ocean wave disturbance, near a Permian sea margin. Field sampling showed uranium content was highest where opportunity for leaching by groundwater was least, as in areas of low hydrographic relief. Carbonapatite is more favorable than fluorapatite, and the outer shells of phosphate pellets are depleted in uranium. The outer shells can be stripped off in the laboratory.

Baldwin, Ewart Merlin

1. 1943, Structure and stratigraphy of the northern half of Lost River Range, Idaho: Doctorate thesis, Cornell Univ., Ithaca, N. Y.

This report covers most of the Borah Peak quadrangle and the northeast corner of the Mackay quadrangle, Custer County, Idaho. The Ramshorn? slate and quartzite in the Lost River Range comprises 1,500± feet of quartzite and 800± feet of slate. Kinnikinic quartzite with carbonate beds, east of Borah Peak is 4,635 feet thick. The formation locally includes greenstone. Baldwin groups the Laketown dolomite of Lone Pine Peak (Bayhorse quadrangle) with the Kinnikinic. He regards the Saturday Mountain formation in the Lost River Range as of limited extent and unconformable under the Laketown dolomite, which is 2,450 feet thick in Mahogany Hill. The Laketown seems conformable with the Jefferson, even though lower Devonian beds are missing. The Jefferson at Mahogany Hill is 1,350 feet thick. The contact with the Grand View is gradational. At Mahogany Hill the Grand View is 1,100 feet thick and overlain conformably by the Three Forks followed by 2,400 feet of the Milligen. Near Freighter Springs the Three Forks formation is 310 feet thick. Incomplete sections of the Brazer limestone are 3,000-3,500 feet thick. About 1,000 feet of glacial debris fills Doublespring Canyon. The sediments in Donkey Hills are mapped with the Challis volcanics, which were deposited on an irregular surface. Folds of Cambro-Ordovician, Laramide, and Miocene ages are reported. Parallel and transverse normal faults, both pre- and post-Challis, are recognized but only one minor thrust. A deformed Pliocene? erosion surface is noted. It is suggested that the region belongs in the Basin and Range Province rather than the Northern Rocky Mountain Province.

---

2. 1943, Three Forks fauna in the Lost River Range, Idaho: Am. Paleontology Bull., v. 28, no. 110, 18 p.

This notes that the author recognized the presence of a unit he correlated with the Three Forks formation of Three Forks, Mont. in the Borah Peak quadrangle in 1941 and 1942. Twenty-three fossils are listed with descriptions.

---

3. 1950, Summary of the structure and geomorphology of the Columbia River basalt: Northwest Sci., v. 24, no. 2, p. 59-64.

"Columbia River basalt" refers to the basaltic flows, generally assigned a Miocene age, that were described and restricted by J. C. Merriam in 1901. Other

extrusive rocks, including much basalt, of Eocene, Oligocene, Pliocene, and perhaps Recent age are found in the same region and were presumably included by Russell in his Columbia River lavas. The thickness ranges up to more than a mile. The flows were extruded on an irregular erosion surface. Lateral stripping over large areas is regarded as doubtful. The formation has been affected by compressional folds and related faults and by broad warping with some faulting.

A brief summary of geomorphic features is given but does not include anything bearing directly on Idaho.

Baldwin, Ewart Merlin

4. 1951, Faulting in the Lost River Range area of Idaho: Am. Jour. Sci., v. 249, no. 12, p. 884-902.

Faults similar to those of the Basin and Range geologic province are inferred to be present in the area of the Lost River Range, an interpretation differing from that of recently published accounts. At least two stages of faults are present. The older stage included normal faults, tear faults, and minor thrusts, older than the Challis volcanics. Of these the tear and thrust faults formed during the deformation of the Paleozoic strata at the end of the Mesozoic, and the normal faults may date from late in the Laramide orogeny. The faults of the younger stage displaced both the Challis volcanics and a prominent post-Challis erosion surface, and formed the present broad basins and fault-block ranges.

Ball, Max Waite (and others)

1. 1951, Rocky Mountain region, in Ball, M. W., ed., Possible future petroleum provinces of North America: Am. Assoc. Petroleum Geologists Bull. v. 35, no. 2, p. 141-498, incl. geol. maps.

The Rocky Mountain region has produced oil in strata ranging in age from Cambrian to Oligocene. The Rocky Mountain region in Idaho here described includes the northern parts of the "Overthrust belt", mostly east of longitude 112°, and of the Great Basin, east of 114°. Oil and gas occurrences are noted only in areas south of Idaho.

Barghoorn, Elso Sterrenberg, Jr.

1. 1953, Evidence of climatic change in the geologic record of plant life, (Chap.) 20 of Shapley, H., ed., Climatic change, p. 235-248.

American early Tertiary flora were featured by a large exotic element which began to decline in the late Eocene and Oligocene. Later and continuing into the Pleistocene the influx of genera native at present to the respective localities increased rapidly. The most significant feature of the Cenozoic migration of vegetation is the steady retreat of the temperate forests from Arctic regions and the retraction of Tertiary tropical elements of mid-latitude flows into the present marginal tropics.

Stromatolites provide evidence of former widespread seas over areas now in cold, temperate, and subarctic regions. Calcareous algae are now world-wide

but mostly in warm, shallow seas. Algal reefs record invasion of warm, shallow seas poleward in the Cambrian and Ordovician.

Barraclough, Jack Thomas

1. 1953, Record of wells in western Jefferson County, Idaho: U. S. Geol. Survey duplicated rept., 54 p.

Data for the 630-sq-mile area include 242 well records and 23 well logs.

Barrette, Keith

1. 1944, Tail end of creation (Idaho's Craters of the Moon): Nat. History, v. 53, no. 4, p. 182-185.

This is a popular account of the Craters of the Moon National Monument, apparently written by a non-geologist.

Bayless, John C.

1. 1950, A geologic reconnaissance of the post-Laramide geology of the southeastern Snake River plains and adjacent mountain ranges in Idaho: Mich. Acad. Sci. Papers, v. 34 (1948), p. 209-226, incl. geol. sketch map.

The area covered is in Fremont, Madison, Teton, Jefferson, and Bonneville Counties, Idaho, and includes over 90 square miles. Pre-Tertiary rocks are exposed in the mountains but are not described. The earliest of the Tertiary sedimentary rocks are here correlated with the Camp Davis formation of Wyoming. Locally this unit is interbedded with or overlain by rhyolitic flows. It is cut by andesitic sills. Deposition was in the Grand Valley fault trough and around the Miocene highlands. The sediments were affected by faulting and by an uplift complementary to the Snake River downwarp. These beds have been correlated with the Salt Lake formation and probably correlate in age with the Payette formation. Erosion remnants of the rhyolitic rocks of the region (which include quartz latite, trachyte, andesite and basalt) are present in the area here mapped. The ancient valley of the Snake River was carved in the two units above mentioned and partly filled with flows, pyroclastics, and lake beds inferred to be Pleistocene. Five tuff cones are in the map area. The Snake River basalt, (or lava) here is also Pleistocene. Lake beds occupy depressionsin it and are covered by wind deposits. Glacial deposits of pre-Wisconsin age extend from the mountains into Teton Basin. Later glacial deposits are confined to the mountains. There is a series of alluvial deposits and some Recent basalt. Low-angle thrusts and parallel folds were formed in Laramide time; block faults in the middle Tertiary and the Snake River downwarp in Pliocene and Pleistocene time.

Berdan, Jean Milton (and Duncan, Helen)

1. 1955, Ordovician age of the rocks mapped as Silurian in western Wyoming, in Wyo. Geol. Assoc., Guidebook, 10th Ann. Field Conf., p. 48.

A typical Laketown fauna from south of Paris Peak in the Preston quadrangle, Idaho, is listed. None of the many collections from the lower Paleozoic rocks of Wyoming has furnished good evidence that Silurian strata are present.

Billingsley, Paul Raymond (and Locke, Augustus)

1. 1941, Structure of ore districts in the continental framework: Am. Inst. Mining Metall. Engineers Trans., v. 144, p. 9-64 incl. discussion and geol. maps.

This general paper makes only incidental reference to mining districts in Idaho, although the state is included in two of the maps. The Coeur d'Alene district is spoken of as along a tear fault, a term which was corrected to steep shear in the discussion. The east-by-north tension veins of Butte harmonize with larger features. They carry quartz porphyry dikes that are the local representatives of a Tertiary dike zone traceable westerly and southwesterly from Butte into Idaho. This zone is similar to the dike and mineral belt of the Colorado Front Range.

Bissell, Harold Joseph

1. 1956, Pennsylvanian and Permian correlations in the Cordilleran area (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1789-1790.

Throughout much of the Cordilleran area, including Idaho, many of the formations of Pennsylvanian and Permian age can be correlated with some accuracy, mainly on paleontologic grounds. Essentially all the Pennsylvanian rocks are marine, in part metamorphosed. Most of the Permian rocks are marine sediments but locally with thick sequences of interbedded volcanic and volcanic-derived rocks. Thus both miogeosynclinal and eugeosynclinal facies are distinguished in both systems.

Fusilinids permit wide-range correlations. Representatives of all Pennsylvanian and most Permian series are present.

Bitten, Bernard I.

1. 1951, Age of the Potato Hill volcanic rocks near Deary, Latah County, Idaho: Master's Thesis, of Univ. Idaho.

The presence of a dike of volcanic rock intrusive into rock of the Idaho batholith and inclusions of rocks from that batholith in part of the Potato Hill flows confirms a post-Idaho batholith age for these volcanic rocks. The flows are rhyolite, rhyodacite, and dacite, and probably are the same age as the Challis and Kamiah volcanics in Idaho, either Oligocene or lower Miocene age.

Blackstone, Donald LeRoy, Jr.

1. 1954, Permian rocks in the Lemhi Range, Idaho: Am. Assoc. Petroleum Geologists Bull., v. 38, no. 5, p. 923-935.

Reports Schagerina (determined by M. L. Thompson and considered by him as middle Wolfcampian in age) from sec. 27, T. 6 N., R. 30 E. in the southern

end of Lemhi Range. State Highway 22 crosses a lava ridge southeast of the locality. Fossils are in gray-to-black dense limestone.

Blackstone, Donald LeRoy, Jr.

2. 1956, Introduction to the tectonics of the Rocky Mountains, in Am. Assoc. Petroleum Geologists Bull., Rocky Mtn. sec., Geol. Record, p. 3-19.

The Rocky Mountains and adjacent areas can be divided into five tectonic divisions: (1) Canadian shield, (2) area in which the shield is only thinly covered by sedimentary rocks, (3) area in which the basement is locally exposed, (4) area in which the basement has been deflected down to great depths and covered by thick sedimentary deposits, (5) areas of later igneous rocks where no Precambrian basement is recognizable. The structural significance of these divisions is shown by generalized maps and text. For Idaho the most significant comment is that Mansfield's concept of the Bannock thrust may be in need of revision. The overthrust belt of Idaho and Wyoming may be more like the sliced belt of Montana than has been generally realized.

Blalock, J. L.

1. 1956, Gem sillimanite from Idaho: Rocks and Minerals, v. 31, no. 5-6, p. 240.

This notes the discovery of varicolored sillimanite, regarded as of gem quality in gravel along the Clearwater River above Lewiston, Nez Perce County, Idaho. One piece weighs 34 pounds.

Boardman, Leona

1. 1949, Geologic map index of Idaho (map with bibliography): U. S. Geol. Survey, Index to geologic mapping in the United States, scale 1:750,000 or approx. 1 in. to 12 miles.

This is a map that shows by line patterns and colors the position, area covered, and scale of available geologic maps in Idaho.

Bonini, William E. (and Lavin, Peter M.)

1. 1957, Gravity anomalies in southern Idaho and southwestern Montana (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1702.

A prominent maximum gravity anomaly is associated with the Snake River downwarp from northeast of St. Anthony to west of Nampa. The maximum is -70 mgals southwest of Mountain Home. A gravity gradient suggests the north edge of the downwarp from Boise to Mountain Home and King Hill may be fault-controlled.

Bostwick, David Arthur

1. 1955, Stratigraphy of the Wood River formation, south-central Idaho: Jour. Paleontology, v. 29, no. 6, p. 941-951.

Sections of the Wood River formation east of Bellevue were measured and the fusilinids in the rocks studied. The thickness measured was 12,190 feet, possibly increased by undetected faults. The conclusions are that the lower third of the formation is Pennsylvanian and the rest Lower Permian (Desmoinesian, Virgillian, Wolfcampian). There may have been sea connections with Utah, Wyoming, Montana, and Colorado and a trough from New Mexico and Texas to the Wood River area.

Bowyer, Ben (Rainey, H. C., and others)

1. 1954, Geologic map of the Wallace and vicinity quadrangle, Shoshone County, Idaho: U. S. Geol. Survey open-file report, 1 map.

Geologic map no text.

The map shows three subdivisions of the Prichard, one each of the Burke and Revett, two of the St. Regis, six of the Wallace, and one of the Striped Peak. Also mapped are monzonites and related rocks, dikes, and three unconsolidated rocks. The area is folded and faulted, and includes a portion of the Osburn fault zone.

Bradley, John D. (and Mecia, Joseph A., and Baker, Robert E.)

1. 1943, Yellow Pine mine (Stibnite, Idaho): Eng. Mining Jour., v. 144, no. 4, p. 60-66, incl. geol. sketch map. (Reprinted in the 45th Ann. Rept. of the Mining Industry of Idaho, p. 51-57).

The Bradley Mining Co. has been interested in the Yellow Pine mine since 1927 and started mining in 1932. Tungsten was discovered in the ore by Donald E. White, U. S. Geological Survey, in February 1941. Extensive drilling has been done by the U. S. Bureau of Mines, and following White's discovery the drill cores were tested for tungsten. Since then the operation has been changed from low-grade gold mining to production of tungsten.

The area of the mine contains quartz monzonite, aplite, pegmatite, and alaskite, dacite and lamprophyre with some quartzite, dolomite, and other metamorphic rocks. Glacial deposits covered most of the outcrop of the ore body. The quartz monzonite is cut by numerous fracture zones, most of which trend north to northeast and dip east and west. The ore is in shear zones in these. Typical ore is a breccia of scheelite and altered quartz monzonite, cemented by stibnite. The gold was distributed in the principal fracture zone without regard to a dacite dike, but the tungsten and antimony ore is confined almost entirely to the block west of the dike. The distribution of the metallic minerals is varied, and deposition took place in several stages. Methods of mining and smelting are described.

Bradley, Worthen D.

1. 1946, Quicksilver in Idaho: Idaho 48th Ann. Rept. Mining Industry, p. 98-101.

Idaho had produced quicksilver to a value of about $2,000,000 to the date of this report. Of this about 9,000 flasks came from Valley County, nearly all from the Hermes, and 3,000 flasks from the Idaho-Almaden mine, Washington County. Beyond these production figures, the report is mainly an outline of the international situation regarding quicksilver, arguing for protection for mines in the United States and a price of at least $125 per flask.

Brandvold, G. E. (Sisco, H. G., and Carson, R. H.)

1. 1956, Idaho, in Water levels and artesian pressures in observation wells in the United States in 1954: U. S. Geol. Survey Water-Supply Paper 1325, p. 33-59.

The observation-well program embraces 86 wells in 16 counties. Water levels tended to decline in wells in most localities.

Bretz, J. Harlen

1. 1939, The physiography of North America, in Geologie der Erde, Erich Krenkel, ed., North America, v. 1, p. 1-40. Introductory chapters and geology of the stable areas, 1939. Eds. Rudolph Ruedemann 1927-1935, Robert Balk 1936-1939 Berlin. Verlag von Gebrüder Borntraeger.

Division of the Rocky Mountain system of the United States into provinces has given rise to the terms of Southern, Middle, and Northern Rocky Mountains. But there are two distinct provinces of the system north of the Northern Rocky Mountains. Hence it is better to "term that part of the system from south-central Idaho (United States) to northern British Columbia (Canada) the Boundary Ranges or the Boundary Range Province. The province is 1,300 miles long and its maximum width at the southern end is 350 miles". The Rocky Mountains are bounded on the west by Purcell Range but p. 22 indicates "Purcell Range" is bounded on the east by the Rocky Mountain Trench, hence Bretz follows Canadians in his definition of Rocky Mountains.

Brooks, James Elwood (and Andrichuk, John Michael)

1. 1953, Regional stratigraphy of the Devonian system in northeastern Utah, southeastern Idaho and western Wyoming, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 28-31.

The Devonian is thick in southeastern Idaho and part of south-central Idaho, but thin in western Wyoming and along its border with Idaho. In Utah there are Devonian rocks older than the Jefferson formation. A section in Grand View Canyon, Custer County, Idaho, by Sloss, is given. It is over 2,200 feet thick and treats the Grand View as the upper member of the Jefferson. It shows 300 feet of "Three Forks", in quotes.

Brown, Roland Wilbur

1. 1940, A bracket fungus from the late Tertiary of southwestern Idaho: Washington Acad. Sci. Jour., v. 30, no. 10, p. 422-424.

The fungus specimen described, here named Fomes idahoensis Brown, N. sp., was collected in 1939 by J. L. Morris, 1-1/2 miles east of a point 5 miles south of Bruneau along the highway. Much fossil wood is associated with it. The specimen is composed mainly of calcium carbonate. The containing beds may belong to the Idaho formation and are probably not later than early Pliocene.

Bulla, Edward W.

1. 1951, A mineragraphic study of ore from the Tamarack mine, Burke, Idaho: Master's Thesis, Univ. Idaho.

Mesothermal galena-siderite veins occupy subsidiary faults that are transverse to the Puritan-Standard fault. Simultaneous deposition of the minerals--galena, sphalerite, and pyrrhotite--is shown by exsolution textures. The mineralization is generally uniform within the veins and various levels of the mine.

Butler, Arthur Pierce, Jr. (and Schnabel, Robert Wayne)

1. 1956, Distribution of uranium occurrences in the United States, in Proc. Internat. Conf. on the Peaceful Uses of Atomic Energy, Geneva, 1955: New York, United Nations, Pub. v. 6, p. 224-230.

This is a summary of the geologic environments and geographic distribution of uranium deposits in the United States. An index map shows that Idaho has uranium veins, deposits in igneous rocks, coal, and placer deposits. The Sunshine mine in the Coeur d'Alene region is mentioned and its deposits are said to be Precambrian. Uraniferous coal in southeast Idaho is referred to, also those in placers in west-central Idaho and in the Phosphoria. None appear to be of much economic importance at the moment.

---

2. 1956, Distribution and general features of uranium occurrences in the United States, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conf. on Peaceful Uses of Atomic Energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 27-40.

This is a somewhat abbreviated version of the paper abstracted above.

Butner, Daniel Worth

1. 1949, Phosphate rock mining in southeastern Idaho: U. S. Bur. Mines Inf. Circ. 7529, 18 p.

This report is concerned mainly with mining methods and costs. Idaho produced 905,000 tons of phosphate rock in 1947; over 75 percent of western production, mostly from two mines. Rock must have 30 percent $P_2O_5$ to be used under methods in use at the time. A depth of 500 feet is the limit of practical mining. The reserve under those conditions is 230,000,000 long tons. The potential value of by-products such as fluorine is referred to. In 1926 Mansfield estimated the total reserve to a depth of 5,000 feet at 4,997,885,000 long tons. Much of this is too deep to be mined under existing conditions. If low-grade rock could be treated, the reserve would increase sharply.

Caldwell, Harry H.

1. 1951, Ed., Idaho Conservation Source Book: Univ. Idaho, Moscow, Idaho, 228 p.

This book contains much data on subjects related to conservation, including a section by L. S. Prater called Mineral resources, metals, nonmetallics, and fuels, p. 210-217 that outlines for Idaho the items listed in the title, with production figures taken from the Minerals Yearbook for 1948, U. S. Bur. Mines, and a section by A. W. Fahrenwald called Progress in the mineral industry, p. 218-222, that outlines the subject for those not acquainted with it, without particular reference to Idaho.

---

2. 1954, Rocky Mountain Province, in Freeman and Martin, eds., The Pacific Northwest, p. 79-87.

Most of this section of the book, The Pacific Northwest, is devoted to the Northern Rocky Mountains in Idaho and western Montana but some data on the southern Rockies, mostly in southeastern Idaho are given. The Okanogan Highlands in Washington and adjacent Idaho are mentioned. The geology of these regions is summarized and the topography described, mainly on the basis of a digest of a few of the many reports published in the past.

Campbell, Arthur

1. 1941-1946, Annual reports of the mining industry of Idaho by years.

Each of these annual reports by the State Mine Inspector lists available data on ownership, development, etc., for all mines for which information is on hand, segregated by counties. The reports also give data on mine accidents, production, etc., and most include short articles either reprinted from current literature or others written specifically for the report. Thus each annual report is a summary of mining conditions in the state for the year it covers.

Campbell, Arthur B.

1. 1953, Geologic map of the Smelterville and vicinity quadrangle, Shoshone County, Idaho: U. S. Geol. Survey open-file report, 1 map.

A geologic map, without text, showing the Prichard, Burke, Revett, and St. Regis formations of the Belt series, dikes, and two unconsolidated rocks. The map also shows folding and faulting.

_____, (Bowyer, Ben; Shenon, Philip John; and McConnel, R. H.)

2. 1953, Geologic map of the Kellogg and vicinity quadrangle, Shoshone County, Idaho: U.S. Geol. Survey open-file report, 1 map.

Geologic map, 7-1/2-minute quadrangle on the scale of 1:24,000. The Prichard, Burke, Revett, St. Regis, Wallace, and Striped Peak formations of the Belt series are mapped. Also mapped are dikes, gravels, Quaternary deposits, and structure.

Campbell, Charles Duncan

1. 1950, Petrology of the Columbia River basalts; present status and ideas for future work: Northwest Sci., v. 24, no. 2, p. 74-83.

The components of the Columbia River basalt range in texture from glassy to holocrystalline. Felted textures are common. Phenocrysts are common but rarely plentiful enough for the rock to be considered porphyritic. Tachylyte and sideromelane glasses are known. The minerals that have been recognized are listed. They indicate most of the flows are basalt but some are pigeonite andesite. A table giving seven chemical analyses and a calculated average indicates that the flows conform in most respects in composition to plateau basalts in other parts of the world. Temperatures during eruption varied from 500° C. to 1545° C. The scarcity of known dike feeders for the later flows suggests these may have erupted from centers lying, perhaps, along a few of the more persistently active earlier fissures.

Canney, Frank Cogswell (Hawkes, Herbert Edwin, Jr.; Richmond, Gerald Martin; and Vhay, John Stewart).

1. 1953, A preliminary report of geochemical investigations in the Blackbird district, Lemhi County, Idaho: U. S. Geol. Survey open-file report, 20 p.

Metamorphosed sedimentary rocks of the pre-Cambrian Yellowjacket formation (Belt series) are cut by mineralized shear zones containing chalcopyrite, cobaltite, pyrite, and pyrrhotite. Weathering and oxidation are commonly deep, and cobalt present in the primary ore suffers leaching in the zone of oxidation.

Soil samples taken at 6- to 9- inch depths and 100-foot intervals were taken along traverses and analyzed for cobalt and copper content. Results from these analyses indicate a reliable correlation between cobalt content, and in some cases copper content, in the soil sample and cobalt mineralization in the

bedrock.

A study of the relation of soil profiles to the surficial deposits was conducted and indicates that a knowledge of the origin and source of surficial deposits, the degree of development of soil profile, and the relative stratigraphic position of a soil is necessary for the interpretation of geochemical anomalies in the soil.

Canney, Frank Cogswell

2. 1956, Geochemical study of soil contamination in the Coeur d'Alene district, Shoshone County, Idaho: U. S. Geol. Survey open-file report.

The report consists of a topographic map and graphs showing the amount of zinc and lead in the soil, and sections showing the vertical distributions of the metals. The data relate to contamination by smelters.

Cannon, Ralph Smyser, Jr. (and Grimaldi, Frank Saverio)

1. 1953, Lindgrenite and cuprotungstite from the Seven Devils district, Idaho: Am. Mineralogist, v. 38, nos. 11-12, p. 903-911.

Lindgrenite, hitherto known only at Chuquicamata, Chile, was recognized by Waldemar Schaller in contact metamorphic ore from the Seven Devils area. Chemical and other properties of this mineral and of the cuprotungstite associated with it are given.

Capps, Stephen Reid

1. 1940, Gold placers of the Secesh Basin, Idaho County: Idaho Bur. Mines and Geology Pamph. 52, 42 p.

This report consists largely of a discussion of the geomorphology of Idaho County and especially of the Secesh Basin, although a number of placers in that basin are described. The production has been $450,000-$500,000. The basin contains quartzite, gneiss and schist of the Belt series, extensive exposures of the Idaho batholith, Tertiary sedimentary rocks, and deposits of Pleistocene and Recent age. The Pleistocene deposits include old and Wisconsin detritus and the Recent ones include peat plus three layers of ash.

In central Idaho (primarily Idaho County and vicinity) the earliest land form discernible is a mature surface (the so-called Idaho peneplain), thought to cut volcanics of Miocene age and to be pre-Columbia River basalt (middle or upper Miocene). In the period between the eruption of this basalt and early or middle Pleistocene time there was extensive block faulting, warping, and regional uplift. Prior to this the Salmon River is thought to have pursued its present westerly course across the State but one result of the orogenic movement was to divert it below Riggins northward along a fault valley. In the Secesh Basin Lake Creek, which rises only 5 miles from the Salmon, flows away from that stream to the south and southeast along a structural valley. After the uplift the streams of the region adjusted their courses, and lake and stream deposits resulted, and a partial erosion surface was formed. In the meantime the master streams had been rejuvenated, in part as a result of the increased elevation of the mountains and in part because of the development of deep canyons along the Snake and Columbia Rivers. By the end of the Pliocene

the canyon of the Salmon had been incised almost to its present depth with comparable deepenings of tributary canyons. This was followed by glaciation, perhaps in four stages. Soil creep has been extensive and has tended to produce forms that could be confused with remnants of old erosion surfaces. The amount of lowering of ridge tops by creep since early Tertiary time is measurable in tens if not hundreds of feet.

Capps, Stephen Reid

2. 1941, Faulting in western Idaho and its relation to the high placer deposits: Idaho Bur. Mines and Geology Pamph. 56, 20 p. incl. geol. sketch maps.

It is postulated that western Idaho was subjected to elevation and extensive block faulting, probably in the Pliocene. The faults postulated have prevailing north or northwest trends, displacements of a few hundred to 3,500 feet are normal, and most faults have east-facing scarps and west-sloping back slopes. Fourteen such faults are described. No evidence of a postfaulting mature erosion surface is found. Such major streams as the Salmon River are antecedent but many of their tributaries were diverted into fault troughs. Many of the high placer areas are in the fault valleys and thus are late Miocene or later. Three stages of Pleistocene glaciation are recognized and glaciation has influenced the distribution of certain placers. Nine types of placers are distinguished. The gold placer production of western Idaho is estimated at $123,000,000+.

Except for minor changes, the present drainage pattern in west-central Idaho was established by early Pleistocene time. Locally the Columbia River basalt is faulted. Elsewhere the evidence for faulting is mainly the drainage pattern.

Carlson, John E.

1. 1951, A lithologic study of some medium-grained Upper Cretaceous sedimentary rocks of southeastern Idaho: Master's Thesis, Univ. Idaho.

A lithologic study of the Frontier and Wayne formations of the Fall Creek Basin and Horseshoe Creek district. Four types of sandstone are recognized, differentiated on the basis of heavy mineral frequencies, light mineral frequencies, tourmaline frequency, and grain morphology and mechanical composition. Facies changes are rapid within short distances grading from terrestrial to fresh water, brackish, and marine deposits. Regional correlation is very difficult due to the similarity of heavy mineral suites within the formations studied.

Carmichael, Virgil W.

1. 1956, The relationship of the "soils" of the Palouse to the Columbia River basalt: Master's Thesis, Univ. Idaho.

Up to 200 feet or more of soil overlies the basalt in some parts of the area studied. Chemical analysis of the basalt, the subsoil, and the soil failed to show any genetic relation. The parent material of the "Palouse soil" was probably loess.

Carmichael, Virgil W.

2. 1956, The relationship of the "soils" of the Palouse to the Columbia River basalt (Washington-Idaho): The Compass, v. 34, no. 1, p. 6-28.

This paper is based mainly on a study of 50 square miles in Whitman County, Washington and Latah County, Idaho. There has been one or more long periods of erosion between extrusion of parts of the Columbia River basalt. Much of the Columbia River basalt came from the Grande Ronde region, Oregon, but that along the margins of the basalt between Moscow and St. Joe, Idaho, had a different source. This basalt has been only locally deformed in post-Miocene time. Up to 800 feet of basalt may have been eroded here before deposition of the "Palouse soil" parent material which is silt beneath the younger deposits known to be loessal. That material was probably loess, a portion of which may have been pumicite from the Cascade Mountains. The "Palouse topography" may result in part from "soils" blown in from the northwest, modified by later winds and dust from the southwest. The amphitheatres that are characteristic of the Palouse hills result in part from soil creep and mudflow around and under winter snowdrifts.

Carson, R. H.

1. 1957, Idaho, in Water levels and artesian pressures in observation wells in the United States in 1955: U. S. Geol. Survey Water-Supply Paper 1408, p. 35-61.

The observation-well program embraced 72 wells in 16 counties. In most areas well levels declined although in most places precipitation was above normal.

Carswell, Louis Duncan (and McKelvey, Vincent Ellis)

1. 1954, Effects of weathering on phosphate rocks, in Geologic investigations of radioactive deposits: Semiann. Prog. Rept., June 1 to Nov. 30, 1954, U. S. Geol. Survey Trace Elements Inv. Rept. 490, p. 193-194.

Samples of phosphate were obtained at Conda, Idaho, and in the Crawford Mountains. They show a steady decrease downward in phosphate content through a range of scores or hundreds of feet. Some uranium is leached during weathering and redeposited at depth, but there is no notable persistent enrichment of uranium with depth.

Cary, Allen Stuart (and McGaroch, C. B., Jr.)

1. 1947, Ramp valleys of northwestern Montana and northern Idaho (abs.): Northwest Sci., v. 21, no. 1, p. 31.

It is postulated that canyons along the Clark Fork, Flathead, Kootenai, and Blackfoot Rivers are ramp valleys, with opposing thrust faults on opposite sides of the valley blocks. As faulting progressed, the previous drainage system slowly disintegrated and the Tertiary "lake beds" record the work of streams

Range are correlative with the Wells formation. Exception is taken to their statement that the Phosphoria is absent in the range. Thick, high-grade phosphate beds have not been found but the Phosphoria is 1,295 feet thick. Occurrences of Phosphoria in the Cassia and Beaverhead Mountains in Idaho and in various places in northern Utah and Nevada are mentioned. The thickening of the formation west of southeastern Idaho is ascribed to greater rate of subsidence rather than greater depth of water. The Phosphoria here is thought to have been deposited in an embayment whose limits to the northwest are unknown.

Cheney, Thomas McGiffin (McKelvey, V. E., and Gere, W. C.)

2. 1956, Fusilinid-bearing rocks in Sublett Range, southern Idaho: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 7, p. 1716-1719, with a reply by Walter Youngquist on p. 1719-1723.

A reply to the above discussion, given on p. 1719-1723, points out deficiencies in general knowledge and probabilities of facies changes that made him and Haegele reluctant to apply established formation names to their rocks in the Sublett Range. For example, he notes that they might have correlated with the Wood River formation just as well as with the Wells. As to deep water, rather than subsidence, Youngquist cites a paper by McKelvey and others in 1953 that seems to agree with Youngquist and Haegele on this point. Incidentally, he notes that in the 1953 paper the term "Central Idaho" appears to be intended to apply to areas near the middle of the southern border of the state and south of the Snake River Plain, which would be incorrect usage.

Youngquist notes that in the 1953 paper the age of the Phosphoria is uncertain "but it certainly spans much of Permian time". Youngquist thinks the whole of the Phosphoria everywhere is now "safely post-Wolfcampian by all opinions". He thinks the unit was deposited in a sea transgressive from a westward direction. The special conditions under which the Phosphoria must have been laid down tend to confuse stratigraphic correlations.

_____, (Gere, W. C., and Wallace, J. H.)

3. 1956, Permian phosphate deposits in northeast Nevada and adjacent parts of Idaho and Utah (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1763-1764.

A phosphatic shale of Permian age (680 ft.) crops out in the Leach Mountains 10 miles west of Montello, Nevada, and is overlain by beds similar to the Dinwoody formation. Reconnaissance in northeastern Nevada and neighboring Idaho and Utah resulted in discovery of 75 miles of outcrop of rocks of Phosphoria age not previously reported.

adjusting themselves to this. Some streams spilled over saddles and are now superimposed across hard rock ridges. Pleistocene glaciation concealed and destroyed much evidence and itself probably made drainage changes.

Caywood, Louis Richard

1. 1948, Yuma point from western Idaho: Am. Antiquity, v. 13, no. 3, p. 251.

At the Johnson Park Reservoir site, 18 miles east of Brownlee, Oregon, on the Snake River, a projectile point of Yuma type has been found in a small stream bed above a filled glacial lake.

Chaney, Ralph Works

1. 1940, Tertiary forests and continental history: Geol. Soc. America Bull. 51, no. 3, p. 469-488.

Tertiary floras migrated southward in response to climatic changes. The coastline and topography of North America during the Tertiary can be reconstructed from a study of the fossil flora. The west coast remained about where it is now but in places there were inward, narrow encroachments, and during much of the period there was a land link with Asia across the site of the Bering sea. The Cascade Mountains were nonexistent early in the Tertiary, and the Sierra Nevada were locally low.

---

2. 1949, Early Tertiary ecotones in western North America (abs.) Science, v. 109, no. 2835, p. 438.

The fossil record gives little support for the idea of climatic uniformity across many degrees of latitude in past ages. Tertiary flora show marked zoning.

---

3. 1949, Early Tertiary ecotones in western North America: Natl. Acad. Sci. Proc., v. 35, no. 7, p. 356-359.

This report contains nothing on Idaho specifically, but its generalizations would apply to interpretation of floras collected in Idaho. The early Tertiary zones are about 20° north of areas where similar vegetation is found at present. A zone of Tertiary floras that includes Idaho is a subtropical assemblage. The climate at the beginning of the Tertiary was warmer than at comparable latitudes now, with the warm zone extending farther north near the Pacific Ocean than inland so the Pacific shore was about at its present position.

Cheney, Thomas McGiffin (McKelvey, V. E., and Gere, W. C.)

1. 1956, Fusilinid-bearing rocks in Sublett Range, southern Idaho: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 7, p. 1716-1719.

It is noted that the rocks described by Youngquist and Haegele in the Sublett

Coats, Robert Roy

2. 1956, Uranium and certain other trace elements in felsic volcanic rocks of Cenozoic age in western United States, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the U. S. Geol. Survey and Atomic Energy Commission for the United Nations Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 75-78.

This is the same as the paper cited immediately above.

Cole, John Wilson (and Bailey, H. D.)

1. 1948, Exploration, development, mining and milling of a unique tungsten ore body at the Yellow Pine mine, Stibnite, Idaho: U. S. Bur. Mines Inf. Circ. 7443, 24 p.

Gold-antimony deposits were known near the site of Stibnite, Valley County, in 1900. The first claims were located in 1914. In 1927 and 1933 groups of claims were acquired by F. W. Bradley from the United Mercury Mines Co. The operating company was known as the Yellow Pine Co. until 1938 when it was taken over by its parent company, the Bradley Mining Co. Antimony-gold ore was produced from the Meadow Creek mine, and milled there from 1932 to 1938 when this mine was closed. Quarry-mining nearby was carried on in 1938 and 1939. The U. S. Bureau of Mines had a drilling program in the winter of 1939-40 and D. E. White noted scheelite in a drill core. A shaft was started in 1941, and by the end of that year all mining had been shifted to the tungsten-antimony-gold ore body disclosed by the drilling. The tungsten ore body was exhausted in 1945. Production tables for the various principal ore bodies are given. The rest of the report, except for a brief summary of the geology based on other reports, deals with engineering features of the Bureau of Mines' work in the area.

Cook, Earl Ferguson

1. 1954, Mining geology of the Seven Devils region: Idaho Bur. Mines and Geology Pamph. 97, 22 p., incl. geol. maps.

The principal rocks of the Seven Devils region are the Seven Devils volcanics (Permian and Triassic) which include sedimentary strata intercalated in the volcanic rocks. These rocks are largely metamorphosed. Unconformably on the Seven Devils volcanics is a thick sequence of locally metamorphosed shale and limestone that seems to be mainly of Triassic age, but may include some Jurassic rocks. There are masses of granodiorite, here interpreted as metamorphosed gabbro (Jurassic). A fresher quartz diorite, which tends to wedge out downward, is later than the granodiorite and probably an extension of the Idaho batholith. There is also some granite. The Columbia River basalt overlies all the older rocks and fills valleys in an erosion surface with a relief of about 2,000 feet. Its maximum thickness is about 2,500 feet. Alluvial and glacial deposits are not abundant. Diversion of the Snake River in this region is thought to be after, rather than before, Columbia River volcanism, and may have occurred in the

Church, P. E.

1. 1954, Climates of the Pacific Northwest, in Freeman, O. W., and Martin, H. H., eds. The Pacific Northwest, an overall appreciation, p. 95-117.

This is a convenient summary of climatological data for the region. It uses physiographic subdivisions that differ from those of other authors because it is based more on climate than on other factors. Most of Idaho is placed in the Northern Rocky Mountains, Snake River Valley, and southern Idaho. The Snake River Valley merges northward with the Columbia Basin. There are highly generalized maps for temperatures, frosts, and precipitation.

Clabaugh, Patricia Sutton

1. 1946, Map of Permian phosphate deposits of Montana, Wyoming, Idaho, and Utah: U. S. Geol. Survey Mineral Inv. Prelim. Map 3-198.

This is a map with no text other than a list of references. It shows distribution of the then-known phosphate deposits in the states listed.

Clabaugh, Stephen Edmund

1. 1945, Paragenesis of the tungsten ore of the Ima mine, Idaho (abs.): Washington Acad. Sci. Jour., v. 25, no. 6, p. 198.

The Ima mine, Blue Wing district, was the second most important tungsten producer in Idaho and contains the largest known hubnerite deposits in the western states. The productive veins occupy small faults in quartzite and granite with associated pegmatite and pre-ore veins containing orthoclase, quartz, mica, pyrite, and molybdenite. Most ore is banded because of repeated fracturing. The general mineral sequence is orthoclase, quartz, mica followed by pyrite and ore, followed by quartz, rhodochrosite, hubnerite, sphalerite, and finally quartz, fluorite, tetrahedrite, galena, and chalcopyrite in the banded ore. Scheelite is in small seams and replaces hubnerite.

Coats, Robert Roy

1. 1956, Distribution of uranium and certain other trace elements in felsic volcanic rocks of Cenozoic age of the western United States, in Proc. Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955: New York, United Nations Pub., v. 6, p. 248-251.

The volcanic rocks of the Columbia Plateau, among others, are completely lacking in known uranium deposits. Rhyolitic and dacitic rocks of Cenozoic age from several western states, including Idaho, were analyzed for uranium and certain other trace elements. Maps indicating the uranium content of these rocks and certain provinces set up to show relationships, show uranium occurrences in such rocks in southern Idaho, and indicate that this part of the state is in the Shoshone province, whereas the rest of the state is in the Shahaptin province. The Shoshone province is a uraniferous province at the levels of concentration here considered.

Pleistocene but before the Wisconsin stage.

The ore deposits and placers have been intermittently worked since 1888 and have an estimated production of $1,000,000, mostly in copper with some lead, tungsten, gold, and silver. The principal activity was in 1890-1900, 1925-28, and the tungsten development began about 1952. Production tables are given. The copper deposits are of hypothermal type in tactite related to the intrusion of the quartz diorite. Disseminated deposits of copper in the Seven Devils volcanics are as yet unproductive but show promise. There are a few chalcocite-bearing veins in breccia zones in the Seven Devils volcanics. The only producer in 1953 was the Alaska tungsten mine in tactite and marble. The ore contains so much molybdenum as to be penalized for it. About 21 properties are described.

Cook, Earl Ferguson (and Larrison, Earl J.)

2. 1954, Late Pleistocene age of the Snake River diversion (Idaho-Oreg.) (abs.): Geol. Soc. America Bull., v. 65, no. 12, pt. 2, p. 1241.

The diversion of the Snake River, from a course which may have taken it into California, by the spilling over of an arm of Lake Idaho into a tributary of the Salmon River probably occurred in the latter half of the Pleistocene. Outwash gravel in southwest Idaho and eastern Oregon occurs near the probable maximum-level of the lake and probably records a late Pleistocene, pre-Wisconsin ice age. The living mammal fauna of the Seven Devils Mountains is largely identical with that of the Wallowa Mountains. Hells Canyon, which intervenes, is regarded as an insurmountable barrier to most small animals. It is estimated that the genetic drift on the opposite sides of the canyon represents not more than 200,000 years, before that the canyon barrier did not exist. On the other hand, without any such barrier, the fauna of the Owyhee desert, south of the Snake, is different, except for a few newly arrived species from the eastern Oregon fauna, supporting the idea that the original course of the Snake was southwest toward California.

---

3. 1955, Prospecting for uranium, thorium, and tungsten in Idaho: Idaho Bur. Mines and Geology Pamph. 102, 53 p.

Most of this paper is devoted to a general discussion of the mineralogy and mode of occurrence of deposits of uranium, thorium, and tungsten, with suggestions as to prospecting. It is noted that in Idaho uranium is known in veins in the Coeur d'Alene mining district, the Gibbonsville district, and in localities in Boundary and Blaine Counties, among others. Some is known in the Phosphoria formation, in lignite in the Salt Lake formation (or similar rocks), and in coal and carbonaceous rocks in the Bear River formation. There is a deposit of uranophane in rhyolite of the Challis volcanics near Salmon. Uranium minerals are known in pegmatites in Garden Valley, Boise County, and near Deary, Latah County; also in placers in a number of localities. Thorium is known in various placers and in lodes in Lemhi County. Neither uranium nor thorium are known in commercially important deposits. Tungsten is known in deposits of widely differ-

ent kinds throughout Idaho, and some of these have been richly productive. A number are briefly described.

Cook, Earl Ferguson

4. 1956, Radioactive minerals in Idaho: in 57th ann. report of the mining industry of Idaho for 1955, p. 42-46.

Uranium was discovered in Idaho in 1920, and 13 uranium-bearing minerals are known in deposits throughout the state and in many geologic environments. Idaho is also favorable prospecting ground for thorium and the rare earths. The largest known uranium reserves in Idaho are in the Phosphoria formation.

---

5. 1956, Tungsten deposits of south-central Idaho: Idaho Bur. Mines and Geology, Pamph. 108, 39 p.

This summary report divides the tungsten deposits of southcentral Idaho into scheelite deposits and black tungsten deposits. The first group includes over 20 deposits characterized as commonly found in tactite formed from an impure calcareous rock near a granitic mass, either intrusive or metasomatic. An exception is the Mackay area where the tactite comes from a pure limestone. Several of the deposits are closely associated with alaskite or leucogranodiorite dikes containing irregular quartz pods. In the northern part of the region the scheelite is not in tactite but is associated with alaskite. The tungsten deposits seem to follow structures of Laramide age, and are supposed to be in areas where the geothermal gradient was high. The deposits were formed where conditions were favorable and are not necessarily of the same age throughout. They are thought to be older than any of Anderson's Tertiary metallogenic epochs but younger than the main mass of the Idaho batholith.

The "black tungsten deposits" contain members of the wolframite group rather than scheelite and were formed at lower temperatures and pressures than the scheelite deposits, with some exceptions. Some of the black tungsten deposits are of mid-Tertiary age. About 8 such deposits are described.

---

6. 1957, Radioactive minerals in Idaho: Idaho Bur. Mines and Geology, Mineral Resources Rept., no. 8, 5 p.

Radioactive minerals in Idaho have been known since 1897 and monazite was first produced in 1910. Uranium is present in veins in the Coeur d'Alene region, the Gibbonsville district, the Hailey gold belt, and in the Stanley Basin. It is present in pegmatite in Garden Valley and in the phosphate rock of the Phosphoria formation, also 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. A uranium-bearing placer is being worked in Bear Valley in Valley County. The major reserves of uranium in Idaho are in the phosphate rock.

Cooper, Chalmer Lewis (and Sloss, Laurence Louis)

1. 1943, Conodont fauna and distribution of a Lower Mississippian black shale in Montana and Alberta: Jour.Paleontology, v. 17, no. 2, p. 168-176.

Fifty-four species of conodonts are recognized in a black shale at the base of the Lower Mississippian Madison group over an area from Alberta to southwestern Montana. The conodonts indicate correlation with the Kinderhook of the Mississippi Valley. Apparently the shale correlates with the basal Lodgepole shale in Montana. The descriptions raise a query as to whether this shale may correlate with the Milligen in Idaho, although this possibility is not mentioned in the paper.

Cooper, Gustav Arthur (and others)

1. 1942, Correlation of the Devonian sedimentary formations of North America (Chart No. 4): Geol. Soc. America Bull. v. 53, no. 12, pt. 1, p. 1729-1793.

In Idaho the chart assigns part of the Milligen to the Upper Devonian (Cassadago), the Three Forks to Cassadago and Chemung stages of the Upper Devonian, and the Jefferson to the Chemung and Finger Lake stages of the Upper Devonian. The Grandview is not mentioned. In the text a collection by Copper and Kirk near Freighter Spring, on the east side of Double Springs canyon is listed and the statement is made that the lower part of the Milligen is shaly and contains species of the Three Forks formation. This is the place Baldwin cited to show the Three Forks is present in the Borah Peak quadrangle.

Cooper, John Roberts

1. 1951, Geology of the tungsten, antimony and gold deposits near Stibnite, Idaho: U. S. Geol. Survey Bull. 969-F, p. 151-197.

This report summarizes the history and general geology of the Yellow Pine mine. The mine was the largest source of tungsten and antimony ores in the United States from 1942 to 1944. It and the neighboring Meadow Creek mine have also yielded gold and silver.

The first stage of metallization is represented by replacement by gold-bearing pyrite and arsenopyrite, the second by less extensive replacement by scheelite, and the third by replacement by stibnite and silver. The main ore bodies are along the Meadow Creek fault, as much as several hundred feet wide, cutting quartz monzonite. Ore bodies are localized by changes in strike and dip of the main zone and by related subsidiary faults. The tungsten ore body at the Yellow Pine mine was exhausted in 1945 after producing 831,829 units of $WO_3$, antimony, and more than 20,000 tons in gold ore. The district was estimated to contain about 740,000 ounces of gold. The report is especially valuable for the numerous mine maps and sections it includes.

Cooper, Margaret

1. 1953, Bibliography and index of literature on uranium and thorium and radioactive occurrences in the United States--Pt. 1, Arizona, Nevada, and New Mexico: Pt. 2, California, Idaho, Montana Oregon, Washington, and Wyoming: Geol. Soc. America Bull., v. 64, no. 2, p. 197-234; no. 10, p. 1103-1171.

The bibliography gives references to published literature, press releases, speeches, and both open-file and other unclassified reports dealing with uranium, thorium, and other radioactive occurrences. Part 2 contains the references to Idaho.

Coulter, Henry Welty

1. 1955, Fucoidal markings in the Swan Peak formation, southeastern Idaho: Jour. Sed. Petrology, v. 25, no. 4, p. 282-284; v. 26, no. 4, p. 369.

It is inferred that the fucoidal markings in the Swan Peak formation result from incorporation of coarse sand particles and organic fragments in a gelatinous organism (either plant or animal) with cementation aided by chemical changes during decay of the organism.

---

2. 1956, Geology of the southeast portion of the Preston quadrangle, Idaho: Idaho Bur. Mines and Geology Pamph. 107, 48 p.

The Cambrian beds total 7,800 feet in thickness in two formations: the Brigham, 2,800-4,800 feet; Langston, 375 feet; Ute, 490 feet; Blacksmith, 725 feet; Bloomington, 14,500 feet; Nounan, 985 feet; St. Charles, 950 feet. The Ordovician formations are the Garden City, 1,280 feet; Swan Peak, 640 feet; and Fish Haven, 200-450 feet. The Laketown dolomite (Silurian) is 1350 feet thick. The Water Canyon formation (Lower Devonian) is 357 feet thick and consists of sandstone and dolomite. The Jefferson dolomite and Madison limestone are represented in fault blocks. The Salt Lake formation (960 feet) and Lake Bonneville sediments, plus hill wash and alluvium are present. The Paleozoic rocks are in a syncline of N10°E trend cut by branching longitudinal faults, apparently steep and normal, plus transverse faults. No evidence of thrust faults was found.

Cox, Doak Carey

1. 1954, Fluorspar deposits near Meyers Cove, Lemhi County, Idaho: U. S. Geol. Survey Bull. 1015-A, p. 1-21, incl. geol. map.

The fluorspar deposits near Meyers Cove follow three groups of shear zones in the Casto and Challis volcanics. Small intrusions of granophyre and lamprophyre cut the volcanics. Many of the lodes are in or near granophyre. The lamprophyre

is post-granophyre and pre-mineralization.

The principal vein minerals are fluorite, chalcedony, and barite. The deposits are epithermal and are formed by replacement and filling of spaces in breccia along shear zones. The wall rock is silicified. The total vertical range through which fluorspar is exposed is about 4,000 feet and the veins formed 7,500-11,500 feet below the original top of the Challis volcanics. Some ore bodies are several hundred feet long and 20 feet wide. The ore can be concentrated by flotation but little of it is of direct shipping grade. Over 20 fluorite bodies are described.

Crandall, Lynn

1. 1948, Comment on the Review Report by the Corps of Engineers dated October 1, 1948: U. S. Geol. Survey open-file report.

A series of comments on specific portions of the review report, attempting to clarify, correct, and supply additional information to statements contained in the report.

---

2. 1953, Future upstream depletion of Snake River in Idaho above Hells Canyon: U. S. Geol. Survey open-file report.

A discussion of the available surface and ground water in the area, summarizing the possible depletion resulting from proposed future irrigation projects. Specific projects discussed are Fort Hall, American Falls, tributary valleys from Portneuf to Salmon Falls River, Bruneau Project, and Mountain Home. Charts outline the increased water consumption between 1947 and 1953, new land areas irrigated from 1947 to 2010, annual precipitation and diversion graphs for the years 1920 to 1950, and annual runoff graphs for the years 1920 to 1950.

---

3. 1953, Ground-water flows of the Snake River Plain: U. S. Geol. Survey open-file report. 6 p.

