Carpathian Journal of Earth and Environmental Sciences, February 2021, Vol. 16, No. 1, p. 17 – 30; Doi:10.26471/cjees/2021/016/152

GEOCHEMICAL CHARACTERISTIC OF THE SILURIAN ROCKS FROM THE EASTERN PART OF MOLDAVIAN PLATFORM (ROMANIA)

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Abstract. The scope of this paper is to assess the hydrocarbon potential of Silurian, respectively, the maturity of this stratigraphical interval, based, especially, of the geological and geophysical data derived from eight boreholes located in the north-eastern part of Moldavian Platform - Romania. The main conclusion is that the organic matter contents measured in the core and cutting samples of the different wells are low with the Organic Carbon (TOC) (residual) mainly clearly lower than 1%. Due to the poorness of the sample and the high maturity the petroleum potential and organic matter cannot be assessed. Estimation of the initial TOC allows to differentiate a richer interval at 24 – 27m thick below the top of Silurian. It shows higher TOC with estimated initial TOC reaching 3.6 % weight at the most. The maturity is high and shows a rapid increase with depth between around 2% at 200m and 4% eq. VRr at 1100m. An estimation of the eroded cap-rock is of around 3000m. Mineral carbon content obtained from Rock Eval permits to separate two lithological intervals: carbonated in the upper part (thickness of 250-300m), argillaceous in the lower part.

Keywords: Silurian, Moldavian Platform, organic matter, TOC %, reflectance

1. INTRODUCTION

The aim of this article is to assess the hydrocarbon potential and maturity of Silurian deposits based on geochemical results from wells of the Moldavian Platform. This objective was possible by using the information acquired from boreholes (Hudești 3613, Hudești 3615, Hudești 27818; Bătrânești 25301, Todireni 3601, Iași 3501, Iași 3502 and Iași 3503) located in the Eastern part of Moldavian Platform (Figure 1).

Geological analyses of the some borehole cores (Figure 2) from the Moldavian Platform performed by many authors (Olaru et al., 2005; Chirilă, 2010; Chirilă & Țabără, 2010, Radkovets et al., 2018), beside to the geophysical recordings (public available seismic profiles – Răileanu et al., 2012) have shown that the sedimentary cover of the Moldavian Platform belong to several megacycles: Ediacaran, Palaeozoic, Cretaceous, Paleogene, and the regional Paratethys stages from the Middle and Upper Miocene: Upper Badenian, Sarmatian and Meotian.

The Late Precambrian-Ediacaran and Palaeozoic sediments (Ionesi, 1994; Radkovets et al., 2018; Poprawa et al., 2018) overlie a metamorphic basement of Precambrian age. These are covered by the Mesozoic and Cenozoic successions (Figure 3).

The total cover thickness varies between 2500 m and 6100 m. Stratigraphic data show that the deposits accumulated during three main phases, separated by gaps corresponding to longer intervals of uplift (Ionesi, 1994; Poprawa et al., 2018).

According to Olaru et al. (2005), after consolidation processes during the Middle Proterozoic, the main tectonic movements recorded in this area are in connection with the uplifting, and probably, weathering processes until Upper Vendian. After this stage, the territory became peneplain when start the sedimentation during the three main sedimentary cycles.

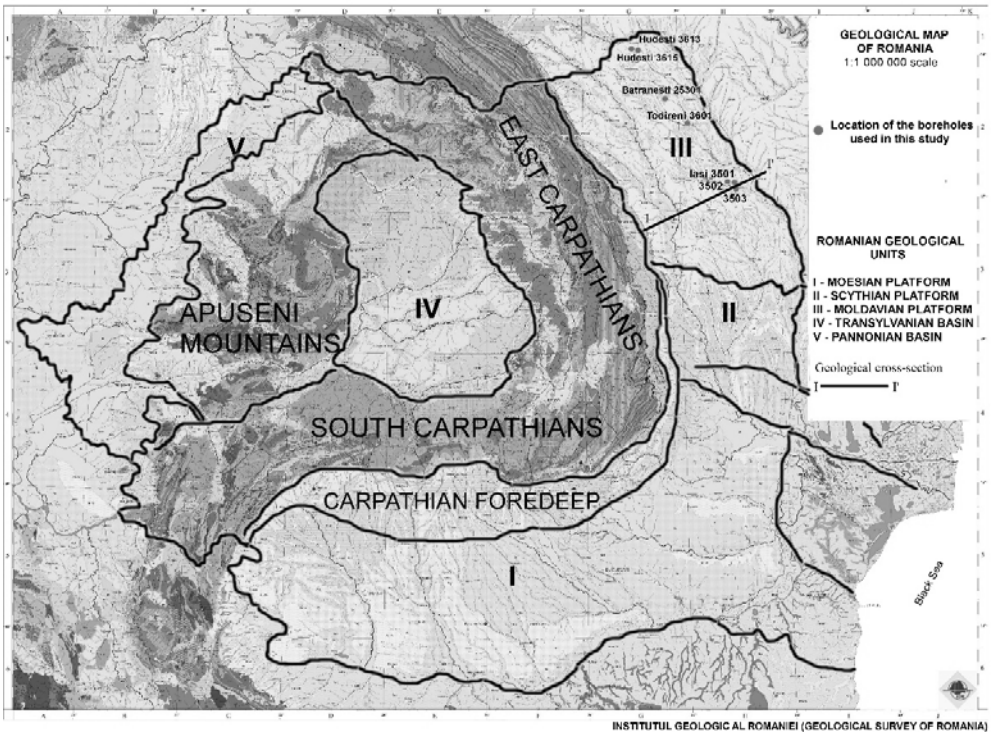

Figure 1**.** The location of the investigated boreholes - Moldavian Platform

From the tectonic point of view, the Moldavian Platform is the prolongation of the East European Craton to the Romanian territory, situated to the west and south-west by the Ukrainian Shield and Massif (Săndulescu, 1984; Olaru et al., 2005). This geological unit is fractured by several trans-crustal faults (Figure 3). It is mentioned that the compressional tectonic regime is also related to slowly strike-slip movements and short moments of extension.

The presence of the Silurian deposits was revealed by characteristic chitinozoans. According to Beju & Dăneţ (1962), Macarovici et al., (1965), Iliescu & Taugourdeau (1981), Silurian is the most represented interval of the Palaeozoic system. The Silurian (Wenlock to Přidoli) is developed over the entire surface of the platform, excepted in its south-west margin. In the north-east it lies close to the surface, but deepens westward and southward. Silurian deposits show two main facies: the limestone facies in the central and eastern parts, named "Bătrâneşti Formation" and the pelitic, graptolitic shale facies in north-west, named "Rădăuţi Formation" (Ionesi, 1994). Paleontological data show that these two facies have been deposited synchronously.

Previously works shows that the pre-Badenian deposits can be new prospective area for the gas-condensate but hydrocarbon accumulations (gas fields) were discovered belonging only to the Neogene formations.

Thus, according to Pene et al., (2007), the oil and gas reservoires (sandstones and sands) belongs to the the Badenian and Sarmatian deposits. Also, was cited Albian as a reservoir in the eastern and southern part of the Moldavian Platform.

The Paleozoic is poorly documented as concerning the hydrocarbon potential aspects. In the Moldavian Platform, the Silurian deposits do not outcrop, the quantity data are provided from boreholes wich had reached or penetrated them at the different depths (Figures 2 and 3).

2. MATERIALS AND METHODS

The methods consisted in processed and integrated data acquired from 114 core and cutting samples to the mentioned boreholes. The samples are provided by the old and uniques drilled boreholes which had as a main scope the clarify the geological settings of this Romanian geological unit. These boreholes were drilled during to the national programme of geological investigations in the 1960-1970 years. The geological and geophysical available data (geological profiles, spontaneous potential curve – Figure 4) were, also, used.

