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MINERALOGICAL-PETROGRAPHICAL STUDIES ON MIDDLE TRIASSIC TUFFS OF THE TRANSDANUBIAN CENTRAL MOUNTAINS, HUNGARY

by

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During the researches of mineral raw material in the Transdanubian Central Mountains, we found some further occurrences of Middle Triassic pyroclastic material of more or less importance, after we had finished the manuscript of our previous publication [1970]. In the present paper we wish to give the petrographical description of these occurrences.

As can be seen from the geological profiles, these new occurrences can be brought into good agreement with the stratigraphical result of our investigations concerning the geological age of the tuff. All tuffs exposed belong to the Middle Triassic, to the lower part of the Ladinian. The places of sampling of tuffaceous material known up to now and the surface distribution of the Middle Triassic are shown in the geological sketch *(Fig. 1)*.

The borehole of the Bauxite Research Enterprise (No. Bszl—5) is situated fifty kilometers north of the village Pécsely, in the northern foreground of the Bakony Mt. After Holocene, Pliocene, Lower Miocene, Upper Oligocene and Middle Eocene strata, the borehole crossed Lower Ladinian tuffaceous rocks. The underlying beds of the pyroclastic material investigated by us in detail (from 340 to 370 meter) consist of Middle Triassic dolomite, cherty dolomite, and cherty limestone. They are covered by cherty limestone. The thickness of the tuffaceous layers of the beds amounts to about 12 metres with thicker or thinner tuffaceous limestone and limestone.

The bauxite research borehole (No. Ma—50) near Magyaralmás crossed sandy, tuffaceous limestone overlying in round 10 m thickness Upper Anisian dolomite. The tuffaceous layers and the covering Diplopora dolomite are of Ladinian age *(Fig. 4)*.

Two shallow borings were, made near Vöröstó and Barnag, disclosed rather thin, tuffaceous limestone of light red and light brown color, deposited on Lower Anisian light red limestone containing many Ammonites. The overlying bed consists of red cherty limestone belonging to the upper part of the Ladinian. With this stratigraphical position, this tuff differs from the above mentioned formations and is the thinnest tuffaceous bed known up to the present *(Fig. 5)*.

The borehole of the Mecsek Ore Mines near Pécsely (No. P—8) crossed Lower Ladinian and Upper Anisian tuff sequences. The underlying layer of the 7 m thick tuff bed, containing phosphate bearing intercalations, is Megyehegy dolomite. Its overlying layer consists of light yellow, bedded, thick-laminated dolomitic limestone of about 40 m thickness, being at the same time the underlying rock

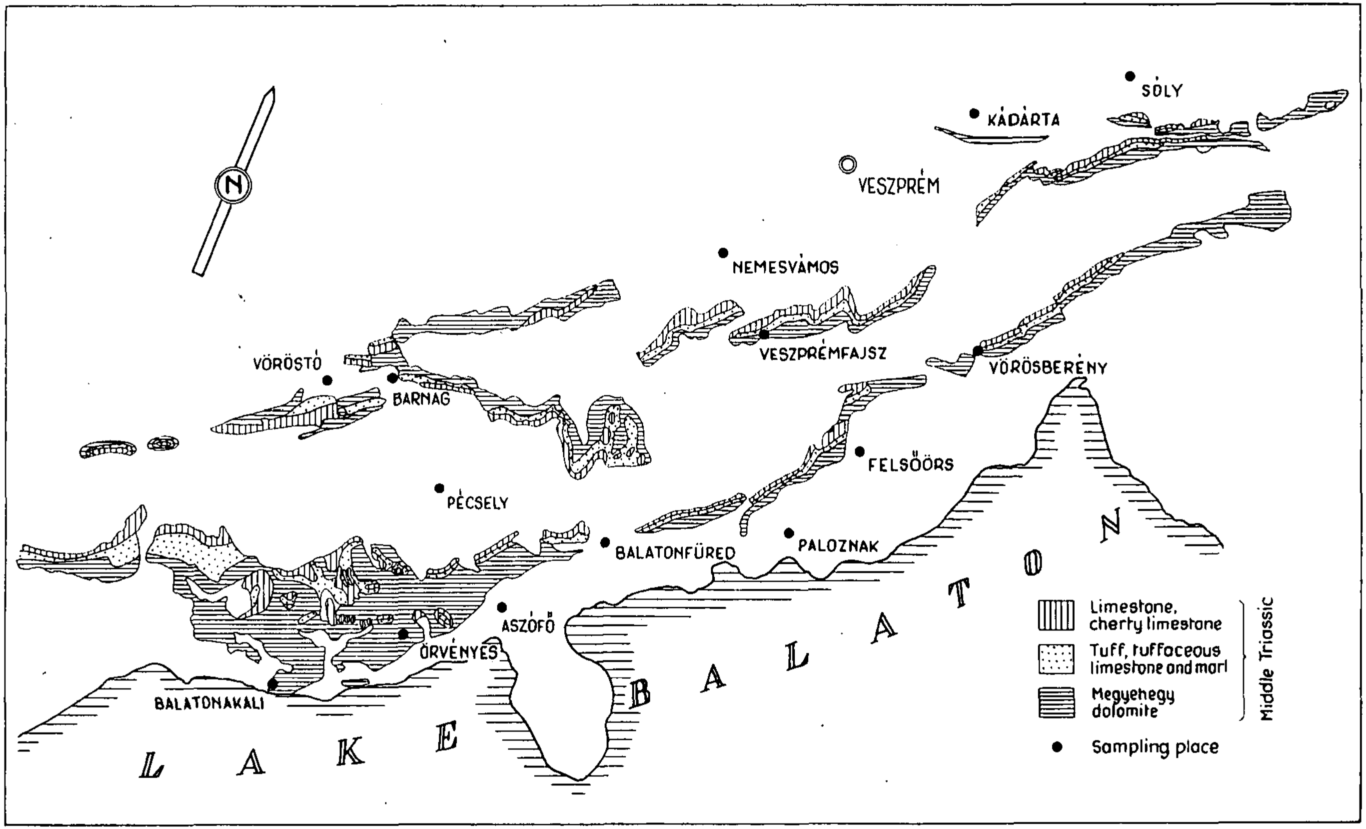

Fig. 1. Geological sketch of the distribution of the Middle Triassic formations in the area of Balaton Highland and Bakony Mountains.

for the upper tuff sequence *(Fig. 6)*. In the core sample of the same borehole, according to the investigations of the Hungarian Geological Institute, tuffite and trachyte tuff could be found above and below the layers studied by us at 322 m, 326 to 329 m, 387 to 390 m, and 466 m.. Together, the total thickness of the pyroclastic material in the profile can be estimated to about 20 meters *(Fig. 2)*.

