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MORPHOLOGY OF THE MAIN MINERAL COMPONENTS OF THE MÁD KIRÁLYHEGY KAOLIN

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ABSTRACT

In this study the different microstructure of Mád Királyhegy siliceous kaolin is presented by scanning electron microscopy, X-ray diffraction and thermal analysis. The ceramic properties of this clay are influenced by the mineral composition and the different morphology.

INTRODUCTION

The Mád Királyhegy kaolin represents the characteristic type of the siliceous kaolins formed during the hydrothermal transformation of rhyolitic tuffs. Externally it is a hard, stone-like, fine-grained material in which in some places the tuff-like structure of the mother rock is preserved while in other places it contains soft centres of kaolin of a compact structure. In the holes of the preserved tuffy rock pumice embeddings and different crystalline formations can be seen. Upon touching both the tuffy and the compact structure rock are rough.

Among the main rock-forming components the following ones were determined: kaolinite, dickite, illite, allevardite, quartz and alunite. Besides the crystalline phases the rock contains a considerable amount of amorphous material, too.

Investigating the external character of the Királyhegy kaolin it can be seen that according to the enrichment of the main mineralogical components three types of rocks can be differentiated: the kaolinitic, alunitic and iron-oxidic ones. The dominant mineralogical components being present form those properties of the rock which must be considered at its utilization in the ceramic industry.

It is known that the ceramic properties of clays are decisively influenced by the morphology of the individual crystal grains forming the mineral raw material. In order to study this, scanning electron micrographs (SEM) were taken about the rock types of the recently opened Királyhegy kaolin quarry. The SEM applied in our work was of the JEOL type of the Institute SZIKKTI. — The micrographs were made by I. WOJNAROVITS.

The type of the investigated rock was determined by X-ray diffraction and thermal analyses.

KAOLINITIC TYPE OF ROCK

Fig. 1 shows the X-ray and thermal diagrams of the sample giving the data of the chemical analysis, too. According to the evaluation of the results the rock consist of 40% kaolinite, ~50% quartz and ~10% X-ray amorphous material. The morphology of the crystalline componensts of the white, compact structured, poorly peptiza-

TABLE 1

Chemical Composition (weight %)

	Kaolinitic type	Alunitic type	Iron-oxidic type
I. L.	6.57	6.60	5,30
SiO_2	72,20	59,40	74,73
Al_2O_3	16,51	17,15	16,01
Fe_2O_3	0,16	0.26	2,24
TiO_2	0.04	0,06	0,13
CaO	0,01	0,11	0,34
MgO	0,20	0,06	0,27
K_2O	0,02	3,33	1,01
Na_2O	0,01	0,04	0,03
SO_3	0,15	12,53	0,13

