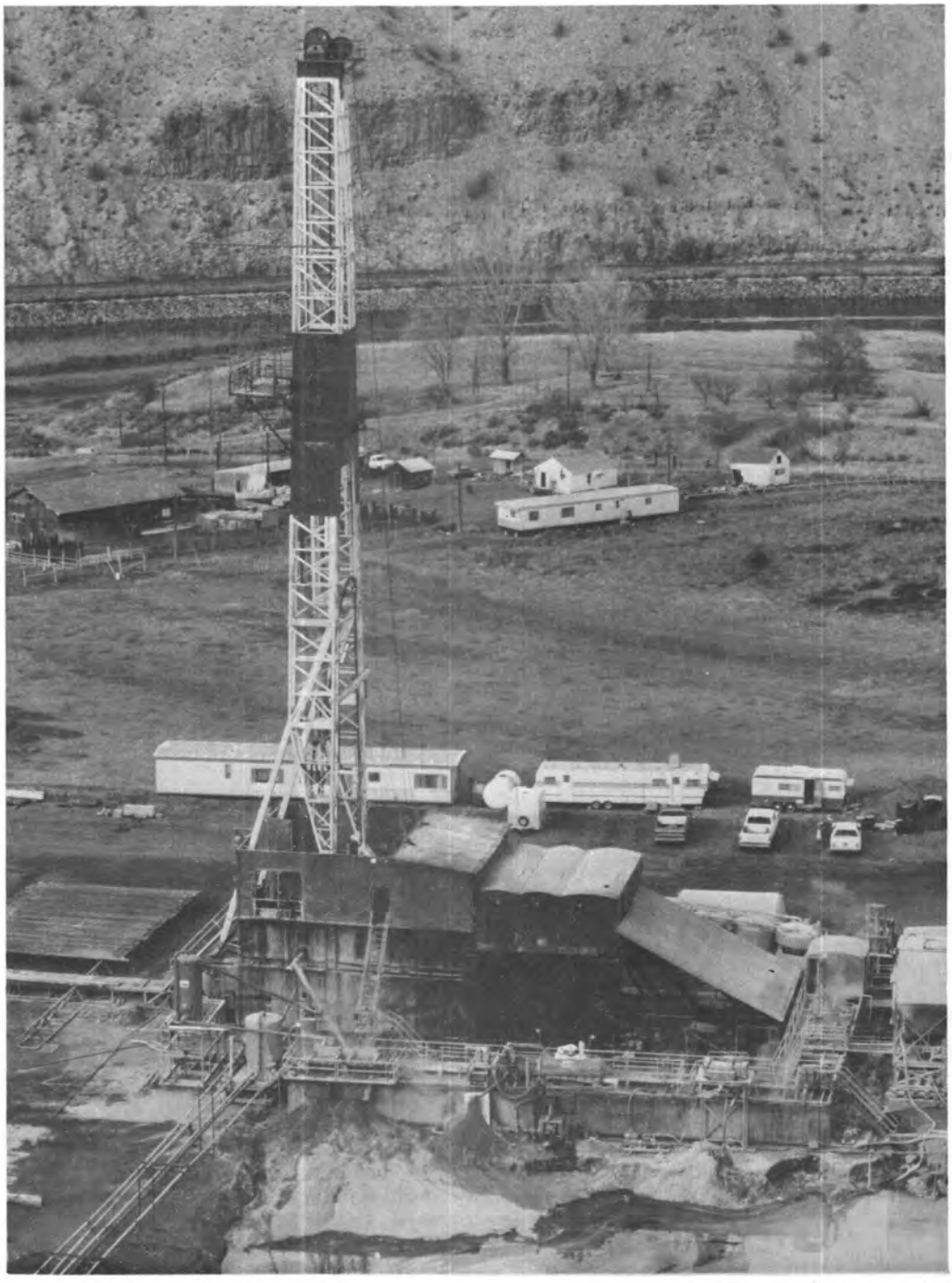
April 1982 Volume 10 Number 2

WASHINGTON GEOLOGIC NEWSLETTER



SHELL OIL CO.'S YAKIMA MINERAL CO. NO. 1-33 EXPLORATORY WELL

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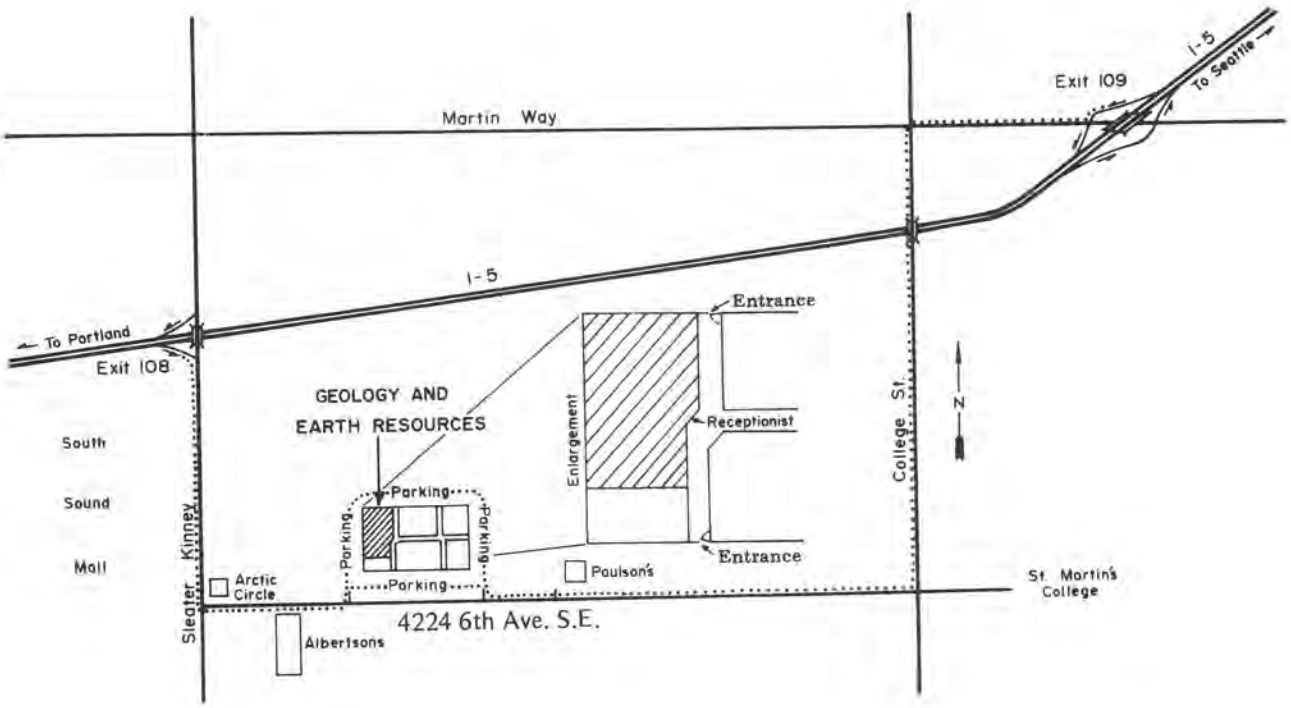

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The Washington Geologic Newsletter, a quarterly report of geologic articles, is published by the Division of Geology and Earth Resources, Department of Natural Resources. The newsletter is free upon request.

The division also publishes bulletins, information circulars, and geologic maps. A list of these publications will be sent upon request.

OIL AND GAS POTENTIAL OF THE NORTHWEST AND 1981 DRILLING ACTIVITIES

by Carl R. McFarland

INTRODUCTION

The Northwest has been no bonanza for oil and gas exploration during its roughly 80 years of exploration history. There have been some 443 wells drilled in the State of Washington (McFarland, 1981), about 275 in Oregon, and 130 in Idaho, since drilling began around the turn of the century. Most of these have failed to achieve true commercial production. The Mist Field discovery in 1979 in Columbia County, Oregon, became the first commercially utilizable field discovered from all of this exploration.

Historically, the first wells that were drilled in the three states, up until World War I, were located, for the most part, on oil and gas seeps. Promotional wells were drilled near towns and on obvious surface features. None of these wells were successful.

