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

Gheorghe Brănoiu, Mihai Ciocîrdel, Ciprian Şoldan

Universitatea Petrol-Gaze din Ploieşti, Bd. Bucureşti 39, 100680, Ploieşti
e-mail: gbranoiu@yahoo.com; cipriadis@yahoo.com

Abstract

This mineralogical-petrographical study made on cores from Miocene (Burdigalian) deposits of the Ticleni oil field structure revealed the presence in appreciable amounts of the trioctahedral smectites (saponite-15Å). This phyllosilicate was evidenced especially by X-rays diffraction. The samples analyzed are detritic 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 deposits rocks both endogenous and exogenous rocks occur.

Key words: *Getic Depression, Carpathian Foredeep, folded flank, saponite-15Å, mineralogical-petrographical investigations*

Introduction

Until now in Romania have been identified eighteen petroleum systems having particular combinations of source rock maturation and migration to reservoirs in a confined area of a sedimentary province [1].

Getic Depression is an area of great promise for hydrocarbons in Central and Eastern Europe. Getic Depression belongs to a large group of petroleum systems in Romania, more specifically Carpathian Foredeep, located close to the entire extent of the Eastern and Southern Carpathians. Generally, Getic Basin is characterized by two basic structural systems: (a) internal folded foredeep, and (b) external epiplatform (unfolded) foredeep. The two petroleum systems acting in the Getic Depression and evolving in parallel are: the Oligocene-lower Miocene system and the Sarmatian-Pliocene system. The Getic basin evolved during Neozoic time as Southern Carpathians foredeep. Sedimentation started in the Paleocene and continued, except for some hiatus periods, until Pliocene [2, 3, 4].

From geological point of view the Ticleni oil field belongs to the internal folded flank of the Carpathian Foredeep. The Ticleni structure is a faulted anticline. The wells that are drilled on this structure crossed deposits belonging to the Burdigalian (Helvetian), Sarmatian, Meotian, Pontian, Dacian and Romanian. In Ticleni oil field, the Burdigalian and Sarmatian deposits proved to be oil productive, and the Meotian deposits proved to be oil and gas productive [4, 5].

This paper presents the mineralogo-petrographic study of core samples from three wells (noted X, Y and Z wells) that crossed the Miocene deposits of the Ticleni oil field structure. The samples were analyzed first by optical microscopy and then by X-ray diffraction.