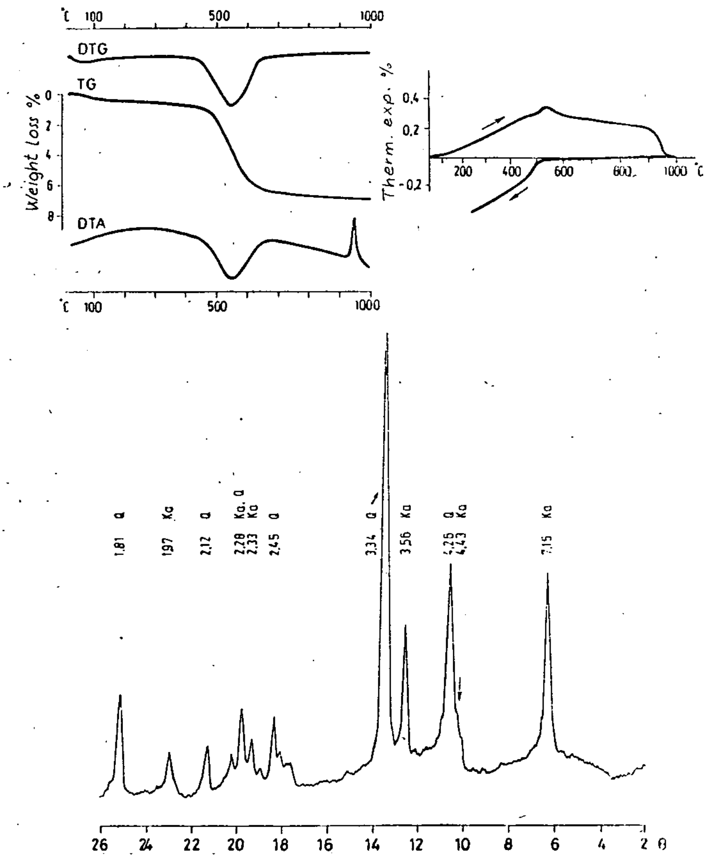

Fig. 1. X-ray diffractogram and derivatogram of a kaolinitic type rock

ble material was studied, by SEM taken of the fracture surface of the rock. On the basis of the electron micrographs two kinds of forms of appearance are characteristic of the morphology of the components of this rock:

— well-crystallized, idiomorphic crystal forms;

— grain aggregates formed of small crystal detritus.

The morphology presented in the picture *(Fig. 2)*) is a classical example of the individual crystal grains of the well-crystallized, idiomorphic kandite-minerals. Pseudohexagonal crystal forms of larger and smaller size can be seen among which the larger ones have an edge length of 1—2 μm. It can be observed that the idiomorphic crystals of this size consist of flakes adhered together. This can well be seen on the

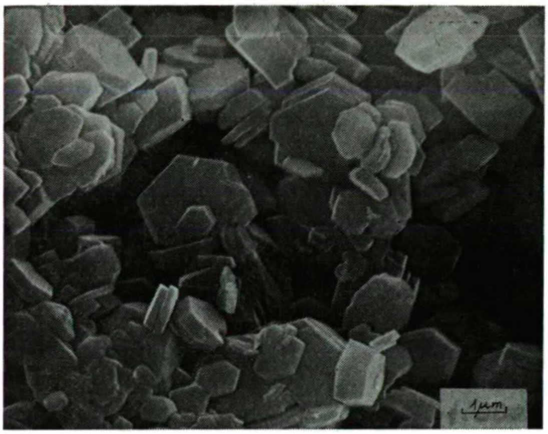

Fig. 2. Morphology of the individual crystal grains of idiomorphic kandite minerals

fracture surface of the large crystal positioned in the middle of the picture and on the other crystal as well, where the thin flakes are a bit slipped on one another. The idiomorphic grains of smaller size are apparent by their thickness. This thickness varies between 0,1 and 0,5 μm. It is conspicuous that hexagonal crystal grains flanked by trapeziform sides can be observed in more places in which the dickite can be identified. Besides this the micrographs show large quartz crystals wedged in between the kandite minerals.

The picture shown in *Fig. 3* is typical of the other form of appearance of the crystalline components of the kaolinitic type rock. Here no regular, idiomorphic crystalline forms can be seen but only the smaller of larger grain aggregates formed of the debris of the crystal. At the same time, however, the pseudohexagonal forms can be recognized on these broken grain aggregates.

Ceramic industrial technological investigations showed that this kaolinitic rock of detrital morphology has a larger shrinkage and can be fired into a more compact material than the rock presented earlier.

ALUNITIC TYPE OF ROCK

The investigated alunitic rock sample originated from the SW workface of the kaolin quarry where it has been locally accumulated in large quantities at the time of sampling. *Fig. 4* shows its X-ray diffraction pattern and thermal curve as well as its chemical analysis. According to the data the mineralogical composition of the rock is the following: 15—20% kaolinite, 30% alunite and 40—45% quartz and X-ray amorphous material. The external appearance of the alunitic type of rock is char-

