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PRELIMINARY MINERALOGICAL CHARACTERISTIC OF KAOLINITIC ROCKS IN WADI SHATTI REGION, LIBYA

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Abstract: This paper deals with preliminary results of mineralogical investigations of samples of mudstones and claystones underlaing Galmoia ore beds. They were collected from five different boreholes and examined using X-ray, thermal and microscopic methods. It was found that the samples in question consist of kaolinite, quartz and muscovite. Because of high kaolinite content in them these rocks can be used in ceramic industry.

INTRODUCTION

During geological investigations carried out in El Khums (Libya) on raw materials for cement industry, the structure of Galmoia iron ore deposit was studies in detail. These exploration works showed considerable reserves of haematite-oölitic ores which can be used as additional component for cement production. Twenty boreholes and four pits were made during geological and mining works. It was found that haematite beds are underlain by mudstones and claystones. From geological point of view especially interesting are physico-chemical and climatic conditions of formation of these rocks. Lack of data on mineral composition of these mudstones and claystones inclined the present author to examine them more in detail. The deposit in question were described by Desio (1943). In 1954 additional data on Wadi Shatti deposits were presented by Muller-Feuga. He described the oölitic zone between Chirra and Galmoia. Goudarzi (1962, 1970, 1971) carried out geological exploration in Wadi Shatti Valley and presented detailed description of the iron ore area. In 1971—1972 geological investigations of the deposits between Taroot and Ash Sheb were carried out by Bureau de Recherches Geologiques et Miniers (France).

Galmoia iron ore deposit is situated in central part of West Libya, in the region of Wadi Shatti Valley which stretches from ENE to WSW and is about 200 km long and 20 km wide. It is bordered on the North

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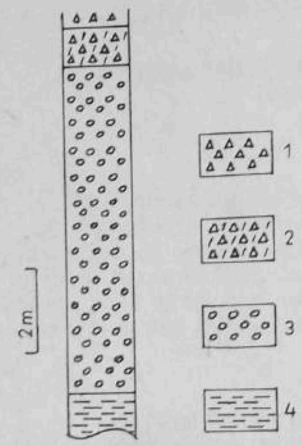

Fig. 1. Geological cross-section of iron ore deposit in Galmoia region
1 — quaternary sands, *2* — quaternary gravels, *3* — haematite-oölitic iron ore deposit, *4* — kaolinite mudstones and claystones

by Jebel Fezzan Mts. and on the South by Az Zallaf peak. The Devonian rocks overlay there Cambrian system (Goudarzi, Tschopke, 1968). Devonian series consist of sandstones, mudstones and siltstones showing variable colouration. In the top part quartzictic beds are observed. The thickness of Devonian rocks is approximately 350 m. The upper part of Lower Carboniferous (Turnosian) deposits consist of lenticular, red--brown sandstones, slates and limonitic claystones. They are overlain by continental grey sandstone. Further upwards they grade into marine beds of Visenian age. Oölitic-chamosite--limonitic beds occur near the contact of continental unit. The rocks on question dip 1—3° to S. The faults system is generally parallel to the strike of the beds. In Galmoia deposit the ore minerals are represented by (Muller-Feuga, 1954): haematite, goethite, limonite, chamostite, siderite, stilpnosiderite, boehmite and traces of aluminum monohydrate. The content of associated manganiferous minerals is up to 2%. The described minerals are accompanied by quartz, kaolinite, feldspars, muscovite and others.

Galmoia deposit display irregular and lenticular development. In Wadi Shatti region the thicknesess of the iron ore beds are up to 15 meters but in Galmoia deposit they are 4.0—7.0 m thick. They show considerable facial horizontal and vertical changes. In the bottom part of haematite--oölitic bed one can observe green-grey, cream and white slightly consolidated claystones of unknown mineral composition. Their thickness is up to 2.0 m (Fig. 1). Galmoia deposit is overlain by Quaternary sands and gravels. The shales and sandstones of upper Devonian age make overburden in some places.

METHODS OF EXAMINATION

100 g of every sample was treated with one liter of destilled water. After one day samples were mixed for 10 hours using electromixer. The separation was carried out using sedimentation methods. Following fractions were obtained:

1) after 8.5 minutes — fraction less than 15 μm,

2) after 8 hours — that below 2 μm.

