RECONNAISSANCE OF THE GEOLOGY AND OIL PROSPECTS OF NORTHWESTERN OREGON

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By Chester W. Washburne.

INTRODUCTION.

The presence of oil in the Coast Range of Oregon has been suggested by the topographic similarity of the locality to the oil regions of California, most of which are in the borders of the Coast Range. A few attempts to obtain oil have been made, eight wells having been drilled in northwestern Oregon, all of which are dry, but one of which, near Dallas, yielded a small flow of gas. All these wells, however, were located without adequate regard to the geologic conditions of the localities and therefore do not afford a fair test of the ground.

This report is based on a hasty reconnaissance made during the summer of 1910 and on several explorations made by the writer in the years 1900 to 1905. In the summer of 1910 material assistance in the field was rendered by Mr. George A. Macready and Mr. Reese F. Rogers, who examined many supposed oil seeps and other reported indications and gathered notes on the geology of the region. In March, 1914, some new reports of oil seeps were investigated, but nothing was found to change the generally negative conclusion of the earlier work.

The evidence gathered in the field seems to indicate that the prospect of obtaining oil in the northern part of the Coast Range near Astoria or Tillamook is slight, but that the chances are much better in the central part of the Coast Range in western Coos, Douglas, and Lane counties or in Lincoln County. It should be borne in mind, however, that this is merely a statement of the writer's personal opinion, based on imperfect evidence, and not a prediction that oil will be found in commercial quantities.

The region covered and the oil prospects are shown on the accompanying map (Pl. I).

TOPOGRAPHY.

The principal topographic feature of the region is the Coast Range, an irregular group of maturely dissected hills that rise gradually from altitudes of only a few hundred feet near the sea to heights of

1,000 to 2,500 feet. The main divide, or watershed, is irregular, running approximately parallel with the coast at a distance of 25 to 35 miles from the sea and 10 to 20 miles from the eastern foot of the range. The main divide does not everywhere correspond with the line of highest summits, but in many places lies east or west of them.

The anomalous course of Nehalem River through the range appears to be due to the peculiar distribution of resistant igneous rocks rather than to capture. Some sections of the summit likewise owe their superior altitude to the presence of resistant intrusives. The bold headlands, typified by Tillamook Head, which stand conspicuously above the neighboring hills and extend their high terminal cliffs well into the sea, owe their existence to the hard basalt composing them. Likewise, the higher mountains of the Coast Range, such as Saddle, Necarney, Onion, Marys, and Roman Nose, are all due to the presence of intrusive dolerite, diorite, and diabase.

VEGETATION AND ROADS.

Geologic work in the Coast Range of Oregon and Washington is done under unusual difficulties, owing to the scarcity of exposures and to the almost impenetrable growth of bushes and ferns. The brush is especially dense along creeks and in old "burns," but it is troublesome everywhere, even in the perpetual shade of the great evergreen forest that covers most of the region. The humid climate of western Oregon has thoroughly decomposed all but the hardest rocks to depths of 20 to 100 feet, unaltered rocks being seen only in artificial excavations or in small cliffs that occur at certain localities along streams and steep hillsides. In the western part of the district some residual soil and a mat of ferns, moss, and bushes cling to the face of nearly vertical cliffs. East of the summit of the Coast Range the vegetation is less dense, and though on the borders of the Willamette Valley the north sides of the hills generally are forested with evergreens, the south sides are bare, owing to differences of exposure to the sun and wind.

The dense brush in the lower parts of the Coast Range makes travel on horseback impossible and work, even on foot, very difficult. In many places near the coast it takes one or two hours to walk a mile through the brush.

Many of the wagon roads are very poor, and in winter they are filled with deep mud. Drilling machinery or other heavy material can be moved without much difficulty from June to September, inclusive. In other months there is risk of much delay and expense in transportation except on the few hard roads, such as that from Astoria to Nehalem. In general the main wagon roads lead from the Willamette Valley across the Coast Range to the principal towns near the coast. There are about ten of these roads between Umpqua and Columbia rivers, most of which are poor, although some are being macadamized. Only a few of the wagon roads connect with one another by north-south branches on the coast or in the mountains.