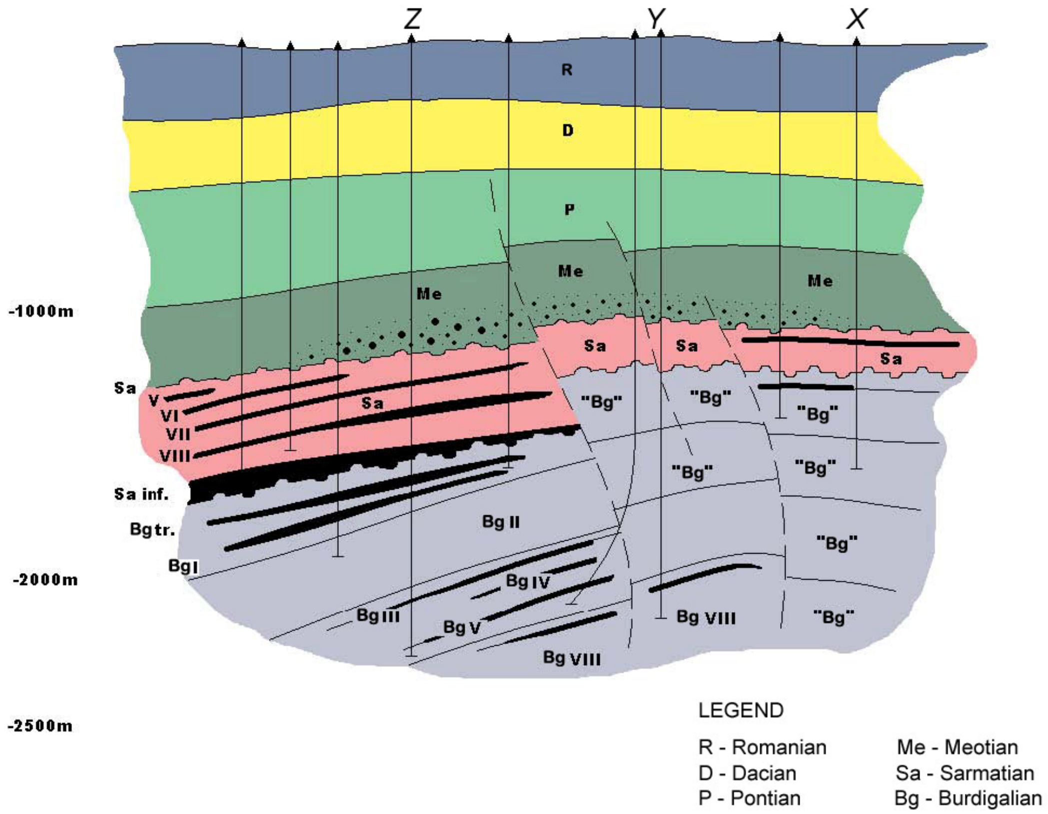

Fig. 0. Schematic geological section on Ticleni oilfield structure (after [4] modified)

Mineralogical-Petrographical Investigations

Optical microscopy

The study was performed on thin sections with a polarizing optical research Steindorff microscope. Images were taken with the camera capture built. The samples analyzed from the Miocene sedimentary deposits are detrital rocks composed of ruditic and arenitic clasts, the arenitic ones being predominant. On the basis of microscopic study these clasts were separated into five categories: granoclasts, lithoclasts, polygranular clasts (not clearly attributable to a type petrographic), bioclasts and other clasts optical undetermined [6, 7].

X Ticleni well

1) In the analyzed sample that represent a polymictic detrital rock were found the following types of epiclasts: quartz granoclasts, and opaque mineral clasts.

a) Quartz granoclasts (fig. 1) show various degrees of rounding: from subangular to rounded.

b) The lithoclasts are represented by shales, carbonate cemented siltstones, marls (consist of clay minerals and microsparitic carbonate), quartz-muscovite mylonite, greywackes, calcareous sandstones.

The shales (fig. 2) is the dominant petrographic type found as lithoclasts. They are composed of phyllosilicates (75-90% – probably illite) and subordinate quartz, feldspar and muscovite siltic granoclasts. They have a planar anisotropy given by the good preferred orientation of the phyllosilicates. Some shales lithoclasts are impregnated on the border with bitumen.

*Carbonate cemented siltstone*s consist of quartz, muscovite, chlorite and poorly chloritised biotite granoclasts, with an intergranular carbonate cement; the structure is anisothropic (the muscovite granoclasts do not have preferred orientation); the grain size is coarse siltic.

The quartz-muscovite mylonites have a microporphyroclastic structure with quartz microporphyroclasts and a very fine granular quartz-micaceous matrix, containing subordinate opaque mineral.

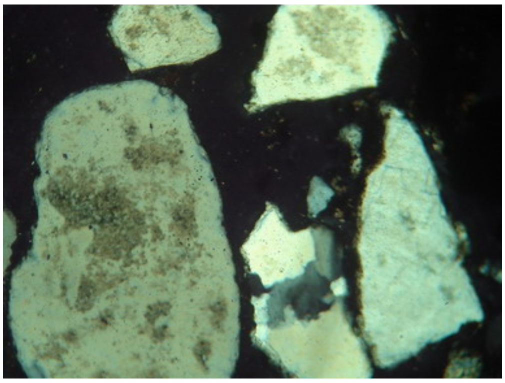

Fig. 1. Quartz granoclast and polygranular clasts of quartz (N+, 100x)

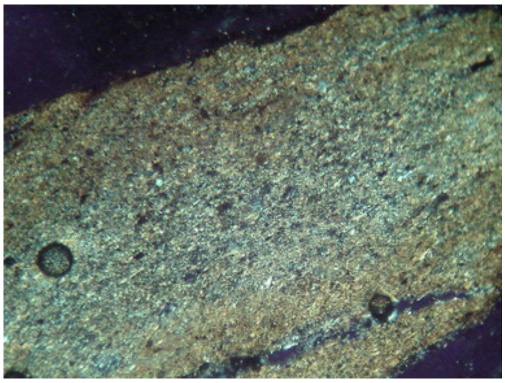

Fig. 2. Shales lithoclast (N+, 100x)

