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BASE DRILLING AND ITS GEOLOGICAL FOUNDATION

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In the USSR the drilling of base /base "opornoye," is probably used here as in the geodetic use of base or reference point; a series of these base shafts would comprise a base network, i.e., a network of representative points./ geological wells in a broad network over the Russian platform and in the Caucasus, Central Asia, and Siberia is now widely employed for the study of deep levels, along with various other geological, stratigraphic, and geophysical studies.

Base drilling is a very important method for locating oil and gas on vast previously uninvestigated territories. It detects coal-bearing strata beneath the cover of comparatively young deposits and reveals the characteristics of geological structures and the distribution of mineral fuels at great depths. In conjunction with geophysical methods base drilling is especially effective in rapidly solving problems of geological structure at great depths. It initiates a new epoch in the search for oil, gas, and coal, and in the geological study of deep strata. The drilling of base wells according to the state's single general plan is the most important characteristic of this method. The importance of base drilling for geological prospecting works can be compared with that of afforestation for agriculture in the Stalin Five-Year Plans.

As long ago as 1936, the founder of Soviet petroleum geology, Academician I. M. Gubkin, recommended that the oil content of the central USSR be determined by the drilling of a series of structural wells in latitudinal and longitudinal directions.

Another important Soviet geologist, Academician P. I. Stepanov, employed base drilling to solve one of the most important problems of goal geology -- the detection of the coal deposits of the east Donbass for clarification of the geological picture of the Greater Donbass.

Base drilling, previously applied to comparatively small areas, became a general state instrument and was applied to vast areas only after World War II, on the basis of a government decree initiated by Stalin.

Study of the base wells already drilled rapidly solved problems of the geology of deep strata of vast areas and oriented future prospecting works in the central, western, and southern regions of the Russian platform, where the depth of the crystallic foundation or the main features of Paleozoic stratigraphy had already been established in many places. Theoretical and practical geological studies of wells drilled in the last 2 years were of much greater importance than all preceding studies on the deep structure of the central regions.

Base drilling also produced important results the first time that it was used in the northern Caucasus. The well at Chernyy Rynok showed the distribution of Maykop deposits in the facies of the Predkavkaz'ye (lands north of the Caucasus) flexure towards the north; this permitted demarcation of the northern boundary of this important oil-bearing structure after comparison with data of wells in the Artezian and Astrakhan regions.

One of the most important characteristics of base drilling is the strict scientific foundation for locating wells, based upon the evaluation of all geological and geophysical data. Base wells are not laid out on geometric equilateral networks, since, if this were the case, the geological conditions of the individual wells would not have been considered.

The location of wells and the problems to be solved by them are determined by the geological characteristics of the regions to be studied by base drilling.

The study by base drilling planned for all parts of the USSR which are of interest because of their gas-bearing or oil-bearing potentialities is based upon the principle of drawing up a regional division which most fully reflects natural geological conditions governing possible oil- and gas-bearing potentialities, coal-bearing belts, etc.

Such a regional division is based upon tectonic characteristics which permit one to unite various sections having identical genesis, history, facial characteristics, and, consequently, geochemistry of oil and gas deposits and similar tectonic structures. The problems to be solved by base drilling must be clearly defined for each section so identified.

By generalizing extensive factual data, Soviet geologists have created tectonic systems that reflect the developmental history of large structural elements. The tectonic system for the USSR published in 1938 by A. D. Arkhangel'skiy and N. S. Shatskiy and subsequently revised is the most complete generalization of USSR geology. This system shows the depth of the foundation for individual sections of the platform which, according to Academician I. M. Gubkin, is of extreme practical importance for evaluating the oil potentialities of platform regions and for evaluating the oil potentialities of platform regions and for laying out base wells.

Without entering into a detailed evaluation of this system as a basis for base drilling, we note that it permits one to divide the territory of the USSR into large tectonic regions characterized by unity or definite genetic and structural similarity and to define the problems to be solved by base drilling for the main types in these regions.

We can distinguish: (a) ancient platforms, Russian and Siberian; (b) Paleozoic folded regions or young platforms, including the Uralo-T'ien-Shan folded region; and (c) young Alpian folded regions, namely the folded region of the southern USSR and the folded region of the Far East. The geological structure and historical development of ancient platforms, young platforms, and folded regions are essentially different, and thus the principles governing the location and problems of base drilling vary with the regions.

