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CHEMICAL RELATIONS OF THE OIL-FIELD WATERS IN SAN JOAQUIN VALLEY, CALIFORNIA

PRELIMINARY REPORT

BY

G. SHERBURNE ROGERS

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INTRODUCTION.

CONCLUSIONS AND RECOMMENDATIONS.

During the rapid rise of the petroleum industry in the last 50 years the geologic occurrence of petroleum has received a great amount of study, and the interesting problems involved in its origin and migration have engaged the attention of many geologists. It has long been known that oil and gas are commonly associated with water, and the great importance of the water as a physical agent in the migration of the oil has been recognized in all geologic theories of the accumulation of oil. Of the chemical relations between the water and the oil, however, we know little, and scientific literature contains only a few references even to the chemical character of the waters themselves. Apparently many of the current ideas on this subject either are erroneous or can be accepted only with important modifications.

In the oil fields of San Joaquin Valley, Cal., the oil and water are found in practically unconsolidated rocks. At most localities several water-bearing sands are intercalated in the shales above the oil measures, and there is also a water sand a short distance beneath them. In some places a water sand occurs in the shale that separates the oil sands, and less commonly oil and water have been found in the same stratum. In sinking a well through this complex it is difficult to prevent the water, which in places is under high head, from entering the oil sand, in which event it may drive the oil some distance back and so ruin a considerable tract of land. The writer studied the physical and chemical relations of the water and oil in these fields during the summers of 1914 and 1915. The chief conclusions concerning the chemistry of the waters, deduced by him from a study of several hundred analyses of water from different depths, are as follows:

1. Oil-field water is not necessarily salty, as is generally believed, and may not be even slightly salty to the taste. The degree of concentration of chloride in such water is governed primarily by local conditions and is not affected by the position of the water in relation to oil.

2. Sulphate, which predominates in most of the shallow ground waters on the west side of San Joaquin Valley, diminishes in amount as the oil zone is approached and finally disappears.

3. The concentration of carbonate increases as the oil zone is approached but depends largely on the concentration of chloride.

4. The horizon, with respect to the oil zone, at which these alterations take place, is different in each field.

On the basis of these conclusions, which appear to be well grounded, at least for the area studied, the following practical suggestions may be made:

In drilling a well in untested territory it may be possible to obtain an indication of the presence or absence of oil and gas below by ascertaining by analysis whether the sulphate is diminishing and the carbonate increasing in the waters successively encountered. In some areas a significant change may be detected as much as 1,000 feet above the oil; in others the upper limit of alteration may be within a few hundred feet of the oil.

The source of the water in a well that produces a mixture of water and oil may be determined, at least in a general way, by studying its chemical composition. In the Westside Coalinga field, for example, the source of the water may thus be determined rather definitely; in the Midway-Sunset field, where the distinctions are less sharp, the success of this method will depend largely on the number of authentic analyses that are available for comparison.

In this report the writer aims first to present the evidence on which the foregoing conclusions are based and to discuss the interpretation of water analyses and their value from the operator's standpoint, and second, to discuss the chemical relations of water and oil in so far as present information permits. It is hoped that this preliminary presentation will indicate the importance of experimental geochemical work on the interaction of the organic constituents of oils and the inorganic substances found in the oil-field waters. Enough is known already to warrant the belief that systematic experimental work in petroleum hydrology will yield results of practical as well as scientific value.

ACKNOWLEDGMENTS.

The writer wishes to express his appreciation of the assistance and cooperation rendered by Mr. R. W. Pack, with whom he was associated in a study of the Midway and Sunset fields for the United States Geological Survey during the summer of 1914. Dr. Chase Palmer and Mr. Herman Stabler, also of the Survey, as authors of

the system of interpretation of water analyses adopted in this report, have been freely consulted, and Dr. Palmer in particular has been a constant source of help in the study of the chemical relations of water and oil. The writer is indebted also to Mr. R. B. Dole for generous consultation on some of the problems touching the chemistry of natural waters. Dr. Chase Palmer and Mr. S. C. Dinsmore made many of the water analyses included in the report.

Special mention should be made of the unpublished work of Mr. E. A. Starke, of the Standard Oil Co., on the chemistry of the waters of the California oil fields. Mr. Starke has collected and studied a large number of water analyses and reached several years ago many of the conclusions that the writer has recently arrived at independently. Mr. Starke noted the absence of sulphate in waters associated with oil and ascribed it to chemical reaction between the two, and so has guided his prospecting to a considerable extent by studying the composition of the waters encountered in prospect wells. The special thanks of the writer are due Mr. Starke for his free discussion of the subject and for the use of some of the analyses included in this report.

The success of any study of underground conditions in an oil field depends on the good will and courtesy of the operators, and the writer desires gratefully to acknowledge the support and cooperation of all the companies visited. A complete list of those who have cheerfully and generously furnished information would include practically all the operators in the Coalinga, Midway, and Sunset fields, many of whom spent considerable time in assisting in the collection of samples of water for analysis. The following gentlemen rendered the writer especially valuable aid: Messrs. B. H. van der Linden, M. E. Lombardi, E. G. Gaylord, Paul Paine, M. J. Kirwan, W. W. Orcutt, M. L. Requa, T. A. O'Donnell, E. O. Faulkner, W. M. Wallace, J. E. Elliot, W. A. Ambrose, F. B. Tough, J. J. Hern, R. D. Bush, T. J. Crumpton, W. A. Greer, W. E. Brown, and J. H. Dearin.

NEED FOR MORE ANALYSES.

In the course of this investigation more than 50 samples of water have been specially analyzed and about 250 analyses, most of them made for industrial purposes, have been furnished by the oil companies. These have been sufficient, it is believed, to form a fair basis for the principles set forth in this paper, but they are inadequate to give more than a general idea as to the character of the waters in any particular locality. In the Westside Coalinga field all the evidence leads to the conclusion that conditions are fairly constant, and that even with the data at hand it is possible to determine the general horizon of a water from its analysis. In the Midway-Sunset field, however, the zone of water altered by the oil may in some localities extend 600 feet above the oil measures, and it is at present impossible to deter-