Fig. 3. Lithoclast of calcareous sandstone with basal cement (N+, 100x)

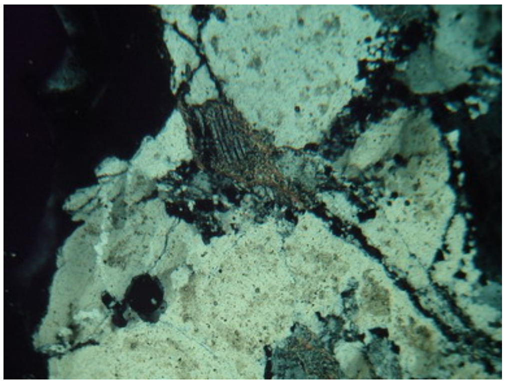

Fig. 4. Polygranular clast of quartz, oligoclase and mica (N+, 100x)

The greywackes consist of quartz, muscovite, feldspar and chlorite (arenitic granoclasts) granoclasts having a predominant lutitic phyllosilicatic-oxidic matrix, with a reddish-brown microscopic aspect. This matrix constitutes approx. 60-65% by volume; the arenitic granoclasts have a subangular shape.

Calcareous sandstones (fig. 3) are composed predominantly of arenitic quartz granoclasts, and subordinately of feldspar and muscovite (<10%); the maximum dimensions observed on quartz granoclasts is 0.33 mm; the cement is basal type microsparitic.

c) Polygranular epiclasts are polygranular quartz and quartz-oligoclase-mica clasts (fig. 4). The observations made on several such polygranular clasts suggest that they come from quartzo-feldspathic gneiss or granitoidic rocks; the oligoclase is partially transformed into small fine granular micas (probably muscovite), some of these clasts show a moderate degree of cataclasation.

2) Regarding to the epiclasts frequency it has been found that shales and polygranular quartz clasts make up over 50% of the total. Opaque mineral clasts are approx. 3-6% of the total volume.

Y Ticleni well

1) The sample analyzed is also a polymictic detrital rock which contains the following types of epiclasts: quartz, microcline, muscovite and opaque mineral granoclasts; lithoclasts and polygranular clasts.

Granoclasts – quartz granoclasts are well rounded, some of them showing strain twinning; microcline or microcline-perthite (microcline-albite intergrowths) granoclasts (fig. 5) are well rounded to subrounded, and micas granoclasts (muscovite and chloritised biotite) are rare.

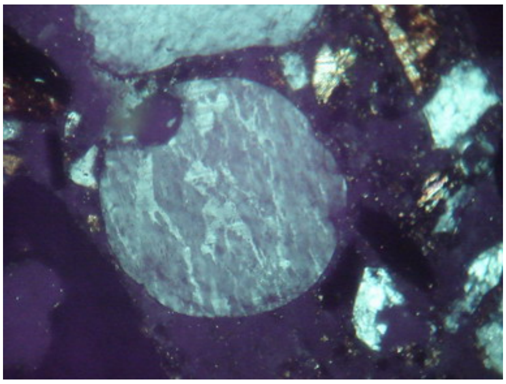

Fig. 5. Rounded granoclast of alkaline feldspar (microcline-perthite) (N+, 100x)

Fig. 6. Polygranular clast composed of quartz, oligoclase and muscovite (N+, 100x)

Fig. 7. Polygranular clast composed of microcrystalline carbonate and rare clasts of feldspar and quartz (N+, 100x)

Fig. 8. Mudrock lithoclast (N+, 100x)

b) *Lithoclasts* – the following types of lithoclasts have been found: shales, mudrocks, marls (composed of clay minerals and microsparitic carbonate), and arcosian sandstone.

The shales consist mainly of phyllosilicate (75-85%) and subordinate quartz granoclasts, muscovite granoclasts and chlorite granoclasts; the structure is siltic. This lithoclasts have a planar anisotropy given by the good preferred orientation of phyllosilicates (similar to those described in the sample from X well). Some shales lithoclasts are impregnated on the border with bitumen.