The ancient platforms are characterized by metamorphic folded crystallic foundations, which represent the lower structural stage, and by a sedimentary nonmetamorphic and comparatively slightly dislocated cover, which is the upper structural stage. There is a sharp boundary between foundation and cover, plus marked discontinuities of deposits and nonconformities in stratification, so that foundation and cover can easily be distinguished.

The foundation is metamorphic and is fused by intrusions; consequently, it cannot be considered to possess promising oil and gas deposits. Oil and gas deposits are concentrated in the sedimentary cover, which is irregularly distributed over the surface of the foundation, that is, in some places the cover is absent and foundation rocks crop out on the surface, which in other places the cover may be quite deep.

The parts of the ancient platform where the foundation is not covered by a sedimentary cover, that is, shields or crystallic masses (for example, Baltic shield, Ukrainian crystallic massif, Aldan shield, Anabar massif), are not promising zones with respect to oil and gas, and base wells should not be drilled there. All remaining sections of ancient platforms, for example, slopes of shields, depressions, underground shelves (anteclises), are promising and must be covered by base wells.

Since geological studies to determine the direction of searches for gas and oil are concerned only with rocks of the sedimentary cover, the base wells must be drilled through the sedimentary layer to the crystallic foundation. In the deeper depressions, like the Caspian syneclise, for example, where the sedimentary cover is 6-8 kilometers deep and the base wells cannot be drilled down to the foundation because of technical difficulties, the task must be limited to the study of the upper part of the deposits forming the sedimentary cover. In this case, it is efficient to mark off in the sedimentary cover on the basis of all available geological and geophysical data "base" [reference] stratigraphic levels to which the base wells must be drilled. For example, in planning base drilling in the Caspian depression, geologists selected the Paleozoic deposits underlying rock salt as the base level. In places without available data upon which to plan a base level, drilling must be planned for the maximum depths technically attainable.

Base drilling down to base levels must also be conducted in boundary flexures, that is, in extreme zones of platforms where the crystallic foundation recedes to great depths in approaching folded zones. Boundary flexures are regions of transition of a platform into a folded (geosynclinal) zone, but they may be considered with respect to structure as deeply depressed boundary parts of a platform.

To locate base wells on ancient platforms requires a detailed regional division of the platforms with isolation of the most important positive and negative structures (anteclises and syneclises), which generally determine the facial variations in the prospective oil-bearing strata that make up the sedimentary cover. This regional division must be based upon the characteristics of the historico-geological development of the individual sections of platforms with a selection of those structural features and elements which are most stable through the history of the platform.

Since the main oil-bearing and gas-bearing regions of the Russian platform known at present are connected with the Middle and Upper Paleozoic eras (Devonian, Carboniferous, Permian), Upper Paleozoic structure should be taken into consideration, but attention should also be given to data on the spread of Lower Paleozoic and Mesocenozoic strata.

The base wells drilled on the Russian platform have answered a number of questions concerning the deep structure of the Baltic depression, the Belorussian massif, the Dneprovsko-Donets depression, and the southern rim of the Moscow

syneclise. The top priority problems of base drilling are: the Caspian depression, the Yergeni massif, the southwest USSR, the central and northern parts of the Moscow syneclise, and the Predkavkaz'ye. In particular, the tracking of Lower Paleozoic deposits east and northeast of the Baltic and Leningrad regions in the depths of the Moscow syneclise is of great interest. Solution of this problem may expand considerably the potential oil resources of the central and northern parts of the Russian platform. A number of important problems must be solved by base drilling in the Caspian depression: the geological nature of the gravitational maxima found in the depression's center; the facial composition and structure of the subsalt deposits from the standpoint of their probable oil content; and boundaries of the belt where the Caucasus-type Paleogene wedges into the south Caspian depression.

Young platforms both differ from and resemble old platforms. Young platforms, the same as old, consist of two geological elements, the folded foundation and the sedimentary cover. The folded foundation, however, is formed not only by pre-Cambrian deeply metamorphicized rocks and dislocated rocks, but also by a whole complex of Paleozoic rocks from Cambrian to Permian and rocks which are metamorphicized to varying degrees. Thus, the folded foundation of young platforms are more mobile because of their lower consolidation than the foundation of old platforms; an example is the Fergana depression, which formed in the body of a young Upper Paleozoic platform because of movements of its folded foundation in the Mesozoic and Cenozoic eras.