The only railroads that cross the Coast Range in Oregon are the Astoria & Columbia River Railroad, which follows the south bank of Columbia River to Astoria; the Pacific Railway & Navigation Co., from Portland to Tillamook Bay; the Corvallis & Eastern Railroad, from Albany to Yaquina Bay; and the Willamette Pacific, under construction, from Eugene to Coos Bay via the Siuslaw Valley.

GEOLOGY.

STRUCTURE.

The Coast Range of northwestern Oregon is a broad, low geanticline of Tertiary formations broken by many igneous intrusions. In most cross sections of the range there are from two to five broad folds of small amplitude, and probably there are many normal faults, of which only indirect evidence can be obtained. Within the range the dips in few places exceed 15°, except near igneous intrusions, and in most places are less than 10°; but along the flanks some dips of 20° to 35° have been observed. In other words, the strata have not been sharply compressed. The major axis of uplift, where well defined, lies 5 to 15 miles west of the summit of the range, which in all places is due to the presence of relatively hard igneous rock or sandstone rather than to geologic structure.

South of Umpqua River the higher part of the range, as shown by Diller, is essentially a syncline with flanking anticlines in the upper valley of the Umpqua and near Coos Bay. The syncline disappears north of Umpqua River, and on Siuslaw River the range is essentially an anticline interrupted by many minor undulations, with marginal dips toward the Willamette Valley on the east and the ocean on the west. The same general structure characterizes the range north of Siuslaw River as far as Columbia River and for at least 50 miles into Washington.

The structure of the Coast Range of Oregon and Washington therefore differs markedly from that of the Coast Range of California, where sharp folds prevail. Notably pronounced geologic structure occurs in the northern Coast Range only near the two higher mountain masses in which it terminates; on the south near the Klamath Mountains of southwestern Oregon and on the north near the Olympic Mountains of northwestern Washington.

Contrary to the commonly accepted idea the structure of the Willamette Valley is essentially monoclinal, the dip of the rocks being almost invariably eastward in the widely separated exposures, which are rare except on the valley border. In some places the dip is so slight as to be scarcely perceptible, in others it reaches 25°. In the lower valley the average dip is 3° or 4°; in the upper valley it is 8° or 10°. A westerly dip has been observed at only one locality, Scotts Mills, on the line between Clackamas and Marion counties, where there is a small monoclinal flexure or fault. Generally speaking, the marine rocks on the east side of the Willamette Valley appear to pass under the lavas of the Cascade Range, within which easterly dips continue for 30 to 50 miles from the valley, but it is possible that there is a large fault along the east margin of the valley and that the marine rocks are later than the lavas of the mountain front.

STRATIGRAPHY.

AGE OF THE ROCKS.

The consolidated rocks of the Coast Range of northwestern Oregon are all of Tertiary age. The oldest known strata are about equivalent to the widespread Tejon formation (upper Eocene) of California, above which there are Oligocene deposits, which occupy comparatively small areas and which are in many places absent beneath the extensive Miocene deposits. Pliocene strata are known at only a few isolated localities. The Quaternary material is limited to river bottoms and terraces and to the broad alluvial plain of the Willamette Valley.

No Cretaceous rocks have been found in northwestern Oregon. It was formerly thought that some very poorly preserved fossils, collected by the writer from metamorphosed sediments on the west slope of Marys Peak, were of Cretaceous age, but further study makes it seem probable that they are Eocene. It was also thought that the rocks which J. S. Diller[1] found unconformably underlying the Astoria shale, opposite Astoria, were Cretaceous or older, but they also are now known to be Eocene.

TERTIARY SYSTEM.

EOCENE SERIES.

