BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LXVII No. 2/2015	73 – 78	Seria Tehnică

The Mineralogical-Petrographic Study of Cores from the Oligocene-Miocene Deposits of the Targu-Jiu Oil Field (Getic Depression)

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Abstract

The Targu-Jiu oil field belongs to the Internal Zone of the Getic Depression and is one of the largest oil fields in the region. In the paper are presented the mineralogical-petrographic researches made on the cores from the Oligocene-Miocene deposits of the Targu-Jiu oil field. The cores were analyzed by optical microscopy and X-ray diffraction. The mineralogical-petrographic study revealed the presence in appreciable amounts of the dioctahedral and trioctahedral phyllosilicates represented by the illite and clinochlore. This phyllosilicates was evidenced especially by X-rays diffraction. The samples analyzed are polymictic detrital rocks being composed by ruditic, arenitic and siltic clasts, and a clayey fraction. The clayey fraction plays the role of matrix for the siltic, arenitic and/or ruditic epiclasts. In the source area of the studied rocks occur both endogenous and exogenous rocks.

Key words: *Getic Depression, Carpathian Foredeep, folded flank, Targu-Jiu oil field, mineralogical-petrographic investigations*

Introduction

The Getic Depression is a mature petroleum province with thousands of wells drilled and several fields discovered since the exploration started more than 100 years ago. The shallow structural plays have been intensively drilled in the past. In turn, only a small number of wells targeted deep objectives typically located at more than 4 km depth. These deep wells had only limited success, but indicated the presence of working petroleum systems [1, 2, 3, 4].

The tectonic evolution of the Getic Depression was marked by the two large geological units, permanent tendency of drawing nearer, through a northward continuous subduction movement of the Moesian Platform underneath the Southern Carpathians Orogene. Throughout its tectonic evolution, since the moment of its formation as a sedimentary basin, in the Eocene, the Getic Depression has known three significant orogenesis phases: Savic, Styrian and Moldavian. At the end of the Oligocene, the first phase of tectonic movements took place – Savic orogenesis phase – in the Getic Depression. Savic orogenesis phase brought about the folding of the Eocene and Oligocene deposits, building up the tectonic framework whereon the structures of newer Miocene and Pliocene deposits were formed. After the Upper Burdigalian, the older uplifts, originated from the Savic orogenesis were re-activated in the Styrian orogenesis phase [4, 5, 6].

In the Getic Depression were separated two favorable areas for hydrocarbon accumulations with distinct characteristics: *Internal Zone*, located to the north of the Cobia-Slătioarele-Ticleni marginal fault, and *External Zone*, located to the south of the Cobia-Slătioarele-Ticleni fault and extended to the Pericarpathian fault. In the Internal Zone, the Oligocene formations have evolved under subnormal thermal regime, and have generated hydrocarbons at depths of 4000-7000m. In this area, the Burdigalian deposits was the main beneficiary of Oligocene source, holding the largest share in total oil reserves discovered in Getic Depression. Some of the oil was accumulated in the Meotian deposits that in eastern part have contact with the Oligocene formations. In the External Zone, source rocks it develops in Badenian and Sarmatian deposits having 4000 m depths and 3500-4000 m thickness, and mainly generated gas.

Geologically the Targu-Jiu (Iași) oil field (fig. 1) belongs to the internal zone of the Getic Depression. It was discovered in 1964 and developed by Petrom company. It began production in 1965 and produces oil and associated gas. The total proven reserves of the Targu-Jiu oil field are around 155 million barrels (20.8×10^6 tons), and production (from Burdigalian + Sarmatian reservoirs) is centered around 3,000 barrels per day (480 m^3/d). [7, 8].

