# DATA ON THE EPIGENE ALTERATION OF ANDESITES

J. MEZŐSI
Institute of Mineralogy and Petrography, University of Szeged

In andesites lacking mafic minerals, i. e. in amafites, under epigene conditions first the magnetite in the matrix is dissolved in places and the microscopical feature of the rock is changed. The originally compact, gray rock becomes mottled. During the weathering, in place of the mottles, minute hollows are formed, filled partly or totally by clay minerals. The colloidal material separates layer by layer which accounts for the layered appearance well discernible under crossed nicols. The clay mineral belongs to the montmorillonite group and it may be considered as a transition member between beidellite and nontronite.

In the Western Mátra Mountains near Szurdokpüspöki in the neighbourhood of mine of Pincepatak there occurs an andesite of very diversified appearance. Beginning from the fresh, unaltered rock the single steps of the clay mineralization can be well noted.

The references dealing with the geological structure of this area refer firstly to the neighbouring diatomite series [H. HORUSITZKY — 1901; J. NOSZKY — 1912; T. SZALAI — 1936, 1949; CHENEVIERE — 1933; F. HORUSITZKY — 1950; Z. SCHRÉTER — 1950; M. HAJÓS — 1954, 1956; HAJÓS—PÁLFALVY — 1959; BÁRDOSSY—HAJÓS — 1960]. Data regarding the eruptive series can be found in the papers of B. MAURITZ [1912], GY. VIGH [1935], J. NOSZKY [1926] and I. KUBOVICS [1965].

In the Upper Tortonian andesite series gray compact andesite occurs as thinner or thicker lava-flow having frequently a streaked appearance *(Fig. 1)*. The lighter streaks — poor in magnetite — are nearly parallel. The streaks and bands suggest often the direction of the flow, in these cases also the microlites show such an arrangement.

The matrix of the rock always predominates wherein porfiric feldspar with cleavage planes of vitreous luster can only be observed in little amount. The porfiric feldspar, 2—3 mm in grain-size, amounts about to 6 per cent. Its appearance is mainly columnar and its composition is between $Ab_{40}$—$An_{60}$. Zonal development is only of a smaller degree. Among the porfiric constituents femic minerals are not present.

Among the microlites of the matrix augite and feldspar occur nearly in equal amount. The size of the magnetite grains does not exceed the 0,01 mm and in the unaltered fresh rock are uniformly distributed. The rock is sometimes penetrated by calcite veins cutting the feldspar too *(Fig. 2)*. In such cases, in some places of the feldspar, secondary calcite appears but not as a weathering product. The calciferous solutions affected only the already solidified rock along lithoclastic lines.

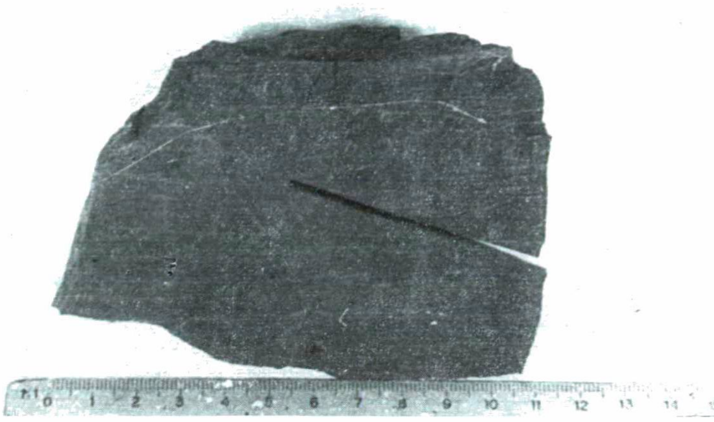

*Fig. 1.* Banded andesite

The rock may be considered also as an amafite.

The chemical composition of the fresh unaltered rock (the sample taken from the N-side of the lower strip pit of the mine of Pincepatak) is as follows:

TABLE 1

| | |
|---|---|
| $SiO_2$ | 53,79 % |
| $TiO_2$ | 1,17 |
| $Al_2O_3$ | 16,39 |
| $Fe_2O_3$ | 4,53 |
| FeO | 4,47 |
| MnO | 0,25 |
| MgO | 3,06 |
| CaO | 7,46 |
| $Na_2O$ | 2,72 |
| $K_2O$ | 2,91 |
| $+H_2O$ | 1,36 |
| $-H_2O$ | 0,97 |
| $P_2O$ | 0,21 |
| $CO_2$ | 0,39 |
| | 99,68 % |

Analysts: Mrs. I. SOHA and L. JANOVICS (1965, Hungarian State Geological Instute).

