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Mineral composition of the clay fractions from sediments of Troyanovo-North mine, East Maritsa Basin (Bulgaria)

Минерален състав на глинестите фракции от седименти от рудник Трояново-север, Източномаришки басейн (България)

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Introduction

The clayey sediments from East Maritsa Basin (EMB) have been studied so far with respect to their mechanical features and slope stability in "Maritsa-Iztok" open-pit mine and dumps. Mineralogical investigations on clay minerals from EMB have been performed from different point of view to estimate their suitability: as building materials (Кремакова-Карапчанска, 1963) and industry raw materials (Ivanova, Yaneva, 2007), for recultivation activities (Valceva et al., 2000) and as a precondition for their microstructure and mechanical features (Демирев и др., 1980; Занева-Добранова, 1996). All authors mentioned that the clay mineralogy of EMB sediments is complex and variable. The aim of the present study is careful identification of the clay minerals as a first step of a comprehensive mineralogical, sedimentological and geochemical study of the sediments.

Background

Clayey sediments are the main component in the overcoal sediment suite of East Maritsa Basin. They have been grouped in Gledachevska Formation (Sarmatian?) and formation of dispersive (fine) ochreous clays (Pliocene) (Недялков, Коюмджиева, 1985). Gledachevska Formation sediments are predominantly gray-green clays, interbedded by limestones, sands and sandstones, formed in freshwater lacustrine environment. Dispersive clays formation consists of ochreous fine and silty continental clays. Black and gray-black clays are accompanying component in coal-bearing Maritsa Formation (Каменов, Панов, 1976).

Material and methods

Five core samples from bore hole B-69/99 were randomly selected to present all clay types differing in colour and grain-size. Bore hole B-69/99 is situated in the central part of Troianovo-North mine, East Maritsa Basin. Samples were characterized by their grain-size distribution and clay fraction (<2μm) mineralogy. Clay fractions were studied both in random and oriented samples in natural and ethylene glycol (EG) saturated state. Powder X–ray data were collected on a TUR M62 diffractometer using Fe-filtered CoKα radiation. A semi quantitative estimation of the clay minerals identified has been made following the Biskaye's method (Biskaye, 1965). TEM study was performed on Philips EM 420T.

Results and discussion

Samples studied differ in their field characteristics. Sample No 18 (16.75 m depth) is light grey to gray-white massive (without bedding) clay with random small ochreous, black and white spots. Sample No 41 (31.50 m depth) is pure (without spots and terrigenous clasts) dark gray-green clay with unclear bedding. Sample No 43 (35.00 m depth) is silty-sandy light to gray-green clay with white spots and unclear bedding. Sample 51 (55 m depth) is gray-green massive silty clay with scarce random lenses of quartz, calcareous and organic matter particles. Some white and reddish spots of gypsum crystals and random muscovite flakes and sulphide crystals are also present. Sample No 66 (69.50 m depth) is dark gray to black, very hard, massive clay.

Two samples contain components soluble in buffered (pH 4.75) acetic acid — No 18 (21 wt.%) and

Table 1. Grain-size distribution (wt.%) in samples studied from borehole 66/99, Troyanovo-north mine, East Maritsa Basin.

Fraction (mm) / Sample No (depth, m)	>2.00	2.00-1.00	1.00-0.50	0.50-0.25	0.25-0.125	0.125-0.063	0.063-0.032	0.032-0.016	0.016-0.002	<0.002
18 (16.75)	0.10	0.38	1.28	1.06	1.16	1.10	1.54	1.02	7.56	63.80
41 (31.50)						<0.02	0.50	1.08	6.90	93.52
43 (35.00)			0.40	4.44	16.06	17.52	9.99	6.16	13.58	35.18
51 (55.00)	0.88	0.04	0.02	0.02	0.04	0.28	0.90	5.40	20.00	72.44
66 (69.50)	0.14	0.12	0.40	0.36	0.56	0.64	0.30	0.30	4.36	91.04

66 (3.20 wt. %). The grain-size characteristics (Table 1) of the samples studied vary and there are no regularities in grain-size distribution with depth. The samples differ significantly in regard to the clay fraction content. The clay fraction quantity dominates and varies from 35.18 to 93.52 wt.%.

