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PEBBLE DEDOLOMITIZATION IN CONGLOMERATES OF THE PIENINY EXOTIC RIDGE AND IN OTHER WEST CARPATHIAN CONGLOMERATES

(Figs. 22)

Abstract: In the "Upohlav" Conglomerates (Cenomanian-Senonian) of the flysch units of the Pieniny Klippen Belt, microconglomerate and coarse-grained sandstone pebbles with dedolomitized (recalcified) clasts are present. The dedolomitization is limited to the microconglomerate pebbles, while the abundant dolomite pebbles in the "Upohlav" Conglomerates are not affected. The dedolomitization was associated with the process of the Pieniny exotic cordillera emersion and destruction. Other examples of the dedolomitization of dolomite pebbles of Paleogene and Neogene conglomerates are also given, but unlike the above-mentioned case they originated mostly by hypergene processes resulting in the formation of hollow pebbles.

Резюме: В «упоглавских» конгломератах (сеноман—сенон) флишевых единиц пенинской утесовой зоны находятся гальки микроконгломератов и грубозернистых песчаников с дедоломитизированными (повторно кальцификованными) обломками. Дедоломитизация ограничена лишь гальками микроконгломератов; обильные гальки доломитов в «упоглавских» конгломератах не претерпели ее. Дедоломитизация была связана с процессом выхода и разрушения пенинского экзотического хребта. Приводятся и другие примеры дедоломитизации доломитовых галек конгломератов палеогена и неогена, но в отличие от вышеприведенного примера это, большей частью, гипергенные процессы, вызывающие образование пустых галек.

Dedolomitization process

The term dedolomitization was proposed by Morlot (1847) as the opposition of dolomitization. The terms recalcification or secondary limestone formation are also used instead of it — resulting from the experience that most dolomites originated by replacement of limestone. Because some dolomites originated by replacement of aragonite and not calcite mud the term recalcification should be replaced by the term dolomite calcification. For the sake of brevity we use the traditional priority term of dedolomitization.

The dedolomitization belongs among epigenetic processes. It is almost invariably caused by ground waters containing sulphate ions. In most cases these originated by the dissolution of gypsum and anhydrite (e. g., Lucia, 1961; Warrak, 1974), the ions, however, may be produced also by pyrite pigment oxidation (e. g., Scholle, 1971).

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Besides the recent and subrecent meteorization processes, dedolomitization is often described in fossil weathering crusts underlying transgression planes (e. g., Folkmann, 1959). This can be proved especially convincingly in deep boreholes where recent weathering could not have taken place (Schmidt, 1965; Mattavelli, 1966). Another type of dedolomitization — burial dedolomitization — not related to a transgression rarely occurs in deep boreholes. Budai — Lohmann — Owen (1984) describe it from a depth of 4450 m, where it is associated with stylolites, cracks and anhydrite nodules. Also Clark (1980) describes dedolomitization formed in depth related to a dislocation zone.

Almost all authors suppose the origin of dedolomitization due to the activity of continental waters. Al Hashimi (1976) gives, however, a recent case of dedolomitization of Carboniferous dolomite in an English coastal cliff caused by sea water.

Also, here, however, a decreased Sr content in the dedolomitized rocks indicates that continental waters were significantly involved, too. Magaritz — Kafri (1981) also describe dedolomitization caused by mixing of sea and meteoric waters, which is proved by isotopic analyses and the Sr/Ca ratio.

Microscope criteria for the identification of dedolomitization have been summarized by Shearman — Khouri — Taha (1961) as follows:
1. relics of small imperfectly replaced dolomite crystals in bigger calcite grains (poikilotopic texture), 2. calcite pseudomorphs after dolomite rhombohedrons. 3. palimpsest textures, in which small former dolomite rhombohedrons appear as phantoms, or traces of former zonal dolomite rhombohedrons can be seen in the form of Fe-oxide pigment amidst newly formed calcite. The above-mentioned authors introduced the term centripetal and centrifugal dedolomitization. During the centripetal dedolomitization the calcification proceeds from the periphery to the centre of the dolomite crystal or aggregate, the centrifugal one progresses from the centre outwards.

