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Uranium Occurrences in the Pacific Northwest

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URANIUM OCCURRENCES IN THE PACIFIC NORTHWEST

by

Charles Van Alstine

A Thesis

Submitted to the Department of Geology
in partial fulfillment of the
Requirements for the degree of
Bachelor of Science in Geological Engineering

MONTANA SCHOOL OF MINES
BUTTE, MONTANA

May 1955

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ABSTRACT

Uranium prospecting and production in the United States have been largely concentrated in the southwestern states, especially the Plateau region of Utah, Colorado, Arizona, and New Mexico. However, even with meager prospecting, numerous occurrences of uranium materials have been found in the Pacific northwest. These occurrences are in rocks ranging in age from pre-Cambrian Belt series to Tertiary volcanics and lake beds.

Thus far, the most promising concentrations of uranium minerals have been as veins in igneous rocks, typified by the Boulder batholith deposits; as fracture fillings and veins in metamorphic rocks, such as the Surprise, Waterhole, and Sunshine occurrences; and along the contacts between intrusive and metamorphic rocks, such as the Midnite deposit. No production has yet been realized from occurrences in sedimentary rocks similar to the Colorado Plateau-type deposits.

More intensive prospecting in this area will disclose other occurrences of uranium minerals, but whether many of these deposits will be of mineable grade and quantity remains to be seen.

URANIUM OCCURRENCES IN THE PACIFIC NORTHWEST

This paper is intended to be a summary of uranium occurrences and literature in the Pacific northwest states----Montana, Idaho, Washington and Oregon. Occurrences of appreciable uranium mineralization are discussed and classified with particular emphasis on geological setting and type of mineralization. Present thought on genesis of some of the deposits is mentioned, but a complete discussion of the problem of genesis of uranium deposits is beyond the scope of this report. Because the included area has not been intensively prospected and recent discoveries have stimulated wide interest, more occurrences of uranium mineralization are almost certain; therefore, this paper must be considered an interim report to the spring of 1955.

Material for this report is gathered mostly from recent U. S. Geological Survey and Atomic Energy Commission publications. Because the field of uranium geology has only been intensively explored in the last few years, information on many of the deposits is of only a general nature. Much information is in the process of being published, and therefore is not available for this report; other publications are classified because they contain information affecting the security of the United States. On several of the more recent and promising deposits, observations by the author and personal communications with government geologists are included with the permission of the owners of such deposits.

ACKNOWLEDGEMENTS

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INTRODUCTION

The advent of the "atomic age"---at least in the field of military weapons---found the United States in the position of being a leader in the development of atomic energy, but depending almost entirely on foreign sources for the raw materials to produce this energy. To stimulate exploration for and development of a domestic uranium supply, the United States government set up an incentive plan which includes a guaranteed price, bonus payments for new discoveries, and a purchasing system. The Raw Materials Division of the Atomic Energy Commission was created to supervise these plans and to aid and encourage prospecting.

In the late 1940's the major uranium occurrences in the United States were in the Colorado Plateau region. Naturally, initial prospecting was concentrated in this area. Encouraged by the success of several early prospectors, the search for and development of uranium deposits in the plateau area of Colorado, Utah, New Mexico, and Arizona grew into what is now called the "uranium boom".

In the Pacific northwest, a lack of known uranium deposits capable of commercial production, and a different geologic situation resulted in only limited prospecting and the absence of the enthusiasm noted in the Plateau. However, the discovery of uranium in localities and geologic circumstances much different from the Plateau, soon stirred interest in the northwest, and this area, long famous for its base and precious metal deposits, may become a prominent uranium producing area.

To encourage and supplement private prospecting, the Atomic Energy Commission, with cooperation from the Geological Survey and the Bureau of Mines, conducts exploration for uranium deposits, investigates and evaluates discoveries, does free assaying of uranium samples, and offers aid and advice in bringing promising prospects into the producing stage. Exploration by government agencies is concentrated mostly in mining districts and areas of probable geologic favorability for uranium deposition.

Besides ground reconnaissance, the Atomic Energy Commission also conducts aerial reconnaissance, using a light plane and a very sensitive scintillation counter. Where areas substantially above normal background radioactivity are found, they are marked on "anomaly maps" which are released through Atomic Energy Commission offices on the fifteenth of the succeeding month. Since the reason for the higher radioactivity can not be determined from the air, these anomalies are usually evaluated after they are posted and private individuals have had an opportunity to look at the area and stake claims if mineralization is found.

The Geological Survey and the Bureau of Mines collaborate on investigating properties for loans under the DMEA program and supervising those loans which are granted. Under the sponsorship of the Atomic Energy Commission, the Geological Survey also carries on regional studies of uranium deposits to determine the circumstances of deposition and other information which may be of value in discovering and evaluating new deposits or extensions of present deposits.

SUMMARY OF INDIVIDUAL OCCURRENCES

The following pages contain a summary of available literature on various uranium occurrences in the Pacific northwest states. The occurrences are arranged according to the type of host rock, and are not necessarily in order of discovery or importance. In each discussion particular emphasis is placed on geological setting, structural control of the deposit, and mineralogy. In most cases accurate figures of grade and extent of the mineralization are not available for this report.

Many of the occurrences listed have little or no potential for uranium production under present circumstances, but are described because they represent conditions which have been found favorable for at least some uranium mineralization.

Several interesting deposits recently found in northeastern Washington and northern Idaho are not included in this report because they have not been sufficiently exposed to permit detailed examination, and therefore, little information is available.

URANIUM DEPOSITS IN INTRUSIVE ROCKS

The first commercial uranium deposits in the Pacific northwest were found in the quartz monzonite of the Boulder batholith in southwestern Montana. Since the original discoveries, many occurrences of small amounts of uranium mineral have been noted, not only in the Boulder batholith, but also in intrusive rocks in Idaho and Washington. Few of these occurrences have a potential for production of ore-grade material under present conditions. In the uranium-bearing veins, quartz and pyrite are the predominant gangue minerals; lead, silver, and copper sulphides are the more common associated minerals.

