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## ACHIEVEMENTS OF RUMANIAN GEOLOGISTS IN THE OIL INDUSTRY

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The increased output of crude oil registered in the Rumanian People's Republic in recent years cannot be adequately expressed in the dry and laconic code of figures unless one is familiar with the conditions which preceded and accompanied the time in evolution towards the present level of extraction which is unique in the history of the Rumanian oil industry.

In 1948, when nationalization was carried out, the country's crude oil output had dropped to under four million tons yearly and it was even doubtful that this level could be maintained.

Based on theoretical criteria, the geologists considered that other regions of Rumania, besides that already known, could present an interest for the oil industry. However, the lack of areas prepared for exploration permitted them to make but few recommendations for starting preliminary drilling work. An inventory of all anti-clinal folds known at that date showed that most of them were incompletely prospected and that their preparation would require a longer period of prospecting means and specialized personnel. Prospecting work started to be actively organized, but this fact although bound to create working prerequisites for the future, did not settle at all the urgent problem of production, and meanwhile the country's recon-

struction work required even more oil.

Two were the ways which the geologists considered fit to tackle for solving this problem, pending the results of prospecting work.

The first way led to the old oilfields under exploitation, which offered certain perspectives of extending productivity at the surface and especially at great depth, below the already known oil strata. A careful study of some of these oilfields confirmed this supposition.

The second way led to the unexplored anticlinal folds, situated in the interior and immediately to the west of the already known oil zone, folds which, although incompletely prospected, presented theoretical conditions favourable to the accumulation of hydrocarbons.

These two ways were followed simultaneously with courage and confidence and good results were obtained.

To form a more comprehensive idea of the geological problems, we deem it necessary to make a general survey of the structural units of the Rumanian land with special reference to those structures which are at present known as hydrocarbon bearers.

Looking over the geographical map of Rumania, one sees that the central zone is occupied by an immense natural fort—a chain of mountains—the Carpathians to the north, east and the south, and the Apuseni mountains to the west, which encircle a depression known as the Transylvanian Depression.

To the west of the Apuseni mountains there is a vast plain which stretches over the western part of the country, and up to the Alps. It is the Pannonian Depression.

The Carpathian mountains are divided into two big structural units, different by the facies of the sediments they are composed of and their folding style: the Eastern Carpathians to the east and south-east and the Southern Carpathians to the south. These two big structural units come into tectonic contact in the region of the Dimbovita Valley. Outside the Carpathian arch, the country's territory is formed of a number of hills, the so-called Subcarpathians, which from the geological point of view belong to a big mio-pliocene depression zone, in which depressions of the second and third order could have been formed. The depression facing the Southern Carpathians is known as the Getic Depression and that facing the Eastern Carpathians as the Subcarpathian Depression.

These two depressions, whose inner sides were folded more or less intensively during the Pliocene orogenesis, lean their unfolded exterior flanks against the Pre-

balkan Platform to the south and against the Podolic Platform to the east. The platforms come into touch in the lower part of the Siret Valley, north of the Danube.

The last structural unit on the Rumanian territory is the region between the Danube and the Black Sea, Dobrogea; formed of crystalline schists and Mesozoic-palaeozoical sediments, transgressively covered to the south by the Tertiary. The northern part of this structural unit seems to thin out.

For a better orientation we give the following additional details: the existence was proved of a big tectonic unit in the Southern Carpathians. It is the Getic sheet formed of crystalline schists and Mesozoic deposits, which superpose on an autochthon whose Mesozoic crystalline strata are different from those of the layer as concerns their facies. The layer was formed during the Cretaceous orogenesis.

The formation of the Eastern Carpathians is of a more complicated nature. They can be differentiated into an inner zone formed of crystalline schists and Mesozoic sediments (the Mesozoic crystalline zone) and an outer zone, formed of Oligocene-Cretaceous sediments, developed in flysch facies. In the formation of this latter zone one can distinguish zones of the second order, the zone of the Cretaceous flysch and the zone of the Palaeogene flysch which, in their turn, can be divided into smaller units.

The structure of the Eastern Carpathians is also a structure of numerous oversliding layers, superposed on one another from the west to the east. Only one layer is definitely proved, the exterior one, the layer of the Tarcău Sandstones, whose deposits, from the higher Cretaceous up to the Oligocene, superpose on the Miocene and the Oligocene in the Subcarpathian Depression. Drilling work proved a superposing of 10 to 15 kilometres. This layer was formed during the Miocene orogenesis. The inner edge of the Eastern Carpathians is formed of a powerful chain of mountains consisting of eruptive rocks (andesites) of the Pliocene age.