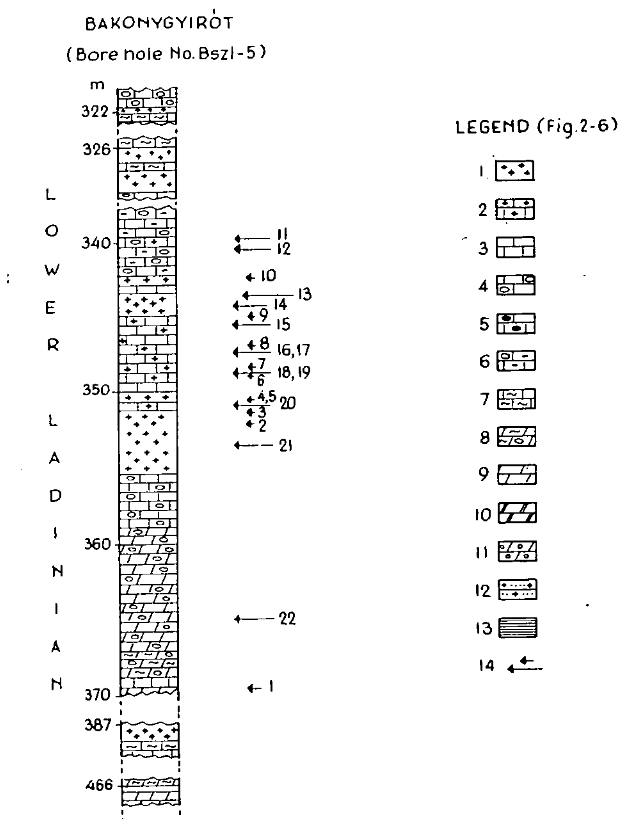

Fig. 2. Geological profile of Bakonygyirót borehole. No. Bszl-5. Legend: *1.* Tuff. — *2.* Tuffaceous limestone. — *3.* Limestone. — *4.* Cherty limestone. — *5.* Red, cherty limestone. — *6.* Cherty marl/clayey limestone. — *7.* Marly limestone. — *8.* Cherty, dolomitic marl. — *9.* Dolomite. — *10.* Megyehegy dolomite. — *11.* Diplopora dolomite. — *12.* Tuffaceous sandstone. — *13.* Bedded chert. — *14.* Number and place of sample.

On the Bocsár-Hill at Balatonfüred an exploratory trench made by the Mecsek Ore Mines exposed two tuff levels in the Lower Ladinian sequence of about 50 meter thickness. The deeper tuff layers are deposited on dark grey, Upper Anisian marly limestone, on a formation of so-called "reifling" type, characterized by Paraceratites trinodosus. The tuff layers of some centimeter alternate with bedded chert, and are separated from the upper tuff level by limestone containing cherty nodules. Also the latter sequence alternates with bedded chert, and is covered with Upper Ladinian limestone containing red cherty nodules. On the base of its fossil remains;

to the occurrence at Balatonfüred and of that at Veszprémfajsz, very similar to the latter in stratigraphical position are shown in *Fig. 3.*

During our earlier studies the potash-trachytic crystal tuff occurrence, considered as type-rock, was exposed by two exploratory trenches of the Mecsek Ore Mines. The Lower Ladinian tuffaceous materials deposited on the Megyehegy (?) dolomite: tuff, tuffaceous limestone, marl, clay, and sandstone frequently alternate with each other within some meters, and the thickness of pure tuff layers is limited to some centimeters *(Fig. 4)*.

PETROGRAPHY

The quantity of the pyroclastic constituents of the tuffaceous rocks known from the core material of the Bakonygyirót research drilling is variable; even the composition of the ejected volcanic material is not uniform. Most frequently potash-trachytic crystal tuff and crystalloclastic limestone are found. Lithoclastic tuff occurs in minor quantities, vitroclastic constituents are to be considered as exceptional. It is characteristic, furthermore, that the thickness of each tuff layer does not exceed 40 cm; the structure of the tuff layers is laminated.

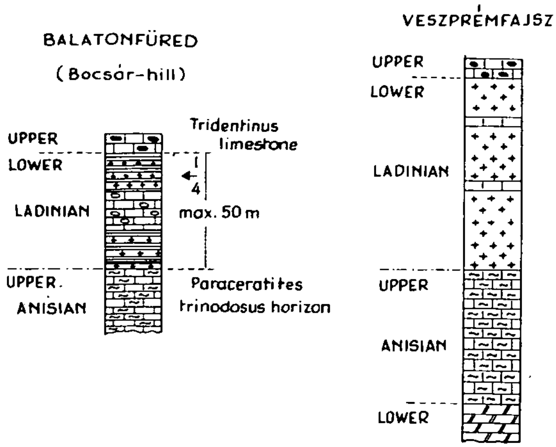

Fig. 3. Geological profile of tuffaceous beds at Bocsár Hill and Veszprémfajsz.

The typical crystal tuff in the borehole profile is macroscopically light green, grayish green, less frequently reddish brown or light red, of medium or low hardness, fine-grained, transected by calcite veinlets of dirty-white colour (samples No. 2, 3, 7).