The oldest known rocks of the Coast Range in northwestern Oregon are of upper Eocene age and carry a fauna similar to that of the Tejon formation of California. No rocks of the age of the Martinez formation of California (lower Eocene) have been found in northwestern Oregon, and in the localities examined by the writer it is highly probable that no strata are older than the Tejon.

In Douglas County the oldest upper Eocene is a thick shale which Diller[2] has named the Umpqua formation. It is especially well

[1] A geological reconnaissance in northwestern Oregon: U. S. Geol. Survey Seventeenth Ann. Rept., pt. 1, pp. 457, 465, 1896.

[2] U. S. Geol. Survey Geol. Atlas, Roseburg folio (No. 49), 1898.

developed in the neighborhood of Cole Valley, west of Oakland. North of Umpqua River it has been doubtfully recognized in the Alsea Valley in southwestern Benton County, where a shale is imperfectly exposed beneath the Tyee sandstone.

The most widespread and conspicuous formation of the Oregon Coast Range is the Tyee sandstone, which extends from the type locality in Douglas County[1] southward to the Rogue River Mountains and northward over 120 miles into Tillamook County. It is not improbable that the upper Eocene on the lower Columbia River is of about the same age. The Tyee sandstone is of medium to coarse grain, in most places thick bedded and highly micaceous. It contains many dull white, mostly subangular grains of decomposed feldspar. Conglomerate is rare in this formation, but some layers contain scattered fine pebbles of quartz and acidic lavas. Locally a few pebbles of more basic igneous rock resemble the diabase of the Roseburg quadrangle. Cross bedding is not common, but ripple marks and sun cracks have been found in the formation on Smith and Siuslaw rivers. Its color is prevailingly light gray, but at the type locality in Douglas County and also in southwestern Polk County, where much of the rock is highly calcareous, it is dark gray. Locally in Lincoln County it is white from the presence of andesitic or dactitic tuff. Marine fossils are abundant at scattered localities at the few horizons where they occur; elsewhere the only fossils are pieces of leaves and wood. Thin beds of lignite are found at a few places, but they have no economic importance unless the coal in the upper and lower Nehalem valleys occurs in this formation, which is not certain. This formation carries some shale, but the shale is very subordinate to the sandstone and is rarely seen, owing to its softness and to the covering of soil and vegetation. The presence of benches on some of the sandstone cliffs, with imperfect exposures of shale, suggests that there may be beds of shale 75 or 100 feet thick. In the cliffs on the Umpqua and Siuslaw rivers some thin partings of shale, a few inches to 10 feet thick, separate massive beds of sandstone 25 to 100 feet thick. Many of these thin partings are minutely contorted, probably from slight movement of the sandstone beds over one another, as the sandstone itself is not affected.

Some vertical sections of the sandstone on the sides of bowlders show many irregular, sharp-cornered little bodies of dark shale, from one-half inch to 2 inches in thickness and commonly about twice as long. Most or all of these are not fragments of an older formation, included as pebbles, but represent clay deposited at the same time as the sand. Evidence of this origin is furnished by filaments of clay, resembling apophyses, which project from the little masses of shale

[1] U. S. Geol. Survey Geol. Atlas, Roseburg folio (No. 49), 1898.

for a short distance along the bedding planes of the sandstone, and by micaceous layers which cross both the sandstone and the shale. The manner in which the little shale bodies accumulated is not clear, but it may be that on the original surface of deposition the greater adhesion of clay to clay caused the clay particles to stick to the clay previously formed rather than to the surrounding sand.

The thickness of the Tyee sandstone on the Siuslaw and Alsea rivers is at least 2,000 feet, but its base is not exposed. The formation appears to be over 10,000 feet thick on Umpqua River and Elk Creek, west of Drain, but the strata in that section may be duplicated by faults. The character of the material suggests that much of it is of fluviatile origin, but marine shells found at different horizons at a few widely separated localities cast doubt on this inference. The formation is not divisible on either lithologic or paleontologic grounds and the percentage of fresh-water sediment it contains is uncertain, although the writer believes it is the predominant element of the formation at all localities north of Umpqua River.