Dedolomitization and dolomitization may alternate many times. Mattavelli — Tana (1967) give examples, in which corroded relics of dolomite crystals in limestone are overgrown by dolomite. A similar oscillation of conditions is mentioned by Cotter (1966).

Tectonic preparation — cracking and brecciation of dolomites facilitate a more intensive process of dedolomitization. That is why dedolomitization is extensively associated with rauhwacke occurrences, in which calcification usually proceeds from small cracks, from the matrix into the fragments (centripetally). In rauhwackes of the Alpine Early Triassic this process is made more intensive by the presence of evaporites (Leine, 1968; Warrak, 1974). Original ideas on the origin of some rauhwacke types due to brecciation caused by high pressures of water vapours at the base of the alpine nappes have been introduced by Masson (1972) and Debelmas — Gidon — Kerckove (1980).

The intensity of dedolomitization increases with the temperature of waters. Fossil thermal waters are responsible for the origin of larger dolomite sand ("dolomite flour") accumulations.

Dolomite usually contains a $Fe^{\cdot\cdot}$ admixture, which, in the course of dedolomitization, is released in the form of $Fe^{\cdot\cdot\cdot}$ hydrooxides (Evamy, 1963) and often caused the ochreous colour of secondary limestones formed by dedolomitization.

Experimental studies of dedolomitization have been carried out by de Groot (1967). They were performed by solutions with a high Ca/Mg ratio, CO_2 partial pressure under 0.5 atmosphere and temperature under 50 °C. Other studies of dedolomitization have been carried out by Yanateva (1955), Sieber — Hoestler (1970) and Orr — Ehrlich (1970).

As far as I know, no work has so far dealt with dedolomitization in conglomerates and therefore in this contribution I want to mention some interesting observations from the West Carpathians.

Earlier data on dedolomitization in the West Carpathians

All hitherto notes concern exclusively Triassic sequences. Mišík (1972, pp. 95—96, Fig. XLVII) has described secondary limestone intercalations in dolomites of the Veľká Fatra and Strážovské vrchy Mts., centripetal calcification of fragments in a dedolomitized breccia in the Malá Fatra Mts. and dedolomitization textures in rauhwackes of the Nízke Tatry Mts. In the Late Triassic Oponitz beds, in the underlier of the Vienna Basin in the Kuklov-3 borehole, Mišík (1986 b, p. 260, 263, Figs. 1—2) describes spotted dedolomitization that originated in depth (burial dedolomitization) from sulphate warm waters that were formed by evaporite dissolution. Fluorite was deposited from the waters, too.

Among the dedolomitization phenomena belongs also dolomite sand "dolomite flour" formation. Such occurrences in Slovakia have been described by Andrusov (1955) that regards them as a pre-Pannonian weathering product due to surficial and ground water activity. According to Jablonský — Turan (1970) the main role in the formation of dolomite sands was played by thermal waters ascending along fault belts into tectonically broken dolomites. The theory on the origin of dolomite sands by fracturing of dolomite due to volume changes accompanying aragonite conversion to calcite (aragonite ought to have precipitated from thermal waters in dolomite pores) has not been proved in Slovak deposits by any aragonite relics.

Mišík (in Marschalko et al., 1976, p. 82, Pl. XXXVII, Figs. 2, 3) mentions briefly dedolomitization of Triassic dolomite clasts in a pebble of lithic sandstone probably of Lutetian age from the Early Priabonian Šambron Conglomerates. The dedolomitization took place at the same time as the cement deposition. The sandstone has a poikilitic cement with calcite individuals up to 1 cm. Former dolomite clasts, about 0.5 mm large, are visible in these calcite grains as phantoms because of their brown pigmentation. Their centre sometimes consists of a calcite grain aggregate inherited from the original dolomite mosaic or they still contain dolomite relics.

