ZEOLITE OCCURRENCE IN THE MÁTRA MOUNTAIN

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SUMMARY

In the cavities of agglomerates of opaline and chloritous andesite tuffs appearing above the schlier formation in the Middle Mátra chabazite and natrolite occur. The oldest mineral in the cavities is chlorite, chabazite and natrolite are younger. Considering that the rocks of the Mátra contain little alkalies, the appearance of natrolite may be accounted for by transvaporisation. The shapes of the zeolites show very little variation. In the opaline part the size of the crystal needles reaches one cm, in the andezite tuffs it is 1—2 mm. Chabazite is always smaller. The succession of the separation may also be characterized by the fact that the sequence of the compound potentials decreases.

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In the Mátra Mountain at the eastern part of the Gallya group the Vércverés (694 m) and the Bagolykő (689 m) are steeply limited towards the North whilst south-westwards they form a gently sloping mountain side. The material of both the Vércverés and the Bagolykő consists of pyroxene andezite containing more hypersthene and less augite. To the North of the Bagolykő on an area thickly covered with debris partly weathered there is a small hill in the direction of Parádsasvár, the „Vadak orma" (520 m) which is remarkable from the point of view of zeolite occurrences.

In a southern direction of Parádsasvár along the „Vadak orma" a helvetian schlier was opened up which according to the examinations of GY. VARGA contains sporadically silicified remnants of tree truncs. Underneath there is thick bedded sandstone which disintegrates towards the top into lamellar pieces frequently 3—5 cm in size. This contains dark coloured finely granular clay embeddings. Sometimes it looks like an eroded suface. Above it sandstone occurs disintegrating always lamellarly. The clayey character of the dark coloured settlements is also illustrated by the fact that their DTA diagrams show the presence of montmorillonite *(Fig. 1/a.)*.

According to the data of the literature rhyolite tuff and andesite tuffs are superimposed on the sandstone. It is, however, interesting that on the north-western side of the „Vadak orma" between the sandstone and the andesite tuffs there is a liver brown in some places blackish brown, opaline separation, which may be followed in fragments along the level during a short distance.

This siliceous rock is ensnared by thin white fissures *(Fig. 2.).* If along these fissures the rocks are separated in the fissures of the thinner cavities chalcedony and natrolite appearing in radial fibers may be found. In the fissures the appearance of fine needles as well as the phenomenon that the ends of the needles are mostly occher yellow may be well observed. The colouration is due to impurities settled on the top which are always well visible under the microscope even under lower magnification. (Fig. 3.).

On the sandstone on the „Vadak orma" agglomeratous andesite tuffs may be found which differ greatly from the similar formations of the neighbourhood. The andesite tuffs vary in colour, generally they are greenish and mostly cemented out of andesite lapilli. Usually the andesite lapilli do not contain coloured minerals. The feldspars are intact, the older minerals porphyrous separated are altered the most. The cementing material is in the first place chlorite, furthermore quartz and limonite which in some places colours the rocks intensively, it may be clay too. In this case the rocks show a hydro-character, montmorillonite appears *(Fig. 1/b.)* The matrix of the lapilli shows generally a pilotaxitic structure. Sometimes lapilli with a dacitic character may also be found in the rocks. The colour of the lapilli varies. It depends upon the matrix (glassy or less glassy), the one to which the colour is due and the impurities. The matrix of the more glassy ones is usually densely scattered with magnetite granules and these are also darker. In the matrix of the lapilli magnetite occurs in the form of crystal skelets. The octahedral shape is always well visible on the skelets. Larger independent magnetite granules occur rarely. The feldspars are mostly very altered, they show a clay mineralization. Under crossed nicols sometimes only the outlines indicate the original size and shape of the feldspar, however, under parallel nicols it may always be well detected *(Fig. 4.).* Their size is at the most 1,2 mm. They sometimes contain smaller