In the early 1930's, major companies began drilling on structures based on surface geology. They were reasonably well located and provided a great deal of information; for example, the Ohio Oil Co.'s 7,000-foot Berry Robinson No. 1 well near Aberdeen. After this drilling, activities subsided until about the end of World War II. At that time the application of geology became more sophisticated. Companies began using geophysical tools, stratigraphic data were applied, and source and reservoir rock potential, as well as the more subtle aspects of structures, were considered. Hundreds of core holes were drilled in the three states during this phase of exploration, making available microfaunas beneath deep zones of weathering that provided much information on the stratigraphy.

The Texas Co. also drilled their Clark & Wilson No. 1 well in Oregon during this period of time, which had a flow of saline water with considerable gas. This well was drilled downdip from the existing Mist Field; in fact, the producing sand of the Mist Field, the Clark and Wilson sand, bears the name of The Texas Co. well. A few years following this flurry of activity, the Sunshine-Medina No. 1 well was drilled near Ocean Shores, which was the only well that approached commercial production in Washington State. The Pleasant Valley Gas and Oil Company drilled their Guenther No. 1 well near Chehalis, Washington, and discovered a domal structure that contained some gas with slightly saline water in the late Eocene Skookumchuck Formation. This structure later became the Jackson Prairie gas storage reservoir. Additional drilling in the 1970's provided much information but little else until the Mist Field discovery in 1979.