Microscopically the bulk of the detrital material is sanidine. The greatest part of the crystals is hipidiomorphic, nearly idiomorphic or allotriomorphic fragments are seldom. Among the crystals of 200 to 300 μ, max. 500 μ dimensions the stubby habit is most frequent, elongated columnar forms are most seldom. Most of them are monocrystals, only few Carlsbad-twins are found. A minor proportion of the crystal fragments is fresh, pure or slightly clouded. Formation of sericite and illite along the cleavage planes and expansion of calcite and mosaic-like quartz is frequent. The last three minerals mostly form simultaneous pseudomorphs after sanidine.

The quantity of primary water-clear allotriomorph quartz of 50 to 150 μ grain size is insignificant. Similarly few more of less chloritized small biotite flakes of 50 to 120 μ in diameter are found. Apatite is accessory and oligoclase is sporadic (sample No. 3.).

Among the secondary minerals the anatase of stubby or elongated habit and 20 to 80 μ in length, found in small crystal aggregates, and forming pseudomorph

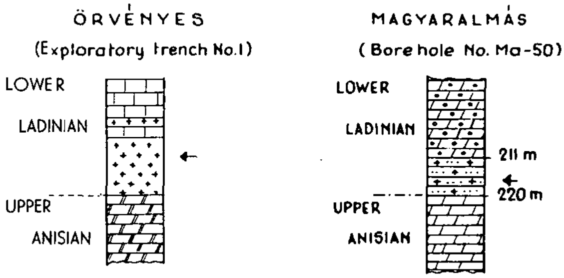

Fig. 4. Geological profile of tuffaceous layers at Örvényes exploratory trenches and Magyaralmás borehole.

after pyroxene is remarkable. The anatase is often pseudomorph with calcite, and forms the frame of the primary mineral, while calcite occupies the interior of the crystal. The place of opaque minerals is also replaced by secondary ores; limonite and leucoxene being formed from the original magnetite, ilmenite and pyrite (Plate III.). The lithoclastic material consists of recrystallized volcanic glass, feldspar microliths and limonitized opaque minerals.

The matrix of the rock is characterized by the illite-hydromuscovite netlace of threadlike structure in which patches of microcrystalline quartz, chalcedony and calcite crystal aggregates can be seen. Sporadically vaguely outlined parts of vesicular texture are observed (Plate I.).

The material of samples No. 5 and 6 is to be considered as a strongly silicificated (and recrystallized) variant, however, is of pyroclastic origin in the bulk.

Macroscopically the slightly cleaveable fine-grained tuff of light green or gray-green colour is mottled with coarser-grained, vivid green, light brick-red and brown intercalations. The matrix is less hard than the intercalations of various forms and colours.

Under the microscope the small quantity, small dimensions and the dominant role of microcrystalline quartz are characteristic. The material of the fragments of 50 to 100 μ in diamater on the average consists of sanidine, biotite and quartz. The feldspar in its lesser part is lath-like and idiomorphic, in its major part of max. 300 μ diamater hipidiomorphic, strongly argillaceous, or partly replaced by calcite and the latter by quartz. The quantity of primary quartz and of strongly altered biotite is small. The ore mineral of the rock is limonite in faint patches.

It is characteristic for the texture of the rock, that the illite, forming a not completely continuous network, encloses partly recrystallized volcanic glass, partly patches consisting of quartz crystals, 5 to 15 μ in diameter, originating from silica impregnation (Plate I.). The rock can be identified as decomposed, silicificated crystallo-vitroclastic tuff.

TABLE 1

Chemical analyses of core samples of Bakonygyirót, borehole No. Bszl-5. Analysts: I. SOHA, L. JANKOVITS *Hungarian Geological Institute*

Weight %	1	2	3	4	5	6	7	8	9	10
SiO_2	12,58	65,04	61,54	57,15	70,69	63,07	49,30	40,79	46,90	38,01
TiO_2	—	0,30	0,08	0,09	0,03	0,19	0,05	0,17	0,05	0,27
Al_2O_3	3,30	16,98	15,58	11,37	13,82	15,24	13,88	15,34	12,26	9,77
Fe_2O_3	0,35	0,68	0,75	0,38	0,55	2,29	0,71	1,11	0,51	1,85
FeO	0,45	0,81	0,94	0,63	0,72	0,81	0,85	0,90	0,76	1,39
MnO	0,05	0,03	0,03	0,02	0,03	0,03	0,03	0,03	0,03	0,06
MgO	17,81	0,42	2,24	1,12	1,41	3,18	3,64	4,20	3,08	7,02
CaO	26,35	1,95	3,51	11,91	0,88	1,57	11,71	14,25	14,84	17,20
Na_2O	0,05	0,06	0,08	0,09	0,20	0,14	0,06	0,06	0,08	0,12
K_2O	0,78	10,20	9,68	7,08	8,70	6,96	7,38	4,50	6,36	3,30
$+H_2O$	0,88	1,89	2,40	1,34	1,77	4,84	3,15	4,66	2,75	2,56
$-H_2O$	0,08	0,34	0,47	0,16	0,31	0,90	1,19	1,94	1,04	0,87
CO_2	38,01	0,77	2,59	8,92	0,56	0,42	8,41	11,84	11,36	17,44
P_2O_5	0,06	0,07	0,06	0,06	0,03	0,07	0,03	0,07	0,04	0,13
	100,75	99,54	99,95	100,32	99,70	99,71	100,39	99,86	100,06	99,99

For the tuffaceous limestone to be described in the following, the deformation (slumping) structure is generally characteristic. Namely, the pyroclastic material of these rocks is weak-laminated often found in nodules, grooved or cleaveing in lusterous shear planes, pinching or bulging out among limestone patches of ellipsoidal form or dissolved contours. In some samples the disturbed sedimentation, continued under changed conditions, can be traced in thin slides too. The subsequent processes of calcitization, dolomitization and silification are evident in most cases. This appears chiefly in the calcitization and replacement by quartz and chalcedony of the pyroclastic material, *i. e.* in the continuous decrease in quantity of the ejecta.

The embedding rock of the light green, slightly stratified, foliated crystalloclastic tuff intercalations is hard, compact, light red, brown mottled limestone with scattered pyrite (samples No. 4, 8, 17, 18).