The mudrocks (silto-lutitic rocks) consist of quartz and muscovite siltic granoclasts, and a fine granular matrix (predominantly lutitic) composed of phyllosilicate and opaque substance. The siltic fraction consisting of quartz and muscovite granoclasts is approx. 15-20% of volume.

Arcosian sandstones consist mainly of oligoclase granoclasts and subordinate of quartz granoclasts both of arenitic size in a predominantly siltic matrix. This matrix is composed mainly of muscovite and quartz, and subordinately of chlorite and opaque mineral.

c) Polygranular epiclasts are: polygranular quartz clasts, clasts composed of microcrystalline carbonate and rare clasts (cataclasts) of feldspar and quartz, and quartz-oligoclase-muscovite clasts. The observations made on several of the later epiclasts suggest that they come from quartzo-feldspathic gneisses or granitoidic rocks; in these epiclasts oligoclase is partially transformed into fine granular micas (probably muscovite). The polygranular clasts consisting of microcrystalline carbonate and quartz, muscovite and feldspar clasts, may be derived from fault or cataclasation zones where postcinematic carbonate deposition had taken place.

2) Regarding to epiclasts frequency it can say that the quartz granoclasts, shales, polygranular quartz clasts and mudrocks lithoclasts represent over to 50% of the total volume. The opaque mineral clasts are approx. 5-8% of the total volume.

Z Ticleni well

The core from Z well is the finest grained sample (mudrock) that was studied. It is composed of fine clayey fraction and an epiclastic silto-arenitic fraction. The clayey fraction plays the role of a matrix for the siltic and arenitic epiclasts. The epiclastic silto-arenitic fraction consists of granoclasts of muscovite, quartz (fig. 9), chloritised biotite (fig. 10) (rare), allogene chlorite (fig. 11), and opaque mineral (accidentally) (fig. 12). Other components are disseminated: sparitic carbonate crystals, and authigenic microcrystalline silica.

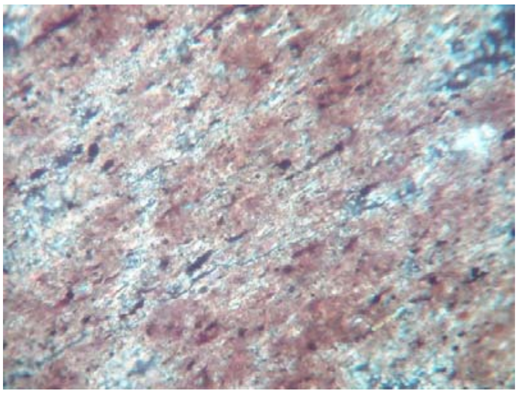

Fig. 9 Image details – muscovite, opaque mineral and quartz epiclasts in the clayey matrix (N+, 250x)

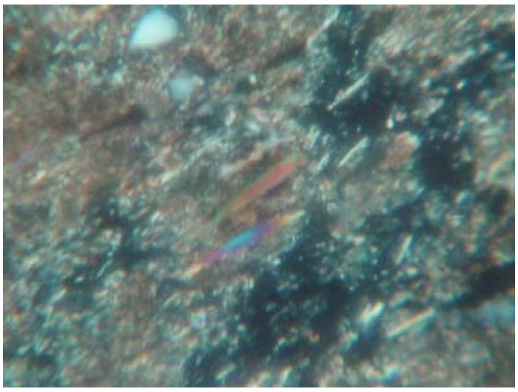

Fig. 10 Image details – it can be observed muscovite, biotite, quartz and opaque mineral granoclasts (N+, 400x)

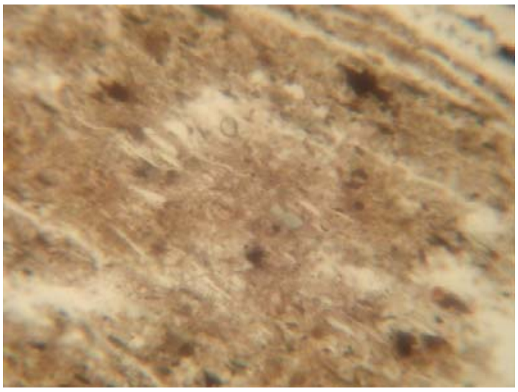

Fig. 11 Image details – chlorite granoclast (N+, 100x)