The CIPW normative minerals calculated from the chemical composition and the mineral composition reckonned according to SZÁDECZKY—KARDOSS's method [1966] are in fairly good agreement and taking into account the distribution of the microlites too, the computed mineral composition approaches the true one. The fact that the secondary minerals, except the calcite, are absent in the fresh rock, is naturally reflected also by the computed mineral composition.

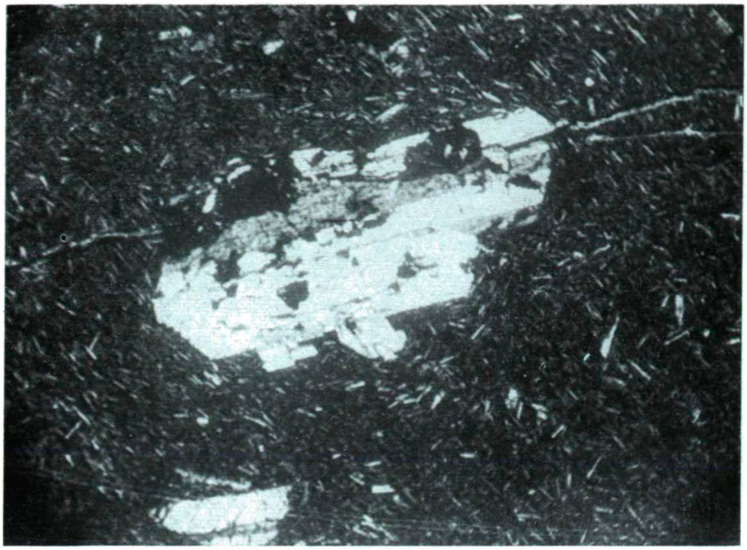

*Fig. 2.* Calcite veinlet cutting the matrix and the feldspar. Crossed nicols, ×30.

TABLE 2

| Mineral | amount of the minerals in weight per cent according to the | |
|---|---|---|
| | CIPW method | Szádeczky—Kardoss's method |
| apatite | 0,67 | 0,5 |
| calcite | 1,08 | 0,9 |
| ilmenite | 2,28 | 2,4 |
| orthoclase | 17,24 | 17,6 |
| albite | 23,06 | 22,2 |
| anorthite | 23,91 | 24,0 |
| diopside | 7,02 | 7,8 |
| hypersthene | 10,62 | 11,0 |
| hematite | 4,48 | 3,9 |
| quartz | 6,93 | 7,2 |
| $H_2O$ | 1,36 | 1,4 |

The beginning of the weathering of the rock under epigene conditions appears firstly in the alteration of the matrix. The magnetite grains uniformly distributed in the fresh rock dissolve in some places, the matrix becomes mottled and owing to this fact, as these mottles contain no ore grains, the whole matrix becomes slightly light *(Fig. 3)*. The distribution of these mottles is mostly quite irregular, sometimes, however, in given direction a banded structure may be established, mostly in accordance with the original banding of the rock *(Fig. 4)*.

In the next step of the weathering the clay mineralization starts in these light mottles. As a result, minute hollows form, wherein, already in the early stage of the weathering, colloform material accumulates. In the colloidal material due to

