

LUDOVIC MRAZEC AND PETROLEUM GEOLOGY

CORNELIU DINU¹, IRINA MIHAELA DINU²

¹ University of Bucharest, Faculty of Geology and Geophysics, 6 Traian Vuia St., 020956 Bucharest 2, Romania

² National Institute for Marine Geology and Geoecology – GeoEcoMar, 23–25 Dimitrie Onciul St., 024053 Bucharest 2, Romania

Abstract. L. Mrazec worked in the field of Petroleum Geology and of petroleum industry for over 40 years, bringing major scientific contributions, from which we remark: the synthesis, on tectonic units (the Sub-Carpathian zone and the Transylvania Basin), on the distribution of the oil and gas fields, the theory of diapirism and of diapiric folds, the organic origin of oil, the concept of primary and secondary oil field waters. Moreover, he defined the notion of petroliferous formation.

Keywords: oil field, tectonics, diapirism, petroliferous formation.

Résumé. L. Mrazec a travaillé dans le domaine de la Géologie du Pétrole et de l'industrie du pétrole pendant plus de 40 ans, apportant des contributions scientifiques majeures, dont on remarque: la synthèse, sur unités tectoniques (la zone des Sous-Carpathes et le Bassin de la Transylvanie), de la distribution des gisements de pétrole et de gaz, la théorie du diapirisme et des plis diapirs, l'origine organique du pétrole, le concept des eaux de gisement primaires et secondaires. De plus, il a défini la notion de formation pétrolifère.

Mots-clés: gisement de pétrole, tectonique, diapirisme, formation pétrolifère.

INTRODUCTION

L. Mrazec began the geological research activity after 1890 and carried it on without interruption during the first four decades of the 20th century. Petroleum Geology research covered most of this period, from 1900 to 1940. Most of this research focused on the Sub-Carpathian hills from Muntenia, on the southern part of Moldova (up to the Bistrița Valley), a rich area in oil and salt deposits, and on the Transylvania Basin, as well as several synthesis studies on the whole territory of Romania.

In 1900, the International Exhibition took place in Paris. This is where Mrazec presented the first map of salt formations in Romania, which was well appreciated by specialists.

In 1901 Mrazec and Teisseyre, together with other geologists (Sava Athanasiu, I. Simionescu, Gh.M. Murgoci, and V. Popovici-Hațeg) were committed by the Minister of Domains, to collect data for a geological map of petroliferous zones in Romania. In November the same year, Mrazec presented the requested map to the Ministry. In January 1902, this map was also presented to His Majesty The King. A report on the geological distribution of oil deposits had been carried out by L. Mrazec, W. Teisseyre, V. Popovici-Hațeg, S. Athanasiu, I. Simionescu and Gh.M. Murgoci.

In 1901 Mrazec and Teisseyre also published a paper on salt deposits of Romania.

Following these activities, as well as his previous research, Mrazec carried out and published a series of papers on the geology of our petroliferous zones. These papers concern the geological distribution of the petroliferous zones of Romania in 1902 (Mrazec, 1902), the study of petroliferous formations of Romania in 1903 (Mrazec, 1903a), the age of the petroliferous layers in 1903 (Mrazec, 1903 b), the geology of the Câmpina and Gura Ociței-Moreni zones in 1903 and 1905 (Mrazec, 1903 c, Mrazec, 1905 a), observations on the oil genesis in Romania in 1905 (Mrazec, 1905 b, Mrazec, 1905 c).

OIL COMMISSION

An initiative of the liberal government led by D. Sturdza in 1903 resulted in the establishment of the Oil Commission, under the leadership of C. Alimănișteanu, V.I.C. Brătianu and L. Mrazec. During 1903–1904, the Oil Commission carried out an intense activity, materialized in a vast plan of works meant to facilitate the development of the crude oil industry in Romania, with these main objectives: carrying out geological research of the country's territory in order to find petroliferous zones, building transport pipelines to the sea, and installation of storing facilities in Constanța.

As a member of the Oil Commission, Mrazec coordinated the geological research in order to make the inventory and identify potentially oil-bearing zones. For this purpose, he also attracted Gh. M. Murgoci, who studied the hill zones from Oltenia, while he, together with W. Teisseyre, stayed in the Eastern Muntenia (the region between the Bistrița Valley and Dâmbovița Valley), and also S. Athanasiu, for the region between the Bistrița Valley and the Bucovina frontier.

In the Report of the Oil Commission in March 1904, Mrazec synthesized the data concerning the geological distribution of the oil deposits, which he grouped in three main subdivisions, corresponding to the three main tectonic units (the flysch zone, the Sub-Carpathian zone and the Western Hills of Romania), and which he reported, very suggestively and correctly, on an annexed geological map, which was subsequently presented at the International Oil Congress in 1907 (fig. 1):