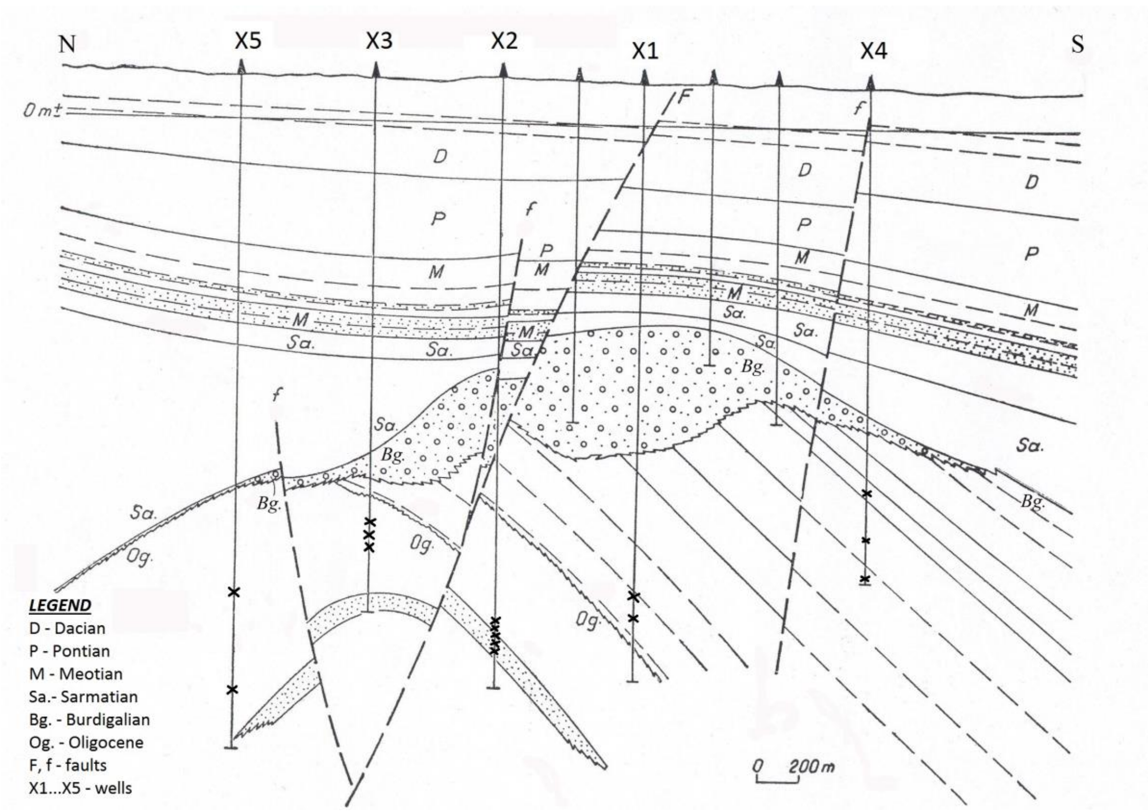

Fig. 1. Schematic geological section in the Targu Jiu oil field structure showing the position of the cores from the wells investigated (after [8] modified).

This paper presents the mineralogical-petrographic study of the cores from five wells (noted X1, X2, X3, X4 and X5) that crossed the Oligocene-Miocene deposits of the Targu-Jiu oil field structure. The cores were analyzed by optical microscopy and X-ray diffraction.

Mineralogical-Petrographic Investigations

Optical microscopy

The optical microscopic study was performed on thin sections with a polarizing optical research Steindorff microscope. The samples analyzed from the Oligocene-Miocene sedimentary deposits are polymictic detrital rocks composed of ruditic, arenitic and silto-lutitic clasts, the silto-lutitic ones being predominant. On the basis of microscopic study these clasts were separated into several categories: granoclasts, lithoclasts, polygranular clasts, and other clasts optical undetermined. The granoclasts prevalent are mainly represented by quartz, feldspars (albite, oligoclase, and microcline), micas (muscovite and biotite), chlorite, calcite and opaque minerals. In the analyzed rocks it have been found the following types of lithoclasts: gneisses; cataclasites, mylonites, metasomatic carbonatites, mudrocks, shales, marls, carbonate cemented siltstones, greywackes, calcareous sandstones [9].

Overall the lutitic rocks consist of fine clayey mass predominantly and a subordinate siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic and arenitic epiclasts. The sandstones are predominantly composed of quartz cemented with microcrystalline silica or sparitic calcite. A special category was the samples identified as microparabreccia having phyllosilicatic or arenitic matrix cemented with sparitic carbonate. Also a clayey limestone predominantly composed of sparitic calcite, lutitic clay fraction, and subordinate silt-arenitic epiclastic fraction. The microscopical observations are summarized in the table 1.

X-rays diffraction

X-ray powder diffraction data were measured using an automated Bruker D8 Advance θ-θ diffractometer, with CuKα radiation (λ = 1,54Å; 40kV; 40mA), a LynxEye detector and Bragg-Brentano geometry, step 0.1º, scanspeed 0.1º/5s, measurement range (2θ) 1-60º. The samples were ground in agate mortar with pestle. The device and emission source profile were modeled using NIST SRM 660a and SRM 676 profile standards.