Besides the vein-type of occurrence, numerous bodies of granite and gneiss have been found which exhibit abnormal radioactivity. This radioactivity is evidently caused either by a high ratio of the radioactive potassium isotope in potash feldspar, or by disseminated crystals of accessory minerals containing uranium and thorium. The maximum uranium content of these bodies is seldom over one or two hundredth of a percent.

Further exploration in intrusive rocks is probable as a result of recent discoveries of the uranium mineral, autunite, associated with this type of rock north and northwest of Spokane, Washington.

THE BOULDER BATHOLITH

Early in 1949, the presence of uranium minerals in the north-central part of the Boulder batholith was noted by prospectors from Boulder, Montana. In the next several years, investigation of the area revealed numerous occurrences of uranium minerals in widespread parts of the batholith. Most of the occurrences are in silicified shear zones; generally, these structures strike northeast-to-east and dip steeply northwest-to-north. Gross-faults commonly off-set the shear zones with displacement as much as 50 feet. Because they often stand as sharp ridges above the less resistant country rock, these structures are referred to as "reefs". Where the shear zones cut quartz monzonite, extensive kaolinization and sericitization of the quartz monzonite is noted, but little alteration is found where the shear zones cut alaskite.

Internally, the "reefs" are composed of silicified country rock with vari-colored lenses and segments of chalcedonic quartz; the several colors represent different ages of quartz. Uranium minerals are usually associated with one of the later ages of dark brown or black chalcedonic quartz. Near the surface, leaching and redeposition have distributed secondary uranium minerals into fractures within the silicified zone, in the altered quartz monzonite, and less commonly in the slightly altered alaskite. The most common secondary uranium minerals are gummite, autunite, meta-autunite, uranophane, and meta-torbernite. The primary uranium minerals, finely divided uraninite with the dark chalcedonic quartz and pitchblende, are usually accompanied by pyrite.

Because of the segmentation of the chalcedonic quartz, and hence the associated uranium minerals, only a few of the "reefs" which have anomalous radioactivity contain commercial concentrations of uranium minerals. Only one, the W. Wilson vein, thus far has been a substantial uranium producer.

Besides the silicified zone type of uranium occurrence, some uranium minerals have been noted with base metal veins near Basin and near Clancy, Montana. Even in these occurrences, the uranium appears to be the result of a later phase of mineralization than the associated base metals.

Descriptions of some of the better known and described uranium occurrences are included below.

The Free Enterprise Mine

The Free Enterprise Mine, located several miles west of Boulder, Montana, was one of the first discoveries of uranium mineralization in the Boulder batholith; Sanford Davis recognized secondary uranium minerals on the dump of an old prospect, and the property was reclaimed by Mr. Davis, Edward Miles, and Wade Lewis. The prospect, renamed the Free Enterprise, was leased to the Elkhorn Mining Company, Boulder, Montana; the early reopening work was done by the Sunshine Mining Company, Kellogg, Idaho, under an agreement with the owners. Reopening and devel-

opment work resulted in the shipment of some low-grade ore to Salt Lake City, and the production of a few tons of high-grade uranium-silver ore. In 1950, after most of the work had been completed, the Sunshine Mining Company discontinued its work at the project. The project was subsequently operated as a "health mine" for persons afflicted with arthritis and other ailments. The purported beneficial effect of these "health mines" is attributed to the concentration of radon gas in the workings.

This mine is located on a silicified shear zone which strikes N 60° E and dips steeply northwest. The roughly lenticular zone cuts both quartz monzonite and dikes of alaskite. Brecciation and discontinuous stringers of chalcedonic quartz within the zone parallel the strike.

On the 80-foot level of the mine, mineralization includes the secondary uranium minerals gummite, meta-torbernite, autunite, and a dark brown mineral which is probably uraninite. The associated minerals are pyrite, ruby silver, argentite, and native silver with some molybdenite, chalcopyrite, and barite. Later observations also indicated the presence of the secondary uranium minerals zeunerite and uranophane. The more soluble meta-torbernite and autunite are found as fracture coatings in and adjacent to the vein; the less soluble gummite and the primary minerals are found as lenses along the vein.

Thurlow and Reyner (1) indicate that secondary enrichment is probably responsible for the ore grade material on the 80-foot level; only slight radioactivity is found on the 140-foot level, which is evidently below the former water table of the area.

(1) Thurlow, Ernest E. and Reyner, M. L., "Free Enterprise Uranium Prospect, Jefferson County, Montana" U. S. Atomic Energy Commission RMO 678, 1950

A number of other "reefs" in the area also show radioactivity, but little work has been done on these since the Free Enterprise failed to produce more than small amounts of ore. The most perplexing problem of this type of discovery is the discontinuity of the ore. This condition is caused not only by discontinuous mineralization, but also by reopening and resilicification of the zones. Gouge material along the contacts of these zones indicates that at least some faulting has taken place along with the reopening of these zones.

The Comet-Grey Eagle Occurrence

The Comet and the Grey Eagle Mines are located several miles northwest of Boulder, Montana, in a rugged heavily wooded area of the northern Boulder batholith. Commonly, the quartz monzonite and associated rocks of this part of the batholith are cut by dikes and masses of what U. S. Geological Survey reports call alaskite; these bodies range in texture from the common aplite to rarer pegmatitic phases. Within this general area, pre-batholith volcanics overlie the intrusive rocks. Both the intrusives and extrusives are cut by dikes of dacite and andesite, and by numerous silicified shear zones.

The major structure of the area is the Comet-Grey Eagle shear zone, which contains silver, gold, lead, zinc, and copper minerals. This shear zone, 50-200 feet wide, strikes N 80° W, dips steeply to the northeast, and is cut by at least one large dacite dike and several smaller dacite and andesite dikes. Associated with the major structure are smaller zones of silicification which contain little of the base metal minerals and are evidently similar to the "reef" type zone of this area.