The folded foundation of young platforms is characterized by nonhomogeneity. In some sections the folded foundation was formed at the end of the Paleozoic, and in others in the Lower Paleozoic or even pre-Cambrian. Thus, young platforms include sections which have the appearance of miniature ancient platforms or sections with Paleozoic or more ancient (Caledonian) folded foundations.

The above statements are well illustrated by recent works in the South Urals, where there were established elements of different ages, and particularly the Mugodzhari anticline fold, which is a section of the pre-Cambrian fold; characteristically, it did not undergo substantial movements in the Mesozoic and Cenozoic eras.

Since the age of the folded foundation within a young platform can be different in different sections, the stratigraphic range encompassed by rocks of the sedimentary cover is first extended and then contracted. Thus, the section of the sedimentary platform cover to be studied by base drilling for oil and gas will, in places, include only Cenozoic and Mesozoic deposits and in other places will also include Paleozoic deposits.

In summation, it can be said that young platforms differ from old platforms by the greater complexity of historical development and tectonic structure.

Thus, it follows that base drilling on young platforms is marked by more complex problems. For example, folded foundations whose rocks may contain beds of oil and gas if they are not strongly metamorphicized must be studied in some regions as well as the sedimentary cover, which may include Paleozoic as well as Mesocenozoic deposits.

This means that base drilling for young platforms cannot be defined in such general form as for ancient platforms, but instead requires consideration of the individual characteristics of the regions to be drilled. Base drilling can solve very important theoretical and practical problems connected with oil and gas prospecting in young platforms in Ustyurt, the Karakum desert, the tertiary depressions of Central Asia, and the West Siberian plain.

The oil-bearing deposits of Manygshlak under the tertiary sediments of Karakum and Ustyurt must be revealed by base drilling, and the deep layers of the Kuznets, Minusinskiy, and Karaganda basins must also be studied by base drilling.

Base drilling on young platforms is of no less importance for detecting coal-bearing strata. Of great interest, in particular, is the detection of the coal-bearing Carboniferous in the Kulundinsk steppe and of Mesozoic coal-bearing strata in the Turgay Strait.

Young folded regions are characterized by the presence of practically a single structural stage, formed by Mesozoic and Cenozoic rocks. The lower structural stage (dislocated and metamorphicized Paleozoic) usually is submerged to very great depths, practically inaccessible by drilling, or comes to the surface inside montain ranges, where it is subjected to strong tectonic and thermal effects and therefore is not of interest in gas and oil prospecting.

For purposes of practical evaluation, young folded regions must be subjected to regional division. Large mountain ranges, which are usually zones that are orographically strongly partitioned and uplifted, metamorphicized and fused by intrusions, are not favorable for the organization of base drilling because of their low potential, since strong dynamic and thermal effects cause thinning and destruction of gas and oil accumulations in these zones (high mountains and partitioned topography are also very unfavorable since they indicate substantial drainage of rock massifs), and because of the complex tectonic structure and the absence of gross structures within which the layers would have static homogeneous stratification for considerable lengths. Actually, base drilling is a completely justified method only when it can be used to discover extensive oil or gas deposits.

Foothill depressions are structures which frequently correspond to boundary flexures of platforms; intermontane (inner) depressions, on the other hand, are highly promising zones. Examples are the Carpathian flexure, the lands north of the Caucasus, the Rionsk and Kurinsk depressions, the depression of southwest Turkmenia, etc.

Submersion zones of mountain ranges, which are essentially the same as foothill and intermontane depressions, are also important objects for base drilling.

An exception is strongly dislocated but weakly metamorphicized zones, that is, sections of foothill and intermontane depressions, reaching towards the central zones of geosynclinal mountain systems (regions of Kakhetiya and the Carpathian slopes). They can be promising and may be of enough interest to organize base drilling. The common deficiency of such zones is the strong tectonic partitioning which naturally limits the application of base drilling.

Base drilling in foothill and intermontane depressions and also in regions of submersions of mountain ranges and systems must reach down to certain definite reference stratigraphic levels, selected in each case with consideration for the characteristics of the region.

From the above it follows that the geological conditions for the most effective use of base drilling exist on ancient platforms, situated on a pre-Cambrian folded Foundation. This in no way lessens the importance of base drilling in folded regions where conditions of strong tectonic partitioning must be taken into consideration in laying out the wells.

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