Petroleum Potential of Wilderness Lands in Oregon

By Thomas D. Fouch

PETROLEUM POTENTIAL OF WILDERNESS LANDS IN THE WESTERN UNITED STATES

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This chapter on the petroleum geology and resource potential of Wilderness Lands in Oregon is also provided as an accompanying pamphlet for Miscellaneous Investigations Series Map I-1544

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ABSTRACT

The Wilderness Lands in the State of Oregon cover nearly 5 million acres and are located across the southwestern, central, and eastern parts of the State. The major areas of concentration of Wilderness Lands are in the region of the Cascade Range province and in the central and southeastern portions of the High Plateau province. The potential for other than trace or show amounts of liquid or gaseous hydrocarbons detected on Wilderness Lands in the State is probably quite low. However, small tracts of Wilderness Lands in the southeastern part of the State may be underlain by nonmarine sedimentary strata that have yielded gas shows or have local basins filled with sedimentary rock sequences with abundant coaly beds. Although the surface terrane of this province is generally covered with volcanic rocks, carbonaceous source beds may underlie or be interbedded with the volcanic units and thus have some potential for gas.

Wilderness Lands of the Cascade Range are generally underlain by rocks not favorable for the formation of oil or gas. However, small areas may be underlain by sedimentary units that are carbonaceous, but the maturation state of the organic matter may be too low to have generated hydrocarbons in other than trace amounts.

In general, geologic factors needed to evaluate the petroleum potential in Oregon are not well known and the State is considered a frontier area for exploration. A qualitative assessment of the petroleum potential of the Wilderness Lands in Oregon is reported by acreage as follows: a medium potential for 138.2 thousand acres; low potential, 2,869.7 thousand acres; and a low to zero potential of 1,857.9 thousand acres.

INTRODUCTION

Wilderness Lands in the State of Oregon are located primarily in the region of the Cascade Range and in the central and northeastern part of the State (fig. 1). A relatively small complex of wilderness tracts is located in the southwest part of the State near the California border.

The potential for other than trace or show amounts of liquid or gaseous hydrocarbons to be detected on Wilderness Lands of the State is probably quite low. However, small parts of tracts in the southeastern part of the State may be underlain by nonmarine sedimentary strata that have yielded gas shows in drill holes or that contain organic matter in surface rocks of adjacent regions. If rocks rich in organic matter occur in the subsurface of the Wilderness Lands in these areas, they may have been subjected to maturation of the organic compounds into oil and (or) gas by thermal or bacterial action.

Wilderness Lands of the Cascade Range are generally underlain by rocks not favorable for the formation of oil or gas. However, small areas may be underlain by sedimentary units that are carbonaceous, but the maturation state of much of the indigenous organic matter is believed to be too low to have generated petroleumlike hydrocarbons in other than trace amounts. Near plutonic and other igneous bodies, organic matter has been locally metamorphosed to a thermal state too high to have preserved petroleumlike hydrocarbons.

In general, factors needed to evaluate the hydrocarbon potential are not well known and the State is considered a frontier area for exploration. Drill holes are sparse and the distribution of source and reservoir beds in the subsurface of the State is very speculative. Although potential structural traps are indicated by surface data, subsurface traps remain unsubstantiated in the absence of numerous drill holes or reflection seismic information.

PURPOSE AND METHODS

The purpose of this paper is threefold: (1) to present a brief geologic characterization of rocks underlying wilderness tracts in Oregon emphasizing those properties that can be related to evaluating the potential of the rocks for yielding hydrocarbons, (2) to indicate some of the publicly available data that can be utilized in assessing the petroleum potential of Wilderness Lands, and (3) to develop a reconnaissance qualitative assessment of the potential of rocks in Oregon wilderness tracts to yield other than show or trace amounts of petroleumlike hydrocarbons. The evaluation is based on an assessment of publicly available data so that it can be independently evaluated.