The workings of the Comet Mine are inaccessible, but the Atomic Energy Commission has sponsored some work to reopen the adit level of the Grey Eagle Mine; so far, only minor radioactivity has been found. The dumps of both of these mines show anomalous radioactivity; select samples from the Grey Eagle dump have run as high as several percent uranium oxide. No uranium minerals have been definitely identified, but some primary mineral with associated secondary minerals is indicated. From the dump material and the small amount of workings reopened in the Grey Eagle, it appears that the uranium is contained in two types of structure---the major vein with primary base and precious metals, and the silicified zones with few other ore mineral types.

Little can be said of the possibilities of this occurrence, or even of the detailed geology of the uranium mineralization until some further work is done to reopen the workings where the uranium was found.

The W. Wilson Claim

The W. Wilson is one of the President group of claims near Clancy, Montana, in the moderately rugged northern portion of the Boulder batholith; part of this group is on private land---the Haynes estate. Ore-grade secondary and primary uranium minerals have been shipped from surface and underground workings on the W. Wilson claim since 1951.

The W. Wilson vein, the major uranium-bearing structure in the group, strikes N 60° E and dips steeply to the northwest. Several of the other northeast-trending silicified shear zones on this property exhibit anomalous radioactivity, but have not been exploited for uranium minerals.

These veins are composed of silicified country rock and discontinuous stringers and lenses of chalcedonic quartz. Several stages of quartz mineralization are indicated by segmentation, brecciation, and subsequent resilicification of the vari-colored quartz stringers. As is the case with other deposits of this type in the Boulder batholith, uranium minerals are evidently associated with one of the later stages of dark chalcedonic quartz, and are likewise in discontinuous stringers and lenses.

Uraninite with closely associated gummite-type minerals is surrounded by torbernite-zeunerite and autunite or uranocircite fracture fillings. Galena, pyrite, iron oxides, and quartz are the main gangue materials. Production from this property required selective mining and careful sorting of the ore with a Geiger counter to maintain ore-grade material.

Considerable diamond drilling and excavation has been sponsored by the Atomic Energy Commission to determine the extent and continuity of the uranium mineralization along these structures and at depth.

The Mooney Group

Radioactivity on what is now the Mooney claim, in the German Gulch mining district, southwest of Butte, Montana, was found by an Atomic Energy Commission geologist and published as a ground anomaly to be staked by private parties. William R. Mooney staked the claims shortly after the anomaly was published. Since that time, the property has changed hands twice, but no ore has yet been produced.

Geologically, this deposit is in the same category as most of the other uranium deposits of the Boulder batholith---the siliceous

"reef" type deposits. The property is near the contact of the host intrusive rocks and the tuffaceous basin deposits to the east which separate this outlier from the main batholith. The country rock is the typical quartz monzonite of the batholith with numerous dikes and irregular masses of alaskite. Siliceous zones in the immediate vicinity of the property are nearly vertical and strike N 70° E-to-east. The Mooney vein does not stand up as a reef, but the vein is outlined by the broken silicified material on the surface. This vein is a typically irregular zone of silicification with discontinuous stringers of silica generally parallel with the trend of the vein. Segmentation of the stringers with recementation by newer ages of quartz is easily distinguished by the different colors of the individual ages of silica. As in the other deposits of this type, black chalcedonic quartz is one of the later stages of silicification and may be associated with the uranium.

The Mooney vein itself is from one-half to one and one-half feet wide and can be traced on the surface for about two hundred feet. Uranium minerals, like the dark chalcedonic quartz, are found in pods and thin stringers along the vein. Near the surface, the uranium minerals are autunite and torbernite, or their meta varieties, distributed along fractures and cavities in the vein, and to a lesser extent in the wall rock. The associated minerals are stibnite, pyrite, and some galena.

The Atomic Energy Commission sponsored drilling on the property to determine the depth and distribution of the uranium mineralization. Uranium mineral was found in some of the drill holes at depths up to 70 feet down the veins, but because of the discontinuity of the uranium

mineralization, this type of exploration was not entirely satisfactory, and correlation between the drill holes and the surface is uncertain.

Exploration on deposits of this type indicates that for large-scale production, more continuous mineralization or larger pockets of ore must be found.

URANIUM DEPOSITS IN METAMORPHIC ROCKS

Occurrences of uranium minerals have been noted in the metamorphic rocks of western Montana, Idaho, and northeastern Washington. In the Montana and Idaho occurrences of this type, the host rocks are usually pre-Cambrian Belt series quartzites, schists, and phyllites. In northeastern Washington, the occurrences in metamorphic rocks have so far been closely associated with the contact zones between paleozoic meta-sediments and Mesozoic intrusives.

The major structures in this type of deposit are fault or contact zones; fracture cleavage and movement along planes of schistosity are usually the controlling factors in the redistribution of secondary uranium minerals.

Quartz, pyrite, and iron oxides are the principal gangue minerals. Autunite, torbernite, and uranophane are the more abundant secondary uranium minerals; uraninite is the usual primary mineral where the deposits have been explored below the zone of weathering.

The Coeur d'Alene district in Idaho and the Midnite contact-type deposit in Washington are presently the most promising of the occurrences in metamorphic rocks. Much of the present exploration in the Pacific northwest is being concentrated on the metamorphic rocks of eastern Washington, Idaho, and western Montana.

COEUR D' ALENE DISTRICT

The Coeur d' Alene mining district has long been noted as a producer of base and precious metals from large veins to the north and south of the Osburn fault. Therefore, when the need for uranium became critical, this area was intensively investigated for uranium mineralization by both government agencies and the interested private parties. No appreciable surface mineralization has been found, but in 1949, in the deeper levels of the Sunshine Mine, several veins close to the major ore-producing veins were found to contain uraninite in association with silicification. Since that time, some exploration work and diamond drilling have been done to determine the grade and extent of the uranium mineralization. Much of this work was done by the Sunshine Mining Company under contract with the Atomic Energy Commission.