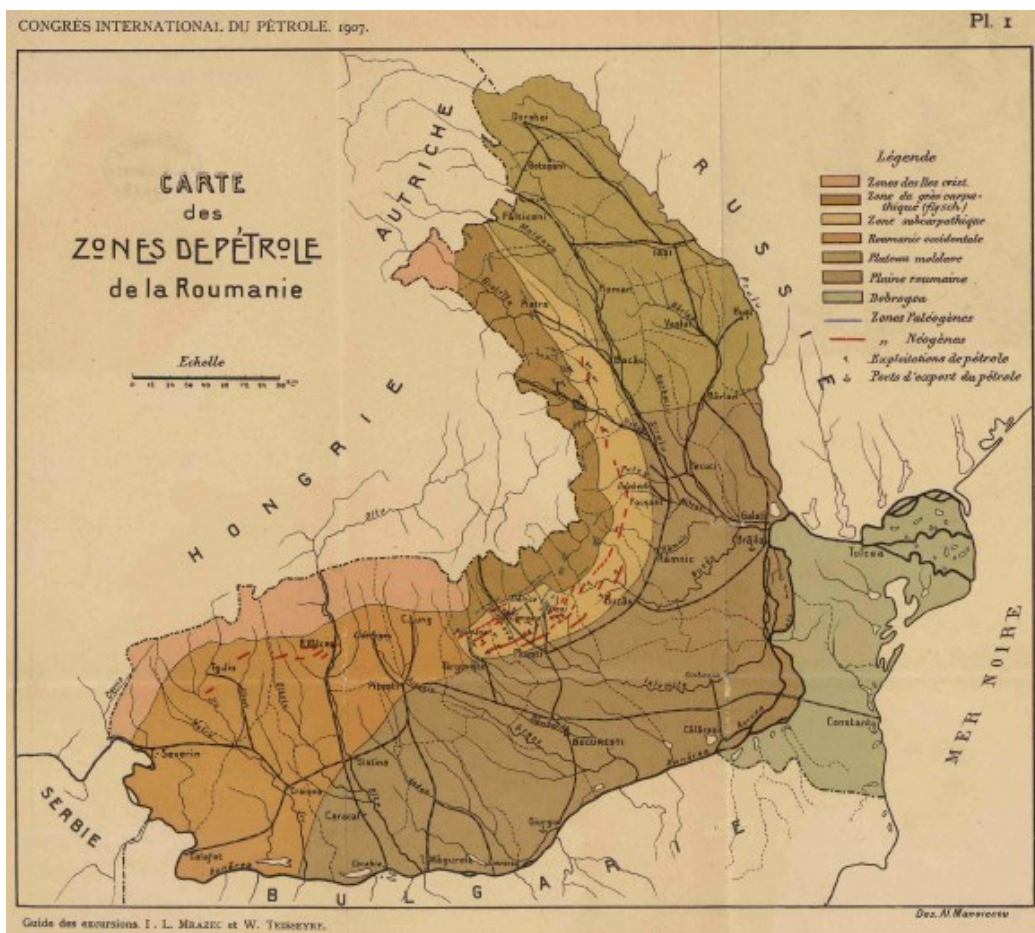


Fig. 1. The tectonic map of Romania with the distribution of the oil deposits on the main tectonic units (the Flysch Zone, the Sub-Carpathian Zone and the Western Hills of Romania) (Mrazec and Teisseyre, 1907).

– The Flysch Zone, inside which he separated, from north to south, 8 zones with oil deposits (south of Bistrița Valley, from Tazlău Valley, from Troțuș Valley, from Oituz Valley, from Slănicul de Buzău Valley and the zone west of Cățiaș);

– The Sub-Carpathian Zone, where he separated 3 regions: North Moldova, Lower Moldova and Eastern Muntenia, being inventoried successively the saliferous deposits from Moldova and Muntenia, the Sarmatian deposits (Sarmaticului) from Moldova and Muntenia, the Meotian (Meoticului) deposits and the deposits bearing the Layers with *Congerina* and *Vivipara bifarcinata*;

– The Western Hills of Romania with three zones: oil zones between the crystalline island and the northern edge of the compact Pontic cover, the oil traces from Slătioara and Mărgărești, as well as the Bălteni region.

For each of these zones, the oil productions on every geological formation were determined and the data synthesized according to age and location, thus establishing the potential and contribution of the main formations, which, at the scale of the country and for the year 1903, were having the following percentages: the Paleogene Flysch from Moldova 2.32 %; the Saliferous from Moldova 0.18 %; the Saliferous from Muntenia 1.64 %; the Sarmatian (from Moldova and Muntenia) 1.50 %; the Meotian 87.74 %; the Layers with *Congerina* and *Vivipara bifarcinata* 6.77 %.

In 1906 he published the paper on the geological structure of the Cămpina-Buștenari region (Mrazec and Teisseyre, 1906), together with a geological map with the distribution of the oil deposits (fig. 2).

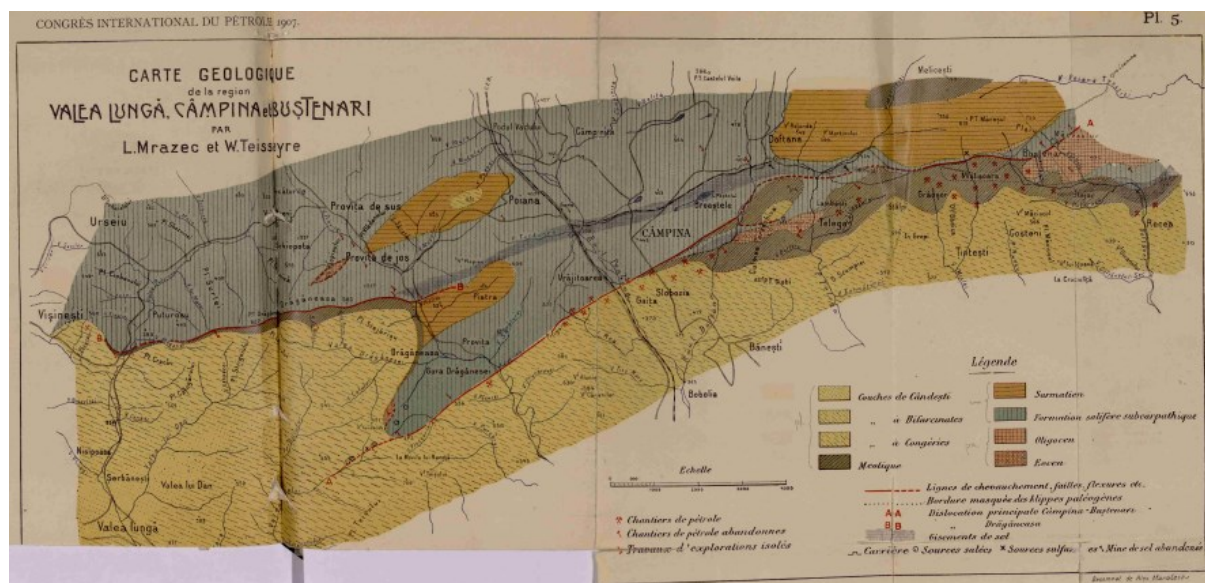


Fig. 2. Geological map of the Valea Lungă-Cămpina-Buștenari region, with the location of the main oil field sites (Mrazec and Teisseyre, 1906).