The dedolomitization in microconglomerate pebbles of Klippen Belt Cretaceous conglomerates, that is dealt with in detail in the following text, has been mentioned in the work Mišík — Sýkora (1981, p. 73).

Geological setting

The conglomerates containing pebbles with the dedolomitization phenomena are associated with Cretaceous flysch formations. These flysch formations deposited in the Kysuce unit of the Pieniny Klippen Belt during the Late Cenomanian—Santonian and in the Klape zone in the near-klippen area during the Albian—Early Cenomanian (600—1000 m) and Senonian. They include facies of central and lower parts of submarine fans containing several paraconglomerate intercalations with numerous exotic rocks (Samuel — Borza — Köhler, 1972; Mišík — Sýkora, 1981 and others). The material was brought by currents from the S and SE (Marschalko, 1986) from the eroded ridge — Pieniny cordillera.

As the lowermost conglomerate horizon contains more than one hundred kinds of rocks, the Penniny exotic ridge must have represented a highly sliced zone, folded and emerged during the Austrian tectonic phase. Abundant ophiolite detritus (serpentine fragments, chrome and iron spinels) in Barremian—Aptian limestone pebbles as well as pebbles of glaucophane-lawsonite rocks and Late Jurassic — Early Cretaceous volcanics suggest that important part of the Pieniny exotic ridge was built of subduction melange and relics of the ocean crust obducted during the continental collision postdating the ocean closure (Mišík, 1978; Mišík — Marschalko, in press).

Microconglomerates and coarse-grained sandstones with dedolomitized clasts were formed in the Albian — Senonian as littoral deposits fringing the Pieniny exotic ridge. Abrasion littoral conglomerates are indicated by a more monotonous composition and *Cyanophyta* overgrowths around some pebbles (initial oncolites). During the continued uplift of the cordillera the above-mentioned littoral sediments emerged and at the same time the dedolomitization of some clasts in microconglomerates took place. Pebbles and blocks of these microconglomerates and lithic sandstones were later transported together with pebbles of various other rocks in the form of fluxoturbidites into the Cenomanian—Senonian deposits. It is noteworthy that they are not present in the Albian fluxoturbidite sediments.

Microconglomerate clasts with dedolomitized pebbles

Dedolomitized pebbles (up to 4 mm) and dedolomitized clasts of arenite fraction have been found in microconglomerate and lithic sandstone pebbles (pebbles and blocks with a diametre of 3 to 40 cm) occurring in the above-mentioned Cretaceous conglomerates in ten localities. The age of these conglomerates varies from the Cenomanian to Maastrichtian. Most occurrences with dedolomitized pebbles are in Coniacian conglomerates of the Kysuca unit. Of 17 microconglomerate pebbles, the dedolomitization occurs in 9 cases, of which it was complete in 3 cases (all dolomite clasts in the rock were affected) and in 6 cases dedolomites were accompanied by unaffected medium-grained dolomites. Moreover, a Senonian bioherm limestone block with disseminated pebbles of various rocks including dedolomitized pebbles has been found.

Clasts in the microconglomerates usually did not exceed 5 mm, rarely attained 4 cm. Carbonatic rocks prevail in their composition. Limestones with calpionels (Tithonian), orbitolinas (Barremian — Aptian), with *Cladocoropsis* *mirabilis* FELIX (Malm), with *Stomiosphaera sphaerica* (KAUFMANN) and *Hedbergella* sp. (Albian), with *Halicoryne carpatica* MIŠÍK and *Involutina friedli* (KRISTAN — TOLLMANN) (Norian), crinoidal, sponge and radiolarian limestones (Jurassic), limestones with calcite and chamosite oöliths (Rhaetian — Hettangian), silicites, sponge cherts, radiolarites (Jurassic), quartzites (Early Triassic), medium-grained dolomites (Middle and Late Triassic), dedolomites, acid and basic volcanics and clastic quartz have been found. The interstitial matter is formed of calcite cement (block cement) or matrix with calcite cement. Pelecypod fragments and redeposited orbitolinas are rare, while silicisponge spicules, fragments of brachiopods, bryozoas and tubes of serpulid worms are very seldom.