Coarser fractions were selected using sieves 0.1 and 0.06 mm. Each fraction was investigated in detail.

Microscopic observations were carried out using polarizing microscope "Polmi-A" (C. Zeiss). Observations of thin sections were used for determination of mineral composition, especially of those present in grains being more than 0.06 mm in diameter. Moreover, microscopic observations of thick fractions were carried out.

X-ray methods were applied for identification of clay minerals. They were carried out using X-ray diffractometer TUR-61 and following con-

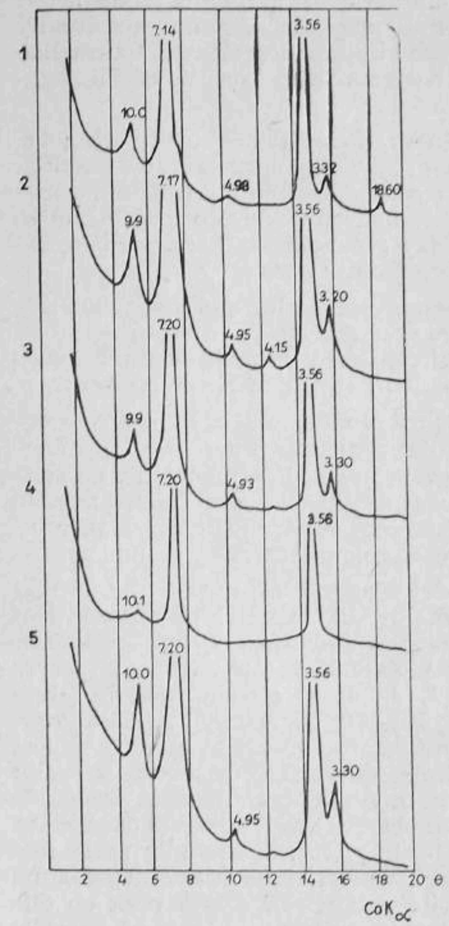

Fig. 2. X-ray diffractometer patterns of natural samples (no 1—5), fractions < 15 μm

Fig. 3. X-ray diffractometer patterns of heated samples (no 1—5), fractions < 15 μm

ditions: filtered CoK_α radiation, GM counter rotation speed 15/min., moving speed of the record's band 600 mm/h. During X-ray investigations artificially sedimented samples have been used. The samples were treated with glycerol, heated to 560°C and treated with 1 : 1 HCl for 6 hours.

Thermal analysis were carried out using fractioned material < 0.015 mm. All five samples has been investigated by means of Hungarian "Derivatograph" (F. Paulik, J. Paulik, L. Erdey) by applying the following conditions: sample's weight 500 mg., heating rate 12°C/min., DTG 1/30, DTA 1/3, TG 100, max. heating temperature 1000°C.

RESULTS

Samples *1* and *5* are kaolinitic mudstones showing slightly parallel structure (Phot. 1). They consist of quartz and clay minerals. Quartz grains are sharp-edged and usually quite clear up to 0.1 mm in diameter. Small flakes of hydromica and euhedral plagioclases grains are locally abundant. Heavy minerals are represented by rounded zircone, tourmaline and sometimes by staurolite grains. The groundmass consists of fine kaolinite microflakes.

Sample *2* represents slightly diagenetized claystone showing irregular structure marked by haematite (Phot. 2). Clay minerals are essential components of the rock. They are represented by thin mikroflakes, sometimes showing directional orientation. Small, euhedral, up to 0.08 mm in size quartz grains are present in the clay groundmass. The described minerals are accompanied by alongated hydromica flakes.

Sample *3* consists of pseudooolites of haematite and clay minerals (Phot. 3). The last one form fine grained groundmass. The structure of rock is irregular because of the presence of dispersed haematite-oölite. Determination of clay minerals is only possible by means of X-ray methods.

Sample *4* represents slightly consolidated mudstone of light-cream colour. In polarized light it shows irregular structure (Phot. 4). Clay minerals as well as quartz and haematite grains are main components. Haematite concentrations are surrounded by thin clay framings showing slightly higher interference colours than clay groundmass.