We are now in what could be the most important period of exploration the Northwest has experienced to date. All of the information gained from past experience and all tools and techniques that were used in the past are available. In addition, we have many new tools, techniques, and geologic concepts today that will aid in the search for petroleum, such as far more sophisticated seismic methods employing computer techniques, advanced knowledge of magnetic surveys, the use of satellite imagery, geochemical surveys and new data on thermal maturity of rocks. In addition, new concepts have developed; for example, exploration related to overthrusting, as applied to drilling in western Montana and eastern Idaho, may now open up new frontiers in other areas of the Northwest.

AREAS OF EXPLORATION INTEREST IN WASHINGTON

South and East Flanks of Willapa Hills

The south and east flanks of the Willapa Hills include much of Pacific and Wahkiakum Counties, and the western edge of Lewis and Cowlitz Counties.

Recent mapping by R. E. Wells (1981) and earlier studies of Wolfe and McKee (1968) now provide basic geologic data for an extensive area of southwest Wash-

ington adjacent to the area of the Mist, Oregon, gas discovery. These studies indicate that a sedimentary sequence ranging in age from Eocene to middle Miocene is moderately folded. Numerous folds secondary to the Willapa uplift have also been developed in these rocks. The late Eocene Cowlitz Formation is within this sequence. These, and other strata of late Eocene age, are equivalent in age and similar in lithology to the producing strata of the Mist Field in adjacent northwest Oregon. Recently, leasing activities have been brisk in this area. It is possible that a well may be spudded within a year.

Grays Harbor, Centralia-Chehalis Basin

The Grays Harbor, Centralia-Chehalis basin has a Tertiary marine sequence consisting of sandstone and conglomerates coupled with marine organic shales. Structures involving these strata are typified by an elongated anticlinal feature such as the Melbourne-Caldwell Creek anticline that extends north through the town of Montesano. This locale appears to be one of the promising areas of the state to search for oil and gas. The Jackson Prairie gas storage structure is located within this basin and has proven that rocks with reservoir characteristics do exist here. The Jackson Prairie unit is completed in the Skookumchuck Formation, a sandstone equivalent to the late Eocene Cowlitz Formation which is similar in age and type to the Clark and Wilson sands of the Cowlitz Formation of the Mist Field in Oregon. Approximately 45 wells were drilled within this basin with many good oil and gas shows. The most notable was the Conoco-Sims Oil Royalty Co. No. 1 located on the Caldwell Creek anticline. Testing in this well produced 60,000 cubic feet (60 MCF) of gas per day at a depth of 2,571 to 2,593 feet from a basal sandstone of the late Miocene Montesano Formation.

Puget Lowland

The Lake Tapps area and the adjoining Black Diamond area of Pierce and King Counties received considerable exploration attention, with approximately 30 wells drilled in the two areas to date. Drilling in the Black Diamond area has been on the Kummer anticline, which is asymmetrical and plunges to the north. Over half of the wells drilled here had good shows of gas or oil. The Washington-California Oil & Gas Co.; Sound Cities Gas & Oil Co., Inc.-Bobb No. 1 well reportedly produced 500 barrels of oil in 14 hours after having pumped water and gas for over a year. At the end of 14 hours, however, production ceased. Efforts directed toward resumption of production caused the casing to collapse. There is no proof that structural closures exist on the Kummer anticline; however, ample evidence indicates that fault traps exist.

On a fold parallel to the Kummer anticline in the Lake Tapps area, Phillips Petroleum Co. drilled their State No. 1 to 12,920 feet, which was the deepest well in the state prior to Shell's recent Yakima Mineral No. 1-33, in Kittitas County that went to 16,199 feet. Several other wells were drilled in the Lake Tapps area with no reported shows.

The rock sequence of the Kummer and associated parallel folds are arkosic sandstones, sandy shales, and carbonaceous shales with occasional coal seams, known as the Puget Group of early Eocene to early Oligocene age. The Puget Group ranges in thickness from 2,000 to over 10,000 feet. Marine rocks of Oligocene and Miocene age overlie the Puget Group in the adjacent areas. A few surface structures and most of the deep structures await test drilling. Tilted stratigraphic traps were formed by wedges of sandstone that have been overlapped by shale units along the eastern margin of the lowland.