Microscopically the majority of the pyroclastic material consists of allotriomorphic, more seldom hipidiomorphic sanidine crystal fragments. The diameter of the crystals is 50 to 150 μ, more rarely 200 to 350 μ, max. 1000 μ. The crystals are seldom fresh, they are replaced by illite, dolomite and calcite. The condition and quantity of biotite is variable. Its flakes, pleochroic or showing chloritization and ferrihydroxide precipitation, are of 200 to 250 μ in diameter. In sample No. 8, small quantities of water-clear, rounded and corroded quartz crystal can be identified. Among the secondary minerals the limonite, strongly staining its surroundings, is dominant; the quantity of the haematite, anatase and leucoxene is minimal. The fragments of fossils are filled by quartz; radiolaria skeletons are also found.

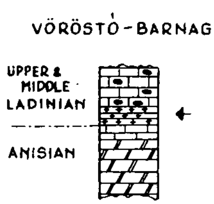

Fig. 5. Geological profile of tuff layers at Vöröstó and Barnag.

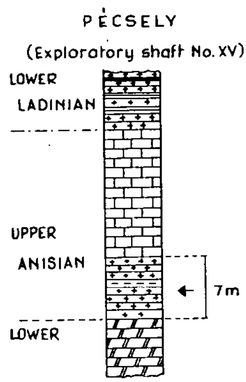

Fig. 6. Geological profile of Pécsely exploratory shaft.

The calcite, forming the bulk of the samples, is present in the form of allotriomorphic crystals of 20 to 30 μ diameter. As pseudomorph after feldspar or when filling up fissures, its diameter is 100 to 150 μ. A progressive state of silification can be observed on sample No. 18. The appearance of the mostly light brown chalcedony and of the minor quantities of water-clear microcrystalline quartz is variable. Both occur in separated patches of circular or irregular shape and as fragments of small spheres. In other cases, in the sections circular calcite fillings are seen. Pellets of 1000 to 1200 μ in diameter and of circular or ovaloid section, coated with chalcedony, can be also found. The material of the pellets consists of a mixture of fine-grained calcite aggregates of mostly irregular shape and of impregnating chalcedony in the form of grains of 2 to 10 μ in diameter, recrystallized in different amounts. In these pellets, crystal fragments of potash-feldspar and biotite of 50 μ diameter on average are found. The margin of the pellet is a calcite corona coated by a thin chalcedony rim and surrounded again by a calcite margin merging into the limy matrix. The pellets containing no volcanogenic material have only a chalcedony coating. The tuff, falling into seawater, mixed with the lime mud of the bottom, and after diagenesis and silification consolidated as tuffaceous limestone. After braking up, calcarenite formed, which, during the repeated formation of tuffaceous limestone was built in as solid detritus into the matrix. The silica, enriched in the seawater by volcanic activity, may have been favourable for the proliferation of radiolaria. The siliceous solutions impregnated the shells of Mollusks and Brachiopoda and enhanced the formation of chert. The dolomitization occurred also during the rock consolidation and recrystallization. So the formation under investigation obtained its actual structure and composition, besides chemical precipitation, in addition by significant mechanical and less important biogenic effects.

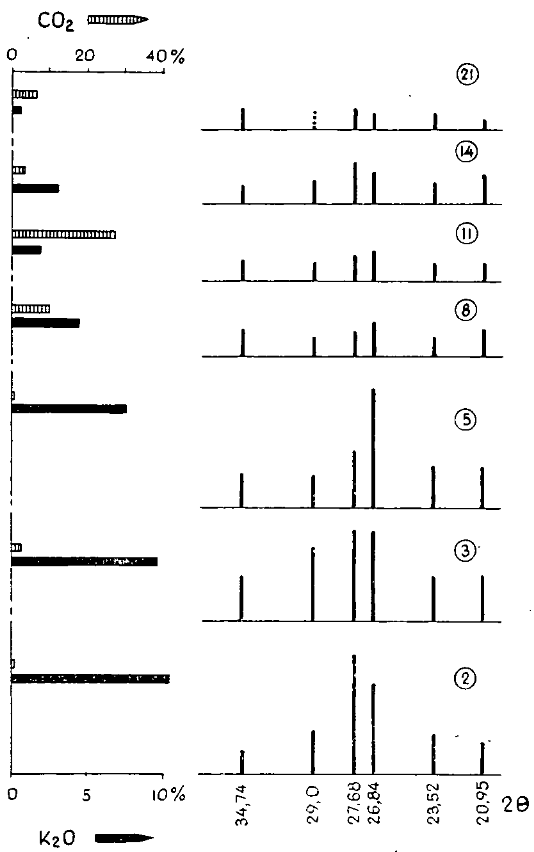

Fig. 7. Tuff — limestone ratio of the tuffaceous material of Bakonygyírót borehole (No. Bszl-5), characterized by the correlation of sanidine, K_2O, CO_2 content.

In two tuffaceous limestone samples (No. 9, 11), greater quantities of volcanic glass, associated with the crystalloclastic material, were found. Macroscopically the tuffaceous part can be distinguished from the greenish-gray limestone by its light green colour and its sheared structure.

Under the microscope, owing to clay-mineralization and calcareous replacement, only fragments of max. 100 μ diameter of the original sanidine crystal fragments of 250 to 300 μ diameter can be recognized. The small quantities of biotite are more or less altered, the primary quartz of minimal amount crenated, with embayed contours or of angular cross section. Accessory minerals are: apatite, zircon,