Mixed-layered I/Sm and kaolinite are predominant clay minerals in all fractions < 2 μm; illite and montmorillonite were identified in some of them. Small amount of quartz admixture and traces of feldspar were also detected.

I/Sm is presented as a random interstratified mixed-layered clay mineral with predominant smectite layers (ca. 70%) (Thorez, 1975). In samples No 18 and 41, the first basal reflection shifts from 14.8 Å to 16.8–17 Å upon EG saturation; in samples No 43, 51 and 66, the shift is from 12.5–13 Å to about 17 Å (Fig. 1a). The difference observed in the d_{001} value

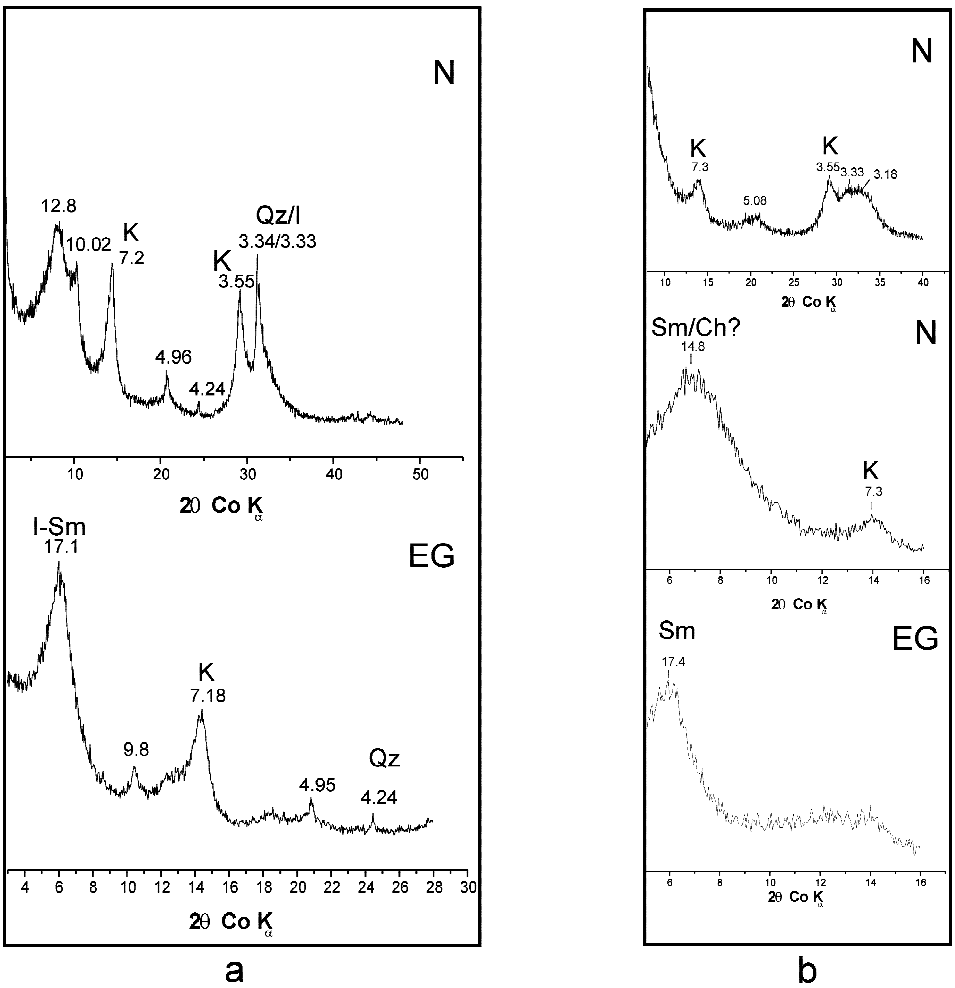

Fig. 1. Powder X-ray patterns of oriented natural (N) and ethylene glycol saturated (EG) sample No 43: a) fraction < 2 μm; b) fraction < 0.5 μm (I-Sm — mixed-layered illite-smectite, K — kaolinite, I — illite, Ch — chlorite, Qz — quartz)

of the natural state may be due to difference in the interlayer cation complex of the expandable component of the mixed-layered mineral.