In 1907 Mrazec became full member of the Romanian Academy. On this occasion, he gave an acceptance speech with the theme *On the formation of oil deposits*, containing a response of Anghel Saligny, issued among the works of the Third International Oil Congress in Bucharest (Mrazec, 1906) (fig. 3).

Also in 1907, the Third International Oil Congress was organized in Bucharest, a major event of recognition of the significant progress and prestige of the Romanian oil school. This congress was carefully prepared, including a series of synthesis papers, field trip guides and annexes, extremely useful to the participants.

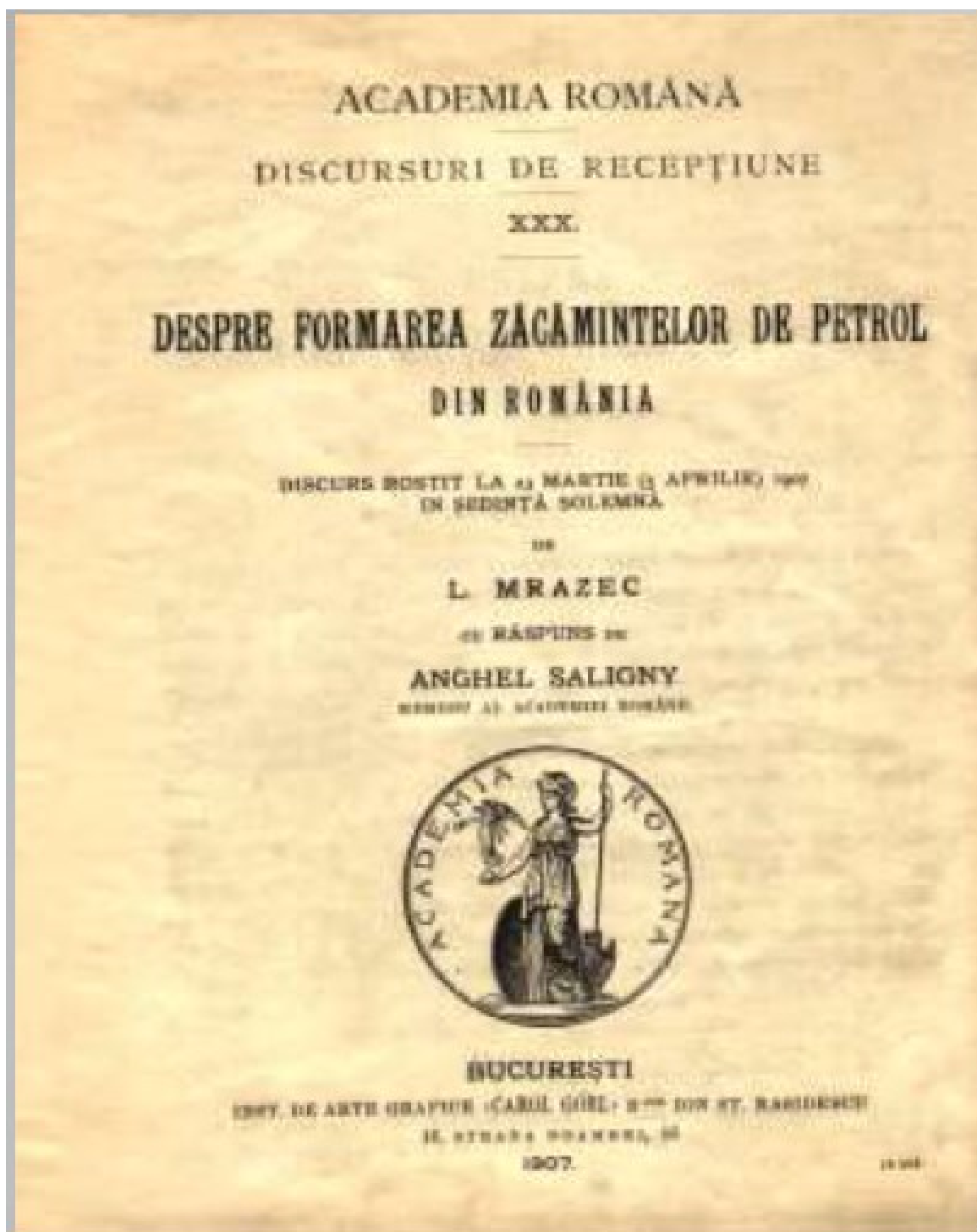


Fig. 3. The acceptance speech for the Romanian Academy – The Third International Oil Congress, Bucharest, 1907.

In 1902, in a conference held at the Conservative Club, concerning the organization of the Second International Oil Congress, which was decided at the First International Congress in Paris, G.M. Murgoci presented arguments for organizing it in Bucharest (Murgoci, 1902). In order to support the congress organization, the President of the First Congress, Mr. Lippmann, following the proposal of the France delegate, Mr. Eng. Lesseur, requested, by means of a letter, the support of Their Majesties, King Carol and Queen Elisabeta (fig. 4). Their Majesties understood the importance of such an international meeting and responded, by mean of the business commissioner, Mr. C. Popovici, that they fully agree to organizing the congress in Bucharest (fig. 4).