The source rock potential was evaluated using the Rock Eval 6 turbo apparatus (Behar et al., 2001). The organic carbon (TOC) was assessed on 88 core and 26 cutting samples to characterize the petroleum potential of the Ordovician-Silurian-Devonian series.

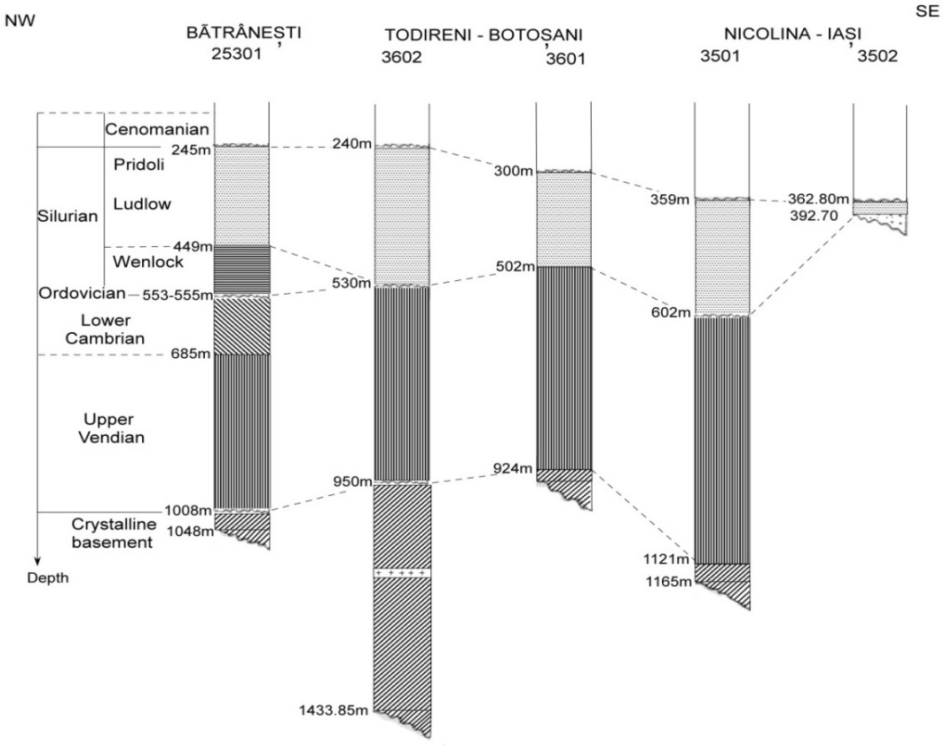

Figure 2. Correlation of the Palaeozoic from NE part of Moldavian Platform

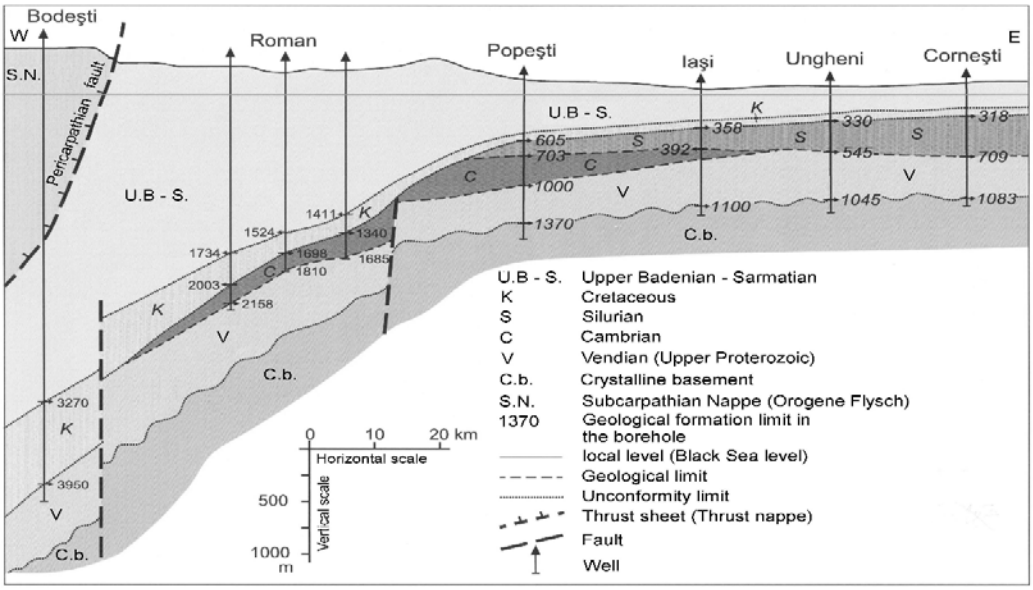

Figure 3. The I - I'geological cross-section (Moldavian Platform) - according to the Pătruț and Dăneț

TOC content corresponds to the sum of the "Generative Organic Carbon" and the "Non-Generative Organic Carbon". Due to the high maturity of the samples (higher than 2 eq. VRo %) the measured TOC only correspond to residual carbon "Non-Generative Organic Carbon". In order to estimate the initial TOC, the loss of the "Generative Organic Carbon" contribution must be estimated. Also, Rock Eval allow to measure the MinC parameter and corresponds to the percentage in weight of the mineral carbon of the rock.

2.1 Optical study of organic matter

Organic matter of 27 samples from Silurian-Devonian interval derived from 8 boreholes (Figures 1 and 4) was studied using reflectance-fluorescence. For each sample we have used two types of preparations: polished concentrates of organic matter obtained by densimetric techniques (mainly for maturity measurements and color of fluorescence estimation), and polished sections of rock grains