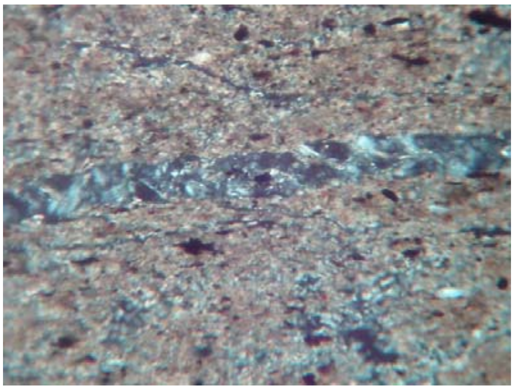

Fig. 12 Microlens of the microcrystalline silica formed by diagenetic process (N+, 250x)

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 solid-state Si detector and Bragg-Brentano geometry. 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 computer program 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 [8].

Rietveld refinement quality is expressed by R-values indices. 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 [9, 10].

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 [9, 10].

The X-ray diffraction analysis shows the presence in large quantity of the dioctahedral and trioctahedral phyllosilicates represented by the illite, muscovite, clinochlore and the saponite. The mineralogical composition of the cores analyzed is presented in table 1 [6, 7].

Table 1. Mineralogical Composition (wt% - Rietveld)

Mineral phase	X Ticleni well	Y Ticleni well	Z Ticleni well
Quartz	34.58	30.90	17.72
Oligoclase (albite calcian)	9.44	14.37	–
Microcline	10.35	10.83	–
Muscovite	13.03	11.67	4.87
Illite	–	7.94	19.97
Clinochlore (chlorite)	18.45	–	24.40
Saponite	8.13	14.33	16.08
Calcite	4.91	7.03	16.96
Magnetite	1.12	2.93	–

The quantitative analysis of the samples analyzed has GOF (goodness-of-fit) indices of 1.16; 1.10 and 1.02 respectively, indicating their good quality. Good quality of the quantitative analysis is also revealed by the Durbin-Watson *d*-statistic values (DW): 2.12; 2.29 and 2.18 respectively [6, 7, 9, 10].

The qualitative and quantitative analysis performed on the cores from X, Y, and Z Ticleni wells are presented in Figures 13-18 [6, 7].

Conclusions

The cores from Miocene (Burdigalian) deposits crossed by X, Y and Z Ticleni wells were analyzed by optical microscopy and X-ray diffraction.

The study of the thin sections revealed the predominance of the lutitic and/or the silto-arenitic rocks. The sample collected from the Z well consists of fine clay mass (lutitic) and epiclastic silto-arenitic fraction, the clay mass playing the role of a matrix for the siltic and arenitic epiclasts. The samples from X and Y wells are composed of ruditic and arenitic clasts, the arenitic ones being predominant. These clasts were separated into five categories: granoclasts, litoclasts, polygranular clasts, bioclasts and other clasts optically undetermined.