Coastal Area and Northwest Olympic Peninsula

The coastal area has had more drilling activity than any other area of the state. Roughly 100 of the 434 wells drilled in the state were located along the Washington coast. The greatest number of oil and gas shows have also been recorded in this area. To date, however, none of these wells have produced commercial quantities of petroleum, but several have produced hundreds of barrels of oil.

In the Ocean City field alone, 29 wells were drilled in an 8-mile area around section 5, T. 18 N., R. 12 W., Grays Harbor County. The Sunshine et al Medina No. 1 produced 12,000 barrels of oil, at depths between 3,952 and 3,958 feet from rocks of early Miocene age, before being plugged and abandoned. Crude oil of several different specific gravities has been produced from various wells in this field, suggesting that more than one oil and gas reservoir may be present. Both mechanical and formation problems resulted in the abandonment of all of the promising wells within this field. Soft formations under high pressures have generally caused the sealing off of production. Thus far, solutions to production under such conditions have not yet been developed for this field.

In addition to the Ocean City area, the Forks-Hoh River area received considerable drilling activity, largely in the 1930's. One of these wells produced several hundred barrels of oil per day before mechanical problems forced abandonment. Since the 1930's some 12 additional wells have been drilled in this area, most of them with shows. Of these, two were drilled near the mouth of the Hoh River within the last 2 years. The locations of these two wells were based on recently completed surface geologic mapping by Weldon Rau (1975, 1979). Neither of these wells have yet been plugged because the operator has hopes that after treatment they might produce.

Also, several major companies are employing geophysical and other modern-day exploration methods in the coastal area, as well as in the adjacent inland area of the Grays Harbor basin.

The geology of the Washington coastal area is particularly complex according to recent mapping and interpretations presented by Rau (1975, 1979) along much of the Olympic coast and by Snavely and others (1980) in the northwest corner of the Olympic Peninsula. The rocks are entirely Tertiary marine sedimentary sequences of siltstone, sandstone, and conglomerate. The older rocks, ranging in age from Eocene to middle Miocene, have undergone a combination of repeated major underthrusting and strike slip faulting. Rau refers to these rocks as the Hoh rock assemblage. Major blocks, sometimes miles across, are separated from each other by extensive zones of melange rock or at least major faults. Seeps of both oil and gas have long been known from these rocks, particularly in areas of melange rocks. In a limited area, primarily along a 12-mile-long coastal area on the Quinault Indian Reservation, moderately folded and faulted rocks of late Miocene and Pliocene age crop out, and extend inland from the coast, generally less than 2 miles.

Coastal rocks along the Straits of Juan de Fuca are a conventional marine sedimentary sequence moderately folded and faulted ranging from Eocene to middle Miocene in age. Less than a dozen wells have been drilled in this area over the years with some modest shows. Renewed interest in this area has been recently indicated by substantial leasing activity. It is thought by some workers that the potential of possible underthrusting may be influencing this interest.

Continental Shelf

The Tertiary basin of the continental margins of the Pacific Northwest are considered by some to hold substantial potential for oil and gas production. Much of this area is blanketed by a sequence of moderately folded and faulted siltstones and sandstones of late Tertiary age, strata equivalent at least in part to the onshore Quinault Formation. The underlying older Tertiary siltstones, sandstones, and conglomerates are complexly folded and faulted in much the same manner as the onshore equivalent Hoh rock assemblage. These older rocks could serve as potential source beds whereas unconformably overlying late Miocene-Pliocene sandstones could supply the needed reservoir. In addition, available records strongly suggest that diapiric folds or piercement structures are common on the continental shelf where masses of highly deformed (melangelike) older rocks have penetrated into the overlying upper Miocene-Pliocene sequence. Upturned sandstones fringing such structures are potential reservoirs.

Many onshore outcrops of Hoh melange rocks emit a petroleum odor and have long been referred to by the Indians as "smell muds." These rocks are therefore regarded by geologists as potential source rock. Abnormally high pressures have been commonly encountered during drilling operations along the Washington coast. Gas under such high pressure is believed to have had a significant effect in the forming of diapirs in the coastal and shelf areas of Washington. Speculation by some researchers suggest that large infold masses of loaves of sandstone and conglomerate may be suspended or are floating in a ground-up melange of the Hoh complex and may form unique reservoirs for oil and gas where they are deeply buried in underthrust zones. Hydrocarbons generated from rocks ranging in age from Eocene to middle Miocene in regions of high temperatures in underthrust zones could migrate into these floating loaves of coarse clastics. Exploration for such accumulations would involve much geologic study and considerable expense, requiring full-scale drilling programs for information, and the use of modern geophysical techniques.

In the 1960's, six wells were drilled on the continental shelf off Washington, none of which proved to be commercial. Based on new knowledge and modern technology perhaps today such wells would be drilled in somewhat different locations.