A discussion of the present ground-water flow patterns and volumes associated with the Snake River Plain, with suggestions for greater uses for this ground water, and capture of surplus flood waters by percolation down to the water table using canals and drainage wells.

---

4. 1954, Hells Canyon: U. S. Geol. Survey open-file report.

Two plans for the construction of a dam or dams in the Hells Canyon area are discussed. The Idaho Power Company proposes a series of three rockfill dams with a power installation of 783,000 kilowatts, a live storage of 1,000,000 acre-feet of water, and at an estimated cost of $133,000,000. The Federal Government proposes a single dam with a power installation of 800,000 kilowatts, a live water storage of 3,800,000 acre-feet, and at an estimated cost of $357,000,000.

The author outlines the advantages and disadvantages of both plans, and in view of feeling in Congress towards the Federal plan, coupled with the present condition of the Federal budget, concludes the Idaho Power Company's plan may be approved by the Federal Power Commission.

Crandall, Lynn

5. 1954, Remarks by Lynn Crandall to the Snake River water users upon the occasion of his 25th election as watermaster: U. S. Geol. Survey open-file report.

A summary of Mr. Crandall's career as engineer and watermaster in the Snake River valley.

---

6. 1955, New storage on Snake River for irrigation use above Milner, Idaho: U. S. Geol. Survey open-file report, 4 p.

A record of water spilled to waste past Milner and reservoir holdovers on Snake River since construction of American Falls reservoir is presented.

The feasibility of building new surface reservoirs above Milner in order to make water available during prolonged dry periods is discussed, and the effect such new reservoirs would have upon the rights of present water users.

---

7. 1958, Snake River: U. S. Geol. Survey open-file report.

An outline of the control of distribution and use of the water of the Snake River, including summaries of the responsibilities of the State Engineer, State Reclamation Engineer, District Engineer, and district watermaster; the operation of gaging stations and compilation of flow records, and the functions of the Committee of Nine.

A map indicates the principal streams and gaging stations of Water District No. 36.

Cressman, Earle Ruppert

1. 1952, Geology of the Dry Valley quadrangle, Idaho: U. S. Geol. Survey open-file report, 12 p.

A preliminary report of material subsequently published in more detail in U. S. Geol. Survey Bull. 1015-I, 1955, (listed below).

---

2. 1954, The Phosphoria formation in north-central Idaho, in U. S. Geol. Survey TEI-490, p. 191, issued by U. S. Atomic Energy Comm. Tech. Inf. Service, Oak Ridge, Tenn.

Notes the discovery in 1952 by C. P. Ross of phosphatic float along Hawley Creek 9 miles east of Leadore and 20 miles west of known outcrops of the Phosphoria in this latitude. A visit there revealed the presence of float of phosphate rock and of chert like the Rex chert. The Phosphoria here is underlain by quartzite similar to the Quadrant and overlain by mudstone like parts of the Dinwoody formation. The Phosphoria consists of 700 feet of cherty dolomite overlain by 150 feet of bedded chert, with phosphate rock at two horizons, possibly in minable thicknesses.

Cressman, Earle Ruppert (and Gulbrandsen, Robert A.)

3. 1955, Geology of the Dry Valley quadrangle, Idaho: U. S. Geol. Survey Bull. 1015-I, p. 257-270.

The Dry Valley quadrangle, Caribou and Bear Lake counties, was geologically mapped as part of an investigation of phosphate deposits. It contains exposures of Brazer limestone, Wells formation, Phosphoria formation, Dinwoody formation, Thaynes formation, and unnamed Tertiary and Quaternary beds. There are open folds of north-northwest trend with a few large faults of similar trends and many short transverse faults. Two zones of phosphate rock suitable for mining are present in the Phosphoria.

Cressman, Earle Ruppert

4. 1957, Preliminary geologic map of the Snowdrift Mountain quadrangle, Caribou County, Idaho: U. S. Geol. Survey Mineral Inv. Field Studies Map MF-118.

Black and white geologic map with sections, 1:24,000, no text.

Crosby, Garth M.

1. 1954, Geology of the Hercules mine (Idaho): Mining Cong. Jour., v. 42, no. 6, p. 43-45, 82.

The Hercules mine in the Coeur d'Alene area in Shoshone County was first located in 1889 and production commenced in 1902. From 1912 to 1925 the mine produced 2,500,000 tons of silver-lead ore, with a gross value of about $80,000,000. Operations were suspended in April 1925. The mine was reopened in 1947. The mine is in the Prichard and Burke formations near a pre-ore monzonite stock. Less wall-rock alteration than is common in the district is present. The minerals include magnetite, siderite, pyrite, pyrrhotite, grunerite, biotite, garnet, adularia, chlorite, chalcopyrite, arsenopyrite, jamesonite, galena, and sphalerite. The vein fissure appears to have little offset on it but is cut by a cross fault with offsets up to 200 feet.

Crosthwaite, Emerson Gerald

1. 1954, Ground-water development and problems in Idaho: U. S. Geol. Survey open-file report, 17 p.

Ground-water development in Idaho has proceeded rapidly since 1945. The more important areas of the Snake River Plain and its tributaries, the Rathdrum Prairie, and the Malad River valley are discussed with respect to type and amount of ground water available, irrigation requirements, use of excess flood water, and recharge problems.

---

2. 1956, Ground-water possibilities south of the Snake River between Twin Falls and Pocatello: U. S. Geol. Survey open-file report, incl. geol. map.

The area south of the Snake River between Twin Falls and Pocatello contains 180,000 acres of irrigated land of which 35,000 acres are irrigated wholly or partly by ground water. Most of the surface water is already obligated. The area also contains more than 200,000 acres that could be farmed if water was available. On the basis of published and unpublished data and some original geologic fieldwork, a geologic map (blue print) has been compiled and ground-water conditions, so far as known, are outlined. Climatic and agricultural data are summarized.

The rocks range in age from Precambrian to Recent and include Cambrian, Ordovician, Mississippian, Pennsylvanian, and Permian marine beds, granitic rocks, Miocene(?) to Recent silicic flows, and pyroclastic and sedimentary rocks. Eleven Tertiary and Quaternary units are distinguished and these are the principal aquifers.

---

3. 1956, Ground-water use in Idaho: A talk at the annual convention of the Idaho State Reclamation Assoc., Boise, Idaho, April 30, 1956, U. S. Geol. Survey open-file report, 7 p.

Use of ground-water has increased markedly in the past 10 years. So far there has been no material interference between pumping projects or between the use of ground and surface water. This may not continue to be true. Irrigation is a major use of ground water but industry, public supply, and domestic uses have had their share. The rural per-capita use of water is about 110 gallons daily, chiefly from ground water. In 1955 ground-water withdrawals for irrigation totalled over a million acre-feet, compared with 350,000 acre-feet in 1950. The rate of increase may be decreasing. The principal areas of development are the Malad Valley in Oneida County, the Mud Lake basin in Jefferson County, the Little Lost River valley in Butte County, the Blackfoot-Taber and Aberdeen-Springfield areas in Bingham County, the Michaud Flats area adjacent to American Falls Reservoir, Minidoka North Side extension area in southern Blaine and Minidoka Counties, the Raft River valley and Oakley basin in Cassia County,

and the vicinity of Murtaugh and Kimberly in Twin Falls County, with less extensive development in other areas. Industrial development in Idaho has increased recently. Further studies leading to conservation and development of ground water are needed.

Crosthwaite, Emerson Gerald (and Scott, Robert Clyde)

4. 1956, Ground water in the North Side Pumping Division, Minidoka Project, Minidoka County, Idaho: U. S. Geol. Survey Circ. 371, 20 p., incl. geol. map.

The U. S. Bureau of Reclamation proposes to irrigate 64,000 acres north and west of the Snake River from 175 wells, plus some surface water. Private parties are developing 20,000 additional acres. The Snake River basalt is the principal water-bearing formation but ground water comes also from the Burley lake beds and other rocks. West of the project much water is discharged from springs in the Snake River basalt. The gross ground-water requirements on the Federal project will be 235,000 acre-feet annually. Data on expected depletion and other factors are given. Chemical analyses of the water are tabulated.

---

5. 1956, Well records and ground-water levels in western Jerome County, Idaho: U. S. Geol. Survey open-file report, 151 p.

In western Jerome County 763 wells have been measured and 8 observation wells are maintained. Tables recording the well data compose most of the report.

---

6. 1957, Ground-water possibilities south of the Snake River between Twin Falls and Pocatello, Idaho: U. S. Geol. Survey Water-Supply Paper 1460-C, p. 99-145.

A preliminary appraisal is given of the ground-water resources of 13 districts, 3,500 square miles. The principal sources are extrusive volcanic rocks of silicic and intermediate composition, sand and gravel in lake beds, basalt, and alluvium. Water from the first two units is commonly under artesian pressure; that from basalt and alluvium is not confined.

Curtis, G. H. (and Reynolds, J. H.)

1. 1958, Notes on the potassium-argon dating of sedimentary rocks: Geol. Soc. America Bull., v. 69, no. 2, p. 151-160.

This paper is a general discussion of dating of geologic units and advocates the potassium-argon method. It notes that the Sierra Nevada, Idaho, and southern California batholiths have an age range of only 100-105 years by the Larsen method, but actually may range in age from the Portlandian (Upper Jurassic) to the Cenomanian stage of the Upper Cretaceous.

Dake, Henry Carl

1. 1942, Latah petrified forests (Washington, Oregon, Idaho): Mineralogist, v. 10, no. 11, p. 339-340, 352-353.

Most of the localities mentioned are in Washington and Oregon but Mann Creek, Washington County, Idaho, is mentioned. It is thought most of the fossil wood in and west of western Idaho is drift wood in Latah deposits.

---

2. 1946, Idaho star garnet: Mineralogist v. 14, no. 10, p. 556, 558.

Asteriated or star garnet occurs at a number of localities in Idaho, notably Emerald Creek in Latah County. Crystals from here are briefly described.

---

3. 1954, Largest petrified trees (Idaho): Mineralogist, v. 22, no. 4, p. 154, 156, 158.

This refers to the fossil trees in the Germer Basin area and suggests the area be made a State Park.

---

4. 1956, Northwest gem trails--a field guide for the gem hunter, the mineral collector and the tourist; includes Oregon, Washington, Idaho, Montana, and Wyoming: Portland, Ore., Mineralogist Pub. Co., 1st ed., 1950, 80 p; 2d ed., 1956, 80 p.

This is a general summary of collecting localities in Oregon, Washington, Idaho, Montana, and Wyoming, with 13 pages devoted to Idaho.

Davidson, David Francis, (Smart, Ross A., Pierce, H. W., and Weiser, Jeanne D.)

1. 1953, Stratigraphic sections of the Phosphoria formation in Idaho 1949, Pt. 2: U. S. Geol. Survey Circ. 305, 28 p.

At its type locality in southeastern Idaho the Phosphoria consists of a lower member, the phosphatic shale, about 180 feet thick, and an upper member, the Rex chert, about 240 feet thick; another member, a thin-bedded cherty mudstone 15-75 feet thick overlies the Rex in most of southeastern Idaho and western Wyoming but is not well defined at the type locality. Seven stratigraphic sections are tabulated.

_____ (and Gulbrandsen, Robert A.)

2. 1957, Selenium in the Phosphoria formation in Idaho, Wyoming, Utah, and Montana (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1714.

The Meade Peak phosphatic shale member of the Phosphoria formation contains some of the most seleniferous sedimentary rocks known, and the richest of these are in southeastern Idaho and western Wyoming, especially in carbonaceous mudstone and in phosphate rock. In the former the concentration ranges up to 1,500+ ppm. and in the phosphate rock up to 300 ppm.

Davidson, Donald Miner

1. 1939, Geology and petrology of the Mineral Hill mining district, Lemhi County, Idaho (abs.): Minnesota Univ., Summaries of Ph.D. theses, v. 1, p. 218-221.

Metamorphosed Precambrian sedimentary rocks are exposed in the southeastern part of the Mineral Hill district and as large lenses along the Salmon River mingled with rocks of granitic aspect. They are traceable northeast into the Belt series. Augen gneiss, originated by crushing of porphyritic granite, forms a large area near Shoup. East of the mapped area the augen gneiss grades into porphyritic granite plus orbicular granite. Aplite and pegmatite are related to the granitic rocks. Dacite porphyry and rhyolitic and granitic porphyry dikes are later and are cut by large faults. Lamprophyre and basalt dikes follow the fault planes. Two analyses are given.

Deiss, Charles Frederich

1. 1941, Cambrian geography and sedimentation in the central Cordilleran region: Geol. Soc. America Bull., v. 52, no. 7, p. 1085-1115.

This paper gives broad generalizations relative to Cambrian rocks in western North America, but chiefly those in western Montana, northern Idaho, northeastern Washington, southeastern Alberta, and southeastern British Columbia. Only those portions of the paper that bear on problems in Idaho are abstracted here.

Deiss indicates that no sediments of Early Cambrian age are present within Idaho but refers to Middle Cambrian rocks in northern Idaho. Most of the Cambrian sediments came from the postulated land mass, Cascadia, to the west. A map shows the western part of Idaho included in Cascadia, but roughly the eastern half in the Eastern Rocky Mountain Basin. The northern half of the east side of this basin was bounded by the land mass called Laurentia, with its western shore in northernmost Montana and in Canada. In the Early Cambrian the whole of Idaho is regarded as part of Montania. This land mass was formerly called the Montana Island but is here regarded as joined to other land areas through much of its history. In Albertian time (Middle Cambrian) geosynclinal seas entered eastern Idaho for the entire length of the state and there were epeiric seas farther east. During part of the Middle Cambrian there was an isolated land mass in northwestern Montana with the Idaho strait west of it. In Late Cambrian time all of Idaho except its southeastern part was above the sea. It appears to have remained so at least until possibly late in the Devonian.

Deiss, Charles Frederich

2. 1946, Stratigraphy and structure of phosphate rock northeast of Georgetown, Idaho (abs.): Geol. Soc. America Bull., v. 57, no. 12, pt. 2, p. 1265-1266.

This paper summarizes data on the Deer Creek-Wells Canyon district, given in greater detail in a later official report, abstracted below.

---

3. 1949, Phosphate deposits of the Deer Creek-Wells Canyon area, Caribou County, Idaho: U. S. Geol. Survey Bull. 955-C, p. 61-101.

The Deer Creek-Wells Canyon area, 18 square miles, is in the southeast corner of southeastern Idaho. It was studied in 1944. The phosphatic lower member of the Phosphoria is 179 to 200 feet thick, is overlain by the Rex member and underlain by the Wells formation. Detailed lithologic and stratigraphic data are summarized on the basis of stratigraphic measurements in 11 trenches and analyses of 202 samples. The inferred reserves total nearly 120,000,000 tons, of which more than 27,000,000 tons are high-grade, nearly 53,000,000 tons medium-grade and nearly 40,000,000 tons low-grade rock.

Dings, McClelland G. (Whitebread, D. H., Yates, R. G.)

1. 1956, Geologic map and sections of the Metaline mining district, Pend Oreille County, Wash.: U. S. Geol. Survey open-file report, geol. map.

This comprises a topographic map, a geologic map, cross sections, and a map explanation; no text. Three units of Quaternary age, two igneous and one detrital unit of Tertiary age, a unit of Silurian and Devonian age (chiefly argillite, some limestone, etc.), Ledbetter slate (Ordovician), Metaline limestone, Moulten phyllite and Gypsy quartzite (all Cambrian), and Monk formation (Cambrian?), plus two altered units, are mapped.

Dobbin, Carroll Edward

1. 1956, Rocky Mountain region, in Guzman Jiménez, E. J., ed., Symposium sobre yacimientos de petroleo y gas: Internat. Geol. Cong., 20th, Mexico, v. 3, p. 189-219.

The Rocky Mountain region as defined in this report barely enters Idaho along the Wyoming border. The eastern limit of the "Paleozoic-Mesozoic geosyncline" is mapped in western Wyoming and Montana, cutting through a corner of Idaho near Yellowstone National Park. It is shown that oil, with a wide range in quality, has been found in the region in rocks ranging in age from Precambrian to Tertiary, but most is thought to be derived from Cretaceous strata beneath thrust faults.

Dort, Wakefield, Jr.

1. 1949, Glaciation of the Coeur d'Alene mining district, Idaho (abs.): Geol. Soc. America Bull., v. 60, no. 12, pt. 2, p. 1883-1884.

During the last glaciation a minimum altitude of 5,300 feet was necessary for the formation of minor ice masses in favorable locations, in the Coeur d'Alene region. Ice streams formed at higher altitudes flowed down valleys to as low as 3,900 feet, cutting cirques and V-shaped valleys. The longest, along Canyon Creek, was about 5 miles long. No ice masses formed on south-facing slopes. Boulder deposits, striations, and other evidence point to ice masses much more extensive than is evidenced by existing cirques and glaciated valleys. Some of the boulders appear to have come from Central Idaho to the south. There was a period of canyon cutting between two glacial stages, the first may correspond to the Spokane advance of Bretz. The second was Wisconsin.

---

2. 1955, New evidence relating to the origin of cirques (Idaho) (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1551-1552.

Cirques are well developed on north-facing slopes of the Bitterroot Mountains in the Coeur d'Alene region at about 6,000 feet altitude. The smooth cirque surfaces are striated and grooved and glacial striations are present on very narrow divides above cirque headwalls, on the crests of spurs between cirques, and on small steps on the upper parts of cirque headwalls. The evidence suggests that cirques are brimful or overfull during waxing and maximum stages of glaciation, and that waxing glaciers accomplish little cirque enlargement.

---

3. 1957, Striated surfaces on the upper parts of cirque headwalls: Jour. Geology, v. 65, no. 5, p. 536-542.

In the Coeur d'Alene mining district, Shoshone County, glacially striated bedrock surfaces high on cirque walls and on narrow divides behind and between cirques are interpreted to mean that during the waxing phase of a glacial age the developing cirques were brimful or overfull of snow, névé and ice, and a carapace of ice may have capped summit areas above the cirques during maximum glaciation.

Douglas, Edwin B.

1. 1949, Cobalt in Idaho: Mining Yearbook, 1949, p. 150-152, Denver, Colo., Colorado Mining Assoc.

The history of the Blackbird district is summarized and the comment is made that the future depends on road construction by government agencies. Vhay has divided the district into three structural blocks (1) Lookout block, (2) Blackbird block, (3) Haynes-Stellite block. The Blackbird block is the one in which the Calera Mining Co. is mainly interested, is the most schistose in the district,

is lightly folded and much sheared in three sets. The Haynes-Stellite block is composed of nonschistose, well-bedded quartzite with breccia zones healed by tourmaline and a little quartz. The only mineralization is in these zones and some of the cobaltite there is minus 300 mesh. In the Blackbird block there are two principal types of deposit, (1) massive sulfides with pyrite, Pyrrhotite, chalcopyrite and cobaltite with a Cu-Co ratio of about 2:1, (2) finely disseminated cobalt in schist with minor pyrite and chalcopyrite, the Cu-Co ratio being about 1:1.

Mining and treating methods are discussed and remarks as to uses conclude the article.

Douglass, Robert M. (and Murphy, Michael J., and Pabst, Adolf)

1. 1954, Geocronite (Utah-Idaho-Calif.): Am. Mineralogist, v. 39, nos. 11-12, p. 908-928.

This is a mineralogic study, including X-rays of geocronite. The mineral is commonly assigned the formula $Pb_5 (Sb_2As)_2 S_8$. It is concluded that no simple formula is strictly correct. Geocronite is easily confused with jordanite and boulangerite; it cannot be determined safely with polished surface observations such as those A. L. Anderson used in the Clark Fork district. One of the specimens used in the present study was from Mackay, Idaho.

Dunham, Kingsley Charles

1. 1948, Introduction to the Symposium: Symposium on the geology, paragenesis, and reserves of the ores of lead and zinc: Internat. Geol. Cong. 18th, London, p. 11-39.

Tables list general production figures for the world, and geologic features of a number of mines in Idaho.

Eakin, Thomas Emory

1. 1946, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1943, pt. 5, Northwestern States: U. S. Geol. Water-Supply Paper 990, p. 8-10.

Four wells were measured in Idaho, all in the Rathdrum Prairie area in Bonner and Kootenai Counties. Water levels in all rose, apparently largely because of an unusually heavy snow cover.

_____, (Nelson, W. B., and Dennis, P. E.)

2. 1947, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1944, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1020, p. 6-26.

In Rathdrum Prairie, Kootenai County, measurements were made in three observation wells. Water levels were low because of deficient precipitation.

In Malad Valley, Oneida County, measurements of water levels, artesian pressure, and flow of 164 wells were made in connection with an extensive ground-water study. The total average annual discharge from the fresh-water artesian system is about 15,000 gallons a minute or 24,000 acre feet a year.

Eakin, Thomas Emory (and Nace, R. L.)

3. 1948, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1945, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1027, p. 54-74.

In Rathdrum Prairie measurements in three observation wells continued. Precipitation was normal and ground water storage increased. Measurements in a well in Bonneville County and one in Boise County as well as the investigation in Malad Valley were continued. In southern Idaho the net storage of ground water increased.

Eardley, Armand John

1. 1947, Paleozoic Cordilleran geosyncline and related orogeny: Jour. Geology, v. 55, no. 4, p. 309-342.

The Cordilleran geosyncline in Paleozoic time consisted of two main troughs, called the Pacific and Rocky Mountain troughs. The sediments of the Pacific trough from California to Alaska have much volcanic material and graywacke in every system. Phyllites, slates, argillites, schists, gneisses, recrystallized chert, marble, metaconglomerate, metaandesite, and pyroclastics make up the thick sequences. Batholiths of Mesozoic age invaded the Pacific trough but only one, the Idaho batholith, reached the Rocky Mountain trough. The results of dynamic metamorphism, batholithic intrusion and blanketing by Cenozoic deposits have left the area between the troughs little known but it is here regarded as one of heavy sedimentation. The Rocky Mountain trough contains mostly marine limestone, shale, and sandstone, relatively little metamorphosed. It is suggested that a volcanic archipelago flanked the Pacific trough on the west and was a site of continuing orogeny during the Paleozoic. It was similar to the present Japanese archipelago. Instead of a rigid land of continental proportions with a shore in western Montana, a volcanic archipelago is believed to have been present, mostly west of the modern Pacific coast. The maps with this paper show basins of sedimentation throughout the Paleozoic. They are of various shapes but include Central Idaho. Part or all of the Panhandle of Idaho is represented as land or shelf during much of the epoch.

---

2. 1949, Paleotechtonic and paleogeologic maps of central and western North America: Am. Assoc. Petroleum Geologists Bull., v. 33, no. 5, p. 655-682.

Twelve paleotectonic and 5 paleogeologic maps present the major stages of the evolution of the central and western part of the continent from early Paleozoic to late Mesozoic. The Cordilleran geosyncline in Cambrian, Ordovician, and

Silurian time was one of great subsidence. Its western part has an assemblage principally of lavas, pyroclastics, conglomerates, graywackes, black shales, massive limestones and cherts, indicating the proximity of a volcanic archipelago on the west. Their metamorphism and unconformities represent fairly continuous orogeny in the volcanic belt. The eastern troughs of the geosyncline were filled with sandstone, shales, limestones, and dolomites from the central part of the continent. The basin of subsidence in Arkansas, Oklahoma, and Texas was small, shallow, and intracontinental. In the Devonian the transcontinental arch rose, and strata on it were removed at the close of the period except for sags in Colorado and Arizona. Great transverse arches developed. The Cordilleran Devonian basin was broad, and centered in Nevada where the most complete Devonian section in North America is found. The Upper and Middle Ordovician rocks overlap on the Lower Ordovician, Cambrian, and Precambrian rocks. Mississippian seas were widespread, and in the Rocky Mountain region a long narrow zone subsided to form the Madison basin. Subsidence exceeded 5,000 feet along the Idaho-Montana and British Columbia-Alberta boundaries. A long eastward basin, the Big Snowy basin, sank in central Montana and continued to sink in Late Mississippian time. The Brazer basin sank in Idaho and Utah in Late Mississippian time, and there was a broad basin of poorly known limits in northern California, southern Oregon, and northwestern Nevada. The rise of the Manhattan geanticline in Central Nevada marked the beginning of a division of the Cordilleran geosyncline. In early Pennsylvanian a deep basin sank rapidly in east Texas, southern Oklahoma, and western Louisiana, and the Lasalle anticlinal belt began to rise. The south-central part of the continent was subject to unrest in the early Pennsylvanian. The volcanic archipelago along the western margin of the continent persisted. There was extensive subsidence in the Cordilleran geosyncline in the Pennsylvanian. A local basin in west-central Utah was filled by up to 25,000 feet of beds. The Manhattan geanticline continued to rise. If the western volcanic belt persisted it was separated from the seaway by a piedmont. Among other movements, an extensive area of Lower Pennsylvanian beds was gently elevated and eroded in Wyoming and Montana. The Marathon orogeny, with thrusting, occurred then. The Permian was marked by extensive volcanism, and the site of maximum fill and subsidence was later the site of the Nevadan batholith. The Manhattan geanticline shifted eastward and separated a deep, small trough in Utah from the volcanic assemblage on the west. Extensive shelf seas stretched east and south from Idaho and Utah. The Ouachita Mountain system may have received its greatest growth at this time and there were various other areas of compression. In the Triassic the Manhattan geanticline developed northward into Canada and was land except for a passageway in Nevada, to the Utah trough. East of the trough the Triassic sediments are largely continental. The western volcanic archipelago apparently continued. The Manhattan geanticline, now called the Cordilleran, became complete in Early Jurassic time. The trough to the west suffered extreme subsidence with accumulation of volcanic rocks, black shale, etc. The eastern trough suffered marine transgression. Most of the continent was being eroded in Early and Middle Jurassic time. The great Nevadan orogeny occurred in the Late Jurassic with compression and batholithic intrusion. To the west a new trough formed and filled. The Utah trough sank, and a shelf sea spread over most of the Rockies and the Great Plains. The Cordilleran geanti-

cline in the Early Cretaceous was composed principally of the Nevadan orogenic belt and a new belt of moderate orogeny; batholithic activity continued perhaps as late as Middle Cretaceous. The Idaho batholith is one result although it may be as late as Late Cretaceous. The southern part of the continent was very active in Early Cretaceous. There was widespread crustal unrest in the Late Cretaceous. The batholith in the Sierra Nevada suffered erosion. The Late Cretaceous seas were more widespread and deposits were thicker than in Early Cretaceous time.

Eardley, Armand John

3. 1951, Structural geology of North America: New York, Harper and Bros., 624 p.

The main feature of this book is a series of paleogeologic and paleotectonic maps. The text comments on these. Most of Idaho is represented as submerged during the Paleozoic. The Idaho batholith is said to be tectonically related to the Sierra Nevada batholith but to be younger.

The tectonic map for Cambrian, Ordovician, and Silurian time shows all of Idaho deeply buried in sediments. The tectonic map for Devonian time shows all of Idaho except the panhandle deeply buried. The geologic map at close of the Devonian shows Idaho and neighboring regions covered by Devonian beds. The tectonic map for Mississippian shows much of southern and south-central Idaho deeply buried, with the Manhattan geanticline entering southwestern Idaho and an orogenic belt along the eastern state boundary. That for the Early Pennsylvanian shows all but the north tip of Idaho deeply buried. The geologic map in mid-Pennsylvanian time shows the entire region covered by Mississippian and lower Pennsylvanian rocks. The tectonic map for the Late Pennsylvanian is similar to the earlier one. The tectonic map for the Permian shows western and most of central Idaho deeply buried and all southeastern Idaho with less than 1,000 feet of sediments. The geologic map at the close of the Permian shows the entire region covered. The tectonic map for the Triassic shows thin deposits along the west edge of Idaho, a dry-land epeirogenic belt in the median portion, with thin deposits east of it in southern Idaho and thick ones farther east. The tectonic map for the Early and Middle Jurassic shows most of Idaho in a broad epeirogenic belt with the Utah trough crossing the eastern part of southeastern Idaho. That for the Late Jurassic shows the Nevadan orogenic belt just entering western Idaho, most of the state in an epeirogenic area and the Utah trough widened in southwestern Idaho. The geologic map at the close of the Jurassic shows Permian rocks covering most of the state except the panhandle, which is in the Nevadan orogenic belt. Triassic rocks are shown in southwestern and southeastern Idaho. The tectonic map for the Early Cretaceous shows most of the state in the Cordilleran geanticline with a trough in southeastern Idaho. The tectonic map for the late Cretaceous shows most of Idaho in an epeirogenic belt belonging to the Cordilleran geanticline, an orogenic belt in the western part of southeastern Idaho, and a trough east of that.

The Cordilleran and Rocky Mountain geosynclines are distinguished but it is noted that the area between them was "also one of heavy sedimentation". This area would include central Idaho. The Montana Island or Montania is mentioned in and north of northern Idaho in Cambrian time but it is remarked that Marshall Kay doubts its existence. The Permian volcanic trough is thought of

as extending eastward to Bayhorse. The volcanic archipelago unit changes to the western border of Idaho in the Silurian. The belt of Laramide orogeny is pictured through most of Idaho. The Idaho batholith is regarded as allied to the Coast Range and Sierra Nevada batholiths, but largely of Laramide age (the last major offspring of the great batholithic belt). The Idaho batholith is regarded as composite with some of the smaller parts and satellites of Late Cretaceous and early Tertiary age and some as young as Miocene. It is at the junction of arcuate segments of the Laramide and Nevadan orogenic belt. It is similar to the batholith of the Nevadan orogeny and dissimilar to the plutons of the Laramide belt.

Eardley, Armand John

4. 1956, Thrust belt of northern Utah, southwestern (southeastern) Idaho and western Wyoming, Abstract in Am. Assoc. Petroleum Geologists Rocky Mtn. Soc. Geol. record Feb. 1956, p. 171; Am. Assoc. Petroleum Geologist Bull. 40, no. 4, p. 791.

The thrust belt is arcuate eastward and most thrusts moved east. The Bannock thrust in Idaho is in the back part of the belt and, instead of one master thrust, may be a complex of imbricate thrusts. Sharp anticlines and synclines in front of or within the Bannock thrust sheet have been drilled without success, whereas a disturbed belt in front of the thrusts and involving Cretaceous and early Tertiary strata has yielded oil and gas.

_____ (and Brasher, George Kirtley)

5. 1953, Tectonic map of northern Utah, southeastern Idaho, and western Wyoming, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf. 1953, p. 78-79.

The map adds little to data shown in the state map, so far as Idaho is concerned. The "post Laramide" normal or steep reverse faults are emphasized by being in red and some are added, apparently on the basis of physiographic evidence.

Eckelmann, Walter R. (and Miller, Donald S.)

1. 1956, New uranium-lead age determinations (abs.): Am. Geophys. Union Trans., v. 37, no. 3, p. 342.

New specimens of uranium minerals examined and subjected to chemical and isotopic analysis includes a specimen of pitchblende from the Sunshine Mine, Shoshone County, Idaho. The pitchblende, which cuts the St. Regis quartzite (Belt series) at the north limb of the Big Creek anticline, is at least 1.2 billion years old, which is a minimum age for the deposition of the Belt series previously thought to be late Precambrian.

Eggler, Willis Alexander

1. 1941, Primary succession on volcanic deposits in southern Idaho: Ecol. Mon. Official Pub. Ecol. Soc. of America, v. 11, p. 277-298, Duke Univ. Press, Durham, N. C.

This gives brief historical, botanical, and climatic data and describes the volcanic rocks in sketchy fashion. Comments are made on "fate of precipitation", saying there is no surface runoff and water sinks in cracks and crevices. Evaporation data, especially for crevices, are given. Data on habitats of plants relative to kinds of lava flows, crevices, etc., are included.

Eilertsen, D. E., (and Lamb, F. D.)

1. 1956, A comprehensive report of exploration by the Bureau of Mines for thorium and radioactive black mineral deposits: U. S. Atomic Energy Comm., Tech. Inf. Service Ext., Oak Ridge, Tenn., RME: 3140, 46 p.

The search for thorium and radioactive black minerals by the U. S. Bureau of Mines in cooperation with the U. S. Geological Survey was carried on in 1948 to 1955. In Idaho 27 projects were undertaken. Of the 39 projects in the western United States, 10 in Idaho are of commercial interest and the only one being commercially exploited is that in Bear Valley, Idaho. Nine published reports on areas in Idaho are abstracted separately. In addition there are 18 unpublished reports on areas in Idaho. All alluvial deposits of economic interest in Idaho and western Montana are associated with the Idaho batholith and found in depressions in which the material weathered from the granitic host rock had not been carried far by streams and had been deposited under quiescent conditions.

Eisenlohr, William Stewart, Jr.

1. 1948, Effect of water temperature on flow of a natural stream: Am. Geophys. Union Trans., v. 29, no. 2, p. 240-242.

About three percent of the variation in streamflow of the Kootenai River near Copeland, Idaho, has been found to be associated with variation in water temperature.

Emigh, G. Donald

1. 1956, Comments on the occurrence and origin of phosphate in Tennessee and in the Phosphoria formation of the west (abs.): Econ. Geology, v. 51, no. 1, p. 113.

The blue rock deposits of Tennessee are products of original deposition of phosphate in limestone. The brown rock deposits there result from the weathering of carbonates from phosphatic limestone. The origin of the phosphate in the Phosphoria is not so clear although a portion is phosphatized fossils as in Tennessee. The talk, of which this is an abstract, is to describe the various components of the Phosphoria and give suggestions as to the origin of the oolitic structure. The importance of weathering of the Phosphoria is mentioned.

Erdmann, Charles Edgar

1. 1941, Geology of dam sites on the upper tributaries of the Columbia River in Idaho and Montana, pt. 1, Katka Tunnel no. 8, and Kootenai Falls dam sites, Kootenai River, Idaho and Montana: U. S. Geol. Survey Water-Supply Paper 866-A, p. 1-36, with geol. maps.

Conditions at three damsites on the Kootenai River between Katka, Idaho, and Kootenai Falls, Mont. are discussed. Only one of these is in Idaho, but this is regarded as the best natural location for a dam. If used, a railroad would have to be moved, which nullifies natural advantages. The country rock at the Katka, Idaho, site is Prichard formation plus younger units of the Belt series. These rocks are cut by calcic sills, one of which is at the site itself.

Evans, Edna Hoffman

1. 1944, Phosphate facts: Nature Mag., v. 37, no. 9, p. 461-464.

This is a general discussion of the value of phosphate, pointing out that some of the battle areas of World War II were in part determined by the presence of phosphate deposits. Idaho is mentioned as one of the states containing important phosphate deposits. The geology, and treatment of Florida phosphate are summarized in the last half of the paper.

Everhart, Donald Lough

1. 1956, Uranium-bearing vein deposits in the United States, in Proc. Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955, New York, United Nations Pub., v. 6, p. 257-264.

In this summary the Sunshine mine, Coeur d'Alene region, is listed in two tables (p. 259, 262, and 263) and it is noted that the supposed Precambrian age of the deposits here is the one exception to a Cenozoic age for uranium deposits in the western United States.

---

2. 1956, Uranium-bearing vein deposits in the United States, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference on peaceful uses of atomic energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 97-103.

This is the same as the paper cited immediately above.

Fader, Stuart Wesley

1. 1951, Water levels in wells and lakes in Rathdrum Prairie and contiguous areas, Bonner and Kootenai Counties, northern Idaho: U. S. Geol. Survey duplicated rept., 90 p.

Data are given for a 270-square-mile area, including measurements of fluctuations in water levels in wells, streams, and lakes.

---

2. 1952, Records of wells and ground-water withdrawals for irrigation in Raft River valley, Cassia County, Idaho: U. S. Geol. Survey open-file report, 134 p.

Data for the 800-square-mile area include 284 well records, 29 well logs, and well-discharge measurements, plus surface-water data.

_____ (and Mower, Reed W.)

3. 1952, Records of wells and ground-water levels in Minidoka County, Idaho: U. S. Geol. Survey open-file rept., 173 p.

Data for approximately the southern two-thirds of Minidoka County consist of canvasses and measurements of all deep wells and representative shallow wells: 479 wells were canvassed. Eleven wells are measured 4 to 6 times a year and 4 wells have continuous-recording gages. Well logs are given where available.

Fahrenwald, Arthur William

1. 1941, Strategic minerals of Idaho: Idaho Bur. Mines and Geology, Press Bull. 20, 5 p.

Of the 19 mineral substances regarded at the time as of strategic or critical importance, antimony, tungsten, mercury, manganese, and cadmium were in production in Idaho, and vanadium was coming into production. The first three listed are of major importance. Deposits of several others were known in Idaho but not then productive. These include chromite, nickel, mica, quartz crystals, aluminum, graphite, asbestos, fluorspar, and titanium. The then-current uses and prices of strategic and critical mineral substances are summarized.

Fairbanks, Ernest Emerson

1. 1946, (Discussion) Lead-silver mineralization in the Clark Fork district (Idaho): Econ. Geology, v. 41, no. 5, p. 554-555.

This notes that the criteria used by A. L. Anderson in the Clark Fork district for the determination of microscopic ore minerals are inadequate.

Farwell, Fred W. (and Full, R. P.)

1. 1944, Geology of the Empire Copper mine near Mackay, Idaho: U. S. Geol. Survey open-file report, 45 maps and sections.

The Empire Copper mine in the Alder Creek mining district in the White Knob Mountains was first operated in 1884, and through 1942 yielded over 55,000,000 pounds of copper, mostly before 1931. Lead-zinc mines nearby have been productive and a carload of tungsten ore was shipped from the Empire in 1942. The deposits are on the margin of a granite stock intruded into Brazer limestone, with a marginal facies of granite porphyry. The limestone has been extensively contact metamorphosed. Tongues and dikes of granite porphyry cut the limestone. The copper deposits are pipelike on margins of tactite bodies. Most of the lead-zinc deposits are veins. The irregular shapes of ore shoots necessitate extensive exploration and ore reserves are small, but possibilities of finding more ore are good.

Felix, Clarence E.

1. 1956, Geology of the eastern part of the Raft River Range, Box Elder County, Utah, in Geology of parts of northwestern Utah: Utah Geol. Soc. Guidebook to the geology of Utah, no. 11, p. 76-97, geol. map.

The northern edge of the area covered by this report is in Cassia County, Idaho. Schist and metaquartzite in the Raft River Range are provisionally called "Harrison series" after Anderson (1931), although differences are noted. Tentatively the age is given as "intermediate Precambrian" which, on the data presented, would be pre-Belt. The old rocks are not mapped within Idaho. Three units tentatively assigned to the Lower Paleozoic are mapped. Of these Unit A is limestone, dolomite, quartzite, and schist, 3,500 feet thick, with possible duplications: unit B is white metaquartzite, 20-197 feet thick; unit C is dolomite, 0-100 feet thick. These look old but perhaps merely because so situated as to have been much metamorphosed. Above is the Oquirrh formation (Pennsylvanian). This is mostly limestone with some sandstone and quartzite, up to 2,000 feet thick, and seems to show onlap southward. Scantily fossiliferous Tertiary sediments are overlain by the deposits of Lake Bonneville and there are glacial and alluvial deposits. Igneous rocks include amphibolite (Precambrian) granite of unknown age, quartzite, latite flows (Tertiary), basalt of pre-Bonneville and probably pre-Snake River basalt age. The quartz latite is the only one of the igneous rocks that extends into Idaho. The range is anticlinal and shows thrust and normal faults. Most of the thrusts bring young rocks over older ones.

Felts, Wayne Moore

1. 1954, Occurrence of oil and gas and its relation to possible source beds in continental Tertiary of Intermountain region: Am. Assoc. Petroleum Geologists Bull. v. 38, no. 8, p. 1661-1670.

This is a general paper which includes an index map that includes locations of gas shows in Idaho. For western Idaho Kirkham's stratigraphy is accepted and

for southern Idaho near Cache Valley that of Neal Smith. The idea that the oil and gas in both localities are derived from peat is accepted. The possibility of obtaining gas of commercial interest from these beds is not ruled out.

Fernquist, Charles O.

1. 1945, Early placer gold mining in the Pacific Northwest: Mineralogist, v. 13, no. 5, p. 163-166.

About two columns on p. 164-165 contain remarks about Pierce, Elk City, Florence, and Warren.

---

2. 1945, Pyromorphite from the Little Giant mine, Idaho: Rocks and Minerals, v. 20, no. 7, p. 312.

This merely notes that Fernquist and a friend found pyromorphite in abandoned mine workings near Mullan.

---

3. 1947, The gem minerals of Idaho: Mineralogist, v. 15, no. 10, p. 510-513.

A few diamonds have been found in placers in Little Goose Creek, Adams County. Quartz is mentioned from upper Lost River, Custer County, Warren, Idaho County, Shoshone County, Silver City, Owyhee County. Amythyst is reported from Pole Creek near Hailey, Blaine County, the low hills near Lost River, Custer County, Silver City, Owyhee County. Chalcedony, jasper and agate are mentioned from near Hailey, Blaine County, near the North Fork of Lost River, Custer County, several places in Idaho County and Owyhee County, the Parker mine, Lemhi County the cinnabar deposits near Yellow Pine, Valley County, the Alder Creek district, Custer County, the Humming Bird mine, Bear Lake County, the Skull Canyon district, Fremont County, and 20 miles below Huntington in Washington County. Opal is mentioned from Moore Creek, Boise County, Whelan and other places in Latah County, May and Panther Creeks, Lemhi County, Clover Creek, Lincoln County, near Lewiston, Nez Perce County, numerous places in Owyhee County. Sapphires are reported in placers near Pierce, Clearwater County and in various placers in Adams and Washington Counties. Malachite occurs at various places but mostly not suited for cutting. Beryl is known in Latah and Nez Perce Counties. Zircon, garnet, andalusite and peridot are present in many places. Topaz has been found in placers at Warren, Idaho County. Kyanite of gem grade is known south of Avon, Shoshone County. The best of the zoisite (var. thulite), chrysocolla, and epidote comes from the Seven Devils district, Adams County. Staurolite is common south of Avery, Shoshone County. Coarse ilvaite crystals are known from the South Mountain district, Owyhee County.

Forrester, James Donald

1. 1942, Mica and beryl occurrence in eastern Latah County, Idaho: Idaho Bur. Mines and Geology Pamph. 58, 16 p. incl. geol. sketch maps.

The mica and beryl occurrences in T. 41 N., R. 2 W. are described, with some remarks as to market requirements for these minerals. Total production has been about $100,000. The two minerals occur as variable and sporadic constituents of pegmatite dikes on the crest of a mountain spur, accessible over an unimproved road. The dikes cut metamorphosed rocks of the Belt series (perhaps in part Prichard) and are roughly parallel to the attitude of the schistosity and relict bedding. They are related to magma here supposed to have been intruded in late Cretaceous or early Tertiary time. The mica is most suitable for use as punch and circle mica. None of the beryl is of gem quality. Quartz and feldspar in the pegmatite might also be marketable.

---

2. 1942, A sillimanite deposit near Troy, Latah County, Idaho: Idaho Bur. Mines and Geology Pamph. 59, 10 p. incl. geol. maps.

Sillimanite is used for high-grade porcelain wares and similar products. An extensive exposure of rock containing it was reported in T. 39 N., R. 2 W., secs. 7-9, and was visited in 1941. It has had no production. The area contains Columbia River basalt and metamorphosed rocks of the Belt series (possibly Prichard). The Belt rocks show effects of dynamic metamorphism and also of "soaking" and injection resulting from batholithic intrusion. They are in the border zone of the Idaho batholith. They are biotite schist and quartzite gneiss, with pegmatite pods. Sillimanite has been concentrated locally. The basalt flows were hot enough to produce a little contact metamorphism in the old rocks but without effect on the sillimanite content. The sillimanite zones appear to have been broken by faulting.

The sillimanite is amenable to concentration by flotation.

_____, (and Nelson, Vincent E.)

3. 1944, Lead and zinc deposits of the Pine Creek area, Coeur d'Alene mining region, Shoshone County, Idaho: U. S. Geol. Survey Strategic Mineral Inv. Prelim. Rept., unnumbered.

The Pine Creek area in the southern half of T. 48 N., R. 2 E., and the northern ties of T. 47 N., R. 2 E., had, when examined, a daily production of lead-zinc ore and ore reserves of 500,000 tons. The production through 1943 was 731,284 tons, having started in 1910. Veins are narrow with irregular and generally small ore shoots. Most of the area is underlain by the Prichard formation, probably over 12,000 feet thick, with two well-defined quartzitic zones; one at the top, the other near the middle. A small amount of Burke quartzite crops out in the area and there are small diabase and lamprophyre dikes. The rocks are folded and complexly faulted. Most faults are steep and fracture movement has

occurred both before and after mineralization. Thirteen mining properties are described.

Freeman, Otis Willard

1. 1940, Physiographic divisions of the Columbia Plateau: Assoc. Pacific Coast Geographers Yearbook, v. 6, p. 12-20.

The Columbia Plateau is really an intermontane lava-covered region, rather than a plateau. This area is here divided into 12 major divisions: (1) Waterville Plateau, (2) Palouse Hills, (3) Channeled Scablands, (4) Central Plains, (5) Yakima Marginal Folds, (6) Blue-Wallowa-Seven Devils Mountains and connecting Snake River High Plateau, (7) Tri-State Slopes, (8) Deschutes-Columbia Plateau, (9) Payette Section, (10) Snake River Plain, (11) Owyhee Section, (12) Harney Basin. Of these, parts or all of nos. 3, 6, 9, 10, and 11 are in Idaho. Each of the subdivisions is briefly described.

_____ (and Martin, Howard Hanna, editors)

2. 1942, The Pacific Northwest, 1st ed. New York, John Wiley and Sons, 542 p.

This is a broad treatment of our northwest from the geographer's viewpoint. There were 31 contributions to the various chapters, which include data on Indians, history, climate, fisheries, forestry, agriculture, manufacturing, and population. From the standpoint of a geologist concerned with Idaho the second and third sections of Chapter 3 "Physical Framework of the Northwest", written respectively by Otis W. Freeman and J. D. Forrester, are of special interest, mainly because they set up physiographic subdivisions that differ in some respects from those rendered standard by Fenneman in his "Physiography of the western United States". The changes are mainly in the direction of greater subdivision. Subdivisions that are largely in Idaho include the northern Rocky Mountains, parts of the Middle Rocky Mountains and the Basin and Range Province, the Snake River Plain and the Payette Section (which together embrace the topographic feature known as the Snake River Plain), the Owyhee Plateau (a new unit), the eastern parts of the Palouse Hills and Tri-State slopes, and the Seven Devils portion of the Blue-Wallowa-Seven Devils Mountains unit.

_____ (and Forrester, James Donald and Lupher, Ralph Leonard)

3. 1945, Physiographic divisions of the Columbia intermontane province: Assoc. Am. Geographers Annals, v. 35, no. 2, p. 53-75.

This is a suggested revision of Fenneman's subdivision of the Columbia Plateau here renamed the Columbia intermontane province with subdivisions called the Columbia Basin subprovince (subdivided into the Waterville Plateau; Yakima Falls, Central Plains, Channelled Scablands, and Palouse Hills of which the last named extends into Idaho), the Central Mountains subprovince, including the Blue Mountains, Wallowa-Seven Devils section, and Tristate uplands, the last two being in part in Idaho, the High Lava Plains subprovince including the Snake River Plains, Malheur-Boise Basin and Harney-High desert, of which only the last named does not extend into Idaho, and the Owyhee Upland subprovince which is largely in Idaho.

Freeman, Otis Willard

4. 1954, Columbia Intermontane province in Freeman and Martin, eds., The Pacific Northwest, p. 65-78.

The Columbia intermontane province corresponds essentially to the Columbia Plateau of Fenneman. It is here subdivided into a number of subprovinces and sections which differ in detail from those proposed in the first edition of the same book. Here the subprovinces are the Columbia Basin, Central Highlands, High Lava Plains, and Owyhee Upland. The only section of the Columbia Basin subprovince that enters Idaho is the Palouse Hills. In the Central Highlands subprovince, the Tristate Uplands and the Wallowa-Seven Devils sections are in part in Idaho. The eastern part of the Malheur-Boise Basin section and most of the Snake River Plain section of the High Lava Plains subprovince are in Idaho. Most of the unsubdivided Owyhee Upland subprovince is in Idaho. It is pointed out that the region is too diversified in topography and geology, and departs too far from the standard concept of a plateau to be well-described by Fenneman's name. The uses to which the sections are put are outlined.

The northern parts of the Basin and Range province extend into Oregon and Idaho and their character and uses are outlined.

_____, (and Martin, Howard Hanna, editors)

5. 1954, The Pacific Northwest, 2d ed., xvi, 540 p. New York, John Wiley & Sons. Includes sections by O. W. Freeman, H. H. Caldwell, P. E. Church and E. T. Hodge, W. A. Rockie, and A. W. Freeman which are cited individually. 30 contributions.

This is a thorough revision, largely by new authors of the first edition. Like that, it gives a variety of geographic information on the Northwest, including Idaho. Those sections that give geomorphic or geologic data pertinent to Idaho are cited individually.

Fryklund, Verne Charles, Jr.

1. 1950, The ore deposits of the Mayflower area, in Anderson, A. L., Kiilsgaard, T. H., and Fryklund, V. C., Jr., Detailed geology of certain areas in the Mineral Hill and Warm Springs mining districts, Blaine County, Idaho: Idaho Bur. Mines and Geology Pamph. 90, pt. 3, p. 63-73.

This report describes the Red Elephant, Mayflower, and associated lead-zinc-silver ore deposits in T. 2 N., R. 17 E. The country rock belongs mainly to the Wood River formation, here somewhat metamorphosed. There are dikes altered beyond recognition and one fresh lamprophyre dike. There is intricate faulting and most of the report is devoted to fault descriptions. Possibly all major faults are preintrusive and, therefore, premineral. Fryklund is noncommittal as to age but appears to favor a Cretaceous age.

Fryklund, Verne Charles, Jr.

2. 1951, A reconnaissance of some Idaho feldspar deposits, with a note on the occurrence of columbite and samarskite: Idaho Bur. Mines and Geology Pamph. 91, 30 p.

General data on feldspar and markets for it are given. Potentially valuable feldspar in Idaho is in zoned pegmatite dikes but distance from markets has hampered development. Prospects in Adams, Boise, Cassia, Clearwater, Elmore, Idaho, and Latah Counties are briefly described. About 18 are mentioned. Those in Garden Valley, Boise County, contain columbium and uranium.

_____, (and Hutchinson, Murl W.)

3. 1954, The occurrence of cobalt and nickel in the Silver Summit mine, Coeur d'Alene district, Idaho: Econ. Geology, v. 49, no. 7, p. 753-758.