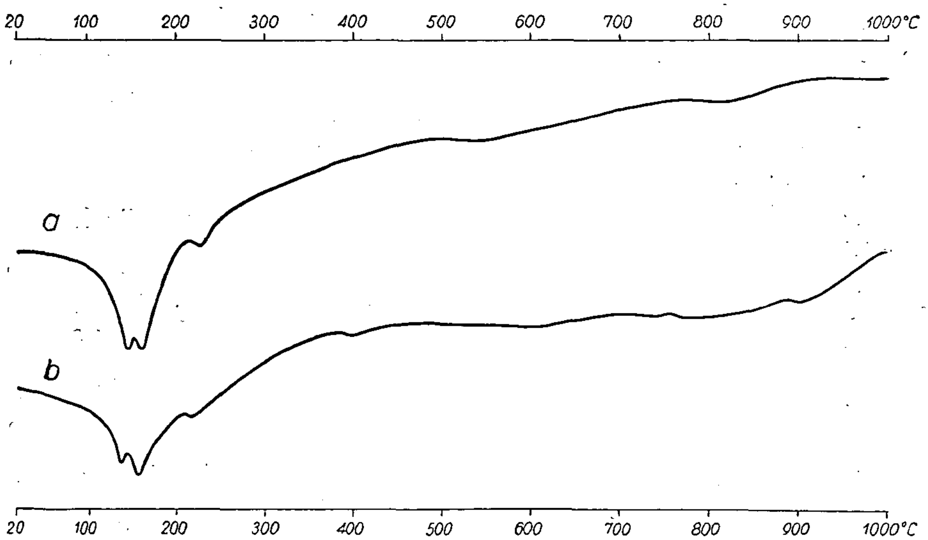

Fig. 1. a) DTA curve of clayey sandstone.
b) DTA curve of chloritous andesite tuff.

cavities filled up by chlorite. Also originally the rocks only contained few coloured minerals. This may be attributed to the chlorite patches some of which developed in a pseudomorphous manner.

The small irregular cavities of the rocks 1—4 mm in size, mostly filled up by chlorite, are interesting. Sometimes the cavities compose one quarter of the rocks. On the walls of the cavities a sort of chlorite with a weak fibrous character showing a dark green colour appears in several very thin layers superimposed on each other. They always run parallel with the wall of the cavity thus they follow the shape of the cavity. Then a small granular light green sort of chlorite succeeds. The smaller cavities are completely filled up by these two sorts of chlorite, but sometimes only by the granular one *(Fig. 5.)*. In larger cavities the chlorite also contains zeolite.

There may be two kinds of zeolite. In some cavities, mainly in the larger ones, both occur, in the smaller ones only the one. If only one sort of zeolite may be found this is always chabazite and it frequently fills out the cavities completely. The cubic like sections of the small crystals are always well visible under the microscope. The natrolite is always the younger, its fine needles are embedded in the chabazite and are always situated in the middle of the cavities. The straight extinction of the radial fibrous natrolite needles and that of the smaller crystals is always unambiguous. It is striking that although carbon acid springs which are still functioning occur frequently in the environment and calcite formation also often occurs here, yet no calcite can be found *(Fig. 6, 7.)*. The natrolite shows both in the cavities of the chloritous andesite tuff agglomerations and in the jasperous part a very simple structure, the shape of the crystals does not vary to a great extent. The columns are usually termined by bipyramids. On the larger crystals the fibrous structure may be well observed *(Fig. 8.)*.

Thus in the Mátra Mountain two kinds of zeolites are known. In the one the matrix contains in some places zeolite which has also been pointed out earlier by B. MAURITZ and the other form is when it fills up smaller cavities as described above. The zeolite occurring in the ore veins of Gyöngyösoroszi is hydrothermal, its genesis is, however, different. Not taking the occurrence of Gyöngyösoroszi into account also in this case the zeolite formed if also not simultaneously but in two generations, which has also been established by. E. SZÁDECKY-KARDOSS in the case of the zeolites of the basalts in the vicinity of the Balaton.

The occurrence of the Mátra like that of the zeolites of the basalts of Transdanubia can be found in rocks settled on clayey sandstone containing a greater amount of moisture. On the action of the volcanic rocks settled on the sedimentary rocks water steam develops in them, which migrates upwards to the magmatic rocks. The volatiles decompose the feldspar of the magmatic rock partly iniciating the zeolite formation, but the zeolites of the matrix may also form in this way. This, however, does not play an essential role in the Mountain of the Mátra. The second phase is here also represented by the zeolites overgrown on the cavities which occur here in few species.