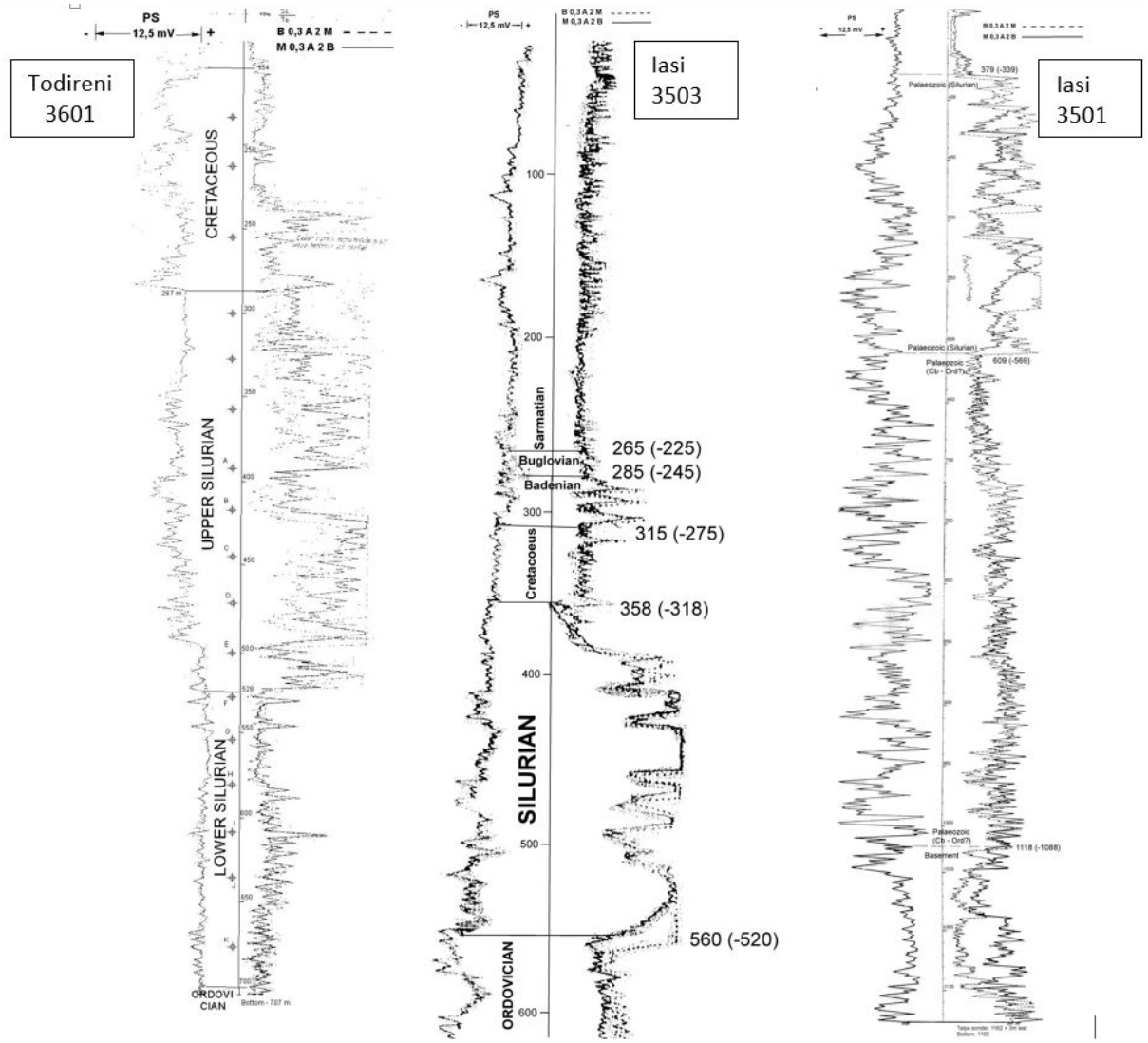

Figure 4. The spontaneous potential curves of some mentioned boreholes from Moldavian Platform

(mainly for description of the organic matter facies and mineral/organic associations). Maturity evaluation was assessed by optical techniques (reflectometry and UV fluorescence) on a Leitz DMRX microscope. The photomultiplier was calibrated with two standards method: saphir at 0.586% Rr and glass at 1.25% Rr for samples with low to medium maturity (values < 1.5% Rr) and glass at 1.25% Rr and zircon at 3.12% Rr for samples with higher maturity. In addition to the Rr measurements VRr equivalent was visually estimated according to the evolution of the colours of fluorescence of algae from green (immature) to dark orange (end of the oil window) – Robert (1988).

2.2 Organic matter description

Due to the poorness in organic matter of the different intervals only few samples per wells have been optically analysed. The choice of the studied samples must permit to determine a regional maturity profile. Under the microscope the studied samples show somewhat varied organic particles. The optical characteristics of the different encountered populations are described hereunder.

2.3 Maturity of organic matter

Due to the low number of samples no maturity profile is determined for each well and only a synthetic regional is proposed for this paper. To this end reflectance measurements have been performed on different types of organic particles. Due to the lack of higher plant remains in the Lower Palaeozoic rocks and, as a consequence, the absence of vitrinite, it is difficult to evaluate the organic maturity. A variety of alternative techniques are achieved for the assessment of the maturity; in optical study, the more common are: reflectance of zooclasts (graptolite, chitinozoan, and scolecodont), the reflectance of bitumen, the fluorescence of algae, the Conodont Alteration Index (CAI) and Thermal Alteration Index (TAI).

2.4 Maturity profile

Depending to the raw data and the correlation between vitrinite reflectance and the different organic substitutes, the most important particles belongs to the graptolite fragments. Thus, some authors propose correlations between vitrinite reflectance and the different organic substitutes: Bertrand & Héroux (1987), Goodarzi et al., (1992), Cole (1994), Zhu et al., (1998), Cao et al., (2000), Suchý et al., (2002), Petersen et al., (2103), Coltoi et al., (2016).

3. RESULTS AND DISCUSSIONS

Based to the optical study of organic matter, including the description and maturity of organic matter, also, the maturity profile and lithology, the main results are the next:

3.1. Optical study of organic matter

Concerning the optical study, in the organic concentrates the optical orientation of the measured surfaces cannot be assessed, therefore all measurements were carried out without stage rotation and correspond to a random reflectance (Rr %), the same method being aplied on the samples from another Romanian geological unit (Coltoi et al., 2016).

Due to the richness and variety of organic particles up to 100 readings per slides have been carried out on some organic concentrates. No TAI/SCI or CAI (transmitted light) was estimated.

3.2. Organic matter description

Vitrinite-like = homogeneous particles: fragments with particularly homogeneous appearance (pure gelified organic matter) with vitrinite aspect (Plate 1). In whole rock they can present somewhat irregular outlines. In concentrate the outlines are clearer. These particles do not present any evidence of bitumen aspect and very probably correspond to zooclasts.

Chitinozoan: they correspond to zooclasts with typical shape (bottle shape of 100 microns at least). In concentrate the fragments show homogeneous aspect (no internal structure or granular surface), regular and angular outlines with sometimes stick shape (fragments of walls). In this study only poorly preserved organisms (whole rock – Plate 2), homogeneous fragments and few walls debris (concentrate – Plate 2) have been observed.

Graptolite: fragments of zooclasts with more or less typical internal structures (exoskeletal). They become anisotropic with increasing reflectance. In whole rock they often appear as thin strings up to 1mm long (Plates 3, 4 and 5). Two branches are often visible (due to the common canal) with more or less irregular outlines. In concentrate the fragments show rare cracks, clear outlines and a relatively isomorphic shape. Graptolite remains often contain both non-granular and granular particles. These two different aspects have been observed in few samples (Plate 4). Typical structured fragments have not been observed in the studied samples. It seems that relations exist between these two types of particles. They are mainly observed in the Iași-3501 well.

Zooclasts/phytoclasts: Due to the absence of typical structure (graptolite) or shape (chitinozoan) some fragments cannot be fully identified and have been classified as zooclasts (Plate 5). It should be noted that typical tubular phytodebris (algal filaments of blue-green algae – Oehler, 1976) frequently observed in the same Silurian formations from another Romanian geological unit, respectively Moesian Platform (Coltoi et al., 2016) are absent in all these samples of the Moldavian Platform. Abundance of inertinitic tubular phytodebris in the Moesian platform indicates a more oxidizing depositional environment and a probable hydrocarbon potential of poorer quality than for the Moldavian Platform.

Lignite contamination: two cutting samples from Iasi-3503 well (370-375m and 565-570m) show contamination by numerous lignite mud additives (vitrinite reflectance around 0.25% VRo).

3.3. Maturity of organic matter

Concerning the well maturity, respectively the optical maturity assessment, the main results are summarized in the Table 1. Based to the graptolite curves, respectively eq VRo%, the reflectance was establish only into the 2 wells: Todireni 3601 and Iasi 3501 having values between 2.88 and 4.00 %.

Hudești 3613 borehole (sample - 219.1m depth). The concentrate is rich in homogeneous (not granular and not structured) and slightly anisotropic vitrinite-like fragments. The whole rock section consists of an argillaceous carbonate with frequents pyrite (not oxidized). Frequent thin layers and small fragments are included in the matrix.

Hudești 3615 borehole. This sample at 257.0m is similar to the Hudesti-3613 one: concentrate and whole rock (Plate 1).

Bătrânești 25301 borehole. Only the concentrate at 394.43m shows frequent homogeneous and isotropic fragments (vitrinite-like). The whole rock sections consist of carbonated

claystone (272.3m) argillaceous carbonate (394.43m) and carbonate (435m) with no oxidized pyrite. Only rare thin layers of organic matter have been observed at 394.43m.

Todireni 3601 borehole. The two concentrates are rich in small homogeneous and slightly anisotropic fragments of zooclasts (chitinozoan and graptolite – Plate 2). The whole rocks consist of a carbonate rich in rhombs (444-445m) and a silty claystone (801-802m). Pyrite is frequent and not oxidized. The organic fragments are rare.