Since the original discovery in the Sunshine Mine, very similar veins containing uraninite have been found in several of the mines of the Coeur d' Alene district. These veins have been found approximately one and one-half miles south of the Osburn fault and in about a twelve mile extent paralleling this fault. It is quite possible that although no production has yet been realized from these occurrences, future exploration will enable uranium to be added to the list of major minerals produced from the Coeur d' Alene mining district.

The occurrence at the Sunshine Mine is the only one discussed in this report because more exploratory and laboratory work has been done on this occurrence, and much of the information is available.

The Sunshine Mine

The Sunshine Mine, Shoshone County, Idaho, is located four miles east of Kellogg in the famous "silver belt" of the Coeur d' Alene mining district. This mine has long been one of the most important silver producers in the northwest. A routine investigation of the workings for uranium mineralization by Atomic Energy Commission personnel revealed that several small veins parallel to the main silver-bearing veins on some of the deeper levels are highly radioactive. Further investigation revealed the presence of appreciable amounts of the primary uranium mineral, uraninite. The Atomic Energy Commission sponsored exploration both by excavation and by diamond drilling to determine the grade and extent of the uranium-bearing structures.

Although ground reconnaissance has not been intensive in this rugged heavily wooded area, there have been no commercial quantities of uranium mineral found on the surface in the mining district. In this occurrence, uranium bearing structures have not been found in the upper levels of the mine; evidently, the uranium mineralization has been confined to greater depths than the base metal mineralization. Work in other areas indicates that uranium mineralization may extend over a much greater depth range than was previously thought. Thus far insufficient exploration has been done to determine the lower limits of the Sunshine uranium-bearing structures; so the production potential of this occurrence can not yet be evaluated.

In each place they have been found, the uraninite veins of the Sunshine have a number of distinctive features. All of the veins with appreciable uranium content are surrounded by a reddish alteration of quartzite. The source of this color, although not definitely determined, is possibly very finely divided hematite in the quartzite. (2) Thus far, the amount of uranium in the veins appears to be roughly proportional to the intensity of the coloration.

The uraninite is associated with pyrite, argentite, tetrahedrite, arsenopyrite, and some chalcopyrite, in a gangue composed mainly of siderite and intensely silicified country rock, cut by veinlets of rose-colored quartz. Galena is an occasional associated mineral, but appears to be later than the other minerals. (3) The uraninite often selectively replaces the rose-colored quartz, and occasionally the tetrahedrite. (4).

The uranium-bearing veins are the product of several periods of reopening and remineralization. Both along the strike and the dip of the vein, mineralization is discontinuous and lenticular. There are some indications that high uranium assays are accompanied by relatively high silver assays at least on the 3100-ft. level.

- (2) Robinson, Raymond F., "Uraninite in the Coeur d' Alene District, Idaho" Economic Geology vol. 45, pp 818-19, 1950
- (3) Kerr, Paul F. and Robinson, Raymond F. "Uranium Mineralization in the Sunshine Mine, Idaho" Mining Engineering vol. 5, pp 495-511, 1953
- (4) Thurlow, Ernest E. and Wright, Robert J., "Uraninite in the Coeur d' Alene District, Idaho" Economic Geology vol. 45, pp 395-404, 1950

A very interesting sidelight to this occurrence concerns the age of the uranium mineralization. Work by Kerr and Robinson (5) for the Sunshine Mining Company indicates that the uranium mineralization may be prior to the major silver-bearing mineralization in the mine. An Atomic Energy Commission age determination places the uranium mineralization 750 million years ago---in the late pre-Cambrian era. Although this age has not yet been confirmed by further determinations, if correct, the uranium minerals were introduced prior to the Laramide disturbance---the period to which the silver mineralization and much of the major structure is attributed. Because of a lack of adequate information as yet, the import of this hypothesis can not be evaluated, but it presents a very interesting problem in the length of time separating various periods of mineralization.

Geologically, the Coeur d' Alene mining district is located in an area of highly disturbed pre-Cambrian metamorphics of the Belt series. The formations, distinguished on the basis of lithology, bedding, and to some extent, color, are the Prichard, Burke, Revett, St. Regis, and Wallace (from oldest to youngest). The uraninite of the Sunshine Mine has been found almost exclusively in the altered quartzite of the St. Regis formation which is generally over a thousand feet thick. These purplish quartzites are bleached where mineralization has occurred. Within this same general area, the Belt series has been intruded by monzonitic stocks which are possibly related to the Idaho batholith; basic dikes are also common in the sediments.

(5) Kerr, Paul F. and Robinson, Raymond F., "Uranium Mineralization in the Sunshine Mine, Idaho" Economic Geology vol. 47, pp 123-124, 1952

Structurally, the Silver Belt lies between two large faults; the Osburn fault on the north has been traced all of the way across northern Idaho with vertical and horizontal displacement in thousands of feet; the Big Creek fault to the south is along the overturned limb of the Big Creek anticline. The main ore-bearing structures between these two faults are a series of shear zones parallel or at low angles to the major faults.

In the Sunshine Mine, the primary uraninite has been found in small veins adjoining the silver ore-bearing shear zones. Most of the uranium mineralization has been found on the footwall side of the main Sunshine vein. "The uranium-bearing structures parallel the strike of bedding and are in part controlled by fracture cleavage." (6) Small anticlinal flexures on the major structure may also be very important in the deposition of uranium; thus far, much of the uranium mineral has been found at or near the crests of these structures.