Cobalt and nickel of possible commercial interest have been found in the Silver Summit Mine, Coeur d'Alene. About 0.40 percent Co and 1.0 percent Ni are reported. Gersdorffite occurs in tetrahedrite-siderite veins and appears to have been the first formed of the valuable minerals. As either cobalt bloom or gersdorffite are known elsewhere in the region, other bodies of cobalt-nickel ore may exist.

_____, (and Harner, Richard Stanley)

4. 1955, Comments on minor elements in pyrrhotite (Idaho): Econ. Geology, v. 50, no. 3, p. 339-344.

The cobalt and nickel content of pyrrhotite from the Highland-Surprise mine, Coeur d'Alene district, Shoshone County, Idaho, were found to be so unsystematically distributed with respect to position in ore shoots as to suggest caution should be used in determinations of temperature conditions during deposition by means of minor elements, principally because these commonly did not attain equilibrium concentrations.

_____, (and Fletcher, Janet D.)

5. 1956, Geochemistry of sphalerite from the Star mine, Coeur d'Alene district, Idaho: Econ. Geology, v. 51, no. 3, p. 223-247.

Forty sphalerite samples from the Star mine, Coeur d'Alene district, and 19 from others in the district have been analyzed for Fe, Cu, Pb, Ca, Ga, Ge, In, Mn, Co, and Hg. The sphalerite may have formed in equilibrium with iron, so the iron content may be used as a relative temperature scale. On this basis the lower portion of the Star ore body formed at lower temperature than the upper portion. Distribution of minor elements in the sphalerite is random throughout the ore body and there is no correlation of Fe with minor elements except Mn suggesting that temperature had no influence on the distribution of minor elements

other than Mn, apparently because equilibrium concentrations were not reached. It is suggested that in general the minor-element concentrations in all ore bodies, except perhaps Mn, cannot be a temperature indicator. Some doubt is cast on application of study of an artificial system FeS-ZnS to temperatures of formation of natural ore bodies.

Full, Roy P.

1. 1955, Structural relations north of the Osburn fault, Coeur d'Alene district, Shoshone County, Idaho: Master's Thesis, Univ. Idaho.

The Belt series and igneous rocks are discussed briefly. The structure includes folding and faulting produced by forces from the west, northwest, east and southeast. The intrusion of a monzonite body, believed to be contemporaneous with the Idaho batholith, represents an early deformational feature. Repeated adjustment along major fault zones has contributed to the development and localization of ore shoots. No major postmineral faulting is apparent. The relation of major faults to veins north of the Osburn fault is discussed.

Fuller, Richard Eugene

1. 1928, The Asotin craters of the Columbia River basalt: Jour. Geology, v. 36, no. 1, p. 56-74.

The Columbia River basalt has long been considered to have come from fissure eruptions. South of Lewiston a line of vents that record explosive eruptions crosses the Snake River. This activity resulted from the contact at depth of basaltic magma in fissures with water-saturated gravel.

---

2. 1950, Structural features in the Columbia River basalt: Northwest Sci., v. 24, no. 2, p. 65-73.

The term "Columbia River basalt" includes the Yakima basalt but not the Wenas basalt or the Steens Mountain basalt, and is presumably unrelated to the Snake River basalt. Surface features such as pressure ridges or collapse surfaces and aa and pahoehoe are commonly absent. Eruption was as thin tongues or flow units that attained a level upper surface rapidly. Gravity differentiation has been observed in the Steens Mountain basalt but not in the Columbia River basalt. The latter has no bombs but some components may be ejectamenta. In areas to the northwest palagonite and pillow lava record intense chilling by glacial or aqueous agencies, and similar features have been noted in the eastern areas also, apparently including Idaho. Vertical and other joints are locally prominent in the Columbia River basalt. Basaltic dikes are locally prominent and were the source of many of the flows but there is some evidence of crater eruptions also.

Gammell, Robert Mancel (and Hundhausen, Robert John)

1. 1948, Sidney Mine, Pine Creek Area, Shoshone County, Idaho: U. S. Bur. Mines Rept. Inv. 4188, 11 p.

The Sidney mine in the Yreka mining district (Pine Creek area) was located in 1896. Its production record through 1944 is given in terms of metal content. The Bureau of Mines trenched extensively and did some drilling, considerable sampling, and some metallurgical testing. They found one ore shoot. Sampling results are shown on 7 maps. J. D. Forrester and V. E. Nelson prepared a mimeographed geologic report on the area in 1944 for the U. S. Geological Survey, which is drawn on for the geologic summary in the present report.

Gardner, Louis Samuel

1. 1944, Phosphate deposits of the Teton Basin area, Idaho and Wyoming: U. S. Geol. Survey Bull. 944-A, p. 1-36.

Permian phosphate deposits in the mountains bordering Teton Basin consist of many thin layers interbedded with phosphatic siltstone, shale, limestone, and chert, intensely folded and faulted. The best deposits are in the shale at the base of the Phosphoria but a few good ones are in the Rex chert. The deposits were trenched and sampled. The best noted are in the Bighole Mountains, Madison and Teton Counties, where 7-10 beds contain 30-78 percent $Ca_3(PO_4)_2$.

Gillette, Norman John

1. 1954, Thuja (Thuites) from the Latah formation of Idaho: Northwest Sci., v. 28, no. 2, p. 77-79.

Describes logs of fossil wood (Thuja) in basalt in a roadcut between Julietta and Arrow Junction along Potlatch Creek, a tributary of the Clearwater River.

Good, Stanley Edgar

1. 1949, Preliminary report of the geology of some mineral deposits in the Twin Crags Area, Kootenai County, Idaho: U. S. Geol. Survey open-file report, 11 p.

The geology and mine workings of the Palisades mine area are mapped. Carbonate veins composed mainly of siderite, with minor amounts of magnetite, barite, galena, and sphalerite vary in width from one inch to 5 feet and have not contained commercial quantities of ore. The relationship of carbonate veins to biotite lamprophyre dikes is not clear, but both occur in the St. Regis formation of the Belt series. The area has only limited commercial possibilities due to the narrowness and discontinuity of the veins, although the veins may be more strongly mineralized at depth.

Good, Stanley Edgar (and Campbell, Arthur B.)

2. 1952, Geologic map of the Twin Crags quadrangle, Idaho: U. S. Geol. Survey open-file report, geol. map.

Geologic map of the Twin Crags quadrangle in Benewah, Kootenai, and Shoshone Counties; 7-1/2-minute quadrangle on the scale of 1:24,000. The Prichard, Burke, Revett, St. Regis, and Wallace formations of the Belt series, metadiorite and lamprophyre dikes, terrace gravels, and Quaternary alluvial deposits are mapped, with structure.

Goodspeed, George Edward

1. 1942, Orbicular rock from Buffalo Hump, Idaho: Am. Mineralogist, v. 27, no. 1, p. 37-47.

Within the area of the Idaho batholith remnants of schist, presumably of the Belt series, contain zones of orbicular rocks interpreted as of metasomatic rather than igneous origin.

Gott, Garland Bayard (and Erickson, Ralph Leroy)

1. 1953, Reconnaissance of uranium and copper deposits in parts of New Mexico, Colorado, Utah, Idaho and Wyoming: U. S. Geol. Survey Circ. 219, 16 p.

In the course of a reconnaissance for possible uranium deposits in copper deposits in sandstone, 18 deposits were examined, of which two were in Idaho. Commercial grade uranium was not found in any of the 18 deposits. Those in Idaho are near Montpelier. Probably both are in the Ankareh shale (Triassic). In both, carbonized plant material is present and some of this is radioactive.

Gray, Frederick Anton

1. 1939, Ore deposits of the Mineral Hill district, Lemhi County, Idaho: Summaries of Ph.D. Theses, Univ. Minn., v. 1, p. 221-224.

The Mineral Hill district, discovered in 1882, was mainly productive in the late eighties and early nineties. The total yield was $8,000,000 mainly from the Kentuck mine. The district contains quartz-biotite schist, schistose quartzite, and nearly pure quartzite (all belonging to the Belt series.) Contacts are gradational and dips are northward and westward. Veins are mostly on joints but some follow schistosity. The veins are related to the granitic rocks and earlier than the rhyolitic dikes. The vein matter includes pyrite, arsenopyrite, galena, sphalerite, calcite, magnetite, and muscovite.

Griggs, Allan Bingham

1. 1952, Geology and notes on ore deposits of the Canyon-Nine-Mile Creeks area, Shoshone County, Idaho: Doctorate Thesis, Stanford Univ.

The Canyon-Nine-Mile Creeks district includes representatives of the Prichard, Burke, Revett, St. Regis, Wallace, and Striped Peak formations of the Belt series, plus small monzonite stocks and dikes of diabase, lamprophyre, monzonite, aplite, and diorite.

The ore deposits include replacement veins in fracture and shear zones of minor displacement, in which predominant values are gold, gold and tungsten, lead and silver, lead, zinc and silver, copper, silver and copper, silver, lead and copper, and antimony. Those in the Nine Mile Creeks district are mainly valuable for lead, zinc, and silver, with the proportions of lead and zinc differing in different lodes. The principal ore minerals are galena, sphalerite, tetrahedrite, and chalcopyrite. The gross value of metals produced in 1951 was $63,779,925. Geologic maps of the area and of mine workings are included.

_____, (Wallace, Robert Earl, and Hobbs, Samuel Warren)

2. 1953, Geologic maps and structure sections of the Mullan and vicinity quadrangle, Idaho: U. S. Geol. Survey open-file report, geol. map.

This is a geologic map of the Mullan and vicinity quadrangle in Shoshone County, with structure sections, no text. The map shows four subdivisions of the Prichard, one each of the Burke and Revett, two each of the St. Regis and Wallace, one of the Striped Peak, plus monzonite and related rocks, and dikes, also three unconsolidated units. The area shows folds and many faults, including the Osburn fault zone.

Gulbrandsen, Robert A. (McLaughlin, Kenneth Phelps, Honkala, Frederick Sauli, Clabaugh, Stephen Edmund, and Krauskopf, Konrad Bates)

1. 1952, Geologic map and structure sections of the Johnson Creek quadrangle, Caribou County, Idaho: U. S. Geol. Survey open-file report, geol. map.

Geologic map 7-1/2-minute quadrangle on the scale of 1:24,000. Topography taken from aerial photographs by multiplex methods in 1947, and field checked in 1949. Sediments of Mississippian through Lower Triassic, Tertiary, and Quaternary ages are mapped, with structure and structure sections.

---

2. 1956, Geology of the Johnson Creek quadrangle, Caribou County, Idaho: U. S. Geol. Survey Bull. 1042-A, p. 1-23.

The Johnson Creek 7-1/2-minute quadrangle includes the Aspen Range, and study was directed mainly at detailed structural characteristics. The quadrangle contains only sedimentary rocks, ranging from Mississippian to Triassic and Tertiary to Recent. It includes the Johnson Creek syncline and Aspen

Range anticline, modified by many minor folds and by faults. Phosphate rock, being mined in 1955, is the only important mineral resource.

Gussman, R. W.

1. 1941, The property of the Lincoln Mining Company, Wallace, Idaho: Bachelor thesis, Univ. Wash.

The property is 1-1/4 miles west of Osburn, Shoshone County. The geography, history, climate, and geology of the region are briefly summarized. The Lincoln Mining Co. owns parts of three vein systems. Of these, the Chester vein strikes E. dipping 65° S., parallel to the Polaris fault. It is traceable for two miles on the surface. Where the footwall is soft the vein tends to pinch. It contains argentiferous tetrahedrite, galena, and pyrite, siderite, quartz, and complex carbonates. Deposition occurred in two stages. The other veins are not well known. Stopes on the Chester are 30-50 feet long and 4-7 feet wide. Ore in present workings is mined out. The geology is regarded as favorable for development at depth. The ore was treated in custom mills at the time of the examination but Gussman ran flotation tests to give data for a possible new mill, if desired.

Haas, O. H.

1. 1953, Mesozoic invertebrate faunas of Peru, pt. 2: Am. Mus. Nat. History Bull., v. 101, p. 9-328.

Newell's (p. 304) collection near Lewiston has the two rare genera Sororcula and Kittlistylus, perhaps even a species of each, in common with bituminous limestone in one collection from Peru. Also the Idaho collection has the Jurassic genus Lamelliphoris.

Halliday, William R.

1. 1954, Ice caves of the United States: Natl. Speleol. Soc. Bull. 16, p.3-28.

This is a general discussion of formation and preservation of ice in caves. Several caves in Idaho are listed and a few are described. The latter include Swan Lakes cave in the Bear River Range, Shoshone cave, north of Shoshone, and caves in the Craters of the Moon National Monument.

Hamilton, Warren Bell

1. 1953, Border rocks of the Idaho batholith near Riggins, Idaho (abs.): Geol. Soc. America Bull., v. 64, no. 12, pt. 2, p. 1531.

The northern part of the Riggins quadrangle contains about 35,000 feet of eugeosynclinal metavolcanic and metasedimentary rocks of Permian, Triassic, and Jurassic(?) ages. From phyllites and greenstones on the west the rocks range through schists and amphibolites to a complex of paragneisses, migmatites, and gneisses and massive granitic rocks in the border zone of the Idaho batho-

lith. In this zone tabular bodies of granitic gneiss, 1 inch to a mile thick are conformable with complex structures in the metamorphic rocks. Gneissic quartz diorite grades into paragneiss. These gneisses and the metamorphic rocks intercalated with them are thought to have resulted from regional and plutonic metamorphism of volcanic and sedimentary rocks. Some of the migmatites may have resulted from differential fusion of metamorphic rocks and to have been mobile enough to intrude upward. The rocks described are intruded by several discordant plutons of quartz monzonite and granodiorite.

The border zone near Riggins resembles the Shuswap terrane, British Columbia, and differs from some other parts of the Idaho batholith and from the rocks of the Sierra Nevada batholith.

Hamilton, Warren Bell

2. 1958, Plutonic history of west-central Idaho (abs.): Geol. Soc. America Bull. v. 69, no. 12, pt. 2, p. 1727.

Work in and near the Riggins quadrangle, Idaho and Adams Counties, has demonstrated the presence of several assemblages of granitic rocks. Quartz diorites and more mafic rocks are intruded within the Seven Devils complex and are mostly sheared, reconstituted and older than the thrusting. Layered gneisses, largely diorite, are thrust over the Seven Devils rocks. Younger quartz diorite is noted north and south of the quadrangle. Eastward the older gneisses give way to younger quartz diorite of simple structure, in part metamorphic, in part intrusive, and this in turn is invaded by concordant quartz monzonite; the complex being sheared and intruded by quartz diorite, granodiorite and other rocks. Farther east the whole is intruded by the granodiorite and quartz monzonite of the Idaho batholith proper (Late Triassic and Middle Cretaceous).

Hansen, Henry Paul

1. 1942, Post-Pleistocene vegetation and climate of the Pacific Northwest (abs.): Am. Jour. Botany, v. 29, no. 8, p. 693-694.

In northern Idaho the climax (post-Pleistocene) forests consist of western hemlock, western red cedar, and lowland white fir, with western white pine persisting due to recurrent fires. The pioneer postglacial forests were mainly lodge pole and white pine. The former was superseded by white pine which remained predominant during the rest of the post-Pleistocene. A definite trend towards a climax forest occurred recently but was apparently interrupted by fire. Similar data are given for other areas in the Northwest.

---

2. 1943, Post-Pleistocene forest succession in northern Idaho: Am. Midland Naturalist, v. 30, no. 3, p. 796-802.

Pollen profiles in a peat bog indicate that the principal postglacial arborescent invader was lodgepole pine. It was superseded by western white pine at an early stage and the latter remains dominant. Changes related to forest fires

are noted. No evidence for climatic trends was obtained.

Hanson, Alvin Maddison

1. 1953, Upper Cambrian formations in northern Utah and southeastern Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., v. 4, p. 19-21.

Brief descriptions of the Upper Cambrian formations are given. These range up to over 2,000 feet in thickness, mostly carbonates, including the Nounan formation (whose lower part may be Middle Cambrian) and the St. Charles formation. The Cambrian-Ordovician boundary is conveniently drawn at the top of the St. Charles but may lie within it.

Hardy, Clyde Thomas

1. 1957, Structural features of parts of northern Utah and southeastern Idaho (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1863.

Numerous structures of regional importance are recognized between Ogden, Utah, and Montpelier, Idaho. Thrusts of this region are attributed to Laramide compression. Eastward movement on the Bannock thrust diagonally opposes westward movement on the Willard thrust. The thrusts may be related to vertical movements resulting from Laramide compression with the fundamental stress axis aligned E-NE. Initial high-angle faulting occurred in association with regional compression, probably Laramide. Later movement on these may account in part for Basin and Range faulting.

Harrington, Eldred Ray

1. 1948, Black Butte, a recent subsidence crater (Idaho): Sci. Monthly, v. 66, no. 6, p. 451-466.

This is a popular account of young volcanic phenomena on the Snake River Plain north of Gooding and Shoshone, particularly of the volcano called Black Butte 15 miles north of Shoshone and its related lava. Big Wood River flows across the edge of the young flow from the Butte in a channel locally 50 feet deep and only four feet wide at the top. Its channel upstream is the old one and is normal.

Harris, A. H., and Jibson, W. H.

1. 1955, Bear River hydrometric data, tri-State investigations: U. S. Geol. Survey, open-file report.

Only a small part of this report relates to Idaho. This includes parts of Oneida, Bannock, and Bear Lake Counties. The report comprises numerous tables relating to streamflow.

Harris, Robert Alan (Davidson, David Francis, and Arnold, Bertha Pearl)

1. 1954, Bibliography of the geology of the western phosphate field: U. S. Geol. Survey Bull. 1018, 89 p.

This comprehensive bibliography lists papers relating to the Phosphoria formation or its partial equivalents, the Park City and Embar formations, through September 1952.

Harris, Sherod A.

1. 1957, The tectonics of Montana as related to the Belt series, in Billings Geol. Soc. Guidebook, 8th Ann. Field Conf., p. 22-33.

This paper advances the hypothesis that the Belt geosyncline with its eastward extension, here called the Big Snowy embayment, was influential in post-Belt deformation. The Belt series is held to be incompetent and to have constituted a zone of weakness that controlled later deformation. The Belt geosyncline had an axis of deposition east of and parallel to the major axis of the Cordilleran geosyncline from northern Montana to south-central Montana where it turned sharply westward and ran into and under the area of Cordilleran sedimentation in Idaho. Post-Belt-pre-Laramide deposition of the area of the Belt geosyncline was mainly of marine shelf and foreland type. The Belt trough acted as a buffer between the eastward orogenic movements in the Cordilleran geosyncline (mainly in Idaho) and the craton (mainly in Montana). Emplacement of the Boulder batholith is related to the effect of Laramide deformation on the portion of the Belt geosyncline lying outside of the Cordilleran geosyncline, just as the Idaho batholith is related to the Cordilleran geosyncline. Numerous speculations as to structural features in Montana are presented.

Hausen, Donald M.

1. 1954, Welded tuffs of Oregon and Idaho: Mississippi Acad. Sci. Jour. 1951-53, v. 5, p. 209-220.

Most of the welded tuffs in Oregon and Idaho vary in composition from dacitic to rhyolitic and range up to 350 feet in thickness. They are mostly Miocene to Pliocene and probably genetically related to the basalt flows of the Columbia River Plateau and Snake River Plain. They are distinguished from silicic flows by occurrence as extensive flat sheets rather than as domes, coulees, and plugs. One idea is that they are pyroclastic, expelled from a conduit as hot clouds of ash and gas, and fell while still hot enough to weld together. The other concept is that they are erupted as a lavalike mass. The pyroclastic hypothesis is the most popular. Published reports from Idaho and Oregon are cited. Hausen's ideas are derived from detailed study near Dorena, Oregon. He thinks the welded tuffs in Oregon and Idaho result from a form of nuees ardentes in which siliceous gas-charged lava welled through open fissures and flowed onto the surfaces, and the escaping gas was accompanied by clouds of ash from the upper surfaces of the flows. The "welded" structure in the part not converted to ash was produced by

flowage along planes of minute vesicles within the partially expanded lava. If correct, he comments that the term "welded tuff" is a misnomer.

Hawley, Robert W.

1. 1950, Phosphoria conodonts from southeastern Idaho: Master's Thesis, Univ. Idaho.

A systematic paleontological discussion of five conodont species from the Phosphoria formation, including three new species. Data are insufficient for regional correlation but a Lower or Lower-Middle Permian age is suggested.

Hazzard, John C. (and Turner, F. Earl)

1. 1957, Décollement-type overthrusting in south-central Idaho, northwestern Utah, and northeastern Nevada (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1829.

A large overthrust of Paleozoic over Precambrian rocks has been described in northeastern Nevada. Four occurrences of a similar and presumably the same overthrust farther north are here described. The one in Idaho is in the Albion Range and represents thrusting of Paleozoic rocks over Precambrian, not, as had been reported, Precambrian crystalline rocks over Carboniferous rock. The thrusting is regarded as post-Early Triassic and pre-Early Cretaceous.

Heikkila, Henry Herman

1. 1953, Horseshoe Creek area, Teton County, Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 93-94.

Describes an area in T. 4-5 N., R. 44 E., with structure section. Wells have recovered gas but nothing of commercial value.

Henry, Darold John

1. 1953, The rock collector's Nevada and Idaho: Long Beach, Calif., Lowell R. Gordon, 72 p.

This cites areas of interest to "rock hounds" and gives sketch maps to aid in finding the areas, also remarks as to rocks, minerals, and fossils to be found in each. The latter part of the book refers to Idaho.

Herdlick, Jared Albert

1. 1946, Little Pittsburgh lead-zinc mine, Shoshone County: U. S. Bur. Mines Rept. Inv. 3999, 8 p.

The Little Pittsburgh property was located about 1897 but little was done. In 1929, a small tonnage was mined and milled unprofitably. In 1941-45, 111,665 tons were milled. The topography, climate, and mining operations are described

and the geology is outlined on the basis of published reports. The U. S. Bureau of Mines drove a 500-foot crosscut and four diamond drill holes.

Herdlick, Jared Albert

2. 1948, Be Van quartz crystal prospect, Lemhi County, Idaho: U. S. Bur. Mines Rept. Inv. 4209.

The deposit was located for gold in 1918, and an attempt to work the quartz crystals there was made by the Montana Coal and Iron Co. over a period of years but the product could not be sold. In 1943 and 1944 the U. S. Bureau of Mines worked the prospect but the quartz obtained was tested and found unsuitable.

Hietanen, Anna Martta

1. 1952, Structure and metasomatism of the Belt series northwest of the Idaho batholith (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, p. 1262-1263, 1953: Am. Mineralogist, v. 38, nos. 3-4, p. 344.

The older rocks around the northwestern corner of the Idaho batholith belong to the Belt series. The area is situated at the junction of two arcuate segments of Nevadan folding and also on the western border of the Laramide orogenic belt. The major fold axes parallel the trend of the northern Nevadan segment (N. 70°-80° W) and the lineation and minor folds parallel the trend of the southern one (N. 50° E.). Both are locally overturned to the south and are accompanied by thrusts. The gentle north-trending folds may be of Laramide age. Block faulting continued to Miocene time.

The main folding was accompanied by small intrusions of gabbro, diorite, and tonalite, intense metamorphism and metasomatic introduction of hornblende, biotite, andesine, and accessories. Locally a second period of metasomatism obliterated folds and is believed to have caused formation of monomineralic rocks such as hornblendites and anorthosites. This second period may be synchronous with the emplacement of the quartz dioritic border zone of the Idaho batholith. Tonalite was intruded west of the batholith and the quartz monzonite of the main body of the batholith was emplaced after the second period of metasomatism.

---

2. 1953, Kyanite, andalusite, and sillimanite in the schists in Boehl's Butte quadrangle, Idaho (abs.): Geol. Soc. America Bull., v. 64, no. 12, pt. 2, p. 1434.

This abstract is the same as that in the American Mineralogist.

---

3. 1954, Kyanite, andalusite, and sillimanite in the schists in Boehl's Butte quadrangle, Idaho (abs.): Am. Mineralogist, v. 39, nos. 3-4, 331-332.

Kyanite, andalusite, and sillimanite occur together in cordierite-bearing mica schist of the Prichard formation in the Boehl's Butte quadrangle. The following inversions are inferred: (1) sillimanite→ kyanite, (2) kyanite→ andalusite, (3) kyanite→ sillimanite, (4) andalusite→ sillimanite, probably because of variations in temperature and stress. Locally the three minerals may have crystallized together. The association epidote-plagioclase in calcium-rich rocks nearby suggests a temperature of close to 400° C during crystallization.

Hietanen, Anna Martta

4. 1956, Anorthosite in Boehl's Butte quadrangle, Idaho (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1770.

Three anorthosite bodies 10-20 km. long and several smaller ones occur in beds assigned to the lower part of the Prichard formation (Precambrian) northwest of the Idaho batholith in the Boehl's Butte quadrangle. Contacts are gradational and diverse inclusions are present in the anorthosite. Emplacement is thought to have been chemical rather than mechanical. The anorthosite is thought to have been derived along with amphibolite, by metasomatic differentiation of constituents of gabbro or diorite.

---

5. 1956, Kyanite, andalusite, and sillimanite in the schists in Boehl's Butte quadrangle, Idaho: Am. Mineralogist, v. 41, no. 1, p. 1-27.

The author describes schist she says is Prichard as highly metamorphosed, bedded, and folded mica schist with fairly pure white to gray quartzite, 1,000 feet thick, close to the middle. Beds probably equivalent of the Burke, Revett, St. Regis, and Wallace formations are exposed in south part of quadrangle.

Hobbs, Samuel Warren (Wallace, Robert Earl and Griggs, Allan Bingham)

1. 1950, Geology of the southern third of the Mullan and Pottsville quadrangles, Shoshone County, Idaho: U. S. Geol. Survey open-file report, 24 p., geol. map.

This is a brief preliminary report with geologic map in which it is noted that the area is underlain by the St. Regis (with two members) and Wallace formation (with four or five members), only the lowest member being present here. The area has at least five metadiorite dikes and one lamprophyre dike, all post-ore. The rocks are folded and faulted. The Osburn fault skirts the northern edge of the mapped area. At least half of the sedimentary rocks are in bleached zones in which sericite content has been increased and carbonate has been added. It is not clear whether these changes represent introduction of material from magmatic sources or recrystallization from existing rocks. Chlorite is locally prominent. Numerous carbonate veins are known, but production has been small. Five, not mutually exclusive, vein types are distinguished.

Hodge, Edwin Thomas

1. 1944, Limestone of the Pacific Northwest; available limestones suitable for calcium carbide and/or for flint glass industries: U. S. Office of Administrator, Bonneville Power Admin., Div. Indus. and Resources Devel., Indus. Analysis sec., p. 64-76.

This general report contains general data as to costs, quality, and other economic features of limestone deposits and on the pages cited above brief descriptions of limestone deposits in Idaho, with index maps. These include deposits in Blaine, Boise, Custer, Nez Perce, Clearwater, Idaho, Valley, Lewis, and Adams Counties. The emphasis is on economic, rather than geologic features. Analyses given show most of the deposits mentioned are high in calcium carbonate. Production has been small but resources are large.

_____, (and Freeman, Otis Willard)

2. 1954, Northwest minerals, in Freeman and Martin, eds., The Pacific Northwest, p. 160-177.

This section of the book, The Pacific Northwest, lists the principal mineral resources and outlines their history and production record.

Holland, Frank Delno, Jr.

1. 1953, Mississippian stratigraphy in the Utah-Idaho-Wyoming area, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., 1953, p. 32-37.

This summarizes history of the formation names and describes them along the route of the conference. In the area the Madison and Brazer are the principal units but a thin shale unit, the Leatham formation, unconformably underlies the Madison near Logan, Utah.

Holland, John S.

1. 1947, Petrography and Petrology of the igneous rocks of the Avery district, Shoshone County, Idaho: Master's Thesis, Univ. Idaho.

The greater part of the area is underlain by rocks similar to the Belt series in the Coeur d'Alene district to the north. These rocks are intruded by a quartz monzonite stock and related dikes and sills of various compositions, all of late Mesozoic age. Petrographic evidence indicates that the igneous rocks form an outlier of the Idaho batholith.

Honkala, Frederick Sauli

1. 1953, Phosphatic rocks in the Centennial Range, Montana-Idaho (abs.): Geol. Soc. America Bull., v. 64, no. 12, pt. 2, p. 1547.

In the Centennial Range the Phosphoria is divisible into members A, B, C, D,

E, of which B and D contain phosphate rock, mostly in B. Member B has detrital material believed to have been deposited near shore, perhaps in places on a beach. The member is absent in the western part of the range. The phosphate rock in member D is composed of collophane oolites or ovules with collophane or francolite cement.

Honkala, Frederick Sauli

2. 1953, Preliminary report on geology of Centennial Range, Montana-Idaho: U. S. Geol. Survey open-file report, 19 p., geol. map.

This report gives detailed stratigraphic data on the phosphate deposits which include large high-grade reserves.

Hopkins, Marie L.

1. 1955, Skull of fossil camelid from American Falls lake bed area of Idaho: Jour. Mammalogy, v. 36, no. 2, p. 278-282.

A camelid skull, here tentatively referred to Camelops, huerfanensis, was found 33 yards out from a cliff of American Falls lake beds (Pleistocene) from which it is believed to have come. The skull is described in detail. The assignment of the beds in the cliff is based on H. T. Stearn's work.

Hosterman, J. W.

1. 1956, Geology of the Murray area, Shoshone County, Idaho: U. S. Geol. Survey Bull. 1027-P, p. 725-748, with areal geol. map.

This paper is supplemental to the earlier one by Shenon. Most of the deposits seen by Shenon were inaccessible to Hosterman, and the whole district shows little activity. Most of the Belt sequence is present and there are many small monzonite stocks, believed to be related to the Idaho batholith (Cretaceous). The report deals only with the lead-zinc mines whose production reached its peak in 1911-1912. There has been intermittent production since and the Jack Waite mine has been very active since 1930. Production tables are given and several mines are described.

Howard, Arthur David

1. 1956, Upland surfaces of the Rocky Mountains in pt. 4 of Internat. Geog. Union Comm. for the study of correlation of erosion surfaces around the Atlantic, 8th Rept.: Internat. Geog. Cong., 18th, and 9th Gen. Assembly, Rio de Janeiro, p. 28-40.

This paper deals mainly with areas south of Idaho but has a two-page summary relating to the northern Rocky Mountains. In this the subsummit surface is considered more likely to have a pediment origin than that of a peneplain (the commonly favored idea). A late Tertiary age is favored.

Howell, Benjamin Franklin (and others)

1. 1944, Correlation of the Cambrian formations of North America (Chart no. 1): Geol. Soc. America Bull., v. 55, no. 8, p. 993-1003.

Cambrian formations in Idaho are not included in the chart but a section in Utah gives those in southeastern Idaho. Also a note indicates that the Gold Creek quartzite, Rennie shale, and Lakeview limestone crop out in the Pend Oreille district. The quartzite is unfossiliferous. The shale fauna has been compared with that in the Ptarmigan formation of Montana and that in the limestone with that in the Spence shale of Utah. Both are tabulated low in the Middle Cambrian.

Hubbard, Charles R.

1. 1955, A survey of the mineral resources of Idaho (with maps): Idaho Bur. Mines and Geology Pamph. 105, 74 p.

This report contains brief summary data on each of the metallic and nonmetallic mineral resources of Idaho with a map showing their distribution. Forty-nine mineral resources are described. Gold mining started in 1860, and until 1870 placer mining was Idaho's chief 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 the two World Wars. Silver has recently markedly increased in importance. Recently, industrial minerals, notably phosphate rock, have become significant. In 1951 Idaho ranked 27th in mineral production, and 6th in production of metallic minerals ($75,079,000). It was first in the production of silver and second in that of lead and zinc.

---

2. 1956, Clay deposits of north Idaho: Idaho Bur. Mines and Geology Pamph. 109, 36 p.

Occurrences in Benewah, Clearwater, Nez Perce, Lewis, Idaho, Kootenai, and Latah counties are mentioned. Deposits of economic interest are mainly in Latah County but one is in Kootenai County. The clay reserves of 8 deposits as tabulated total 465,579,000 dry tons, and the production in the past 55 years is estimated to be not over 250,000 tons. Some of the clay is in residual deposits on exposures of pre-Tertiary intrusive rock. Some of these are capped by lava. Many of the deposits consist of clay that has been transported from such residual deposits and collected in sedimentary beds intercalated in the Columbia River basalt or on that basalt. The principal known deposits are described individually.

---

3. 1956, Geology and mineral resources of Nez Perce County: Idaho Bur. Mines and Geology, County rept. no. 1, geol. map.

Nez Perce County has large agricultural and forest resources and development. Lewiston (747 feet above sea level) is a major supply point. The county contains the Uniontown Plateau, the Clearwater Escarpment, the Lewiston Plateau, and the Crazy Mountain Uplift. Much of the county is covered by Miocene basalt, resting on an irregular surface, and with intercalated sediments and ash with some bituminous material (Latah beds). Rocks regarded as related to the Belt series, gneiss, schist, and metasedimentary rocks, and rocks related to the Seven Devils volcanics which are extensively intruded by granitic dikes and stocks are exposed in places through the basalt cover. Placers and some copper and gold lodes are known. Industrial mineral deposits of interest include limestone, gravel, stone, sand, and clay.

Hubbard, Charles R.

4. 1957, Mineral resources of Latah County: Idaho Bur. Mines and Geology, County rept. no. 2, geol. map.

Latah County is on the western border of the Idaho Panhandle. First comers were miners but lumbering and farming soon became important. The county is partly in the Columbia Plateau Province and partly in the Northern Rocky Mountain Province and includes part of the Palouse country. The rainfall is 25.30 inches annually and irrigation is unnecessary. The more rugged areas contain the Belt series, in part metamorphosed to quartzite, gneiss, and schist, and outliers of the Idaho batholith. About a third of the county is covered by basalt flows, deposited on a terrain of considerable relief and with intercalated lacustrine deposits. About 99 percent of metallic mineral production has been in gold, but copper, silver, iron, tungsten, cobalt, and titanium are known.

No mining districts are described. The major potential mineral wealth is in industrial minerals, especially high-grade fire clay and high-alumina clay. Mica, beryl, and other nonmetallic materials are also present. A number of deposits of the industrial minerals are described.

Hubbs, Carl Leavitt (and Miller, Robert Rush)

1. 1948, The zoological evidence; Correlation between fish distribution and hydrographic history in the desert basins of western United States; in The Great Basin, with emphasis on glacial and postglacial times: Univ. Utah Bull., v. 38, no. 20, p. 18-166.

This paper summarizes data on fishes in various localities in and near the Great Basin in relation to their bearing on geomorphic history. Most of the data are unrelated to Idaho but it is suggested that the assemblages of fishes in the upper Snake River differ from those below the major falls; the fishes in streams of the Snake River Plain were mostly killed during Pleistocene volcanism; there was an interchange of fishes during the period in which Lake Bonneville overflowed into the drainage basin of the Snake River; and streams such as Big and Little Wood Rivers and Big and Little Lost Rivers, that now are largely or entirely cut off from the main Snake River, have distinctive fish assemblages, suggesting that their present isolation dates back a long time.

Huff, Lyman Coleman (and Taylor, George Carroll)

1. 1942, Idaho, in Meinzer, O. E., and others; Water levels and artesian pressure in observation wells in the United States in 1942, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 948, p. 9.

Six wells in the Rathdrum Prairie area, in Bonner County, were measured and two measurements were made in the Palouse River area in Latah County.

Hulin, Carlton Dewey

1. 1950, Mineral deposits of Idaho: in The 51st Ann. Rept., Mining Industry of the State of Idaho for 1949, p. 60-63.

In the Coeur d'Alene region vertical persistence of mineralization has been demonstrated down to a depth of over 5,000 feet, an illustration of deep-seated ore bodies. Certain deposits containing quicksilver, precious metals, and tungsten illustrate the shallow type. Of the several main periods of mineralization in Idaho the most important is related to the emplacement of the Idaho batholith. A second period is of late Tertiary date, and quicksilver mineralization was later still, probably near the end of the Tertiary. Deposits of the first period are around, rather than within, the main batholith. They include those of the Coeur d'Alene and Pend Oreille regions, those near Salmon, Mackay, Hailey, and others. They were originally noted mainly for production of lead, zinc, copper, gold, and silver, but the tungsten deposits of the Ima Mine and the cobalt and copper of the Blackbird district are included. Deposits of the second and third periods are widely distributed in Idaho and include the Silver City, Delamar, Thunder Mountain, Yankee Fork, and other districts; as well as quicksilver deposits near Weiser, and tungsten, gold, and antimony deposits at Stibnite. The future for development of metallic deposits in Idaho is encouraging. Phosphates and other nonmetallic mineral deposits are also encouraging.

Imlay, Ralph Willard

1. 1945, Occurrence of Middle Jurassic rocks in western interior of United States: Am. Assoc. Petroleum Geologists Bull. v. 29, no. 7, p. 1019-1027.

The presence of Middle Jurassic rocks in the western interior of the United States is shown by Bajocian ammonites in the Twin Creek limestone of southeastern Idaho. Other Middle Jurassic ammonites (Tathonian) occur low in the Ellis formation in Montana. Marine Jurassic deposits older than the Bathonian stage appear to be limited to the center of the sedimentary trough and will probably be found only along the border between Idaho and Wyoming, in north-central Utah and southwestern Montana.

Imlay, Ralph Willard

2. 1949, Paleoecology of the Jurassic seas in the western interior of the United States: in Report of the Committee on a treatise on marine ecology and paleoecology; 1948-49, Harry S. Ladd, chairman, Natl. Res. Council, Div. Geology and Geog., rept. 9, p. 72-104.

This paper deals with the paleoecology of Jurassic rocks throughout western North America, and especially the western interior of the United States. Its maps show that Jurassic seas from the Arctic entered southeastern Idaho. Among incidental remarks involving rocks in Idaho is the statement that limestone near the base of the Twin Creek limestone is correlated with phosphatic shale in western Montana and probably reflects incomplete aeration of the sea bottom. Most of the upper part of the Twin Creek limestone may be of chemical origin. The salt in the Preuss sandstone in Idaho indicates the presence of a dead sea or saline lakes in and south of Idaho. Glauconite is present in sandstone in the lowest limestone member of the Twin Creek limestone, representing the initial deposits of a transgressive sea under reducing conditions, shallow water and slow deposition.

---

3. 1952, Correlation of the Jurassic formations of North America, exclusive of Canada: Geol. Soc. America Bull., v. 63, no. 9, p. 953-992.

The principal feature of this paper is a stratigraphic correlation table, supported by brief discussion of the literature. The table contains no columns taken from Idaho, but formations tabulated in adjacent states are also present in Idaho.

---

4. 1952, Marine origin of Preuss sandstone of Idaho, Wyoming, and Utah: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 9, p. 1735-1753.

The red beds of the Preuss sandstone grade westward into fossiliferous, near shore, marine sandstone and limestone. The red sandstone and salt beds are considered to have formed in highly saline lagoons bordering a large island that rose from the sea in southwestern Montana in middle Callovian time. Lateritic soils on this island were a main source of iron oxide and sand in the Preuss sandstone, which was formed during early part of the upper Callovian and at about the same time as the red beds at the base of the Upper Jurassic in the Gulf region of the United States and Mexico. A paleogeographic map indicates that in Preuss time a narrow belt of dry land extended from Canada to cover essentially all of the Panhandle of Idaho, widening southward to include all of that part of the northern boundary of Nevada that borders Idaho.

Imlay, Ralph Willard

5. 1952, Summary of Jurassic history in the western interior of the United States, in Sonneberg, F. P., ed. Billings Geol. Soc. Guidebook, 3rd Ann. Field Conf., 1952, p. 79-85.

This is a general summary which includes a columnar section for the Freedom quadrangle in southeastern Idaho and incidental mention of Idaho in the text.

---

6. 1953, Characteristic marine Jurassic fossils from the western interior of the United States: U. S. Geol. Survey Prof. Paper 214-B, p. 13-32.

Eight ammonite zones have been recognized in the marine Jurassic deposits of the western interior of the United States, three of which appear to be present in southeastern Idaho. Systematic fossil descriptions occupy much of the report.

---

7. 1953, Characteristics of the Jurassic Twin Creek Limestone in Idaho, Wyoming, and Utah, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., 1953, p. 54-62.

This is essentially a descriptive paper dealing with the Twin Creek limestone. Two of the sections reach into Idaho from Wyoming.

Intermountain Association of Petroleum Geologists

1. 1953, Guide to the geology of northern Utah and southeastern Idaho, 4th annual field conf., (June 25-27) 1953. 143 p., incl. geol. maps (Salt Lake City).

Contains papers by numerous authors which are cited individually.

Jarrard, Leonard D. (and Moen, Wayne S.)

1. 1955, Uranium in the Northwest--mineralized areas and prospecting suggestions: Butte, Mont., pub. by authors, 93 p.

This is a general discussion of the occurrence of uranium and factors influencing its discovery, mining, etc., in nontechnical language. A map and brief descriptions of uranium occurrences in Idaho are given. These include deposits in rhyolitic rock near Salmon, one of which has shipped ore, deposits in the Belt series near Gibbonsville, in a lead mine near Hailey, and in the Coeur d'Alene area. The thorium deposits near Leadore are mentioned.

Jemmett, Joe Paul

1. 1955, Geology of some of the phosphate deposits in the Centennial Mountains of Idaho and Montana: Master's Thesis, Univ. Idaho.

The Phosphoria formation is divided into five members (A-E). The B member contains the only bodies of phosphate rock of minable thicknesses. Permian sedimentation is inferred to have taken place in a miogeosyncline. Factors of deposition that relate to the genesis of phosphate are outlined. The calculated phosphate reserves are over 4,000,000 tons and are confined to a single bed 3-6 feet thick.

Johnson, Bertrand Leroy

1. 1945, The phosphate rock deposits and industry of the western states (abs.): Econ. Geology, v. 40, no. 1, p. 87-88.

The originally extensive Phosphoria formation was shattered during a series of tectonic movements in late Cretaceous and early Tertiary times and the remnants are scattered over a presently visible area of about 100,000 square miles from the Garnet Range in southwestern Montana to the Uinta Mountains in northern Utah and from the Owl Creek Mountains in central Wyoming to the Blackfoot Mountains in southeastern Idaho. Distinctive structural provinces resulted. Mountain arcs formed under forces from the southwest and west between the stable area of the central U. S. and the Colorado plateau, partly encircling the latter. The western ends of three such arcs formed westward-pointing buttresses which later stopped overthrusts from the west. These bent into the reentrant between the Uinta and Wind River Mountains and formed the Idaho-Wyoming phosphate region. In Montana the structure was further complicated by east-west faulting and batholithic intrusion and only scattered blocks of the Phosphoria remain. The abstract gives no data on the industry, in spite of its title.

Johnson, Clayton Henry

1. 1943, Igneous metamorphism in the Orofino region, Idaho: Doctorate Thesis, Cornell Univ., geol. map.

The area mapped includes about 300 square miles around Orofino, and embraces parts of Clearwater and Nez Perce Counties. Much of it is in the Columbia Plateau; the rest in the Clearwater Mountains. Deep canyons in the plateau have bordering land slides. Anderson is quoted as now regarding his Orofino series as of Paleozoic or early Mesozoic age. During Miocene time the Columbia River basalt covered a surface that had a relief of at least 2,000 feet. The metasedimentary rocks along the Clearwater River, its North Fork, and Orofino Creek are mainly gneisses ranging from diorite to granodiorite. Hornblendite, diorite, and marble are subordinate. The diorite and certain masses of quartz diorite are regarded as igneous and the last named rock belongs to the margin of the Idaho batholith. The metasedimentary rocks retain bedding but emanations from the Idaho batholith have replaced most of them so as to give them appearance of granitic rocks.

Johnson, Clayton Henry

2. 1947, Igneous metamorphism in the Orofino region, Idaho: Jour. Geology v. 55, no. 6, p. 490-507.

The rocks exposed beneath the Columbia River basalt in the canyons of the Clearwater River and its tributaries around Orofino are regarded as siliceous sedimentary rocks largely so thoroughly metamorphosed by replacement by solutions from the Idaho batholith that the author calls them quartz diorite, granodiorite, etc. They are gneissic, with schistose facies. Later ultrabasic rocks in small bodies are present.

Johnson (p. 491) notes that Anderson originally called the metamorphic rocks the Orofino series and assigned them to the lower part of the Belt series, but has told Johnson he now regards them as Paleozoic or early Mesozoic in age.

Johnson, F. A.

1. 1947, Report on water-utilization possibilities in the upper Bruneau River basin, Idaho-Nevada: U. S. Geol. Survey open-file report.

This report is a description of the general characteristics of the Bruneau River basin, with some estimates of the water supply made. Monthly precipitation and run-off data, and discharge records are presented in table and graph form. Photographs of the Bruneau River and of several proposed dam sites are included.

Water supply, utilization, regulation, and storage is discussed.

Johnson, P. H.

1. 1956, An evaluation of the Skyrocket and Croesus claims, Camas County, Idaho: Bachelor of Sci. Thesis, Univ. Washington.

The claims examined are in T. 3 N., R. 15 E. Development and production have been small but further exploration may be warranted. The country rock belongs to the Milligen formation, plus intrusive rhyolite, both of which are cut and altered in mineralized shear zones. Eleven samples show a maximum of 0.04 ounces Au, 0-37.60 ounces Ag, 0-28 percent Pb, 0-4.14 percent Zn.

Jones, Daniel John (and Anderson, Norman R.)

1. 1956, A faunule of unusual nonmarine Ostracoda from the Pliocene of Idaho (abs.): Jour. Paleontology, v. 30, no. 4, p. 1010.

Ostracods of unusual type are prolific at a locality 60 miles south of Boise, in Owyhee County, in fine siltstone. They include Candona, Cyprios limocythere, Ilyocipris, Chytherissa, Tuberocypris, Tuberocyproides, Darwinula in highly ornate and spinose forms.

Kaiser, Edward Peck

1. 1956, Preliminary report on the geology and deposits of monazite, thorite, and niobium-bearing rutile of the Mineral Hill district, Lemhi County, Idaho: U. S. Geol. Survey open-file report, Geol. map series no. 390, 45 p.

This report covers the eastern part of the old Mineral Hill mining district and the western part of the old Spring Creek mining district and concerns the rare minerals listed in the title, rather than the gold and copper deposits for which the area was formerly known. The minerals described form small, irregular deposits in metamorphosed limestone layers less than 8 feet thick, typically in or near small folds. They are thought to be metamorphic segregations formed during regional metamorphisms. There are at least 30 prospects but the deposits have not been demonstrated to be of present economic value.

An inferred major fault separates moderately metamorphosed rocks on the northeast from more intensely metamorphosed ones to the southwest. The former definitely and the latter probably belong to the Belt series. The highly metamorphosed rocks southwest of the fault include feldspar-quartz-biotite gneiss, mica schist, quartzite (or feldspar-rich rocks), limestone, amphibolite, metadiabase, and pegmatite and are cut by rhyolite dikes. The coarse gneiss has an igneous appearance but is here interpreted as metasomatic. The amphibolite and especially the metadiabase could be igneous rocks but this interpretation is not accepted here. There is a possibility that the limestone is of hydrothermal rather than sedimentary origin but this is here considered so unlikely that it is not stressed in the discussion.

Kauffman, A. J., Jr.

1. 1954, The potentiality of titanium and zirconium from the alluvial sands of Idaho: in The 55th Ann. Report, Mining Industry of Idaho, 1953, p. 49-58.

Large tonnages of alluvial gravel occur in Idaho, including substantial reserves of monazite, ilmenite, magnetite, zircon, garnet, and columbium-tantalum minerals; some with gold. Monazite is being marketed and other minerals are being stocked pending a market. A firm local market would assure continued dredging for a long time to come.

Kay, George Marshall

1. 1945, Paleogeographic and palinspastic maps: Am. Assoc. Petroleum Geologists Bull., v. 29, no. 4, p. 426-450.

The paper is mainly a discussion of preparation of paleogeographic and palinspastic maps but includes remarks regarding overthrusts in Idaho. Those in the Wood River region are said to be possibly Nevadan and related to thrusts in central Nevada. The thrusts in southeastern Idaho are regarded as related to Laramide deformation.

Kay, George Marshall

2. 1947, Geosynclinal nomenclature and the craton (North America): Am. Assoc. Petroleum Geologists Bull., v. 31, no. 7, p. 1289-1293.

Geosynclines are the largest stratigraphic units. Classification is based on the rocks rather than on the form of the original surface of deposition. A craton is a consolidated, rather immobile area. Monoclinal flexure or hinge delimits the craton. That on the west of the early Paleozoic craton in North America is the Wasatch line, extended from western Mackenzie through western Alberta, Montana, and Wyoming to central Utah, southeastern Nevada, and western Sonora.

This flexure enduring into the late Mesozoic (fig. 1) shows the Frazer Belt, eugeosynclinal, covering Washington, Oregon, and western Idaho; the Millard Belt, miogeosynclinal, covering the eastern part of the Idaho Panhandle and central and southwestern Idaho; the Wasatch line just nicks Idaho west of Yellowstone Park. These belts are defined in this paper. East of the Wasatch line is the hedrecraton, covering most of the continent. A miogeosyncline is defined as near the craton, rather regularly sinking as deposition progresses and lacking appreciable volcanic material. The more distant eugeosynclines had rapidly sinking linear geosynclines with locally thick and abundant volcanic rocks as well as sediment eroded from rising narrow intervening lands like island arcs.

---

3. 1951, North American geosynclines: Geol. Soc. America Mem. 48, 143 p.

This memoir is concerned with the definition of the term "geosyncline" and the definition and description of varieties of geosynclines as well as their distribution in North America. The maps and portions of the text that deal with the distribution of the various geosynclines in the western part of North America include much generalized information relative to Idaho. This information may be summarized by the statement that in Paleozoic time most of Idaho belonged to a major miogeosyncline, called the Millard belt, and that a large eugeosyncline west of that belt extended into the extreme western part of Idaho.

Keenmon, Kendall Andrews (Kupsch, Walter Oscar, and Scholten, Robert)

1. 1951, Tectonic history of the Lima region, southwestern Montana and adjacent Idaho (abs.): Geol. Soc. America Bull., v. 62, pt. 2, no. 12, p. 1454-1455.

The Lima region covers the Tendoy, Blacktail, and portions of the Beaverhead and Ruby ranges and the intervening valley. Pre-Beltian diastrophism, accompanied by intrusion of the Dillon batholith, is marked by regional metamorphism. The geosynclinal margin fluctuated during the Paleozoic. The Laramide orogeny began with northeast folding, probably in the Paleocene, followed by northwest folds in the Eocene. Later intense thrusting took place in the western part of the area, leaving the eastern shelf area unaffected. Block faulting along the present northwest-trending mountains may have started locally as early as late Eocene and in part continued into Recent time. Widespread volcanism accompanied these movements.

