OIL PROSPECTING IN WESTERN ILLINOIS ON THE BASIS OF THE STRUCTURE OF COAL BEDS.

ALFRED H. BELL, ILLINOIS STATE GEOLOGICAL SURVEY.

Introduction.

The most efficient and economical development of oil resources depends in part upon an understanding of the mode of origin and accumulation of oil pools. Oil is found in the interstices of porous strata, mainly sandstones and limestones; most sedimentary strata are not porous enough to contain oil that can be profitably extracted. Moreover, many sufficiently porous strata contain salt water or gas instead of oil. Two of the fundamental questions of petroleum geology are, first, when and where have the porous beds been formed; and, second, what conditions govern the filling of some with salt water and some with oil or gas?

The Anticlinal Theory.

One of the earliest generalizations concerning the occurrence of petroleum is known as the anticlinal theory. According to it, oil is found at the crests of anticlines, or up-bowings of the strata, and gas, oil and water have a definite succession in the porous stratum according to their respective specific gravities. The warpings of the strata may be shown on a map by contours which represent lines of equal elevation of some stratum called the "key horizon" which passes over the fold.

Relation of Oil and Gas Fields to Structure in Southwestern Illinois.

The known occurrences of oil and gas in southwestern Illinois accord with the anticlinal theory. Figure 1[1] shows the location of oil and gas producing areas in southwestern Illinois (except the Waterloo field in Monroe County). Practically without exception they are situated upon, or are closely related to, well-defined anticlinal structures. Most of these anticlinal structures are features both of the shal-

[1]Bell, A. H., The Sorento dome: Illinois State Geol. Survey, Press Bulletin Series, Illinois Petroleum No. 6, Fig. 1, p. 2, Dec. 4, 1926.

lower and of the deeper strata, but are usually more accentuated in the latter.

Choice of a Key Horizon.

The requisites of an ideal key horizon are first, that it shall be an easily recognizable stratum or contact, and, second, that it shall have a stratigraphic position near the prospective oil-bearing stratum. Wide separation of the key horizon from the oil-bearing bed is undesirable because of the chance of unconformity between them.

Structure Mapping in Southwestern Illinois.

In most of the area of figure 1 the presence of an overlying mantle of glacial and fluvial deposits of Pleistocene age prevents the determination of structure by means of surface outcrops. As there is no traceable outcropping key horizon sub-surface structure is determined almost entirely by the use of the data supplied by well borings and mines. Because of the economic importance of Herrin (No. 6) coal in southwestern Illinois more datum points are known for it than for any other bed either above or below, and it is therefore usually chosen as the key horizon for structure maps in this area. It possesses physical characteristics that render its identification easy where it is present in its normal thickness and even in places where it is thin or absent, its stratigraphic position may usually be recognized in carefully kept logs by a correlation of other beds.

Because the vertical section supplied by the diamond drill core shows the strata in their proper order, and because the lithologic character and fossil content of the core may be studied in detail, the geological information obtained from core drilling is, in general, superior to that obtained from churn drilling. The accuracy of maps prepared from sub-surface data varies according to the closeness of spacing of the datum points.

The use of Herrin (No. 6) coal as a reference bed in structure contour maps has the disadvantage commonly attending wide separation of the key horizon and the oil-bearing sand. The most productive oil sands in the general region are of Chester age and are separated from the key horizon by the inter-systemic unconformity at the top of the Chester. The problem of the relation of Pennsylvanian to pre-Pennsylvanian structure in Illinois is important for its economic as well as its geologic interest.

The use of diamond drill logs not previously employed made possible the revision of the earlier structure map of parts of Bond, Madison, and Montgomery counties.[2] For example, the construction of such new maps as those showing the structures of the Ayers and Sorento domes by 10-foot instead of 50-foot contours has been made possible by the use of data derived from diamond drill records. As a result of this more detailed mapping, structures appear which were not previously delineated (fig. 2[3]).

It might be of interest to know that shortly after the publication in December, 1926, of Illinois Petroleum No. 6, describing the Sorento dome, the acreage on the top of the New Douglas dome was leased and so far, one well, located 40 feet down from the crest of the dome on the southwest flank, has been completed to a depth of 841 feet. Although considerable sand was found both in the Pennsylvanian and in the Chester, it was filled with salt water and there was no showing of oil. A second test is to be drilled higher on the structure.