Quantitative analysis was performed using Diffracplus Topas 4.1 software by Rietveld method. Pseudo-Voigt (pV) profile function was used for the fit of the peaks. Qualitative analysis was carried out using Diffracplus EVA software and database ICDD PDF-2 Release 2008. Identification of crystalline phases (minerals) was made using "best quality marks": (*=high quality) and (I=indexed) respectively, after removing the background and Kα2 radiation [10].

The X-ray diffraction analysis shows the presence in large quantity of the tectosilicates represented by quartz and feldspars (oligoclase and microcline) and the dioctahedral and trioctahedral phyllosilicates represented by the illite, muscovite, and clinochlore. The mineralogical composition of the cores analyzed is presented in Table 2.

Rietveld refinement quality is expressed by R-values indices: the goodness-of-fit (GOF) and Durbin-Watson *d*-statistic (DW). The goodness-of-fit (GOF) is the ratio between Rwp (R-weighted pattern) and Rexp (R-expected) and cannot be less than 1. A good Rietveld refinement gives GOF values lower than 2. The Durbin-Watson *d*-statistic is used to quantify a serial correlation between adjacent least squares residuals in a Rietveld refinement based on step-scan powder diffraction data. In X-rays diffraction the ideal value of DW indices is 2 [11, 12].

The quantitative analysis of the samples analyzed has GOF (goodness-of-fit) indices ranging from 1.13 to 1.40 (most values being in the range of 1.21 to 1.32), and χ^2=1.27, this indicating their good quality. Good quality of the quantitative analysis is also revealed by the Durbin-Watson (DW) *d*-statistic values ranging from 1.98 to 2.54, and the value in the way of 2-sigma being 2.28 [10, 11, 12].

Table 1.

Well	Core Depth (m)	Geological age	Microscopic description	Rock diagnosis
X1	2584-2588 (sample 1)	Miocene	Rock with phyllosilicates matrix of silt grained, which has locally microdomains of carbonates	Micropara-breccia
X1	2584-2588 (sample 2)	Miocene	Rock consisting of fine clayey mass (lutitic grained) playing the role of matrix for the siltic-arenitic epiclastic fraction	Clay
X1	2699-2703 (sample 1)	Miocene	Rock consisting of fine clayey mass (lutitic grained) and siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic-arenitic epiclasts	Clay
X1	2699-2703 (sample 2)	Miocene	Rock with arenitic matrix cemented with sparitic carbonate	Micropara-breccia
X2	2744-2747	Oligocene	The rock is composed of a dominant phyllosilicates fraction of silt grained, a clayey fraction unevenly distributed in phyllosilicates silt fraction and an epiclastic fraction of silt-arenitic grained	Clayey siltstone
X2	2790-2794	Oligocene	Rock composed of sparitic calcite (predominantly), lutitic clay fraction (clayey particles are included in carbonate and lutitic clay fraction is unevenly distributed in the mass rock), and a silt-arenitic epiclastic fraction poorly represented (up to below 15% by volume)	Clayey limestone
X2	2798-2802	Oligocene	Rock consisting of fine clayey mass (lutitic grained) and a siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic-arenitic epiclasts	Clay
X2	2834-2838	Oligocene	Rock cemented by thin borders of crypto-microcrystalline silica present mainly in the limits of granoclasts (not filling the interclastic spaces)	Sandstone
X2	2872-2876	Oligocene	Rock cemented with microcrystalline silica, weak yellow pigmented	Sandstone
X3	2288-2292	Oligocene	Rock consisting of fine clayey mass (lutitic grained) and a siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic and arenitic epiclasts	Clay
X3	2346-2350	Oligocene	Rock consisting of siltic-arenitic epiclastic fraction (siltic predominantly) and a lutitic clayey mass (subordinated in terms of quantity)	Clayey siltstone
X4	2050-2051	Miocene	Rock consisting of fine clayey mass (lutitic grained) and a siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic and arenitic epiclasts	Clay
X4	2274-2275	Miocene	Rock consisting of fine clayey mass (lutitic grained) and a siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic and arenitic epiclasts	Clay
X4	2470-2471	Miocene	Rock composed of a phyllosilicates matrix of silt grained, and a coarse grained fraction (coarse silt to arenitic grained)	Siltstone
X5	2601-2608	Oligocene	Rock consisting of fine clayey mass (lutitic grained) and subordinate siltic-arenitic epiclastic fraction. The clayey mass plays the role of matrix for the siltic and arenitic epiclasts	Clay
X5	3102-3104	Oligocene	Fine rock with sparitic carbonate binder	Sandstone