DRILLING IN WASHINGTON FOR 1981-82

Four wells were drilled or are in the process of drilling, in Washington in 1981-82. The Shell-Yakima Mineral Co. No. 1-33 in Kittitas County was drilled to a total depth of 16,199 feet and is currently testing. The

Shell-Yakima Mineral Co. No. 2-33, twin to the No. 1-33, is at a total depth of 5,600 feet and testing. The Shell BISSA No. 1-29, also in Kittitas County, is currently drilling below 11,600 feet. This well is projected for 20,000 feet. Sunburst Petroleum, Ltd., drilled their Sunburst No. 1 well in Jefferson County to a total depth of 7,500 feet and ran casing. They have closed down operations on the well, which they have not tested. Snowbird Resources Ltd. have suspended operation on their Moses Lake No. 1 well in Grant County for the present time. The operator will not give out any information on this well. The Horse Heaven Drilling Company-Moon No. 1 is drilling below 500 feet. This well is projected for a total depth of 2,000 feet.

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HIGH-ALUMINIA-BEARING MINERAL DEPOSITS IN WASHINGTON

by Vaughn E. Livingston, Jr.

INTRODUCTION

Washington has several high-alumina-bearing minerals that have economic potential. Foremost of these are the ferruginous bauxite deposits of the Kelso-Cathlamet area of the state. Here, laterites have formed on the surface of Miocene basalt flows. The high-alumina clays and the high-alumina metamorphic minerals — andalusite, sillimanite, and kyanite - may also have possibility. Only the ferruginous bauxite has been reported on in detail and it shows some promise. Although there appear to be extensive deposits of the metamorphic minerals, preliminary work indicates that, at least at the surface, they have undergone extensive alteration and are lower in aluminum content than might be expected. High-alumina clays have had considerable interest shown in them and the work done so far is encouraging.

ALUM

The single confirmed occurrence of alum minerals in the state is near the top of Mount Adams, one of Washington's five big volcanoes. The minerals are associated with sulfur deposits and were probably formed by the action of sulfuric acid on the volcanic rocks of the upper cone. The alum minerals so far identified are alumian (Al_2O)$(SO_4)_2$, alunogen $Al_2(SO_4)_3.18H_2O$, and aluminite $Al_2O_3:SO_3.9H_2O$, with smaller amounts of mendozite, melanterite, copiapite, and blodite (Glover, 1936, p. 118). This deposit is more of a geologic curiosity than anything else because of its size and location.

ALUNITE

Alunite was first encountered by the White River Logging Co. in 1928, in King and Pierce Counties when they were constructing their main rail line through the NE¼ sec. 7, T. 19 N., R. 8 E. At first it was thought to be an ordinary clay and went unidentified until 1934 (Kirkemo, 1940, p. 3). In 1939, the Kalunite Co. of Salt Lake City, Utah, became interested in the deposits and did exploration work on them. The U.S. Geological Survey and the Washington Division of Mines and Geology also did considerable work on them about the same time. This exploration activity resulted in 4,400 feet of diamond drilling and 3,600 feet of trenching. Kelly and others (1956, p. 32) reported the reserves as follows: In the SE¼ sec. 4, T. 19 N., R. 8 E., some 600,000 tons of 30 percent alunite was found, 1¼ miles southeast an estimated 240,000 tons of 21.4 percent alunite was found, and in the NE¼ sec. 7, T. 19 N., R. 8 E. and in secs. 5 and 6, T. 19 N., R. 8 E. there is some 300,000 tons, making a total of 1,140,000 tons of alunite-bearing rock. This covers a few of the 12 sections reported to contain alunite. The others are secs. 9 and 10, T. 19 N., R. 8 E.; secs. 31, 32, and 33, T. 20 N., R. 8 E.; sec. 36, T. 20 N., R. 7 E.; and secs. 1 and 12, T. 19 N., R. 7 E. If these additional occurrences were considered, no doubt the reserves would be larger, but they are low grade and in some areas the deposits are complicated by landsliding.

The alunite occurs in andesitic rocks of the Ohanapecosh(?) Formation. The unit is composed of flows, flow breccias, and water-laid pyroclastic breccias. Hammond (1963) mapped part of the area in which the alunite occurs, and he shows intrusive rocks on the ridge immediately north of the deposits that could have supplied the hydrothermal solutions that formed the deposits. Ohanapecosh(?) rocks have been severely altered in the area; they vary from hard, completely bleached and silicified material to a soft pyritic clay. The silicified rock is porous, containing many quartz crystal-lined cavities, varying in size from microscopic to almost a foot in diameter. Many of these cavities are filled with clay. The softer altered rock is chiefly a mixture of clay, quartz, alunite, and pyrite.