The latter mostly appear in a chlorite environment which is always the oldest mineral in the cavity fillings. If we taken into account that the temperature of chlorite formation is 100—300° C and according to NIGGLI-KÖNIGSBERGER that of the zeolites 70—90° C the formation temperature will

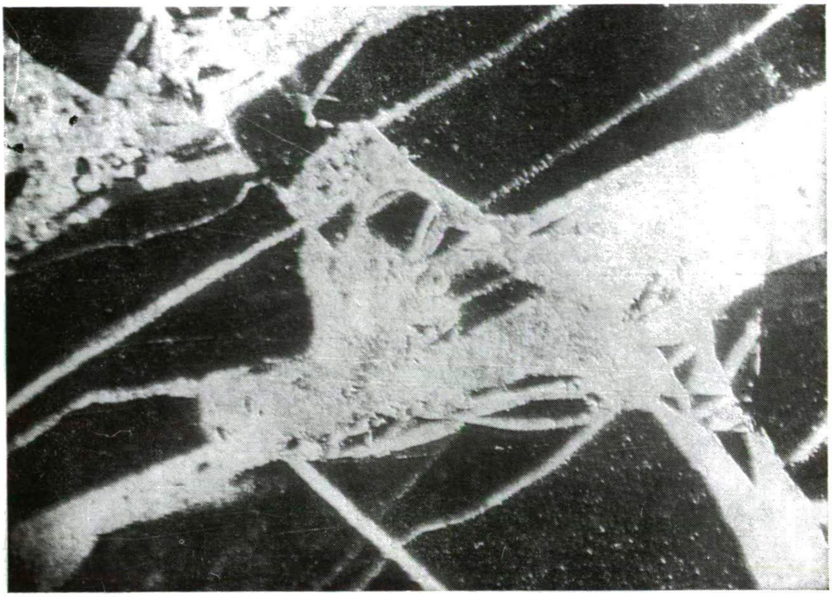

Fig. 2. Zeolitic veinlets in siliceous rock. Thin section, plain light, ×30.

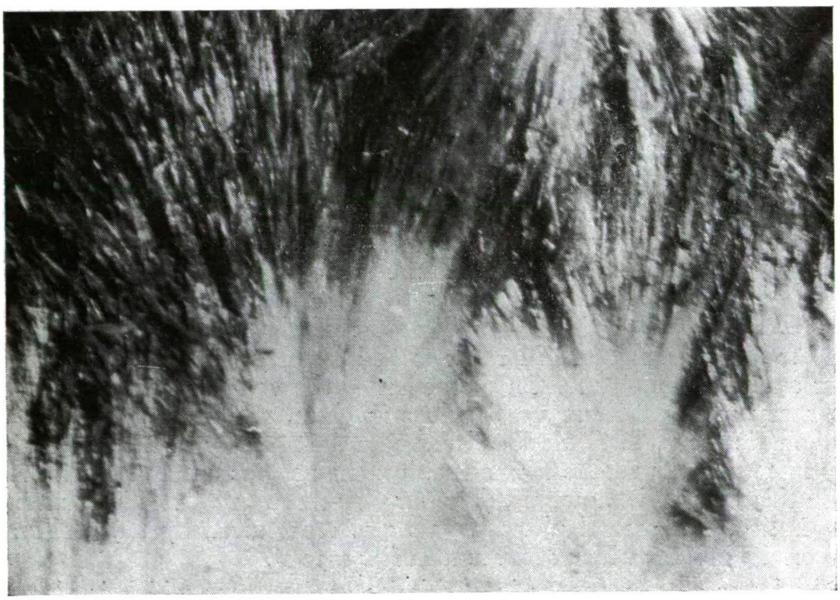

Fig. 3. Crystal aggregate of natrolite in a cavity of siliceous rock. Thin section, plain light, ×25.