The Midnite Mine

Although some radioactive minerals were reported from the state of Washington, no deposit capable of commercial production was found until 1954 when two brothers, James and John LeBret, from the Spokane Indian Reservation found uranium minerals in the northern part of that reservation---about 60 miles northwest of Spokane. Prospecting with a Geiger counter along a contact of granite with metamorphics, the two brothers found several areas of high count. An ultraviolet light

(6) Thurlow, Ernest E. and Wright, Robert J., "Uraninite in the Coeur d'Alene District, Idaho" *Economic Geology* vol. 45, pp 395-404, 1950

indicated that the yellow-green flakes found in outcrops and old prospect pits along the contact were the uranium mineral, autunite. The mineral is possibly the more common meta autunite. Several months were consumed in forming a partnership with the Wynecoop brothers and negotiating a lease from the reservation on land along the contact. A corporation, Midnite Mines, Inc., was later formed.

Early in the fall, surface mining was started on the property, and in December a U. S. Bureau of Mines drilling rig started drilling for the Atomic Energy Commission to determine the attitude and nature of the ore zone at depth. The first ore from the mine was shipped early in December, and by the end of that month, twelve cars of ore had been shipped to the Salt Lake buying station.

The Midnite Mine is located in the moderately rugged mountains of southern Stevens county, Washington; vegetation and soil cover are moderate, and outcrops are common on the ridges and steeper hillsides. The exposed rocks are the Loon Lake granite and a thick series of lower (?) Paleozoic metamorphics---the Stevens series. The Loon Lake granite is commonly medium to coarse grained; the composition is generally granitic, but gradations to syenite and diorite are found.

The Stevens series is composed of beds of argillite, quartzite, schist, and limestone or dolomite. This series is generally considered to be the lower Paleozoic strata in this area. Because of the metamorphism and intrusion in northeastern Washington, little has been done to correlate the Paleozoic of this area with unmetamorphosed strata, or even to correlate the various occurrences of the Paleozoic metamorphics within this region.

In the area of the property, the Stevens series is represented by a brown-to-dark gray thinly-bedded argillite and schist sequence---the

Deer Trail argillite. At the surface exposures of the contact the metamorphic rock is a brown quartz-mica schist. The schistosity is approximately along the bedding, strikes N 10° W-to-N 30° E and dips 50-70° E. Occasional outcrops of white quartz are noted within several hundred feet of the contact.

The contact itself is irregular, but trends generally north with a variable dip to the east. In the area of the initial mining operation, the contact appears to dip with the schistosity---50-60° E; outcrops to the north and south, however, indicate that the contact often dips only 20-30° E. The ore uncovered has been on either or both sides of the contact; however, the ore shipped thus far has come almost entirely from the schist side of the contact. Mineralization in the schist is concentrated in the fracture, shear, and foliation planes of the rock; thus, the mineralization tends to be more concentrated in zones of intense fracturing. In the granite, on the other hand, the mineral is disseminated through the rock with less restriction to parting and fracture planes.

A thin elongate body of fine-grained granitic material dipping with the contact was uncovered by the mining. Little count or mineralization has been found in this material, although mineralization is visible on both sides of the body. Whether this is merely a chilled phase of the granite, or a dike forced in along the contact has not been determined; the lack of mineralization in the material suggests the latter explanation because the normal granite is usually well mineralized at the contact. The effect of this body and several large shear zones close to the contact can not be determined without further work.

Ore minerals so far identified include autunite and uranophane; torbernite and several rarer uranium minerals are probably present although not yet positively identified. No primary uranium mineral has been seen in the surface workings and cuts. Abundant pyrite is found in certain zones in the argillite; dark gray-to-black quartz, a common mineral with hydrothermal uranium deposits, is found near the contact as veinlets and lenses. Clay minerals and very finely-ground biotite are found in shear zones paralleling the contact. Stains and veinlets of iron oxides are especially prevalent along the fracture planes; also noted is a bright red fracture-staining in the schist which may be hematite, another common associate of hydrothermal uranium deposits.

The width of the mineralized zone varies from several inches to tens of feet; in most cases the highest radioactivity is at the contact. As in many uranium deposits, some sorting, especially in the wider ore zones, is necessary to maintain commercial grade material. The future of this mine depends very much on the distribution of the mineralization at depth.

The Garm-Lamoreaux Occurrence

The Garm-Lamoreaux property is located on Allen Creek, 11 miles north of North Fork, Idaho. Several adits on the property were originally worked for gold in quartz-pyrite veins.

The country rock in this area is pre-Cambrian Belt series quartzite, schist, and phyllite. The uranium minerals, torbernite, uraninite, and possibly autunite, occur with galena and gold as lenses and stringers along the main fracture zone which strikes approximately N 80° W and dips 60-80° NE. The gangue minerals are quartz and iron oxides. No production has been realized from this property.

MISCELLANEOUS URANIUM OCCURRENCES

Uranium has been found in a number of occurrences which are not commercial under present conditions, but which may be utilized if the need for uranium becomes critical, or if more economical methods of treating the ore to extract uranium are found for these types of occurrences.

Appreciable amounts of uranium occur in the Permian Phosphoria formation of southwestern Montana and eastern Idaho. No economical method has been developed for treating this material solely for uranium; as a by-product, however, uranium has been extracted from similar deposits in Florida. Some of the lignite beds of eastern Montana and the adjoining areas of North and South Dakota contain uranium minerals in commercial grade under present conditions, but the uranium can not be economically extracted by present methods. Concentrations of primary and secondary uranium minerals are found in some pegmatite dikes, but only as small pods and stringers; attempts to exploit these structures for the uranium content alone have not proven economical.

Uranium Deposits in Lignites

A different type of sedimentary uranium occurrence has caused interest recently in easternmost Montana and the adjoining areas of North and South Dakota. In this area secondary uranium minerals are found in low-grade coal horizons of Tertiary sandstones and mudstones. Uranium minerals in these lignites are not evenly distributed, but are found in seemingly erratic concentrations in the carbonaceous material. The grade and extent of the various occurrences have not been completely determined as yet.