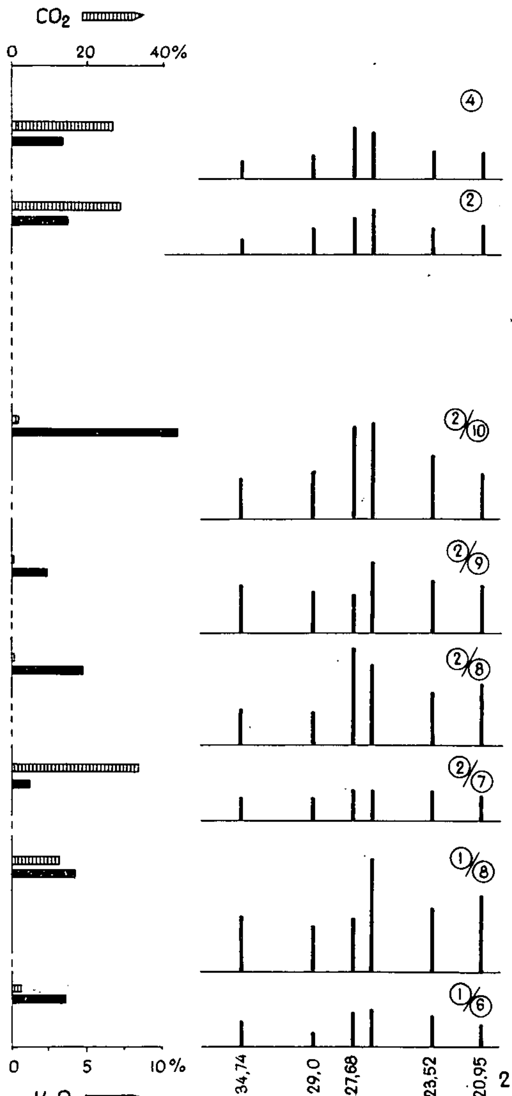

Fig. 8. Tuff — limestone ratio of the tuffaceous material of Barnag shallow boring (upper part),and Örvényes exploratory trenches (lower part), characterized by the correlation of sanidine, K_2O, CO_2 content.

anatase, limonite. Brown volcanic glass shards of pumiceous structure and somewhat higher index of refraction compared with canada balsam, chiefly recrystallized to chalcedony and quartz are found in somewhat greater quantities (Plate I.).

In the formation of pseudomorphs and even in the replacement of the material of the limestone, besides SiO_2, dolomite plays a comparatively very significant role.

A decrease in the amount of pyroclastic material is shown by two samples of silty limestone and one of fine-grained sandy limestone, taken from the tuff sequence. These rocks consist of allotriomorphic calcite crystals of 5 to 15 μ in diameter on the average, in which chert and comparatively great quantities of fossils can be determined. The expansion of the calcareous and siliceous material exceeds the grade of pseudomorph-formation and becomes dominant. The pyroclastic fragments consist of quartz, potash-feldspar, minimum quantities of plagioclase, chlorite, illite, zircon, epidote, apatite, pyrite, sphene; the contours of the trachyte fragments of the glassy matrix are dissolved. The average dimensions of the fragments are uniformly 10 to 30 μ, max. 100 μ (Plate III.).

Our attention was called to the rocks containing pyroclastic material, exposed in the Örvényes exploratory trench during our earlier investigations, when the tuff of the Upper Anisian sequence (Ágasmagas Hill, exploratory shaft No. 1) proved to be typical potash-trachytic crystal tuff. The material of the tuff intercalations in both trenches shows similarities, despite the differences in the embedding rock. The tuff in the upper level was lithoclastic, beneath it crystallo-lithoclastic, in the deeper level typical crystalloclastic potash-trachytic tuff was found.

TABLE 2

Trace element analyses of core samples of Bakonygyirót, borehole No. Bszl-5. Hungarian Geological Institute (ppm)

	B	Mn	Cu	Pb	Ga	V	Ti	Zn	Ni	Co	Sr	Cr	Ba	Li
1.	250	1000	40	4	4	25	600	<160	16	10	160	16	400	40
2.	160	160	60	6	25	25	6000	250	4	<6	160	4	400	40
3.	160	100	60	60	16	160	6000	160	16	16	160	40	400	40
4.	100	600	40	100	25	25	6000	<160	<4	<6	250	10	600	60
5.	100	160	25	<4	16	16	1600	<160	<4	<6	60	<2,5	400	60
6.	160	100	40	4	16	25	2500	250	4	<6	25	4	100	60
7.	100	400	25	10	16	16	2500	<160	4	<6	160	2,5	250	60
8.	100	600	25	16	16	25	4000	<160	10	<6	250	6	160	100
9.	100	600	25	25	16	40	2500	<160	<40	<6	250	4	400	60
10.	160	1600	100	4	16	60	4000	<160	40	16	250	60	400	60

Below the limit of detection are:

Be (250), As (600), Te (250), Hg (1000), Sb (160), Ge (25), W (100), Bi (25), Mo (10), Cd (60), Co (1600), In (4), Y (250), Sc (160), Nb (160), Tl (1), Sn (6), Ag (0,25)

The matrix of the macroscopically greenish-gray or light green lithoclastic tuff, often showing white or vivid green spots under the microscope proved to be clay-mineralized, calcitized and dolomitized. The glassy trachyte fragments and the small quantities of sanidine are not fresh. The matrix of the angular fragments, often subangular due to the calcareous replacement, is slightly devitrified rock glass, in which feldspar lathes of 50 to 100 μ in length, showing flow texture, are situated. The rather frequent light green patches of clay minerals containing calcite fillings in tiny vesicles or veinlets, are volcanogenic components, the original material of which cannot be traced back. Beside the Carlsbad-twinned sanidine some quartz and in isolated grains or aggregates and frames, leucoxene can be determined.

For the lower tuff levels, enrichment in sanidine crystal fragments and the decrease of the trachyte rock fragments is characteristic. These layers occur generally in light brown, reddish brown and light red limestone, cherty limestone, marl and clay. The material of light green or yellow-green colour, coarser grained than the embedding rock, is situated in thin streaks.

Microscopically the pure tuff, tuffaceous limestone, tuffaceous clay and their transitions can be well distinguished. The material of the crystal fragments is almost exclusively potash-feldspar. Its shape and dimensions are different, of 300 to 500 μ, some of 1200 μ diameter, the crystals are often idiomorphic, some specimens are slightly perthitic. Twin formation according to the Carlsbad twin law is frequent. Secondary minerals — in the order of their formation — are illite, sericite, glauconite, and, by replacement, chalcedony, dolomite and quartz. The presence of the original mafic silicates can be concluded only from the limonite, anatase, and glauconite observed in patches or frames. Accessory minerals are: apatite, perovskite. In some samples the enrichment of one of the above minerals (e. i. opaque constituents, glauconite) or the laminated structure is characteristic (Plate I, II.).