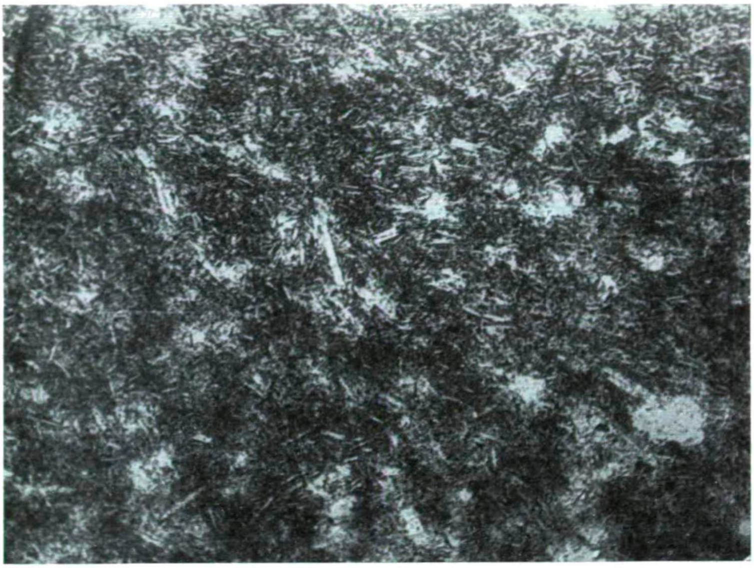

*Fig. 3.* Matrix becoming mottled at the early stage of the weathering. Crossed nicols, ×30.

loss of water irregular cracks can be observed as in *Fig. 5.* After a certain time the crystallization of the colloform material begins layer by layer and the material becomes ordered which can be especially well established between crossed nicols (*Fig. 6*). The clay mineral on the wall of the hollows is of fine-fibrous appearance, the fibres in the single layers are perpendicular to the surface, in the inside of the

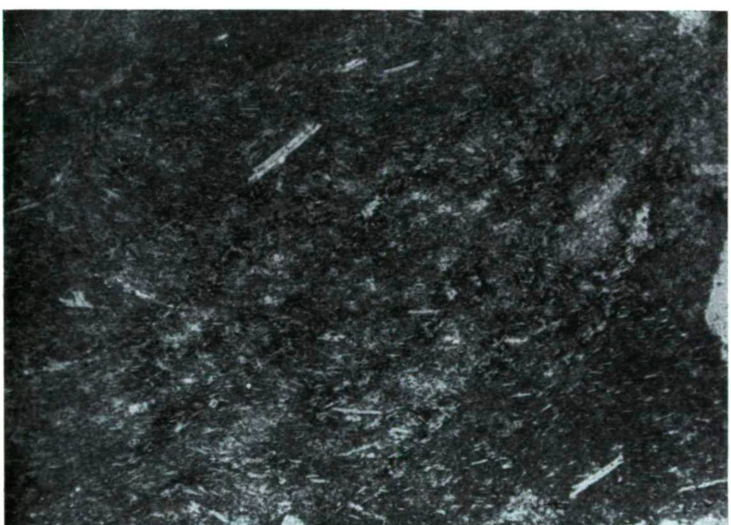

*Fig. 4.* Banded matrix at the beginning of weathering. Crossed nicols, ×30.

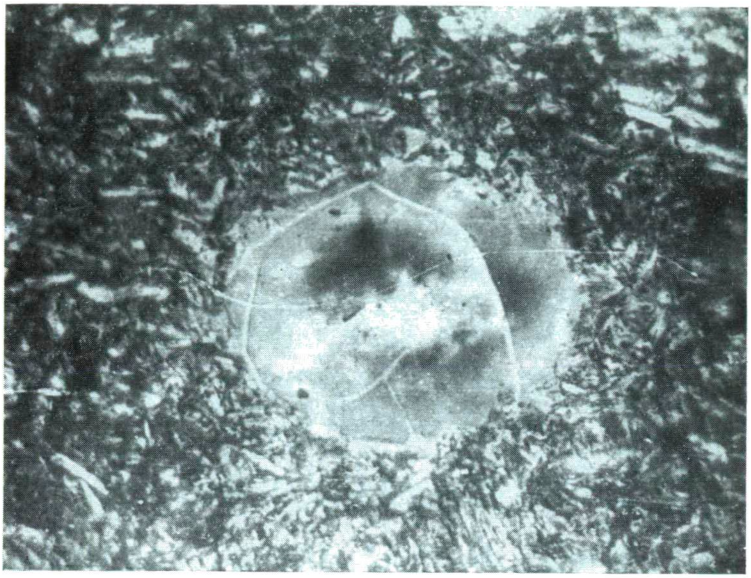

*Fig. 5.* Clay mineral as cavity filling. Plain light, ×100.

hollows, however, it is fine-grained. The clay mineral is light-yellow coloured with very weak pleochroism. The minute hollows are sometimes filled totally by this clay mineral, sometimes it appears only as a thin incrustation. The shape of these hollows varies greatly. Then and there they show spherical cross-section, sometimes are elliptical elongated *(Fig. 7)* and are always well contoured.