Besides the above-mentioned block of Senonian age there are no direct paleontological criteria for age determination of the microconglomerates. As it is substantiated in the following text we regard them as littoral (transgressive) conglomerates deposited on the margin of the Pieniny exotic ridge during the Middle and Late Cretaceous. In the course of continued uplift of the ridge (cordillera), in continental conditions, they were dedolomitized and then eroded and transported in the form of clasts into the intraformational conglomerates of submarine fans.

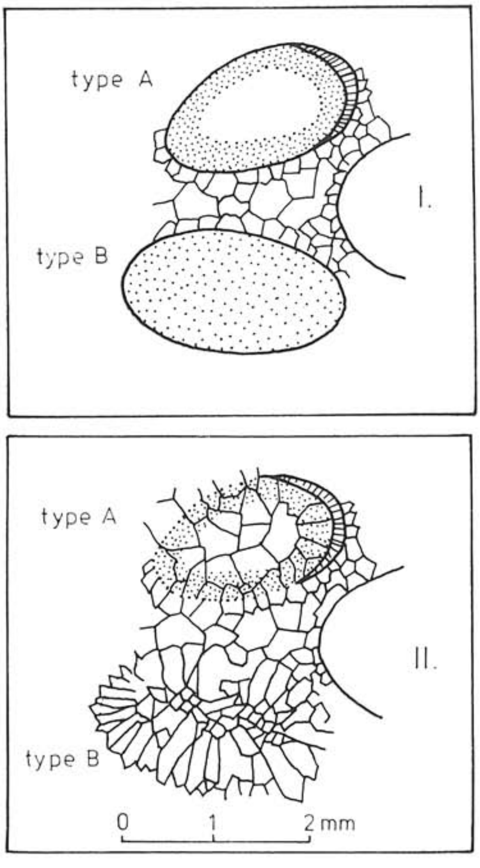

Fig. 1. - I. Textures prior to the dedolomitization process. The microconglomerate is lithified by block calcite cement. Only a small fraction of thin rims of initial fibrous, originally aragonite cement paramorphosed by calcite has been preserved. Central part of the type A dolomicrite pebble was leached by hypergene processes and a hollow was formed in it. The bituminous dolomicrite (type B) pebble was not leached.

Fig. 1. - II. Dedolomitization texture. The dedolomitization proceeded centripetally, mostly by syntaxial overgrowths on the grains of block cement. In the type A the pebble contour is formed of micrite crust remains with fibrous cement. In the other parts of the pebble the contours are visible because of tiny dolomite grain inclusions. The type B tends to radiaxial structure. Original pebble contours are observable due to the brown pigmentation.

Dedolomite pebbles

The dedolomitization processes have been studied in thin sections coloured by alizarin and in some instances also by potassium ferrocyanide (Evamy, 1963). Ca, Mg and Fe contents of seven dedolomitized pebbles and clasts of psammite category have been studied by means of a microprobe. The dedolomitization textures indicate that the dedolomitization took place as late as in the lithified microconglomerate and exclude the possibility that the clasts originated by erosion of a dedolomitized dolomite formation.

Contours of dedolomitized clasts

On the basis of contours two following types can be distinguished:

a) Contours of dedolomitized clasts are visible as ghosts because of continuous brown tinge of the dedolomite (Figs. 2, 6—8), or in the case that the dedolomite is formed of limpid secondary calcite the original pebble contour is visible because of tiny dolomite inclusions (Fig. 3). In both cases, grains of the calcite mosaic do not respect pebble contours. Part of the optical calcite individual is a constituent of the cement and the other part of the individual is a component of the pebble filling (e. g., Figs. 2, 16, 17).

b) The contour is represented by a continuous micritic fringe formed around the original dolomite pebble already in the sedimentary environment (Fig. 4). Micritic fringes usually originate by boring activity of algae, the canals of which are filled with microcrystalline calcite (mud).

c) The micritic fringe is only partly preserved (Figs. 12—15, 17). The rest of the pebble — its contour — is completely lost because of recrystallization.