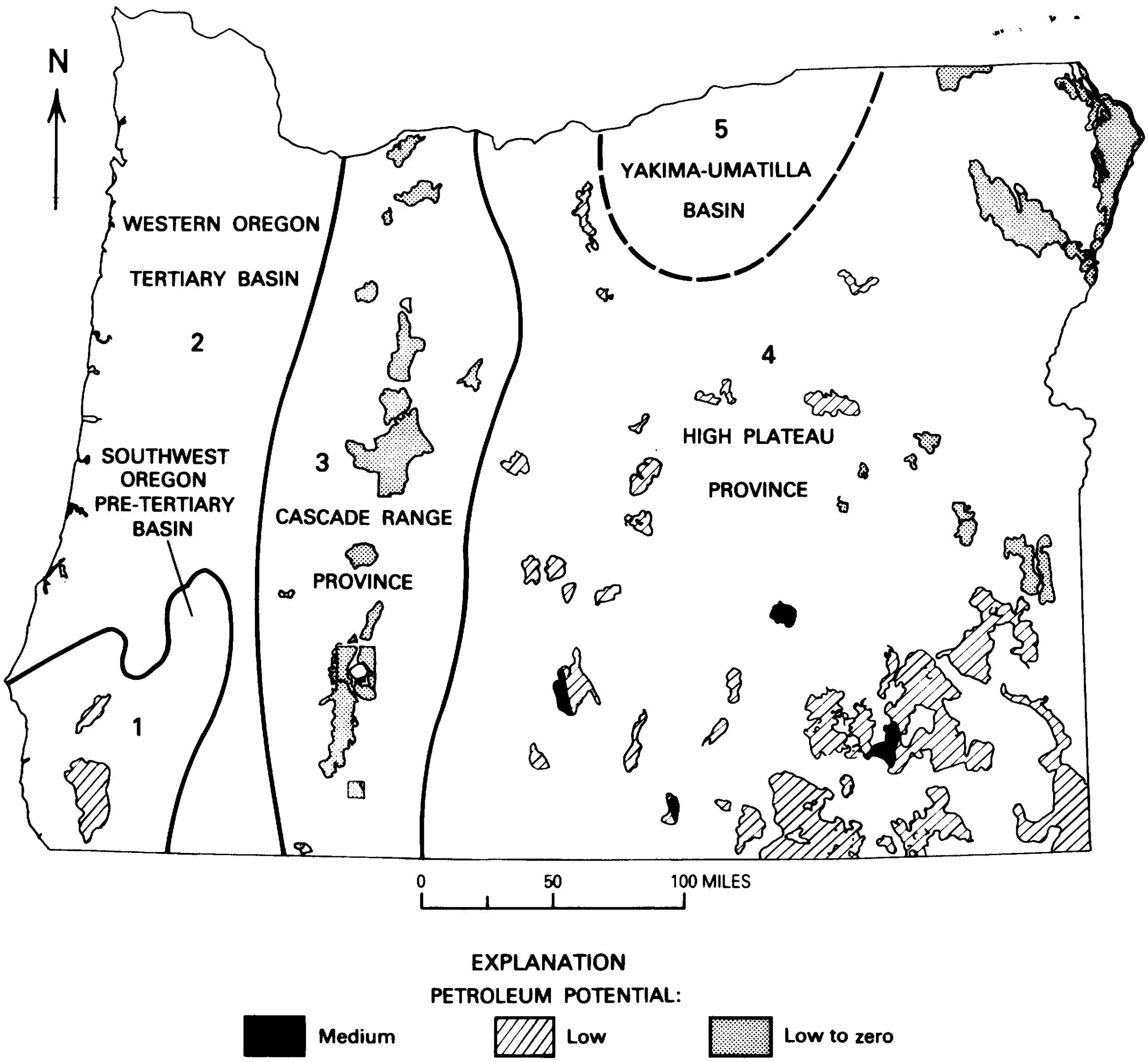

FIGURE 1.—Map of Oregon showing the location of Wilderness Lands. Geologic basin and province boundaries shown are (1) Southwest Oregon pre-Tertiary basin, (2) western Oregon Tertiary basin, (3) Cascade Range Province, (4) High Plateau Province, and (5) Yakima-Umatilla basin.

For purposes of this assessment of Oregon Wilderness Lands, rocks are separated into groups with similar geologic properties and assigned geographically into five provinces or basins. Boundaries among the provinces and basins are approximately, and in some cases arbitrarily, drawn because the areal and subsurface extent of many of the defining geologic units is uncertain. Of primary concern is the recognition of the presence and character of potential reservoir, source, and trapping units for petroleum, the main ingredients of a petroleum province. Because oil and gas are recovered only in the northwest part of the State, the petroleum potential of frontier nonproductive regions is estimated largely by identifying the presence or absence of organic matter in the rocks (i.e., coal, carbonaceous shale, or reports of a fetid odor on freshly broken rock) and estimating the level of maturation of the organic compounds. Values of coal rank, and vitrinite and Rock-Eval data (T. D. Fouch and D. A. Anders, 1981, unpublished data) provided the principal indices of thermochemical maturation. These indices were related to the major stages of thermochemical maturation of organic matter into oil or gas by using data summarized by Bostick (1979).