Kennedy, George

1. 1949, Preliminary report on the geology of a portion of the southeast quarter of the Lyon quadrangle, Montana-Idaho: U. S. Geol. Survey open-file report 31, 19 p.

The rocks are metamorphosed Precambrian gneiss etc., Flathead quartzite, overlain by younger Paleozoic, Mesozoic, and Tertiary sedimentary rocks. A major normal fault bounds the north side of the Centennial Range. Extensive lake beds and lava flows conceal the older rocks on both sides of the range. A stratigraphic section and geologic map constitute the main part of the report.

Kennedy, Vance Clifford

1. 1952, Geochemical studies in the Coeur d'Alene mining district, Idaho: U. S. Geol. Survey Circ. 168, 15 p.

Quick field tests were so successful that soil analysis for lead, zinc, and copper would probably be an effective method of prospecting in the Coeur d'Alene region.

Kerr, Paul Francis (and Kulp, John Laurence)

1. 1952, Precambrian uraninite, Sunshine Mine, Idaho: Science, v.115, no. 2978, p. 86-88.

Uranium ore was first discovered in the Sunshine mine, Coeur d'Alene region, in 1949. Uraninite is in veins somewhat like the nonpegmatitic occurrences in the northwestern Canadian shield. These are cut by silver-bearing siderite veins but the uraninite has recently been regarded as later than the tetrahedrite. Specimens studied at Columbia University indicate the uraninite is the older; how much older, is not clear. The computed age for the uraninite is 750 M. Y.

_____, (and Robinson, Raymond F.)

2. 1953, Uranium mineralization in the Sunshine mine, Idaho: Mining Eng., v. 5, no. 5, p. 495-511.

Uranium mineralization in general preceded that in which silver was deposited but in places the two seem to merge. The uranium came in after the major folding but before much of the complex faulting and brecciation. The major folding was previously regarded as Mesozoic but now seems Precambrian. There were three major stages of mineralization, each preceded and followed by deformation. The mine is in one of the bleached zones of the region, here regarded as resulting from sericitization.

Kiilsgaard, Thor H.

1. 1949, Descriptions of some ore deposits and their relationships to the Purcell sills, Boundary County, Idaho: Idaho Bur. Mines and Geology Pamph. 85, 32 p.

This report summarizes a reconnaissance of mineral deposits east of the Purcell Trench in Boundary County, Idaho. Mineral production has been slight, in part because of ill-advised methods of operation, but there is hope for future production. Eleven mining properties are described.

The area is underlain by metamorphosed rocks of the Belt series intruded by large, differentiated sills, up to 2,000 feet thick, consisting largely of altered gabbro and diorite but with granophyre locally in their lower parts. The sills are regarded as of Precambrian age and the differentiation is regarded as gravitational. The total thickness of the sills has been estimated at 10,000 feet. A granitic stock with related dikes (Cretaceous?) is also present.

Several kinds of mineral deposits are described. One kind includes veins in dilation joints formed during cooling of the sill rock. These unproductive veins contain quartz, calcite, and locally minor amounts of various sulfides. The most common kind of veins is within shear zones that border the contacts between sills and sedimentary rock; other veins follow joints in granitic rock but these do not have an encouraging past production record. Finally, there are deposits called "immiscible liquid segregation deposits", mainly known in one mine, the Montgomery. In these deposits pyrrhotite and minor quantities of other sulphides, including pentlandite and gerrgoysite, are disseminated in the rock of the sill and are interpreted as consolidated late in the differentiation of the sills. The veins contain much the same assemblage of galena, sphalerite, chalcopyrite, tetrahedrite, etc., in a gangue that includes quartz and siderite with sericite and chlorite in the wall rocks that is common in the Coeur d'Alene region to the south. Presumably this is the principal reason the deposits have been regarded as of Laramide age. It would seem from the descriptions that the deposits filling dilation joints, and, especially, the immiscible liquid segregations are so closely akin to the sills as to be likewise of Precambrian age.

Kiilsgaard, Thor H.

2. 1949, The geology and ore deposits of the Boulder Creek mining district, Custer County, Idaho: Idaho Bur. Mines and Geology Pamph. 88, 28 p., geol. map.

The report describes silver-lead deposits containing jamesonite. In the Livingston, the principal mine, the ore is chiefly a replacement of a rhyolite porphyry dike, cut by the Livingston fault which directed the flow of mineralizing solutions. The ore shoots tend to be at intersections of the fault and the western, footwall part of the dike. Most activity ceased in 1930 but interest was renewed in 1946. The production from 1926 to 1930 totaled $650,752.23 gross value.

The area includes part of the Idaho batholith, Paleozoic beds, mainly Milligen, numerous dikes and areas covered by Challis volcanics. Detailed data on the Livingston workings, mineralogy of the ore, etc., are given.

---

3. 1950, The geology and ore deposits of the Triumph-Parker mine mineral belt: Part II, in Anderson, A. L., Kiilsgaard, Thor H., Fryklund, V. C. Jr., Detailed geology of certain areas in the Mineral Hill and Warm Springs mining districts: Idaho Bur. Mines and Geology Pamph. 90, p. 39-62.

The area is underlain mainly by the Milligen formation (Mississippian) 5,500 to 7,500 feet thick. Thrust remnants of the Wood River formation cap some hills and ridges. Along the western border the Milligen is overlain by volcanic and sedimentary rocks, here called Miocene(?) in age. Andesite dikes and sills are widespread and are pre-ore. The area has a series of major shear zones, mostly with west-northwest strike and southwest dip. Many are mineralized, principal values being in lead, zinc, and silver. Some ore bodies are fissure fillings; others, replacement bodies in limestone. The district has been intermittently productive since the 1880's and many ore shoots were bottomed at comparatively shallow depths, but ore should be present below the present levels of mining.

The Milligen consists mostly of carbonaceous argillite but has limestone beds that are locally converted to tactite. In the Triumph mine area four limestone beds are of use in exploration for ore and are mapped in this report. The Milligen is strongly folded and is cut by thrust, reverse, and normal faults. Some normal faults are post-ore. The minerals of the ore deposits include quartz, calcite, siderite, pyrite, galena, sphalerite, tetrahedrite, and ruby silver. Deposits in tactite are thought to be later than the contact metamorphism. Date of origin is uncertain but a post-Idaho batholith, early Tertiary age is favored. Twenty-one properties are described with maps.

Kiilsgaard, Thor H.

4. 1951, The geology and coal of the Horseshoe Creek district, Teton County, Idaho: Idaho Bur. Mines and Geology Pamph. 92, 42 p., with geol. map.

The district contains sedimentary rocks of Mississippian through Cretaceous age with volcanic rocks of Tertiary age and alluvium above these. The coal is in the Frontier formation (upper Cretaceous). The coal is of excellent quality, ranging from subbituminous to high-grade bituminous. It tends to break into fine sizes during mining but this would not be a disadvantage for use in stoker and blower type furnaces. The Frontier formation has been folded and faulted but at practical mining depths these factors are not regarded as serious detriments. There are believed to be 7 commercial coal beds, minimum thickness 2 feet, in the district. Past production is roughly estimated at 100,000 tons with an indicated 4,523,650 tons still available. One mine was successfully operated during the early 1900's and the poor record of the district since then is attributed to poor management and ill-advised development work.

The report includes much information as to the general geology of the district plus descriptions of the various coal beds and the workings in them.

Kinnison, Phillip T.

1. 1954, A survey of the ground water of the State of Idaho: Master's Thesis, Univ. Idaho.

Idaho is divided into ground water regions on the basis of accepted physiographic units, and each region is discussed. The principal environments in which ground water is found are: (a) valley-fill sand and gravels, (b) basalt,

(c) sand and gravel intercalated with basalt, and (d) lacustrine sands and gravels.

Kinnison, Phillip T.

2. 1955, A survey of the ground water of the State of Idaho: Idaho Bur. Mines and Geology Pamph. 103, 40 p.

This report is based on a "questionnaire canvass" supplemented by field trips and is a general summary of ground water data for Idaho. Most of the water from wells is derived from valley-fill, much comes from fractured basalt, some from glacial fill, and from lake beds. The ground water features of the nine physiographic subdivisions of Idaho are outlined.

Kline, M. H. (Carlson, E. J., and Griffith, R. H.)

1. 1950, Boise Basin monazite placers, Boise County, Idaho: RME 3129, U. S. Bur. Mines for U. S. Atomic Energy Comm., 37 p.

The U. S. Bureau of Mines explored monazite placers in Boise Basin in 1949. Thirty-seven holes were drilled, 17 trenches dug, and 12 shafts sunk; 404 samples were taken. The principal reserves were tailings from early operations on Moores, Grimes, Granite, and Elk Creeks, with virgin ground along Wolf Creek, Grassy Flats, Moores Creek, and Fall Creek. The minerals noted in the black sand included monazite, samarskite?, ilmenite, magnetite, garnet, zircon, gold, hematite, pyrite, rutile, and a bismuth mineral. Lake beds near Idaho City were found to be 850 feet thick. Similar beds are present on Muddy, Granite, and Wolf Creeks. The supposed samarskite contains 10-20 percent $U_3O_8$. Monazite in the black sand ranges up to 13 pounds per cubic yard of gravel. Relatively pure monazite from Boise Basin contains 3.2 percent $ThO_2$ and 0.102 percent $U_3O_8$.

_____, (and Storch, R. H.)

2. 1951, Big Creek monazite placers, Valley County, Idaho: RME 3131, U. S. Bur. Mines for U. S. Atomic Energy Comm. 24 p.

Churn drill exploration in the Big Creek placer area in the southern part of Long Valley was conducted by the U. S. Bureau of Mines in 1950. Thirty-nine holes, aggregating 2,355 feet, were drilled. No bedrock was reached. A total of 519 samples, weighing over 28 tons was recovered. The area is large and has much gravel of a character physically favorable for dredging. The pounds of monazite per cubic yard ranged from 3.37 to 0.33. In selected samples $ThO_2$ ranged up to 0.48 percent and $U_3O_8$ up to 0.041 percent. The gravel contains monazite, ilmenite, garnet, zircon, and magnetite. Gravel size is small, few pebbles over three inches in diameter being encountered in drilling. The principal black sand layers overlie impervious clay. Tables showing results of testing the samples are given.

Kline, M. H. (Carlson, E. J. and Storch, R. H.)

Long Valley

3. 1951, Scott Valley and Horsethief Basin monazite placers, Valley County, Idaho: RME 3133, U. S. Bur. Mines for U. S. Atomic Energy Comm., 22 p.

The gravel in Scott Valley and Horsethief Basin was studied by the U. S. Bureau of Mines in 1950 by 16 drill holes in Scott Valley and three in the Horsethief Basin. A total of 171 samples weighing about 8.5 tons was collected. Scott Valley has a large volume of gravel but the smaller deposits in Horsethief Basin had larger quantities of monazite per cubic yard.

_____, (Carlson, E. J., Storch, R. H., and Robertson, A. F.)

4. 1953, Bear Valley radioactive mineral placers, Valley County, Idaho: RME 3130, U. S. Bur. Mines for U. S. Atomic Energy Comm., 23 p.

Three areas in Bear Valley were explored by the U. S. Bureau of Mines in 1951 and 1952, in 83 drill holes up to 120 feet deep, and 971 samples weighing 89,779 pounds were obtained. The principal radioactive minerals noted were monazite, euxenite, samarskite, fergusonite, xenotime, zircon, allanite, and sphene. The ilmenite contains variable amounts of minerals of the columbite-tantalite group. Substantial quantities are present. The monazite equivalent in pounds per cubic yard of gravel ranged up to 0.73.

_____, (Carlson, E. J.)

Long Valley

5. 1954, Pearsol Creek monazite placer area, Valley County, Idaho: RME 3134, U. S. Bur. Mines for U. S. Atomic Energy Comm., 23 p.

The exploration of the Pearsol Creek area, 1 1/2 miles from Cascade, by the U. S. Bureau of Mines was done in 1951; involved 65 drill holes, totaling 3,898 feet; 780 samples weighing almost 36 tons were collected. The gravel area is large and a third of it contains more monazite than the rest. The black sand concentrates include monazite, ilmenite, magnetite, garnet, and zircon. The richer lenses have three to 30 pounds of monazite per cubic yard.

_____, (Carlson, E. J., and Horst, H. W.)

Long Valley

6. 1955, Corral Creek monazite placer area, Valley County, Idaho: RME 3135, U. S. Bur. Mines for U. S. Atomic Energy Comm., 22 p.

Exploration of the Corral Creek area in 1951 by the U. S. Bureau of Mines involved 61 drill holes aggregating 3,518 feet and 773 samples weighing almost 35 tons. The black sands contained 4.2 to 38.3 percent monazite by weight. The monazite contained 4.29 percent $ThO_2$ and 0.10 percent $U_3O_8$.

Kullerud, Gunnar

1. 1956, Geochemistry of sphalerite from the Star mine, Coeur d'Alene district, Idaho, Discussion: Econ. Geology, v. 51, no. 8, p. 828-830.

In reply to the article by Fryklund and Fletcher on the Star mine, Kullerud discounts their doubts as to application of deductions from an artificial system to a natural one on the basis that small quantities of extraneous substances have been shown not to affect the situation materially. He further indicates that the presence of water in natural solutions would be an important influence only where hydrous minerals were found, which is not true in the sphalerite under duscussion. He adds that the manganese content in the sphalerite in the Star mine cannot be used in geologic thermometry because MnS is not present.

Kulp, John Laurence (Ault, Wayne U., and Feeley, Herbert W.)

1. 1956, Sulfur isotope abundances in sulfide minerals: Econ. Geology, v. 51, no. 2, p. 139-149.

The sulphur -32/sulphur -34 ratios in some 80 samples of sulfides have been measured. These include three samples from the Minnie Moore mine, Bellevue, Idaho. The sulphur isotopic abundances appear independent of the mineral species, but the ratio cited is related to the source of the sulphur. A high ratio indicates a source initially rich in sedimentary sulfide, a low one a source rich in sulfate. Most have a ratio near 22.2 that is that of meteoritic sulphur. The three from the Minnie Moore give 21.92, 21.99, 22.02, suggesting a sulfate dominant source.

Kummel, Bernhard, Jr.

1. 1953, Regional relationships of Triassic formations in eastern Idaho and adjacent areas, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf. 1953, p. 48-53.

This paper gives formation descriptions and a correlation chart. The Lower Triassic seaways in western North America were more widespread than those of Middle or Upper Triassic time. In the Lower Triassic the pattern is similar to that of the upper Paleozoic with eugeosynclines and miogeosynclinal belts and abrupt thinning eastward of the "Wasatch line". The miogeosynclinal facies disappeared after this, and later Triassic rocks are continental. The eastern Nevada geanticline of Nolan probably extended across Nevada and northward at this time. Middle and Upper Triassic marine rocks are confined to western Nevada, California, Oregon, and western Idaho. The source of the Lower Triassic sediments in Idaho was to the east but Upper Triassic rocks had sources peripheral to the area of deposition.

---

2. 1954, Triassic stratigraphy of southeastern Idaho and adjacent areas (Wyoming-Montana): U. S. Geol. Survey Prof. Paper 254-H, p. 165-194.

Thick marine strata of Early Triassic age occur in and near eastern Idaho along the eastern margin of an ancient miogeosyncline. Basinward (west) the strata are thick and fossiliferous. Eastward they thin and intertongue with red sandstones and shales. The Dinwoody and Thaynes formation attain their thickest marine development in the Fort Hall Indian Reservation. To the east, north and south they intertongue with the red Woodside and Chugwater formations. The Thaynes tongues cut eastward into the Ankareh and Chugwater formations. The zone of intertonguing for the Dinwoody is along the Idaho-Wyoming boundary and turns westward in Utah. For the Thaynes it is similar except in Utah. New data on fossils are given. The post-Thaynes rocks of Triassic age are continental and the miogeosnyclinal belt was destroyed in Early Triassic time by an eastward extension of the Nevada Geanticline.

Kummel, Bernhard, Jr.

3. 1955, Facies of Lower Triassic formations in western Wyoming (and Idaho), in Wyoming Geol. Assoc. Guidebook, 10th Ann. Field Conf. 1955, p. 68-74.

The Lower Triassic strata in and near southeastern Idaho are along the eastern margin of an ancient miogeosyncline. They are thickest in the region of the Fort Hall Indian Reservation, Idaho (6500 feet). A diagramatic cross section from there to Lander, Wyoming, illustrates the situation. Isopach and lithofacies maps show the eastward thinning, the prevalence of shale in Idaho, and the passage northeastward into red beds in Wyoming in the time of the lower Dinwoody formation, and similar transitions in the time of the upper black limestone member of the Thaynes formation.

Lame, C. C.

1. 1953, Star garnet and opal from Idaho -- the gem state, how to find and cut them: Lewiston, Idaho, Commercial Printing Co., 16 p.

This paper gives general data on star garnet and opal, and directions, with maps, for finding garnet in Idaho. A few occurrences of opal in Idaho are given but the occurrence most stressed is in Washington.

LaMotte, Robert Smith

1. 1952, Catalogue of the Cenozoic plants of North America through 1950: Geol. Soc. America Mem. 51, 381 p.

This very comprehensive catalogue, with bibliography, lists many plant fossils known to occur in Idaho.

Larsen, Esper Signius, Jr. (and others)

1. 1954, Age of the southern California, Sierra Nevada, and Idaho batholiths (abs.): Geol. Soc. America Bull., v. 65, no. 12, pt. 2, p. 1277.

On the basis of geologic evidence the southern California batholith is of late Cretaceous age. The lead-alpha method gives it an average age of 105,000,000 years. On geologic evidence the Sierra Nevada batholith is late Jurassic. The average lead alpha age is 100,000,000. The Idaho batholith is Cretaceous and its average lead alpha age is 103,000,000. Thus by the lead alpha method the three are essentially the same age, 102,000,000 years.

Larsen, Esper Signius, Jr. (Phair, George, Gottfried, David, and Smith, William S.)

2. 1956, Uranium in magmatic differentiation, in Proc. Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955: New York, United Nations Pub. p. 240-247; also in Page, L. R., Contributions to the geology of uranium and thorium..., U. S. Geol. Survey Prof. Paper 300, p. 65-74.

Among batholiths of Mesozoic age in the United States, which includes the Idaho batholith, a substantial part of the uranium content is late and in most plutonic series the youngest members contain the most uranium. The average uranium content of the Idaho batholith is about 2.1 ppm.

Larsen, Leonard H.

1. 1955, Zircon in tonalite, Priest Lake, Idaho (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1588.

Zircon in a sample from the Kaniksu batholith in northern Idaho, is found in all the major minerals, and hence, formed early.

Lee, Donald E.

1. 1958, A chlorine-rich biotite from Lemhi County, Idaho: Am. Mineralogist, v. 43, no. 1, p. 107-111.

Biotite-garnet schist about 23 miles west of Salmon contains biotite with 1.1 percent Cl and 0.23 percent F. A complete analysis of this biotite is given and the schist is described.

Lee, Heungwon

1. 1955, Tungsten mineralization at the Wildhorse mine, Custer County, Idaho: Master's Thesis, Univ. Idaho.

A discussion of the schists, gneisses, marbles, migmatites, and tactites cut by alaskite dikes. The main structural feature is a northwest-plunging anticline.

The mineralization occurred as a result of hydrothermal activities along the tactite zones, involving ionic substitution of tungsten for aluminum and/or silicon ions, and formation of scheelite by replacement of tactite minerals along chloritized microfractures.

Leland, George R.

1. 1957, General geology and mineralization of the Mackay Stock area: Master's Thesis, Univ. Idaho.

Mississippian quartzites, marbles, and limestones are intruded by the Mackay stock of probable Cretaceous age, and Tertiary volcanics. The stock is nearly circular, 4 1/2 miles in diameter and made up of dacite, granodiorite, and quartz monzonite. Mineralization in the area was due to hydrothermal solutions ascending along fault fractures.

Leonard, Benjamin Franklin

1. 1957, Geology of the Big Creek quadrangle, central Idaho (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1867.

The Big Creek quadrangle displays roughly equal parts of metasediments of the Belt series, intrusive granitic rocks of the Idaho batholith and Challis volcanics, with patches of Casto(?) volcanics and a series of Tertiary dikes, mostly in a sheared, silicified zone in granodiorite. Deposits of tungsten minerals, etc., are present in this and other silicified zones. Quartzite, argillite, and limestone of the Belt series are in synclinal roof pendants. The larger granodiorite masses appear to have been emplaced by discordant upward(?) movement of magma accompanied in marginal zones by sheetlike injection of more mobile granite and syenite.

Libbey, Fay Wilmott

1. 1943, Some mineral deposits in the area surrounding the junction of the Snake and Imnaha Rivers in Oregon: Oregon Dept. Geology Mineral Industries G. M. I. Short Paper, 11, 17 p., incl. geol. maps.

This paper is confined to discussion of an area in Oregon but includes a geologic map of the area around the mouth of the Imnaha River that extends into Idaho. This map, based in part on one by the Army Engineers shows metasedimentary rocks, Lower Permian or older, under the Permian volcanic rocks.

---

2. 1957, Limestone resources of the Pacific Northwest: Raw Materials Survey, Inc., Resources Report no. 9, 824 SW Fifth Ave., Portland, Ore., 92 p. Section on Idaho is p. 30-36.

An index map shows 17 deposits in Bonner, Clearwater, Nez Perce, Lewis, Idaho, Boise, Blaine, Fremont, Butte, Owyhee, Cassia, Teton, Bingham, Bannock, Caribou, and Bear Lake Counties. Summary data are given for a cement plant near Pocatello and a high-grade limestone quarry in Nez Perce County, and adjacent Asotin County, Washington.

Littleton, R. T. (and Crosthwaite, E. G.)

1. 1957, Ground-water geology of the Bruneau-Grand View area, Owyhee County, Idaho: U. S. Geol. Survey Water-Supply Paper 1460-D, 198 p.

The Bruneau-Grand View area is part of an undeveloped artesian basin, largely in the Snake River valley. There are silicic and calcic intrusive and extrusive igneous rocks and compacted stream and lake sediments, all Tertiary or later. The principal artesian aquifers are volcanic rocks, imperfectly confined under sediments. Locally natural discharge results in water logging and development of alkali soil. Much of the water is of poor chemical quality which will hinder use of the substantial supply that is available. Yields range from one to more than 3,500 gal. per minute.

Lobeck, Armin Kohl

1. 1957, Physiographic diagram of the United States: The Geographical Press, Maplewood, N. J.

The map of North America on the front page is a topographic diagram with three geologic block diagrams below it, none crossing Idaho. On the back of the sheet is a map of physiographic provinces of North America. Those that involve Idaho include the northern Rockies Province, with subdivisions called Purcell Range, Selkirk Mountains, Bitterroot section, and Salmon River Mountains (the last includes more than the names suggest). The part of the Columbia Plateau that enters Idaho includes the Snake River Plain, Blue Mountains section, and the Payette section.

This is the latest of 22 revisions of the diagram that have been published.

Lochman-Balk, Christina

1. 1949, Paleoecology of the Cambrian in Montana and Wyoming, in Report of the Committee on a treatise on marine ecology and paleoecology: 1948-49, Harry S. Ladd, Chairman, Natl. Research Council, Div. of Geology and Geography Rept. no. 9, p. 31-71.

The maps in this general paper include Idaho and purport to show the kinds of sediments there at various times in the Cambrian period. Otherwise Idaho is not discussed.

---

2. 1956, The Cambrian of the Rocky Mountains and southwest deserts of the United States and adjoining Sonora Province, Mexico, in El sistema Cámbrico, su paleogeografía y el problema de su base, Symposium: Internat. Geol. Cong., 20th sess., Mexico, p. 529-662. Also section entitled "The Idaho-Washington (northwestern) province of deposition", p. 687-689; section entitled "The northeast Utah-southeast Idaho Cambrian sequence", p. 583-589.

North of the Willard thrust in the Wasatch Mountains, Utah, and west of the overthrust belt the Cambrian sequence shows signs of deposition in a miogeosyncline.

Summary data are given on the following formations: Brigham quartzite, 2,000 to over 4,800 feet thick; Langston formation, 380 feet thick; Ute formation, 500-665 feet thick; Blacksmith dolomite, 325-800 feet thick; Bloomington formation 1,200 feet thick, Nounan formation, 825-1,125 feet thick; St. Charles formation, 1,015-1,130 feet thick. The Brigham quartzite has usually been assigned to the lower Cambrian, but it is here considered that part of it must be and all of it need be no older than earliest middle Cambrian. It is possible that an angular unconformity between Cambrian and Precambrian rocks is present within the Brigham as mapped. The thickness of the Brigham causes suspicion in comparison to the Flathead in Montana. The three Cambrian formations in the Pend Oreille district in northern Idaho are middle Cambrian.

Lohr, Edwin Wallace (and Love, Samuel Kenneth)

1. 1954, The industrial utility of public water supplies in the United States, 1952, Part 2, States west of the Mississippi River: U. S. Geol. Survey Water-Supply Paper 1300, p. 154-165.

This gives chemical analyses and other data for the principal cities in Idaho that use ground water for their public supplies.

Long, Albert E.

1. 1949, Experimental diamond core-drilling in the Phosphoria formation in southeastern Idaho and southwestern Wyoming: U. S. Bur. Mines Rept. Inv. 4597, 29 p.

This records the results, with drill core descriptions, of diamond drilling in southeastern Idaho by the U. S. Bureau of Mines in cooperation with the U. S. Geological Survey. Previously 30-60 percent of the core was recovered and the present study was aimed at increasing core recovery by improving methods. Complete core recovery cannot be obtained but the percentage of recovery can be much improved by methods and equipment described in this report.

Lowell, Wayne Russell

1. 1952, Phosphatic rocks in the Deer Creek-Wells Canyon area, Idaho: U. S. Geol. Survey Bull. 982-A, p. 1-52, incl. geol. map.

The area is in Caribou County, Idaho, 25-30 miles by road north of Montpelier. The phosphatic shale member of the Phosphoria here consists of shale, siltstone, limestone, and phosphate rock, of marine origin. Collophane is the common phosphate mineral. Francolite is present in the gray and brown phosphate rock. Phosphatic pellets are here named ovules. Three zones of phosphate rock are present and one of these is of high grade. The phosphate rock may be a chemical precipitate.

Ludlum, John Charles

1. 1942, Precambrian formations at Pocatello, Idaho: Jour. Geology, v. 50, no. 1, p. 85-95, incl. geol. maps.

The formations here assigned to the Precambrian crop out in the northern part of the Bannock Range. They include in order of decreasing age the redefined Bannock volcanic formation, at least 400 feet thick with base not exposed, the newly defined Pocatello formation comprising 1,100 feet of tillite, etc., and 35 feet of varved slate, and the Blackrock limestone, 535 feet thick, overlain unconformably by Brigham quartzite (Lower or Middle Cambrian). Correlation of the Pocatello formation with similar rocks in the Wasatch Mountains, Utah, is suggested.

---

2. 1942, Structural-stratigraphic interpretations of a part of the Bannock Range, Idaho: Doctorate Thesis, Cornell Univ., geol. map.

In the part of the Bannock Range, Bannock County, studied, major drainage is controlled by the Portneuf River, which may have been eroded along a transverse fault zone. Lake Bonneville is thought to have overflowed into the Portneuf through Marsh Creek. There are evidences of three partial erosion cycles; Putnam, Gibson, and Spring Creek cycles of Mansfield. The oldest unit is the Bannock volcanic formation (Precambrian), minimum thickness 400 feet, base not exposed; next is the Pocatello formation (Precambrian) with tillite in its lower part (1,100 feet) and varved slate above (350 feet); the Blackrock limestone which is oolitic and up to 535 feet thick. The Brigham quartzite (Cambrian) is unconformable on the Blackrock, and is 3,200 feet thick, and is thought to be nonmarine. Above this quartzite is a succession of limestone (4,250 feet thick) and of Cambrian and Ordovician age. These are sparsely fossiliferous including Girvanella-like algae. The next unit is the Swan Peak formation (Ordovician) 785 feet thick. The Salt Lake formation is up to 235 feet thick, with the top eroded. Rhyolite and basalt flows exist. Folds are overturned westward and apparent thicknesses are exaggerated by repetition. A number of high-angle faults are present and appear related to major thrusts in neighboring areas. The Bannock Range may be a window along the Putnam-Bannock thrust.

---

3. 1943, Structure and stratigraphy of part of the Bannock Range, Idaho: Geol. Soc. America Bull., v. 54, no. 7, p. 973-986, incl. geol. maps.

The stratigraphy of the area is briefly reviewed. In this connection it is noted that an apparent thickness of 8,000 feet for the Brigham quartzite, much greater than is normal, results from repetition through isoclinal folding. The rocks assigned a Precambrian age are thought to have suffered broad folding and some faulting prior to deposition of Cambrian beds, but the beds above and below the contact are nearly parallel. It is suggested that the range is a window exposed by erosion of the Putnam-Bannock thrust and that the structures in the range originated in a segment underthrust relatively westward.

Lupher, Ralph Leonard (and Warren, Walter Cyrus)

1. 1942, The Asotin stage of the Snake River Canyon near Lewiston, Idaho: Jour. Geology, v. 50, no. 7, p. 866-881, geol. maps.

Dissection attendant on the start of deformation of the Columbia River basalt produced a synclinal trough near Lewiston, and the canyon of the Snake River is in the axis of this trough. Deep canyons were formed after the deformation and that of the ancestral Snake River here was cut to a depth of 1,200 feet and then nearly filled with lava. This period of erosion is here termed the Asotin stage. An arkosic sandstone interbedded with the Columbia River basalt modified the shape of the canyon locally. The intra-canyon lava never completely expelled the river from its canyon. The present Snake River cuts across the winding, old, filled channel but is mostly very close to that channel. The Asotin stage is probably of early Pleistocene age. The ancestral Snake River that made the filled canyon was a smaller stream than the present Snake River and may have carried drainage mainly from the Grande Ronde and Salmon River systems. Also, the Clearwater River may have had a somewhat different course then, than now.

---

2. 1944, Clastic dikes of the Columbia Basin region, Washington and Idaho: Geol. Soc. America, Bull., v. 55, no. 12, p. 1431-1461.

Pleistocene lake and stream deposits and locally the Columbia River basalt of southwest Washington and the adjacent part of Idaho are cut by many clastic dikes. They were formed by repeated filling of growing fissures, mostly by streams, lake currents, and waves, in part by collapse of fissure walls or by pouring in from unconsolidated deposits above. Small amounts were carried in by underground currents and some may be windborne. The fissures were formed through uneven settling during melting of buried ice, through gravity sliding and faulting on inclined zones of subsurface melting, through cavity-forming during melting, through erosion by underground streams, and through faulting and fissuring by landslides in the basalt.

---

3. 1945, Clarkston stage of the northwest Pleistocene (U. S.): Jour. Geology, v. 53, no. 5, p. 337-348.

Most of the deformation and dissection in the region around Lewiston, Idaho came after the Asotin stage, and downcutting continued until the major canyons were nearly as deep as they now are. Prior to the end of the Pleistocene there were three episodes of proglacial deposition, of which the one here called the Clarkston was the first. Gravel accumulated to a depth of 400 feet in the canyon of the Snake River and at times spilled over into the valley of the Clearwater. This was caused by increased load, indirectly by aggradation along the Columbia River at the mouth of the Snake or, possibly by regional deformation.

Lupton, D. Keith

1. 1956, Soda-rich igneous rocks of Hell's Canyon, Idaho (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1717.

The high-soda content of the Seven Devils volcanics (Permian) is regarded as of primary origin and comparable to the Clover Creek greenstone of the Baker quadrangle, Oregon. The small satellite of the Idaho batholith near Hell's Canyon is composed of tonalite and sodaclase tonalite identical with soda-rich intrusive rocks in eastern Oregon.

McConnell, Duncan

1. 1952, The nature of rock phosphates, teeth, and bones: Washington Acad. Sci. Jour., v. 42, no. 2, p. 36-38.

McConnell concludes that the physical and chemical properties of rock phosphates, etc., are dissimilar to those of fluorapatite and resemble those of francolite or dahlite. Nothing is said about Idaho.

McDivitt, James F.

1. 1952, A report on gypsum deposits in Washington County, Idaho: Idaho Bur. Mines and Geology Pamph. 93, 15 p.

Gypsum deposits along the Snake River, where it borders Oregon, have long been known but those in Idaho have not become productive. They are in secs. 7, 8, 17, 18, and 20, T. 13 N., R. 7 W., Washington County. They 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 are thought to have slid downhill but this is improbable. The report closes with a general discussion of uses, prices, etc., for gypsum.

---

2. 1956, Economic evaluation of phosphate and other minerals in southern Idaho: Idaho Bur. Mines and Geology Pamph. 111, 48 p.

This emphasizes economic factors influencing the phosphate industry in southeastern Idaho but also comments on various other minerals, metallic and nonmetallic, in southern and southcentral Idaho. It points out that the geologic history of many ore deposits is such that they occur in mountainous country with the attendant isolation from markets, difficulties in transportation, etc. The expense of prospecting related to this is high but is decreased by the work of government agencies. Existing railroads in Idaho are far from many of the mining districts but highways are helping development. Distance from markets is an adverse factor. Costs for power are high for much of southern and southcentral Idaho but future development, including use of local coal and of natural gas, should help. Varying governmental policies, in part favorable, in part un-

favorable, influence mining. Climate hampers early development. Prior claims to water by irrigation users may hamper mining. Difficulties in getting adequate labor and financing also enter. The phosphate industry in Idaho has recently expanded and prospects are good. The various economic factors affecting this industry are discussed in some detail. Brief case studies of cobalt, lead, zinc, copper, fluorspar, barite, and pumice are appended.

McDonald, J. V.

1. 1954, Glaciation of the Seven Devils Mountains as an example of Pleistocene glaciation in central Idaho: Master's Thesis, Univ. Idaho.

Pleistocene glaciation of the Seven Devils Mountains was of the alpine type confined to cirques and stream valleys. Glacial features described included cirques, tarns, rock steps, U-shaped valleys, lateral, recessional, and ablation moraines, horns, aretes, rock drumlins, kames, and striations.

Glaciation was asymmetrical due to the control of differential snow accumulation and solar heating, and fracture-controlled valleys.

McDowell, George A.

1. 1947-1957, 47th-57th Annual reports of the mining industry of Idaho by years.

Each of these annual reports by the State Mine Inspector lists available data on ownership, development, etc., for all mines for which information is on hand, segregated by counties. The reports also give data on mine accidents, production, etc., and most include short articles either reprinted from current literature or written specifically for the report. Thus each annual report is a summary of mining conditions in the state for the year it covers.

McGuinness, Charles Lee

1. 1951, The water situation in the United States with special reference to ground water (with a summary of the current situation by states based on data supplied by field offices of the Water Resources Division): U. S. Geol. Survey Circ. 114, 138 p.

Circular 114 comprises appendixes B and C of a report prepared by the U. S. Geological Survey in April 1950 for the President's Water Resources Policy Commission. It describes the principles of occurrence of ground water, especially in relation to surface water, the general occurrence of ground water in the United States, stresses the deficiency of basic hydrologic data and summarizes briefly the current water situation. The appendix (appendix C of the original report) consists of a brief summary of the water situation in each state. The report emphasizes the necessity of consistent legal treatment of water-rights problems and introduces the subject of water law.

Maps of the United States show ground-water areas (by H. E. Thomas); areas of substantial ground-water information; and ground-water pumpage in 1945 for municipal, industrial, and irrigation uses (by W.F. Guyton). It is

estimated that ground-water draft for irrigation in Idaho in two to five years from the date of tabulation may be 4,000,000 acre-feet. Available data for the state are tabulated in the appendix.

MacKenzie, Wayne O.

1. 1949, Geology and ore deposits of a section of the Beaverhead Range east of Salmon, Idaho: Master's Thesis, Univ. Idaho.

A discussion of the igneous rocks of the area and their relation to local structure and ore deposition. General description of the Carmen Creek, Ajax Bell, and Dike mines, with Brunton compass and tape surveys of some of the underground workings. Precambrian metamorphics, Tertiary sediments, and glacial deposits are discussed briefly.

McKelvey, Vincent Ellis

1. 1946, Preliminary report on stratigraphy of the phosphatic shale member of the Phosphoria formation in western Wyoming, southeastern Idaho, and northern Utah: U. S. Geol. Survey open-file report.

The lithology and stratigraphy of the phosphatic shale member of the Phosphoria formation are described in detail, accompanied by maps, 13 measured sections, 7 correlation charts, and a table outlining distribution of fauna for the area.

The source of phosphate deposits and the conditions of their deposition are discussed in an attempt to ascertain criteria for use in prospecting for new deposits.

---

2. 1949, Geological studies of the western phosphate field, in Symposium on western phosphate mining: Mining Eng., v. 1, no. 8, p. 270-279; Am. Inst. Mining and Metall. Trans., v. 184.

This paper summarizes the objectives and accomplishments of the study of the western phosphate field by the U. S. Geological Survey. The presence of significant amounts of fluorine, vanadium, nickel, molybdenum, and uranium is cited. The western field covers 100,000 square miles in Montana, Idaho, Wyoming, Utah, and Nevada. The eastern portion has relatively simple structure and the western portion, which is in and near Idaho, has complex structure, phosphate deposits are thick and of high quality, although most individual minable deposits are small. Additional discoveries are expected. Total reserves are large.

_____, (and Nelson, John Marshall)

3. 1950, Characteristics of marine uranium-bearing sedimentary rocks: Econ. Geology, v. 45, no. 1, p. 35-53.

This is a summary paper with only brief reference to the Phosphoria formation in Idaho and adjacent states.

Many marine black shale and phosphorite units in Sweden and elsewhere contain some uranium, suggesting that this may be true in the United States also. The uranium-bearing shales are rich in organic matter and sulfides, and low in carbonates. The best are in relatively thin formations of pre-Mesozoic age. All the marine phosphorites tested are uraniferous, the uranium increasing generally with the phosphate content. Significant concentration of uranium in other marine sediments are known only in beach placers and the Witwatersrand conglomerate.

McKelvey, Vincent Ellis (Cathcart, J. B., Altschuler, Z. S., Swanson, R. W., and Buck, Katherine L.)

4. 1953, Domestic phosphate deposits United States, Chap. 11 of Pierre, W. H., and Norman, A. G., eds., Soil and fertilizer phosphorous in crop nutrition: New York Acad. Press, p. 347-376.

This is a general discussion of uses, geology, and distribution of phosphorus deposits. Those in Idaho are mentioned as "geosynclinal deposits". The fluorapatite content in visible layers is commonly 3,000-25,000 Kg per square meter and that of the whole formation may be 25,000-75,000 Kg per square meter. In the western field (Idaho-Wyoming-Montana) operations started in 1906; about 6 million long tons were produced through 1949 of which 55 percent of the total was produced in 1946-49. Some are in the Brazer limestone, but most are in the Phosphoria. A map and description of these deposits are given. The western field has produced (in long tons): 6.8 million, 1.4 millions $P_2O_5$, inferred reserves, 3,000 millions, additional possible future resources 20,000 millions, 5,800 millions $P_2O_5$.

_____ (Swanson, Roger Warren, and Sheldon, Richard Porter).

5. 1953, The Permian phosphorite deposits of western United States, in Saint Guilhem, P. L. R., ed., Origine des gisements de phosphates de chaux: Internat. Geol. Cong., 19th, Algiers, Comptes Rendus, sec. 11, fasc. 11, p. 45-64.

The Permian phosphorite deposits of the western United States are in the Phosphoria formation and its partial equivalents over an area of 135,000 square miles in Montana, Idaho, Wyoming, Utah, and Nevada. In the western part of the field the Phosphoria is a part of the folded Cordilleran miogeosyncline; to the east it lies on the platform bordering the geosyncline and farther east tongues into continental red beds. The lower part of the formation in the geosyncline is absent on the platform. The phosphorite deposits consist mainly of colloform carbonate-fluorapatite, quartz, and clay. In addition to phosphorus and fluorine, they contain vanadium, chromium, zinc, rare earths, uranium, and other minor metals. Stratigraphic sections from northeastern Nevada to the Rattlesnake Hills in eastern Wyoming are shown. The area of the Phosphoria sea in which normal marine facies were deposited was about 225,000 square miles, possibly greater at times. The marginal sea may have covered 25,000-75,000 square miles more. A map shows the western shore crossing the Idaho-Nevada boundary just west of longitude 115° and reaching to a pointed end near longitude 113°, latitude 47° in Montana.

Kazakov's hypothesis for the origin of phosphorites is accepted for those of the Phosphoria, with modification. Thus, the Phosphoria accumulated in a large-shelving embayment bordered by low lands that contributed little detritus. Cold phosphate-rich waters upwelled into this basin from the ocean reservoir to the south or southwest. Phosphorite was deposited from these waters, probably in depths of 1,000 to 2,000 meters, as the pH increased with increase in temperature and decrease in partial pressure of $CO_2$, carbonates were precipitated when these waters reached shallower depths, at higher pH. The phosphate-rich waters nurtured a luxuriant growth of phytoplankton and other organisms, some remains of which were concentrated with fine sediments in relatively deep water. Part of the phosphate and probably some of the fine-grained silica in the formation were concentrated by these organisms. These conditions persisted over much of Permian time.

McKelvey, Vincent Ellis (Swanson, Roger Warren, and Sheldon, Richard Porter)

6. 1953, Phosphoria formation in southeastern Idaho and western Wyoming, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 41-47.

The Phosphoria contains large resources of phosphorus, fluorine, vanadium, uranium, and other elements of economic importance. It has been cited as a petroleum source bed as it is rich in carbonaceous matter, contains some oil shale, and in central Wyoming does yield oil. At its type locality in Phosphoria Gulch in southeastern Idaho it overlies the Pennsylvanian Wells and underlies the Triassic Dinwoody. Here it has three members; in Montana and northwestern Wyoming it has 5, of which the lowest may be equivalent to upper Wells. In north-central Utah the Park City overlies the Weber, and its lower part is probably equivalent to the upper Wells. The rest of the Park City would thus be equivalent to the Phosphoria. There are affinities with Permian rocks in the Confusion Range, Utah, Goshute Range, Nevada, and in Cassia County, Idaho, but relations are not clear. To the east the Phosphoria and its partial stratigraphic equivalents extend over more than 225,000 square miles, phosphorites over about 135,000 square miles. Facies changes are marked, but individual layers persist for miles. A map shows platform area mostly in Wyoming, and miogeosyncline westward to roughly longitude 114°.

_____, (and others)

7. 1953, Stratigraphic sections of the Phosphoria formation in Idaho, 1947-48, pt. 1: U. S. Geol. Survey Circ. 208, 49 p.

This is one of a series of progress reports. Twelve stratigraphic sections and some spectrographic data are tabulated.

---

8. 1953, Stratigraphic sections of the Phosphoria formation in Idaho, 1947-48, pt. 2: U. S. Geol. Survey Circ. 301, 58 p.

This is one of a series of progress reports. Eight stratigraphic sections, plus analytical data, are tabulated.

McKelvey, Vincent Ellis (and Strobell, John Dixon, Jr.)

9. 1955, Preliminary geologic maps of the Paris-Bloomington vanadium area, Bear Lake County, Idaho: U. S. Geol. Survey Mineral Inv. Field Studies Map MF 41, 4 sheets.

This consists of two black and white geologic and topographic maps, one at 1:4,800 and one at 1:12,000 and a separate sheet of structure sections for the 1:12,000 maps.

_____ (and Williams, J. S., Sheldon, Richard Porter, Cressman, E. R., Cheney, T. M., and Swanson, Roger Warren.

10. 1956, Summary descriptions of the Phosphoria, Park City and Shedhorn formations: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 12, p. 2826-2863.

The Phosphoria formation (Permian) consists of chert, carbonaceous mudstone, and phosphorite in its typical area in Idaho. These rocks intertongue with and pass into sandstone in northwestern Wyoming and Montana, carbonate rock in west-central Wyoming, and carbonate rock with subordinate sandstone in northeastern Utah. The carbonate rocks intertongue with and pass laterally into greenish-gray and red beds to the east, southeast, and south. The nomenclature adopted retains Phosphoria formation for the chert-mudstone-phosphorite facies, identifies as tongues of that formation such rocks where they interfinger with others on the fringe of the phosphate field, uses Park City formation (Permian) for carbonate rock and sandstone in Utah and west-central Wyoming and tongues of such rock that interfinger with the Phosphoria. A new name, Shedhorn sandstone, is used for sandstone of Phosphoria age in and near northwestern Wyoming, and beds of sandstone are identified as tongues of the Shedhorn that interfinger with the Phosphoria and Park City in northwestern Wyoming and southwestern Montana.

_____

11, 1956, Uranium in phosphate rock, in Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, Geneva, 1955, New York, United Nations Pub. v. 6, p. 499-502; also in Page, L. R., Contributions to the geology of uranium and thorium..., U. S. Geol. Survey Prof. Paper 300, p. 477-481.

Marine phosphorites commonly contain 0.005-0.03 percent U roughly in proportion to phosphate content. Locally in the Phosphoria formation the uranium content is higher in the geosynclinal than in shaly facies.

McKelvey, Vincent Ellis (and Carswell, Louis D.)

12. 1956, Uranium in the Phosphoria formation, in Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, Geneva, 1955, New York, United Nations Pub. v. 6, p. 503-506; also in Page, L. R., Contributions to the geology of uranium and thorium ..., U. S. Geol. Survey Prof. Paper 300, p. 483-488.

The Phosphoria covers 135,000 square miles in Montana, Idaho, Wyoming, Utah, and Nevada. The phosphorites contain 0.005-0.03 percent uranium, locally in thin layers up to 0.06 percent. The formation is 200-1,500 feet thick and consists of two overlapping couplets each consisting of a carbonaceous phosphatic shale overlain by chert. The lateral sequence of facies is carbonaceous mudstone and phosphorite; chert, carbonate rock, and sandstone; and redbeds and evaporites. The lateral sequence is reproduced, in whole or in part, in the same or in reverse order, in vertical sections. The lateral sequence results from deposition on a shelving bottom. The vertical one results from deposition on rising and vice versa on sinking bottoms. The phosphate content is greatest in southwestern Idaho and the uranium content is roughly proportional to the phosphate. There are various variations in uranium content.

MacKichan, Kenneth A.

1. 1951, Estimated use of water in the United States, 1950: U. S. Geol. Survey Circ. 115, 13p.

This presents in graphic and tabular form an inventory of water use, by states, for various basic purposes: The amounts withdrawn from surface-water supplies and from ground-water supplies for each state for each purpose are indicated. The 1950 use is estimated to have been 170,000 million gallons per day. This amounted to 1,100 gallons per day for each person in the United States. An additional 1,100,000 million gallons per day was used to generate water power. In 1950 estimated ground water withdrawal was 2,858 million gallons per day for rural use, 3,584 million gallons per day for municipal use, and 5,525 million gallons per day for industrial use; estimated irrigational use was 20,204 acre-feet per year (17,982 million gallons per day). Nonwithdrawal uses, such as navigation, waste disposal, recreation, and fish and wildlife, also are discussed and evaluated. For Idaho, withdrawal of ground water for rural use is estimated at 20 million gallons daily, for municipal use 50,000,000 gallons daily, for industrial use the same, and for irrigation 350,000,000 gallons daily.

McKinstry, Hugh Exton (and Svendsen, R. H.)

1. 1942, Control of ore by rock structure in a Coeur d'Alene mine, (Idaho): Econ. Geology, v. 37, no. 3, p. 215-230.

The relations between ore shoots and structure in the Interstate mine, Coeur d'Alene region and in neighboring areas, are discussed. This mine has produced nearly 1,000,000 tons of high-grade zinc ore. The fissures showed displacement

and were ore-bearing where they cut through flat bedding, and showed little displacement and were tight where they cut through steep bedding. Ore formed where brecciation was at a maximum. A plane of weakness along a monzonite porphyry dike was a location for ore. The geologic history was (1) folding, (2) intrusion of monzonite stocks (Cretaceous or early Tertiary), (3) fracturing, perhaps accompanied by folding, (4) ore deposition, (5) intrusions of basic dikes, (6) post-mineral faulting.

Mackin, Joseph Hoover (and Coombs, Howard Abbott)

1. 1945, An occurrence of "cave pearls" in a mine in Idaho: Jour. Geology, v. 53, no. 1, p. 59-65.

Pisolites have been noted in depressions in a veneer of calcium carbonate mantling rubble in an abandoned mine in the Iron Mountain district in western Idaho. The pisolites were formed within the 35 to 42 years prior to their discovery in 1943.

---

2. 1947, Iron ore deposits in the Clearwater district, Idaho County, Idaho: U. S. Geol. Survey open-file report.

Four prospects in the Clearwater district were examined, data were accumulated, and reconnaissance maps made to aid in future possible studies.

The Clearwater deposits are relatively small pods of high-grade magnetite, generally lying parallel to northerly trending foliation of metamorphic rocks, probably originally Belt series sediments. Known deposits of the ore are small, the largest having an inferred tonnage of 51,000 tons. The incompleteness of present data and the generally poor surface indications of deposits would suggest the possibility of the discovery of larger deposits with the use of geophysical exploration and drilling. .

---

3. 1947, Preliminary report on iron ore deposits of the Iron Mountain district, Washington County, Idaho: U. S. Geol. Survey open-file report.

This report discusses the geology, occurrence, and economic value of five iron deposits of the Iron Mountain district, and is published in U. S. Geol. Survey Bull. 982-E, (listed below).

---

4. 1953, Iron ore deposits of the Iron Mountain district, Washington County, Idaho: U. S. Geol. Survey Bull. 982-E, p. 121-151.

Greenstone and marble, thought to be probably correlative with the Permian Clover Creek greenstone, are cut by granodiorite and associated rock thought to be outliers of the Idaho batholith (here assigned to the Late Jurassic?). A

sheared fanglomerate is interpreted as part of a detrital mass at the front of, and overridden and sheared by a thrust plate, possibly of late Cretaceous-early Eocene date. These rocks are divided by an erosion surface tentatively regarded as early Tertiary, which is buried by andesite flows. The flows were faulted, eroded, and covered by Columbia River basalt.

The iron deposits are specularite, and magnetite replacements in Permian marble, associated with tactite and sulphide deposits. There are also red-hematite deposits formed by weathering over supergene copper deposits.

Available reserves are 150,000-200,000 tons of which about 20,000 are measured ore.

Mackin, Joseph Hoover (and Schmidt, Dwight L.)