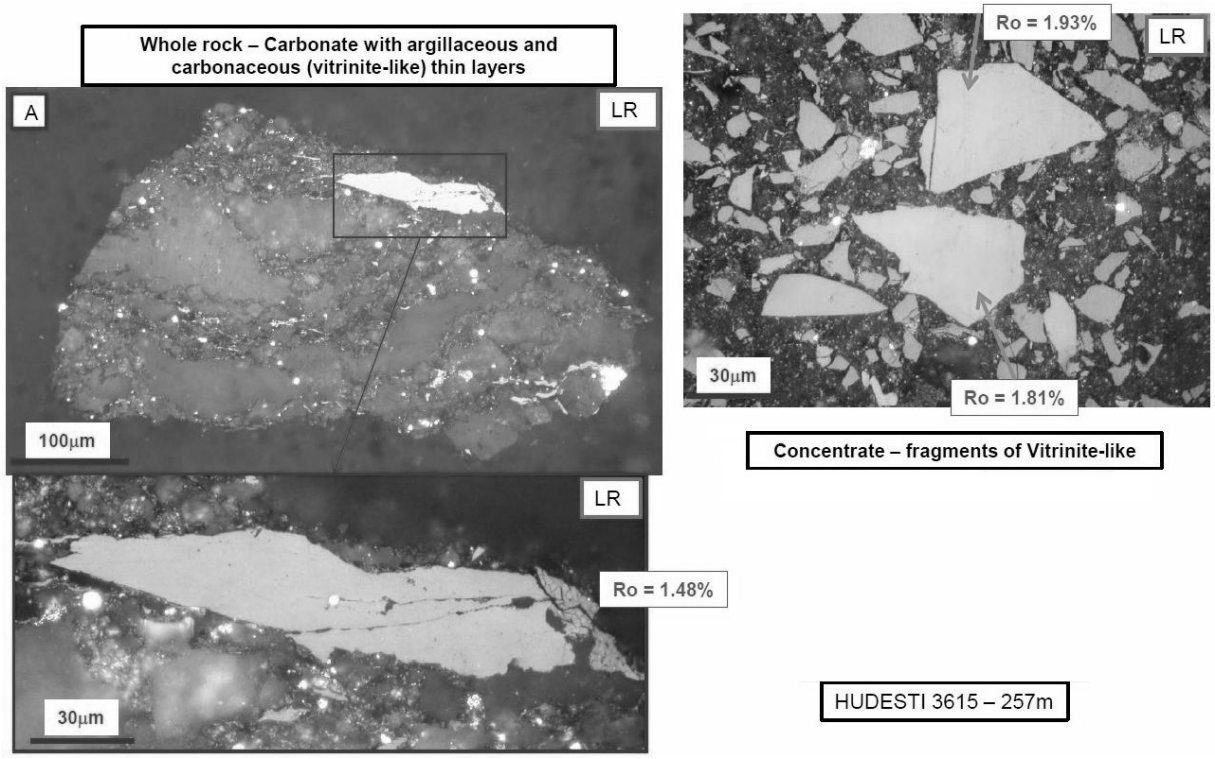

Plate 1. Fragments with homogenous vitrinite-like appearance – Hudești 3615 borehole

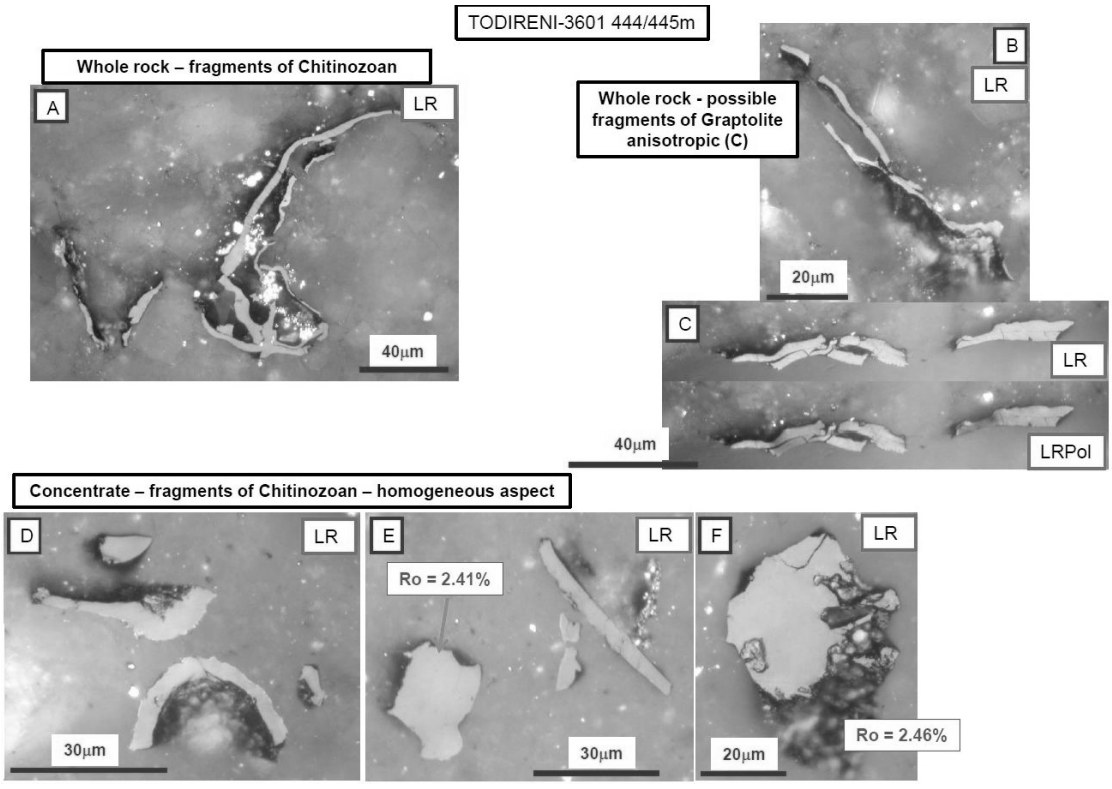

Plate 2**.** Wall debris of Chitinozoan and possible Graptolite – Todireni 3601 borehole