Filling of dedolomitized clasts

During partial dedolomitization, sponge-shaped calcite crystal intergrows through the intergranular spaces into the dolomite mosaic. In the advanced stage the newly formed calcite crystal intergrows, in a poikilitic manner, relict grains and grain clusters of dolomite. There exist two types of entirely dedolomitized clasts (secondary limestones):

Fig. 2. Dedolomitized pebble of Triassic dolomite that was replaced by a calcite mosaic. The pebble contours are visible because of the original pigmentation of the dolomite, the boundary runs across the grains (part of the grain belongs to the cement, the other part to the filling of the pebble). Middle Cretaceous microconglomerate pebble in Coniacian conglomerates of the Kysuca unit of the Pieniny Klippen Belt, locality Zádubnie. Magn. 43 ×

Fig. 3. Dedolomitized pebble of the type A. The calcite mosaic grew centripetally, the grainsize increases from the periphery toward the centre. In the peripheral part of the pebble are abundant dolomite inclusions — calcite intergrew through the porous spongy mass of the decomposed dolomite. The central part of the pebble was leached, clear calcite crystals grew into the hollow. Zástranie-Ix, thin section No. 7927 (coloured by alizarin). Magn. 20 ×.

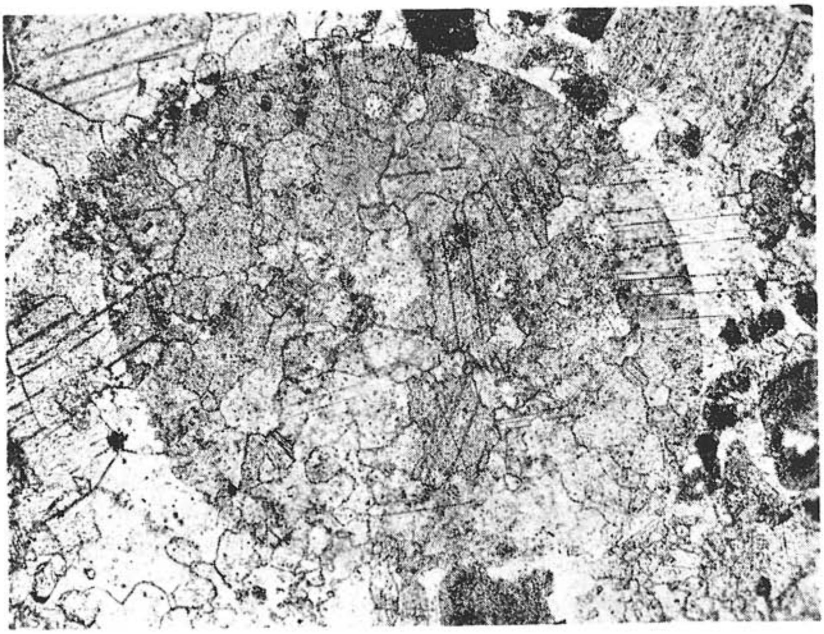

Fig. 2.