Several hypotheses have been proposed for the origin of the uranium minerals. One of these hypotheses is that the uranium was deposited in the lignite by hydrothermal solution, although, in most cases, there are no nearby igneous bodies as a source of the solutions. A second hypothesis is that the uranium was deposited with the carbonaceous material and redistributed either shortly after deposition, or much later by meteoric waters. A third, and perhaps the most promising hypothesis, is that the uranium was leached from overlying tuffaceous sandstone beds and precipitated from solution by the carbonaceous material. In some places the tuffaceous sandstone still overlies the formation containing the lignite, but in many occurrences, erosion has removed the sandstone source beds.

Progress in the development of this type of occurrence may be slow because as yet, no economical method of extracting the uranium has been found, and therefore, only limited quantities have been purchased for experimental use and stockpiling.

Uranium in Pegmatites

Although commercial production of uranium from pegmatites is unlikely, complex pegmatites containing uranium, thorium and rare earth elements are found in all of the states of the northwest. Typically, uranium-bearing pegmatites are zoned with uranium, thorium, and rare earth minerals being more abundant in one or more of the inner zones. These minerals are found as crystals, groups of crystals, or stringers.

Primary minerals include uraninite, thorianite, and a host of complex oxides, phosphates, and silicates; the more common of these minerals are samarskite, euxenite, fergusonite, monazite and allanite. Each of these complex minerals can contain variable amounts of uranium as a minor constituent. The most common secondary uranium minerals are the typical orange, yellow, and green minerals; such as gummite, uranophane, uranocircite, autunite, and torbernite. The gummite is usually found with the remaining primary mineral, but the other more soluble uranium minerals tend to migrate to fractures in the pegmatite and surrounding rock.

Commercial production from this type of occurrence is improbable because the primary and secondary uranium minerals are a very small part of the dike material; the complex oxides likewise are sparsely distributed, and contain too little uranium to make mining and concentrating of the minerals profitable for uranium production.

Uranium in Black Marine Shales

Detailed examination and sampling of black marine shales have shown that some of these sediments, especially those forming the Devonian-Mississippian boundary in the east central United States, contain a significant amount of uranium. Although even the higher grade zones in these black shales only assay .02-.03 percent U_3O_8 , the vast amount of such material makes the formations interesting as a possible source of uranium. The distribution of the uranium indicates that it is probably syngenetic with the black shale; investigations thus far also indicate that the uranium tends to be higher grade in the more carbonaceous zones of the black shale.

Investigations of black shale outcrops in Montana and Idaho have failed to find exposures with uranium content comparable to such formations as the Chattanooga shale in Tennessee or the Hartville formation in Wyoming.

THE FUTURE OF URANIUM IN THE PACIFIC NORTHWEST

Prior to 1953, the only substantial producing uranium deposit in the Pacific northwest was the W. Wilson Mine in the Boulder batholith. Prospecting had not been intensive, even in the batholith where several occurrences were known; most of the metamorphic and igneous rocks of the northwest had received only cursory coverage in spite of the uranium occurrences in the Coeur d' Alene district metamorphics. Relatively few people were engaged in actually prospecting for uranium. Airborne work by the Atomic Energy Commission in central Montana did not disclose commercial sedimentary deposits of the plateau type.

By the spring of 1955, the situation was greatly changed. Failure of further prospecting in the Boulder batholith to find more commercial deposits made the future of siliceous "reef" type deposits in this area uncertain. The geographical distribution of commercial uranium deposits in the western states widened to include new areas in Arizona, Nevada, California, Texas, South Dakota, and Wyoming; this development caused increased interest and prospecting in the Pacific northwest as people began to realize that the distribution of uranium deposits was much greater than first thought. The largest single factor causing a change in the uranium picture of the northwest was the discovery and development of several commercial or near commercial deposits in the metamorphic rocks of Montana, Idaho, and Washington---the Waterhole, Surprise, and Midnite deposits.

The Surprise and Waterhole discoveries caused widespread interest in eastern Idaho and western Montana. The Midnite deposit created interest in northeastern Washington and northern Idaho of almost boom proportions. Despite the fact that the Midnite began actual production late in the fall, there was a rush of prospecting, staking, and leasing in Stevens county. Considerable private flying was done and numerous anomalies were reported from the air but winter weather hampered ground evaluation.

The emphasis of uranium prospecting in the northwest, then, has become centered on the metamorphics, intrusives and the contacts between these rocks, with special interest in northeastern Washington and northern Idaho. At least one other interesting property has been found in northern Spokane county, Washington, but snow prevented enough work to indicate the potential or even the specific geology of the occurrence.

The spring and summer of 1955 should be the best period thus far in the development of a uranium industry in the Pacific northwest. More occurrences in northeastern Washington and northern Idaho seem assured; the potential of such deposits remains to be seen. It would also seem that the central part of Idaho, parts of western Montana, and the Cascade Range, especially in northwestern Washington, would be favorable for more vein-type deposits. Central and eastern Montana have not been thoroughly prospected, and it is quite possible that more intensive work may result in deposits in this area.

From the above, it may be deduced that the 1955 field season will be a crucial period for the field of uranium in the northwest. Certainly, more prospecting will be done than in previous years; the results of this prospecting will do much to set the pace of development in the next few years.