A qualitative estimate of the potential of the rocks in the wilderness tracts of Oregon to yield oil or gas is provided by using the terms zero, low, or medium. Potential is used herein to indicate the expectation of recovering liquid and (or) gaseous hydrocarbons in other than trace amounts. Expressions of potential, such as low and medium are relative to other areas in the State of Oregon and may not equate to a similar expression of potential in a different hydrocarbon province. A map of Oregon has been prepared at a scale of 1:1,000,000 that shows the petroleum potential of Oregon's Wilderness Lands (Miscellaneous Investigations Series Map I–1544, in press).

PROVINCES AND BASINS

SOUTHWEST OREGON PRE-TERTIARY PROVINCE

Basin rocks include Mesozoic and late Paleozoic sedimentary, plutonic, and metamorphic units. The surface is locally underlain by Paleogene and Neogene sedimentary beds that contain carbonaceous organic matter.

Virtually no literature documents the maturation state of organic matter in pre-Tertiary strata, but it is probably too high for stable hydrocarbons. However, coaly material in Neogene and late Paleogene rocks of adjacent regions is of a low thermal rank and probably has not yielded thermally generated gas and (or) oil. As a result, it seems reasonable that little or no hydrocarbons have originated from the thermal degradation of carbonaceous organic matter in the basin. Cretaceous units near the coast offer the only possible exception (Braislin and others, 1971).

WESTERN OREGON TERTIARY BASIN

The surface of the basin is principally underlain by Paleogene and Neogene sedimentary rocks formed from sediments deposited in littoral to deep marine depositional settings. Basaltic volcanic units that formed on the floor of the Eocene ocean are nearly ubiquitous, as are local accumulations of volcaniclastic sedimentary rocks formed in association with the volcanic units. Sedimentary Paleogene clastic units are nonmarine in the southern and eastern part of the basin but grade to marine beds at variable positions in the central and western part of the basin. The Paleogene rocks have been variably transported from their original site of formation by tectonic forces but their origin can be approximated. In general, west- and northwest-flowing streams transported volcaniclastic debris across a coastal plain with a well developed wetland plain. Locally impounded and slow moving streams accumulated herbaceous and woody plant tissue that was subsequently transformed into carbonaceous shale and coal beds. Much of the terrestrial organic matter was washed from the wetlands into oceanic settings and then redistributed by marine currents to sites well removed from the coastline.

Late Eocene and Oligocene rocks indicate that streams flowing west from east of the present site of the Cascade Range transported micaceous arkosic sand through the ancestral Cascade Range to the coastal plain and seaway. This material was subsequently redistributed along the western edge of the seaway to form a complex of arkosic sandstone units that extends from at least as far south as the central part of the basin north into the State of Washington. The arkosic sandstone units are exposed in northwest Oregon and have been penetrated in drill holes over much of the north half of the basin (Newton, 1976).

Newton (1980) indicates that Eocene beds in the south coastal part of the basin contain organic matter that originated from woody and herbaceous plants. Some samples contain amorphous organic matter, a type that may yield oil upon maturation. Unpublished Rock-Eval analyses (T. D. Fouch, D. A. Anders, B. E. Law, and C. M. Molenaar) indicate that most of the organic matter in sampled rocks originated from terrestrial plants. Sparse analytical data of coal rank and vitrinite and Rock-Eval analyses of the maturity of the matter indicate that only locally have exposed Paleogene units reached thermochemical maturity. It is reasonable that Paleogene beds have been heated to sufficient levels to yield some hydrocarbons in those areas with a thick section of younger Paleogene and Neogene strata. Isotopic analyses of the gas at Mist field in the north part of the basin suggest that the gas originated by thermal processes but at a relatively low value of maturation for thermal hydrocarbons (D. A. Rice, T. D. Fouch, unpublished data).

CASCADE RANGE PROVINCE

The area of the Cascade Range is underlain principally by volcanic and sedimentary rocks (Peck and others, 1964). Very young nonmarine sedimentary units that contain organic matter were developed in local mountain lakes. Near the boundary of the range with the Western Oregon basin some Paleogene carbonaceous sedimentary units may be present within the Cascade Range province, but these rocks are not thought to be deeply buried.The ubiquitous presence of volcanic rocks and the absence of source, reservoir, and trapping units for oil and (or) gas indicate the potential of the province is zero.