In the preceding description the area of the Tyee sandstone has been extended far north of the Roseburg region, in which it occurs as first described by Diller.[1] This extension appears justifiable, because of the apparent continuity of the sandstone along the Coast Range and because of the many new localities in which the fauna contained in the Tyee sandstone at the type locality (Basket Point, on Umpqua River) has been found.

The lowest formation outcropping in the Astoria region is of upper Eocene age and consists of a series of diabase tuffs and breccias, which are well exposed in the hills and railroad cuts west of Megler, Pacific County, Wash. The formation also includes a few thin flows of diabasic lava and in its lower part considerable massive sandstone, which is quarried near McGowan station for foundation stones and for use in the revetment work of the Ilwaco Railroad.

The formation is markedly different in texture and composition from the overlying Astoria shale. Its relation to the shale is not certain, but Diller[2] observed an unconformity below the Astoria shale east of Megler which the writer failed to find. The rock at the locality mentioned by Diller is clay shale interbedded with many layers of sandy shale, which are much harder than the typical Astoria shale and which contain numerous veins of calcite. If there is an unconformity at this locality it will be necessary to consider the hard shale, about 150 feet thick, and 400 feet of underlying sandstone and shale as the top member of the Eocene formation.

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[1] U. S. Geol. Survey Geol. Atlas, Roseburg folio (No. 49), 1898.

[2] U. S. Geol. Survey Seventeenth Ann. Rept., pt. 1, p. 465, 1896.

The conformity of the Eocene formation and the Astoria shale is suggested by the structure at the west end of the railroad tunnel at Fort Columbia, where the main body of tuff is overlain, with apparent conformity, by 50 feet of soft clay shale, identical in appearance with the Astoria shale and containing many fossils of a species (*Pecten peckhami*) that is abundant in that formation and is unknown in the Eocene of Oregon.

The question of the conformity of the Astoria shale on the Eocene formation must therefore be left open. The age of the latter is determined by the discovery of a characteristic Eocene shell (a hinge of *Venericardia planicosta* Lamarck) in the fine tuff east of McGowan station.

The formation, which is similar to many others of upper Eocene age in northwestern Oregon and western Washington, is a tuff or agglomerate composed of angular or slightly rounded fragments of basic lava, probably diabase, separated by minute veinlets of calcite. In many places calcite is so abundant that beds of the rock 10 to 20 feet thick have a mottled appearance. The average diameter of the individual ejecta is about half an inch, but some fragments are a foot or more across. Beds of massive coarse gray sandstone occur in the upper and lower parts of the main body of tuff, both above and below which are beds of sandstone nearly 100 feet thick. At several horizons in the tuff, water worn pebbles of diabase sandstone and concretionary limestone are mixed with the angular ejecta. Locally the water worn pebbles are sufficiently abundant to make beds of tuffaceous conglomerate, which in places is so thoroughly indurated that a fracture will pass through both pebble and matrix. Near the middle of the main body of tuff there is a thin sheet of somewhat vesicular basic igneous rock, about 10 feet thick, probably a contemporaneous flow. Near the top of the tuff, in the bed of the first creek west of Megler, there is a basic lava flow, largely fragmental, about 35 feet thick, beneath which is 20 feet of micaceous tuffaceous laminated sandstone full of plant fragments, and above which is 25 feet of hard thin-bedded sandstone. Several dikes of fine-grained diabase, from 2 to 10 feet thick, cut across the tuffaceous strata west of Megler.

The following section was measured from the high river bluff north of Megler, westward along the Ilwaco Railroad tracks to the axis of the anticline near McGowan station. The lower sandstones and much of the tuff is missing from the west limb of the anticline, indicating a fault along the axis with downthrow on the west side, amounting to a stratigraphic displacement of over 1,000 feet.