BIBLIOGRAPHY

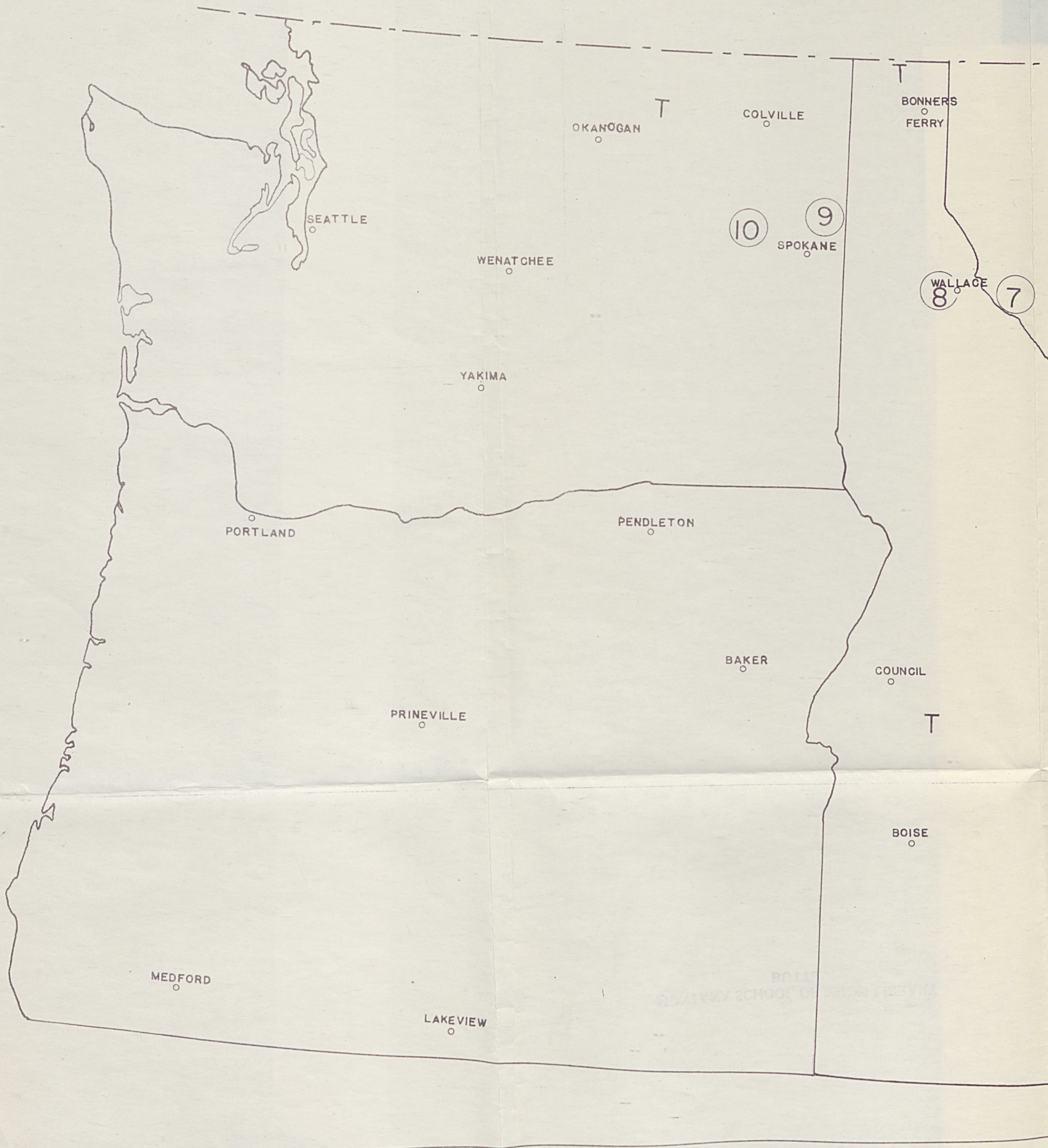
- Becraft, George E., "Preliminary Report on the Comet Area, Jefferson County, Montana" U. S. Geological Survey Circular 277, 1950
- Duncan, Donald C., "Reconnaissance Investigations for Uranium in Black Shale Deposits of the Western States During 1951 and 1952" U. S. Geological Survey TEI 381, 1953
- Everhart, Donald L., and Wright, Robert J., "Geologic Character of Typical Pitchblende Veins" Economic Geology vol. 45 pp 77-96, 1953
- George, D'Arcy, "Mineralogy of Uranium and Thorium Bearing Minerals" U. S. Atomic Energy Commission RMO-563, 1949
- Hail, W. J. Jr., Gill, J. R., "Reconnaissance of Uraniferous Coal, Lignite, and Carbonaceous Shale in Western Montana, 1953" U. S. Geological Survey Circular 251, 1953
- Kaiser, E. P. et al., "Selected Papers on Uranium" U. S. Geological Survey Circular 220, 1952
- Kerr, Paul F. and Robinson, Raymond F., "Uranium Mineralization in the Sunshine Mine, Idaho" Economic Geology vol. 47 pp 123-124, 1952
- Kerr, Paul F. and Kulp, J. Lawrence, "Pre-Cambrian Uraninite, Sunshine Mine, Idaho" Science vol. 115, pp 86-88, 1952
- Kerr, Paul F. and Robinson, Raymond F., "Uranium Mineralization in the Sunshine Mine, Idaho" Mining Engineering vol. 5, pp 495-511, 1953
- Knoerr, Alvin W. "Uranium" Engineering and Mining Journal vol. 153, no. 2 pp 92-94, 1952
- Love, J. D., "Uranium Content of Mid-Pennsylvania Black Shales Penetrated in Well in Southeastern Wyoming" U. S. Geological Survey TEM 122, 1950
- McKelvey, V. E. and Nelson, J. M., "Characteristics of Marine-Uranium-bearing Sedimentary Rocks" Economic Geology vol. 45, pp 35-53, 1951
- McKelvey, V. E., Page, L. R., Fischer, R. P., and Butler, A. P. Jr., "Uranium Deposits in the United States" (abs) Economic Geology vol. 47, no. 1, p 125, 1952
- Moen, Wayne S., "Uranium Mineralization at the Mooney Claim, Silver Bow County, Montana" U. S. Atomic Energy Commission RME 2006, 1954
- Nininger, Robert D., "Minerals for Atomic Energy" D. Van Nostrand Company, Inc., New York, 1954