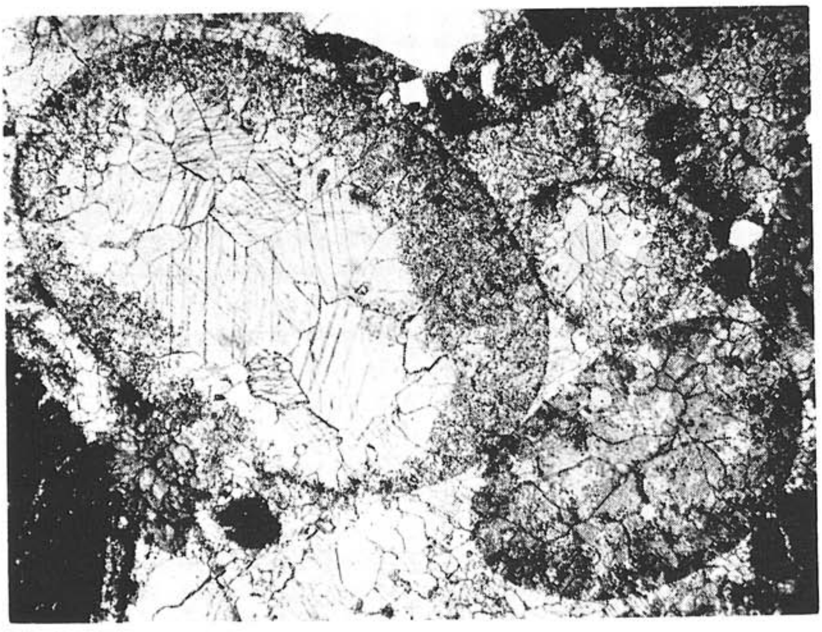

Fig. 3.

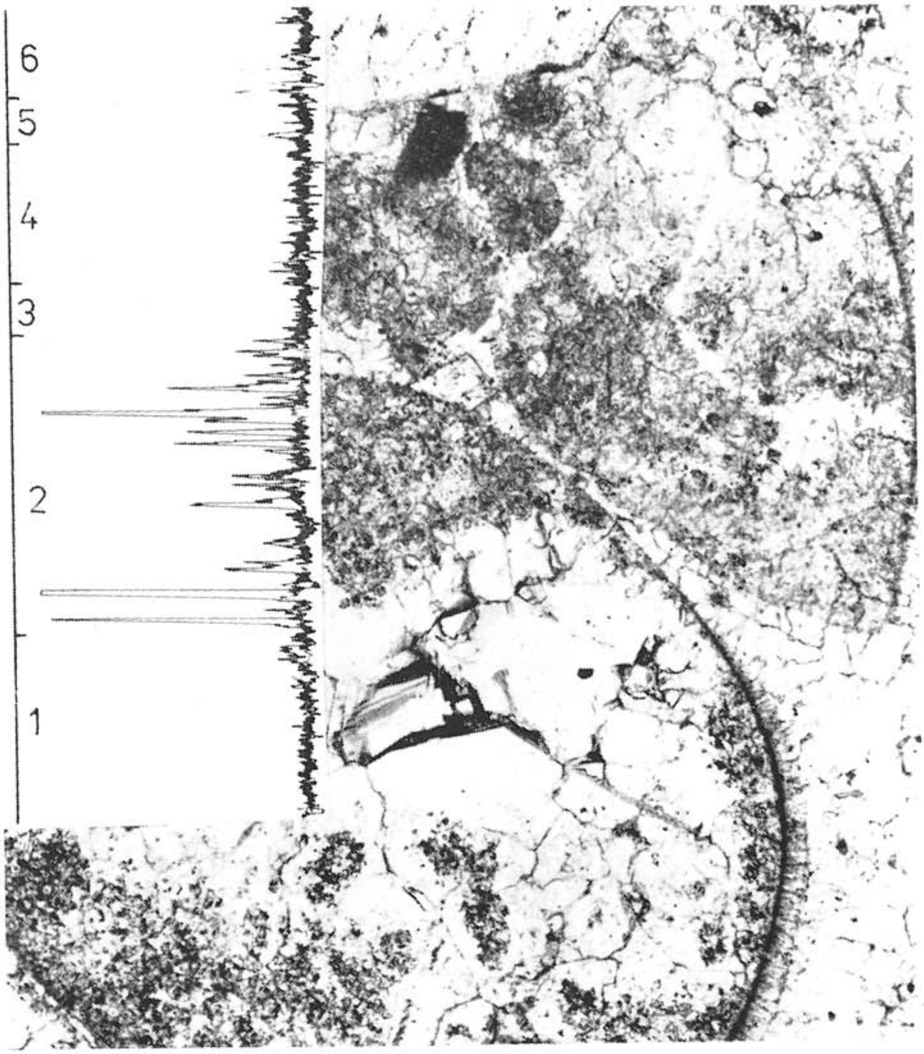

Fig. 4. Dedolomitized pebble of the type A. Part of the periphery is fringed by a relic of initial fibrous cement.
Microanalyser record: 1 — central part without inclusions, 2 — peripheral part with dolomite inclusions (Mg peaks), 3 and 5 — calcite cement among clasts, 4 — small dedolomitized clast, 6 — grain of clastic quartz (Fe peaks). H. Vadičov — a; Metal-coated thin section. Magn. 38 ×.