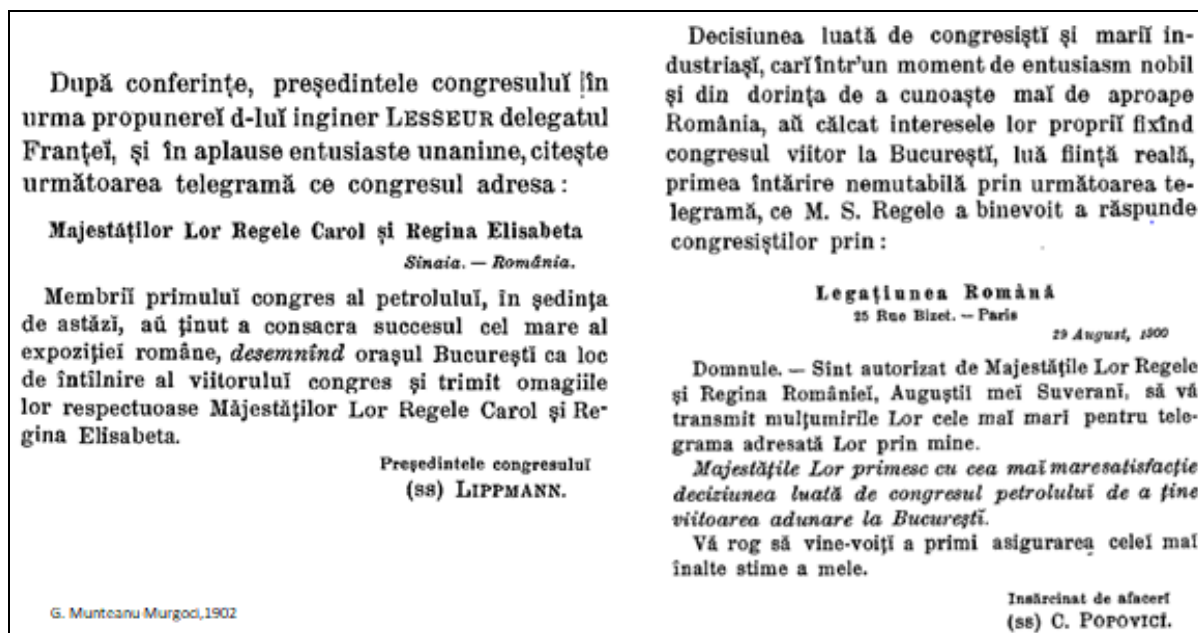


Fig. 4. Letter of the President of the International Oil Congress in Paris to Their Majesties King Carol and Queen Elisabeta and letter of response of His Majesty The King to the congress organizers from Paris, with acceptance of the proposal to hold the following oil congress in Bucharest (after Murgoci, 1902).

Even though there were consistent arguments brought into discussion, concerning both economic advantages and mostly the prestige brought to the country and to the specialists, the politicians postponed taking a decision. In the meantime, the Second Congress was organized in Liège in 1904.

THIRD INTERNATIONAL OIL CONGRESS

Only in August 1907 the Geological Institute of Romania could to organize the Third International Oil Congress in Bucharest.

As a recognition of his achievements, L. Mrazec was elected President of this International Oil Congress.

For the International Oil Congress in 1907, within the Geological Institute, 6 volumes with synthesis works and field trip guides were prepared. The first 3 volumes contained works to which Mrazec was author or co-author, concerning (fig. 5): The tectonic sketch of Romania (Mrazec and Teisseyre, 1907 a), The tectonic sketch of the Sub-Carpathians from the Prahova Valley (Mrazec and Teisseyre, 1907 b), Field trip in the petroliferous region from the Prahova Valley (Mrazec and Teisseyre, 1907 c), Field trip to the Slănic salt mine (Prahova district) (Mrazec, 1907 b).

Three great scientific achievements of Prof. L. Mrazec were also presented to the International Oil Congress: The theory of diapirism and of the diapiric folds; The organic origin of oil; Oil field waters.

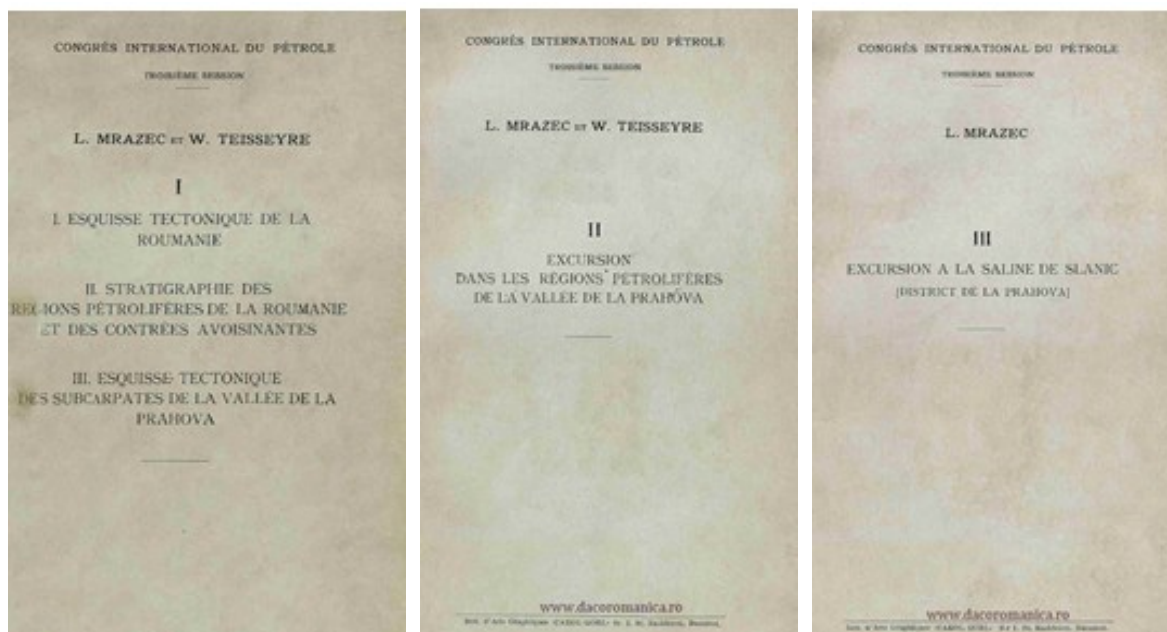


Fig. 5. Volume covers with Mrazec's contributions edited for the International Oil Congress in 1907.

