

THE PRINCIPLES UNDERLYING THE OCCURRENCE OF OIL AND GAS AND THEIR APPLICATION TO WESTERN CANADA

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In this article an attempt will be made to show, from the similarity of geological conditions in Alberta and other parts of western Canada to the usual conditions accompanying the hydrocarbons throughout the world, that great possibilities await the exploiters of petroleum and natural gas in these western fields. It is recognized that the economic geologist cannot reason safely from analogy; at the same time, he would be wrong, while investigating one field, in disregarding conditions in other fields and refusing to apply them. Without the presumption of trying to show that western rocks are reeking with oil, there will be no harm in pointing out the similarity in conditions in these fields to the proved oil and gas fields of the world by means of a geological comparison.

Oil and gas occur in rocks of all geological ages from Silurian to those of recent formation. Of the oil and gas fields of the United States, which has a much greater production than any other country, the largest, or Appalachian field, has the oil and gas distributed in many favorable formations of a great series of Palaeozoic rocks. The Ohio-Indiana, the mid-continental of Kansas and Oklahoma and the Illinois fields are all represented by Palaeozoic formations, generally by the younger groups. California oils are found in rocks ranging in age from Jurassic to Quaternary time, but are chiefly in the Tertiary. The Texas-Louisiana oil-bearing strata are of Cretaceous to Quaternary age. Colorado and the bulk of Wyoming oils are in Cretaceous. In Alaska, formations from Jurassic to Tertiary are the favorable ones. Most of the oils of Europe and Asia are in rocks of age from Jurassic to Tertiary, frequent occurrences being known in even the latest of the Tertiary formations.

Oil and gas reservoirs.—Any porous rock or cavity or open fissure may be a reservoir for oil or gas, provided that other conditions are suitable. Sandstones are the most abundant of the very porous rocks and are, as would be expected, the most important oil and gas holders. Porous limestones also hold large quantities. Rocks made porous by fracturing and fissuring may and do hold workable pools. Series of alternating sandstones, shales and limestones seem to offer the best facilities as a source and place of accumulation for the hydrocarbons. If these rocks exist with the proper structural relations, we have what may be described as geologically possible oil and gas ground.

Besides a porous rock to serve as a reservoir, there is needed an impervious overlying rock to keep the hydrocarbons from gaining access to the surface, where they would be lost. In general, oil and gas are collected in the highest underground places they can reach, and most of them are under a pressure sufficient to cause their escape through any but the most impervious rocks. As a rule, oil and gas are found under a stratum of damp clay or shale, which is the common impervious rock in the sedimentary formations. It is on account of the general tendency of the lighter hydrocarbons to work upwards, evidently driven and compressed by water currents from below, that they are generally found in the apex of low anti-

clines or domes in the strata. There have been doubts cast on the applicability of the anticlinal theory of accumulation of oil and gas, but, with a few exceptions, it has proved to be, when combined with good judgment, the only valuable hypothesis of general application available for the prospector. In areas where dry wells exist, the hydrocarbons, not being under the influence of underground waters, are likely to be found in an opposite condition than would be indicated by the anticlinal theory. In some of the other fields where the application of this theory has failed, local conditions seem to upset the applicability of the theory rather than the theory itself.

Gas nearly always accompanies oil, but the finding of gas in a well, on the other hand, in no way assures us that oil will be found, though it may be regarded as a favorable indication of the presence of oil. As a general rule, where the two are found, the gas is above the oil; this does not exclude the possibility of there being two horizons, one above the other and each containing both of the hydrocarbons. On account of these definite relations between gas and oil, it is important that an oil well be sunk in the right place to avoid complications with gas in getting the oil and to make use of the pressure of the gas to force out the oil.

Surface indications.—Oil and gas pools have been located without any real surface indications beyond formations and structures which would indicate geologically favorable ground. These formations and structures point to a good locality for prospecting, but as a rule surface indications are looked for and are desirable, especially in unproven territory. In most of the fields that have been discovered there have been gas springs and often oil seepages. These escapes generally, and especially in a plains country, indicate that the hydrocarbons are under pressure and that they are of the normal type. Having found surface indications, the general structures of the area are examined in order to find the most likely location of the reservoir. As a rule it is found at the crest of an anticline. If the anticline is low or the rocks are horizontal, it is more difficult to decide on the best location for a well, and it is then that surface indications in the way of gas escapes under pressure and oil seepages from below may prove helpful in giving a clue as to the location of the pools.

In summing up the principal features in regard to oil and gas formations, it might be said that favorable conditions are afforded by thick series of sandstones, conglomerates, limestones and shales of age from Silurian to Recent, that have been left undisturbed except for general elevation or have suffered only minor folding. The conditions which are essential for the accumulation of large pools of oil and gas are: first, a source for the oil; second, porous rock to serve as a reservoir; and third, an impervious stratum to prevent escape. The sources generally favored by geologists are thick beds of shales, preferably those which show evidence of abundant life, either animal or plant or both, and limestones, which in themselves always