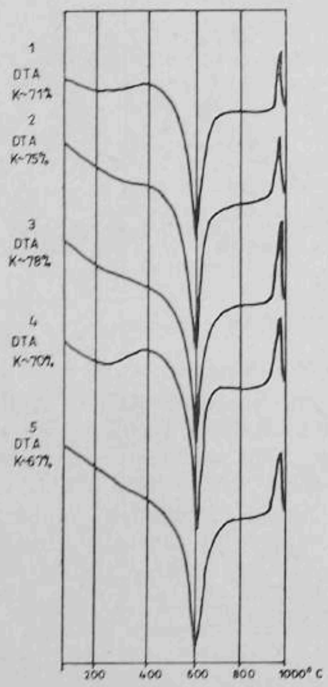

Fig. 4. DTA curves of investigated samples fractions < 15 μm

X-ray analysis has shown (Fig. 2) that kaolinite is the essential clay mineral of the fraction less than 15 μm (reflexions d_{hkl} = 7.14—7.20 Å, 3.56 Å, Fig. 2, curves *1, 2, 3, 4*). It is accompanied by illite (d_{hkl} = 9.9—10.1 Å, and 4.95 Å). Moreover, in this fraction as well as in fraction less than 2 μm, quartz and haematite are also present in small quantities. In sample *5* one can observe small amounts of chlorite. After heating (Fig. 3) kaolinite peaks disappeared, this effect is due to degradation of kaolinite. Lack of 4.48 Å peak on diffractometer patterns of natural samples makes kaolinite similar T_c modification (Stoch 1974).

Thermal analyses confirmed the presence of kaolinite in all samples. Two strong thermal effects are observed on DTA curves (Fig. 4). The first one, endothermic at temp. 600°C, is due to desintegration of kaolinite structure. The second, exothermic effect at temp. 970—980°C, is typical for the formation of mullite. The amount of water lost at temp. 600°C (9.5—11.0 weight per cent) shows that fraction less than 15 μm contains 68—78% of kaolinite. Total quantity of kaolinite in all samples ranges between 30 and 60 weight per cent.

CONCLUSIONS

The examined mudstones and claystones underlaying iron ore deposit in Galmoia region consist essentionally of T_c kaolinite (30—60%) accompannied by detrital quartz, hydromicas, plagioclases and heavy minerals. This kaolinite is the product of desert weathering of muscovite and hydromicas. This process can be observed now in thin sections. It is supposed that some part of kaolinite results from kaolinitization of feldspars. The quality of kaolinite clays makes them a good row material for ceramic production. It is to recommended to examine more in detail the kaolinite mudstones and claystones underlaying iron ore deposit and occurring in the Wadi Shatti Valley. Moreover, it would be important to find the proper geological and mining conditions for exploitation of this kaolinite raw material.

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WSTĘPNA CHARAKTERYSTYKA MINERALOGICZNA SKAŁ KAOLINITOWYCH Z REJONU WADI SHATTI, LIBYA

Streszczenie

Przedstawiono wyniki wstępnych badań mineralogicznych próbek mułowców i iłowców podścielających złoże żelaza w Galmoi. Próbki zostały pobrane z pięciu różnych otworów wiertniczych. Poddano je badaniom rentgenowskim, termicznym i mikroskopowym. Stwierdzono, że próbki składają się głównie z kaolinitu, kwarcu oraz muskowitu. W związku z wysoką zawartością kaolinitu badane skały mogą stanowić surowiec dla przemysłu ceramicznego.