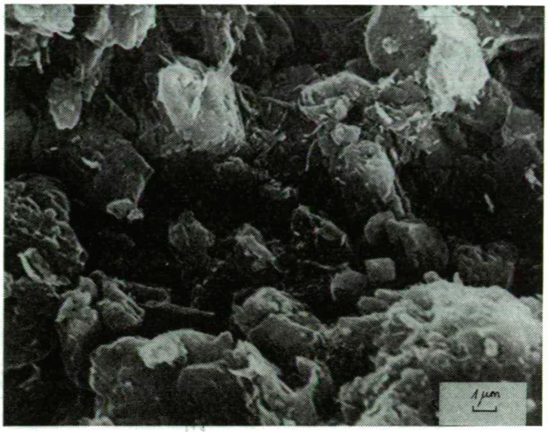

Fig. 3. Grain aggregates formed of the debris of crystals

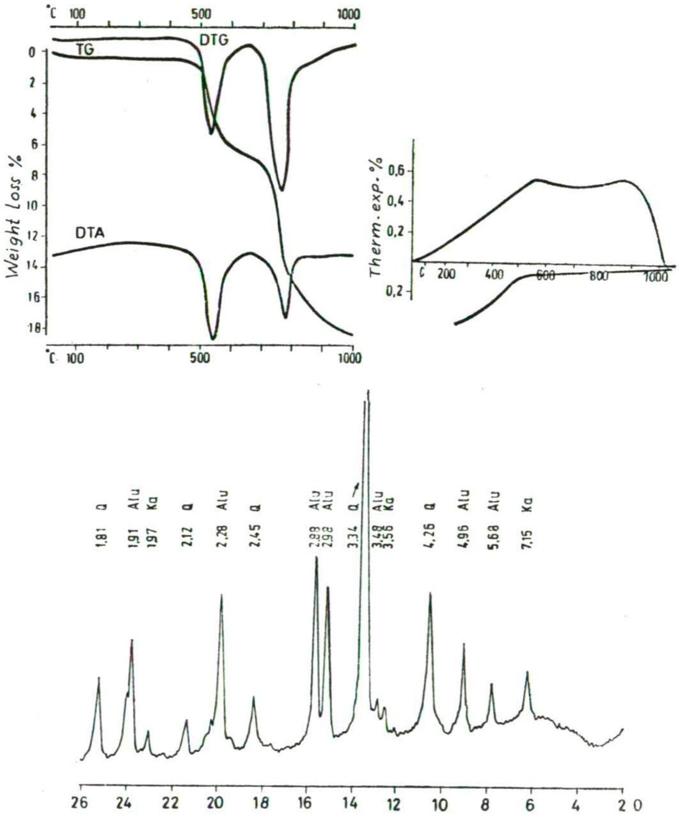

Fig. 4. X-ray diffractogram and derivatogram of an alunitic type rock

acterized by greyish-white, pink and yellowish colour and a hard, stone-like, strongly cemented, porous tuffy structure. In the voids of the tuff the alunite forms druses while in the mother rock it is finely distributed. The morphology of the mineralogical components of this type of rock can be studied in *Fig. 5*. The alunite being present

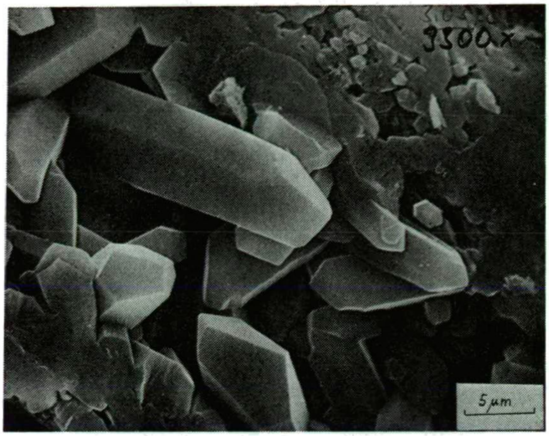

Fig. 5. Morphology of alunite and quartz crystals

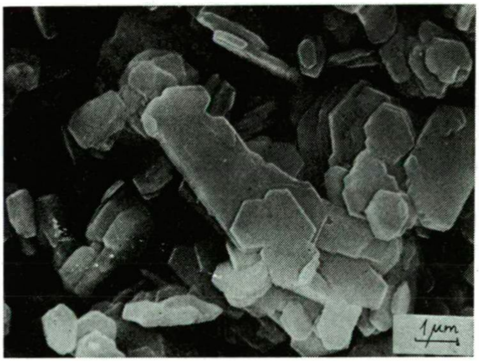

Fig. 6. Morphology of the kandite minerals being present in the alunitic type rock