Of all the above-mentioned geologic units, only the Subcarpathian Depression was known in 1948 as an oil bearing region and only in two areas: the northern areas, to the west of the town of Bacău, entirely devoid of importance, and the southern region, between the Buzău Valley and the Ialomita Valley, an oil zone of paramount importance in the Rumanian People's Republic.

The former productive zone, that to the west of the town of Bacău is situated at the exterior border of the layer of Tarcău Sandstones. The crude oil in this region, situated in the Oligocene of the autochthonous layer has been known for hundreds of years, but its output was always poor. In 1948, the three small

oilfields here (Zemes, Solont and Moinesti) produced together only 180 tons a day.

Until after the War, the current opinion was that the region presented no importance, that the Oligocene Sandstones, the Kliwa Sandstones being impermeable could produce but small quantities (from several litres to several tons a day), through pumping and that the profitableness of intensive drilling based on the Rotary system, was doubtful.

An oil-well which after the War had opened a new structure and started an eruptive production of 50 tons a day destroyed the idea about the lack of permeability of the Oligocene Sandstones, but the prospect of extending this result appeared to be limited.

The detailed geological analysis of the older oilfields and of the relations between them led to the conclusion that the exploitations had not got to the core of the problems, that the productive structures were incompletely known, the old oil wells had not opened the entire section of the Oligocene and that underground and surface exploitation carried out from a new geological angle, was absolutely necessary.

The planning of exploration was very difficult because of the tectonic complications of the region. The intimate structure of the Tarcau sandstone layer, mapped at the surface, showed an extremely complicated folding in very close scale folds, slanted from the west to the east. This structure did not mould itself on that of the productive autochthon of the layer, therefore the folds of this foundation, although more simple, could only be deduced with great difficulty.

Carefully working on the geologic material resulted from mapping and speculating with courage, together with the information obtained from older drilling sites, a more conclusive geologic idea could however be formed on the structure of the autochthon, which was not only harmoniously uniting the old productive structures but also showed clearly the perspectives of work. This idea proved right. In but several years after work had been started, a wide productive zone was linking the three old sites between them, and a production 30 times greater than in 1948 was reached. Also the insignificant exploitations at Solont, which in 1948 produced only 6 tons a day from over 30 oil-wells, were producing 40 to 50 tons a day each began to operate successively.

The productive region to the west of Bacău in Moldavia\* had become a genu-

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\* Moldavia is the region which stretches in the western part of Rumania between the mountain crests and the Prut river).

ine oil region. To the north and south of the productive zone, intensive exploitation is carried out and hopes are high that production will be steadily brought up.

The second productive zone, the most important in the country, the one between the Buzău and Ialomița Valleys, is situated from the geologic viewpoint on the northern side of the Subcarpathian Depression, were intensely folded sometimes in the form of anticlinal folds with axial salt cores. That is why this region is defined by some researchers as the zone of overthrust folds.

The folds are formed of Neogene sediments and generally productive is the Maeotian. On some of the folds the Dacian and exceptionally even on the Helvetian were also productive.

The eastern part of the zone is less productive and it includes only two small oilfields at Arbănaș-Berca and Sărata-Monteoru (the latter being exploited through drifts). The region to the north and north-west of the town of Ploești is very rich. The anticlinal folds at Ceptura and Boldești, the overthrust folds at Băicoi-Tintea and Moreni-Gura Ocniței etc, had yielded high and continue to yield even now scores of years since their discovery.

In 1949, it was in the interior of this zone, under the productive Pliocene, that the geologists chose their deep exploration objectives. The results were satisfactory. Worth mentioning is the discovery in 1950 of the Sarmatian deposits at Boldești which, at a given moment, turned this oilfield into one of the biggest in the country.

Remarkable results were obtained in the Sarmatian on the southern side of the overthrust fold at Tintea and in the Helvetian on the southern side of the Viforita Teiș structure.

Deep exploration is now carried out on other structures too. Simultaneously with exploration at great depth, exploration work was started on several new anticlinal folds, two of which proved to be of a greater importance: the fold at Colibași discovered in 1949 and that of Podenii Vechi, opened in 1953. Prior to the War, an oil-well was sunk on each of the two folds but lack of any indication led to their abandonment. Exploration through transverse sections, a method based on the Soviet working system, led however to different results and conduced to the turning into account of two new oilfields with Maeotic production.

Of particular geologic interest, in the years preceding the First Five-Year Plan, was the region to the west of the Ialomița Valley, which stretches to the west of the oil bearing zone. It was the first step made and on it seemed to depend the future of the Rumanian oil industry.