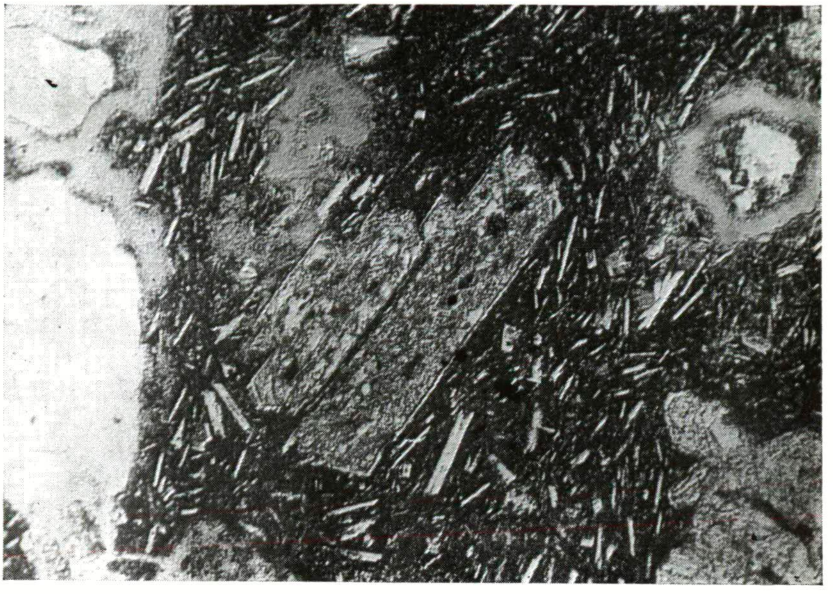

Fig. 4. Altered feldspars in andesite tuff. Thin section, plain light, ×80.

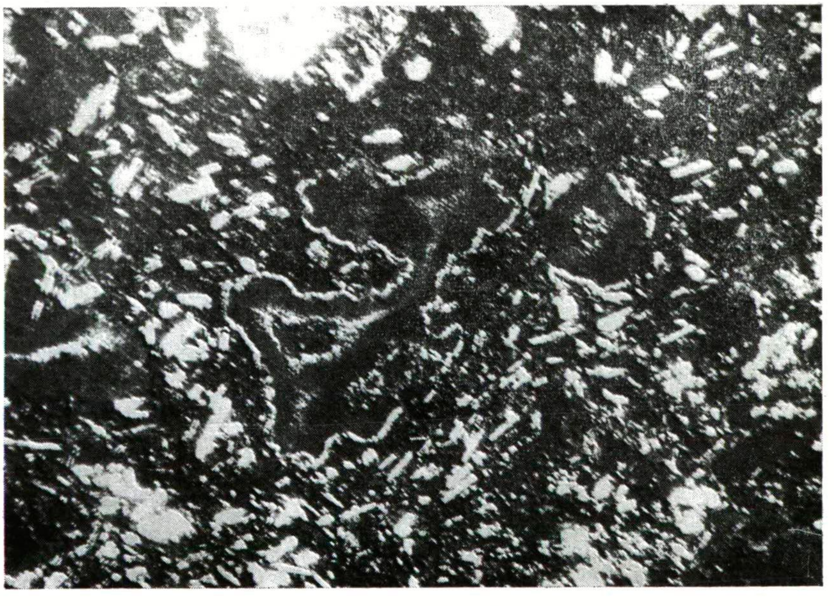

Fig. 5. Chloritous cavity-filling in andesite tuff. Thin section, crossed nicols, ×80.

not vary considerably in this case either, thus they formed at a relatively low temperature. Considering that there is transvaporization between schlier and the magmatite settled on it there is undoubtedly also an interaction between the country rock and the magma. That this interaction really exists is proved by the fact that on the action of the volatiles the feldspars decomposed to a great extent and were replaced by secondary clay minerals so that often only a narrow intact border shows the original state.

The appearance of natrolite in the Mátra Mountain is unusual. All the more because the rocks of the Mátra in the first place the andesites, contain very little alkalies. This is also suggested by the fact that at the rock norms-calculations there always remains an excess of aluminum oxide after the formation of the feldspars. Thus the formation of natrolite can only be accounted for by Na^+ migration.

It is well known that Na is easily soluble and knowing the solubility conditions of SiO_2 according to which with the increase of the pH value a larger amount of SiO_2 dissolves, the SiO_2 migration seems also natural. At lower temperatures the SiO_2 becomes still more mobile. If therefore there was not a larger amount of Na^+ in solution, there was enough silicic acid available for the formation of hyrosilicates (zeolites), partly on the basis of this fact and partly through the silicic acid released due to the weathering of the feldspars. The above holds good, if also to a smaller extent, for the Ca^{2+} ion thus finally what kind of minerals form in the cavities will be determined by the ratio of the ions taking part in the migration. The migrating elements migrate partly as ions and partly as complex anions.