5. 1953, Placer deposits of radioactive minerals in Valley County, Idaho (abs.): Geol. Soc. America Bull., v. 64, no. 12, pt. 2, p. 1549.

Reconnaissance in Long Valley and Bear Valley shows the chief placer minerals are monazite and a group of uranium-bearing rare earth columbates and tantalates. Dredging was in progress in Long Valley. The monazite is a widespread accessory mineral in the Idaho batholith; the others originate in pegmatite dikes in the batholith. All the known concentrations in soils are in areas that escaped glaciation in two late Pleistocene stages. Deposits suitable for dredging are in valley fill formed through Pleistocene block faulting, through damming of streams by glaciers or glacial outwash and/or through aggradation due to increase in load under periglacial climatic conditions. The typical fill consists of intertonguing deposits of different origin.

---

6. 1953, Reconnaissance geology of placer deposits containing radioactive minerals in the Bear Valley district, Valley County, Idaho: U. S. Geol. Survey open-file report, 32 p.

A geologic interpretation of placer deposits of monazite and a group of uranium-bearing rare earth columbates and tantalates. The monazite is an accessory mineral in the granitic country rock; the columbates and tantalates occur in pegmatite dikes.

The richest placer deposits are in Big Meadow which occur in valley fill formed as a result of blocking of Bear Creek by a Pleistocene glacier. Forty-three holes were drilled into placers and about 400 pan concentrates collected. The amounts of various minerals present were calculated in the field to provide a general picture of the feed of placer minerals into the main valleys.

In this preliminary report, the placer mineral content of bedrock and residual soil, morainal materials, and the channel deposits of the present streams, are discussed in qualitative terms only.

---

7. 1953, Reconnaissance geology of placer deposits containing radioactive minerals in the Bear Valley district, Valley County, Idaho: U. S. Geol. Survey Trace Elements Mem. Rept. 602.

This study was undertaken to provide a geologic interpretation of placers drilled by the U. S. Bureau of Mines, containing monazite and a group of uranium-bearing rare earth columbates and tantalates (here termed radioactive blacks). The monazite is an accessory in the granitic country rock, the others are in pegmatite. The supply in the placers was controlled by their occurrence in the parent rock and by the distribution of glaciers of two late Pleistocene stages. The richest are in Big Meadow, a valley fill formed by blocking of Bear Creek by an Illinoian? glacier. Others await prospecting. The main country rock belongs to the Idaho batholith, cut by pegmatite and aplite. Later porphyry dikes of varied compositions are plentiful, notably on Red Mountain. Some drilling by private companies has been done.

Mackin, Joseph Hoover

8. 1956, Cause of braiding by a graded river (Idaho) (abs.): Geol. Soc. America Bull. v. 67, no. 12, pt. 2, p. 1717-1718.

South of Hailey, Idaho, the Wood River meanders in a forest for many miles, braids in a three-mile segment of a prairie-type valley floor, and meanders again where it reenters a forest. The river is stable or slowly degrading in all three segments. The differences noted result from differences in bank resistance due to presence or absence of bank vegetation.

_____, (and Schmidt, Dwight L.)

9. 1956, Uranium and thorium-bearing minerals in placer deposits in Idaho, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Comm. for the United Nations Internatl. Conf. on Peaceful Uses of Atomic Energy, Geneva, 1955, Proc. Internatl. Conf. on Peaceful Uses of Atomic Energy, United Nations Pub. v. 6, p. 587-592: U. S. Geol. Survey Prof. Paper 300, p. 375-380.

Commercial placers in Idaho are confined to areas of fill deep enough to support large scale dredging. These are formed through (1) Pleistocene block faulting as at Cascade, (2) late Pleistocene derangement of drainage as in Bear Valley, and (3) blocking of drainage by Pleistocene basalt flows as in the Hailey area. Monazite is widely but irregularly distributed in the Idaho batholith and is the source of most placers here considered. Euxenite in trace amounts is widely distributed in the batholith, but the only commercial placer is in Bear Valley and is supplied from a 6-square mile area of quartz diorite. Factors contributing to concentration of heavy minerals in the placers are discussed.

Mallory, William Wyman

1. 1956, Tectonic development of the Cordilleran region, in Am. Assoc. Petroleum Geology, Rocky Mtn. Sec., Geol. Record, p. 37-47.

This is one of numerous papers that argues for a broad geosyncline that stretches the full length of Idaho and far beyond to the north and south. The first stage

in tectonic development of the region is postulated as a brief one in which the continental margin subsided behind an inward migrating sinuous hinge line in Cambrian time. The second stage started in the Ordovician and was a complex interplay of orogeny, volcanism, and deposition. Early in this stage, deposition was dominant; later tectonic activity became dominant. Little is said directly as to conditions in Idaho during this stage but it is implied that much or all of the state was under the water of the geosyncline. It is assumed that the Phi Kappa and Trail Creek formations were far more widespread than they have been recorded as being. It is also stated that the Phi Kappa and Kinnikinic formations are interbedded and that the Laketown dolomite and Trail Creek argillites are also interbedded. The Pennsylvanian is reported to mark the beginning of segmentation of the geosyncline into local basins and intrageosynclinal land areas. In Permian time volcanism spread eastward into Idaho. In the Triassic the geosyncline was almost divided into two separate troughs by linear bands and this division was completed in the Jurassic. The third stage witnessed climactic orogeny and the close of deposition. Granodiorite batholiths came in near the Pacific Ocean in late Upper Jurassic time. In Early and Middle Cretaceous time orogenic movements spread east. Deposition was restricted to a narrow strip in eastern Idaho and near Salt Lake, but marine cratonic accumulation was widespread. By the Late Cretaceous overthrusting was marked and the Idaho batholith was emplaced in an anomalous inner belt location. In the fourth stage the region east of the Pacific trough was a mountainous area that soon began to founder into a jumble of block mountains and intermontane basins.

Mansfield, George Rogers

1. 1942, Phosphate deposits of the world, with special reference to those of the United States: Indus. and Eng.Chemistry, Indus. ed., v. 34, no. 1, p. 9-12.

This is a brief general summary in which the reserves in Idaho are listed as 5,736,335 tons.

---

2. 1942, Recent studies of reserves of domestic phosphate: Am. Inst. Mining and Metall. Eng., Tech. Pub. 1208, v. 4, no. 3, 10 p., 1940; reprinted in Trans. v. 148, p. 59-68, 1942.

In a table Mansfield estimated Idaho reserves at 5,736,335 tons of high grade. Inclusion of low-grade rock might triple this figure. An exceptionally detailed section of the phosphate rock at the Anaconda mine near Conda is given.

---

3. 1952, Geography, geology, and mineral resources of the Ammon and Paradise Valley quadrangles, Idaho: U. S. Geol. Survey Prof. Paper 238, 92 p., incl. geol. map.

This report incorporates fieldwork in two 15' quadrangles southeast of Idaho Falls, done in the 1930's, publication being delayed by Mansfield's illness and

death. Hence the stratigraphic data are in some respects out of date for the time of publication. Some review of this situation is included in the report.

The geologic formations include representatives of the Carboniferous and later systems but parts of the Triassic, Jurassic, Cretaceous, and early and middle Tertiary are either absent or not recognized. The Wells and Phosphoria formations, believed to be separated from each other by an unconformity, are mapped in accordance with Mansfield's practice in other areas in southeastern Idaho but problems as to their age are appreciated. Part, perhaps most, of the Wells may be Permian. On the other hand, some have regarded the lower part of the Phosphoria as Pennsylvanian. There are also problems relative to the stratigraphic assignments of some of the Mesozoic units. The Salt Lake formation in the area is not older than Pliocene and is in part Pleistocene or younger. The igneous rocks include andesitic breccia and tuff, silicic welded tuff, volcanic ash related to the Salt Lake formation, basalt and basaltic ash of several ages.

The rocks are folded and broken. Folds tend to be overturned eastward. There are several overthrusts, including the Bannock thrust, which here has three branches. Horst and graben structure is continued into the area from the southeast. Many of the structural features of the two quadrangles are concealed beneath a widespread blanket of Tertiary and later rocks.

The mineral resources include phosphate rock (described by townships), limestone, road metal, building stone, and volcanic ash, all in sufficient quantity to supply local needs for some time to come. Occurrences of coal and nitrate have also been noted.

Mapel, William Jameson (and Hail, W. J., Jr.)

1. 1956, Tertiary stratigraphy of the Goose Creek district, Cassia County, Idaho, and adjacent parts of Utah and Nevada, in Geology of parts of northwestern Utah: Utah Geol. Soc. Guidebook to the geology of Utah, no. 11, p. 1-16.

Sedimentary and pyroclastic rocks of late Miocene and early Pliocene(?) age in the Goose Creek district are regarded as belonging to the Payette(?) and Salt Lake formations respectively. Detailed sections of both units are given. Diatoms from the Payette(?) are regarded by Lohman as early Pliocene in age while Brown regards the leaves as latest Miocene. Pre-Tertiary units are not discussed but three units assigned to the lower(?) Paleozoic are mapped and the Oquirrh formation (Pennsylvanian) is shown above these with the Harrison series (middle (?) Precambrian) below.

---

2. 1956, Uraniferous black shales in the Northern Rocky Mountains and Great Plains Regions: in Proc. Internat. Conf. on Peaceful Uses of Atomic Energy: Geneva, 1955: New York, United Nations Pub., v. 6, p. 445-451.

This summary includes a note that a black phosphatic shale is known at the base of the Brazer limestone in Utah and Idaho but uranium was found in it only in Utah.

Mapel, William Jameson

3. 1956, Uraniferous black shales in the Northern Rocky Mountains and Great Plains Regions, in Page, L. R., and others. Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations Internat. Conf. on Peaceful Uses of Atomic Energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 469-476.

This is the same as the paper cited immediately above.

---

4. 1956, Uranium in black shale deposits, northern Rocky Mountains and Great Plains: U. S. Geol. Survey Bull. 1030-H, p. 211-235.

Reconnaissance examinations were made in Montana, North Dakota, Utah, Idaho, and Oregon. Data for numerous Precambrian and Paleozoic rocks in various parts of Idaho are tabulated but nothing of present economic interest was found.

Maxey, George Burke

1. 1957, Lower and Middle Cambrian stratigraphy in northern Utah and southeastern Idaho (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2 p. 1764.

The stratigraphic succession of Lower and Middle Cambrian rocks in the area, determined from 13 measured sections, includes, in upward succession, the Prospect Mountain quartzite, Pioche formation, Langston formation, Ute limestone, Blacksmith dolomite, and Bloomington formation. All probably were deposited in a shallow, chiefly transgressive sea, starting from eastern to western Utah in earliest Cambrian (pre-Olenellus) time. The area remained submerged until late in Cambrian time.

---

2. 1958, Lower and Middle Cambrian stratigraphy in northern Utah and southeastern Idaho: Geol. Soc. America Bull., v. 69, no. 6, p. 647-688.

This discussion emphasizes data in Utah but includes information on four localities in southeastern Idaho and three others just south of the Idaho border. The Brigham quartzite is equated with the Prospect Mountain quartzite and is stated to be overlain by the Pioche formation and, successively upward, by the Langston formation, Ute limestone, Blacksmith dolomite, and Bloomington formation. Maxey's Pioche formation near Pocatello is regarded as the upper part of the Brigham quartzite plus the lower part of the Spence shale member of the Langston formation. Newly measured sections in Utah are listed. Diagnostic Lower and Middle Cambrian fossils from localities in Utah are listed and faunizones are proposed.

All the Lower and Middle Cambrian sediments are believed to have been deposited in a shallow, chiefly transgressive, though oscillating, sea that transgressed a low-lying, mature topography eastward to western Utah by

Cambrian (pre-Olenellus?) time and to eastern Utah by the end of Early Cambrian time. The area remained submerged during Middle Cambrian and much of Late Cambrian time.

Melear, John D.

1. 1953, The petrology and ore deposits of the Seafoam mining district, Custer County, Idaho; Master's Thesis, Univ. Idaho.

A petrologic discussion of the igneous and metamorphic rocks of the area. The igneous rocks are divided into two groups, those related to the Idaho batholith and those of Tertiary age.

The Mountain King, Seafoam, and Greyhound mines are described and their geology, mineralogy, and controls of ore deposition discussed. Two types of mineral deposits are recognized, the most important being cavity fillings which yield gold and silver. Replacement type deposits contain silver, lead, and zinc.

Merritt, Z. S.

1. 1956, Upper Tertiary sedimentary rocks of the Alpine, Idaho-Wyoming area, in Wyo. Geol. Assoc. Guidebook 11, Ann. Field Conf., p. 117-119.

The part of Idaho touched on in this report is Grand Valley, Bonneville County, which is a down-dropped fault block in which thick Pliocene beds have been preserved. This valley is expected to be flooded by a dam so that its rocks will become inaccessible. These rocks are here correlated with the Teewinot formation in Wyoming. A section described in the present report is over 5,000 feet thick and does not represent the whole formation. The unit includes a lower limestone facies (not in measured section), a silty sandstone and clayey siltstone facies, a clayey siltstone, a tuff and pumicite facies and conglomerate at the top. Locally the Long Spring formation overlies the Teewinot. It consists mostly of conglomerate, is a few feet to 200 feet thick, and is late Pliocene or Pleistocene.

Mielenz, Richard Childs

1. 1948, Fusion of sandstone by intrusive andesite, Palisades damsite, Idaho (abs.): Am. Mineralogist, v. 33, nos. 3-4, p. 202.

At Palisades damsite an irregular sill-like body of hypersthene-augite andesite invades sandstone, siltstone, and claystone and has penetrated and fused the sediments in a zone up to 8 feet wide. Sandstone at the contact has fused and flowed locally.

Miller, Donald S. (and Gast, Paul W.)

1. 1957, Isotope geology of some lead ores (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1767-68.

Among samples from various localities, four from the Sunshine mine, Kellogg, Idaho, covering a vertical distance of 1,000 feet and a horizontal distance of 500 feet, isotopic compositions are constant within 0.6 percent.

Miller, Loye Holmes

1. 1944, Some Pliocene birds from Oregon and Idaho: Condor, v. 46, no. 1, p. 25-32.

Bird remains from two localities in Oregon and two in Idaho were studied in the laboratory. One of the Idaho localities is along Snake River 13 miles northwest of Grandview; the other on the Barbour Ranch 3.3 miles east of the Bruneau-Mountain Home bridge. The birds resemble Pleistocene forms from the Pacific coast but on the basis of mammalian remains found with them the age is regarded as Pliocene, slightly younger than the Hagerman lake beds, then regarded as upper Pliocene.

Milner, Carlos E., Jr.

1. 1950, Geology and ore deposits of the Princess Blue Ribbon mine, Camas County, Idaho: Master's Thesis, Univ. Idaho.

A lenticular vein deposit 2-15 feet wide contains gold-quartz with less than 10 percent associated base metal sulphides. Mineralization occurred in two stages under mesothermal conditions. The vein has been segmented by postmineral faulting.

Mitcham, Thomas Wilson

1. 1952, Indicator minerals, Coeur d'Alene silver belt (Idaho): Econ. Geology, v. 47, no. 4, p. 414-450.

Outcrops in the Silver Belt (formerly Dry Belt) are so poor that much of the prospecting has been by tunnels, and some of the rich ore shoots found have their tops thousands of feet below the surface. Hence the importance of indicator minerals. It is noted that the country rock belongs to the Belt series. Where these rocks are high in sericite valuable ore shoots are unlikely. No ore has been found where the wall rocks are carbonate-rich. Diabase and lamprophyre dikes are present and may be of late premineral age. The Belt rocks contain strongly bleached zones which broadly outline the ore-bearing areas of the Belt. The bleaching results from breakdown of the coloring matter, not from extensive sericitization. Arsenopyrite tends to form in an envelope around an ore shoot. In the Coeur d'Alene region generally hydrothermal alteration was in three stages: (1) bleaching alteration stage, (2) carbonate-quartz stage, (3) sulphide stage. The area of deposition of the stages was progressively less extensive with time.

---

2. 1952, Significant spatial distribution patterns of minerals in the Coeur d'Alene district, Idaho: Science, v. 115, no. 2975, p. 11.

In the Silver Belt of the Coeur d'Alene region deeply buried ore shoots are in carbonate-quartz veins. Studies of distribution patterns of the minerals has been made in order to learn features indicative of the proximity of ore shoots.

Disseminated arsenopyrite forms envelopes around a number of the highest grade ore shoots. Similarly late hydrothermal chlorite is an indicator, but it may be sporadically distributed. Where sericite and carbonates earlier than the hydrothermal veins are abundant little ore is found. As beds rich in detrital quartz are the best ore horizons, such rocks are indicators. Six genetic types of chlorite are recognized. The hydrothermal-vein history shows three stages. The hydrothermal bleached zones result largely from the destruction of rock pigments, not, as has been supposed, from strong sericitization.

Moore, Raymond Cecil (and others)

1. 1944, Correlation of Pennsylvanian formations of North America: Geol. Soc. America Bull. v. 55, no. 6, p. 657-706.

The text of this report makes little reference to Idaho. In the three columns in the chart that are concerned with Idaho (collated by J. S. Williams) the Wood River formation near Hailey, Blacklead limestone in the Seven Devils region, and Wells formation in southeastern Idaho are indicated as equivalents to each other in age. Note, however, that the Blacklead limestone is in the Orofino region and Anderson called it merely Paleozoic(?).

Moritz, Carl Albert

1. 1953, Summary of the Cretaceous stratigraphy of southeastern Idaho and western Wyoming, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 63-72.

A descriptive paper with generalized map and correlation charts. In Idaho the formations include the Ephraim conglomerate, Peterson limestone, Bechler conglomerate, Draney limestone, and unnamed red beds (all of the Gannett group), the Bear River formation, Aspen shale, and Frontier formation. The division between Lower and Upper Cretaceous is placed within the Wayan.

Mower, Reed W.

1. 1953, Records of wells and ground-water levels in eastern Jerome County, Idaho: U. S. Geol. Survey duplicated rept., 91 p.

Data for the 221-square-mile area include 165 well records and 93 well logs.

---

2. 1953, Records of wells, ground-water levels, and ground-water withdrawals in the lower Goose Creek basin, Cassia County, Idaho: U. S. Geol. Survey duplicated rept., 92 p.

Data for the 470-square-mile area include 579 well records, 66 well logs, and well-discharge measurements.

Mower, Reed W. (and Nace, Raymond Lee)

3. 1957, Water consumption by water-loving plants in the Malad Valley, Oneida County, Idaho: U. S. Geol. Survey Water-Supply Paper 1412, 33 p.

Nearly all available natural-flow surface water in the Malad Valley is appropriated for irrigation. The surface water supply, including that in reservoirs, would not be adequate for all irrigable lands in the valley. Wells supply part of the water for irrigation. Even so, more water is desired. Increase in supply might be had by reducing use by water-loving native vegetation and by substitution of vegetation of high value for that of low value. In the southern part of the valley 16 species of water-loving plants consume about 37,000 acre-feet annually. The only high-value water-loving plant grown is alfalfa, which consumes nearly 5,000 acre-feet of water. The residual 32,000 acre-feet would, in suitable circumstances, irrigate 10,000-15,000 acres. Samples of water from 40 sources average 970 ppm dissolved solids. The soil in areas occupied by water-loving plants is generally of poor quality and the same holds for the water available in these areas. About 75 percent of the area occupied by water-loving plants is irrigated. The eradication and control of these plants would effect various improvements.

Mundorf, M. J.

1. 1958, Water for the Snake River Plain: U. S. Geol. Survey open-file report.

This paper summarizes the occurrence and movement of ground water in the basalt aquifers beneath the Snake River Plain. Probable increases in the use of ground water for irrigation purposes necessitates steps being taken to insure continued ground water availability in the future.

More data as to natural and artificial recharge are required, in conjunction with studies of flow rates and directions. From these data it can be determined how much ground water should be developed in the future.

Munyan, Arthur Claude

1. 1956, A different stratigraphic interpretation for the Trias-Permo-Pennsylvanian sequence in northern Wyoming and adjacent areas (abs.): Oil and Gas Jour., v. 54, no. 53, p. 142.

The suggestion is offered that in Wyoming and surrounding areas no hiatuses of systemic rank separate the Tensleep, Phosphoria, and Dinwoody formations from each other even though the Tensleep is commonly said to be Pennsylvanian, the Phosphoria is Permian, and the Dinwoody is largely Triassic in age.

Murphy, Leonard M. (and Cloud, William K.)

1. 1954, United States earthquakes, 1952: U. S. Coast and Geod. Survey ser. no. 773, p. 60.

A table on page 60 lists fluctuations in 42 wells in Idaho, ranging in amplitude from 0.02 to 3.2 feet.

Murphy, Leonard M. (and Cloud, William K.)

2. 1955, United States earthquakes, 1953: U. S. Coast and Geod. Survey ser. no. 785, p. 33-35.

Tables show fluctuations in well-water levels throughout 1953. For Idaho 81 wells are listed. Amplitudes of fluctuations noted range from 0.01 to 1.61 inches.

---

3. 1956, United States earthquakes 1954: U. S. Coast and Geod. Survey ser. no. 793, p. 63-67.

A table on page 63-67 lists fluctuations in 202 wells in Idaho, ranging in amplitude from 0.2 to 0.86 foot.

Nace, Raymond Lee

1. 1948, Preliminary report on ground water in Minidoka County, Idaho, with special reference to the North Side Pumping Division of the Minidoka Project: U. S. 81st Cong, 2d sess., House Doc. 721, p. 157-207.

The chief aquifer is the Snake River basalt. The amount of ground water that can be withdrawn perennially from wells in the North Side Pumping Division appears to be limited only by the ability of the lava aquifers to transmit water from the regional body of ground water in the Snake River Plain to the areas of local withdrawal. Aquifer tests indicate that irrigation wells can be pumped at rates in excess of 2,100 gallons per minute each, with small or negligible drawdowns.

Data for the 750-square-mile area include 93 well records, 13 test hole logs, 30 well logs, 30 chemical analyses, and a water-level map.

---

2. 1948, Preliminary report on ground water in Minidoka County, Idaho, with special reference to the North Side Pumping Division of the Minidoka Project: Idaho Dept. of Reclamation, 71 p.

A geologic reconnaissance was made, samples of water analyzed and well logs, etc., assembled and correlated. The water table was contoured and data on artesian reserves and directions of ground water underflow learned. The average total discharge of proposed irrigation wells in the North Side Pumping Division would be about 1,030 second-feet, that from proposed wells nearby might be 290 second-feet. Total withdrawal might therefore be 1,300 second-feet during the four months of the irrigation season. The total average discharge of ground water from the Snake River plains on the north side of the Snake River canyon between Milner and King Hill is between 5,000 and 6,000 second-feet. Hence the average discharge from the wells would be 22 percent of the discharge from springs and seeps and will represent salvage of water that would otherwise reach the river from springs. The amount that can be perennially withdrawn from wells in the pumping division and contiguous areas appears to be limited only by the

ability of the lava aquifers to transmit water. The main sources of ground water are east of the area. The effect of Lake Walcott at Minidoka dam has not been determined.

Nace, Raymond Lee

3. 1949, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1946; pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1075, Idaho p. 20-32.

As part of a systematic investigation of the ground-water resources of Idaho begun on July 30, 1946, in cooperation with the Idaho Department of Reclamation, a statewide network of selected wells was developed in Ada, Boise, Bonneville, Canyon, Cassia, Kootenai, and Oneida Counties.

In northern Idaho the water table has risen in response to above-normal precipitation. Water table records in southwestern Idaho show rises because of irrigation and drainage in spite of subnormal precipitation. In Oneida County, Idaho, decrease in precipitation plus pumping have lowered the water table slightly.

_____, (and Fader, S. W.)

4. 1950, Records of wells on Rathdrum Prairie, Bonner and Kootenai Counties, northern Idaho: U. S. Geol. Survey duplicated rept., 49 p.

Data for the 270-square-mile area consist of 150 well records and 14 well logs.

_____

5. 1951, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1947, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1100, p. 29-40.

The state-wide investigation continued with variable results, mostly small increases.

_____

6. 1951, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1948, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1130, p. 20-37.

The general investigation continued and in most areas ground-water storage rose in response to heavy precipitation.

_____

7. 1952, Record of wells and springs in western Oneida County, Idaho: U. S. Geol. Survey open-file report, 51 p.

Data for approximately 700 square miles of western Oneida County, consist of location, ownership, uses, type, and depths of 258 wells, with reported or measured water levels, pump capacities, geologic settings, and elevations.

Nace, Raymond Lee (and Fader, S. W.)

8. 1952, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1949, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1160, p. 22-37.

The investigation of ground water throughout the state was continued and expanded. At the end of 1949 measurements were being made in 79 wells and storage tended to increase.

---

9. 1952, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1950, pt. 5, Northwestern States, U. S. Geol. Survey Water-Supply Paper 1169, p. 17-39.

The observation-well program embraced 108 wells in 18 counties. Water levels varied but in most areas tended to decline.

---

9A. 1954, Preliminary statement. Ground water resources of the Raft River basin, Cassia County, Idaho. A summary of unpublished data: U. S. Geol. Survey open-file rept.

Large areas in the Raft River valley can be irrigated, if at all, by ground water only, as the available supply of surface water is inadequate. Substantial private tracts are already being thus irrigated (probably 6,000 acres). At certain times and places the water table is so high that ground water is discharged into the river channel, but elsewhere there is loss by percolation of surface water. Lake Walcott is a reservoir that might suffer if much pumping was undertaken in the valley of Raft River. The total drainage area is about 1,840 square miles, of which 360 square miles are irrigable. The principal crops are hay and grain. The discharge of the Raft River at its mouth may be less than 9,000 acre-feet per year and the unused ground water discharged by underflow might be of the order of 390,000 acre-feet per year but various considerations indicate it is less than 120,000 acre-feet per year. All this could not be salvaged as pumping would be for fractions of a year only. It is estimated that the total ground water supply in the valley is enough to support substantial new development, but the chemical character of the water has not been studied and the effects of pumping on supplies along the Snake River below Minidoka Dam are not known.

_____, (West, Samuel Wilson, and Mower, Reed W.)

10. 1955, Feasibility of ground-water features of the alternate plan for the Mountain Home Project, Idaho (abs. and summ.): U. S. Geol Survey open-file report, 24 p.

An abstract and summary of U. S. Geol. Survey Water-Supply Paper 1376.

Nace, Raymond Lee

11. 1956, Ground water in the water economy of Idaho: U. S. Geol. Survey open-file report, 23 p.

A study of the increasing rate of water use, compared to the amount and distribution of ground water that is potentially available for use. Effective methods of accumulation, storage, and re-use of natural water resources would insure an adequate supply in face of increased demand in the future.

_____ (West, Samuel Wilson, and Mower, Reed W.)

12. 1957, Feasibility of ground-water features of the alternate plan for the Mountain Home Project, Idaho: U. S. Geol. Survey Water-Supply Paper 1376, 121 p.

One of several proposed plans for irrigation of 183,000 acres south of Boise would involve pumping ground water in the Boise Valley to make up for surface water diverted from that valley and incidentally to drain waterlogged land there. Available records, plus field studies for the present project raise serious doubts as to whether the results of pumping would offset the diversion of surface water in such a way as to satisfy Boise Valley water users.

_____

13. 1958, Hydrology of the Snake River basalt (abs.): Wash. Acad. Sci. Jour., v. 48, no. 4, p. 136-138.

The Snake River Plain, a huge structural depression in southern Idaho, has been considered part of the Columbia Plateau Province, but differs from that province in Oregon and Washington. The part of the plain east of Bliss is a natural physiographic and geologic subdivision built largely by basalt flows, perhaps in a graben, and mantled by loessal sediments, with other sediments intercalated in the flows (chiefly Pliocene). From the mouth of Henry's Fork to that of Boise River, the Big Wood (Malad) River is the only stream that crosses the plain from the mountains to the north. The Snake River Plain east of Bliss (the part treated here) covers about 17,000 square miles and may be the largest unified ground-water reservoir in North America, with a zone of saturation averaging 1,000 feet. This reservoir discharges through springs between Milner and Bliss at an average rate over 5,000 cfs and amounting to 4,000,000 acre-feet per year. Since irrigation began the discharge has increased at least 25 percent. Nearly all water available from the Snake is appropriated and further development will depend on ground water. Fractures in pahoehoe lava are numerous; the water capacity per unit volume is small but aggregate capacity is large. Lava tubes in pahoehoe carry much water. As lava is among the most permeable of all types of rock and talus breccia is similar. The formational permeability of many zones in the Snake River basalt is high. Most of the ground water is unconfined but locally artesian conditions are approached. The water table in much of the plain

has been mapped but it is complex and the maps are highly generalized because wells are widely spaced. The rate and character of movement of the ground water are not clearly known. Both are important in relation to disposal of radioisotope wastes, etc.

Neighbor, Frank

1. 1953, Big Elk Mountain anticline, Bonneville County, Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 88-92.

Big Elk Mountain anticline in T. 2 S., R. 44 and 45 E. is mapped and described. An unsuccessful test well for oil was stopped at a depth of 5,597 feet.

Nelson, Vincent Edward (and Smith, J. F., Jr., assisted by Duell, G. A., and Hutchinson, R. M., surveyed in 1943).

1. 1945, Surface geology map of the Pine Creek area, Coeur d'Alene region, Shoshone County, Idaho: U. S. Geol. Survey Prelim. Map.

This is a geologic map with structure sections, scale 1,000 feet to the inch. The mapped units are alluvium (Quaternary) Burke formation and the Prichard formation with quartzite members, both belonging to the Belt series (Precambrian), and lamprophyre and diabase dikes (age not stated).

Newcomb, Reuben Clair (and others)

1. 1953, Seismic cross sections across the Spokane River valley and the Hillyard Trough, Idaho and Washington: U. S. Geol. Survey duplicated rept., 16 p.

Two cross sections based on refraction profiles yielded data on the position of the water table, the base of the glacial and glaciofluvial deposits, and the buried bedrock surface.

Newell, Norman Dennis (and Kummel, Bernhard, Jr.)

1. 1940, Permo-Triassic boundary in southeastern Idaho and western Wyoming (abs.): Oil and Gas Jour., v. 38, no. 48, p. 66.

Preliminary study of Woodside and Dinwoody faunas indicates an Early Triassic age for both.

---

2. 1942, Lower-Eo-Triassic stratigraphy, western Wyoming and southeast Idaho: Geol. Soc. America Bull., v. 53, no. 6, p. 937-995.

Stratigraphic and paleontologic data on the beds of Early Triassic age in the region are reviewed in detail with particular reference to the relations with the underlying beds of Permian age, also as to confusion in interpretations of the

relations of the Woodside and Dinwoody formations. A thickness of from 1,000 to 2,000 feet of strata in western Wyoming, southeastern Idaho and southwestern Montana is shown to belong to the Otoceras and probably to the Genodiccus zones of the Scythian stage of the Lower Triassic. These beds, classified in the present paper as Dinwoody and Woodside, overlap the Phosphoria, indicative of a marked hiatus at the Permo-Triassic boundary.

Newell, Thomas R.

1. 1956, Stream flow East Fork Bruneau River below Three Creek, Idaho: U. S. Geol. Survey open-file report.

The East Fork Bruneau River discharge has been studied on the basis of records from monthly and daily gaging station readings.

Local topography and geologic forms are discussed in relation to the drainage pattern, as are the local hydrologic conditions.

All data are presented in table and graph form, with accompanying maps, as an aid to estimating flow depletion along the river.

_____ (and Travis, W. I.)

2. 1956, The December 1955 flood in west-central Idaho: Talk at the meeting of the southern Idaho section, Am. Soc. Civil Engineers.

A wintertime flood in central or southern Idaho is an extraordinary occurrence but has happened before. Such a flood results from very warm rains. Where reservoir capacities are large the drainage is small. The December 1955 flood centered in the Weiser and Payette basins, but there was spectacular damage along the Little Salmon River. Data on present measurements of stream-flow, etc., are summarized.

Okeson, Clifford J.

1. 1946, Geology of Anderson Ranch Dam, Boise River, Idaho (abs.): Geol. Soc. America Bull., v. 57, no. 12, pt. 2, p. 1221.

Anderson Ranch dam, under construction at the time, was to be 444 feet high, the highest earth-fill dam in the world. The bedrock is a granitic complex, ranging widely in quality, texture, composition and color and containing many dikes, sills and inclusions. The rock is severely jointed, with clay films on the joints; shear zones and faults are numerous. Hence difficult engineering problems were encountered, materially influencing design of the cutoff walls, outlet works and spillway.

O'Malley, Frank Ward (and others)

1. 1953, Stratigraphic sections of the Phosphoria formation in Idaho, 1947-48, pt. 3: U. S. Geol. Survey Circ. 262, 43 p.

This is one of a series of progress reports; ten stratigraphic sections are tabulated, plus analytical data.

Osmond, John C.

1. 1957, Sevy formation, Lower Devonian, in the Cordilleran miogeosyncline (abs.): Geol. Soc. America Bull., v. 68, no. 12, pt. 2, p. 1869.

The Sevy formation, mostly tan dolomite, thickness 500 feet, is recognizable over an area of 100,000 square miles in California, Nevada, Utah, and Idaho, overlain by the Simonson, Jefferson, or similar Middle Devonian strata. It is thought to be an evaporite formed on extensive mud flats at or near sea level with sandy material derived from Ordovician rocks to the east.

Parks, James Marshall, Jr.

1. 1951, Corals from the Brazer formation (Mississippian) of northern Utah: Jour. Paleontology, v. 25, no. 2, p. 171-186.

This paper describes corals from two sections near the type locality of the Brazer and proposes a number of new names based on thin section studies. The Brazer rests on Madison without angular discordance and is overlain by Wells (Pennsylvanian) with an erosional unconformity. The lower 950 feet of the Brazer is composed of sandstone, siltstone, and arenaceous limestone. The upper 1,290 feet is composed of grayish-black fine-grained limestone, containing abundant solitary and compound corals. In a section where the basal member and part of the limestone member are buried, over 2,000 feet of limestone and including silty limestone and shale are exposed so the formation thickness is well over the 2,240 feet recorded at the first section. Five coral zones are recognized.

Patton, William W., Jr.

1. 1948, Geology of the Clayton area, Custer County, Idaho: Master Sci. Thesis, Cornell Univ., geol. map about 1 in.= 1,000 ft.

An area in parts of T. 11 N., R. 17, 18, E., Custer County, is described. Stratigraphy of the Paleozoic rocks was studied in detail and the major features are summarized in the table herewith. A gabbro sill and remnants of the Challis volcanics are included in the mapped area. The Ordovician rocks are folded in an asymmetrical anticline, N. 20° W., steepened to the east, and with local crumples broken by longitudinal, reverse, and normal faults, and by transverse faults.

| | | Feet |
|---|---|---|
| | Saturday Mountain formation | 3,000± |
| Kinnikinic quartzite | South Butte quartzite | 840 |
| | Ella dolomite | 340 |
| | Clayton quartzite | 1,580 |
| | Lower member of Kinnikinic including dark quartzite and dolomite, dark shale | 2,200 |
| | Total | 4,960 |
| | Ramshorn slate | 2,000± |

Peace, Frank S.

1. 1956, History of exploration for oil and gas in Box Elder County, Utah, and vicinity, in Geology of parts of northwestern Utah: Utah Geol. Soc. Guidebook to the geology of Utah, no. 11, p. 17-31.

Gives data on several exploratory wells, only one of which is in Idaho. This one is in sec. 10, T. 14 S., R. 30 E., Oneida County, stopped in Mississippian rocks at a depth of 12,841 feet and yielded only minor shows of gas and oil.

Perkins, Beauregard, Jr. (and others)

1. 1947, Subsurface structure of Snake River Valley, Idaho, from Seismograph records of ammunition explosions (abs.): AAPG-SEPM-SEG Joint Ann. Mtg., Los Angeles, p. 70; Geophysics, v. 12, no. 3, p. 496.

In 1946 a series of explosions of unserviceable ammunition at a locality in the Snake River Plain gave opportunity for seismographic study of subsurface conditions. Three velocity zones were indicated. The first zone of thick lava flows separated by thin layers of clay, sand, and gravel has a sound velocity of 6,600 feet per second and is about 500 feet thick. The second zone is similar to the first to a depth of 700 feet except for the presence of water. This is shown by wells of this depth. The sound velocity in this "bed" is 9,900 feet per second. It apparently starts at the water table and extends to a depth of 4,500 feet. The third zone transmits the sound wave at 19,800 feet per second and may be tightly folded sedimentary rocks or igneous rocks.

Peterson, Donald W.

1. 1955, The prebasalt surface in the vicinity of Peck, Idaho: Northwest Sci., v. 29, no. 1, p. 1-9.

The base of the Columbia River basalt was mapped in an area of 30 square miles near Peck, Idaho, in the basin of the Clearwater River. The general geology of the region is outlined and the basalt in the area studied is described. Here the basalt is up to 2,000 feet thick. The base is contoured. Along the base and intercalated in the basalt are sediments referred to the Latah formation. It is assumed that postbasalt deformation is negligible in the area. On this basis the prebasalt surface had marked relief (over 1,200 feet). The basalt is believed to have come from the west and flowed east up old valleys.

Peterson, James Algert

1. 1957, Marine Jurassic of northern Rocky Mountains and Williston Basin: Am. Assoc. Petroleum Geologists Bull., v. 41, no. 3, p. 399-440.

The marine Jurassic rocks in and near southeastern Idaho differ from those of Montana and much of Wyoming. They include the continental Nugget sandstone, the marine Twin Creek limestone, Preuss formation, Stump sandstone and the Beckwith formation of Gannett group, and the non-marine Morrison formation. These are in the Twin Creek trough which lies along the Idaho-Wyoming boundary.

The beginning of a new clastic source area on the west, probably associated with an early phase of the Nevadan orogeny in Idaho, is evident from the sandy character of the uppermost part of the Twin Creek limestone, while the trough containing this formation continued to terminate against a positive element called the Belt island beginning in southwestern Montana.

Piper, Arthur Maine (and LaRocque, George Albert, Jr.)

1. 1944, Water-table fluctuations in the Spokane Valley and contiguous area, Washington-Idaho: U. S. Geol. Survey Water-Supply Paper 889-B, p. 83-139.

The plains in Idaho are Rathdrum Prairie and contiguous areas northeastward to Lake PendOreille. They are largely undrained and were formed by outwash and other glacial deposits. They are pervious and contain much unconfined water. Underflow of large volume extends to and beyond Spokane. Movement of the ground water is controlled largely by the configuration of the bedrock surface which is the trunk valley of a preglacial stream that drained the basin of the present Clark Fork of the Columbia and thus crosses the divide between two principal modern streams. The report includes and interprets about 12,000 measurements of water level in wells.

Popoff, Constantine C.

1. 1953, Hermada antimony deposit, Elmore County, Idaho: U. S. Bur. Mines Rept. Inv. 4950, 21 p.

The Hermada antimony deposit is 77 miles northeast of Boise in Elmore County north of the Middle Fork of the Boise River. Stibnite mineralization occurs over an area one mile wide and two miles long in the Swanholm district. In 1947 high-grade ore was discovered on the East Fork of Swanholm Creek. The production for 1947-56 was 5,000 tons of ore containing 640 tons of antimony. The district is in a sheared and faulted part of the Idaho batholith which has guided intrusions of dikes and mineralization. The ore bodies in the Hermada are quartz fissure veins with abundant stibnite and without precious metals. Other sulfides are rare. Native antimony was noted in lamprophyre near ore shoots. A map of the Hermada pit with some geology is given. Claims near the Hermada are also described.

Powers, Harold Auburn

1. 1947, Diatomite deposits of southwestern Idaho: Master's Thesis, Univ. Idaho.

Sixty-three samples of diatomite from 20 localities in 9 counties were analyzed, and are considered to be from a Tertiary accumulation of diatom frustules. The uses and physical and chemical properties of diatomite are discussed. Ore reserves are conservatively estimated at 4,416,000 tons.

Powers, Harold Auburn

2. 1947, Diatomite deposits of southwestern Idaho: Idaho Bur. Mines and Geology Mineral Res. Rept., no. 4, 27 p.

The report outlines the occurrence, properties and uses of diatomite in general, notes occurrence in Adams, Washington, Gem, Ada, Boise, Payette, Owyhee, Elmore, Camas, and Twin Falls counties, Idaho. Descriptions of many of the deposits are given, some of which have geologic maps. The total reserves are estimated as 4,615,000 tons. Near Weiser the Idaho formation is represented as folded, not faulted.

Price, R. A.

1. 1956, The base of the Cambrian system in the southeastern Cordillera of Canada: Canadian Mining Metall. Bull. v. 49, no. 535, p. 765-771.

This paper deals primarily with Canada but has an isopach map indicating that Lower Cambrian beds ranged from 0 to 8,000 feet in thickness at the northern end of Idaho. The existence of a conformable sequence of rocks ranging in age from late Proterozoic to Early Cambrian is advocated. Transgression began in the interior of British Columbia in the Proterozoic and terminated in the present Canadian Rockies in the Waucobian. The configuration of the advancing shoreline was controlled by the positive element Montania in northwestern Montana and by another such element in British Columbia.

Reed, Glenn Cornelius

1. 1946, Exploration of the Avon mica district, Latah County, Idaho: U. S. Bur. Mines Rept. Inv. 3898, 23 p.

The mica deposits of the Avon district are in pegmatite bodies concordant to schistosity and, where visible, to bedding in Precambrian schist, near a granitic mass presumed to be an outlier of the Idaho batholith. Past production of mica exceeds $100,000. Recent production (Sept. 1943 to April 1945) of punch mica had a gross value of $434,298. Reserves are estimated at 600-1,000 tons of combined indicated and inferred crude block mica. One deposit is inferred to have 150-450 tons of beryl. Most of the mica reserves are minable profitably only under good cost-price conditions. A dozen properties are described.

_____, (and Herdlick, Jared Albert)

2. 1947, Blackbird cobalt deposits, Lemhi County, Idaho: U. S. Bur. Mines Rept. Inv. 4012, 14 p.

This report summarizes the results of trenching, drilling and sampling by the U. S. Bureau of Mines from 1942 through 1945. The results of metallurgical tests are also given. The history and production of the district are outlined and some geologic data are given. Twenty-five mine maps give general features of the geology and record sampling results. At the time of the report the district had been known since 1893, or earlier but production had been minor. The

Howe Sound Co. optioned much of the ground in 1943, starting active development.

Reed, John Calvin

1. 1942, Veins in the Warren district, Idaho, in Newhouse, W. H., ed., Ore deposits as related to structural features, p. 175.

Hypogene gold ore in the district was deposited in fractured zones in long lenticular quartz bodies, most of which trend N. 80° E. and dip 55°-70° S. These veins occupy the most prominent set of fractures in the district. Another set trends NW and dips NE. Post-mineral faults along the second set have offset the veins short distances. Some of these faults are filled by lamprophyre dikes. The veins are in quartz monzonite and related rocks of the Idaho batholith. Inconspicuous foliation in the quartz monzonite strikes N. 20°W. and dips NE with variations. Ore minerals include gold, galena, sphalerite, tetrahedrite, stibnite, and pyrite plus a little quartz which came in late in the sequence of mineralization.

Reesor, John Elgin

1. 1957, The Proterozoic of the Cordillera in southwestern British Columbia and southwestern Alberta, in The Proterozoic in Canada, Royal Soc. Canada, Spec. Pub. no. 2, J. E. Gill ed., p. 150-177.

This is primarily a summary of data on late Precambrian rocks in parts of British Columbia and Alberta, immediately north of dominantly clastic rocks of the Purcell and Windermere systems, forming a limited northward extension of the "Belt Terrain" into Canada. The source of the Belt series is inferred to be to the east. An unconformity is reported at the top of the Purcell but not at the top of the Windermere. Rocks known to be Cambrian are here removed from the Windermere. The Kintla is regarded as upper Purcell which implies that no Windermere is present in mapped parts of Idaho. Open sea may have extended west of the area of Purcell deposition.

Rezak, Richard

1. 1957, Stromatolites of the Belt series in Glacier National Park and vicinity, Montana: U. S. Geol. Survey Prof. Paper 294-D, p. 127-154.

This is a general discussion of stromatolites, their identification, and ecologic and geologic significance, based primarily on field studies in Glacier National Park and in the Bahamas. It notes that stromatolites have been found in the Prichard and Burke formations in the Coeur d'Alene district.

Rhodenbaugh, Edward F.

1. 1953, Is Boise (Idaho) sitting on a volcano?: Earth Sci. Digest, v. 7, no. 2, p. 7-11, 27.

This is a popularly worded account. It draws attention to a lacolithic intrusion exposed in Little Table Rock near the state penitentiary. There are warm springs near the base of the rock and wells furnish more hot water here and elsewhere in Boise. The intrusion is andesitic and supposedly Pliocene. Rhodenbaugh suggests that the heat for the water comes from an unexposed basaltic sill of Pleistocene age although the water is groundwater. He finds no evidence to suggest Boise need fear future eruptions.

Rhodenbaugh, Edward F.

2. 1953, Sketches of Idaho Geology: Boise, Idaho (privately printed?), Caldwell, Idaho, Caxton Printers: 267 p.

This book is a popular account touching on some highlights of the geology of the state. First is given a description of the physiographic subdivisions of Idaho following A. L. Anderson with a few additional subdivisions suggested by the author. The rest of the book gives an elementary or popular account of various geologic and geomorphic processes and their results, with illustrations taken largely from localities in Idaho. The subjects treated include weathering, erosion, ground water, glaciation, wind effects, volcanoes, lithology, structure, and brief comments on stratigraphy and paleontology.

The data summarized are taken mainly from the literature and in some cases are not up-to-date. However, the author has travelled widely in Idaho and his descriptions are enriched by personal observations.

Richmond, Gerald Martin

1. 1957, Three pre-Wisconsin glacial stages in the Rocky Mountain region: Geol. Soc. America. Bull., v. 68, no. 2. p. 239-262.

Small patches of till, regarded as pre-Wisconsin, are widely distributed in the Rocky Mountains. The deposits tend to be finer grained, more compact, and more strongly jointed than the Wisconsin deposits. Commonly a thick, mature soil profile is preserved on them. In places the relations to one intra-canyon erosion surface and two pre-canyon surfaces suggest that three stages of glaciation are represented. The three stages may represent the Nebraskan, Kansas, and Illinois stages of the Mississippi Valley, but this is unproved. Six localities in Idaho are cited but not described.

Roberts, Wayne A.

1. 1953, Metamorphic differentiates in the Blackbird mining district, Lemhi County, Idaho: Econ. Geology, v. 48, no. 6, p. 447-456.

Quartz pods and veins, without economic minerals, are present in the Blackbird district, noted for its cobalt-copper deposits. The barren quartz bodies are thought to be derived from the enclosing quartz-biotite and quartz-biotite-garnet-chloritized schists by metamorphic differentiation. The schists are derived from rocks of the Belt series. Two zones of regional metamorphism are recognized. In addition contact metamorphism has affected the rocks adjacent to the Idaho batholith later than the regional metamorphism.

Robertson, Almon Ford (and Storch, R. H.)

1. 1955, Camp Creek radioactive mineral placer area, Blaine and Camas Counties, Idaho: RME 3136, U. S. Bur. Mines for Atomic Energy Comm. 27 p.

The Camp Creek area has a large volume of minable gravel containing appreciable quantities of uranothorite, sphene, magnetite, ilmenite, hematite, and some zircon. The exploratory work by the Bureau of Mines was in 1954 and included 37 drill holes and 31 containing only traces of radioactive minerals in the Willow Creek area. Along Camp Creek 337 samples weighing over 13 tons were collected. Clean uranothorite was found to contain 51.92 percent $ThO_2$ and 5.54 percent $U_3O_8$. Clean separation in milling would present some difficulty.

---

2. 1955, Rock Creek radioactive mineral placer area, Blaine County, Idaho: RME 3139, U. S. Bur. Mines for Atomic Energy Comm. 25 p.

The U. S. Bureau of Mines explored the Rock Creek area in 1954. Minable gravel is contained in three separate areas, two of which could be dredged. The third and smaller area might be mined by surface methods. The three areas were tested by 44 drill holes, aggregating 1,126 feet, yielding 232 samples. In areas not suitable for dredging, 25 test pits, aggregating 233 feet in depth, yielded 55 samples. The black sand minerals include magnetite, sphene, ilmenite, plus hematite, zircon, uranothorite, and others listed in order of decreasing abundance. The uranothorite contains 49.5 percent $ThO_2$ and 6.23 percent $U_3O_8$.

Robinson, John W. (and Taylor, George C., Jr.)

1. 1941, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1940, pt. 5, Northwestern States: U. S. Geol. Water-Supply Paper 910, p. 7-12.

The section dealing with Idaho is mainly a tabulation of well data.

Robinson, Thomas William

1. 1949, Areas and use of water by phreatophytes in the western United States: U. S. Geol. Survey duplicated rept., 11 p.

Estimates of the area covered by phreatophytes and their annual use of water are given for 13 of the western states including Idaho. Partial data given show an area of 10,852 acres of phreatophytes and an annual use of 15,267,800 acre feet of water. Extrapolation of the data suggests a total of 15,000,000 acres of phreatophytes and a total water use of 20,000,000 to 25,000,000 acre feet per year in the 17 western states.

Roby, Robert Neil

1. 1948, Investigation of the Hornsilver lead-zinc property, Butte County, Idaho: U. S. Bur. Mines, Rept. Inv. 4277, 15 p.

The mine is in the Lava Creek district in the southeast part of the Mackay quadrangle. Ore was discovered in the district in 1883 and much high-grade silver ore was shipped prior to 1887 from shallow workings. In 1928 and 1929 and again in 1937 intermittently through 1946 there was activity. The district contains sphalerite, wurtzite, galena, pyrite in a siliceous gangue. The Last Chance (near the Hornsilver) contains cadmium. A bulk sample gave 0.12 percent cadmium and concentrates from there yielded 0.59 percent cadmium. In 1941 the Era Mining and Development Co. acquired the Hornsilver, Last Chance, and Ella group and worked until April 1946, shipping 14,562 tons 0.027 ounce gold, 2.62 ounces silver, 0.26 percent copper, 3.58 percent lead, and 6.52 percent zinc.

The total recorded production from this part of the district follows:

| Year | Tons ore | Gold oz. | Silver oz. | Lead, lb. | Zinc, lb. |
|---|---|---|---|---|---|
| 1886-87 | 7,535 | -- | 226,050 | -- | -- |
| 1937-41 | 1,095 | 137.97 | 18,286 | -- | -- |
| 1943-46 | 14,562 | 393.17 | 38,152 | 1,042,639 | 1,901,797 |
| | 23,192 | 531.14 | 282,488 | 1,042,639 | 1,901,797 |

Surface and underground maps and sections are given. The deposits are in two approximately parallel zones of fissuring, one in andesite, the other in tuff. The Hornsilver-Last Chance zone strikes N 15° E., dips 75°-85° W. in andesite. Intense sericitization extends far into the walls, producing a broad zone traceable on the surface for 2,000 feet.