Table 2. Mineralogical Composition (wt% Rietveld)

Well and core depth (m)	Quartz	Albite	Oligoclase	Microcline	Muscovite	Biotite	Clinochlore (chlorite)	Illite	Calcite
X1 (2584-2588) (sample 1)	20.16	-	23.26	-	6.65	8.36	28.53	-	12.94
X1 (2584-2588) (sample 2)	6.57	-	8.85	-	12.05	-	57.65	10.37	4.51
X1 (2699-2703) (sample 1)	3.28	-	7.93	-	4.40	4.22	46.81	26.81	6.55
X1 (2699-2703) (sample 2)	15.23	-	20.38	21.95	8.65	4.03	13.70	-	16.05
X2 (2744-2747)	6.49	-	6.48	-	15.49	-	45.03	24.81	-
X2 (2790-2794)	3.76	-	4.54	-	3.66	-	15.30	-	72.73
X2 (2798-2802)	9.43	-	3.56	-	18.99	-	42.70	25.31	-
X2 (2834-2838)	54.00	-	11.25	10.60	9.62	4.07	5.58	-	4.90
X2 (2872-2876)	49.68	-	16.05	22.62	7.01	-	4.63	-	-
X3 (2288-2292)	12.29	6.91	-	-	5.63	-	61.02	8.45	4.25
X3 (2346-2350)	6.90	5.91	-	-	6.14	-	71.49	4.85	4.72
X4 (2050-2051)	9.63	-	-	-	17.28	-	53.49	15.77	3.82
X4 (2274-2275)	10.05	-	4.87	3.80	7.67	-	73.61	-	-
X4 (2470-2471)	12.80	6.17	-	-	7.16	-	21.08	52.79	-
X5 (2601-2608)	9.21	-	-	-	9.55	-	36.10	40.65	4.49
X5 (3102-3104)	36.90	-	-	17.26	15.13	-	11.68	-	19.03

Conclusions

The cores from Oligocene and Miocene (Burdigalian) deposits crossed by the five wells (X1, X2, X3, X4 and X5) in the Targu-Jiu oil structure were analyzed by optical microscopy and X-ray diffraction.

The samples analyzed from the Oligocene-Miocene sedimentary deposits are polymictic detrital rocks composed of ruditic, arenitic and silto-lutitic clasts, the silto-lutitic ones being predominant. The clasts were separated into several categories: granoclasts, lithoclasts, polygranular clasts, and other clasts optical undetermined.

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X-ray diffraction measurements were performed with a Bruker-AXS diffractometer D8 Advance type with CuKα radiation. The qualitative analysis was made with Diffracplus EVA software and the quantitative analysis was made with Topas 4.1 software by Rietveld method.

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In the source area of the studied rocks were found both endogenous rocks (gneisses, mylonites, cataclasites, metasomatic carbonatites), and exogenous rocks (mudrocks, shales, marls, carbonate cemented siltstones, greywackes, and calcareous sandstones).

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Studiul mineralogo-petrografic al carotelor din depozitele oligocen-miocene de pe structura Targu-Jiu (Depresiunea Getică)

Rezumat

Zăcământul de petrol Târgu-Jiu aparține zonei interne a Depresiunii Getice și este unul dintre cele mai mari zăcăminte din aceasta regiune. În lucrare se prezintă cercetările mineralogo-petrografice efectuate pe carote din depozitele oligocen-miocene de pe structura petroliferă Târgu-Jiu. Carotele au fost analizate prin microscopie optică și difracție de raze X. Studiul mineralogo-petrografic a relevat prezenta în cantități apreciabile a filosilicaților dioctaedrici și trioctaedrici reprezentați prin illit și clinoclor (clorit). Filosilicații au fost identificați în special prin difracție de raze X. Eșantioanele analizate sunt roci detritice polimictice compuse din claste ruditice, arenitice și siltice, și o fracțiune argiloasă. Fracțiunea argiloasă are rol de matrice pentru epiclastele siltice, arenitice și/sau ruditice. În aria sursă a depozitelor studiate apar atât roci endogene cât şi roci exogene.