OBJAŚNIENIA FIGUR

Fig. 1. Profil geologiczny złoża żelaza w Galmoi
1 — piaski czwartorzędowe, *2* — żwiry czwartorzędowe, *3* — hematytowo-oolitowe złoże rud żelaza, *4* — kaolinitowe mułowce i iłowce

Fig. 2. Dyfraktogramy rentgenowskie próbek naturalnych (nr 1—5), frakcja < 15 μm

Fig. 3. Dyfraktogramy rentgenowskie próbek prażonych (nr 1—5), frakcja < 15 μm

Fig. 4. Krzywe DTA badanych próbek (nr 1—5), frakcja < 15 μm

OBJAŚNIENIA FOTOGRAFII

Fot. 1. Mułowiec kaolinitowy zawierający kwarc, hydromiki i in. Nikole ×, pow. × 34
Fot. 2. Iłowiec kaolinitowo-hematytowy. Nikole ×, pow. × 34
Fot. 3. Iłowiec kaolinitowy zawierający nieregularne koncentracje oolitowo-hematytowe. Stropowa część warstwy iłowca. 1 nikol, pow. × 68
Fot. 4. Czysto kaolinitowy iłowiec. Nikole ×, pow. × 180

Мацией ПАВЛИКОВСКИ

ПРЕДВАРИТЕЛЬНАЯ МИНЕРАЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА КАОЛИНИТОВЫХ ПОРОД РАЙОНА УЭД ШАТТИ, ЛИБИЯ

Резюме

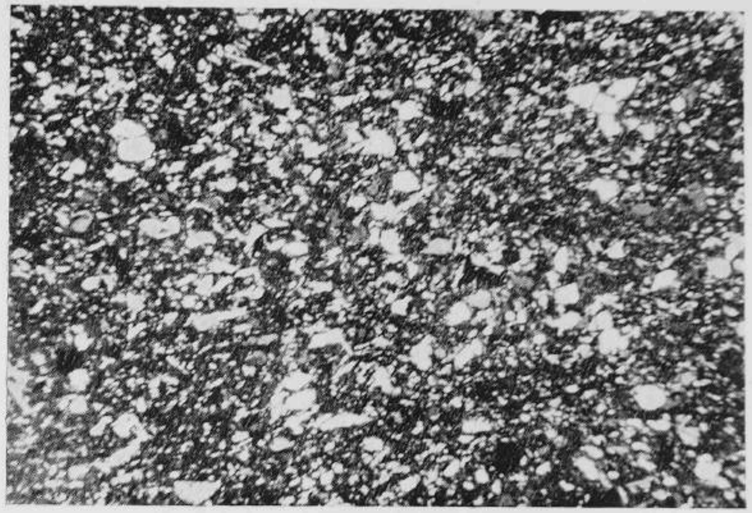
Представлены результаты предварительных минералогических исследований алевролитов и аргиллитов подстилающих железорудную залежь в Гальмон. Образцы отобраны из пяти разных буровых скважин. Они были подданы рентгеновским, термическим и микроскопическим исследованиям. Обнаружено, что образцы состоят главным образом из каолинита, кварца и мусковита. Благодарья высокому содержанию каолинита изучаемы породы могут являться сырьем для керамической промышленности.

ОБЪЯСНЕНИЯ К ФИГУРАМ

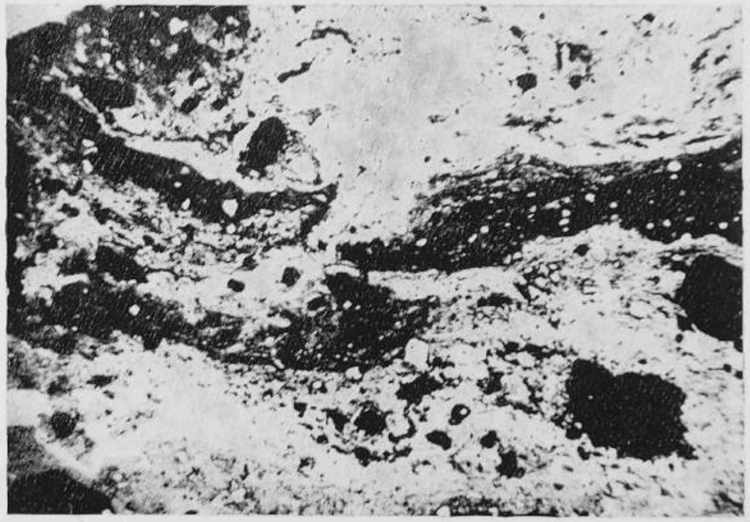
Фиг. 1. Геологический разрез железорудного месторождения Гальмон
1 — четвертичные пески и гравий, *2* — гематит-оолитовая железорудная залежь, *3* — каолинитовые алевролиты и аргиллиты
Фиг. 2. Рентгенограммы естественных образцов (№ 1—5) фракция $< 15\,\mu$м
Фиг. 3. Рентгенограммы прокаленных образцов (№ 1—5) фракция $< 15\,\mu$м
Фиг. 4. Кривые дифференциального термического анализа (№ 1—5) фракция $< 15\,\mu$м