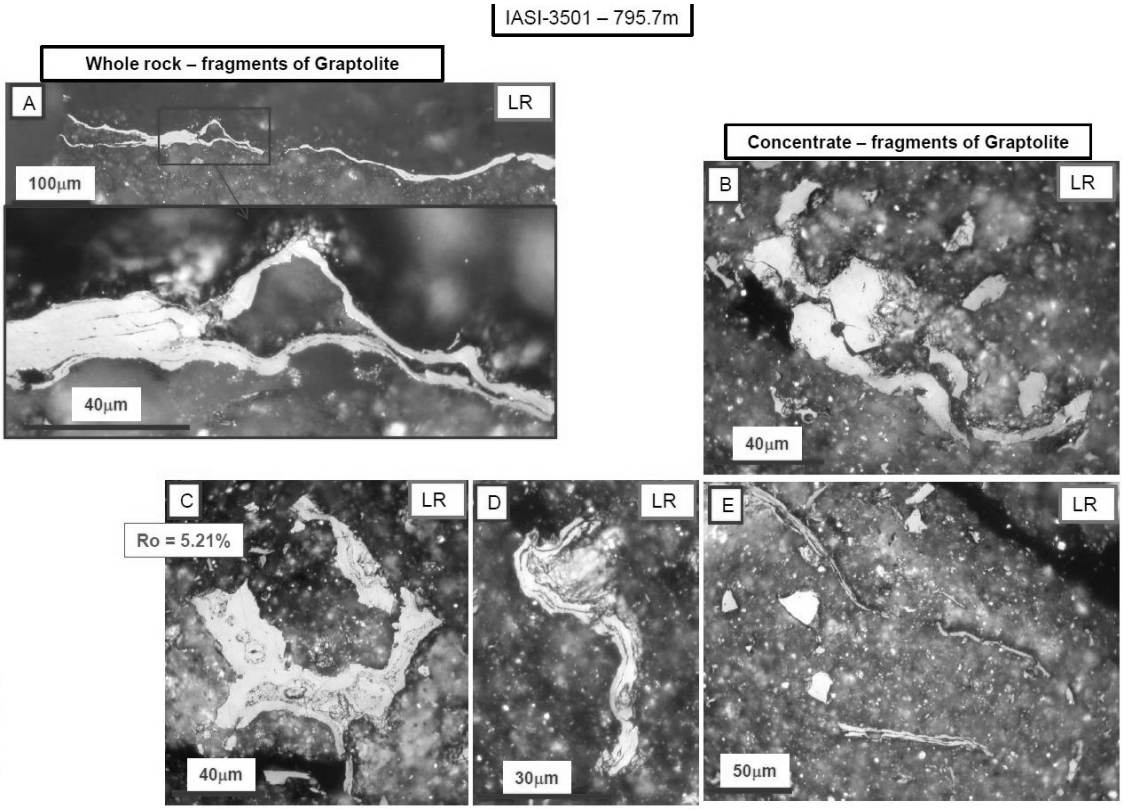

Plate 3**.** Fragments of zooclasts with more or less typical internal structure – Iași 3501 borehole

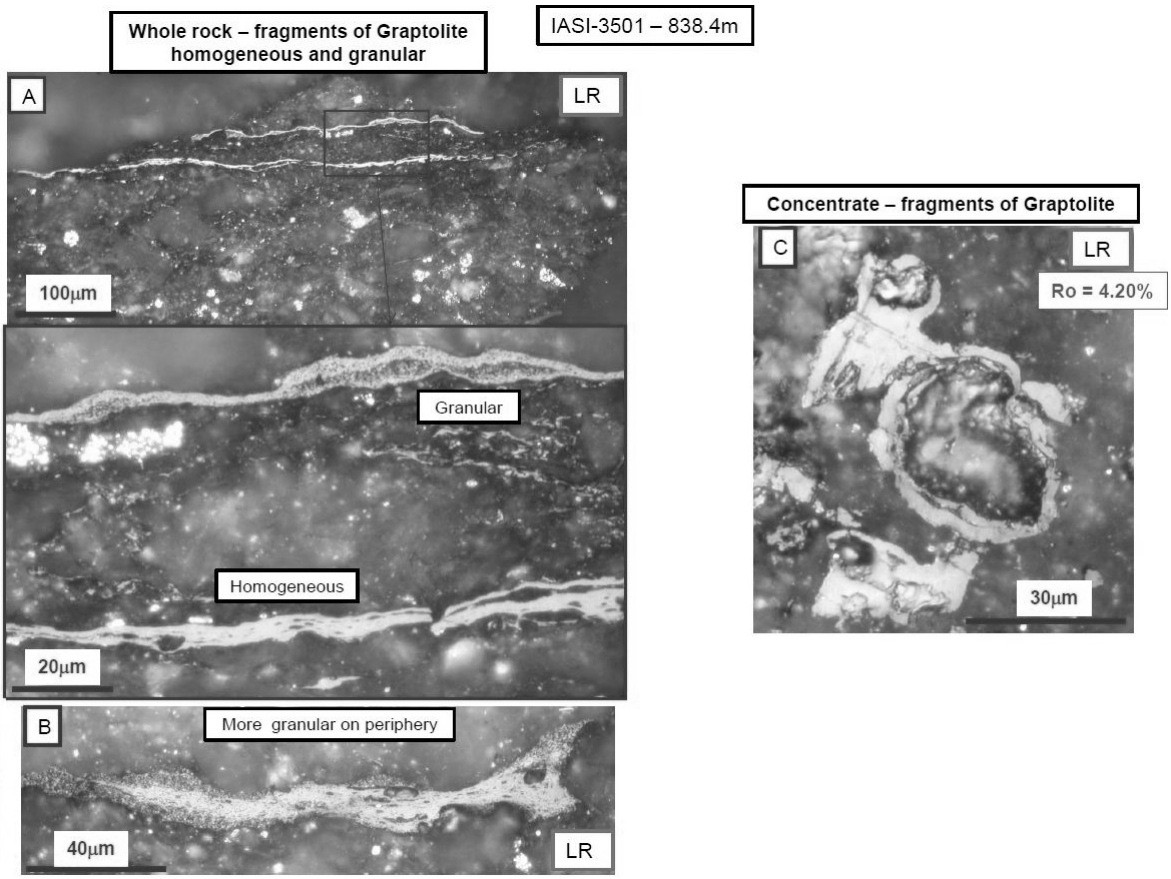

Plate 4. Fragments of zooclasts with more or less typical internal structure – Iași 3501 borehole

Table 1. Optical maturity assessment – Moldavian Platform

WELL	Age	Top Depth m/RKB	Bottom Depth m/RKB	Samp Type	REFLECTANCE					
					Type	mean %Rr	S.D.	N.M	Q	Eq.VRo %
Hudesti 3613	Silurian	219.10		K	VL (Grapt?)	1.75	0.14	60	I	
Hudesti-3615	Silurian	257.00		K	VL	1.73	0.16	60	I	
Batranesti-25301	Silurian	272.30		K	?	1.37 - 3.69		32	L	
Batranesti-25301	Silurian	394.43		K	VL	2.06	0.19	70	I	
Batranesti-25301	Silurian	435.00		K		N/A		22	L	
Todireni-3601	Silurian	444.00	445.00	K	Chiti	2.53	0.19	66	I	
Todireni-3601	Silurian	444.00	445.00	K	Grapt ?	3.17	0.10	23	L	
Todireni-3601	Ordovician	801.00	802.00	K	Grapt	3.57	0.47	80	I	2.85
Iasi-3501	Silurian	795.70		K	Grapt	4.74	0.28	75	I	3.77
Iasi-3501	Silurian	838.40		K	Grapt	4.46	0.30	75	I	3.55
Iasi-3501	Silurian	1078.00		K	Grapt	5.03	0.50	75	I	4.00
Iasi-3502	Silurian	388.80		K	Zoo	2.94	0.29	72	M	
Iasi-3503	Silurian	370.00	375.00	Cttg		N/A				
Iasi-3503	Silurian	565.00	570.00	Cttg	Zoo (VL?)	2.64	0.32	61	I	
Iasi-3503	Silurian	775.00	780.00	Cttg	Zoo (Grapt?)	3.74	0.52	55	M	
Iasi-3503	Silurian	775.00	780.00	Cttg	Zoo (Grapt?) Gnl	2.65	0.14	18	L	
Iasi-3503	Silurian	1107.00	1110.00	K	Grapt ?	4.76	0.49	32	I	
Iasi-3503	Silurian	1107.00	1110.00	K	Grapt ? Gnl	2.96	0.38	37	L	

Sample type: Cttg = Cuttings, K = Core, Ro% = reflectance, Type = type of measured particles: Grapt = graptolite, Chtii = Chitinozoan, VL = vitrinite like, Zoo = Zooclast, Gnl = granular, S.D. = standard deviation
N.M. = number of measurements, Q = quality code of Ro value from particules appearance and abundance (I = important, M = medium, L = low ; NS = Not significant), eqVRo% = équivalent VRo (Graptolite curve)