THE THEORY OF DIAPIRISM AND OF DIAPIRIC FOLDS

It has marked a new stage in petroleum geology, with great echo in exploration and production of the folded Neogene zone between Buzău Valley and Ialomița Valley. Mrazec elaborated the theory of diapirism in 1906 and published it in 1907. He introduced the “diapir” term and the “diapirism” phenomenon, which means plastic deformations and salt uplift by piercing the formations above the deposit of rock salt, showing that the diapiric structures may provide efficient traps for the hydrocarbon deposits (Mrazec, 1906, Mrazec, 1907 c, Mrazec and Atanasiu, 1927). Oil is located in the flanks of diapiric anticlines, while their cores are made of salt. In this context, prof. Mrazec explained the distribution of hydrocarbons' accumulations in the Neogene Sub-Carpathian zone, making in 1914 the geological map with the locations of the diapiric structures in the zone between the Ialomița Valley and Urlați-Cricov (fig. 6). This one had a special impact in the exploration and exploitation of oil and natural gas, as it opened new perspectives. Until then, the only trap model was represented by anticline domes closed on all four sides. The complex problems of diapiric folds and diapirism have been taken over again and developed further, while the mechanisms of formation and evolution were refined and extended to other types of rocks, with practical consequences concerning the hydrocarbons deposits, synthesized in the works from 1915 and 1927 (Mrazec, 1915, Mrazec, 1927). Thus, Mrazec (1915) exemplified the existence of oil deposits: in the diapiric core (in the Sarmatian and Meotian of the Berca–Policiori–Arbănași anticline), in the crossed layers (in the southern and western flanks of the Moreni anticline, in the southern flanks of the diapirs from Băicoi and Ochiuri), in vault of the fold (the Țintea anticline and West of Băicoi) (fig. 6). He also explained the origin of the salt domes from the Gulf Coastal Plain from the Texas and Louisiana states (USA).

Another practical consequence is represented by the development of oil traps at various stratigraphic levels penetrated by the salt cores and of vertically overlapped deposits. This concept was proved on the zone of diapiric folds, where wells open successively and produce from Dacian deposits, from depths not exceeding 1000 m, while after rotary drilling, they reach depths over 2000 m and open Meotian deposits in all the already productive Dacian fields. This fact allowed reaching a maximum oil production of 8.8 million tons in 1936.

THE ORGANIC ORIGIN OF OIL

Starting from 1907, Ludovic Mrazec launched, for the first time in Romania, the hypothesis of the organic origin of oil and that the origin of the Romanian oil is bound to the Upper Eocene – Lower Oligocene and Lower Miocene (Cornu Layers) formations. L. Mrazec assigned the formation of hydrocarbons to a process of bituminization of organic substance originating from decomposition of microfauna and fauna from pelagic zones of seas, from gulf waters, lagoons, deltaic zones or salt lakes covered by sediments formed by slimes (muds).

The practical research and exploration of deposits were connected to solving problems concerning the origin of oil and genesis of oil deposits.