The anticlinal fold at Suța-Seacă had been known for a long time. On this

fold, along its axis zone two wells had been sunk before the War, but as both of them had found the Maeotian flooded, the structure was abandoned as devoid of interest,

A new geologic analysis, in a regional framework, suggested however another hypothesis of work. Starting from the reduced thickness of the Maeotian met through the two wells in the axial zone of the fold, from its more discordant position on older strata than the Sarmatian and from the fact that the anticlinal structure seemed to have been formed in a parallel with the sedimentation phenomena, the idea was accepted that in the axle of the structure only the upper part of the Maeotian was present and that its lower part should be developed on the sides of the fold. This idea proved right and in 1949, the first exploration well in the southern flank of the structure came across lower productive maeotic deposits. The anticlinal fold at Suța-Seacă, stretching over 30 kilometres and being productive in the southern flank of the Sarmatian, can be considered as one of the biggest oilfields of the country. One year later, in 1950, a new oil-bearing anticlinal fold was discovered at Dragomirești to the northwest of Suta-Seacă.

Proof was made that oil deposits could exist also outside the zone known up to then as productive. This fact powerfully stimulated the exploration work and late in 1950 a special unit was set up, the Trust of Geologic Exploration. Its major exploration objective was the western part of the Depression outside the Carpathian arch, that is the Getic Depression. Subsequently, however, work with a deep prospecting or even exploration character was started also on other structural units.

Hydrocarbons appearing at the surface had been known in the Getic Depression, near the town of Tg. Jiu, in the superior Pliocene and in the Helvetian. In the latter region, a rudimentary exploitation with several small-depth oil wells had existed in 1916. The Helvetian, however, the only formation which could be productive was entirely opened and this fact led to the conclusion that along the geological times the deposits had been degraded. Therefore it was considered as more fit to put into exploration anticlinal folds, well closed by Pliocene deposits.

The drilling work in the Getic Depression faced the geologists with entirely new problems. The old prospecting work showed that some of the facies of the Neogene formations which entered into its composition, were different from those known in the east. The folding style of the formations seemed to be similar to that encountered in the old oil zone. The data obtained from the first wells did not confirm this point of view. They showed that in the northern flank of the depression the Pliocene deposits form a slightly undulating cover which overspreads in a discordant and transgressive manner over older Miocene folds, in most cases of the same reduced amplitude as the Pliocene folds. Only now a number of data obtained previously by prospecting could be understood and rightly appreciated and evidences were established of Pliocene synclinals superposed on older anti-

clinals, of Pliocene anticlinals placed on Miocene synclinals or Pliocene monoclines over older anti-Pliocene folds.

At Tîrgu Jiu, the first structure explored in the Gêtic Depression, the geologists had to deal for the first time with a Pliocene synclinal, broken in many clefts, but with inclinations of strata which did not surpass several degrees, superposed on an anticlinal which presented some interest only for the Miocene (the Sarmatian and Helvetian respectively) with inclinations on sides only by several degrees higher than those of the Pliocene, but inversely.

Situations of this kind and of different kinds were often encountered but no general rule could be established. That is why, the exploration lasted more than it was anticipated.

However in 1952 the deposit in the Sarmatian near Tîrgu Jiu was tapped as well as the Pliocene and Helvetian deposits to the east of Pitești (Leordeni) and in 1953 and 1954 new Sarmatian and Helvetian deposits were tapped and two Maeotian to the west of Pitești. The old productive zone of Ploesti Tîrgoviște was extended to the west up to Pitești and beyond it and the Gêtic Depression became a new oil province of the country.

Exploration work is now carried out on other anticlinal folds of this new province. The indications obtained are good and justify the conviction that shortly this province will be ranked in productivity next to the old oil region of Ploesti. These are the geologic conditions which ensured a steady increase in crude oil production in recent years and will ensure it in the years to come.

Of course, this increased production of crude oil is, to a great extent, the result of the creative, elaboration work of the geologists. But that could not have been sufficient by itself. Without the full confidence and aid received from all the creative energies in the oil industry, workers, technicians and engineers, without the courage inspired them by their leaders, the results would certainly not have been the same.

But our work is only at the beginning. Prospecting work whose capacity has yearly increased is steadily confronting the geologists with new problems, and deep reference drilling brings ever richer data which sometimes fundamentally change geologic outlooks that seemed generally valid.

By active cooperation the same as until now, it is sure that the geologists in the Rumanian oil industry, old and young alike, on sites, in offices or laboratories, engaged in prospecting exploration or exploration work, side by side with the workers and technicians and sharing with them their science and experience and to make them a common boon which comes from all and belongs to all, will succeed in further ensuring to the Rumanian People's Republic the full utilization of this wonderful source of energy and raw material which is the crude oil.