The alunite is regarded as having been deposited in open spaces along faults in the silicified rocks by ascending solutions of an active hydrothermal system. Both core and trench samples show angular fragments of silicified rocks cemented by alunite. Because of their close spatial relation, it is thought that possibly the silicification and alunitization are part of the same alteration phase, although the alunite, at least in part, may be later. The highest grade alunite occurs in small bodies that formed in places most favorable for maximum replacement. This, of course, depended on the location of channels for ascending solutions, conditions of deposition, and a continuous supply of replacing minerals. Outside of these small high-grade areas, alunite is disseminated in varying amounts through the altered rocks. Most of the alunite thus far discovered has been beneath a cap of silicified rock, so areas where silicification occurs must be considered as favorable for prospecting.

ANDALUSITE, SILLIMANITE, AND KYANITE

Andalusite occurs in San Juan, Stevens, Pend Oreille, Kittitas, and Spokane Counties. Sillimanite has been reported in Spokane and Pend Oreille Counties, and kyanite deposits have been examined in Chelan and Skagit Counties (Valentine, 1960, p. 5).

The kyanite occurrences are primarily isolated small veins that do not appear to have much significance. However, two occurrences in Chelan County, one in the Mad River Canyon on the east side of Maverick Peak in the NW¼ sec. 16, T. 27 N., R. 18 E. (Valentine, 1960, p. 5), and the other at Twentyfive Mile Creek near the W¼ cor. sec. 1, T. 28 N., R. 20 E., at elevation 3,300 feet (Valentine, 1960, p. 5), probably warrant more investigation. At the Mad River deposit, "massive crystalline kyanite" has been reported, and at the Twentyfive Mile Creek deposit large kyanite crystals have been found irregularly distributed through a mica schist over an area of undetermined size that is said to be at least several hundred square feet (Thorsen, 1966, p. 223-224).

Sillimanite is found over a wide area west of Ione, in Pend Oreille County, in sec. 27, T. 38 N., R. 42 E. It is in the form of fine needlelike crystals that make up as much as 50 percent of the hornfels country rock (Thorsen, 1966, p. 223). In the Spokane area, sillimanite occurs in Precambrian schists as sparse disseminations and thin bands in gneiss. For additional information the reader is referred to Thorsen (1966, p. 219-224).

Andalusite occurs at several localities in rocks along the borders of batholithic rocks in Stevens, Pend Oreille, and Spokane Counties (Valentine, 1960, p. 5-6). Many of the deposits appear to be promising but, in most cases, the andalusite is either partially to totally sericitized. Extensive andalusite-rich beds have been found in Stevens County on Aladdin Mountain (sec. 33, T. 38 N., R. 41 E.), where there are at least two andalusite-mica schist beds over 100 feet thick (Thorsen, 1966, p. 221); in

the vicinity of the Longshot mine in sec. 18, T. 36 N., R. 41 E., where the andalusite-bearing schist is exposed over a distance of 3,000 feet (Thorsen, 1966, p. 221); near Meadow Creek in sec. 35, T. 38 N., R. 41 E., where a 60-foot bed is exposed for about 300 feet on a low ridge (Thorsen, 1966, p. 221); on Parody Peak, where a 50-foot-thick± bed can be traced for more than 9,000 feet (Thorsen, 1966, p 221). In Pend Oreille County, there are three well-defined andalusite schists that range in thickness from 80 to 120 feet in secs. 29 and 32, T. 38 N., R. 42 E., on Huckleberry Mountain. The thickest of these beds crops out along strike for about 3,500 feet (Thorsen, 1966, p. 221).

FERRUGINOUS BAUXITE

The ferruginous bauxite (laterite) deposits are confined to Cowlitz and Wahkiakum Counties. The deposits are scattered discontinuously along the upland north of the Columbia River, between the towns of Longview and Cathlamet. The laterites were formed from the weathering of Miocene basalt flows of the Yakima Basalt Subgroup in Pliocene-Pleistocene time, during a period of apparent abundant rainfall. The laterite averages about 12 feet in thickness. Average analysis is Al_2O_3, 38 percent; SiO_2, 6 percent; Fe_2O_3, 27 percent; and TiO_2, 4 percent (Livingston, 1966, p. 89).

The outline of the deposits apparently is controlled to a large extent by the topography. Most of the broad interfluves between Coal Creek, on the east, and the Elochoman River, on the west, are capped by laterite. The deposits are almost sheetlike in shape, covering the ridge tops and draping a short distance down the adjacent slopes. The laterite has been covered by silt deposits, probably a loess, the base of which has been laterized, that effectively mask any irregularities in its surface; however, drilling in the area indicated that the laterite surface is fairly uniform. The base of the ore probably is fairly regular also. Variations in jointing and(or) mineralogy in the parent rock may have influenced the depth of laterization, but resulting irregularities in the base of the ore probably are small.