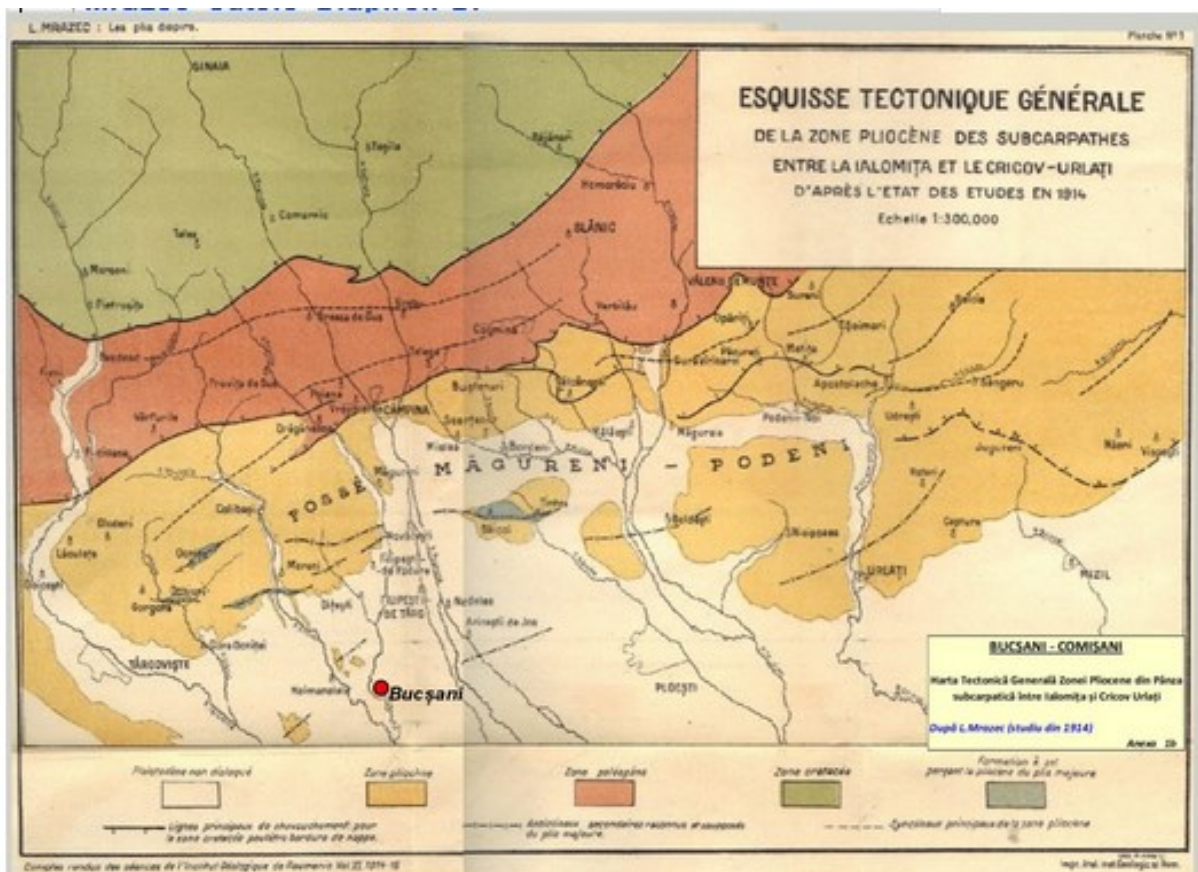


Fig. 6. Tectonic sketch of the Sub-Carpathian zone between the Ialomița Valley and Cricov Valley, emphasizing the diapiric anticlines (Mrazec, 1915).

By studying the oil deposits of Romania, Mrazec categorized them in: deposits “of Paleogene flysch type”, formed during Eocene-Oligocene and “of Mio-Pliocene type”, formed in Mio-Pliocene deposits, but assessing the role of source-rock to the Miocene “saliferous formation” to both types of deposits. Later, he admitted the Oligocene bituminous shales as source-rock as well, but only for the Paleogene flysch deposits (Mrazec 1907 d).

Fluid migration would have occurred on short distances, in the case of the first type of deposits, and on long distances, by the migration ways opened by salt, for the second type of deposits.

He supported, for the first time, “the autochthonous position” of oil only in the Oligocene deposits (primary deposits) and separated three areas with the most important oil deposits from the Pre-Carpathian Depression, thus: the Sub-Carpathian hill zone from Moldova; the zone of diapiric folds from Muntenia; the Getic Depression (west of Dâmbovița Valley).

THE OIL FIELD WATERS

Mrazec was one of the first researchers in the world who studied the oil field waters, and stated that these “veteric” or “fossile” waters have higher salt concentration than marine or lagoon waters, the sodium chloride prevailing. A specific characteristic of these waters is given by the presence of boron and iodine.

Ludovic Mrazec considered the presence of boron as an evidence of the marine origin of the waters, and the presence of iodine as an argument for the organic origin of oil.

Based on the association of the oil field waters to oil, Mrazec defined, also based on their origin and chemical composition, primary oil field waters (sigenetic or veteric waters), that migrated from the source-rock together with oil, and secondary oil field waters, that come from the oil source-rocks or from the mix of these waters with primary waters.

The theories developed by Mrazec concerning the organic origin of oil and its connections to salty deposit waters, from the Miocene and Oligocene deposits of the Flysch Zone, the Pre-Carpathian Depression and the Transylvania Basin have directed the research in Petroleum Geology and established a starting point in their practical activity (Mrazec, 1923).

In the period 1907–1915, prof. Mrazec gave the Course on oil deposits to the School of Bridges and Roads in Bucharest. Within this lectures, he developed the theory of diapirism and formation of diapiric folds, as well as their implications on the formation of oil deposits, on the organic origin of oil, its migration, as well as the role of deposit waters. Later, in 1922, he published the *Course on Oil Deposits* (Mrazec, 1922).

THE ACTIVITY OF L. MRAZEC DURING THE FIRST WORLD WAR AND IMMEDIATELY AFTER

The progress achieved in the development of oil industry of Romania was suddenly interrupted by the destructions caused at the beginning of the military campaign of Romania during the period 1916–1918. In order to prevent the Central Powers from using our crude oil in the war against The Entente, the Romanian government ordered – by the time of the withdrawal in Moldova (1916) – the destruction of the whole petroliferous region from Muntenia. On that occasion, in the Prahova, Dâmbovița and Buzău counties, more than 1,500 oil rigs were covered and other 1,000 oil wells and oil rigs were set on fire.

In the following two years (1916–1918), the territory administration was taken over by the Germans who, through sustained efforts, succeeded, within short time, to partly remove the effects of destructions in the oil industry by the end of 1916. Thus, in February 1917, they managed to put into

functions the first crude oil production well. Then the number of production wells increased continuously, up to 492 in September 1918. After the victory of The Entente, in November 1918, the German troops started to withdraw from Muntenia. As a consequence, the crude oil industry has been abandoned, suffering no longer serious damage, due to the express orders of Mackensen.

At the Peace Conference in Paris, from 1919, France and Great Britain appeared to be very interested in the Romanian oil and they proposed to the Prime Minister I.I.C. Brătianu to conclude an agreement for oil exploitation. I.I.C. Brătianu delegated L. Mrazec to negotiate with the French commissioner Bérenger, fearing that a *de plano* rejection of the presented offers might harm Romania's position at the Peace Conference, leading to a "less condescending" attitude of the concerned powers towards his country.

The negotiations with Great Britain and France concerning the problem of the Romanian oil occurred on the basis of an *Aide-mémoire* that Mrazec proposed to Bérenger. On April 4, 1919, Sir John Cadman, H. Bérenger and I.I.C. Brătianu signed a "Memorandum", which admitted the English-French collaboration for the exploitation of Romanian crude oil and obliged Romania to inform its partners upon the whole "orientation given to its oil policy". On the opinion of the Romanian delegates to the Peace Conference, the mentioned document *did not effectively engage* the government from Bucharest in matters concerning oil, but represented only a "statement of principles". The Romanian side obtained the inclusion in the "Memorandum" of the provision that, in the future, it will keep watch for a "reasonable and active" exploitation of the petroliferous resources and according to the overriding interests of the country. The English and French governments, recognizing this principle, offered to cooperate to the development of the Romanian oil industry. I.I.C. Brătianu thought that the "Memorandum" should be known and approved in Bucharest as well and, for this purpose, sent Mrazec to Romania. The Cabinet in Bucharest met on April 17, 1919 under the chairmanship of M. Pherekyde and approved the "Memorandum" brought by Mrazec and authorized I.I.C. Brătianu to go on the oil negotiations with the Allies according to its provisions.