in large quantities can be recognized in forms flaked by pentagonal sides. The quartz can be seen in long, columnar forms. — At the same time, in this type of rock also the kandite crystals having well-crystallized idiomorphic shape can be found, see *Fig 6*. The morphology of the well-crystallized kaolinite and the dickite crystals thickened in the direction of the „c" axis can be observed. On the basis of its morphology the alunitic type of rock, like the former one, cannot be peptized and plastically formed. Due to the high alunite content it cannot be utilized as a ceramic raw material.

IRON-OXIDIC TYPE OF ROCK

The X-ray pattern and the derivatogram (*Fig. 7*) are quite similar to those that were made of the kaolinitic rock samples. The mineralogical composition of the rock is the following: 40—50% clay-mineral, 45—50% quartz and 10% X-ray amor-

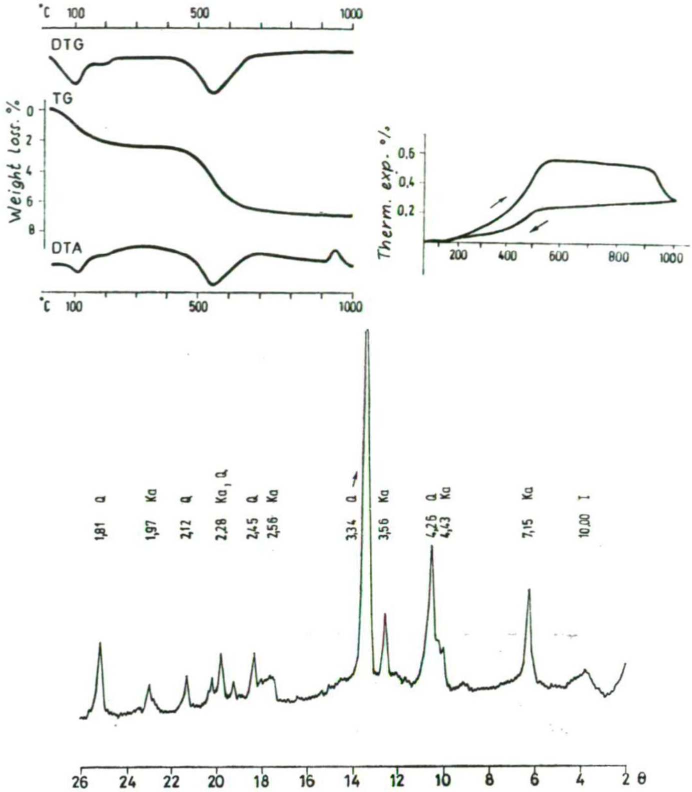

Fig. 7. X-ray diffractogram and derivatogram of an iron oxidic type rock

phous material. This type of rock has an earthy appearance but is of good strength, the tuffy structure is mainly preserved and greenish clay-mineral centres are accumulated in the voids of the rock. Although this rock has been differentiated due to its reddish-brown colour originating from the iron-oxide, the main difference to the

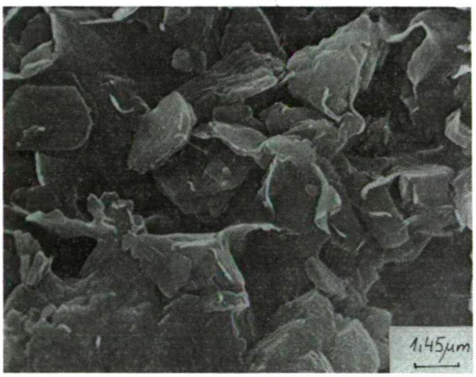

Fig. 8. Broken kandites embedded into a plastic material

kaolinitic type of rock lies in the composition of the accumulated centres of clay-minerals. The micrographs *(Fig. 8)* made of the fracture surface of the rock show that the kandites becoming distinct by well-crystallized, definite edges and characterizing the kaolinitic type are missing here. There are kaolinite and dickite crystals but these are mainly brcken edged and embedded into some kind of material that seems to be velvety.