Three basic ore types occur in the bauxite deposits of the Longview-Cathlamet area – earthy, nodular, and pisolitic (for convenience, the term "pisolite" is used herein to include both oolites and pisolites). The color of the ferruginous bauxite varies from mustard yellow through brown and various tones of red, with red being the most common. The nodules from core holes are always yellowish, but those found in surface outcrops are reddish. Pisolites are dark brown to black on fresh surfaces and weather to dark reddish brown. They also show varying degrees of magnetic susceptibility, some being attracted to a magnet only slightly, whereas others are very strongly attracted.

The nodular ore is a mixture of hard, gibbsite-rich nodules and soft earthy material. Thin sections of nodules viewed by plane polarized light show that the original intersertal igneous texture of the parent rock is preserved.

The original plagioclase crystals were mostly subhedral to euhedral laths, but there were also a few tabular forms. The groundmass or matrix is mottled and cloudy, and reddish brown in color. It appears to have been made up of granules, probably of augite and glass, before alteration. The opaque minerals are all black and occur in acicular blades, dendritic masses, and irregular equidimension grains. Examined under crossed nicols, the texture of the nodules is seen to be granular. The plagioclase crystals have been replaced by gray, finely granular gibbsite, and the augite grains by a mixture of gibbsite and reddish iron oxide. Some fractures extending through the nodules have been filled with gray crystalline gibbsite, and others with a creamy red material that has a scalloped or colloform structure. The earthy material appears to be the same in both the earthy and the mixed nodular and earthy varieties of ore. The texture is granular, and there are easily recognized grains of clear gibbsite in an extremely fine-grained matrix. The matrix is cloudy and has areas of deep red, creamy-textured material that often has a colloform structure along fractures.

Examination of a thin section of pisolitic ore taken from an old well (SW¼NE¼ sec. 1, T. 8 N., R. 4 W.) showed that the bauxite was made up of larger pisolites imbedded in a matrix of smaller pisolites and fine-grained granular material. The fine-grained granular part of the matrix is similar to the earthy variety of the ore. There were no relict igneous textures present in any part of the pisolitic ore that was examined. Most of the pisolites have a granular texture, and many are grouped together in reniform masses. The smallest pisolites are less than 0.01 mm in diameter, and the largest are more than 1 cm. Most of them, however, fall in the 0.5 mm to 5 mm size range.

The pisolites vary in composition. Some are fairly homogeneous, being made up mostly of a light-brown mixture of isotropic cliachite(?) and limonite and a scattering of clear grains of gibbsite. Other pisolites have a dark opaque core surrounded by a rim of light material similar to that described above in the homogeneous

pisolites. Some of the larger pisolites are aggregates of tiny pisolites and homogeneous granular material.

Pisolites from the base of the loess(?) formation that overlies the bauxite are very different from the pisolites that occur in the bauxite. They are composed of opaque steel-gray and almost opaque rust-red iron minerals. Entombed in the pisolites are abundant quartz grains that are euhedral to subhedral in shape. These are terminated hexagonal dipyramids. Even though these crystals appear to be typical of high-temperature quartz, they are thought to be authigenic here. Rust-red material having a granular texture and colloform structure is common. It contains little cavities and fractures that are lined with clear gray gibbsite crystals. Under a metallographic microscope, the opaque gray mineral was tentatively identified as magnetite. It has a coloform structure and forms an irregular core in the pisolites. It has inclusions of rust-red material and a lighter gray reaction rim surrounding it. Several minerals were recognized in the bauxite, the most abundant being gibbsite. Goehtite, a kaolinite-type clay, magnetite, and quartz have also been identified (Livingston, 1966).

HIGH-ALUMINA CLAY

High-alumina clays have been found in Cowlitz, King, and Spokane Counties (Hosterman and Livingston, 1966, p. 184). In Spokane County the high-alumina clays occur on the south and west sides of Mica Peak, southeast of the city, in the Latah Formation. In King County the deposits occur in the Puget Group, southeast of Seattle. In Cowlitz County the clays occur in the Cowlitz Formation, northeast of the town of Castle Rock. In Spokane County there is about 12 million tons of clay that average 20 percent or more Al_2O_3. In King County there is an estimated 20 million tons that average 30 percent or better Al_2O_3, and in Cowlitz County, 17 million tons averaging 29 percent or better Al_2O_3 (Hosterman and Livingston, 1966, p. 184).