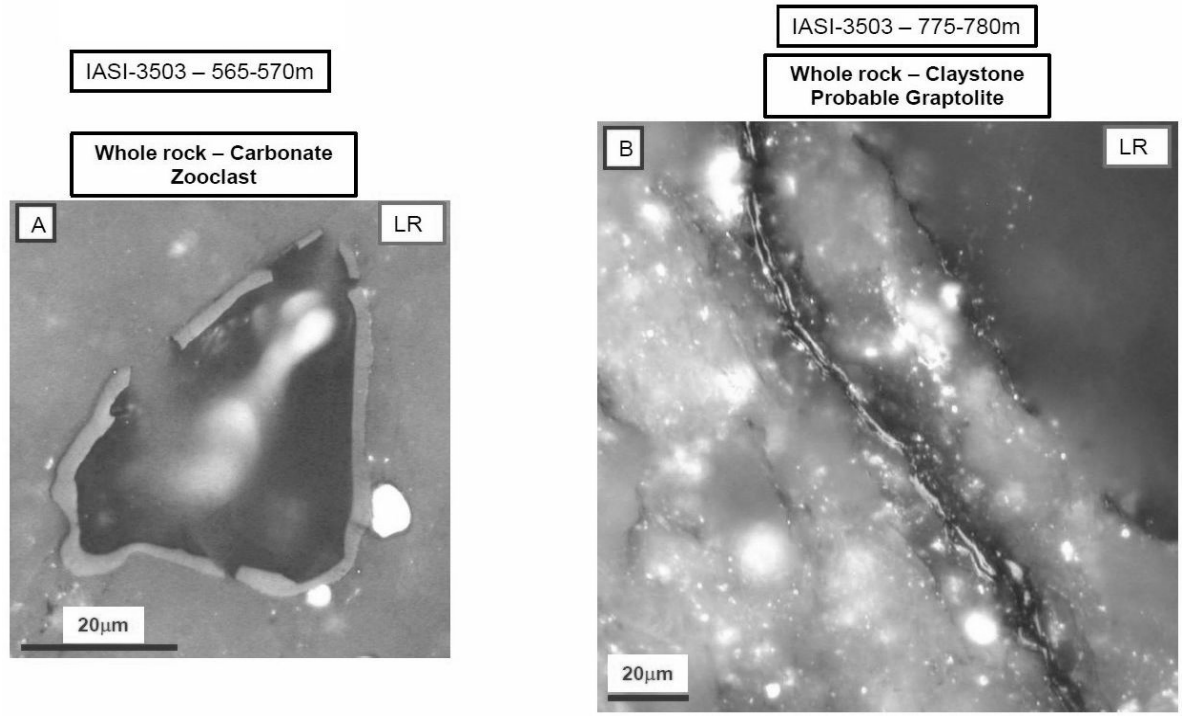

Plate 5. Fragments of zooclasts – Iași 3503 borehole

Iași 3501 borehole. The three concentrates show abundant fragments of graptolite more or less anisotropic. Most of the fragments are homogeneous (Plate 3 and 4), some others are slightly granular (Plates 3 and 4). The whole rocks consist of silty claystones with framboids of not oxidized pyrite. Frequent thin layers of organic matter (graptolite) are present in the matrix (Plate 3 and 4).

Iași 3502 borehole. The concentrate is rich in small homogeneous and anisotropic fragments of undifferentiated zooclasts (no typical structure or shape). The whole rock section consists of a carbonate with some pyrite (not oxidized framboids). Rare small organic remains are present in the matrix.

Iași 3503 borehole. The two shallower samples are highly contaminated by lignite mud additives and the autochthonous organic matter is difficult to observe and to characterize. Frequent (775-780m) and some fragments of zooclasts (1107-1110m) have been observed (Plate 5). They mainly correspond to homogeneous (frequent) and granular (rare) graptolite (more characteristic in whole rock sections). The whole rocks consist of silty claystones with not oxidized pyrite. Rare thin layers of organic matter (graptolite) are present in the matrix (Plate 5).

3.4. Maturity profile

Concerning the maturity profile, respectively the measured values versus depth diagram it is observed that two main trends occur: the first one for the graptolite particles (homogeneous) and the second one for the other type of fragments (like vitrinite-like, chitinozoan and zooclast). The zooclasts without specific determination observed at Iași-3502 borehole – 388.8m belongs to the homogeneous graptolite trend and so probably correspond to graptolite fragments. Granular graptolite and homogeneous graptolite reflectance measurements on the same sample (Iasi-3503 borehole) are in good agreement with the worldwide relation.

In this article, the maturity has been assessed from the reflectance of graptolite remains according to a vitrinite/graptolite correspondence curve deduced from Cole (1994):

VRo = 0.785 GRr + 0.05

According to this graptolite/vitrinite correspondence curve (Figure 5) a maturity trend in equivalent vitrinite reflectance (eq. VRo %) can be proposed for the studied area (Figure 5). For this point of view, excepting the graptolite fragments, the other measured types of particles are more or less in the regional trend and no specific corrections have to be done. This trend indicates a high thermal evolution with an increase of maturity with depth reaching more than 2 eq. VRo% for 1000m.

Taking into account this thermal gradient a possible uplifting of maximum 3000m (Figure 6) of the Silurian series can be roughly estimated for the studied area (Moldavian Platform). This value must be taken with caution due to the uncertainties on the

vitrinite equivalence and the dispersion of measurements. Also, this recorded uplift and erosion af the area is in concordance, somewhat, with the new results of the researchers the erosion being estimated to having maximum 1000m (Poprawa et al., 2018).

The main results of the quality evaluation and organic matter from the quantity point of view are summarized based to the organic carbon content, type of kerogen, initial organic carbon estimations, lithology.

3.5. Organic carbon content

The organic carbon content of the different studied interval shows the next values:

Bătrânești 25301 – samples from Silurian and Ordovician.

- Most of the samples (33 samples) are very poor in organic matter with TOC less than 0.2% wt., with the lowest values (TOC < 0.1% wt.) in the bottom section of the studied interval (Ordovician). Only one sample at 272.3m presents a TOC higher than 1% wt. The high maturity of these samples (between 2.0 and 2.6% eq. VRo – Figure 5) implies that the measured TOC values correspond to residual TOC.
- **Hudești 3613** – samples from Silurian.

The six core samples studied in the Silurian interval (218.1 – 269.8m) are poor in organic matter with TOC less than 0.75 % wt. The high maturity of these samples (around 2.0 % eq. VRo – Figure 5) induces that these TOC correspond to residual TOC.

Hudești 3615 – samples from Silurian.

The TOC content is almost similar to the ones observed in Hudești 3613 well, with very low to low TOC associated with carbonated rocks (MinC ranging between 8.4 to 10.9 % wt.) with no to very low petroleum potential. Due to the high maturity (around 2.0 % eq. VRo – Figure 5) the measured TOC corresponds to residual TOC.

- **Iași 3501** – samples from Silurian.

The bulk of the 24 core samples are very poor in organic matter with TOC less than 0.3% wt., with only five samples have TOC ranging between 0.3 and 0.75 % wt. (low TOC content). The high maturity of the interval (eq. VRo increase with depth between 2.8 and 3.6 % - Figure 5) leads that these TOC values correspond to residual TOC.

- **Iași 3502** – samples from Silurian.

The 5 core samples are very poor in organic matter with TOC lower than 0.15% wt. Due to the high maturity (around 2.3 % eq. VRo – Figure 5) the measured TOC values only correspond to residual TOC.

- **Iași 3503** – samples from Silurian.

The 26 cutting and the core samples are very poor in organic matter with all TOC lower than 0.4% wt. The high maturity of this interval (maturity increases with depth between 2.3 and 3.8% eq. VRo – Figure 5) implies that the measured TOC values correspond to residual TOC.

- **Todireni 3601** – samples from Silurian and Ordovician.

Silurian. The five core samples analysed are very poor in organic matter with TOC lower than 0.15% wt.

Ordovician. The core sample (802.0m) is also very poor in organic matter with TOC content of 0.3 % wt. The carbonate content is very low (MinC < 0.1 %). The high maturity of these samples (between 2.3 and 3.3 eq. VRo % – Figure 5) shows that these measured TOC values correspond to residual TOC.

3.6. Type of kerogen and their maturity potential

The high maturity of the analysed intervals (maturity between 2 and 4 eq. VRo %) does not allow to estimate the oil potential of these series. Due to the TOC poorness and the high maturity, most of the Rock Eval results are not reliable (Espitalié et al., 1985) and the type of organic matter (pseudo Van Krevelen HI vs OI diagram) cannot be assessed.