In the next picture (*Fig. 9*) columnar kaolinite, a crystal formation of very interesting habit can be seen, the elongated figures in the background remind of illite.

In the time of the geological research from this material also the allevardite was determined. — In order to get a better knowledge of the morphology of allevard-

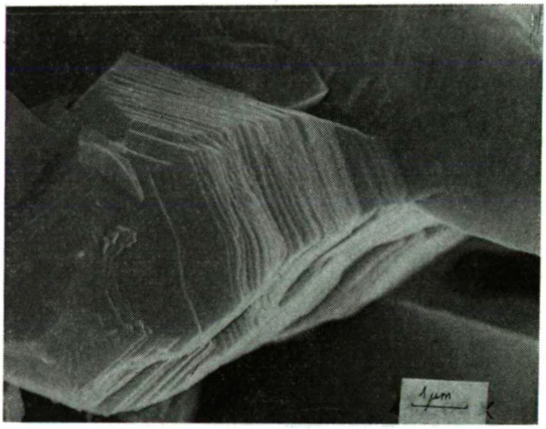

Fig. 9. Kaolinite crystals of columnar development

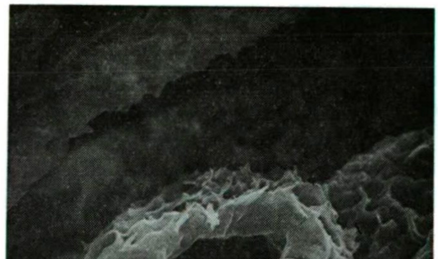

Fig. 10. Morphology of a prepared clay mineral specimen containing allevardite

ite the prepared part was dispersed in water and SEM were taken of the fine particles. The image appearing on the screen caused a real experience to the spectators. See here picture about the most interesting sample *(Fig. 10)*. In this picture thin, slightly transparent, strongly slashed, twirledly edged, frayed aggregates forming bands and nests can be seen. Their surface is sensibly soft like a velvet. These do not possess idiomorphic-crystal forms. It is, however, worthwile to observe that there is an individually large size kaolinite crystal aggregate settled into the voids placed between the bands.

The next picture also was taken of the fracture surface of the specimen, see *Fig. 11*. Here again nice kaolinite crystal aggregates can be seen. The interesting point

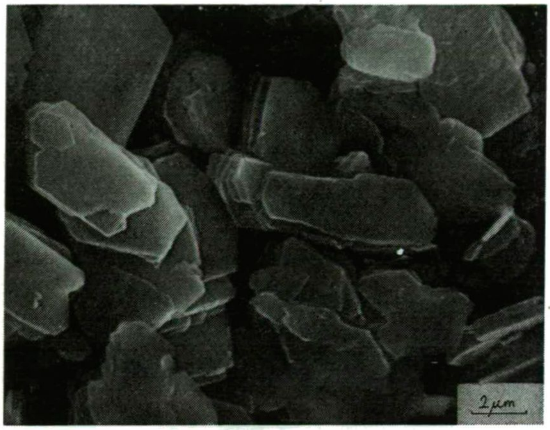

Fig. 11. Crystals formed at the broken edges of kaolinite

of this picture is — what could already be seen in more pictures — that one corner of the crystal is broken and due to this the sides are a bit sloped and smaller crysta, aggregates are settled into this spot. I show this picture with a higher magnificationl too, with the intention to make the experts dealing with the genesis of kaolins give a possibly explanation of this phenomenon.

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