▲ Alum
Alunite
Bauxite
Andalusite, sillimanite, kyanite
High alumina clay area

LOCATIONS OF HIGH-ALUMINA MINERALS IN WASHINGTON

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LOCAL HERITAGE BOOK NOW AVAILABLE

The Holden mine, located in the remote drainage of the Lake Chelan country in the Railroad Creek valley, became Washington State's largest copper, gold, and zinc mine, and remained so until it was closed in 1957. This 87-page book documents the history of promotion and development of the Holden mine – from the staking of the claim in 1896, to the shipment of the first concentrate in 1938. It's a story that will provide enlightened reading to those interested in the mining history of north-central Washington.

The book, "The Holden Mine: Discovery to Production, 1896-1938," may be purchased for $6 from the author Nigel Adams, 39044-258th Ave. SE., Enumclaw, WA 98022.

CORRECTIONS FOR ARTICLE IN JANUARY NEWSLETTER

The following corrections are noted for the article, "Minerals and Energy Exploration Activities in Washington, 1981," which appeared in our last newsletter.

Page 1, last paragraph, left-hand column

Conoco's metals office in Spokane is in operation, with no plans for closure.

Page 2, 2nd paragraph, left-hand column

John Domek is vice president of Spectre Engineering, Inc. The president of Spectre is James E. Bradbury, a metallurgical engineer. Spectre plans to work the claims and tailings piles at the First Thought mine near Orient.

Page 2, 1st paragraph under Okanogan County

The Copper Glance property near the Eight-Mile Creek area north of Winthrop was worked on in the summer of 1981 by Denison Mines. Information concerning mining plans, joint ventureship, and ore grades is incorrect.

THESIS ADDED TO DIVISION LIBRARY

The thesis listed below is now available for inspection in the Division of Geology and Earth Resources library:

Christenson, B. W., 1981, Structure, petrology, and geochemistry of the Chilliwack Group near Sauk Mountain, Washington: Western Washington University Master of Science thesis, 181 p., 1 plate.

RECENTLY RELEASED REPORTS OF THE DIVISION OF GEOLOGY AND EARTH RESOURCES

Copies of the two reports listed below may be obtained by writing to the Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA 98504. You may also call us at (206) 459-6372. These publications are free of charge.

Rau, W. W.; McFarland, C. R., 1982, Coastal wells of Washington: Washington Division of Geology and Earth Resources Report of Investigations 26, 4 sheets.

Hooper, P. R.; Webster, G. D., 1982, Geology of the Pullman, Moscow West, Colton, and Uniontown 7½-minute quadrangles, Washington and Idaho: Washington Division of Geology and Earth Resources Geology Map GM-26, scale 1:62,500.

RECENT U.S. GEOLOGICAL SURVEY OPEN-FILE REPORTS ADDED TO OUR DIVISION LIBRARY

The following U.S. Geological Survey Open-File Reports are now available for inspection in our division library. However, if you wish to purchase any of these reports, please write or call:

Open-File Service Section
Branch of Distribution
U.S. Geological Survey
Box 25425, Federal Center
Denver, CO 80225
(303) 234-5888

Dinehart, R. L.; Ritter, J. R.; Knott, J. M., 1981, Sediment data for streams near Mount St. Helens, Washington — Volume 1, 1980 water-year data: U.S. Geological Survey Open-File Report 81-822, 82 p.

Fox, K. F., Jr., 1973, The geology of alkalic complexes in north-central Washington: U.S. Geological Survey Open-File Report 73-73, 249 p., 5 plates.

Miller, F. K.; Theodore, T. G., 1982, Molybdenum and tungsten mineralization associated with two stocks in the Harvey Creek area, northeastern Washington: U.S. Geological Survey Open-File Report 82-295, 8 figs., 31 p.

Snavely, P. D., Jr.; Wagner, H. C., 1981, Geologic cross section across the continental margin off Cape Flattery, Washington, and Vancouver Island, British Columbia: U.S. Geological Survey Open-File Report 81-978, 5 p., 2 plates.

Waitt, R. B., Jr., 1981, Concepts of classification and nomeclature for surficial deposits: U.S. Geological Survey Open-File Report 81-28, 33 p.

White, A. C.; McKenzie, S. W., 1979, Benthic invertebrates, periphyton, and bottom materials and their trace-metal concentrations in Salmon Creek basin, Clark County, Washington: U.S. Geological Survey Open-File Report 79-978, 18 p.

RECENT APPLICATION FOR OIL AND GAS EXPLORATION DRILLING

Operator	Permit no.	County	Well name	Location	Ground elevation (feet)	Estimated total depth (feet)	Spud date	Date permit issued
Oil and Land Enterprise, Inc.	352	Lewis	State No. 1	1632 FEL, 1171 FSL sec. 17 (14-3W)	320	8,000		Pending

Department of Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504

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