ОБЪЯСНЕНИЯ К ФОТОГРАФИЯМ

Фот. 1. Каолинитовый алевролит содержащий кварц, гидрослюды и др. Николи скрещ. × 34
Фот. 2. Каолинит-гематитовый аргиллит. Николи скрещ. × 34
Фот. 3. Каолинитовый аргиллит содержащий неправильные оолитово-гематитовые концентрации. Образец из кровли аргиллитового слоя. Один николь, × 68
Фот. 4. Сплошной каолинитовый аргиллит. Николи скрещ. × 180

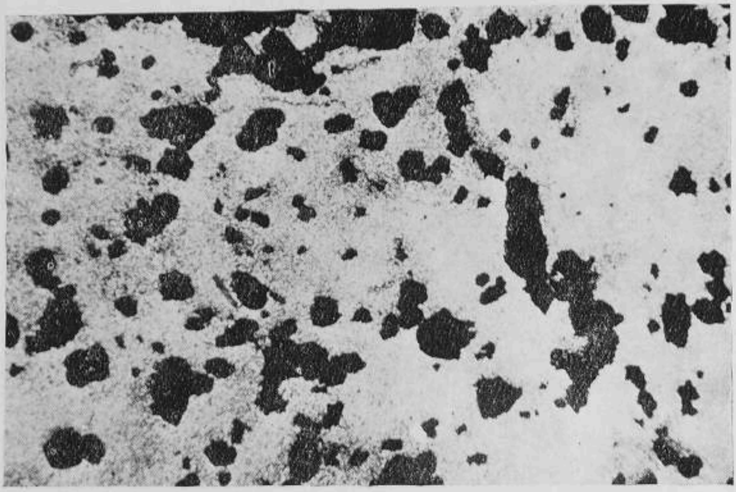


Phot. 1. Kaolinitic mudstone containing quartz, hydromicas and others minerals. Crossed nicols, × 34

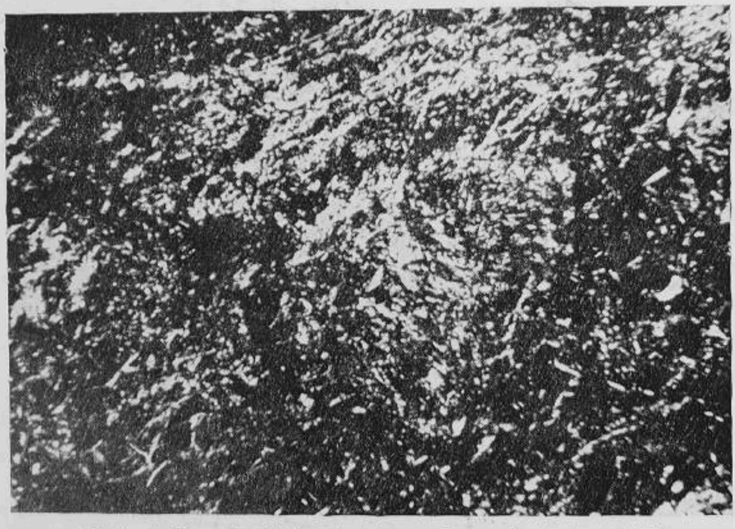


Phot. 2. Kaolinite-haematite claystone. Crossed nicols, × 34

Maciej PAWLIKOWSKI — Preliminary mineralogical characteristic of kaolinitic rocks in Wadi Shatti region, Libya



Phot. 3. Kaolinitic claystone containing irregular oolite-haematite concentrations. Top part of claystone layer. One nicol, × 68



Phot. 4. Pure kaolinite claystone. Crossed nicols, × 180