In 1918, L. Mrazec made a trip to USA to visit the zones with oil deposits and salt diapirs from Texas and Louisiana states, following which he elaborated and presented in 1920 the paper *Origin of Salt Domes from the Gulf-Coastal-Plain, plain of the Gulf of Mexico from the Texas and Louisiana States* (Mrazec, 1920).

The lectures given at Sorbonne (1921) and at the University of Prague (1931) also had the subject of oil deposits (Mrazec, 1931). On these occasions he showed the generality of the bituminization phenomenon, the evolution and tectonics of the oil deposits.

Later, in 1924, analyzing the geologic and geographic conditions of oil, Mrazec specifies: "a petroliferous formation can be defined as a complex of rocks impregnated with gaseous and liquid hydrocarbons accompanied by salty fossil waters" (Mrazec, 1924). He defined primary petroliferous formations (where oil, gas and saltwater can be found in the bearing sediments (sediments in place) and secondary petroliferous formations (within which oil, gas and water, or only two of them, reached by migration and impregnated the porous rocks). The oil source-rocks are the ones in which hydrocarbons formed and were fixed by sedimentation. These are clayey rocks and sometimes siliceous rocks.

THE MINE LAW OF 1924

In the spring of 1915 Professor L. Mrazec made a report for the exclusive use of the government, entitled *The Problem of Oil in Romania with Respect to the World Problem in 1915*. The report was going to be published by the author only 25 years later, in 1940 (Mrazec, 1940). In this report he stressed the need for a state policy in the field of oil as being "of capital importance". Mrazec wrote "...The economic independence means the same thing as political independence; an economic

independence without our own energy generators cannot be conceived". Just to save what "can still be saved", the author indicated that the state should "start a new oil policy favourable and corresponding to the economic and political interests of the country". This wish couldn't be achieved if the Romanian state was going to "half-measures". For the start, the author recommended the introduction of a state monopoly on oil, which would disagree to the oil regime established by the mine law of 1895. This view was shared immediately and unreservedly by Vintilă Brătianu and finally led to the enthronement of "the great principle" of nationalization of the mining subsoil in 1923.

The Law of 1924 was the result of a serious and longtime work, carried out by a team of Romanian specialists, led by L. Mrazec, I. Tănăsescu, I. N. Angelescu and others. The text of the Mine Law adopted in 1924 is incomparably more precise and more complex than the one of the precedent law of 1895. In many ways (classification of mineral deposits, assessing the ways to exploit them, the provisions concerning their consolidation, the mining books etc.), the text was going to remain almost unchanged within the subsequent mining laws, of 1929 and 1937, which only modified, and did not replace, most of the articles ruled in 1924. The considerations exposed fully justify the name of "mining code" given to the law from 1924.

Following the proposition of the Geological Institute of Romania, from Mrazec's initiative, in 1929 the Mine Law admitted that granting concessions of exploitation was conditioned by simultaneous exploration works in the unknown zones; but the principle was not respected and no sanctions were applied. Moreover, the author insisted on conservation of deposits, by rational exploitation, collaboration between companies, land consolidation.

In 1922, L. Mrazec was Secretary-General of the Ministry of Industry and Trade. In this quality he led the Commission for the study of electrification of the country and the Commission for coordination of fuel exploitation, under the "Commission for the study of electrification of the country and coordination of exploitation of its natural factors for energy production" within the Ministry of Public Works, presenting a report on this commission in 1926. In this complex report, for the oil domain he carried out an evaluation of the oil deposits. For this purpose he created a department for evaluation of the oil potential within the Geological Institute of Romania. This department was carrying out the following activities: collection of data concerning the structure of each deposit; its exploitation, production and evolution in time; evaluation of the oil deposits on various units and geological formations.

In 1924, Ludovic Mrazec proposed that the geological maps carried out at the scales 1: 1.000.000 and 1: 500.000 would represent deep structures using data acquired at the drilling of wells. Also from his initiative, one of the subjects discussed at the International Drilling congresses, which took place during the period 1925–1939, referred to the methodology of well data use for the study of the lithosphere, that is the solid part at the exterior of a planet and which, in the case of the Earth, varies from few kms up to several hundreds of kms.

THE TRANSYLVANIA BASIN

In 1926, SONAMETAN (established in 1924) started a research program on the Transylvania Basin. The field works were committed to the young geologists A. Vancea and D. Ciupagea, under the direct coordination of Ludovic Mrazec. The research was focused mainly on the gaseous domes from the central zone of the depression. Also, between the years 1924–1927, the geologists I. Atanasiu and E. Jekelius from the Geological Institute studied the gaseous domes from Zău de Câmpie, Bazna, Saroș (Deleni) and Sărmășel.

On the occasion of the *Congress for advancement of the Carpathians geology* of 1927, L. Mrazec and E. Jekelius published a study concerning the structure of the Neogene and of the methane gas deposits of the Transylvania Basin (Mrazec and Jekelius, 1927).

In the paper *Considérations sur l'origine des depressions internes des Carpates Roumaines*, published by Mrazec (Mrazec, 1932), the main stratigraphic and structural elements of the Intra-Carpathian depressions and especially of the Transylvania Basin were presented. It was shown that the Transylvania Basin has a basement made of the elements of the meso-Cretaceous nappes and their Upper Cretaceous cover, over which Paleogene and Neogene sediments are disposed (remarking the presence of Oligocene shales with fossils fish remnants). From the tectonic and sedimentary facies points of view, three extension areas were distinguished (from exterior to interior): a border of the Neogene layers, discordantly disposed on the basement, unfolded or gently folded and faulted, with low inclinations towards the center of the basin, consisting of predominantly sandstones deposits in littoral facies, continental facies with coal, rich in fossils; an intensively folded zone with typical diapirs with salt cores, predominantly clayey-marly; the inner sink of the basin, with dome structures, which comprises the main mass of the depression sediments, with thickness that may reach 3,500 m in the central part, being dominantly clayey in the lower part and with sandstones in the upper part.