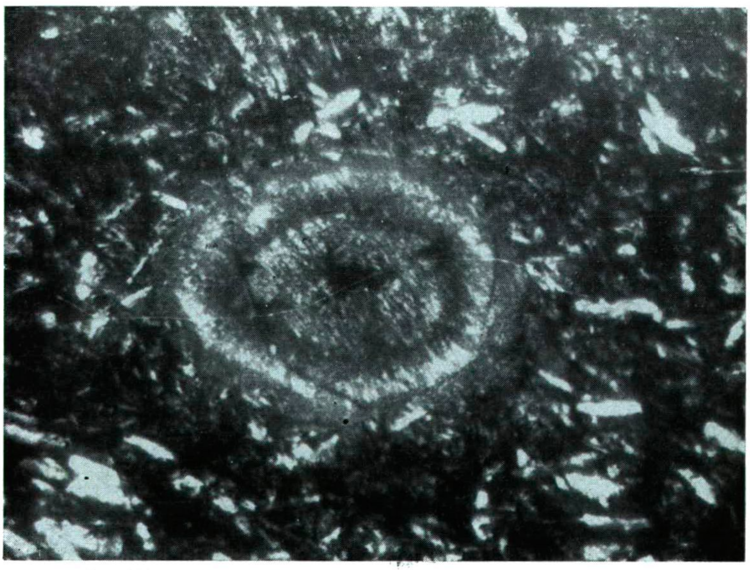

*Fig. 6.* Clay mineral as cavity-filling. Crossed nicols, ×100.

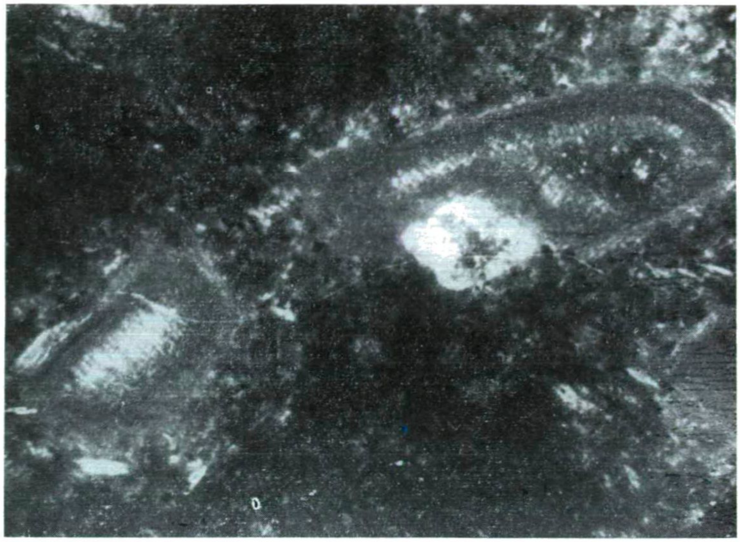

*Fig. 7.* Clay mineral filling of hollows of elliptical cross-section in the rock of banded matrix. Crossed nicols, $\times 100$.

At an advanced stage of the weathering, the originally compact rock becomes porous, visible also to naked-eyes, and the walls of the — now already greater — irregular hollows are covered by gray, yellow, dust-like incrustation of clay minerals *(Fig. 8)*. These hollows are occasionally ordered in parallel rows following the original banded texture of the rock, mostly, however, arranged irregularly.