The continual acquisition of new data by the Survey makes possible from time to time the revision of earlier maps and the delineation of structure in greater detail. A continuation of this type of work constitutes one of the activities of the petroleum section of the Survey. The purpose of this work is to present the most accurate information possible in regard to structures thereby encouraging prospecting for oil in a systematic manner and preventing as far as possible useless expenditure on wild cat drilling in localities that are geologically unfavorable. The generalized character of some of the earlier maps accounts for occasional failures even when the wells were drilled on indicated structures. Moreover, favorable structures even though accurately mapped are not always productive of oil; other favorable conditions besides structure are necessary for the accumulation of oil in commercial quantities. For these reasons many of the oil operators are not fully convinced of

[2]Blatchley, R. S., Oil and gas in Bond, Macoupin and Montgomery Counties, Illinois: Illinois State Geol. Survey Bull. 28, pl. II, 1914.

[3]Bell, A. H., The Sorento dome: Illinois State Geol. Survey Press Bulletin Series, Illinois Petroleum No. 6, Fig. 2, p. 7, Dec. 4, 1926.

the value of geological studies in the development of oil production.

In order that the relationship between geological structure and oil production may be more fully realized, it is clear that the structures should be indicated with the greatest possible accuracy. In demonstrating the usefulness of geological information the Survey has an educational function. Eventually, perhaps, the oil operators of Illinois will employ geologists of their own to a greater extent than at present. The Survey will still have an important function of acting as a clearing house for geological information and of carrying forward the study and interpretation of the ever-increasing mass of geological data from the State as a whole. Thus, by a study of so-called "pure" science, the economic interests of both present and future generations are served.