The Transylvania Depression is a post-tectonic cover, subsequent to the formation of meso-Cretaceous nappes, probably born at the end of Oligocene, maybe even in Miocene and its evolution is simultaneous to the successive overlapping of the Flysch nappes.

In 1935, Mrazec published the paper *The State and the National Oil Policy* (Mrazec, 1935) in which the reputed man of science recommended firm regulations for prospecting and opening of an offensive for oil explorations, if it was not desired that, in the following ten years, a drastic decrease of production would occur. Ensuring a fair ratio between extraction and reserves was compulsory. At the same time, exploitation had to be rational, while research should have led to the discovery of new reserves, which would replace the extracted ones.

REFERENCES

- Mrazec, L., Teisseyre, W., 1901. *Aperçu sur la formation salifère et les gisements de sel de Roumanie*. Moniteur Petr. Roum.
- Mrazec, L., 1902. *Distribuirea geologică a zonelor petrolifere în România*. Monitorul Int. Petrol Rom., **III**: 271–281.
- Mrazec, L., 1903a. *Contribution à l'étude des formations petrolifères de Roumanie*. Mon. Petr. Roum.
- Mrazec, L., 1903b. *Communication préliminaire sur l'âge des couches petrolifères de la Roumanie*.
- Mrazec, L., 1903c. *Géologie de la zone de Câmpina*. Mon. Petr. Rom., **V**.
- Mrazec, L., 1905a. *Contribuțiune la geologia regiunii Gura Ocnitei–Moreni*.
- Mrazec, L., 1905b. *Observații asupra genezei petrolului în România*. Mon. Petrol Rom., **VI**.
- Mrazec, L., 1905c. *Observations sur la genèse du pétrole en Roumanie*. Bul. Soc. de Științe.
- Mrazec, L., 1906. *Sur les plis de percements*. Communication faite à la Soc. des Sciences de Bucarest.
- Mrazec, L., Teisseyre W., 1906. *Communication préliminaires sur la structure géologique de la région Câmpina-Buștenari*. An. Acad. Roum.
- Mrazec, L., 1907a. *Despre formarea zăcămintelor de petrol în România*, București, Tip. Carol Göbl, Discurs de recepție la Academia Română, **XXX**.
- Mrazec, L., 1907b. *Excursion à la saline de Slănic (District de la Prahova)*, Congr. Geol. Inter. Petrole, **III**: 137–157.
- Mrazec, L., 1907c. *Despre cute cu sămbure de străpungere*. Bul. Soc. de Științe, România, **16**: 6–8.
- Mrazec, L., 1907d. *Sur la formation des gisements petrolifères de Roumanie*. Mon. Petr. Roum.
- Murgoci, G.M., 1902. *Congresul petroliștilor la București*. Rev. Română politică și literară, no. 6, 41 p.
- Mrazec, L., Teisseyre, W., 1907a. *Esquisse tectonique de la Roumanie*. Congr. Géol. Inter. Petrole, **I**: 3–17.
- Mrazec, L., Teisseyre, W., 1907b. *Esquisse tectonique des Sous-Carpates de la vallée de la Prahova*. Congr. Géol. Inter. Pétrole, **I**: 18–50.
- Mrazec, L., Teisseyre, W., 1907c. *Excursion dans les régions petrolifères de la vallée de la Prahova*. Congr. Géol. Inter. Pétrole, **II**, 53–133.
- Mrazec, L., 1915. *Les plis diapirs et le diapirisme en général*. C.R. Inst. Géol. Roum., **VI**: 226–270.

- Mrazec, L., 1920. *Originea domurilor cu sare (Salt Domes) din Gulf-Coastal-Plain, șesul Golfului de Mexico din statele Texas și Louisiana*. D. S. Inst. Geol. Rom., 47–61.
- Mrazec, L., 1922. *Leçons sur les gisements de petrol*. An. Min. Rom., V.
- Mrazec, L., 1923. *Despre compoziția apelor fosile din zăcământ din formațiunile de petrol și originea iodului lor*. D. S. Inst. Geol. Rom., VI: 104–115.
- Mrazec, L., 1924. *Le pétrole. Conditions géologiques et géographiques*. Annales de Géographie, 33, n°186, 505–522.
- Mrazec, L., 1927. *Les plis diapirs et le diapirisme en général*. C. R. Inst. Géol. Roum., VI: 226–270.
- Mrazec, L., 1931. *Aperçu sur le caractère des gisements de pétrole de la Roumanie*. Publications de la Faculté des Sciences de l'Université Charles, Prague, 118 p. Résumé en Ref. Bul. Lab. Min. gen. Univ. Bucuresti, 1: 136–139.
- Mrazec, L., 1932. *Considérations sur l'origine des dépressions internes des Carpates Roumaines*. Bul. Soc. Rom. Géol., 1, 115–125.
- Mrazec L., 1935. *Statul și politica națională a petrolului*. Analele Economice și statistice no. 10–15, 182–192.
- Mrazec L., 1940. *Problema petrolului în România față de problema mondială din 1915*, București, p. 41.
- Mrazec L., Jekelius E., 1927. *Aperçu sur la structure du Bassin néogène de Transylvanie et sur ses gisements de gaz*. Assoc. pour l'avanc. de la Géologie des Carpates, Bucarest, Guide des excursions.
- Mrazec L., Atanasiu I., 1927. *L'anticlinal diapir Moreni – Gura Ocnitei*. Assoc. pour l'avanc. de la Géologie des Carpates, Bucarest. Guide des excursions, 171–193.