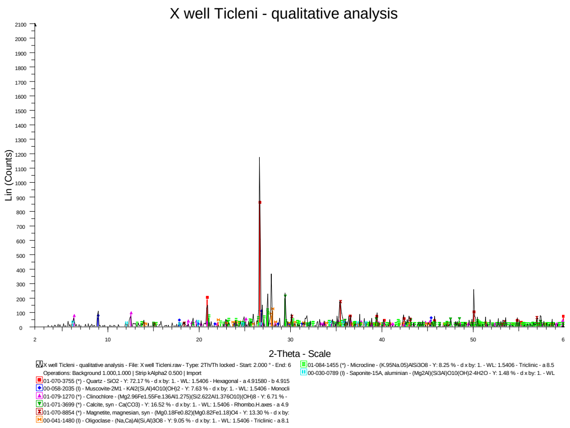

Fig. 13. Qualitative analysis of core from X Ticleni well

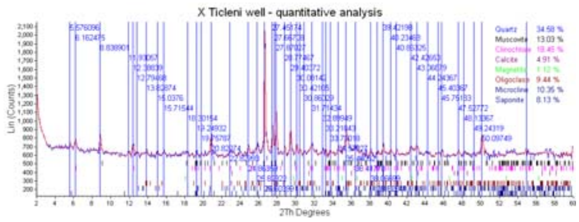

Fig. 14. Quantitative analysis of core from X Ticleni well

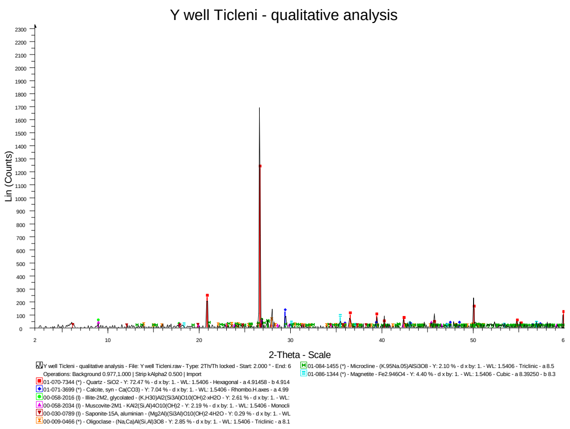

Fig. 15. Qualitative analysis of core from Y Ticleni well

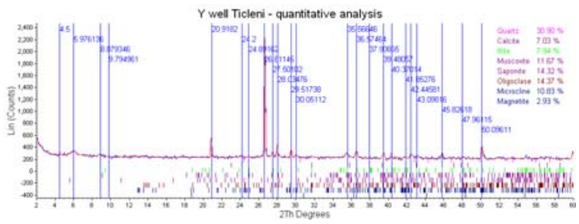

Fig. 16. Quantitative analysis of core from Y Ticleni well

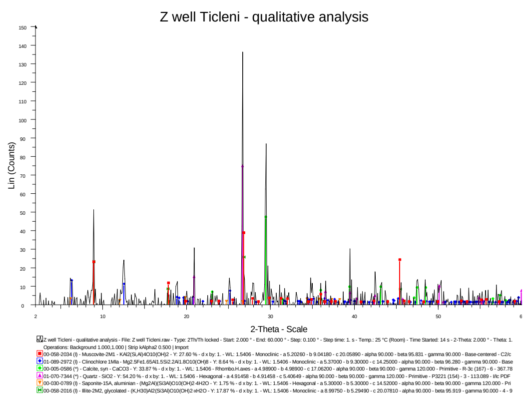

Fig. 17. Qualitative analysis of core from Z Ticleni well

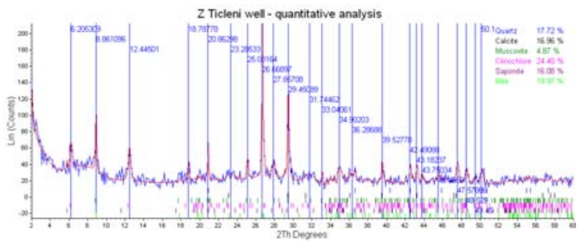

Fig. 18. Quantitative analysis of core from Z Ticleni well

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.

As a novelty is noted the presence into appreciable quantity of trioctahedral smectites (saponite-15Å) revealed by X-ray diffraction.

In the source area of the studied deposits rocks were found as endogenous rocks: quartzo-feldspathic gneisses, mylonites, cataclasites, granitoidic rocks, and that exogenous rocks: shales, carbonate cemented siltstones, marls, greywackes, calcareous sandstones, mudrocks, and arcosian sandstone.

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

Rezumat

Studiul mineralogo-petrografic efectuat pe carote din depozitele miocene de pe structura Ticleni au relevat prezenta in cantitati apreciabile a smectitelor trioctaedrice (saponit) puse in evidenta in special prin difractie de raze X. Esantioanele analizate sunt roci detritice formate din claste ruditice si arenitice, o fractie epiclastica silto-arenitica si o masa argiloasa fina. Masa argiloasa are rol de matrice pentru epiclastele siltice, arenitice si/sau ruditice. În aria sursă a depozitelor studiate apar atât roci endogene cât şi roci exogene.