Silicification occurred along fissures within this zone. The Hornsilver shoot is at the north end of this zone and was mined down the rake for 600 feet. The ore at the bottom is at least as good as in the stopes. Stope lengths averaged 150 feet.

The Ella zone is to the northwest. It strikes N. 30° E. dips 60°-75° W. in tuff. Sericitization was less intense than in the other zone. The zone has been traced for 1,000 feet but mining has been limited. Most of the zone is too low grade to work. Surface and underground maps and sections, with sampling results, are included in the report. Tests indicate that concentration of the ore offers no serious problem.

Rockie, W. A.

1. 1954, Soils and their conservation, in Freeman, O. W., and Martin, H. H., eds., The Pacific Northwest, an overall appreciation, p. 121-148.

Much of this section of the book, The Pacific Northwest, is devoted to a general discussion of soils and their conservation, but the soils of the Northwest, including Idaho, are named and briefly described, with small-scale maps. The principal kinds in Idaho include the Portneuf series, Nez Perce series, Helmer series, Wheeler series, and unnamed series.

Rooney, Lawrence F.

1. 1956, Organic carbon in Phosphoria formation: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 9, p. 2267-2271.

The source of the carbon in the Phosphoria was probably plants. The Phosphoria sea may have been a restricted basin in which the organic matter that sank to the bottom was decomposed by anaerobic bacteria. The $C^{12}/C^{13}$ ratios appear to favor a stagnant water environment for the parent flora. The 10 samples tested are from Montana.

Ross, Clyde Polhemus (and Carr, Martha E. S.)

1. 1941, The metal and coal mining districts of Idaho, with notes on the nonmetallic mineral resources of the state. In three parts in Idaho Bur. Mines and Geology Pamph. 57, 263 p.

This report contains an annotated and cross-referenced bibliography of geologic reports on Idaho through April 15, 1941, with brief descriptions of mining districts, notes on nonmetallic mineral resources and a map showing the mining districts of the state.

_____, (and Forrester, James Donald)

2. 1947, Geologic map of the State of Idaho. Map with sections, index map, no text, scale 1:500,000 or approx 1 in. to 8 miles: U.S. Geol. Survey.
(abs.), Washington Acad. Sci. Jour., v. 30, no. 3, p. 135.

This is an advance notice of the publication of the geologic map of the state, mentions the principal units mapped and lists the principal metals mined in the state, also phosphate.

_____

3. 1947, Geology of the Borah Peak quadrangle, Idaho: Geol. Soc. America Bull. 58, no. 12, pt. 1, p. 1085-1160, geol. maps.

The Borah Peak quadrangle contains parts of two sharply defined narrow ranges of northwest trend, flanked by intermontane valleys. The Lemhi and Swauger quartzites are named and assigned to the Belt series (Precambrian). Certain beds of old but doubtful age assignment in one locality are described. The definitely Paleozoic units in order of decreasing age are the Kinnikinic quartzite (3,000 feet±), the Saturday Mountain formation (500-700 feet), the Laketown dolomite (6,000 feet+), the Jefferson dolomite (1,000 feet +), the Grand View dolomite (2,000 feet+), the Three Forks limestone (20-35 feet), the Milligen formation (1,000 feet±), the Brazer limestone (4,000 feet ±), the Wood River formation (500 feet+). The Challis volcanics (Oligocene or Miocene) constitute the first stratified unit known to have been laid down after Paleozoic deposition ceased but there was a little intrusive activity late in the Mesozoic. They are

locally succeeded by the Donkey fanglomerate (Pliocene?). Quaternary glacial and alluvial deposits are plentiful in valleys. The Belt rocks were broadly folded prior to Paleozoic sedimentation. The Paleozoic rocks were much deformed during two orogenic periods. Most demonstrable normal faults are transverse to the trends of the ranges but along parts of one range normal faults parallel to the range front may have helped guide erosion. The present major topographic features are about in the position occupied by similar features in the early Tertiary although several incomplete erosion cycles coupled with glaciation have modified the topography.

Ross, Clyde Polhemus

4. 1947, Structure of the front of the Bitterroot Range, Montana (abs.): Washington Acad. Sci. Jour., v. 37, no. 10, p. 375; Geol. Soc. America Bull., v. 58, no. 12, pt. 2, p. 1222-1223.

The gneissic rocks of the portion of the front of the Bitterroot Range that borders the long valley in which Hamilton, Mont., is situated have been interpreted previously as the result of crushing along a fault but, instead, they result from injection and replacement of sedimentary rocks by igneous juices related to the Idaho batholith and the range front is a dip slope in beds of the Belt series.

---

5. 1956 (1957), Quicksilver deposits near Weiser, Washington County, Idaho: U. S. Geol. Survey Bull. 1042-d, p. 79-104.

Quicksilver deposits near Weiser were first recognized in 1936 and worked successfully in 1939-43, with resumption of activity in 1955. The deposits are of opalitic type, in Tertiary sedimentary rocks, which have been hydrothermally altered along fractures and zones of tension, mainly under an impermeable cover. Silica and clay minerals formed in several pulses of mineralization, much of the cinnabar being deposited during the last pulse. The principal ore body was in a shallow topographic and structural depression on the crest of a poorly defined anticline.

---

6. 1956, The Belt series in relation to the problems of the base of the Cambrian system, in Rogers, John, ed. El Sistema Cámbrico, su paleogeografiá y el problema de su base, Symposium, pt. 2, Internat. Geol. Cong. 20th, Mexico, p. 683-699.

The Belt series of Montana and Idaho is among the assemblages of sedimentary rocks in the western United States generally supposed to be of late Precambrian age that resembles in degree of metamorphism strata of Paleozoic age. The basin of deposition may have reached from the Arctic Ocean to the Pacific Ocean near southern California. The series consists of thick formations of sombre, mostly fine-grained clastic rocks with subordinate carbonate, volcanic and conglomeratic rocks. Contacts are gradational and lateral variations are common.

Deposition was largely in exceptionally shallow water. The commonly-held belief in an unconformity at the top of the Belt series is only partially supported by available facts. Locally there may be a gradation from Belt into Cambrian rocks and some rocks now mapped as Belt may be of Early Cambrian age. The apparent break may record change in depositional conditions rather than a time gap.

Ross, Clyde Polhemus

7. 1958, The Belt series (Idaho): (abs.) Geol. Soc. America Bull., v. 69, no. 12, pt. 2, p. 1742.

This is a general summary of data on the Belt series, a thick provincial series resting on rocks of Archean type and overlain by strata regarded as of Paleozoic age, widespread in Montana, Idaho, and adjacent regions. The series is divided, in descending order, into the Missoula, Piegan, and Ravalli groups, with apparently older formations locally, not assigned to formal groups. The North Boulder group is recognized locally in Montana.

_____, (and Forrester, James Donald)

8. 1958, Outline of the geology of Idaho: Idaho Bur. Mines and Geology Bull. 15, 74 p.

This paper was prepared as an aid in using the geologic map of Idaho, by the same authors. The stratified units on that map mostly are systemic but larger and smaller subdivisions are used in special cases. Igneous rocks are mapped in as much detail as possible but lack of information has prevented adequate mapping of certain border zones of intrusive masses, notably parts of the Idaho batholith. Each unit shown on the state map is briefly described, which permits more complete explanation of special groupings of rock units than was given on the map legend. The geologic and geomorphic history of the state is outlined and the geomorphic provinces represented are briefly discussed and mapped. The metallic and nonmetallic mineral resources are outlined in their relation to the geologic features shown on the map. Their distribution is shown on a map compiled by C. R. Hubbard. Comments as to the relations between stock raising and farming and geology are given. A glossary of geologic terms and definitions of mineral and rock names used, as well as a table summarizing the formations throughout the state, are added for the benefit of those not specially trained in geology.

_____

9. 1958, Paleozoic seas of central Idaho (abs.): Geol. Soc. America Bull., v. 69, no. 12, pt. 2, p. 1743.

It is customary to suppose that central Idaho was part of a major geosnycline throughout the Paleozoic time. On the contrary, available field data support the concept that the area of the present Idaho batholith has been a positive

block since Precambrian time, comparable to, but seemingly of longer duration, than the geanticline in northern Nevada. Any invasion of the main area of the batholith by marine waters during the Paleozoic was local and brief.

Ross, Reuben James, Jr.

1. 1953, The Ordovician system in northeastern Utah and southeastern Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 22-26.

Gives brief descriptions of the formations and a correlation chart, which does not include central Idaho. The formations in northeastern Utah and southeastern Idaho are the Garden City, (early Ordovician), Swan Peak formation, and Fish Haven dolomite. The lower 150 feet of the Swan Peak contains thin beds of crystalline limestone interspaced in black, flaky shale beds, whereas the upper 190 feet is quartzitic.

Rubey, William Walden

1. 1943, Vanadiferous shale in the Phosphoria formation, Wyoming and Idaho (abs.): Econ. Geology, v. 38, no. 1, p. 87.

The presence of vanadium in the Phosphoria has been known since 1941 and in the two years previous to this report some has been produced. Recently the U. S. Geological Survey has tested many phosphate samples for vanadium, the highest concentrations (0.5-2.0 percent $V_2O_5$) being found in carbonaceous and graphitic(?) mudstone, especially in a single bed, three feet thick.

---

2. 1955, Early structural history of the overthrust belt of western Wyoming and adjacent states, in Wyo. Geol. Assoc., Guidebook, 10th Ann. Field Conf. p. 125-126.

The belt of mountains and overthrusts in western Wyoming is, as it were, a bit of Idaho and Utah thrust eastward. There was a long preliminary stage of geosynclinal sinking and accompanying uplift farther west, a brief climax of deformation, and a closing stage in which the overthrust belt was broken and tilted along faults of Basin Range type. The current interpretation of the geosynclinal stage underestimates the importance of Paleozoic and Mesozoic uplift in the center of the supposed depositional trough. In parts of western Wyoming beds from Cambrian to upper Cretaceous appear to have been derived from the west, rather than the east, which is the conventional view. In Carboniferous through Triassic time, particularly, there appears to have been a barrier, perhaps mountainous, extending northward through central Idaho. The principal upland axis appears to have shifted 150 miles eastward in the late Paleozoic. The persistence and narrowness of these central uplands indicates they were tectonically active. They were a dominant feature of the regional geology through much of the Paleozoic and Mesozoic.

Ruedemann, Rudolph

1. 1939, General paleogeography of North America, in Geologie der erde, Krenkel, Erich, ed., Geology of North America, v. 1, p. 72-87, introductory chapters and geology of stable areas, 1939. Eds., Rudolph Ruedemann 1927-35, Robert Balk, 1936-39, Berlin. Verlag von Gebrüder Borntraeger.

Ruedemann quotes Walcott as to the fresh-water origin of the Belt series. Organic life existed in its lowest form in Archeozoic time as shown by graphite, possible algae, and bacteria in the Ogishke conglomerate of Minnesota. Land may have had lichens and mosses. Paleozoic strata rest on Precambrian with marked and usually angular unconformity. During a long time interval, the interval of Walcott in which the sea was largely withdrawn, terrestrial sedimentation with water-laid deposits, such as the Belt series, collected in fresh water.

Scheid, Vernon E.

1. 1937, Discovery of fossil fish in the Latah formation: Northwest Sci., v. 11, no. 1, p. 74.

Parts of 12 fish skeletons have been found in a roadcut on the north bank of the Clearwater River 11 1/2 miles east of Lewiston, Idaho, associated with fossil leaves. They are considered to belong to Leuciscus.

_____, (and Sohn, Israel Gregory)

2. 1945, Preliminary report, Deary high-alumina clay deposit, Latah County, Idaho: U. S. Geol. Survey, Strategic Minerals Inv. Unnumbered Prelim. Rept., with geol. map.

This is a report of studies by the U. S. Bureau of Mines and the U. S. Geological Survey of the Deary clay deposit in Latah County. The deposit is in the Palouse Hills section of the Columbia Basin province in one of the embayed valleys where Columbia River basalt overlaps the irregular margin of hills composed of pre-Tertiary rocks, including granodiorite (Cretaceous?) and quartzite (Precambrian). Basaltic eruptions from the southwest began in the Miocene and continued into Pliocene time. Continental deposits underlie and interfinger with the flows. These include the clay beds mined in the Deary deposit. The Excelsior surface is recognized, and it and old rocks are covered by residual basaltic and granitic clays which are also mined. Clay was considered ore if it contained over 20 percent available $Al_2O_3$ and below 10 percent available $Fe_2O_3$. Reserves are 10,852,000 long tons of indicated ore, of which 65 percent is sedimentary. The surrounding country may contain additional deposits. Ceramic tests and drill hole data are tabulated.

Scheid, Vernon E.

3. 1947, Excelsior surface, an intra-Columbia River basalt weathering surface (abs.): Northwest Sci., v. 21, no. 1, p. 34.

In the investigation of clay deposits in Washington and Idaho during World War II, a surface within the Columbia River basalt and in part extending over older crystalline rocks adjacent to the basalt was found to be underlain by residual clay up to 124 feet thick, indicating a long period of weathering, free from volcanism. It is suggested that the period of weathering represented by this surface (termed the Excelsior surface) may have been from early Miocene or even Eocene to late Pliocene. Perhaps the basalt flows below and above this surface are sufficiently different from each other to deserve separate stratigraphic names. The surface may extend over 200 square miles. Parts of it were never covered by the later flows.

---

4. 1947, Excelsior surface, an intra-Columbia River basalt weathering surface (abs.): Geol. Soc. America Bull., 58, no. 12, pt. 2, p. 1224-1225.

The existing concept of the Columbia River basalt is that of a series of horizontal lava flows formed during a single period of extrusion with a few feet of residual clay or of clastic deposits formed along the numerous short breaks in extrusive activity. However, up to 124 feet of residual clay, found by drilling, indicate one long period of weathering in which a mature surface, here called the Excelsior surface, was produced. This surface was widespread and may have extended to the Pacific Ocean.

---

5. 1953, Geologic setting of the clay deposits of Latah County, Idaho, and adjacent areas: U. S. Geol. Survey open-file report.

The major clay deposits of Latah County are in a 40-mile zone easterly from the border of Washington to Elk River, mostly along the base of the Thatuna Hills and resting on Columbia River basalt. On the eroded surface of the Belt series volcanic rocks were extruded in late Paleozoic (Permian?) or possibly later time.

In the Cretaceous(?) these were cut by granitoid rocks, which were later exposed and weathered. Eruption of the Columbia River basalt began in the Miocene. It dammed streams and the Latah formation was deposited in the resulting lakes. It consists of granitic and older rocks and is interlayered with basalt. The Excelsior erosion surface formed during a lull in the volcanism, mostly pre-Latah. The Palouse formation is Pleistocene and overlies all older rocks. Many streams are bordered by terrace deposits and flow or alluvium. Ash and loess formed still later. Workable sedimentary clay deposits belong to the Latah formation and were originally covered, at least in part, by lava.

Scheid, Vernon E.

6. 1951, Landslide caused by over-irrigation near Cambridge, Washington County, Idaho (abs.): Geol. Soc. America Bull. v. 62, no. 12, pt. 2, p. 1511.

Extensive irrigation plus moisture from the record snow fall of the previous winter resulted in a landslide in Pleistocene gravel resting on lava. Eighty acres were moved and a house was threatened. It was recommended that irrigation be permanently stopped here or that the house be abandoned.

---

7. 1954, Stockton and Stanley Hill clay deposits, Kootenai County, Idaho: U. S. Geol. Survey open-file report, 24 p.

The Stockton and Stanley Hill deposits contain two types of clay: granitic residual clay, derived from the weathering of Cretaceous granitic gneiss in place; and transported clays of the Latah formation derived from the weathered debris of the granodiorite and older rocks. The Stockton deposits average more than 20 percent available alumina and less than 10 percent available ferric oxide and are therefore a small source of low-grade high-alumina clay. Both Stockton and Stanley Hill deposits contain clays with more than 15 percent available alumina and less than 5 percent available ferric oxide which are of ceramic grade, with some clays possibly suitable for high-heat or super-heat products. Limited amounts of basaltic residual clay are of no economic value.

Data are tabulated from chemical analyses of samples from 162 hand-augered holes from the two deposits, listing ignition loss at 700° C, available alumina, and available ferric oxide. Maps delineate the deposits and indicate the location of sample holes.

_____, (and Hosterman, John W.)

8. 1954, Bovill clay deposit, Latah County, Idaho: U. S. Geol. Survey open-file report, 25 p.

The Bovill deposit contains three types of clays: granitic residual clay derived from weathering of Cretaceous granodiorite in place; basaltic residual clay derived from the weathering of Tertiary Columbia River basalts in place; and transported clays of the Latah formation derived from the weathered debris of the granodiorite and older rocks.

The deposit averages about 22 percent available alumina and four percent available ferric oxide, and therefore could serve as a source of low-grade high-alumina clay. The clays are also suitable for ceramic structural wares such as bricks, terra cotta, and drain tile, and some may qualify for use in high-heat or super-heat products. Maps delineate the deposit and indicate the locations of 14 hand-augered sample holes. Samples from these holes were analyzed for ignition loss at 700° C, available alumina, and available ferric oxide, and the resulting data are tabulated.

Scheid, Vernon E. (Sohn, Israel Gregory, and Hosterman, John W.)

9. 1954, Camas Prairie clay deposits, Lewis and Idaho Counties, Idaho: U. S. Geol. Survey open-file report, 21 p.

The Camas Prairie deposits contain clays of three types: granitic residual clays derived from the weathering of Cretaceous granodiorite in place; basaltic residual clay derived from the weathering of Tertiary Columbia River basalts in place; and transported clays of the Latah formation derived from the weathered debris of the granodiorite and older rocks. The transported clays are potentially usable for high-alumina or ceramic purposes, with from 5 to 10 million tons of clay inferred to be available for aluminum uses. Maps locate the clay deposits and positions of four hand-augered sample holes. The samples were analyzed for ignition loss at 700-800° C, available alumina, and available ferric oxide, and the data are tabulated.

_____, (and Hosterman, J. W.

10. 1954, Canfield-Rogers high-alumina clay deposit, Latah County, Idaho: U. S. Geol. Survey open-file report, 28 p.

The Canfield-Rogers clay deposit is northeast of Moscow, Idaho. It was studied in connection with test drilling by the U. S. Bureau of Mines. It contains 1) granitic residual clay, 2) basaltic residual clay, 3) sedimentary clay belonging to the Latah formation. The deposit averages about 20 percent available alumina and three percent available ferric oxide.

_____, (Sohn, Israel Gregory, and Hosterman, John W.)

11. 1954, Deary high-alumina clay deposit, Latah County, Idaho: U. S. Geol. Survey open-file report, 30 p.

The Deary deposit contains two types of clay: residual clay derived from the weathering of Tertiary Columbia River basalts and transported clays of the Latah formation derived from the weathered debris of granodiorite and older rocks.

The deposit averages 24.9 percent available alumina and 6.1 percent available ferric oxide. This deposit could serve as ceramic clay or as a source of high-alumina clay.

Maps delineate the deposit and indicate the positions of the 26 hand-augered sample holes. Samples were analyzed for ignition loss at 700° C, available alumina, and available ferric oxide, and the data tabulated.

_____, (Hosterman, J. W., and Sohn, Israel Gregory)

12. 1954, Olsen high-alumina and high-iron clay deposits, Latah County, Idaho: U. S. Geol. Survey open-file report, 25 p.

The Olsen deposits contain three types of clays: granitic residual clay derived from the weathering of Cretaceous granodiorite in place; basaltic residual clay

derived from the weathering of Tertiary Columbia River basalts in place; and transported clays of the Latah formation derived from the weathered debris of the granodiorite and older rocks. The high-alumina clays average 24 percent available alumina and four percent available ferric oxide, and the high-iron clays average 22.4 percent available alumina and 17.1 percent available ferric oxide. The high-alumina deposit could serve as a source of low-grade alumina clay and is suitable for ceramic products and possibly high-heat or super-heat duties. The high-iron deposit could serve similar purposes if a cheap method of extracting the ferric oxide was developed.

Two hundred and ninety-five hand-augered sample holes were made, and samples analyzed for ignition loss at 1000° C, available alumina, and available ferric iron, and these data are tabulated. Maps delineate the deposits and locate the sample holes.

Scheid, Vernon E. (Hosterman, John W. and Sohn, Israel Gregory)

13. 1954, Stanford clay deposit, Latah County, Idaho: U. S. Geol. Survey open-file report, 27 p.

The Stanford deposit contains three types of clay: granitic residual clay derived from weathering of Cretaceous granodiorite in place; basaltic residual clay derived from the weathering of Tertiary Columbia River basalts in place; and transported clays of the Latah formation derived from the weathered debris of the granodiorite and older rocks. Only the transported clays contain an average of 24.8 percent available alumina and two percent ferric oxide, rendering them suitable for use in ceramic structural ware such as bricks, terra cotta, and drain tile, and a potential source of available alumina.

Chemical analyses were made from samples taken from 10 hand-augered holes in the area, and the ignition loss at 700° C, available alumina and available ferric oxide data tabulated. Maps delineate the deposit and indicate the location of sample holes.

Schipper, Warren B.

1. 1955, The Tendoy Copper Queen mine: Master's Thesis, Univ. Idaho.

Copper sulphides occur in quartzites of the Belt series and in igneous dikes. The copper veins are replacement deposits in zones of fault breccia near propylite dikes and are classed as mesothermal. The structural features are complex and involve much jointing and faulting.

Schmidt, Dwight L.

1. 1957, Petrography of the Idaho batholith in Valley County, Idaho: Master of Sci. Thesis, Univ. Washington.

This study was undertaken as a background for an investigation by the U. S. Geological Survey, of monazite and euxenite in placers. Detailed petrographic data are given, based on 55 samples of metasedimentary rock and 75 of granitic rock collected over an area of 2,500 square miles in the western and southern

parts of Valley County. Six major rock types are distinguished across the western border and interior of the Idaho batholith. From west to east these are the Council Mountain schist, McCall migmatite, Rock Creek quartz dioritic gneiss, Little Valley leucocratic quartz diorite, Gold Fork granodiorite, Warm Lake quartz monzonite. All contacts are gradational and most zones contain inclusions, mostly schist and calc-silicate granulite. Modal proportions, chemical composition, optic properties, size, shape, and amount of alteration vary systematically from the border to the core of the batholith.

Schmidt says that prevalent hypotheses of the origin of the batholith are: 1) a single intrusion differentiated into a basic marginal rock and a more acidic core, 2) formation by multiple intrusions, of which the marginal phase was early, 3) the second hypothesis modified by endomorphic alteration. He suggests a fourth mode of origin by metamorphic and metasomatic processes, with or without mobilization of the interior core. Monazite and kindred minerals are interpreted as sporadically distributed integral parts of the rock they occur in, and may be pre-granitization minerals of detrital origin.

Schmidt, Dwight L.

2. 1958, Reconnaissance petrography of the Idaho batholith in Valley County, Idaho (abs.): Geol. Soc. America Bull., v. 69, no. 12, pt. 2, p. 1704.

The rocks of the west-central part of the Idaho batholith grade in structure and composition from highly foliated metasedimentary rocks on the west to massive granitic rocks in the interior. Five major belts are distinguished in the area studied. The anorthite content of the plagioclase and the percentages of potassium feldspar, biotite, etc., vary systematically across these belts. In the outer schist belt the metamorphic grade is that of the kyanite zone. The grade increases across the first three zones, then reverts to the kyanite zone farther east. Regional synkinematic metamorphism and progressive granitization are indicated, with the genesis of the interior of the batholith remaining in doubt.

Schmitt, George Theodore

1. 1953, Regional stratigraphic analysis of Middle and Upper marine Jurassic in northern Rocky Mountains-Great Plains: Am. Assoc. Petroleum Geologists Bull. v. 37, no. 2, p. 355-393.

This general discussion of Jurassic stratigraphy gives only incidental attention to rocks in Idaho. The maps show that in Middle and Late Jurassic times sediments accumulated to greater depths in and close to southeastern Idaho than elsewhere and suggest that these rocks once extended west of present exposures in Idaho. These rocks accumulated in a basin that was a major feature of Jurassic time.

Scholten, Robert (Keenmon, Kendall Andrews, and Kupsch, Walter Oscar)

1. 1955, Geology of the Lima region, southwestern Montana and adjacent Idaho: Geol. Soc. America Bull., v. 66, no. 4, p. 345-403, incl. geol. map.

Most of the region covered by this report is in Montana but a little of Clark County, Idaho, is included. Pre-Belt rocks are confined to Montana. Diverse sedimentary and igneous rocks ranging in age from Belt to Recent are present but within Idaho only small areas of the Belt series, the Kinnikinic quartzite (Ordovician), several units of Mississippian age, some Cretaceous strata and rather wide expanses of Tertiary and Quaternary sedimentary and volcanic rocks are mapped. Mesozoic beds are not present near Idaho in the Beaverhead Mountains but cross the boundary near Monida, and Silurian rocks are absent. The Paleozoic strata thicken westward to a maximum of about 10,000 feet. There are several disconformities but angular discordance was noted only at the top of the pre-Belt rocks and at the top and bottom of the Paleocene rocks. There is a transition upward from chiefly marine deposits to dominantly terrestrial rocks starting in the Upper Mesozoic. Most of the strata were deposited on a shelf but the Belt series and the Milligen and Brazer formations were laid down in a geosyncline so the axis or hinge line passes through the mapped area. Most of the marine sediments had sources to the east but the Belt series and the Milligen formation were derived from the west. North-east folds formed in middle Laramide time, followed late in the Laramide by folds and thrusts of northwest trends and still later by normal faults of northwest trends. Some north-east trending streams are antecedent to the normal faults. Three major erosion cycles, with interruptions, are distinguished. These are of middle Tertiary, late Tertiary and Quaternary ages. Two stages of mountain glaciation are recorded.

---

2. 1957, Paleozoic evolution of the geosynclinal margin north of the Snake River Plain, Idaho-Montana: Geol. Soc. America Bull., v. 68, no. 2, p. 151-170.

The hinge belt between the Paleozoic Rocky Mountain geosyncline of central Idaho and the cratonic shelf in Montana is regarded as critical with respect to stratigraphic changes. It appears to have been recurrently uplifted during the Paleozoic. In early Paleozoic time broad uplift is thought to have affected part of the site of the Beaverhead Mountains. The hinge belt is regarded as a zone of weakness along which a prominent belt of thrusting developed in the Laramide revolution. A stratigraphic correlation table for Paleozoic rocks and five isopach maps are given. Angular unconformity between the Belt series and the Kinnikinic quartzite is reported in the Beaverhead Range.

Scholten, Robert

3. 1957, Preliminary interpretation of Permo-Carboniferous stratigraphy in east-central Idaho (abs.): Geol. Soc. America Bull., v. 68 no. 12, pt. 2, p. 1794.

There are complex facies changes in the Permo-Carboniferous strata between the eugeosyncline of central Idaho and the miogeosyncline near the Montana border. In southwestern Montana the sequence includes Madison limestone (up to 2,000 feet), Big Snowy and Amsden limestone and fine clastics (1,000 feet) and Quadrant quartzite (up to 3,000 feet). In the Bayhorse quadrangle, Idaho, the Carboniferous comprises Milligen shale (3,000± feet), mostly Mississippian and Wood River sandstone (8,000± feet), partly Pennsylvanian. In the Lemhi and Beaverhead ranges Milligen equivalents are thin to absent and an arch is postulated. The shaly Lodgepole (lower Madison) probably interfingers with the lower Milligen. Between the Bayhorse quadrangle and the Montana border the Milligen is overlain by thousands of feet of so-called Brazer limestone, much of which appears to be of Pennsylvanian and Permian age. This is interpreted as a carbonate wedge that deserves a new name.

Schuchert, Charles

1. 1939, The greater structural features of North America, the geosynclines, borderlands, and geanticlines, in Geologie der Erde Krenkel, Erich, ed., Geology of North America v. 1, introductory chapters and geology of the stable areas, p. 56-71, Eds. Rudolph Ruedemann, 1927-35, Robert Balk, 1936-39, Berlin, Verlag von Gebrüder Borntraeger.

Most of the geosynclines, and more certainly the larger and better known ones of North America, originated in the Proterozoic. In Proterozoic the continent had at least 6 primary geosynclines (1) the western trough, beginning in the Arctic Ocean and terminating in the Pacific Ocean, (2) the Sonoran or southwestern extension (ends at Bay of Baja, California), (3) Ontarian which united in the southwest with the Sonoran extension and in the northeast may have gone unbroken, into (4) Belcher and (5) Labrador troughs, (6) Eastern transformed into mountains (Penokean or Killarney, Belcher and Labrador) in late Proterozoic. Only the eastern and western ones persisted into Paleozoic times. The primary western geosyncline gave rise toward the close of Proterozoic to the central Cordilleran geanticline with a narrow primary Pacific geosyncline on the west and a wider sequent Cordilleran geosyncline in east. The latter begins with Lower Cambrian time and goes to Middle Mississippian. Maps show it includes much of western geosyncline. The continent was originally larger than now. Greater North America was established in Proterozoic time and possibly early in that era as the two main geosynclines (east and west) appear to have been present at least since late Proterozoic.

---

2. 1955, Atlas of paleogeographic maps of North America: New York, John Wiley and Sons, 177 p.

This series of 84 paleogeographic maps shows the author's final ideas as to the distribution of seas in North America at various times in the geologic past. According to the maps the earliest Cambrian seas did not enter Idaho. Later seas reached into the northern and southeastern parts of the state and by Middle Cambrian time these had joined. Late in Cambrian time some retreat occurred. During much of Ordovician time seas were present in parts of northern and southeastern Idaho only. By the later part of Middle Ordovician time seas had retreated but late in Late Ordovician time they advanced along the eastern margin. Seas were absent during much of the Silurian but entered southeastern Idaho during part of the Middle Silurian. They were absent during Early Devonian time but covered parts of the state during the Middle and Late Devonian, retreating again at the beginning of the Mississippian. However, parts of the state are shown as submerged during much of the Mississippian, Pennsylvanian, and Permian, with fluctuations. Southeastern Idaho was submerged during much of Triassic time, but, except along the extreme western border of the state Upper Triassic deposits are nonmarine. Some marine deposition occurred late in the Jurassic and again late in the Cretaceous, mainly in southeastern Idaho. Volcanic activity is recorded for Paleocene and early Eocene time, and again for Pliocene time.

Scott, R. C.

1. 1955, Ground-water supply possibilities in parts of Bear Lake and Caribou Counties, Idaho: U. S. Geol. Survey open-file report, 27 p.

Bear Lake valley is a broad depression in central Bear Lake County, in part occupied by Bear Lake, in part by irrigated farm land. It is a downwarped and faulted depression between hills of folded Cretaceous and older rocks. In Cenozoic time there may have been alternate periods of erosion and deposition, often controlled by climatic changes and interrupted by minor warping and volcanism. The valley contains younger alluvium (500-800 feet), lake beds, about 20 feet, older alluvium (0-100 ft.), Salt Lake formation (0-1,000 ft.) Wasatch formation, (0-1,500 ft.), and older rocks. The younger alluvium is the principal aquifer and some wells in it show artesian pressure. Deep water appears to be of better quality than that from shallow wells. The ground water capacity appears adequate, even in drought years.

Sears, Richard S.

1. 1955, Phosphate deposits in the Caribou Range, Bonneville County, Idaho (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1680.

Phosphate deposits in the Caribou Range, east of Idaho Falls, are on the flanks and crest of the north-west trending Snake River anticline, in the Phosphoria formation, about 190 feet thick, of which the lower phosphatic member is 55 feet thick and the Rex chert is 135 feet thick. The high-grade phosphate rock at the top of the shale member is 1 1/2-10 1/2 feet thick and comprises four rock types.

Seavy, L. M.

1. 1948, Sedimentation survey of Arrowrock reservoir: U. S. Bur. Reclamation Sedimentation Sec. Rept.

This report primarily concerns sedimentation in Arrowrock reservoir on the Boise River and concludes that the sedimentation rate has been low. The report notes that about 90 percent of the 2,170 square miles of the drainage area of the reservoir is underlain by the Idaho batholith, and over 230 miles are covered by Snake River basalt. About 10 square miles are covered by Recent basalt. Alluvial deposits cover one percent of the area. A small amount of silicic volcanic rock was noted near the head of Willow Creek. Near the head of Little Smoky Creek is a small area of Carboniferous sedimentary rocks bordered on the north by basalt of Columbia River type. These geologic features are mapped on Fig. 1, a reconnaissance map of the watershed.

Sharp, William N. (and Cavender, Wayne Sherrill)

1. 1953, Thorium deposits of the Lemhi Pass district, Lemhi County, Idaho, and Beaverhead County, Montana (abs.): Geol. Soc. America Bull. v. 64, no. 12, pt. 2, p. 1555.

Quartz veins, some with thorite, occur over a 10-square-mile area in the Beaverhead Mountains near Lemhi Pass, cutting the Belt series. Dioritic dikes are the only intrusives. Olivine basalt to rhyolite porphyry flows (Tertiary) are probably younger than the dikes. The veins range from a few inches wide and 100 feet long to 30 feet wide and several hundred feet in length. They include (1) those with copper sulfides, (2) those with hematite, (3) those with barite, hematite, and thorite, (4) those with copper sulfides and thorite. The thorium content in types 3 and 4 is 0.1-2.0 percent, averaging less than 1.0 percent. The thorite veins are associated with the dikes.

Shaw, Walter

1. 1948, Seeking sand in Idaho: The Compass, v. 26, no. 1, p. 58-67.

This is a travelogue of W. W. Staley's field studies in the summer of 1947 mainly in search of data on monazite. It is written by his assistant and contains little of geologic interest.

Sheldon, Richard Porter (and others)

1. 1953, Stratigraphic sections of the Phosphoria formation in Idaho, 1949, pt. 1: U. S. Geol. Survey Circ. 304, 30 p.

This is one of a series of progress reports. Seven stratigraphic sections are tabulated, plus analytical data.

Sheldon, Richard Porter

2. 1954, Geology of the Phosphoria formation in Wyoming and east-central Idaho in Geologic Investigation of radioactive deposits; Semiannual prog. rept., June 1 to Nov. 30, 1954, U. S. Geol. Survey Trace Elements Inv. Rept. 490, p. 192-193.

Three sections were measured, one at Mahogany Ridge. Correlation of the Rex chert in these areas was substantiated. The upper part of the phosphatic shale changes facies from mudstone and chert in Idaho to chert at Flat Creek, Wyo. A previously unknown horizon of phosphate rock was found in the upper part of the Rex in the section in Idaho. Some phosphorite pellets formed diagenetically.

Shenon, Philip John

1. 1942, Bedding vein deposits near Murray, Idaho, in Newhouse, W. H., ed., Ore deposits as related to structural features, p. 159-160.

The district contains gold-tungsten veins that lie along bedding planes in thinly laminated argillite belonging to the Prichard formation. Some are on pitching minor folds. Several stages of mineralization and of fracturing are represented. The minerals were deposited in the following sequence: albite, quartz, scheelite, quartz, ankerite, sericite, specularite, pyrite and arsenopyrite, sphalerite, chalcopyrite, galena and gold. The thickest and best ore bodies are localized, generally, above quartzite beds, and apparently were determined by open spaces near the crests of pitching folds.

_____, (and Reed, John Calvin)

2. 1942, Veins in the Elk City district, Idaho, in Newhouse, W. H., ed., Ore deposits as related to structural features, p. 175-176.

The ore bodies are in a system of fissure veins, mostly in banded gneiss and schist with some augen gneiss and quartzite, adjacent to part of the Idaho batholith. They are radial to the curving contact of the batholith in a zone 2 miles by 2 miles and nearly normal to the linear elongation in the gneiss and hence apparently related to the tension or Q joints. Lenses of quartz formed in openings in the veins were later fractured along certain zones and gold and sulphides deposited in the fractures.

The banded gneiss, schist and quartzite are believed to be metamorphosed parts of the Belt series, with a northwesterly regional trend. The augen gneiss is in bodies transverse to this trend and may represent igneous rock intruded prior to the development of foliation. The internal structure in the augen gneiss conforms to that of the surrounding rocks.

---

3. 1948, Lead and zinc deposits of the Coeur d'Alene district, Idaho, in Dunham, K. C., ed., Symposium on the geology, paragenesis and reserves of the ores of lead and zinc, Internat. Geol. Cong., 18th,

London, p. 78-80; (abs.): Volume of titles and abstracts p. 50, 1948.

The mines of the Coeur d'Alene district are in an area 25x15 miles with the world's greatest silver producers at its southern end. The ore bodies follow well-defined fractures or shear zones in the Belt series. Intrusive rocks include monzonite stocks, diabase, and lamprophyre dikes. The common minerals include galena, sphalerite, tetrahedrite, chalcopyrite, pyrrhotite, magnetite, and arsenopyrite with gangue of quartz, siderite, and other carbonates, locally barite. The mineralization is accompanied by bleaching of the adjacent rock due to the development of sericite, clay minerals and carbonates. The deepest mine then exceeded 4,000 feet.

Shockey, Philip Nelson

1. 1957, Reconnaissance geology of the Leesburg quadrangle, Lemhi County, Idaho: Idaho Bur. Mines and Geology Pamph. 113, 42 p.

The Belt series is represented by 35,000 feet of metamorphosed rocks, in two units, phyllite and gray quartzite, overlain unconformably by 4,000 feet of Kinnikinic quartzite (Ordovician). The Precambrian rocks were warped during a disturbance of inferred Ordovician date. In the late Mesozoic a reverse-faulted syncliniorum trending N. 45° W. was formed. Later, and after dynamic metamorphism, apophyses of the Idaho batholith were emplaced, marginally by igneous metamorphism. In the Tertiary alternate erosion and deposition produced erosion surfaces, early conglomerate, Challis volcanics, lake beds, and late ash. The pre-Challis surface had a regional relief of several thousand feet. In the middle Tertiary the Challis volcanics were warped into a gentle, N. 45° E. anticline. A late mature erosion surface formed in the Pliocene. Pre-Wisconsin and Wisconsin glacial deposits are present. Pre-Challis drainage was southeastward to the Salmon River near Williams Creek but lake bed drainage was southwest.

Deposits of cobalt, copper, radioactive rare-earth metals, gold, tungsten, lead, and silver are present. The gold placers are of Wisconsin and later age. Opalized wood is an important product. Lode output in 1901-54 has been 1,146 oz. Au, 5,822 oz. Ag, 28,217 lb. Cu, 113.836 lb, Pb. Placer output was 7,635 oz. Au, 589 oz. Ag. One copper mine has been recently active. The lode deposits may be of mid-Tertiary age.

---

2. 1957, Reconnaissance geology of the Leesburg quadrangle, Lemhi County, Idaho (abs.): Dissert. Abs., v. 17, no. 12, p. 2980.

Metasedimentary rocks of the Belt series, about 35,000 feet thick crop out over nearly two-thirds of the Leesburg quadrangle and are unconformably overlain by about 4,000 feet of Kinnikinic metaquartzite. There was a progressively shallowing Belt sea with a possible westerly source for the sediments. The Kinnikinic is a basal sand deposited during northeasterly transgression of a shallow Ordovician sea. The Belt series was warped during the pre-Middle Ordovician disturbance, here termed the Skull Canyon disturbance, following Scholten. Late

in the Mesozoic a reverse-faulted syncliniorum of N. 45° W. trend formed. Later apophyses of the Idaho batholith were emplaced. Considerable portions of these are products of igneous metamorphism. Alternate erosion and deposition in the Tertiary resulted in erosion surfaces, conglomerate, Challis volcanics, lake beds, and ash. The Challis volcanics are in a gentle anticline trending N. 45° E. A mature erosion surface formed in the Pliocene. Pre-Wisconsin and Wisconsin drift are separated by 1,000 feet of canyon cutting. Mineral deposits include cobalt, copper, gold, tungsten, lead, silver, and rare-earth minerals. They range in age from late Mesozoic to middle Tertiary. Gold placers are Wisconsin and younger. Opalized wood is valuable.

Shuter, Eugene

1. 1953, Records of wells and water-level fluctuations in western Bingham County, Idaho: U. S. Geol. Survey duplicated rept., 99 p.

Data for the 900-sq.-mi. area include 207 well records, four test-hole logs, 12 well logs, and discharge measurements.

Sidler, Aubrey Gene

1. 1957, The origin of heavy minerals in the Boise Basin, Idaho: Master's Thesis, Univ. Idaho.

Faulting and differential uplift resulted in the formation of basin depressions and steepened stream gradients, causing deep erosion on the flanks of the basins. Twenty-three of the twenty-eight heavy minerals found in the placer deposits were identified in thin sections of the quartz monzonite and diorite. The origin of the heavy minerals is discussed.

Simons, Wilbur O. Douglas (and others)

1. 1953, Spokane-Coeur d'Alene River basin, Wash.-Idaho, Chap. 10, Subsurface facilities of water management and patterns of supply--type area studies, in The physical and economic foundation of natural resources: U. S. Cong., House Comm. Interior and Insular Affairs, v. 4, p. 162-185.

Volume 4 of this general report on natural resources contains summaries of the water situation in numerous type areas. Chapter 10 describes one such area that lies in part in Idaho. This is a segment of the Columbia River basin and the Pacific Northwest. It is one of the more humid parts of the United States, but much of the precipitation is snow. The area has a wide diversity in climate, topography, geology, land use, and water yield. A major use of water is for generating power. Forests cover 75 percent of the basin, growing mainly on well-consolidated rocks of relatively low permeability. Most of the rest of the basin is less rugged and used for dry farming and grazing. Yearly precipitation ranges from 12 inches on the west to at least 70 inches annually in the mountains in the eastern part of the basin. The snow in the mountains gives rise to

extreme spring runoff. Tables and graphs summarize various data relative to water losses, uses, floods, etc., in the basin. The water supply is adequate but proper regulation presents problems. Much now escapes use.

Sisco, Harold C.

1. 1954, Records of wells, water-level fluctuations, and ground-water withdrawals in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho: U. S. Geol. Survey duplicated rept., 50 p.

Data for the 275-square-mile area include 78 well records, 24 well logs, water-level measurements, and a summary of ground-water withdrawals in 1953, with a summary of pertinent geologic data for the area.

---

2. 1955, Records of wells and water-level fluctuations in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho, in 1954: U. S. Geol. Survey open-file report, 31 p.

Tables of water level recordings for 1955 in this area, and a map showing the location of wells in which observations were made. This is the third in a series of annual reports starting with that for 1953.

---

3. 1955, Records of wells and water-level fluctuations in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho, in 1954: U. S. Geol. Survey duplicated rept., 30 p.

Data include records of 28 observation wells and periodic water-level measurements.

---

4. 1956, Water levels in observation wells in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho, in 1955: U. S. Geol. Survey open-file report, 32 p.

This is a progress report. It lists data on water-level measurements in 25 wells, recording gages in 6 wells, and drilling of three observation wells.

Skipp, Betty Ann Lindbergh

1. 1958, Significant sedimentary features in Mississippian rocks in Custer County, Idaho (abs.): Geol. Soc. America Bull., v. 69, no. 12, pt. 2, p. 1744.

This describes a small area in the Mackay quadrangle in which limestone with intercalated clastic rocks, 9,000 feet thick, of Mississippian age was studied

in detail. These rocks result from normal marine deposition simultaneous with emplacement of originally fluviatile gravel modified by marine currents in a marginal miogeosynclinal environment with gradual shoaling of the seas.

Sloss, Laurence Louis

1. 1950, Paleozoic sedimentation in Montana area: Am. Assoc. Petroleum Geologists Bull., v. 34, no. 3, p. 423-451.

Isopach maps for longitude 99-120°, latitude near 43° to 53°, include much of Idaho. Maps for the Cambrian and Ordovician systems imply great thicknesses in Idaho; the same for the Silurian. A map showing pre-Middle Devonian paleogeology shows much Silurian in central Idaho, surrounded by Ordovician which goes almost to the western boundary in latitude 43°-45° and crosses that boundary farther north. Precambrian rocks are indicated west of the Ordovician. Cambrian rocks stop along the Montana boundary. One map shows Devonian rocks 5,000 feet thick about longitude 113°, latitude 43°, thinning both ways from there. Thus the thick area is conveniently in the Snake River Plain with northwestward extension into an area free from known Devonian rocks. Thicknesses of 2,000 feet of Lower Mississippian strata are indicated about latitude 46°30' in Idaho, where there are no Paleozoic rocks and none in the area where the Milligen (Lower Mississippian) is reported as about 3,000 feet thick. Similarly Upper Mississippian strata are indicated as 7,000 feet thick in the Snake River Plain, longitude 113°± latitude 43°±, and thinning from there northward, where such rocks are thick. The Pennsylvanian is shown in somewhat similar fashion, with a narrow zone of no deposits near the eastern border of the Idaho batholith. Permian rocks are shown extending across central Idaho, consisting of volcanic material in the western part.

The discussion of tectonic controls and of the position and character of geosynclinal sediments is directed mainly at conditions in Montana and Wyoming but overlaps into Idaho.

---

2. 1951, The Central Montana uplifts in relation to Late Mississippian stratigraphy, in Billings Geol. Soc., 2nd Ann. Field Conf., p. 64-66.

This includes two maps showing isopachs and facies from base of Kibbey sandstone to base of Pennsylvanian rocks. These extend into Idaho and show a northeast axis for isopachs. The term "Brazer" is not used.

---

3. 1954, Lemhi arch, a mid-Paleozoic positive element in south-central Idaho: Geol. Soc. America Bull., v. 65, no. 4, p. 365-368.

A measured section of strata of early Paleozoic age in the southern part of the Lemhi Range is given and the inference is made that a positive element, the Lemhi arch, was active in what is here called the western part of the south-

central Idaho area in Middle and Upper Devonian time. By this designation part of the Lemhi Range appears to be meant.

Sloss, Laurence Louis

4. 1955, Progress and promise in Rocky Mountain exploration, in Am. Assoc. Petroleum Geologists Rocky Mtn. Sec., Geol. record, p. 11-36.

The history of exploration in the Rocky Mountain region comprises five episodes, each dominated by a particular set of guiding principles. There remains an encouraging field for an expanding exploration program. Nine tectonic maps that include Idaho and show major stratigraphic features are presented and briefly discussed. In Cambrian through Early Ordovician time the whole state was under deposition with a major depression from the southwest corner of the state northeast across central Idaho and another turning west of north across the northern tip of the state. In Middle Ordovician through Early Devonian time submergence is depicted as continuing through most of the state with major depressions in the eastern part of south-central Idaho and near the boundary between northern Idaho and northeastern Washington. The Middle Devonian through Middle Mississippian sequence is interpreted as showing eugeosynclinal conditions in eastern Washington and Oregon and adjacent parts of Idaho, a major trough of northeast trend from northeastern Nevada across the southeastern part of south-central Idaho and submergence over most of the rest of the state. One map shows most of the state in a "black shale basin". In Late Mississippian through Early Jurassic time the eugeosyncline is shown as having spread eastward farther into Idaho. It is bordered by a sinuous trough and the trough in south-central Idaho is still of northeasterly trend but not extending into Nevada. Another deep depression in Utah reaches into southeastern Idaho. The isopachs on one map suggest that most of Idaho received thick Pennsylvanian deposits, many with high proportions of sand with a deep depression in southeastern Idaho.

_____, (and Hamblin, Ralph Hugh)

1. 1942, Stratigraphy and insoluble residues of Madison group (Mississippian) of Montana: Am. Assoc. Petroleum Geologists Bull., v. 26, no. 3, p. 305-335.

The Madison group, as the term is here used, comprises the Mission Canyon limestone at the top and the Lodgepole limestone below, the latter being subdivided into two members, of which the lower contains much black shale. The Madison group was deposited in a large basin that extended eastward from the Cordilleran trough. An isopach map shows that the Madison is present in southeastern Idaho. Otherwise the paper contains no direct reference to Idaho.

Smart, Ross A. (and others)

1. 1954, Stratigraphic sections of the Phosphoria formation in Idaho, 1950-51: U. S. Geol. Survey Circ. 327, 22 p.

This is one of a series of progress reports. Seven stratigraphic sections are tabulated, plus analytical data.

Smedes, Harry Wynn

1. 1958, Interpretation of geologic structure of western Montana and northern Idaho (abs.): Geol. Soc. America Bull., v. 69, no. 12, pt. 2, p. 1745.

A trough marking a major crustal block in western Montana has affected sedimentation since Belt time and influenced Laramide deformation. The Boulder and Philipsburg batholiths and an eastern salient of the Idaho batholith are restricted to this trough; its northern boundary, marked by folds and thrusts, lies on strike with the straight northern edge of the Idaho batholith. Thrust belts bulge eastward within the trough. A wedge pattern of northwesterly faults in Idaho forms an apparent apex near Missoula. It is deduced that in the Laramide orogeny the supracrustal rocks of the trough (and perhaps the crustal block itself) moved eastward producing a left lateral tear zone along the northern border which may have localized the northern contacts of the Idaho batholith and the eastward deflections of the Lewis-Lombard and Philipsburg belts of deformation.

Smedley, Jack E.

1. 1948, The stratigraphy of part of the Lemhi Mountains, Idaho: Master's Thesis, Univ. Idaho.

A basement of metamorphic rocks is unconformably overlain by 5,490 feet of Cambrian(?), Ordovician, and Mississippian sediments. Limestones, shales, dolomites, and quartzites are described in detail and dated on the basis of lithologic similarities, stratigraphic position, and fossil identification.

Smith, Helen V.

1. 1940, Notes on the systematic and ecological implications of the Miocene flora of Sucker Creek, Oregon and Idaho: Am. Midland Naturalist, v. 24, no. 2, p. 437-443.

The area is in Malheur County, Oregon, and Owyhee County, Idaho, and some 58 species of fossil plants are recognized. These belong to 37 genera, of which 23 now occur in the west, three are now confined to Asia, and others grow in eastern America. The Thorn Creek flora is different from that of the Sucker Creek area. In the latter the physical and climatic conditions during growth were not unlike those of the low hills of northern California and southern Oregon or the rolling regions of southern Michigan. The rainfall was 30-40 inches annually, with no prolonged summer dry spell.

---

2. 1941, A Miocene flora from Thorn Creek, Idaho: Am. Midland Naturalist, v. 25, no. 3, p. 473-522.