That schlier and the sedimentary rocks beneath it contained and contain Na^+ and that its migration must be taken into account is proved by the fact that the spring at Parádsasvár — near to the occurrence — breaking up to the surface from the sandstone of Oligocene age contains a considerable amount of Na^+. Expressed in THAN values this quantity amount to nearly 56 per cent. Simultaneously the amount of Ca^{2+} is about 28 per cent, whereas that of Mg^{2+}: is 16—17 per cent.

E. SZÁDECZKY-KARDOSS examining the sequence of formation of the zeolites contained in the basalts in the vicinity of the Balaton as well as the formation-temperature of the zeolites contained in the fissures of the crystalline schist of the Alps establishes that this succession is partly determined by geo-energetic facts in turn partly determined through the properties of the lattice structure. Hence, first the cubic, then the lamellated and finally the fibrous zeolites form. Taking the ionic potential values into consideration the minerals occurring in this neighbourhood may be ranged in the following sequence:

Mineral	Compound potential
Pennine $(MgAl_3)(OH)_2AlSi_3O_{10}$	2,92
Chabasite $(CaNa_2)(Al_2Si_4O_{10}) \cdot 6H_2O$	0,91
Natrolite $Na_2(Al_2Si_3O_{10}) \cdot 2\,H_2O$	0,83

In the case of the zeolites the number of the water molecules was not taken into account. In view of the low potential values this value decreases for the cubic zeolites to a somewhat greater extent and for the fibrous zeolites somewhat less. This is, however, partly compensated by the different — mainly

Fig. 6. Natrolite and chabasite in cavity filled out by chlorite.
Thin section, crossed nicols, ×80.

Fig. 7. Zeolites in chlorite-filled cavity. Thin section, plain light, ×80.

Si-Al — possibilities of substitution. Finally the succession of formation established on the basis of the data collected by other observations, is also supported by the fact that the compound potential values decrease.

The synthetic experiments prove that the formation temperature is low, besides the temperature values the composition of the solution plays an important part too. Hence for example, from a system containing Na_2O, Al_2O_3, SiO_2 and H_2O at 80—180° C natrolite, at higher temperatures till 430° C analcite and at still higher temperatures nepheline forms.

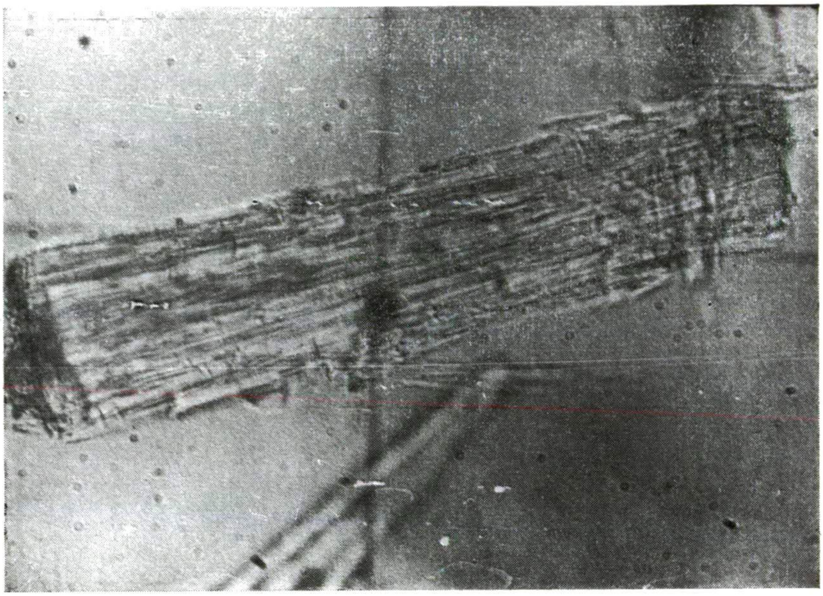

Fig. 8. Fibrous natrolite crystal. Thin section, plain light, ×500.

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