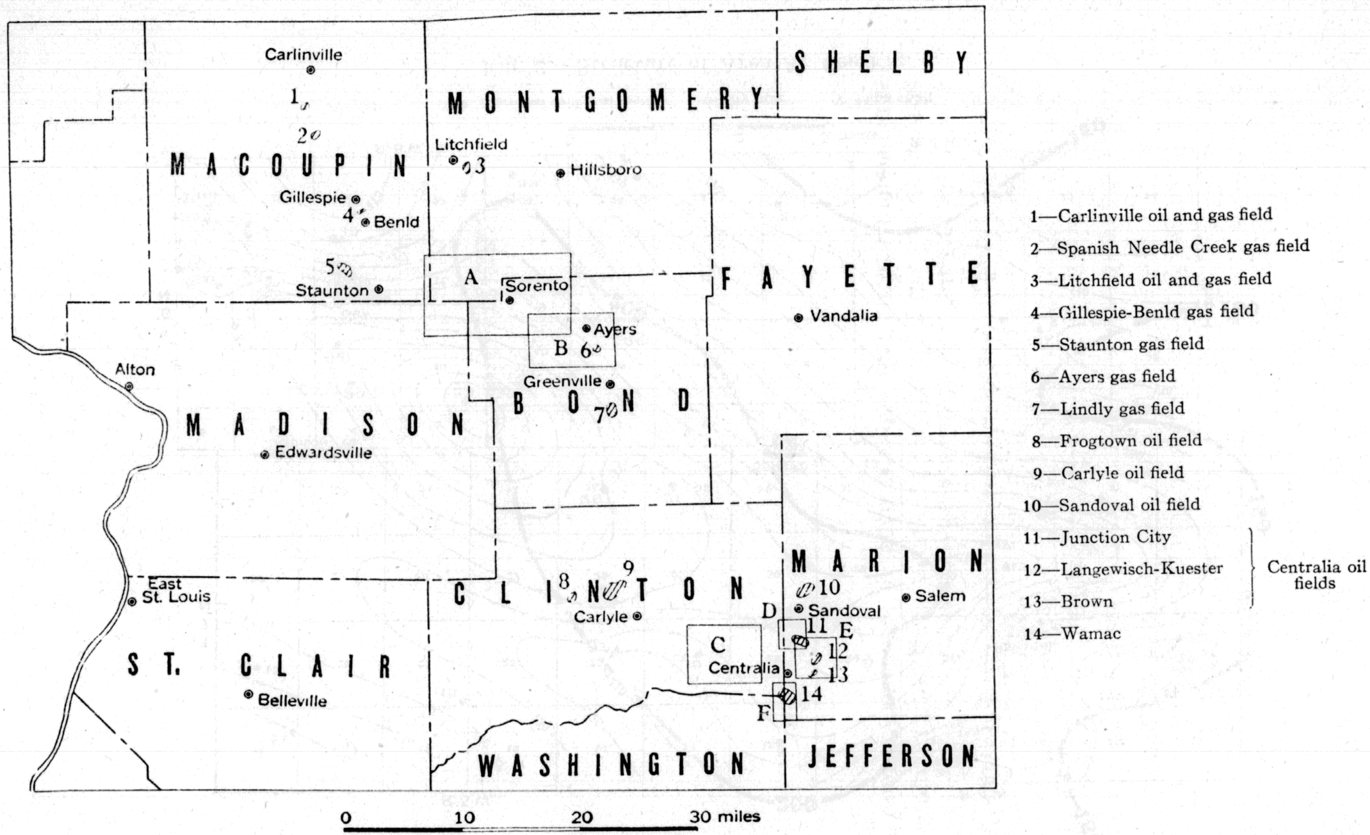

Fig. 1.—Index map showing locations of oil and gas fields in part of southwestern Illinois. Structure of area A is shown in figure 2. (By A. H. Bell, State Geological Survey.)

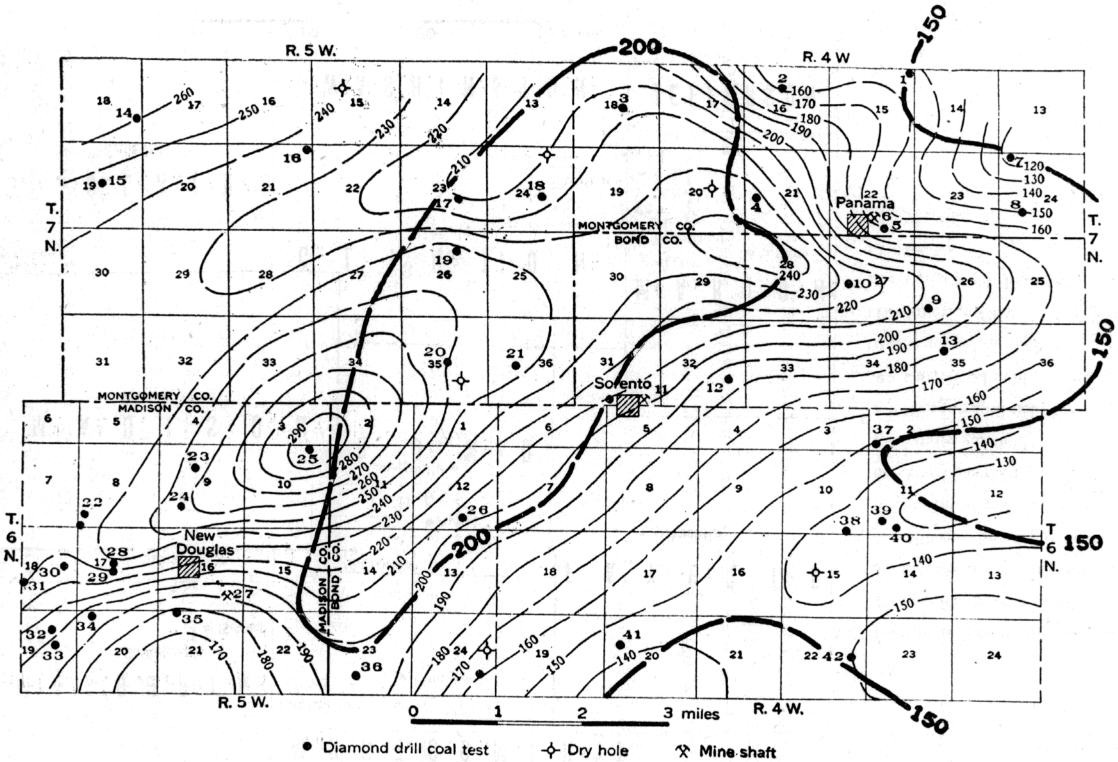

Fig. 2.—Structure of Area A. See Fig. 1.