Roadcut and landslide exposures along Thorn Creek on the southern edge of the Boise Basin have yielded many plant fossils. Sixty-four species identified from

2,010 specimens are listed. The aspect of the flora is modern and includes species living in the eastern United States, the Rocky Mountains, and along the Pacific coast and in the southwest. No eastern Asiatic element is present. The age is regarded as late Miocene. The flora indicates a considerable range in altitude, from lowland swamps to uplands above 5,000 feet. Hence the flora grew in an area of marked relief. The general aspect of this flora is distinctive but is more like that of the Latah, the upper Cedarville of Nevada and California and the Eagle Creek of the Columbia River gorge than any others. Systematic descriptions of the species are given.

Smith, Neal Johnstone

1. 1953, Tertiary stratigraphy of northern Utah and southeastern Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., 1953, p. 73-77.

This is a descriptive paper in which Salt Lake group, Wasatch group, and early Eocene and Paleocene are made to include all the Tertiary sediments in southeastern Idaho and the lavas are Snake River basalt and unnamed silicic rocks (Oligocene and Miocene?). The early Tertiary conglomerate, sandstone, and shale of northern Utah and southeastern Idaho are correlated with the Wasatch group of Veatch (1907) in Utah.

Sohn, Israel Gregory

1. 1952, Geologic environment map of alumina resources of the Columbia Basin: U. S. Geol. Survey Mineral Inv. Res. Appraisals Map MR 1, scale 1:1,500,000 (about 1 in. to 24 mi.) with text.

The main map shows (1) areas known to contain deposits of high-alumina clays and similar materials, (2) areas in which sedimentary deposits of high-alumina clay may occur, (3) areas in which such clays derived from weathering of granitic rocks may occur, (4) areas in which high-alumina clay and laterite derived from weathering of basalt may occur. Two small locality maps for certain clays and one showing electric transmission lines are given. In the text 11 occurrences in Idaho are described. These are in Kootenai, Latah, Benewah, and Nez Perce Counties. There is a geologic cross section and diagrams showing distribution of potential alumina ore reserves. In the Columbia Basin 40 percent are in Idaho.

---

2. 1952, Industrial clays, other than potential sources of alumina, of the Columbia Basin: U. S. Geol. Survey Circ. 158, 18 p.

This report is a summary of available literature on clays of relatively low aluminum content in the Columbia Basin. Deposits of bentonite, brick and tile pottery, and slip clay are listed in the table that constitutes the main part of the report. In Idaho such clays are noted in Ada, Adams, Bannock,

Bear Lake, Benewah, Boise, Bonner, Bonneville, Canyon, Cassia, Elmore, Franklin, Fremont, Gem, Idaho, Kootenai, Latah, Lewis, Nez Perce, Payette, Power, Twin Falls, Valley, and Washington Counties, but Latah County is the only one in which more than three deposits are tabulated.

Sorenson, Robert E.

1. 1947, Deep discoveries intensify Coeur d'Alene activities (Idaho): Eng. Mining Jour., v. 148, no. 10, p. 70-78.

The geology of the Coeur d'Alene region is outlined and comments on a number of mines given. The article emphasizes that the region has sustained a continued and expanding production over a long period because of repeated discoveries at depth.

---

2. 1948, Silver Summit (Coeur d'Alene area, Idaho) opens rich ore (adapted from a paper presented before the Idaho Mining Assoc. Sun Valley, Idaho): Eng. Mining Jour., v. 149, no. 7, p. 70-73, 151.

The discovery of a rich ore body at a depth of 4,400 feet in the Silver Summit mine in the Silver Belt of the Coeur d'Alene region is noted and the ore body is described. Other recent activity in the area is mentioned.

The best places to look for ore bodies in the district are near anticlinal crests and large faults within bleached zones in the Belt rocks. Points where veins cross folds or warps, are themselves warped, approach strong faults or where those not in strongly bleached zones enter such zones are all favorable for prospecting.

---

3. 1951, Shallow expressions of Silver Belt ore shoots, Coeur d'Alene district, Idaho: Mining Eng., v. 3, no. 7, p. 605-611; AIME Trans. 1951, v. 190, 1952.

In the Silver Belt veins that crop out tend to be of slight value and to consist largely of quartz and pale carbonate. Rich ore shoots may be buried thousands of feet beneath the present surface. Their carbonate is siderite. An early chloritic alteration in broad zones is followed by later sericitization and removal of coloring matter. Most, but not all, of the good ore is in these bleached zones. Many almost barren veins in the shaly Wallace formation contain rich shoots shortly after entering the brittle, friable quartzite of the underlying St. Regis formation. Structural features of the veins are also guides. These include crossings of folds or warps in the country rock, warps in the veins themselves, approach to prominent pre-ore faults.

Squires, D. F.

1. 1956, A new Triassic coral fauna from Idaho: Am. Mus. Novitates, pub. by Am. Mus. Nat. History, no. 1797.

First collections were made by Williams and Reed, U. S. Geological Survey in 1936. These were visited by N. D. Newell of the American Museum, who got the corals reported on here. The outcrop is just above a limestone quarry on east side of Mission Creek in Lapwai Indian Res. Nez Perce County. An inlier of meta-limestone under lava may be a roof pendant in Idaho batholith. Age is Norian (Triassic). Fossils show only on weathered surfaces. Corals are silicified, imperfectly. A dozen corals and two questionable ones are listed. Associated with the corals are gastropods, pelecypods and sponges, Bryozoa, cidaroid, echinoids, and brachiopods.

Probably these represent a shoal or bank, not a reef.

Staley, William Wesley

1. 1945, Coal in Idaho: Idaho Bur. Mines and Geology Mineral Res. Rept. 1, 4 p.

The report deals mainly with the Driggs area, Teton County, but the Willow Creek-Caribou district, 25 miles southeast of Idaho Falls, and the Continental Divide district near Kilgore, Clark County are also mentioned. All three are in the Frontier formation (Upper Cretaceous). The coal field near Driggs has been called the St. Anthony, Teton Basin, and Horseshoe Basin field. The last name is preferred. The coal beds are one to 9 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.

---

2. 1946, Gold in Idaho: Idaho Bur. Mines and Geology Pamph. 68, 32 p., incl. geol. maps.

This is a general summary aimed at promoting the production of gold in Idaho when that industry is able to resume. Gold is supposed to have been first discovered in 1860 at Pierce, Clearwater County, and many of the districts now known were found soon after this. The early history of Alturas (now in part Elmore), Boise, Custer, Idaho, Lemhi, Owyhee, and Washington Counties is outlined, illustrated by maps from P. J. Scott's report of 1882. Production tables are given. The total production of gold since 1900 is 2,575,888 oz., of which 1,026,198 ounces came from placers. Descriptions of gold districts in each of the present counties that contain them are given. These consist largely of production figures and outline geologic maps.

---

3. 1946, Fine gold of Snake River and lower Salmon River, Idaho: Idaho Bur. Mines and Geology Pamph. 72, 11 p.

The presence of gold along the Snake River and Salmon River was recognized early but active mining did not begin until 1871. Almost from the Snake River source in Wyoming to its junction with the Columbia in Washington placer

operations have been undertaken at various times. A table showing that the range in gold value (at the price of $20.67 per ounce) in black sand concentrates ranges from $537 to $1,154.57 per ton is given. The table records the presence of platinum in two places. Most activity along the Salmon River has been between Riggins and Whitebird. A table, totalling 99,832 ounces, gives the estimated production from Snake River by counties. It is suggested that old auriferous channels may be buried in the Snake River basalt and could be looked for by geophysical methods. The placer gold along the Salmon has a fineness of 850 or less, that of the Snake averages about 950. A table showing areas along the Snake where mining has been done is given. The paper closes with a discussion of mining and treatment.

Staley, William Wesley

4. 1948, Distribution of heavy alluvial minerals in Idaho: Idaho Bur. Mines and Geology Mineral Res. Rept. no. 5, 12 p.

The minerals in alluvial deposits 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 is small. Tables indicating the proportions of the principal minerals in placer deposits in Idaho are given, also a map showing distribution. A large prospective tonnage of monazite, zircon, and ilmenite is available.

---

5. 1950, Pumice and perlite in Idaho: Idaho Bur. Mines and Geology, Mineral Resources Rept., no. 6, 10 p.

The manufacture of light-weight aggregate units using pumice and Portland cement has become substantial in southern Idaho, at Idaho Falls, Jerome, Boise, etc. The gross value in 1949 was $2,500,000. Methods of manufacture are outlined. Among the pumice deposits are one 7 miles south of the intersection of Highways 95 and 20 out of Marsing, in Owyhee County, another near Fairfield, Camas County, another near Hollister, Twin Falls County, another near Rockland, Power County, others near Ammon south of Idaho Falls, another north of Magic Reservoir, Blaine County, and one near Tetonia, Teton County. Deposits of perlite have been little more than prospected as yet. They are known in Owyhee County, Blaine County, Twin Falls County, etc.

---

6. 1952, Monazite in Idaho: Compass, v. 29, no. 4, p. 302-312.

This is similar to Staley's Mineral Resources Rept. no. 5 but has some more recent production figures.

Staley, William Wesley (and Browning, James S.)

7. 1949, Preliminary investigation of concentrating certain minerals in Idaho placer sand: Idaho Bur. Mines and Geology Pamph. 87, 23 p.

The minerals of possible commercial value in Idaho black sands include monazite, magnetite, ilmenite, zircon, and garnet. Methods of treatment are discussed.

_____, (and Prater, Lewis Seward)

8. 1945, Sulphur in Idaho: Idaho Bur. Mines and Geology Mineral Res. Rept. no. 2, 7 p.

Sulphur deposits near Soda Springs, Caribou County, have been known since 1872, in a fault breccia composed of tuff, limestone, and quartzite. Past reports have indicated the presence of 1,000,000 tons containing 10 percent sulphur, but attempts to mine have failed. In the future, development may be successful.

Stearns, Harold Thornton

1. 1951, Outcrops of Payette formation along Snake River near Hagerman, Idaho: Geol. Soc. America Bull., v. 62, no. 9, p. 1149.

An outcrop, 40 feet square, of firmly cemented sandstone with scattered pebbles in SW 1/4, sec. 29, T. 8 S., R. 14 E., Twin Falls County, is thought to belong to the Payette. It is in an area previously mapped by Stearns as a fault complex of Hagerman lake beds and Banbury-type basalt.

_____

2. 1952, Bedding-plane faults at Cabinet Gorge dam, Bonner County, Idaho (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, p. 1371.

Minor bedding plant faults in the Striped Peak formation caused difficulty with the dam foundation and required replacement of much otherwise sound rock with concrete.

_____

3. 1952, Unusual gravel at the Strike dam, Elmore County, Idaho (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, p. 1372.

Excavation at the Strike damsite revealed well-rounded pebbles, cobbles, and boulders of clay up to 12 feet across scattered among quartzite and basalt gravel. The deposit is interpreted as the result of a catastrophic flood from the overflow of a temporary Pleistocene lake formed a short distance upstream by a lava dam.

Stearns, Harold Thornton

4. 1953, Ancient buried soil in the Columbia River lavas at Lewiston, Idaho (abs.): Geol. Soc. America Bull., v. 64, no. 12, pt. 2, p. 1556.

In Idaho the lowest elevation at which the Columbia River basalt is exposed is at Lewiston. Drill cuttings here indicate a buried soil 300 feet below the surface, and 10 feet thick which suggests such a long-time break as to raise the question as to whether all the Columbia River basalt was erupted in one geologic epoch.

---

5. 1954, Evidence of a missing Lower Paleozoic(?) formation in the Hells Canyon area, Idaho-Oregon: Geol. Soc. America Bull., v. 65, no. 9, p. 939.

Exceedingly well-rounded cobbles and boulders of tan and yellow quartzite occur in stream beds that formerly drained westward prior to the eruption of the Columbia River basalt. The quartzite is said to be unlike that in the Belt series but to resemble that in the Brigham and Kinnikinic formations.

---

6. 1955, Pillar Falls and flow and Shoshone Falls andesite near Twin Falls, Idaho: Geol. Soc. America Bull., v. 66, no. 4, p. 463.

Reexamination of the Pillar Falls and flow indicates that it is the top of the Shoshone Falls andesite, rather than a mud flow. The andesite was originally considered of Miocene(?) age but may be Pleistocene.

---

7. 1955, Discovery of Cretaceous(?) sediments in south-western Idaho (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1681-1682.

A single, flattened, fossil, fresh-water shell formed in tuffaceous sedimentary rocks that have been correlated with the Payette formation has been identified by Reeside as Vivaparus or Campeloma, not older than Early Cretaceous or younger than Paleocene, probably Late Cretaceous. This raises doubts as to the age assignment of the Payette, although Miocene plants have been recorded from the same locality.

---

8. 1955, Spectacular displacement of Snake River by a lava flow near Bliss, Idaho (abs.): Geol. Soc. America Bull., v. 66, no. 12, pt. 2, p. 1681.

In the late Pleistocene a pahoehoe basalt built the flat dome called McKinney Butte and poured into the canyon of the Snake River, 11 miles away, damming a lake 22 miles long, which was partly filled with sediments before it was drained.

The lava reached the canyon wall in a 6-mile stretch above the dam.

Stearns, Harold Thornton

9. 1956, Ancient Lake Payette in Idaho (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1736.

Recent field work and study of 10 miles of drill cores show that the Payette is a group of local deposits ranging in age from the earliest to the latest of the flows of Columbia River basalt, and not all lacustrine. The group is pre-Snake River downwarp and the faults associated with it.

---

10. 1956, Lake Idaho problem (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1736.

The "Lake Idaho" formation is a group of deposits separated from the Columbia River basalt by angular and erosional unconformities and is made up of three different units or formations, older than the Snake River basalt of Quaternary age and thus Pliocene.

---

11. 1956, Snake River--Idaho's greatest resource: Idaho Power Co. Bull., v. 13, no. 2, p. 3-6.

This is a popularly written summary of geologic conditions in Snake River Plain relative to ground water. During the Pleistocene lava erupted intermittently from vents in the valley. Previously eruptions had occurred but long, broad lakes had dominated the area of the Plain. These were shallow in the basin east of Glenns Ferry. Uplift drained the lakes and the Snake River cut a valley in them. The Pleistocene flows built up flat domes, cinder and spatter cones, and most of the lava passed to the flow ends through tubes, now caverns. Most eruptions were north of the Snake and the flows cascaded into the valley of the river, forming pillow lava where it reached water. Each flow made a temporary dam but the river promptly cut new channels and the resulting cascades have left piles of boulders, gravel, and sand. Later the lava became covered by wind deposits. Some flows are young and flows in the future are possible. There are seven lava-filled abandoned channels of the Snake and Thousand Springs is where the present river cuts these. The springs discharged some 6,000 second feet of water daily. The ground water reservoir is replenished annually. About 67 reservoirs along the Snake and its tributaries give control. These hold about 7,500,000 acre feet and others are being built.

_____, (and Isotoff, Andrei)

12. 1956, Stratigraphic sequence in Eagle Rock volcanic area near American Falls, Idaho: Geol. Soc. America Bull., v. 67, no. 1, p. 19-34.

Studies near American Falls in connection with search for a damsite resulted in modification in detail of Stearns' original ideas on the area. Tentative correlations of the Neeley lake beds (lower Pliocene?) with the Salt Lake formation to the east and the Payette formation to the west are offered. Also the Raft River lake beds are said to be possibly correlative with the Idaho formation. The Tertiary and late Pleistocene beds are separated by a major unconformity. The latter are represented by the Cedar Butte basalt which displaced the Snake River for 55 miles and produced a lake 40 miles long and 12 miles wide. The name Eagle Rock tuff is abandoned and Walcott welded tuff substituted for it. The junior author, in addition to his field work on the stratigraphy, contributed petrographic descriptions.

Stewart, Joseph W. (Nace, Raymond Lee, and Deutsch, Morris)

1. 1951, Preliminary report on ground water in the Michaud Flats Project, Power County, Idaho: U. S. Geol. Survey, 44 p.

The project here described includes 65 square miles in central Power County, centering in American Falls. The purpose of the work was study of the possibility of developing substantial quantities of ground water for irrigating high and outlying lands. Initial findings are favorable enough to warrant further work. About 10,000 acres in the project can be irrigated from the Snake River and a larger area not accessible to the river can be irrigated from wells, but how successful this would be is not known. Sedimentary, pyroclastic and volcanic rocks (late Cenozoic) are exposed at the surface and continue downward into the zone of saturation. Ground water occurs under perched, unconfined and artesian conditions. The southwestern part of the American Falls reservoir and a segment of the river below the dam may be perched. Ground water appears to move below this to the Snake River Plain, northwest of the river. Matters of rate of recharge, seepage, losses, etc., require further study.

---

2. 1954, Preliminary report on ground water in the Michaud Flats Project, Power County, Idaho: U. S. Cong., 83rd, 2d sess, House Doc. 485, p. 55-77.

The possibility was investigated of developing substantial quantities of ground water for irrigating high and outlying lands in the proposed Michaud Flats project area. Initial findings are sufficiently favorable to warrant a comprehensive further investigation which is outlined.

Data for the 65-square-mile area include 81 well records, 9 well logs, and a water-level map.

_____, (and Shuter, Eugene)

3. 1954, Idaho, in Water levels and artesian pressures in observation wells in the United States in 1951; pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 1195, p. 30-57.

The observation-well program, begun in 1946, now includes measurement of 95 wells in 17 counties. In most areas water levels rose in the wells, partly because of high precipitation in recent years.

Stewart, Joseph W. (Shuter, Eugene, and Brandvold, G. E.)

4. 1955, Idaho, in Water levels and artesian pressures in observation wells in the United States in 1952, pt. 5, northwestern states: U. S. Geol. Survey Water-Supply Paper 1225, p. 28-61.

The observation-well program now includes 99 wells in 17 counties. In Latah County a well that has been declining showed a rise in level as did most wells measured, because of high precipitation.

_____, (Sisco, Harold G., and Ragsdale, R. F.)

5. 1956, Idaho, in Water levels and artesian pressures in observation wells in the United States in 1953, pt. 5, northwestern states: U. S. Geol. Survey Water-Supply Paper 1269, p. 36-62.

The observation-well program begun in 1946 now includes measurement of 95 wells in 17 counties. In most areas water levels were slightly below normal.

Stinson, Melvin C.

1. 1950, Mineralogy of the heavy minerals from some placers of Central Idaho: Master's Thesis, Univ. Idaho.

A description of the occurrence and relative quantities of 17 heavy minerals (specific gravity greater than 2.9) from the Secesh, Stanley, and Boise Basins, and east and north-central Idaho. The quantity of monazite and zircon in the placers examined is related to the frequency of occurrence of igneous dikes.

Stocking, Hobart E. (and Page, Lincoln Ridler)

1. 1956, Natural occurrence of uranium in the United States, a summary, in Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Comm. for the United Nations Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 5-12.

This is a summary of the types of deposits containing uranium in the United States. Among vein deposits, the Sunshine mine, Coeur d'Alene region (p. 212) is mentioned, and the Phosphoria formation in the southeastern part of Idaho is included among occurrences in marine (p. 215-216) sedimentary rocks.

Stokes, William Lee

1. 1952, Paleozoic positive area in northwestern Utah (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, p. 1300.

The site of the Raft River Range in Utah, Idaho, and Nevada had pronounced positive tendencies during the Paleozoic. The area is near the center of the Cordilleran geosyncline on current paleogeographic maps, but Paleozoic deposits seem relatively thin with only representatives of the Cambrian and Pennsylvanian system present. The Precambrian granitic rocks are overlain unconformably by vitreous quartzite, schist, dolomite, and limestone, the whole ranging from a few feet to about 2,500 feet in thickness. Above these metamorphic rocks, which are inferred to be Cambrian, and separated from it by a basal quartzitic conglomerate or sandstone are unmetamorphosed limestone and silty limestone, up to 3,000 feet thick. About 1,000 feet above the base fusilinids (Waeringella) of probable Virgil age were collected.

Stokes, William Lee

2. 1953, Fossil peccary from Franklin, Idaho (abs.): Utah Acad. Sci. Proc. 1952-53, v. 30, p. 118.

A fossil peccary, Platyganus compressus has been found at Franklin, Idaho, apparently in sediments related to Lake Bonneville. As the peccary is warmth-loving, the fossil may have lived in an interglacial stage.

---

3. 1953, Silurian rocks of southeastern Idaho and adjacent territory, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., 1953, p. 27.

This gives a brief description of the Laketown formation.

---

4. 1953, Summary of Paleozoic and Mesozoic stratigraphy, (Idaho), in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 14-18.

This gives sketch maps showing approximate distribution of Cambrian, Ordovician, Silurian, and Mississippian formations in southeastern Idaho, which show they do not extend much west of the western border of Oneida County nor far east of the Wyoming border. Another map shows the western outcrop of Cretaceous beds starts at the southeast corner of Idaho and the assemblage covers the Wyoming border in a diagonal belt. All the Paleozoic and Mesozoic units are briefly described.

---

5. 1953, Western margin of the Rocky Mountain geosyncline in the Great Basin (abs.): Am. Assoc. Petroleum Geologists Bull., v. 37, no. 11, p. 2612.

The concept of an inner and an outer belt in the Paleozoic of the Great Basin is useful in a broad way but it is impossible to draw a well marked dividing line

between the two basins. No sharp uplift or uplifts ever separated the two. The miogeosynclinal sediments are chiefly carbonates with minor shale and sandstone. The eugeosnyclinal sediments are highly siliceous types, such as chert, arkose, argillite, tuff, and black shale.

The western edge starts near Burley, Idaho, thence to northwestern corner of Utah, through Wells, Cortez, Manhattan, and Goldfield, Nevada, ending near Owens Lake, Calif.

Stoll, Walter Clericus

1. 1950, Mica and beryl pegmatites in Idaho and Montana: U. S. Geol. Survey Prof. Paper 229, 64 p.

In Idaho pegmatites are in metamorphosed rocks of the Belt series and in marginal parts of the Idaho batholith. High quality mica has been produced from 14 properties in Latah County, one in Adams County and one in Idaho County. Beryl production has been small and mainly from the muscovite mine, Latah County. Columbite is known in Boise Basin. Descriptions of mines and prospects are given, also a production table.

Storch, R. H. (and Robertson, Almon Ford)

1. 1954, Beaver Creek monazite placer area, Valley County, Idaho: RME 3132, U. S. Bur. Mines for Atomic Energy Comm., 15 p.

The Beaver Creek area was explored by the U. S. Bureau of Mines in 1952 by means of 16 drill holes, and almost 11 tons of samples were collected. The monazite content of the gravel was 0.188 to 0.847 pound per cubic yard. The volume of minable gravel is large.

Stringham, Bronson Ferrin (Galbraith, F. McIntosh, and Crosby, Garth M.)

1. 1953, Mineralization and hydrothermal alteration in the Hercules mine, Burke, Idaho: Mining Eng., v. 5, no. 12, p. 1278-1282; AIME Trans. v. 196, 1954.

The Hercules mine was operated from 1886 to 1925 and dewatered in 1947 for further development. The country rock belongs to the Prichard and Burke formations and is in a broad, faulted synclinorium. The mine is in a block bounded on the east by an overthrust and on the west by a monzonite stock. The Hercules vein is intersected by a premineral fault, along which some postmineral movement has occurred and which is thought to have originated during intrusion of the stock. The vein is along the course of a shear zone, now a braided network of gouge seams in crushed and shattered country rock. Quartz formed continuously throughout mineralization but other minerals came in successive stages; stage 1 yielded biotite and andradite, grunerite, adularia, and chlorite; stage 2 yielded siderite; stage 3 yielded magnetite; stage 4 yielded pyrrhotite, pyrite, chalcopyrite, arsenopyrite, jamesonite, galena, and sphalerite, of which the last two are much the most valuable; stage 5 yielded calcite, and stage 6 pyrite. Wall rock alteration, with biotite, garnet, etc., does not extend far from the main fissure. Sericitization, widespread in the region, is not present in significant amount in the Hercules.

Sturm, Fred H.

1. 1954, General geology of some replacement monazite deposits in Lemhi County, Idaho: Master's Thesis, Univ. Idaho.

Replacement monazite deposits occur in zones of marble situated between Indian and Spring Creeks in the Mineral Hill and Indian Creek mining districts. The country rock is Precambrian metamorphics, with pegmatitic and rhyolitic intrusives of probable Tertiary age.

The origin of the monazite is interpreted as replacement of phosphatic limestone by rare-earth elements carried in migrating solutions derived from sediments containing rare-earth minerals.

Swanson, Roger Warren (McKelvey, Vincent Ellis, and Sheldon, Richard Porter)

1. 1953, Progress report on investigations of western phosphate deposits (Mont.-Idaho-Wyo.-Utah): U. S. Geol. Survey Circ. 297, 16 p.

A comprehensive study of the western phosphate deposits has been in progress since 1947 and most of the field work was finished when this summary was written. The principal deposits are in the Phosphoria and Park City formations over an area of about 135,000 acres in Montana, Idaho, Wyoming, and Utah. The rocks in the western part of the field are chiefly dark phosphatic shales and cherts deposited near the margin of the Paleozoic Cordilleran miogeosyncline; those in the east are thinner and were laid down on the stable continental platform. They include limestone and sandstone that grade eastward into red beds. Structure in the area of the miogeosyncline is complex; that in the east simpler.

Two black, phosphatic shale members characterize the Phosphoria; the lower is the thickest and most important in southeastern Idaho and pinches out to the south and east. The upper member is best developed in southwestern Montana. Chert characterizes the intervening member but limestone and sandstone are important to the north and east, where chert and sandstone are also prominent above the upper phosphate member.

The Bear River region in and near southeastern Idaho has the greatest total amount of phosphate and the thickest beds.

_____ (and others)

2. 1956, Stratigraphic sections of the Phosphoria formation, 1953: U. S. Geol. Survey Circ. 375, 30 p.

The parts of this report that concern Idaho include a map of exposures of the Phosphoria in Idaho, a generalized stratigraphic section at Trail Creek, Caribou County, and more detailed sections, with analyses, in Little Long Valley, in Georgetown Canyon, Bear Lake County; at Clear Creek, and Phosphoria Gulch, Caribou County, plus a general description of the formation in Idaho and Utah, showing that at its type locality the formation consists of phosphatic shale, 180 feet thick, overlain by the Rex chert, 240 feet thick. In northeastern Utah the formation is similar. In Idaho most of the phosphatic beds are in the phosphatic shale member. In Utah the middle shale member of the Park City forma-

tion probably is equivalent in major part to the phosphatic shale member of the Phosphoria and the upper limestone member is probably equivalent to the Rex chert. The Phosphoria overlies the Wells formation (Pennsylvanian) and underlies the Dinwoody formation (Triassic). The uppermost Wells may be the partial equivalent of the lowermost Phosphoria in Montana.

Swanson, Vernon Emanual

1. 1956, Uranium in marine black shales of the United States: in Proc. Internat. Conf. on peaceful uses of atomic energy; Geneva, 1955: New York, United Nations Pub., v. 6, p. 430-434.

This summary includes a map of the distribution of significantly uraniferous black shale that shows such rock in the Centennial Range, and along the Idaho-Wyoming boundary, within the Phosphoria formation, and gives a brief description of the formation showing that the average uranium content is about 0.010 percent but some thin units carry as much as 0.033 percent uranium.

---

2. 1956, Uranium in marine black shales of the United States, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 451-456.

This is the same as the paper cited immediately above.

Swartz, Charles Kephart (and others)

1. 1942, Correlation of the Silurian formations of North America (Chart no. 3): Geol. Soc. America Bull., v. 53, no. 4, p. 533-538.

The feature of this paper is the stratigraphic correlation table. One column in the table lists the Laketown dolomite and Trail Creek formation in central Idaho, both Niagaran.

Sweeney, Gerald T.

1. 1957, Geology of Copper Basin, Custer County, Idaho: Master's Thesis, Univ. Idaho.

This is a reconnaissance of the general geology of Copper Basin which is in the Mackay quadrangle, Custer County, and includes only incidental reference to the mines there. Rocks assumed to belong to the Casto volcanics (Permian?), Milligen formation (Devonian? and Mississippian), Brazer limestone (Mississippian), Paleozoic strata of unknown affinities, Challis volcanics (Oligocene-Miocene), Pleistocene deposits, and intrusive monzonitic and rhyolitic rocks (late Mesozoic or early Tertiary) are mapped. The sedimentary rocks are briefly de-

scribed and thicknesses are estimated. Petrographic data indicate the Challis volcanics range in composition from basalt to rhyolite. Specimens of spilite, andesite, tuff, and latite were examined petrographically. The pre-Challis strata, particularly those termed Casto volcanics and those of unknown age, are much folded. Faults roughly at right angles to each other may cross Copper Basin diagonally and may have contributed to the genesis of the basin.

Sweetwood, Charles W.

1. 1952, Western phosphate mining--a growing industry: Mining Eng., v. 4, no. 9, p. 863-865.

This is a description of the operations of the Simplot Fertilizer Co., on the Fort Hall Reservation, starting in 1945, with some data on the stratigraphy in their Gay mine.

Taylor, Dwight Willard

1. 1956, Pliocene mollusks from Jackson Hole, Grand Valley, and Star Valley, Wyoming and Idaho, in Wyo. Geol. Assoc. Guidebook, 11th Ann. Field Conf., p. 123-125.

Data on 26 species of Tertiary mollusks are tabulated. These are probably of Pliocene age. Those from Star Valley, Bonneville County, may be fluviatile.

Taylor, George Carroll, Jr.

1. 1942, Idaho, in Water levels and artesian pressure in observation wells in the United States in 1941, pt. 5, Northwestern States: U. S. Geol. Survey Water-Supply Paper 940, p. 7-9.

Measurements of four wells continued in 1941 in the Rathdrum Prairie region and of one well in the upper basin of the South Fork of the Palouse River. The water level was below normal in all observation wells.

Thomas, Harold Edgar

1. 1952, Ground-water regions of the United States--their storage facilities, v. 3 of The physical and economic foundation of natural resources: U. S. Cong., House Comm. Interior and Insular Affairs, p. 3-4.

This general summary embraces ground-water conditions throughout the United States. Only sections pertinent to Idaho are abstracted here. In the chapter on western mountain ranges, nearly all of Idaho north of the drainage basin of the Snake River is included. Precipitation is relatively plentiful in the mountains but the water is mainly needed in the valleys. The rocks are well-consolidated and ground water occurs mainly in the weathered material, the overlying mantle, and in fractures of diverse kinds. Ground-water reservoirs tend to be individually small and are varied. In the chapter on the Columbia Lava Plateau most of the drainage basin of the Snake River is included. The rocks are largely basalt

flows with interbedded sediments and range widely in water-bearing properties. In Idaho much of the pore space is provided by fractures. Locally, as near Twin Falls, water is confined under sufficient artesian pressure to produce flowing wells. In parts of the Snake River Plain the amount of water stored in and discharged from the ground-water reservoirs has been increased through irrigation. It has been estimated that the ground-water reservoir and the plain above King Hill yields 3,600,000 acre-feet annually by spring discharge and that below King Hill may yield 1,000,000 acre-feet more. Locally alluvium stores ground water and in some of these places problems of over-saturation have developed.

Thompson, Mary E.

1. 1953, Distribution of uraniun in rich phosphate beds of the Phosphoria formation: U. S. Geol. Survey Bull., 988-D, p. 45-67.

Five sets of samples, two of which were from southeastern Idaho, were analyzed radiometrically for uranium and chemically for $P_2O_5$, CaO, organic matter, and loss on ignition. Preliminary studies indicate that the concentration of uranium in these samples of phosphate rock is not due wholly to phosphate content but may depend in part on organic matter and other constituents.

---

2. 1954, Further studies of the distribution of uranium in rich phosphate beds of the Phosphoria formation: U. S. Geol. Survey Bull. 1009-D, p. 107-123.

The five sets of samples of phosphate rock cited in Miss Thompson's previous report have now been analyzed for F and $CO_2$ and good correlations between these and $P_2O_5$ found in several of them. The size of phosphate pellets was measured in two sets of samples but no significant correlation between size and uranium content was found.

The samples from Idaho are from Caribou County.

Thune, Howard Willis

1. 1941, Mineralogy of the ore deposits of the western portion of the Little Eight-Mile mining district, Lemhi County, Idaho: Master's Thesis, Univ. Idaho.

The ores have a low silica content but an abundance of carbonate minerals. The ore-bearing solutions are assumed to have been hypogene, and mineral deposition occurred at moderate temperatures. Separate mineral suites are associated with (a) lead-silver veins, and (b) dacite dikes; indicating two stages of mineralization.

Thurlow, Ernest E. (and Wright, Robert James)

1. 1950, Uraninite in the Coeur d'Alene district, Idaho: Econ. Geology, v. 45, no. 5, p. 395-404.

Traces of uraninite occur in the lower levels of two silver-base-metal producers in the Coeur d'Alene district. Most of the uranium-bearing veinlets follow small structures in the quartzitic wall rock of the major ore bodies. The ore is characterized by tetrahedrite, pyrite, arsenopyrite, and chalcopyrite in a siderite-quartz gangue. Uraninite in small spherulites replaces quartz, quartzite, and (to a lesser extent) tetrahedrite. It was apparently deposited in the late stages of mineralization.

Treves, Samuel B.

1. 1953, General geology of the Seafoam mining district: Master's Thesis Univ. Idaho.

The Seafoam district lies just inside the eastern border of the Idaho batholith. Remnants of the original rock cover of Paleozoic sediments and Precambrian schists found in the district indicate that the batholithic rock is the roofward portion of the batholith. The high concentration of folded and faulted sediments in the eastern part of the area and their absence in the western part indicate that the roof of the batholith dips to the east in the area studied.

_____ (and Melear, John D.)

2. 1953, The geology and ore deposits of the Seafoam mining district, Custer County, Idaho: Idaho Bur. Mines and Geology Pamph. 96, 19 p. incl. geol. map.

The Seafoam district is in the northwest corner of Custer County, Idaho. Placer mining was carried on in the 1880's but with scant success. The Greyhound lode mine was developed in the early 1900's including installation of a mill and smelter but was unprofitable. In 1926 the Seafoam Mining Co. started their mine and in 1928 put up a mill and shipped some bullion. The Mountain King mine was located about this time and was active from 1945 up to the time of this examination in 1952. U. S. Bureau of Mines reports give the production for 1933 through 1950 as 2,103 tons with a total value of $127,904 in gold, silver, copper, lead, and zinc. The district is underlain mainly by the Idaho batholith. Here most of the rock is granodiorite, regarded as belonging to the marginal zone of the batholith but some apparently younger quartz monzonite belonging to the core of this batholith, is also present. The granitic rocks include bodies of schist (Precambrian) and dolomitic limestone with some quartzite and shale (Ordovician?). Dikes of rhyolite, andesite, and lamprophyre, in order of increasing age are present but not abundant or large. The major structural features trend northwest at various angles. The granodiorite may have resulted from the metamorphism of sedimentary rocks.

The mineral deposits include those in shear zones in granitic rock and those in replacement deposits in limestone. The deposits, especially those in limestone, are cut by the dikes.

Trites, Albert Fillion, Jr. (and Tooker, Edwin W.)

1. 1953, Uranium and thorium deposits in east-central Idaho, southwestern Montana: U. S. Geol. Survey Bull. 988-H, p. 157-209.

In 1950, 39 properties in east-central Idaho and southwestern Montana were examined radiometrically for uranium and thorium. Uranium occurs principally in gold, lead, copper, and quartz-hematite veins in the Belt series and in Paleozoic limestone and shale. Known reserves are small. Uranium content is 0.02-0.1 percent. Thorium in significant amounts is present in three copper deposits and at least 9 quartz-hematite veins, content being 0.1-1.2 percent thorium.

Tullis, Edward Langdon

1. 1944, Contribution to the geology of Latah County, Idaho: Geol. Soc. America Bull., v. 55, no. 2, p. 131-163, incl. geol. maps.

Latah County lies within the Coeur d'Alene Mountains and the Columbia Plateau. The Plateau is mantled with loess and has been carved into the mature Palouse topography whose origin is influenced by the shape of the topography buried under the loess, by landslides, and by wind erosion. The mountains are largely underlain by the Belt series, here affected by dynamothermal metamorphism followed by retrograde changes. Material of magmatic origin was introduced into the series during the metamorphism. Representatives of the Wallace, certainly, and the Burke, Revett, and St. Regis formations, possibly, are present. The Prichard may also be present. Permian(?) volcanics are locally present. The Thatuna batholith, of varied composition, may have suffered much endomorphism. It is supposed to be related to the Idaho batholith. The Gold Hill stock, mainly syenitic, has also suffered changes. It resembles intrusive rocks in the Coeur d'Alene region and may differ materially in age from the Thatuna batholith. The Columbia River basalt and younger volcanic rocks are also present.

The principal economic ground-water reservoirs are residual granitic and transported clays formed mainly by weathering. Clays in the basalt appear to be of hydrothermal origin.

Turneaure, Frederick Stewart

1. 1955, Metallogenetic provinces and epochs, <u>in</u> Pt. 1 <u>of</u> Bateman, A. M., ed., Econ. Geology, p. 38-98.

This is a general summary of data on metallogenetic provinces and epochs in North America, South America, Africa, and Australia.

Idaho is not a well-defined province as the deposits are varied and represent at least two metallogenetic epochs. Ross is said (inaccurately) to regard the Idaho batholith as comparable to the Nelson batholith and of Late Jurassic or Early Cretaceous age. Anderson adds that it acted as a rigid mass and was broken by Laramide faults. Eardley thinks the Idaho batholith was probably the last of the Nevadan plutons and in part correlates with Laramide structures. The batholith is cut by dikes and stocks regarded by Ross as trending in accord with structures in the Challis volcanics and he assigns the intrusions an early Miocene age. Anderson, in addition, distinguishes an earlier group of intrusions he calls

Laramide. Ross thinks the principal mineral deposits in and near the Idaho batholith are Nevadan and genetically related to the batholith and Anderson calls them Laramide and post-batholith. The stocks in the Coeur d'Alene region may be outliers of the Idaho batholith but Anderson regards them as Laramide and the mineral deposits there appear also to be Laramide. Small shoots containing uraninite in part of the region are of late Precambrian age. These are older than the lead-silver minerals in the same mines but how much so is not clear. The deposits in the Challis volcanics and related dikes are of Miocene age. Anderson separates the deposits of the Silver City district which he calls Pliocene and post-Challis.

Twenhofel, William Henry (and others)

1. 1954, Correlation of the Ordovician formations of North America: Geol. Soc. America Bull., v. 65, no. 3, p. 247-298, with an introduction by C. O. Dunbar, and a discussion of British-American correlation by H. B. Whitington.

The Kinnikinic quartzite resembles the Eureka quartzite lithologically and implies active erosion and the transportation of much sand whereas the Bighorn and its equivalents spread over an extensive peneplaned surface. The committee was not cognizant of the fossils in the Kinnikinic. The Ramshorn slate is stated to be of Canadian (Early Ordovician age). The Phi Kappa formation is not mentioned in text or chart. The Saturday Mountain formation is said to contain fossils diagnostic of the early Richmond invasion from the Arctic. The chart has one column relative to Idaho and credited to C. P. Ross but it is not an adequate presentation of data relative to the state.

_____, (and Buck, K. L.)

1. 1956, The geology of thorium deposits in the United States, in Proc. Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955: New York, United Nations Pub., v. 6, p. 562-567.

Includes a map of the United States showing three deposits in Idaho and one on the Idaho-Montana boundary and a brief description of deposits in the Lemhi Pass area and of placers in Idaho, with a note on the Mineral Hill district.

---

2. 1956, Geology of thorium deposits in the United States, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 559-566.

This is the same as the paper abstracted above.

United States Geological Survey, Water Resources Branch

1. 1944-1950, Surface water supply of the United States, pt. 13, Snake River Basin.

This is a water-supply paper dealing with surface water aspects of the Snake River plain.

---

2. 1940-1955, Water levels and artesian pressures in observation wells in the United States, pt. 5, Northwestern States.

Part 5 includes tables of water-level and artesian pressure data gathered from observation wells in the northwestern states.

_____, (and U. S. Atomic Energy Comm.)

3. 1956, Natural occurrence of uranium in the United States, in Proc. Internat. Conf. on peaceful uses of atomic energy, Geneva, 1955: New York, United Nations Pub. v. 6, p. 211-216.

This is a summary of the types of deposits containing uranium in the United States. Among vein deposits, the Sunshine mine, Coeur d'Alene region, is mentioned and the Phosphoria formation in the southeastern part of Idaho is included among occurrences in marine sedimentary rocks.

Vhay, John Stewart

1. 1948, Cobalt-copper deposits in the Blackbird district, Lemhi County, Idaho: Geology by J. S. Vhay, assisted by George M. Sowers, David Joseph Varnes, John Gerard Broughton, and Joseph Leonard Weitz; Topography by the Topographic Branch, June 1946: U. S. Geol. Survey Strategic Minerals Inv. Prelim. Rept. 3-219, 26 p., with geol. maps.

The Blackbird district, 20 miles southwest of Salmon, is one of deeply weathered, flat-topped uplands with several steep-walled canyons, tributary to the canyon of Panther Creek. The rocks are mostly metamorphosed beds of the Belt series. They are locally granitized along gabbro contacts. The Idaho batholith, here a granite, cuts across the northern part of the district. There are post-batholith acid porphyry dikes and pre-batholith, possibly Precambrian, basic dikes. The sedimentary rocks are divided by faults into three roughly north-trending blocks, of which the center one (called the Blackbird block) appears to have been more tightly squeezed than the others and has relatively tight folds and marked schistosity. The north end of the western block is also schistose and is cut by thrusts. The north-plunging folds control ore shoots. The northern parts of the northern and central blocks have garnet, chloritoid, and cordierite. The Blackbird block is cut by mineralized shear zones. The mineralized rock contains chalcopyrite, cobaltite, pyrite, and pyrrhotite in quartz, biotite, tourmaline, ankerite, and muscovite, formed by replacement. In addition, there are north-

dipping and west-to-northwest-striking thrusts and a number of high-angle faults.

The district was first prospected about 1893; the Brown Bear property was worked in 1899-1903; the Haynes-Stellite in 1917-20; and the Uncle Sam in 1938-41. The district was studied during World War II by the U. S. Bureau of Mines and the U. S. Geological Survey. The Howe Sound Co. started drilling then and its subsidiary, the Calera Mining Co., began mining in 1945. There had been little production up to the date of the present report but a large tonnage of copper-cobalt ore is believed present. Descriptions and maps of the workings are given. Most of the early work was for copper and gold, with little production. The Haynes-Stellite shipped some cobalt concentrates and the Uncle Sam later shipped copper concentrates. The Haynes-Stellite property is in the block east of the Blackbird block and contains much tourmaline.

Vhay, John Stewart

2. 1951, Reconnaissance examination for uranium at six mines and properties in Idaho and Montana: U. S. Geol. Survey Trace Elements Mem. Rept. 30A, 21 p.

The Lemhi County, Idaho, properties examined for radioactivity were the Grunter mine, the Kentuck mine, the Ulysses-Kittie Burton mill, and the Garm-Lamoreaux mine. Of these, only the Garm-Lamoreaux mine showed appreciable radioactivity, where the lowest level dump gave readings averaging 10 times the background count. Since the majority of all samples analyzed showed a low uranium content it is suggested that the abnormal radioactivity was not caused by uranium, although one sample from the Garm- Lamoreaux mine assayed 0.11 percent uranium.

---

3. 1952, Cobalt resources, Chap. 6 of U. S. Bur. Mines, Materials Survey, Cobalt, 56 p. Idaho is on p. 40-42.

The Idaho localities cited are near Porthill, Boundary County, The Homebuilders Mining and Development Co., Kootenai County (doubtful), the Copper Chief M. and M. Co. near Troy, Latah County, near Avery and Kellogg, Shoshone County, and at Blackbird, Lemhi County, the only occurrence of present importance.

The Blackbird district was first prospected about 1893 and cobalt was noticed a few years later. Considerable development was done in 1890-1902 for gold and copper. During World War I cobalt ore was mined and some concentrate shipped. The operations ceased about 1920. In 1938-41 the Uncle Sam mined copper ore, suppressing the cobalt because of smelter penalties. During World War II the U. S. Bureau of Mines and U. S. Geological Survey investigated the cobalt deposits. The Calera Mining Co., a Howe Sound subsidiary, acquired options and did much work. Their mill was expected to produce late in 1951. Most of the ore deposits are in a north-trending block, 1 1/2-2 1/2 miles wide and at least 6 miles long, bounded by faults. The rocks in the block are schistose and those outside it more quartzitic. All belong to the Belt series. The

block is cut by mineralized shear zones in which the ore formed mostly by replacement. Many ore shoots plunge 30°-40° N. The ore contains chalcopyrite, cobaltite, safflorite, pyrite and pyrrhotite in quartz, biotite, and some ankerite, muscovite, and tourmaline. There are some post-mineral faults, both high and low angle.

The reserves of the Calera Mining Co. as of Dec. 31, 1949 are 1,743,900 tons containing 0.74 percent Co and 1.59 percent Cu. The reserve of undeveloped ore in the district is probably much larger.

Vhay, John Stewart

4. 1953, Use of geology in developing the Blackbird cobalt-copper deposits, Idaho (abs.): Econ Geology, v. 48, no. 4, p. 332-333.

The importance of plunge in the shapes of the cobalt-copper deposits of the Blackbird district is emphasized. If this had been appreciated the sites for drilling could have been selected better. The deposits are replacements along shears in strongly metamorphosed rocks of the Belt series. Recently, use of geochemistry has shown an area of background higher in cobalt to which future prospecting can be limited. Geology was little used in early development but is now successfully used in planning development and in mining.

Vine, James Davis (and Moore, George William)

1. 1952, Uranium-bearing coal and carbonaceous rocks in the Fall Creek area, Bonneville County, Idaho: U. S. Geol. Survey Circ. 212, 10 p.

Uraniferous coal, carbonaceous shale, and limestone occur in the Bear River formation (Lower Cretaceous) in the Fall Creek area. The uranium is thought to have come from mildly radioactive silicic volcanic rocks (Tertiary) through descending meteoric water.

---

2. 1956, Uranium-bearing coal in the United States, in Proc. Internat. Conf. on the peaceful uses of atomic energy, Geneva, 1955: New York, United Nations Pub., v. 6, p. 452-457.

Unusually high concentrations of uranium in coal have been reported from many parts of the world, although coal is commonly considered to be one of the least radioactive rocks. In Idaho the Fall Creek area has uranium in coaly shale in the Bear River formation (Cretaceous) and the Goose Creek area has uranium in lignite and lignitic shale of the Salt Lake formation (Pliocene).

---

3. 1956, Uranium-bearing coal in the United States, in Page, L. R., and others, Contributions to the geology of uranium and thorium by the United States Geological Survey and Atomic Energy Commission for the United Nations International Conference on Peaceful uses of Atomic Energy, Geneva, 1955: U. S. Geol. Survey Prof. Paper 300, p. 405-411.

This is the same as the paper abstracted above.

Visher, Stephen Sargent

1. 1945, Climatic maps of geologic interest: Geol. Soc. America Bull., v. 56, no. 7, p. 713-736.

Thirty maps of the United States showing climatic conditions which influence geologic processes are presented. These serve as convenient summaries but are highly generalized and for regions like Idaho large parts of which are rugged and without official weather stations are not satisfactory. The report cites earlier papers by Visher and others of interest to those who wish to pursue the subject further.

Wagner, Warren Richard

1. 1944, A landslide area in the Little Salmon River Canyon, Idaho: Econ. Geology, v. 39, no. 5, p. 349-358.

Landslides that have damaged U. S. Highway 95 and that may continue to do so have occurred in the unconsolidated detrital material of an ancient, major slide across which the highway is built.

---

2. 1945, A geological reconnaissance between the Snake and Salmon Rivers north of Riggins, Idaho: Idaho Bur. Mines and Geology Pamph. 74, 16 p.

The area contains the Seven Devils volcanics, (Permian), 10,000 feet thick(?): a new unit called the Pittsburg formation, 200-300 feet thick; the Lucile series, mostly metamorphosed sedimentary rocks, 2,000+ feet thick, (Triassic) possibly cut by the Idaho batholith; the Columbia River basalt, 2,200+ feet thick; the Latah formation and Quaternary deposits. There are numerous granitic bodies, some correlated with the Idaho batholith. The Seven Devils volcanics were folded at the end of the Paleozoic, and there was much post-Paleozoic folding, plus much faulting.

---

3. 1949, The geology of part of the south slope of the St. Joe Mountains, Shoshone County, Idaho: Idaho Bur. Mines and Geology Pamph. 82, 48 p., incl. geol. maps.

The report covers the Slate Creek, Black Prince, and the southern half of the Placer County mining districts and was undertaken to learn the relations between these districts and the richly productive part of the Coeur d'Alene region just to the north. The area of this report has a number of prospects but no mines and the future does not seem encouraging.

Travel through the area is difficult and exposures poor, in part because of chapparal resulting from the 1910 forest fire. Three old erosion surfaces are recognized, the oldest Cretaceous or early Tertiary, and present streams are incised in the youngest surface along their lower reaches.

The sedimentary rocks include Burke, of unknown thickness; Revett, 800± feet; St. Regis, 1,000 feet; Wallace 4,500 feet; Striped Peak 2,000± feet. Sills of diorite and gabbro are of Precambrian or early Paleozoic age. A quartz monzonite stock, supposedly an outlier of the Idaho batholith, has a border zone of hybrid rocks and related dikes of lamprophyre, granophyre, etc. A little Columbia River basalt is present. The Belt series, in general mildly metamorphosed, has been affected by three periods of folding and by complex, in part large, faults. The principal mineral deposits are in areas of major deformation. The bleached zones that are known to be favorable to ore deposition elsewhere are present in the northern part of the area. The Wallace formation, not regarded as favorable to ore deposition farther north, covers much of the area here described.

In general, the mineral deposits, a number of which are described, are similar in character to many in the Coeur d'Alene region.

Wagner, Warren Richard

4. 1951, Microscopic study of an inclusion in the Idaho batholith (abs.): Geol. Soc. America Bull., v. 62, no. 12, pt. 2, p. 1543.

An unusually well preserved inclusion of Triassic? schist in the Idaho batholith near the junction of Carey Creek with the Salmon 15 miles east of Riggins seems to have suffered few physical changes and resembles the Triassic rocks at the border of the batholith 7 miles westward. The inclusion is sheathed in a thick coating of biotite mica that protected it. It is at least 1,500 feet vertically below the present erosion top of the intrusive.

Walker, Eugene Hoffman

1. 1954, Glacial terraces of the upper Snake River, Wyoming-Idaho (abs.): Geol. Soc. America Bull., v. 65, no. 12, pt. 2, 1317-1318.