2 6 7 2 3

- Page, L. R., "Uranium in Pegmatites" Economic Geology vol. 45, no. 1, pp 12-34, 1952
- Reyner, M. L., "Reconnaissance of Basin-Boulder-Clancy Area, Jefferson County, Montana" U. S. Atomic Energy Commission RMO 674, 19
- Roberts, W. A. and Gude, A. J. 3rd, "Uranium-bearing Deposits West of Clancy, Jefferson County, Montana" U. S. Geological Survey Bulletin 988-F, 1953
- Robinson, Raymond F., "Uraninite in the Coeur d' Alene District" Economic Geology vol. 45, pp 818-819, 1950
- Thompson, M. E. "Distribution of Uranium in Rich Phosphate Beds of the Phosphoria Formation" U. S. Geological Survey Bulletin 988-D, 1953
- Trites, Albert F. and Tooker, Edwin W., "Uranium and Thorium Deposits in East-central Idaho and Southwestern Montana" U. S. Geological Survey Bulletin 988-H, 1953
- Thurlow, Ernest E. and Reyner, M. L., "Free Enterprise Uranium Prospect, Jefferson County, Montana" U. S. Atomic Energy Commission RMO 678, 1950
- Thurlow, Ernest E. and Wright, Robert J., "Uraninite in the Coeur d' Alene District, Idaho" Economic Geology vol. 45, pp 395-404, 1950
- Vhay, J. S., "Reconnaissance Examination for Uranium at Six Mines and Prospects in Idaho and Montana" U. S. Geological Survey TEM 30-A, 1951
- Vine, J. D. and Moore, J. W., "Uranium-bearing Coal and Carbonaceous Rocks in the Fall Creek Area, Bonneville County, Idaho" U. S. Geological Survey Circular 212, 1952
- Weaver, Charles E., "The Mineral Resources of Stevens County" Washington Geological Survey Bull. No. 20, 1920
- Youngberg, Elton A. and Wilson, Thomas L., "The Geology of the Holden Mine" Economic Geology vol. 47, pp 1-12, 1952

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SEATTLE

OKANOGAN

COLVILLE

BONNERS FERRY

WENATCHEE

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9

SPOKANE

WALLACE

7

YAKIMA

PORTLAND

PENDLETON

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COUNCIL

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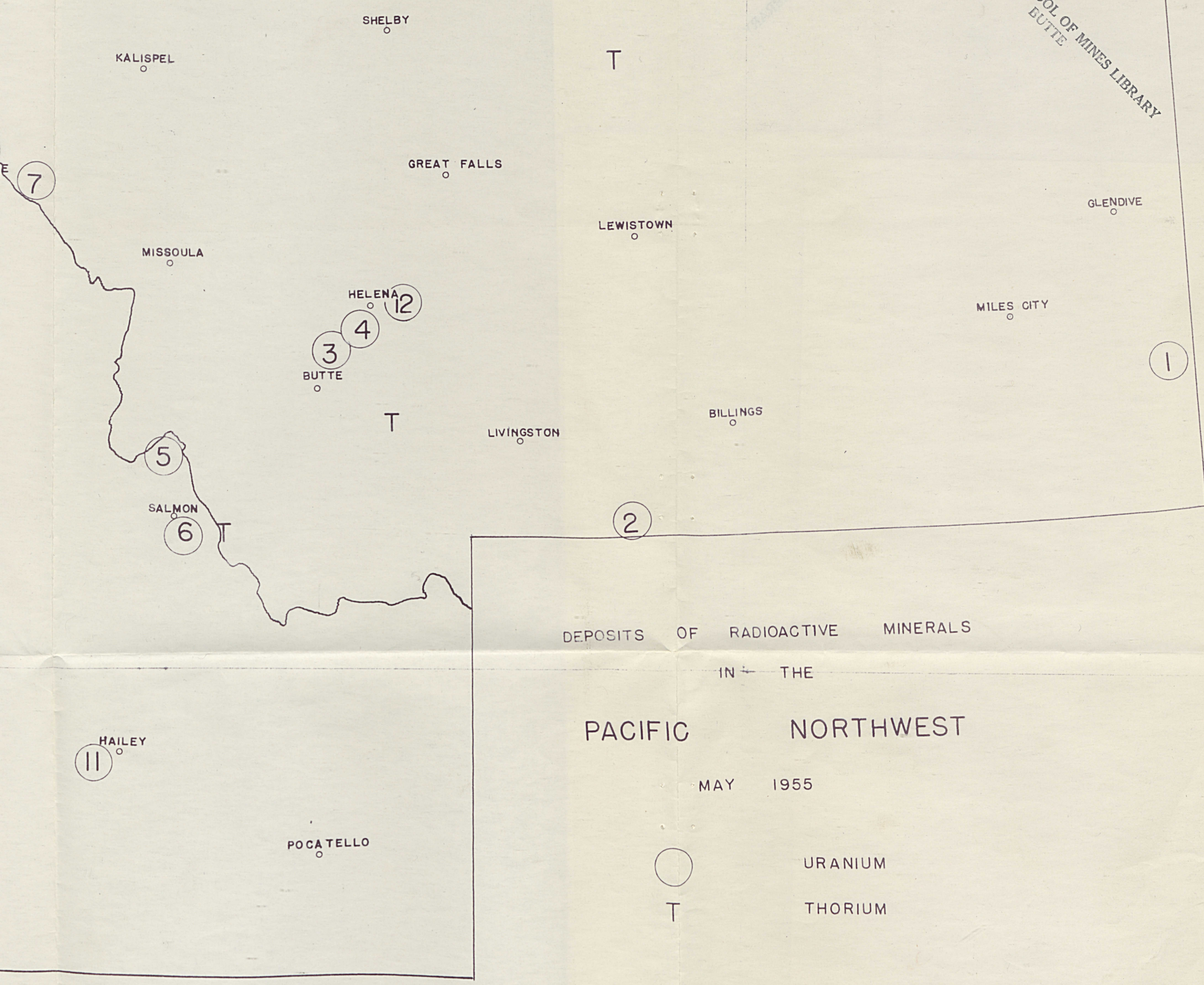
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DEPOSITS OF RADIOACTIVE MINERALS
IN THE

PACIFIC NORTHWEST

MAY 1955

○ URANIUM
T THORIUM