The material of the rock fragment is more or less clay-mineralized trachyte of similar dimensions and mineral composition as described above.

The rock varieties conisting of several sedimentary constituents contain fossil debris consisting of calcite and quartz material and pellets of calcareous material.

The thinner or thicker light green layers of the Bocsár Hill tuffaceous rocks can be well distinguished with naked eye from the gray, slaty bedded chert and the dirty-white radiolarian limestone layers bedded alternating with tuff.

In these sections, on the other hand, the presence of crystalline tuff components can be observed, though only in small quantities, in the bedded chert and limestone layers neighbouring the tuff, while the material of the layers considered as tuffs proves to be strongly silicified or calcitized; therefore, owing to the wide range of the transitions, it would be very difficult to draw sharp lithologic boundaries. The bedded chert contains calcareous (dolomite) and argillaceous (illite, chlorite) constituents, the cherty limestone significant quantities of quartz and chalcedony. I.e. the outcrop represents a sedimentary series, in which the volcanogenic material is demonstrated in the first line by the abundant SiO_2 rather than by the quantity of mineral fragments present. The interpretation of the microscopical picture was hampered by the darkening effect of opaque minerals of reddish-brown and black reflection, present in great quantities in different layers. The partly chloritized biotite of 60 to 70 μ diamater is comparatively frequent, quartz of 30 to 60 μ diameter is seldom, the alkali-amphibole of elongated columnar habit and 10 to 30 μ length is sporadic. The minimal quantities of sanidine, plagioclase, dolomite, illite can be demonstrated only by X-ray diffractograph. The radiolaria skeletons are frequent (Plate II.).

The material of the core sample from the Magyaralmás borehole is sandy limestone; among the detrital components, also material of pyroclastic origin can be found. Macroscopically the rock is coloured and appears as consisting of red-brown, dirty-white, and gray spots with light brown background.

Microscopically, built up allotriomorphic calcite crystals of 30 to 60 μ diamater, forming an almost equigranular texture, and great quantities of fine- and medium-grained sand, rounded in varying degrees can be seen in the limestone. Most of the detrital material is quartz of mixedly magmatic and metamorphic origin. The magmatic quartz is rounded in a lesser degree. Rock fragments, quartzite, muscovite bearing quartzite, recrystallized volcanic glass and pellets of limestone are found. The quantity of muscovite, potash-feldspar, and plagioclase is less than that of biotite; chlorite, clay-minerals, zircon, apatite is of minimal quantity. Few fossil debris of calcareous material are to be found.

In the light brown limestone of the Vörösberény road cutting, tuff intercalation of greenish brown colour is found. The pyroclastic material is represented chiefly by sanidine. The crystals of originally 500 to 600 μ diameter are practically pseudomorphs filled up by calcite, illite, and chalcedony, in which the feldspar has persisted only in small spots. Illite fragments containing round, pumiceous pores filled up with calcite, can also be found in this rock.

The Lower Ladinian compact limestone crossed by the Barnag shallow boring is characterized by vivid colour (yellow, light red, light green, reddish green), spotted, dendritic pattern and dissolved structure. In this hard rock strongly stained by haematite-limonite crystalloclastic-trachytic tuff of dirty-white or green colours occur in thin layers. The greater part of the crystal fragments consists sanidine of 300 to 500 μ in diameter, slightly clay-mineralized and partly replaced by calcite, dolomite and quartz. Water-clear, angular or resorbed and mostly ragged, weathered biotite of 150 to 200 μ in diamater is found in substantionally less quantity. Among the opaque minerals haematite occurs in great amounts, the anatase forming crystal aggregates is sporadic (Plate I, II.).

The macroscopically light brown rock covered by vivid green flakes, originating from Pécsely borehole, limestone with clay-mineralized pumice fragments. The material of the pumice is partly replaced by calcite and dolomite, partly clay-mineralized, chalcedonized. The original pores and holes of the fragments of 500 to 1000 μ diameter, are filled with brownish green illite and ivy green glauconite. The walls of the pores are lined with light brown chalcedony or ferrooxide-ferri-hydroxide. Few crystal fragments are to be seen in the rock; a few zoned or albite-twinned fragments of water-clear oligoclase and a some scrabs of biotite. Chalcedony can be observed also in veins as a mineral replacing the calcareous material. As secondary cavity filling mineral or in thin veins also chlorite of apple-green can be found. The volcanogene pyroclastic material of the place of occurrence is calcalkali-type.

CONCLUSIONS

The composition of the material of the potash-trachytic tuff and tuffaceous materials investigated, supports our earlier opinion according to which the Middle Triassic pyroclastics, occurring in the Transdanubian Central Mountains, are to be considered as alkali (trachyte) magmatites instead of the composition thought earlier to be diabase. Furthermore, the recent investigations confirm our earlier observation that alkali character is exclusive in the Anisian and restricted to the older formations, whereas in the upper part of the Ladinian a less amounts of pyroclastic material may occur, which gradually become of calcalkali-type.

Among the tuff varieties that of crystalloclastic composition is most frequent; this is often mixed with the trachytic-lithoclastic tuff. The vitroclastic variety occurs in comparatively small quantities. In the tuff sequences of the greater thickness, the production of volcanic material appears shifted from the crystalloclastic towards lithoclastic composition with the progress of time.

The tuff fell into seawater, and depending on its quantity, either thin layers consisting only of pyroclastics were formed, or more often it occurs as a detrital constituent in limestone, marl, dolomite host rock. The halmyrolitic weathering was extensive, in addition, the subsequent calcitization, silification, and dolomitization, leading to the decreasing quantity of the tuff were also important. Considering the quantity of sanidine crystal fragments and the carbonate content as the two most characteristic features of the tuff — limestone ratio, we wished to illustrate the changes in this ratio by plotting simultaneously the histograms of the percentual distribution of K_2O and CO_2 and the schematic diffractograms of the rock samples off our occurrences in *Figs. 7, 8.*

Examining the geological sections in their continuity, it can be easily seen, that the chert contant of the limy, clayey rocks, their frequent impregnation by silica, the presence of Radiolaria, in extreme cases the formation of bedded chert; i.e. the enrichment in SiO_2 is immediately connection with the quantity of the tuff fallen into the seawater.