Only six T_{max} values are valid (Espitalié et al., 1985) with values ranging between 423° and 440°C. The four low values (423 – 431°C) obtained at Iași-3503 well are probably due to lignite drilling mud additives as seen in optical study.

The two low values (431 and 440°C – immature to low mature) measured at Hudesti-3615 well are also probably due to contamination as being significantly lower than the retained regional profile (Figure 5).

3.7. Initial organic carbon estimations

The Silurian series of the Moldavian Platform (Figure 7) are constituted of slaty clays and blackish limestones of marine origin (chitinozoan, graptolite) and the organic matter kinetic comportment related to the type II of kerogen.

Different methods exist for the estimation of the initial TOC. Two of them are the following:

- The first method is empirical: for high maturity the initial TOC (type II organic matter) corresponds to the residual TOC multiplied by 2 / 2.5 or 3 maximum.
- In this case was estimated initial TOC for the different lithologies (claystone if MinC < 2%, argillaceous carbonate if 2% < MinC < 6% and carbonate if MinC > 6% wt).

- In the case (max) of a multiplication by 3, two samples present an estimated initial TOC higher than 3% (BTNI-1 at 272.3m and HDI-3615 at 257m) and 4 samples present an estimated initial TOC between 1.5 and 3% wt.

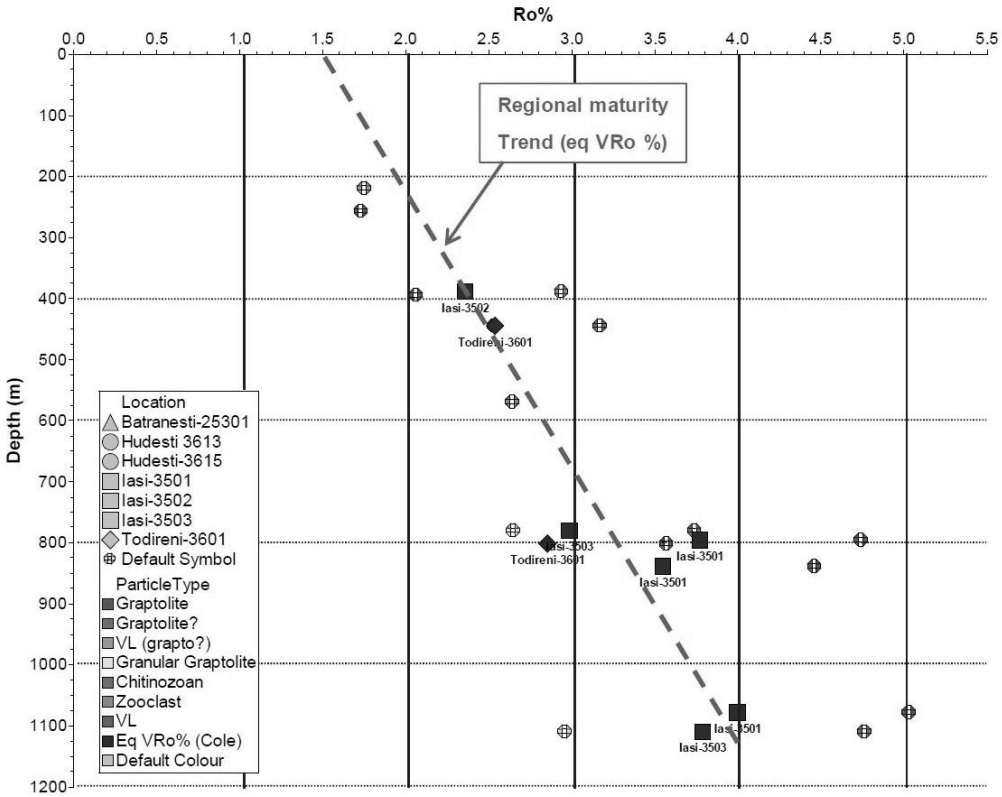

Figure 5. Maturity versus depth (m/RT) – Regional maturity trend: eq. VRo%

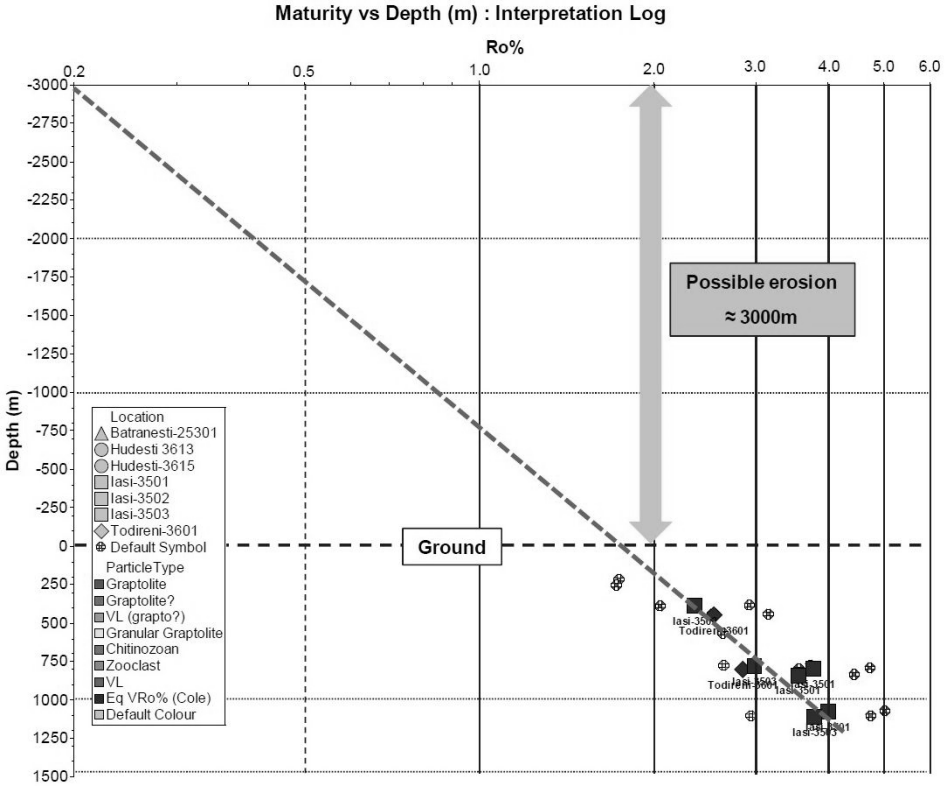

Figure 6. Estimated regional erosion

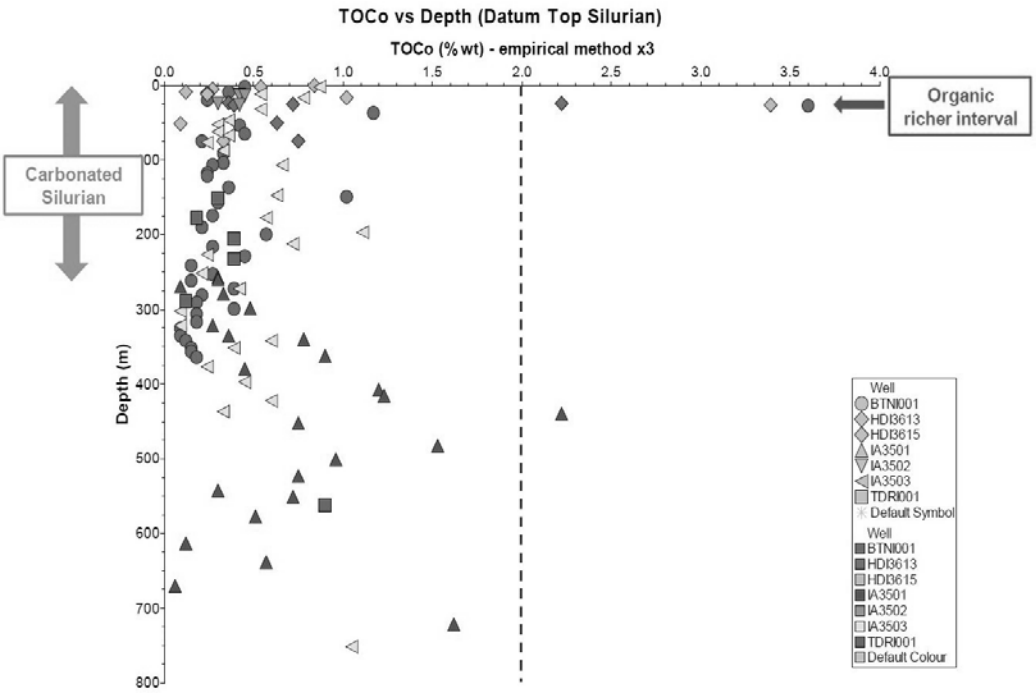

Figure 7. TOCo versus Depth: Datum = Top Silurian

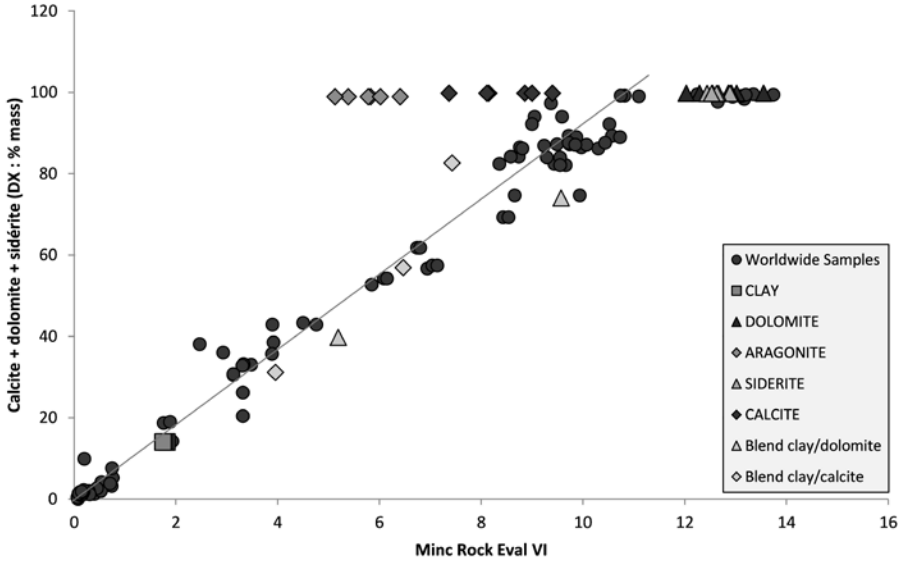

Figure 8. Relation between Carbonate from DX and MinC of Rock Eval 6

▪ The second method is a calculated method taken into account the initial HI value (HIo):

GOCo% of TOC = (HIo / 1177) x 100

GOCo = initial Generative Organic Carbon

TOC initial = Non-generative Organic Carbon + initial GOCo

In this case the initial HI must be estimated.

To calculate the initial TOC of the Moldavian Platform samples three different initial HI were retained: 300, 450, and a high value of 600 mg HC/g TOC (max for type II organic matter). The values obtained with a HIo of 600 mg HC/g TOC are almost similar to those obtained with the empirical method and a multiplier factor of x2 (Table 3). With HIo of 450 mg HC / g TOC the calculated maximum TOC are always lower than 2 % wt. for the three different lithologies.

The initial TOC (estimated or calculated) is low with values mainly lower than 1% TOCo. An interval at the top of the carbonated Silurian presents the best organic matter content with values, at the most higher than 2 % wt. in three wells: HDI-3613 (-24.1m), HDI-3615 (-26.0m) and BTNI-1 (-27.3m). This interval is situated 24 to 27 m below the Top

Silurian, the MinC varying from 4.6 to 9.9% weight and the maturity is of around 2% eq VRo.

3.8. Lithological aspects

Based to that criteria, in the Figure 8 is showing a good relation which exists (except for pure carbonate samples) between the measurements of the carbonate content from DX analysis and the carbonate (MinC < 1% wt., less than 10% of carbonate).

HUDEȘTI 3613 and 3615. Carbonates are abundant with MinC values ranging from 6.3 and 10.0 % weight (more than 50 % wts. of carbonates).

IAȘI 3501. The MinC are very low, that corresponds to rock almost devoid of carbonated minerals.

IAȘI 3502. MinC values are high and ranging between 5.3 and 11.3% weight indicating a high content of carbonate (> 50% wt. of carbonate).