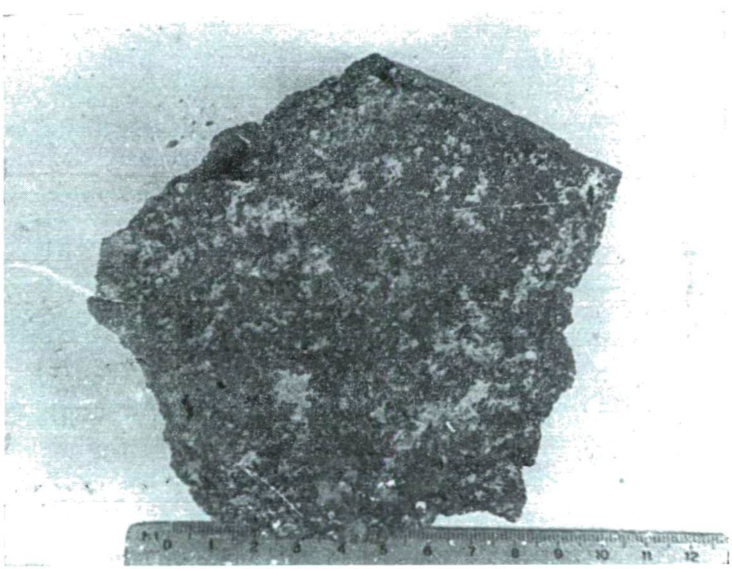

*Fig. 8.* Yellowish-gray clay mineral incrustation in the hollows of the rock becoming porous due to the weathering.

The clay mineral incrustation could be cautiously removed from the wall of the hollows. The X-ray study of different samples were performed, exposed in camera with 57,3 mm radius. The X-ray powder patterns are listed in *Table 3.*

TABLE 3

| 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| d | I | d | I | d | I | d | I | d | I | d | I |
| 4,527 | s | 4,550 | s | 4,504 | s | 4,550 | diff | 4,52 | 10 | 4,55 | 10 |
| | | | | | | | | 4,18 | 2 | | |
| | | | | | | | | 3,82 | 2 | | |
| | | | | | | | | 3,37 | 2 | | |
| 3,141 | m | 3,218 | m | 3,196 | m | 3,196 | m | | | 3,11 | 2 |
| | | | | | | | | | | 2,96 | 2 |
| 2,569 | s | 2,591 | s | 2,555 | s | 2,541 | w | 2,61 | 5 | 2,62 | 8 |
| | | | | | | | | 2,538 | 3 | 2,56 | 8 |
| 1,764 | m | | | | | | | 1,723 | 4 | 1,72 | 4 |
| | | 1,694 | m | 1,682 | m | | | 1,675 | 5 | 1,67 | 4 |
| 1,520 | s | 1,518 | s | 1,513 | s | 1,511 | w | 1,519 | 10 | 1,52 | 10 |
| | | | | | | | | 1,310 | 7 | 1,32 | 4 |
| | | 1,295 | w | | | | | | | 1,30 | 4 |
| | | | | | | | | | | 1,27 | 4 |
| | | 1,259 | w | | | | | 1,258 | 6 | 1,25 | 4 |

1. Cu radiation without filter, 40 kV, 10 mA
2. Cu radiation with Ni filter, 40 kV, 10 mA
3. Cu radiation with Ni filter, 40 kV, 10 mA
4. Cu radiation with Ni filter, 40 kV, 10 mA, the sample treated with glycerine
5. Nontronite, Fe radiation without filter [MICHEJEV, 1957].
6. Nontronite, Fe radiation without filter [ASTM card, NAGELSCHMIDT, 1938]

s = strong, *m* = middle, w = weak lines.

Taking into consideration the literary data too, the clay mineral in question can not be considered as montmorillonite as in these patterns is lacking the strong line at 1,50 Å characteristic of the montmorillonite. The lines in the patterns point to beidellite and nontronite, respectively. The patterns are fairly poor in lines which fact can point rather to nontronite, although the line at 1,295 Å refers to beidellite. It seems possible that such a clay mineral is present, in whose octahedral layers no total exchange exist between $Al^{3+}$ and $Fe^{3+}$ ions and therefore it may be considered as a transition member between nontronite and beidellite, for the latter itself is also a transition member. In the pattern of the sample treated with glycerine the line at 4,55 Å became diffuse, the intensity and the number of the lines decreased.

The possibility of the formation of beidellite and nontronite under hydrothermal conditions is given according to NOLL's experiments [1936]., however, occurrences under epigene conditions are also known.

At the dissolution of the vitreous matrix the $Al(OH)_3$ and together with it a small $Fe(OH)_3$ separates and by these colloidal gels $SiO_2$ can be adsorbed. The formation of montmorillonite-type clay minerals requires no higher temperature and pressure, thus at the beginning of the crystallization the possibility of the formation of beidellite or nontronite is at hand.

This example shows that at the clay mineralization of fresh andesites under epigene conditions, clay mineral belonging to the montmorillonite-type may be formed owing to the effect of surficial descendent waters too. This may be one of the possibilities of its formation.

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