HIGH PLATEAU PROVINCE

Strata of this province are composed primarily of Neogene basalt locally intercalated with nonmarine sedimentary rock that contains coaly material. Local basins that formed in Neogene time are filled with sedimentary rock sequences with abundant coaly beds. Mesozoic and Paleozoic rocks, which are exposed at several localities, locally underlie the Neogene units. Oil shows have been reported in rocks as old as Jurassic (Deacon and Benson, 1971). The maturation level of the Mesozoic units is not documented, but it is thought to be too high in pre-Cretaceous (or perhaps pre-Jurassic) beds in most parts of the province to have preserved stable hydrocarbons. Most pre-Cretaceous rocks of the basin have undergone at least incipient mineral metamorphism. Eocene and Oligocene beds locally contain coal of a lignitic rank that indicates that these beds could only yield gas where buried much more deeply.

Drill holes that penetrated Neogene strata in relatively small local basins have detected gas shows (Newton and Corcoran, 1963; Deacon and Benson, 1971). However, wilderness tracts in this province are not generally located in these areas. Those tracts that bound such areas may have a higher potential than tracts well removed from the thick sequences of Cenozoic sedimentary rocks. Although the surface of the province is generally underlain by volcanic rocks, carbonaceous source beds may underlie or be interbedded with the volcanic units, and thus there is a small potential for gas in the area.

YAKIMA-UMATILLA BASIN

This basin is underlain by Paleogene and Neogene volcanic and sedimentary rocks. Nonmarine sedimentary beds of Eocene and Oligocene age, which contain coal and carbonaceous matter of low thermal rank, are locally developed. Neogene volcanic units are locally intercalated with carbonaceous rock and could yield small quantities of gas in drill holes. Older Paleogene and pre-Tertiary sedimentary rock may underlie the Neogene units but this relation is speculative for most of the basin in the absence of drill holes.

SUMMARY

Of the 4,865,739 acres included in this study for the assessment of the petroleum potential of the Wilderness Lands in Oregon, the potential acreage can be summarized as follows: medium potential, 138.2 thousand acres; low potential, 2,869.7 thousand acres; and low to zero potential, 1,857.9 thousand acres. The petroleum potential by acreage of all Wilderness Land categories in the Western United States is shown in this circular by B. M. Miller in table 1, chapter P.

REFERENCES CITED

Bostick, N. H., 1979, Microscopic measurements of the level of catagenesis of solid organic matter in sedimentary rocks to aid exploration for petroleum and to determine former burial temperatures—a review, *in* Scholle, P. A., and Schluger, P. R., Aspects of Diagenesis: Society of Economic Paleontologists and Mineralogists Special Publication 25, p. 17–44.

Braislin, D. B., Hastings, D. D., and Snavely, P. D., Jr., 1971, Petroleum potential of western Oregon and Washington, and adjacent continental margin, *in* Cram, I. H., ed., Future Petroleum Provinces of the United States—Their Geology and Potential: American Association of Petroleum Geologists Memoir 15, v. 1, p. 229–238.

Deacon, R. J., and Benson, G. T., 1971, Oil and gas potential of eastern Oregon and Washington and Snake River basin of Western Idaho, *in* Cram, I. H., ed., Future Petroleum Provinces of the United States—Their Geology and Potential: American Association of Petroleum Geologists Memoir 15, v. 1, p. 355–359.

Newton, V. C., Jr., 1976, Geology, prospective fold structures, and reservoir characteristics in the upper Nehalem River basin, Oregon, *in* Newton, V. C., Jr., and Van Atta, R. O., eds., Prospects for natural gas production and underground storage of pipe-line gas in the upper Nehalem River basin, Columbia-Clatsop Counties, Oregon: State of Oregon Department of Geology and Mineral Industries Oil and Gas Investigations 5, p. 1–25.

—— 1980, Geology and oil and gas prospects of the Coos Basin, Oregon, *in* Newton, V. C. Jr., ed., Prospects for oil and gas in the Coos Basin, Western Coos, Douglas, and Lane Counties, Oregon: State of Oregon Department of Geology and Mineral Industries Oil and Gas Investigation 6, p. 1–15.

Newton, V. C., Jr., and Corcoran, R. E., 1963, Petroleum geology of the western Snake River basin, Oregon-Idaho: Oregon Department of Geology and Mineral Industries Oil and Gas Investigations 1.

Peck, D. L., Griggs, A. B., Schlicker, H. G., Wells, F. G., and Dole, H. M., 1964, Geology of the central and northern parts of the western Cascade Range in Oregon: U. S. Geological Survey Professional Paper 449, 56 p.