Kaolinite is also present in all samples studied (d_{001}=7.18 Å, d_{002}=3.56 Å) in different quantity. It is the most abundant component in sample No 51; in sample No 43 the kaolinite quantity is almost the same as those of the mixed-layered mineral.

Illite was identified as a distinct mineral in samples No 41 and 43 (d_{001}= 10 Å).

It is difficult to certainly verify discrete montmorillonite in the clay fractions in the co-presence of an expandable mixed-layered mineral. It was possible to separate ultra fine fraction (<0.5 μm) from samples No 41 and 43 where the main clay component was identified as montmorillonite (d_{001} increased after EG-sarturation from 14.8 to 17.6 Å — Fig. 1b); the finest fraction of sample No 51 is built up of mixed-layered I/Sm. Kaolinite-type mineral (d_{001}= 7.35 Å) was also detected in all those ultra fine fractions as a minor phase, which is most probably halloysite. Fine elongated crystallites — a morphology characteristic of halloysite, were observed in TEM (Fig. 2).

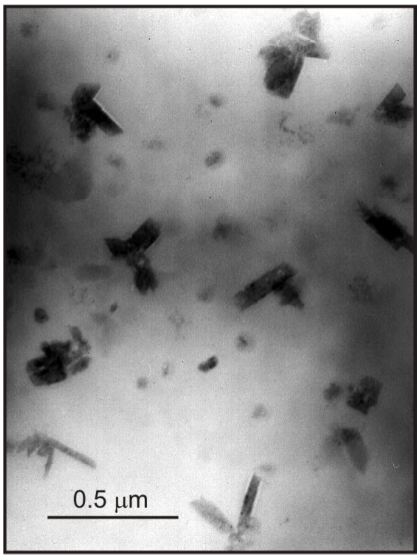

Fig. 2. TEM image of elongated halloysite crystallites (x 31 000)

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References

Демирев, А., К. Ангелов, Г. Хубенов, М. Тодорова, В. Осипов, В. Шликов, В. Соколов. 1980. Минерален състав на плиоценските глини от Източномаришкия басейн. — *Инж. геол и хидрогеол.*, *10*, 3—12

Занева-Добранова, Е. 1996. Минерален състав на седиментните скали от Източномаришкия въглищен басейн. — *Год. МГУ, 41,* 33—36.

Каменов, Б., Г. Панов. 1976. Геоложката връзка между въглищните пластове от Марица-Запад и Марица-Изток в Маришкия басейн. — *Нефт. и въгл. геол.*, *4*, 60—71.

Кремакова-Карапчанска, Б. 1963. Минералният състав на глините от Марица-изток — важен фактор при оценка на строителните им качества. — *Строит. матер. и силикат. пром., 6*, 9—11.

Недялков, Н., Е. Коюмджиева. 1983. Стратиграфия на надвъгленосните седименти в Източномаришкия басейн. — *Спис. Бълг. геол. д-во, 44*, 3, 259—264.

Biscaye, P. 1965. Mineralogy and sedimentation of recent deep sea clay in the Atlantic Ocean and adjacent seas and oceans. — *Geol. Soc. Am. Bull., 76*, 803—832.

Ivanova, R., M. Yaneva. 2007. Clay minerals from the sedimentary cover of East Maritsa coalfield (South Bulgaria). — *Book EUROCLAY 2007*, *Abstr.,* p. 75.

Thorez, J. 1975. *Phillosilicates and Clay Minerals: A Laboratory Handbook for Their X-ray Diffraction Analysis*. Dison, G. Lelotte, 579 p.

Valceva, S., E. Djourova, T. Stanimirova, D. Dimitrova, L. Aleksieva. 2000. Mineralo-geochemical features of Gledachevska Formation sediments in the Maritza-East lignite basin and in the technogenous soils of the recultivated terrains. — *Ann. Univ. Sofia, Fac. Geol. Geogr., 92*, 1-geol., 203—212.