Four terraces cut from glacial valley trains can be identified along the Snake River but are lost down stream amid recent volcanic features.

Wallace, Robert Earl

1. 1950, Columbia River basalts: a recorded informal discussion; Northwest Sci., v. 24, no. 2, p. 51-58.

This is a transcription of a tape recording of an informal discussion after 10 papers dealing with the Columbia River basalt were presented at the 1947 annual meeting of the Geology-Geography section of the Northwest Scientific Association. Six of these papers have been published and those that bear on problems in Idaho are abstracted separately. The parts of the informal discussion that relate to Idaho mostly concern the supposedly widespread interbasalt weathered surface that Scheid has called the Excelsior surface.

Wallace, Robert Earl (Hobbs, Samuel Warren, Rainey, H. C., and Bowyer, Ben)

2. 1952, Geologic map of the Pottsville quadrangle, northern Idaho: U. S. Geol. Survey open-file map, scale 1:24,000.

This map, with structure sections but no text, shows seven units of the Belt series, dikes, veins, and three Quaternary units. It covers only a part of the Pottsville quadrangle, Shoshone County.

Wallace, Robert Earl (Hobbs, Samuel Warren, and Griggs, Allan Bingham)

3. 1953, Magmatic source of Idaho ores: Northwest Sci., v. 27, no. 2, p. 73-76.

Referring to A. L. Anderson's paper of the above title, Wallace, Hobbs, and Griggs point out that it contains assumptions presented in such a way that they might be accepted as facts by those not acquainted with the geology of the region. For example, Anderson speaks of intrusive bodies in the Coeur d'Alene region as localized along a zone of weakness dominated by the Osburn fault. Actually they are on a line almost at right angles to that fault and some individual stocks are similarly elongated. It is further noted that Anderson's assignment of a Laramide age to the fault is in accord with usual assumptions but is supported by little evidence. Anderson's statement that close association of the ore deposits and igneous rocks in the region "is a matter of record" is not supported by the facts. Many of the ore deposits, not the intrusions, are aligned along the Osburn fault and in detail there is little spacial relationship of ore bodies to monzonite. Anderson's remark as to potash-rich emanations in relation to the bleached zones is also challenged. Anderson's idea that the original intrusions were dioritic and were later changed by potash-rich emanations is questioned in part because of the absence of bleached zones near the intrusives. In regard to other positive statements of Anderson's, it is noted that lack of evidence prevents discussion but at the same time shows that flat statements are not justified at present.

Waring, Gerald Ashley (and Meinzer, Oscar Edward)

1. 1947, Bibliography and index of publications relating to ground water prepared by the Geological Survey and cooperating agencies, U. S. Geol. Survey Water-Supply Paper 992, 412 p.

This bibliography, an extension of Water-Supply Paper 427, lists 1,777 papers, including all those listed in Water-Supply Paper 427 and 1,168 additional papers issued through January 1946. It contains an abstract of each paper and an index of subjects and authors. Papers pertinent to Idaho are here listed separately.

Warner, Maurice Armond

1. 1956, The origin of the Rex chert (abs.): Dissert. Abs., v. 16, no. 5, p. 947-948.

Most of the bedded chert was deposited as a finely divided chemical precipitate, with smaller amount formed from the silicification of bioclastic limestone. Most of the chert formed in relatively deep and quiet water in an east-trending trough surrounded on at least three sides by platform areas. Silica has a solubility of 84 ppm in sea water, much in excess of that naturally present. Most silica at present is removed as iron and aluminum silicates. A combination of lateritic weathering in the source areas plus iron oxide in the stream waters and restricted circulation in the marine basin would lead to deposition of excess silica. The red beds present as facies equivalents of the chert and carbonate rock of the Rex suggest that the needed conditions existed at the time of formation of the Rex.

Warren, Percival Sidney

1. 1940, Sedimentation in the Cordilleran geosyncline in Alberta and British Columbia: Pacific Sci. Cong., 6th Proc. p. 245-251.

The Cordilleran geosyncline in British Columbia and Alberta was in existence in Precambrian time. For at least part of the time it was present there was a partial barrier near 49th parallel as many Canadian formations do not pass through into Idaho-Montana. In the Selkirk Mountains (including the Purcell Range) Daly measured 40,000 feet with Shuswap in the lower part, Belt, 32,000+ feet above and unconformity between. The Shuswap is on the west side of the Selkirks and has volcanics and intrusions and is metamorphosed. According to Daly's correlations the belt thins to east so Cascadia was already in existence to west.

Weller, James Marvin (and others)

1. 1948, Correlation of the Mississippian formations of North America (Chart 5): Geol. Soc. America Bull., v. 59, no. 2, p. 91-106.

There is a brief mention of rocks in central Idaho in which it is stated that Three Forks fossils have been found in the lower Milligen and Brazer fossils in the upper Milligen. The published statement as to Three Fork fossils refers to a locality in the Borah Peak quadrangle mapped as Three Forks, not Milligen. If Brazer fossils have been found in the Milligen, the statement does not appear to have been published.

West, Sam W.

1. 1955, Ground-water and drainage problems in the Whitney terrace area, Boise, Idaho: U. S. Geol. Survey duplicated report., 21 p.

The Whitney terrace has been changing from a farming to an urban area. Coincident with the change, the amount of farm irrigation has decreased but the amount of recharge from lawn sprinkling, yard irrigation, and liquid sewage effluent is much greater. Ground water and drainage problems can be relieved by reducing the excessive recharge.

A map shows depth to water in the five square miles of the Whitney terrace area.

West, Sam W.

2. 1956, Ground water in part of the Fort Hall Indian Reservation, Bannock and Bingham Counties, Idaho: U. S. Geol. Survey open-file report, 41 p., geol. map.

The possibilities for ground-water irrigation, especially in the Lincoln Creek and Ross Fork units and certain terrace lands in the reservation were studied. Most irrigation water for the reservation comes from the Snake and Blackfoot Rivers, a little from Lincoln and Ross Fork Creeks. The water from the last two named is inadequate and potential reservoir sites are reported to be poor.

The rocks of the reservation include highly deformed Paleozoic and Mesozoic units, Tertiary silicic volcanic rocks, Snake River basalt, and younger alluvium and wind deposits. The volcanic rocks including the basalt and the valley alluvium are important sources of water from wells. In a few places artesian aquifers have been tapped. Data on use, recharge, etc., are given. The usable ground-water supply in the Lincoln Creek district is enough to irrigate about 850 acres; in the Ross Fork district about 1,500 acres at least; in the Gibson terrace about 6,500 acres; in the northern part of the reservation, exclusive of foothills, about 8,900 acres. Thus a comprehensive investigation of the water resources is warranted if the figures cited are large enough to be of interest to the Office of Indian Affairs.

_____, (and Fader, S. W.)

3. 1952, Records of wells and ground-water withdrawals in the Dry Creek area, Cassia and Twin Falls Counties, southern Idaho: U. S. Geol. Survey duplicated report, 114 p.

Data for the 120-square-mile area include 227 well records, 105 well logs, and well-discharge measurements.

Wheeler, Harry Eugene

1. 1940, Permian volcanism in western North America: Pacific Sci. Cong., 6th, 1939, Proc., v. 1, p. 369-376.

Areas containing old volcanic rocks in Nevada, California, Oregon, and Idaho are discussed and the conclusion is reached that much of the rock of this sort previously called "Triassic" and "Juratrias" is of Permian age, especially in California and Nevada. The ages assigned in Idaho appear to be accepted by Wheeler.

_____, (and Quinlan, James J.)

2. 1951, Precambrian sinuous mud cracks from Idaho and Montana: Jour. Sed. Petrology, v. 21, no. 3, p. 141-146.

In most specimens each ripple mark trough is occupied by a single sinuous trace. In some, such traces merge into mud cracks and it is concluded that all are of that origin.

Wheeler, Harry Eugene (and Cook, Earl Ferguson)

3. 1954, Structural and stratigraphic significance of the Snake River capture, Idaho-Oregon: Jour. Geology, v. 62, no. 6, p. 525-536.

Previous ideas are reviewed and in large part repeated. The primary factor in first-order drainage control along the Snake has been late Tertiary folding, with faults and volcanic dams playing a secondary and local role. The present course of the Snake between Idaho and Oregon is much later than the Miocene and Pliocene deposits. The previous concept that the Snake formerly crossed northeastern Oregon via parts of the valleys of Burnt, Powder, and Grand Ronde Rivers is not supported by the present drainage pattern and the lake basins interpreted as related to the old valley of the Snake are too old for these, are not confined to the drainage basins concerned, and are not in structural adjustment with the present topography.

There are both interbasalt and postbasalt sediments in the Miocene-early Pliocene succession but the Pliocene and/or early Pleistocene beds are unconformable on that succession, are only about 1,000 feet thick, relatively undeformed, virtually restricted to the Snake River valley in western Idaho and adjacent Oregon below about 3,000 feet in altitude. The late Pliocene-early Pleistocene deposits are regarded as the Idaho formation formed in Idaho Lake. There are at least three distinct lacustrine units in the late Tertiary-early Quaternary sequence. The late Pliocene-Quaternary deposits resulted from impounding of drainage systems on surfaces similar to those of the present. In the late Pliocene the Snake flowed west along the Snake River downwarp and was impounded by deformation, perhaps augmented by lava-damming, to create Idaho Lake. At its highest stage, the lake spilled over a divide at the Oxbow, 55 miles below Huntington, into a northward-flowing tributary of the Salmon River, creating the present course of the Snake. Much of the tributary drainage and local portions of the Snake below the Oxbow are controlled by a fracture system, mostly northeastward, but in part northwest, probably related to late Tertiary folding. Apparently this deformation is regarded as pre-Columbia River basalt. The Oxbow capture may be post-early Pleistocene. The suggestion is made that the early Snake River may have had a southwesterly course from western Idaho through southeastern Oregon via the general route of the lower Owyhee River and Crooked Creek, thence across northwestern Nevada to Chilcot Pass and westward into Feather River.

The silicic volcanics (Kirkham's Tertiary late lavas) are later than the unconformity above the Miocene-Pliocene strata and below the Idaho formation of the present authors.

Willard, Max Emery

1. 1941, Mineralization at the Polaris mine, Idaho: Econ. Geology v. 36, no. 5, p. 539-550.

The Polaris mine is in the "Silver Belt" of the Coeur d'Alene region. Its Polaris and Chester veins are in a bleached, sericitized zone in the St. Regis formation and the Silver Summit vein is in unbleached beds of the Wallace formation. Only the Polaris vein has yielded commercial ore. The hypogene minerals are pyrite, gersdorffite(?), arsenopyrite, tetrahedrite, chalcopyrite, bournonite, galena, boulangirite, siderite, ankerite, calcite, and quartz. Supergene minerals include proustite, anglesite, and cobalt bloom. The minerals were deposited in a definite sequence, interrupted by fracturing. The sequence began with pyrite and ended with galena and possibly boulangirite and calcite in order. All the valuable minerals are later than the quartz.

Willey, Emerson C. (Cheney, Thomas M., Pierce, Howard W., and Grose, L. T.)

1. 1955, Status of ownership of part of lands on which phosphate-bearing beds crop out in southeastern Idaho: U. S. Geol. Survey open-file report, 10 p.

A series of maps designating status of ownership of land containing phosphate-bearing rocks. Status of ownership is broadly classified into these groups: (a) phosphate rights owned by the Federal Government; (b) phosphate rights not owned by the Federal Government; (c) phosphate rights for which the ownership status is uncertain. The first two groups are subdivided into more specific categories.

_____, (Cressman, Earle R., Pierce, Howard W., and Cheney, Thomas M.)

2. 1955, Status of ownership of part of the lands on which phosphate-bearing beds crop out in southwestern Montana and northeastern Idaho: U. S. Geol. Survey open-file report, 10 p.

A series of maps designating status of ownership of land containing phosphate-bearing Permian rocks. Status of ownership is broadly classified into three groups: (a) phosphate rights owned by the Federal Government; (b) phosphate rights not owned by the Federal Government; (c) phosphate rights for which the ownership status is uncertain. The first two groups are subdivided into more specific categories.

Williams, James Steele

1. 1948, Mississippian-Pennsylvanian boundary problems in the Rocky Mountain region, in Weller, J. M., ed., Symposium on problems of Mississippian stratigraphy and correlation: Rocky Mountain region, Jour. Geology, v. 56, p. 327-351.

This paper is a general discussion of the subject with only incidental reference to southeastern Idaho. Matters pertinent to problems in Idaho may be summarized as follows: In southwestern Montana, western Wyoming, and the part of Idaho near Afton, Wyo., the Mississippian-Pennsylvanian contact is within the Amsden or comparable units, not separable in mapping on present information. Much of the Amsden is red and most of the beds at this general horizon are non-resistant types. There may be an unconformity at the base of the Amsden. Much more

paleontologic and other work is needed before the two systems can be satisfactorily separated in the region.

Williams, James Stewart

1. 1952, Red Rock Pass (Idaho), outlet of Lake Bonneville (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, p. 1375.

Lake Bonneville overflowed into Idaho in T. 12 S., R. 38 E. in a channel 400 feet wide at the top and 500 feet deep cut along the strike of limestone and dolomite regarded as belonging to the Bloomington and Nounan formations (Cambrian). These are flanked by the Salt Lake group. The original low point in the lake rim appears to have been at an altitude of 5,135 feet. The downcutting of the outlet was intermittent.

---

2. 1953, Pennsylvanian and Permian rocks in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 38-40.

Over most of the area the Pennsylvanian rocks can be called Wells, but Oquirrh, Morgan, and Weber affinities are present. The Morgan may be related to the Amsden. The Wells is equivalent to the lower part of the Park City and the upper part of the Wells as mapped is Permian. All the Permian rocks in the region might well have been called Park City. The major unconformity lies within the Wells rather than at the base of the Phosphoria. Emphasis on the Phosphoria resulted from its economic importance.

---

3. 1955, Resumé of Paleozoic stratigraphy, Ordovician to Pennsylvanian, of the Green River Basin area, Wyoming, in Wyo. Geol. Assoc., Guidebook, 10th Ann. Field Conf., p. 43-47.

Three sections in Idaho were considered in preparing this paper but are not listed therein. The notes abstracted below have bearing on stratigraphic problems in Idaho. The Swan Peak formation appears to be a littoral facies of the Garden City limestone. The Laketown dolomite is not known east of its type locality in Laketown Canyon. The Water Canyon formation (Lower Devonian) is thin in Laketown Canyon and is not mentioned for any Idaho locality. Other notations in the report seem to be without direct bearing on Idaho problems.

---

4. 1956, Geomorphic effects of late Pleistocene climatic changes in southeastern Idaho and northern Utah (abs.): Geol. Soc. America Bull., v. 67, no. 12, pt. 2, p. 1804.

The Wisconsin periglacial climate appears to have left topographic forms shaped by a much larger overland runoff than the present in Dry Valley in the Preuss Range and in other localities in southeastern Idaho and northern Utah. Fan growth is credited to the altithermal age, 7,500-4,500 B. P. and truncation and regrading to the more humid medithermal age which has followed.

Wilson, John Andrew

1. 1946, Preliminary notice of a new Miocene vertebrate locality in Idaho (abs.): Geol. Soc. America Bull., v. 57, no. 12, pt. 2, p. 1262.

During the summer of 1941 the author investigated reports of the discovery of vertebrate fossils in the Lemhi Valley of east-central Idaho. The beds are intermontane and extend from the vicinity of Salmon on the north to an unknown distance south of Gilmore. In places they are overlain by Pleistocene and Recent alluvial fans and moraines but they outcrop intermittently over an area roughly 70 miles north-south and five miles east-west.

Those fossils collected by the author are tentatively identified as Promerychocherus sp., Techoleptus sp., Porhippus sp., and Alticamelus sp. Others collected in the same area by Mr. Ralph Nichols of Grant, Montana, have been identified by C. L. Gazin as "rhino teeth", Parahippus, Mylaganlus, and Merychyus. From the above faunal list it appears that the age of the beds is somewhere between Lower Miocene and Lower Pliocene, perhaps equivalent in part to the Payette of western Idaho.

Wisser, Edward H.

1. 1957, Deformation in the Cordilleran region of western United States, in Hartman, H. L., chairman, Behavior of materials in the earth's crust: Colo. School Mines Quart., v. 52, no. 3, p. 55-73.

This is a general discussion in which Idaho is only incidentally mentioned. The conclusions are that deformation in the Cordilleran region has been effected largely by differential vertical movement of crustal blocks, some of which are ancient. Most of the sharp folds result from uplift rather than external tangential compression. They result from gravitational sliding down the flanks of bulges in the basement. Many flat "thrusts" are gravitational slides.

Yen, Teng-Chien

1. 1944, Notes on fresh-water mollusks of Idaho formation at Hammett, Idaho: Jour. Paleontology, v. 18, no. 1, p. 101-108.

Systematic accounts of 17 species and subspecies, of which 8 species and three genera are new. Two genera are of the "Balkan type", known only from the Balkan peninsula and Idaho.

---

2. 1945, Late Tertiary fresh-water mollusks of southeastern Idaho (abs.): Geol. Soc. America Bull., v. 56, no. 12, pt. 2, p. 1214.

A deposit hitherto assigned to the Salt Lake formation contains fossils indicative of a lacustrine deposit of Late Miocene age. It is in NW 1/4 sec. 8, T. 12 S., R. 43 E., near Montpelier.

Yen, Teng-Chien

3. 1946, Late Tertiary fresh-water mollusks from southeastern Idaho: Jour. Paleontology, v. 20, no. 5, p. 485-494.

The material described is from sec. 8, T. 12 S., R. 43 E., near Montpelier, and the matrix is coarse, oolitic, calcareous sandstone that has been assigned to the Salt Lake formation (a loose term for rocks of varying age). There are 19 species of gastropods, of which 11 species and one subspecies are thought to be new. The fossils indicate the rock is lacustrine and of shallow water origin. The age appears to be upper Miocene.

Young, Jack (John) Cannon

1. 1953, Geology of the North Dry Valley structure, Caribou County, Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 83-85, with geol. map.

This gives structural details and a geologic map. In the well that was drilled Brazer formation goes from the surface to 7,524 feet, with 344 feet of Madison limestone below it. The well was abandoned at 7,868 feet. The structure section indicates the well started near top of Brazer. Area is in T. 7-10 S., R. 44 E.

Youngquist, Walter Lewellyn (and Kiilsgaard, Thor H.)

1. 1951, Recent test drilling, Snake River Plains, southwestern Idaho: Am. Assoc. Petroleum Geologists Bull., v. 35, no. 1, p. 90-96.

Three test holes for oil were drilled in 1950 in the Indian Cove-Sailor Creek area of northeastern Owyhee and southern Elmore Counties, Idaho. The deepest of these is 3,808 feet deep and mostly was in silt and sand regarded by the authors as belonging to the Idaho formation (Pliocene). About 400 feet of the lowest part of the hole yielded basaltic material that represents one or more flows tentatively regarded as belonging to the upper Columbia River basalt. It is concluded that the Cenozoic rocks of the Snake River Plain do not constitute a source for oil. Most, if not all, of the natural gas reported here is derived from lacustrine and paludal deposits of organic material. Geological exploration at present can be better carried out in the Paleozoic and Mesozoic exposed in surrounding uplands.

_____, (Hawley, R. W., and Miller, Arthur K.)

2. 1951, Phosphoria conodonts from southeastern Idaho: Jour. Paleontology, v. 25, no. 3, p. 356-364.

Available data on Permian conodonts are scanty, so small collections from the Phosphoria of the Preuss and Bear River ranges in southeastern Idaho are significant. Three genera are represented and three new species are established. The collection yielded 100 specimens.

Youngquist, Walter Lewellyn

3. 1952, Triassic conodonts from southeastern Idaho: Jour. Paleontology, v. 26, no. 4, p. 650-655.

Ammonite-bearing limestone (Lower Triassic) from southeastern Idaho, near Paris, yielded conodonts when dissolved in acetic acid. At least five genera of true conodonts were found. They appear not to be reworked and fit with known evolutionary trends, strenghthening hitherto weak evidence that conodonts persist into Triassic time. As is usual, these conodonts are associated with fish remains.

_____, (and Haegele, Jerald R.)

4. 1955, Fusilinid-bearing rocks in Sublett Range, southern Idaho: Am. Assoc. Petroleum Geologists Bull., v. 39, no. 10, p. 2078-2090.

Strata in the Sublett Range in eastern Cassia County, Idaho, are described. The lowest unit known is at least 1,000 feet of black shale (Mississippian?) resembling the Milligen of south-central Idaho. Above this shale is 600 feet of fusilinid-bearing sandstone and limestone, with some conglomerate near the base. This unit is of Pennsylvanian and Permian age. The total thickness of the unit in the Sublett Range may exceed 10,000 feet, of which at least 2,600 and possibly more than 5,000 feet is Permian, but different in facies from the Phosphoria. However, the Phosphoria may be present farther south in the Sublett Range and the writer's unpublished studies in the Cassia Mountains, 50 miles to the west, show the presence of a thick section of fossiliferous rocks which may include more than 10,000 feet of rocks of Permian age, including Phosphoria equivalents. The Permian rocks in the Cassia Mountains are thought to have been deposited near the central part of a basin, whereas those in the Sublett Range are thought to have formed neither in the center nor at the basin edge.

_____

5. 1956, Geological reconnaissance of the Cassia Mountain region, Twin Falls and Cassia Counties, Idaho: Idaho Bur. Mines and Geology Pamph. 110, 18 p.

This is a reconnaissance study but includes some measured sections. The Cassia Mountains consist chiefly of silicified limestone and orthoquartzite of late Paleozoic age, largely Permian. The total thickness exceeds 10,000 feet. Fossiliferous Ordovician limestone and quartzite crop out on the northwest flank of the mountains. Pyroclastic rocks of Tertiary age cap peaks.

Zeni, Milton

1. 1953, Geology of Sheep Creek anticline, Bear Lake County, Idaho, in Intermountain Assoc. Petroleum Geologists, 4th Ann. Field Conf., p. 80-82.

This describes the anticline, with a structure contour map and columnar section. No oil was found in the well drilled.

Zeni, Milton

2. 1954, Geology of the disturbed belt of southeastern Idaho (abs.): Oil and Gas Jour., v. 52, no. 50, p. 209: Am. Assoc. Petroleum Geologists Bull., v. 38, no. 5, p. 952-953.

The disturbed belt of southeastern Idaho is on the eastern edge of the Cordilleran geosyncline and the structure and stratigraphy harmonize with those in areas thus situated from Canada to southern Nevada. Oil is being produced in a similar environment in Canada. Southeastern Idaho can be divided into parallel zones of crustal shortening, with synclinoria and anticlinoria, the latter much broken by thrusts. The rocks include some of basinal, marginal and foreland thicknesses. Five unsuccessful wells have been drilled but the possibilities of finding oil have not been exhausted.

p 192 blank

# INDEX, BY COUNTY AND SUBJECT

BONNER COUNTY (CONTINUED)

Ground water

Observation wells: Eakin, 1; Huff, 1; Taylor, G. C., 1.

Rathdrum Prairie, wells, and lakes: Fader, 1, Nace, 4.

Mineralogy

Geocronite: Douglass, 1.

Zircon in tonalite, Priest Lake: Larsen, L. H., 1.

Paleontology

Cambrian of the Rocky Mountains: Lockman-Balk, 2.

Physical geology

Cabinet Gorge dam, bedding plane faults: Stearns, 2.

Glacial geology: Alden, 1.

Ramp valleys: Cary, 1.

BONNEVILLE COUNTY

Economic geology

Big Elk Mountain anticline: Neighbor, 1.

Clays, industrial potential: Sohn, 2.

Mineral resources, Ammon and Paradise Valley quadrangles: Mansfield, 3.

Petroleum possibilities: Ball, 1.

Phosphate deposits, Caribou Range: Sears, 1.

Uranium-bearing coal, Fall Creek area: Vine, 1.

Ground water

Observation wells: Eakin, 3.

Historical geology

Southeast Snake River plains, post-Laramide: Bayless, 1.

Paleontology

Mollusks; Pliocene: Taylor, D. W., 1.

Petrology

Falls Creek area, carbonaceous rocks: Vine, 1.

Fusion of sandstone by intrusive andesite: Mielenz, 1.

Physical geology

Ammon and Paradise Valley quadrangles; Mansfield, 3.

Big Elk Mountain anticline: Neighbor, 1.

Lithology of Fall Creek Basin and Horseshoe Creek district: Carlson, 1.

Southeast Snake River plains: Bayless, 1.

BOUNDARY COUNTY

Economic geology

Cobalt: Vhay, 3.

Lead-zinc, Moyie-Yaak district: Anderson, A. L., 12.

Ore deposits: Kiilsgaard, 1.

Geologic maps

Dam sites of upper tributaries of the Columbia: Erdmann, 1.

Ground water

Effect of water temperature on streamflow, Kootenai River: Eisenlohr, 1.

Physical geology

Dam sites on upper tributaries of Columbia: Erdmann, 1.

Glacial geology: Alden, 1.

Purcell sills: Kiilsgaard, 1.

Ramp valleys: Cary, 1.

BOUNDARY COUNTY (CONTINUED)

Stratigraphy

Cambrian system: Price, 1.

Proterozoic of the Cordilleran: Reesor, 1.

BUTTE COUNTY

Economic geology

Lead, silver; Dome district: Anderson, A. L., 23.

Lead, zinc; Hornsilver property: Roby, 1.

Ore deposits, southwestern Lemhi Range: Anderson, R. A., 1.

Silver, lead, zinc; Lava Creek district: Anderson, A. L., 21.

Geologic maps

Hornsilver mine: Roby, 1.

Southwestern Lemhi Range: Anderson, R. A., 1.

Historical geology

Lemhi Arch, mid-Paleozoic: Sloss, 4.

Lemhi Range, Permian: Blackstone, 1.

Physical geology

Craters of the Moon: Andrews, 2; Barrette, 1.

Dome district; structure, alteration: Anderson, A. L., 23.

Geology and mineralization of the Mackay Stock: Leland, 1.

Ice caves: Halliday, 1.

Southwestern Lemhi Range: Anderson, R. A., 1.

Stratigraphy

Part of the Lemhi Range, Smedley, 1.

CAMAS COUNTY

Economic geology

Ore deposits, Princess Blue Ribbon mine: Milner, 1.

Radioactive placer minerals: Robertson, 1.

Skyrocket and Croesus claims, evaluation: Johnson, F. H., 1.

Physical geology

Princess Blue Ribbon mine: Milner, 1.

CANYON COUNTY

Economic geology

Clays, industrial potential: Sohn, 2.

CARIBOU COUNTY

Economic geology

Phosphate: Anonymous, 2.

Phosphate deposits, Deer Creek-Wells Canyon area: Deiss, 3; Lowell, 1.

Phosphate deposits, Dry Valley quadrangle: Cressman, 1, 3.

Sulphur: Staley, 2.

Geologic maps

Johnson Creek quadrangle: Gulbrandsen, 1.

Snowdrift Mountain quadrangle: Cressman, 4.

Ground water

Supply possibilities: Scott, 1.

Historical geology

Jurassic history: Imlay, 2.

Paleontology

Fossil plant localities: Andrews, H. N., 1.

Idaho Tempskyas: Andrews, H. N., 1, 5, 7.

CARIBOU
~~CANYO~~N COUNTY (CONTINUED)

Paleontology (Continued)

Phosphoria conodonts: Youngquist, 2.

Physical geology

Deer Creek-Wells Canyon area, phosphate rock: Lowell, 1.
Dry Valley quadrangle: Cressman, 1, 3.
Effect on phosphate rock of weathering: Carswell, 1.
Johnson Creek quadrangle: Gulbrandsen, 1, 2.
North Dry Valley, structure: Young, 1.
Northeast of Georgetown, phosphate rock; structure: Deiss, 2.

Stratigraphy

Phosphoria formation, sections: Swanson, R. W., 2.

CASSIA COUNTY

Economic geology

Columbite and samarskite, occurrence of: Fryklund, 2.
Feldspar deposits: Fryklund, 2.
Industrial clays; Sohn, 2.
Phosphate deposits: Cheney, 4.
Phosphoria formation: McKelvey, 6.
Uranium-bearing coal: Vine, 2.

Geologic maps

Ground-water possibilities: Crosthwaite, 2.

Ground water

Dry Creek area: West, 1.
Goose Creek Basin: Mower, 2.
Possibilities: Crosthwaite, 2, 6.
Raft River Valley: Fader, 2; Nace, 9-A.

Historical geology

Paleozoic area: Stokes, 1.
Phosphate deposits, Permian: Cheney, 3.

Paleontology

Fusilinid-bearing rocks, Sublett Range: Cheney, 1.

Physical geology

Geological reconnaissance, Cassia Mountain region: Youngquist, 5.
Phosphoria formation: McKelvey, 6.
Raft River Range: Felix, 1.

Stratigraphy

Cache Valley, Tertiary rocks: Adamson, 1.
Goose Creek district, Tertiary stratigraphy: Mapel, 1.

CLARK COUNTY

Economic geology

Lead-zinc-copper deposits, Birch Creek district: Anderson, A. L., 11.
Phosphate deposits, Centennial Range: Honkala, 2.
Uranium in marine black shales: Swanson, V. E., 1, 2.

Geologic maps

Centennial Range: Honkala, 2.

Physical geology

Centennial Range, phosphatic rocks: Honkala, 1, 2.
Lima region: Scholten, 1.

GROUND WATER (CONTINUED)

Water-Supply papers, observation wells: USGS, Water Resources Branch, 1, 2.

GYPSUM

Deposits in Washington County, report on: McDivitt, 1.

HISTORICAL GEOLOGY (See also subheading Historical Geology under the counties)

Cenozoic

Ancient Lake Payette in Idaho: Stearns, 9.
Cache Valley, Tertiary: Adamson, 1.
Clarkston stage of northwestern Pleistocene: Lupher, 3.
Continental Tertiary, possible source beds for gas and oil: Felts, 1.
Ecotones in western North America, Tertiary: Chaney, 2, 3.
Effects of late Pleistocene climatic changes in southeastern Idaho: Williams, J. Stewart, 4.
Felsic volcanic rocks of Cenozoic age, western United States: Coats, 1, 2.
Forests and history, Tertiary: Chaney, 1.
Idaho batholith during Laramide orogeny: Anderson, A. L., 24, 26.
Late Pleistocene age of Snake River diversion: Cook, 2.
Northern Idaho, Post-Pleistocene: Hansen, 2.
Pacific Northwest, Post-Pleistocene: Hansen, 1.
Pleistocene glaciation in central Idaho, Seven Devils Mountains: McDonald, 1.
Rocky Mountains, Tertiary-Pleistocene transition: Atwood, 1.
Southeastern Snake River plains, post-Laramide: Bayless 1.
Western North America climate and evolution, middle Pliocene: Axelrod, 1.

Mesozoic

Age of Idaho batholith: Larsen, E. S., 1.
Idaho batholith during Laramide orogeny: Anderson, A. L., 24, 26.
Jurassic history in western interior of United States: Imlay, 5.
Origin of Preuss sandstone in Idaho: Imlay, 4.
Permo-Triassic boundary in southeastern Idaho: Newell, N. D., 1, 2.

Paleozoic

Cordilleran region, Cambrian: Deiss, 1.
Lemhi arch, mid-Paleozoic, south-central Idaho: Sloss, 4.
Missing lower Paleozoic formation in Hell's Canyon: Stearns, 5.
North American geosynclines: Kay, 3.
Northern Rocky Mountain and Great Plains area, Devonian: Andrichuk, 1.
Ordovician age of rocks: Berdan, 1.
Paleozoic Cordilleran geosyncline: Eardley, 1.
Paleozoic evolution of geosynclinal margin north of Snake River Plain: Scholten, 2.
Paleozoic positive area: Stokes, 1.
Paleozoic seas of central Idaho: Ross, C. P., 9.
Paleozoic sedimentation in Montana area: Sloss, 2.
Permian volcanism in western North America: Wheeler, 1.
Permo-Triassic boundary in southeastern Idaho: Newell, N. D., 1, 2.
Rocky Mountain geosyncline in Great Basin, western margin: Stokes, 5.
Structural history of overthrust belt: Rubey, 2.
Tectonic development of Cordilleran region, Rocky Mountains: Mallory, 1.

HISTORICAL GEOLOGY (CONTINUED)

Precambrian

Age determination, St. Regis (Belt series): Eckelmann, 1.
Pre-Cambrian sinuous mud cracks from Idaho: Wheeler, 2.
Pre-Cambrian uraninite: Kerr, 1.

IDAHO COUNTY

Economic geology

Clay deposits: Hubbard, 2; Scheid, 9.
Columbite and samarskite: Fryklund, 2.
Feldspar deposits: Fryklund, 2.
Gold placers, Secesh Basin: Capps, 1.
Iron-ore deposits, Clearwater district: Mackin, 2.
Mica and beryl: Stoll, 1.
Ore deposits, Elk City district: Shenon, 2.
Ore deposits, Warren district: Reed, J. C., 1.
Placer gold mining: Fernquist, 1.
Tungsten deposits: Cook, 3.
Uranium, niobium, Red River Valley placer deposits: Armstrong, 4.

Historical geology

Pleistocene glaciation of the Seven Devils Mountains: McDonald, 1.
Plutonic history of west-central Idaho: Hamilton, 2.

Mineralogy

Gem minerals: Fernquist, 3.
Heavy mineral placers: Stinson, 1.
Pyromorphite, Little Giant mine: Fernquist, 2.

Petrology

Inclusion in Idaho batholith, microscopic study: Wagner, 4.
Orbicular rock, Buffalo Hump: Goodspeed, 1.

Physical geology

Big Creek quadrangle: Leonard, 1.
Front of Bitterroot Range, structure: Ross, C. P., 4.
Warren district, structural: Reed, J. C., 1.

IRON

Deposits of the Clearwater district: Mackin, 2.
Deposits of the Iron Mountain district: Mackin, 3, 4.

JEFFERSON COUNTY

Ground water

Records of wells: Barraclough, 1.

Historical geology

Southeastern Snake River plains and adjacent mountains, post-Laramide: Bayless, 1.

JEROME COUNTY

Ground water

Records of wells: Crosthwaite, 5; Mower, 1.

Physical geology

Pillar Falls mud flow and Shoshone Falls andesite: Stearns, 6.

KOOTENAI COUNTY

Economic geology

Clay deposits: Hubbard 2; Scheid, 7.
Geology of some mineral deposits in Twin Crags area: Good, 1.

LEMHI COUNTY (CONTINUED)

Geologic maps

Blackbird district: Vhay, 1.
Borah Peak quadrangle: Ross, C. P., 3.
Leesburg quadrangle: Shockey, 1.
Meyers Cove district: Anderson, A. L., 9; Cox, 1.
Mineral Hill district: Abbott, 1.

Historical geology

Lima region, Tectonic: Keenmon, 1.

Mineralogy

Chlorine-rich biotite: Lee, D. E., 1.
Gem minerals: Fernquist, 3.
Paragenesis of tungsten ore, Ima mine: Clabaugh, S. E., 1.
Quartz crystal: Herdlick, 2.

Paleontology

Fusilinid-bearing rocks, Sublett Range: Cheney, 2.
Vertebrate locality, Miocene: Wilson, 1.

Petrology

Blackbird mining district, metamorphic studies: Roberts, 1.
Magmatic and granitized rocks, Yellowjacket district: Anderson, A. L., 36.
Mineral Hill mining district: Davidson, D. M., 1.
Paragenesis of tungsten ore, Ima mine: Clabaugh, 1.

Physical geology

Baker quadrangle: Anderson, A. L., 42.
Beaverhead Range, east of Salmon: MacKenzie, 1.
Borah Peak quadrangle: Ross, C. P., 3.
Calcareous rocks, structure: Abbott, 1.
Glacial: Alden, 1.
Leesburg quadrangle: Shockey, 1, 2.
Mineral Hill mining district: Davidson, D. M., 1; Kaiser, 1.
Salmon quadrangle: Anderson, A. L., 41.

LEWIS COUNTY

Economic geology

Clay deposits: Hubbard, 2; Scheid, 9.
Clays, industrial potential: Sohn, 2.

LINCOLN COUNTY

Mineralogy

Gem minerals: Fernquist, 3.

Physical geology

Black Butte, a recent subsidence crater: Harrington, 1.
Ice caves: Halliday, 1.

MADISON COUNTY

Economic geology

Petroleum, possibilities: Ball, 1.
Phosphate deposits, Teton Basin area: Gardner, 1.

Historical geology

Southeastern Snake River plains, post-Laramide: Bayless, 1.

MERCURY

Deposits near Weiser: Ross, C. P., 5.
Idaho Almaden quicksilver mine: Anderson, A. L., 1.
In Idaho: Bradley, W. D., 1.

OWYHEE COUNTY

Ground water

Bruneau River Basin: Johnson, F. A., 1; Littleton, 1; Newell, T. R., 2.

PALEONTOLOGY (See also subheading Paleontology under the counties)

Cenozoic

Birds, Miller, L. H., 1.
Bracket fungus: Brown, 1.
Ecotones in western North America: Chaney, 2, 3.
Fish distribution and hydrographic history, Great Basin: Hubb, 1.
Flora, Sucker Creek: Smith, H. V., 1.
Flora, Thorn Creek: Smith, H. V., 2.
*Fomes idahoensis* Brown: Andrews, 6.
Forest succession in northern Idaho: Hansen, H. P., 2.
Forests and continental history: Chaney, 1.
Fossil peccary: Stokes, 2.
Fossil plant localities: Andrews, 3.
Fossil polypores: Andrews, 4.
Idaho formation, fresh-water mollusks: Yen, 1.
Idaho *Tempskyas*: Andrews, 1, 5.
Latah formation, fossil fish: Scheid: 1.
Latah formation, Thuites: Gillette, 1.
Latah petrified forests: Dake, 1.
Mollusks: Taylor, D. W., 1.
Nonmarine, ostracods: Jones, 1.
Petrified trees: Dake, 3.
Plant life, climatic change in geologic record of: Barghoorn, 1.
Plants of North America, catalogue of: LaMotte, 1.
Primary succession on volcanic deposits in southern Idaho: Eggler, 1.
Skull of fossil camelid, American Falls lake bed: Hopkins, 1.
Vegetation and climate, Pacific Northwest: Hansen, H. P., 1.
Vertebrate locality: Wilson, 1.

Mesozoic

Conodonts: Youngquist, 3.
Coral fauna: Squires, 1.
Invertebrate faunas: Haas, 1.
Marine fossils from western United States: Imlay, 6.
Northern Rocky Mountains and Williston Basin, marine: Peterson, J. A., 1.
Paleoecology of seas of western United States: Imlay, 2.

Paleozoic

Brazer formation, corals from: Parks, 1.
Conodont fauna and distribution of a lower Mississippian black shale in Montana and Alberta: Cooper, C. L., 1.
Fucoidal markings in Swan Peak formation: Coulter, 1.
Fusilinid-bearing rocks in Sublett Range: Cheney, 2; Youngquist, 4.
Paleoecology of the Cambrian in Montana and Wyoming: Lochman-Balk, 1.
Phosphoria conodonts from southeastern Idaho: Hawley, 1; Youngquist, 2.
Three Forks fauna, Lost River Range: Baldwin, 2.

Precambrian

Belt series, stromatolites from: Rezak, 1.

PHYSICAL GEOLOGY (CONTINUED)

Tectonic development of Cordilleran region, Rocky Mountains: Mallory, 1.
Tectonics as related to Belt series: Harris, S. A., 1.
Tectonics of the Rocky Mountains, Introduction to the: Blackstone, 2.
Three pre-Wisconsin glacial stages, Rocky Mountain region: Richmond, 1.
Thrust belt, southwestern Idaho: Eardley, 5.
Utah-Idaho thrust belt: Anonymous, 3.

PLACERS

Dismal Swamp, Elmore County: Armstrong, 2.
Distribution of heavy alluvial minerals in Idaho: Staley, 5.
Faulting related to placers: Capps, 2.
Gem minerals in placers: Fernquist, 3.
Gold placer mining in Pacific Northwest: Fernquist, 1.
Gold placers, Idaho County: Capps, 1.
Gold placers of Snake and Lower Salmon Rivers: Staley, 4.
Method of concentrating placer sand minerals: Staley, 6.
Monazite placers: Kline, 1, 2, 3, 4, 5, 6; Mackin, 5, 6, 7, 9; Staley 5, 6, 8; Storch, 1.
Radioactive mineral placers: Robertson, 1, 2.
Uranium-bearing: Armstrong, 4; Butler, 1.

POWER COUNTY

Economic geology

Clays, industrial potential: Sohn, 2.

Ground water

Michaud Flats Project: Stewart, 1, 3.
Possibilities, south of Snake River: Crosthwaite; 2, 6.

Paleontology

Skull of fossil camelid, American Falls lake bed: Hopkins, 1.

Stratigraphy

Eagle Rock volcanic area: Stearns, 12.

RUTILE

Mineral Hill district deposits: Kaiser, 1.

SELENIUM

In the Phosphoria formation: Davidson, D. F., 1.

SHOSHONE COUNTY (also see list - back of pamphlet)

Economic geology

Bedding vein deposits near Murray, structure: Shenon, 1.
Cobalt-nickel, Silver Summit mine, Coeur d'Alene district: Fryklund, 3.
Cobalt resources: Vhay, 3.
Copper deposit, near Coeur d'Alene: Anderson, A. L., 2.
Deep discoveries, Coeur d'Alene district: Sorenson, 1.
Distribution pattern of minerals, Coeur d'Alene district: Mitcham, 2.

Kyanite-andalusite deposits, Goat Mountain: Abbott, 2.
Lead-zinc, Canyon-Nine-Mile Creeks area: Griggs, 1.
Lead-zinc deposits, Coeur d'Alene district: Shenon, 3.
Lead-zinc mine, Little Pittsburgh: Herdlick, 1.
Lead-zinc, Murray area: Hosterman, 1.
Lead-zinc, Pine Creek area: Forrester, 3.
Lincoln Mining Company, Wallace, Idaho: Gussman, 1.
Mineralization and alteration, Hercules mine, Burke: Stringham, 1.

SHOSHONE COUNTY (CONTINUED)

Economic geology (Continued)

Mineralization, Polaris mine: Willard, 1.
Ore from Tamarack mine, Burke: Bulla, 1.
Pine Creek area, Sidney mine: Gammell, 1.
Radioactive minerals: Cook, 4.
Rich ore, Silver Summit: Sorenson, 2.
Shallow ore shoots, silver belt, Coeur d'Alene district: Sorenson, 3.
Silver, lead, Hercules mine: Crosby, 1.
Uranium-bearing vein deposits: Everhart, 1.
Zinc ore, Coeur d'Alene mine: McKinstry, 1.

Geologic maps

Kellogg and vicinity quadrangle: Campbell, A. B., 1.
Mullan and vicinity quadrangle: Griggs, 2.
Murray area: Hosterman, 1.
Pine Creek area: Nelson, 1.
Pottsville quadrangle: Wallace, 2.
Smelterville and vicinity quadrangle: Campbell, A. B., 2.
South slope of St. Joe Mountains: Wagner, 3.
Twin Crags quadrangle: Good, 2.
Wallace and vicinity quadrangle: Bowyer, 1.

Historical geology

Age determination, Sunshine mine: Eckelmann, 1.

Mineralogy

Distribution, pattern of minerals, Coeur d'Alene district: Mitcham, 2.
Gem minerals: Fernquist, 3.
Indicator minerals, Coeur d'Alene silver belt: Mitcham, 1.
Isotope geology of some lead ores: Miller, D. S., 1.
Mineragraphic study of ore, Tamarack mine, Burke: Bulla, 1.
Mineralization and alteration, Hercules mine, Burke: Stringham, 1.
Mineralization, Polaris mine: Willard, 1.
Minor elements in pyrrhotite: Fryklund, 4.
Sphalerite from Star mine, Coeur d'Alene district: Fryklund, 5.
Kullerud, 1.
Uraninite, Coeur d'Alene district: Thurlow, 1.
Uraninite, Pre-Cambrian, Sunshine mine: Kerr, 1.
Uranium mineralization, Sunshine mine: Kerr, 2.

Petrology

Igneous rocks of Avery district: Holland, J. S., 1.
Monzonite intrusion and mineralization, Coeur d'Alene district: Anderson, A. L., 28, 30.

Physical geology

Bedding vein deposits near Murray, structure: Shenon, 1.
Coeur d'Alene district: Kennedy, V. C., 1.
Glacial: Alden, 1.
Glaciation of Coeur d'Alene district: Dort, 1.
Mullan and Pottsville quadrangles: Hobbs, 1; Wallace, 2.
Murray area: Hosterman, 1.
Reconnaissance geology of western Mineral County, Mont., (and part of Shoshone County): Wallace, 3.

SHOSHONE COUNTY (CONTINUED)

Physical geology (continued)

Rock structure, Coeur d'Alene mine: McKinstry, 1.
Soil contamination in Coeur d'Alene district: Canney, 2.
South slope of St. Joe Mountains: Wagner, 3.
Striated surfaces on upper parts of cirque headwalls: Dort, 3.
Structure of ore districts in continental framework: Billingsley, 1.
Structural relations north of Osburn fault: Full, 1.

SILLIMANITE

Deposit near Troy: Forrester, 2.
Gem sillimanite from Idaho: Blalock, 1.
In schists in Boehl's Butte quadrangle: Hietanen, 2, 3, 5.

SILVER

Boise Basin: Anderson, A. L., 4.
Clark Fork district: Anderson, A. L., 14, 17, 22; Fairbanks, 1.
Coeur d'Alene silver belt: Mitcham, 1.
Dome district: Anderson, A. L., 23.
Hailey-Bellevue district: Anderson, A. L., 31.
Hercules mine: Crosby, 1.
Lava Creek district: Anderson, A. L., 21.
Little Wood River district: Anderson, A. L., 13.
Mayflower area: Fryklund, 1.
Mineral deposits of Idaho: Hulin, 1.
Mineral district: Anderson, A. L., 35.
Seafoam mining district: Treves, 1.
Triumph-Parker mine mineral belt: Kiilsgaard, 3.
Yankee Fork district: Anderson, A. L., 29.

STRATIGRAPHY (See also subheading Stratigraphy under the counties)

Cenozoic

Continental Tertiary, possible source beds for gas and oil: Felts, 1.
Felsic volcanic rocks of Cenozoic age, western United States: Coats, 2.
Rocky Mountains, Tertiary-Pleistocene transition: Atwood, 1.
Southeastern Snake River plains, post-Laramide: Bayless, 1.
Tertiary stratigraphy of Goose Creek district: Mapel, 1.
Tertiary stratigraphy of southeastern Idaho: Smith, N. J., 1.
Upper Tertiary sedimentary rocks: Merritt, 1.

Mesozoic

Characteristics of Jurassic Twin Creek limestone in Idaho: Imlay, 7.
Cretaceous stratigraphy of southeastern Idaho, summary: Moritz, 1.
Facies of lower Triassic formations: Kummel, 3.
Jurassic formations of North America: Imlay, 1, 3.
Lower Eo-Triassic stratigraphy, southeastern Idaho: Newell, N. D., 2.
Middle and upper marine Jurassic in northern Rocky Mountains and Great Plains: Schmitt, 1.
Middle Jurassic rocks in western United States: Imlay, 1.
Origin of Preuss sandstone in Idaho: Imlay, 4.
Permo-Triassic boundary in southeastern Idaho: Newell, N. D., 1, 2.
Summary of Paleozoic and Mesozoic stratigraphy: Stokes, 4.
Trias-Permo-Pennsylvanian sequence: Munyan, 1.
Triassic formations in eastern Idaho: Kummel, 1.

STRATIGRAPHY (CONTINUED)

Mesozoic (continued)

Triassic stratigraphy of southeastern Idaho: Kummel, 2.

Paleozoic

Base of the Cambrian system, north Idaho: Price, 1.
Belt series in relation to Cambrian system: Ross, C. P., 6.
Cambrian formations of North America: Howell, 1.
Cordilleran area, Pennsylvanian and Permian correlation: Bissell, 1.
Correlation of Mississippian formations of North America: Weller, 1.
Correlation of Ordovician formations of North America: Twenhofel, W. H., 1.
Devonian sedimentary formations of North America: Cooper, G. A., 1.
Distribution of a lower Mississippian black shale in Montana and Alberta: Cooper, C. L., 1.
Fucoidal markings in Swan Peak formation: Coulter, 1.
Interpretation of Permo-Carboniferous stratigraphy in east-central Idaho: Scholten, 3.
Late Mississippian stratigraphy in relation to central Montana uplifts: Sloss, 3.
Lemhi Range, Permian rocks: Blackstone, 1.
Lower and middle Cambrian stratigraphy in southeastern Idaho: Maxey, 1, 2.
Missing lower Paleozoic formation in Hells Canyon: Stearns, 5.
Mississippian-Pennsylvanian, in Rocky Mountain region: Williams, J. Steele, 1.
Mississippian stratigraphy: Holland, F. D., 1.
Northern Rocky Mountain and Great Plains area, Devonian: Andrichuk, 1.
Ordovician age of rocks: Berdan, 1.
Ordovician system in southeastern Idaho: Ross, R. J., 1.
Paleozoic sedimentation in Montana area: Sloss, 2.
Pennsylvanian and Permian rocks: Williams, J. Stewart, 2.
Pennsylvanian formations of North America: Moore, 1.
Permo-Triassic boundary in southeastern Idaho: Newell, N. D., 1.
Regional stratigraphic analysis of Devonian system: Andrichuck, 1.
Regional stratigraphy of Devonian system in southeastern Idaho: Brooks, 1.
Resumé of Paleozoic stratigraphy, Green River Basin: Williams, J. Stewart, 3.
Sections of the Metaline mining district, Pend Oreille County, Wash.: Dings, 1.
Sedimentation in the Cordilleran geosyncline: Warren, 1.
Sevy formation, lower Devonian: Osmond, 1.
Silurian formations of North America: Swartz, 1.
Silurian rocks of southeastern Idaho: Stokes, 3.
Southeast Idaho Cambrian sequence: Lockman-Balk, 1.
Stratigraphic sections of Phosphoria formation in Idaho: Davidson, D. F. 1; Sheldon, 1; Smart, 1.
Stratigraphy of Madison group of Montana: Sloss, 1.
Stratigraphy of part of Lemhi Mountains: Smedley, 1.
Summary of Paleozoic and Mesozoic stratigraphy: Stokes, 4.
Trias-Permo-Pennsylvanian sequence: Munyan, 1.
Upper Cambrian formations in southeastern Idaho: Hanson, 1.