Type A) The calcite grain aggregate is clear or only slightly brown coloured. It is formed of an isometric mosaic, the grainsize of which, according to the druse rule, increases from the margin to the centre of the pebble or arenite clast (Figs. 3—5).

Type B) It is a radial calcite aggregate, or at least an aggregate with a ten-

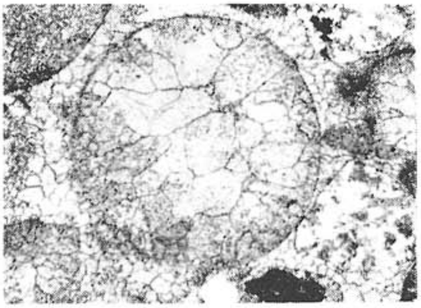

Fig. 5. Dedolomite of the type A. Middle Cretaceous microconglomerate pebble in Coniacian conglomerates of the Klape unit. Teplička n. V. Thin section No. 8778. Magn. 20 ×

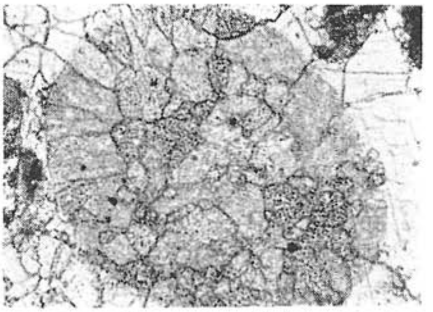

Fig. 6. Transitional type dedolomite. Original contours are visible because of pigmentation. Some grains are elongated and of radial orientation. As in the preceding. Thin section No. 8550. Magn. 43 ×.

Fig. 7. Dedolomite of the type B. Phantoms of the original pebble are visible due to brown pigmentation. The filling consists mostly of elongated calcite individuals of radial orientation. H. Vadičov — a. Thin section No. 10016. Magn. 48 ×.

Fig. 8. The same. Teplička n. V. Thin section No. 8777. Magn. 43 ×.

Fig. 9.

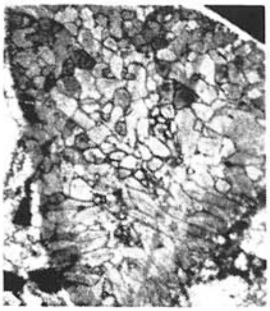

Fig. 10.

Fig. 11.

Fig. 9. Dedolomite of the type B. The radial structure is less regular. Thin section No. 6337. Magn. 43 ×.
Fig. 10. As in the preceding. Thin section No. 7071. Magn. 13 ×.
Fig. 11. As in the preceding. Metal-coated thin section. Magn. 30 ×.

dency to radial arrangement, cloudy with a marked brown shade (Figs. 7—11). In bigger clasts, the radiaxial aggregate passes in the centre to a brown fine-grained mosaic. In some instances the youngest innermost part of this mosaic was coloured in blue by potassium ferrocyanide, that means that it was formed already in a very oxygen-poor environment.

Transitions between the types A and B are rare (Fig. 6).

The type A often contains relics of small dolomite inclusions, which are most abundant near the pebble margin (Figs. 3—5). In the type A there is often a micrite rim or only its part. On the micritic rim are in places remains of fibrous calcite cement (initial cement) that originally coated the pebbles (Fig. 3).

The type B contains neither dolomite inclusions nor relics of micritic rims with remains of fibrous initial cement.