The deformation structures observed and described, the pellett formation draw our attention to the mobility of the sedimentary basin. We consider these movements as due, in the first line, to tremblings connected with volcanic activity

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EXPLANATION OF PLATES

Plate I

1. Sanidine and biotite in tuffaceous limestone. — Barnag, shallow boring No. Ba-2. — || N, 30x.

2. Crystallo-lithoclastic tuff. — Örvényes, exploratory trench No. 1. — || N, 50x.

3. Tuffaceous (crystalloclastic) limestone. — Bakonygyirót, borehole No. Bszl-5, sample No. 9. — +N, 30x.

4. Vitroclastic tuff. — Bakonygyírót, borehole No. Bszl-5, sample No. 5. — +N, 50x.

Plate II

1. Illite in tuffaceous (lithoclastic) limestone. — Pécsely, borehole No. P—8. —|| N, 30x.

2. Opaque minerals in bedded chert. — Bocsár Hill. — +N, 50x.

3. Glauconite and calcite pseudomorph after feldspar in tuffaceous limestone. — Örvényes, exploratory trench No. 1. — || N, 50x.

4. Altered sanidine and biotite in tuffaceous (crystalloclastic) limestone. — Barnag, shallow boring No. Ba-2. — || N, 50 .

Plate III

1—2. Calcareous, clay-mineralized crystal-tuff. — Bakonygyirót, borehole No. Bszl-5, sample No. 7. — || N (1), +N (2), 30x.

3. Silty limestone with fossil debris. — Bakonygyírót, borehole No. Bszl-5, sample No. 20. — || N, 50x.

4. Cherty limestone with debris of radiolaria skeletons. — Bakonygyírót, borehole No. Bszl-5, sample No. 21. — || N, 50x.