IAȘI-3503. MinC are medium to high in the upper part of the interval with values ranging between 3 and 12.4% weight between 360 and 605m (30 to ≈ 100% of carbonate). The carbonate content decreases with depth with values ranging between 0.15 and 2% between 625 and 755m and MinC lower than 0.5% at the bottom of the interval (no carbonate content).

TODIRENI 3601. In the Silurian strata, MinC are high with values higher than 7.5% wt. (more than 60% weight of carbonate). In the Ordovician section MinC are lower than 0.4% indicating the absence of carbonated minerals.

MinC data allow to differentiate two lithological intervals (Figure 8):

- An upper interval (around 300 meters thick) with high MinC values corresponding to Silurian carbonated rocks.
- A lower interval of argillaceous rocks (more than 500 meters thick) with very low MinC values. This interval is dated Ordovician at Bătrânești-25301 and Todireni-3601. The equivalent interval in the Iași wells is probably of the same age (Ordovician instead of Silurian as firstly proposed?).

4. CONCLUSIONS

The organic matter contents in the samples of the studied wells of the Moldavian Platform are low with residual TOC mainly less than 1%. The high maturity the hydrocarbon potential is difficult to determine and kerogen can only be II and/or mixed II/I type.

Estimation of the initial TOC permits to distinguish a richer interval at 24 – 27m thick below MinC values of the Rock Eval 6. So, the use of the MinC of the Rock Eval 6 is a good tool to have an estimation of the carbonate content of the samples.

BĂTRÂNEȘTI 25301. Most of the MinC values are high with values ranging between 4.5 and 9.9 % wt. indicate a high content of carbonates (more than 40% of the total rock wt.). Five samples in the Silurian and the samples at the bottom of the interval (Ordovician) are clearly poorer in the top Silurian. It shows the highest TOC with estimated initial TOC reaching 3.6 % wt. in the best case.

Regarding the optical maturity, the assessment revealed that most of the fragments are homogeneous and graptolites are the dominant type of measured particles.

Due to the high maturity level (higher than 1.5% Rr) fluorescence of the organic concentrates and whole rock is null for all the samples.

A regional maturity profile is proposed from zooclasts reflectance measurements.

The maturity is high and shows a rapid increase with depth between around 2 at 200m and 4 eq. %VRo at 1100m. An estimation of the eroded over-series is of around 3000m.

Mineral carbon content obtained from Rock Eval 6 allow to separate two different lithological intervals: carbonated in the upper part (thickness of around 300m), argillaceous in the lower part (more than 500m thick).

Due to these new geochemical and optical data, the Silurian series from the Eastern part of the Moldavian Platform cannot be considered as a source rocks of the Neogene Gas fields of this area. If we have in mind the thickness of the Badenian level with anhidtrite, it is imposible to explain the existence of Neogene gas accumulations in conection with the Paleozoic series from Moldavian Platform.

Acknowledgement

This paper is result of the research works concerning the assessment of shale gas from Romania as a scientific collaboration between TOTAL Company and Geological Institute of Romania. We express our thanking to the anonymous reviewers for their reviews and useful comments, which significantly improved the manuscript.

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Received at: 10. 09. 2020
Revised at: 14. 11. 2020
Accepted for publication at: 27. 10. 2020
Published online at: 12. 12. 2020