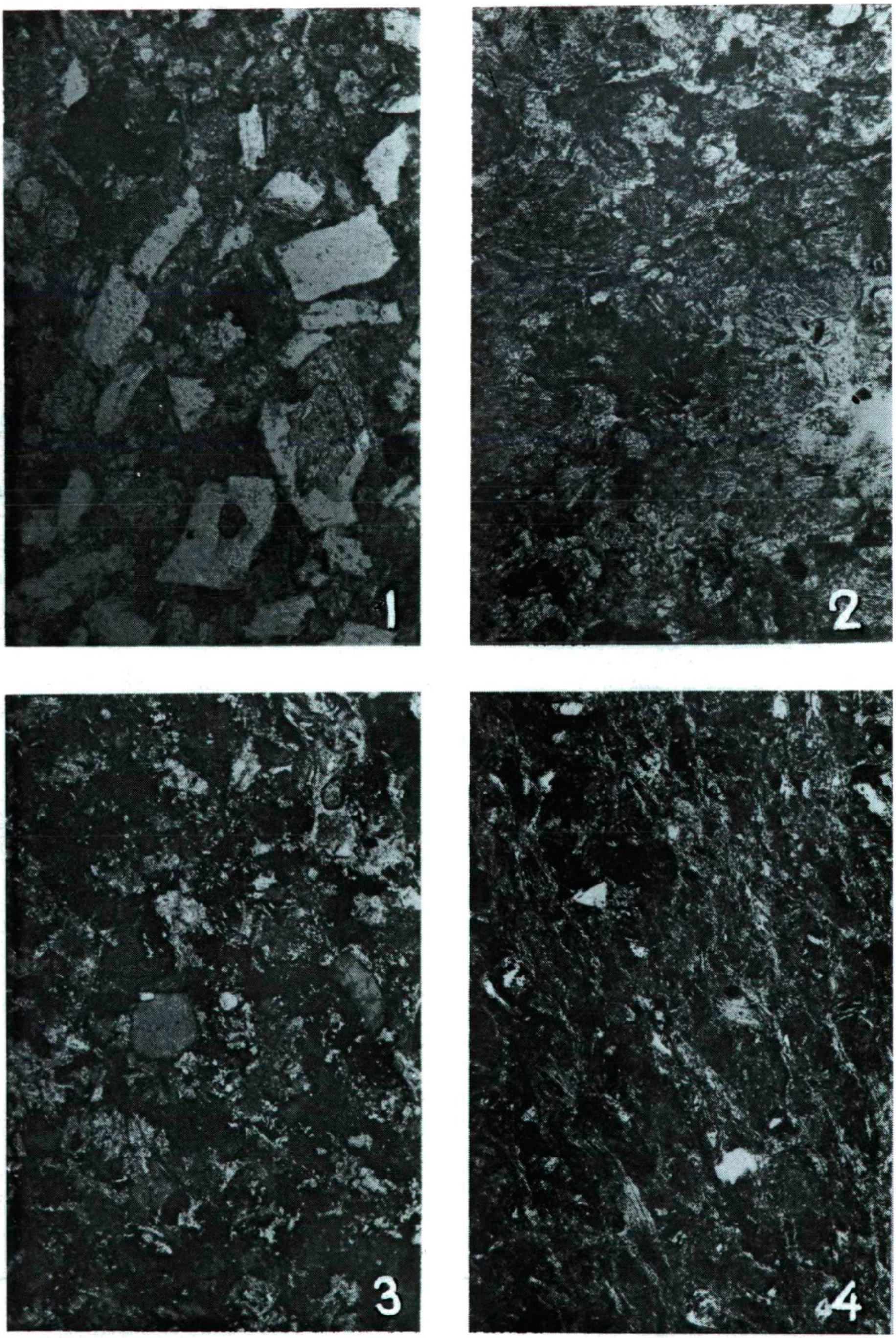
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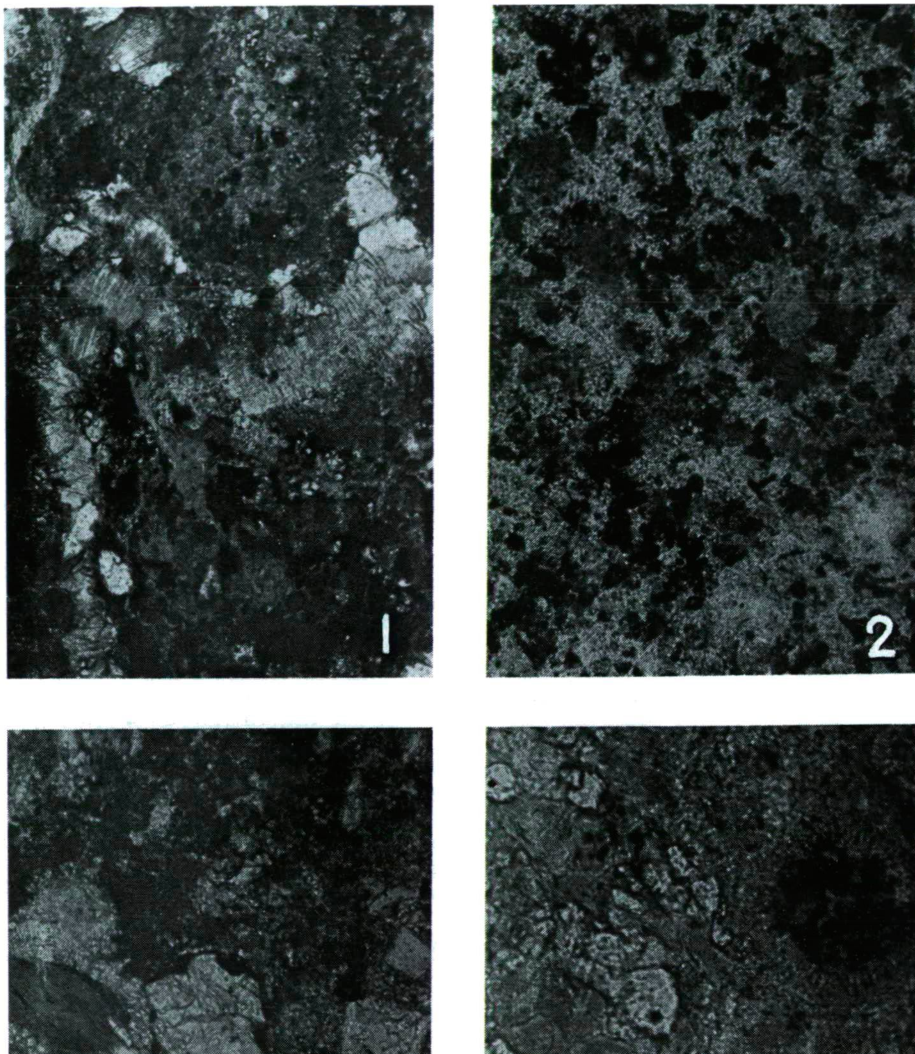
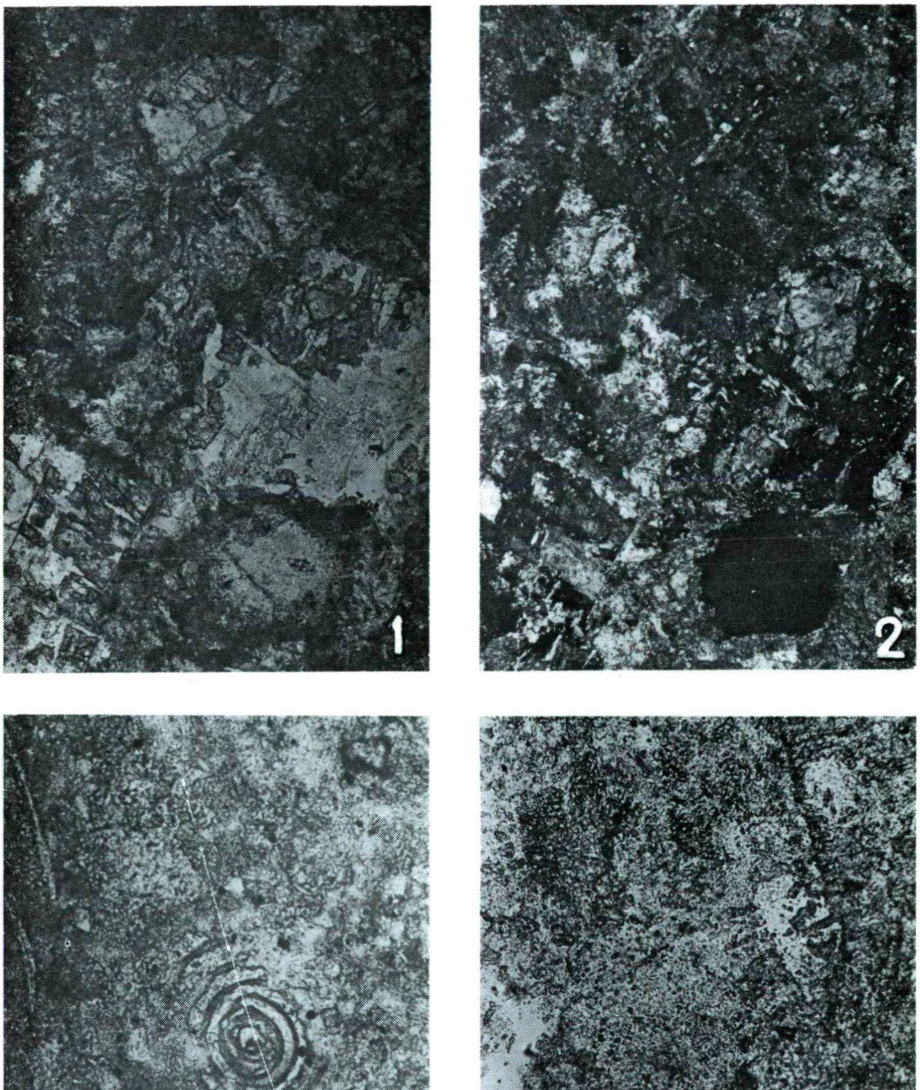
PLATE II

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