I assume that the existence of these two types is due to a different composition of parent rocks. The type B probably originated from bituminous dolomicrites and the type B from dolomites without bituminous admixture. I tried to verify the supposition that the brownish shade is not caused by $Fe^{\cdot\cdot\cdot}$, but a bituminous admixture by means of a JEOL microprobe (analyses have been performed by Dr. J. Krištín, CSc.). The average FeO content of five analyses of brown-pigmented dolomites — 0.045 % is only a little higher than those of the limpid dedolomites of the type A 0.021 % (3 analyses) and the calcite cement among the pebbles — 0.020 % (4 analyses). The presence of the dolomite inclusions in the type A dedolomite (Fig. 4) shows an average MgO content of 1.416 % (3 analyses), while the type B — 0.312 % and the calcite cement among the pebbles 0.423 % (4 analyses). The dedolomitization affected preferentially finer-grained rocks. It is indicated by cases where the microconglomerate comprises, together with dedolomites and partly dedolomitized clasts, also unaffected medium-grained dolomites with mosaic hypidiotopic texture. In some localities all clasts, including medium-grained ones, were dedolomitized as it is evidenced by relics of relatively large dolomite grains in partially dedolomitized clasts.

Dedolomitization progress deduced from the study of textures

After the accumulation of pebbles (clasts) in the littoral sediment the deposition of the initial cement took place — a thin coating of fibrous, probably aragonite, aggregate began to form around the clasts (Fig. 4). A mutual impressing of dolomite pebbles accompanied by dissolution ("pressure solution", "pitted pebbles") has been observed only very rarely. The stage of the radiaxial mosaic formation, which is common during the diagenesis of limestones, is absent in the microconglomerate cement. The initial fibrous cement was immediately succeeded by the block (isometric) cement stage represented by non-ferroan calcite (verified with potassium ferrocyanide).

The process ion for ion replacement obviously did not take place during the dedolomitization because the original textures of the dolomite rocks have not been preserved in the dedolomitized pebbles. The dedolomitization was preceded, or eventually accompanied, by partial and rarely also complete leaching of the dolomite pebbles (negatives after the pebbles remain — moldic porosity). The leaching of central parts of dolomite pebbles in conglomerates is described by Fytrolakis — Theodoropulos (1975 — "Lochverwitterung"). I can prove it also by my own observations (Mišík, 1986 a) of the Jablonica Conglomerates of the Karpatian of the Vienna Basin, Badenian of the Vienna Basin, Central Carpathian Paleogene (Fig. 20, material of Gross) and of the Pannonian — Pliocene conglomerates of the Turčianska kotlina Basin (material of Pivko). In such cases a hollow arises in the centre of the dolomite pebble and its peripheral part is altered to a highly porous dolomite aggregate gradually disintegrating to a powder.

The dedolomitized clasts of the type A can be derived of these leached hollow dolomite pebbles (sketch). Calcite crystals begin to grow centripetally from the periphery toward the centre of the pebble. At first they penetrate through the spongy highly porous to powdery mass of the relict dolomite (peripheral part of the dedolomitized clasts of the type A is therefore full of dolomite inclusions) and continue to grow into the central hollow, into the empty space (calcite grains in the central part of the dedolomitized clasts are therefore clear). There is no evidence that the clear aggregate in the centre of the former clast originated by displacement of impurities — inclusions to the periphery of the growing crystal. The centripetal growth is evident from the enlargement of the grains from the periphery to the centre (geometric choice). The centripetal growth of scalenohedral calcite crystals can be sporadically proved also by the arrangement of inclusions. Thin coatings of the initial fibrous, probably aragonite, cement were only rarely paramorphosed by calcite in situ. They were mostly dissolved, too and the block cement calcite then continued in its syntaxial growth into the former dolomite pebble (this is the case of the "phantom contours" of clasts).

The spongy powdery relics of the inner walls of the hollow pebble were presumably rolled off and accumulated gravitationally at the bottom of the hollow thus forming the top and bottom textures. Such cases, however, have not been unequivocally confirmed.

The complete leaching of the pebbles has been doubtlessly proved in a conglomerate layer amidst a bioherm Senonian limestone olistolith. Here occur, in association with dedolomites of the type A, negatives after pebbles

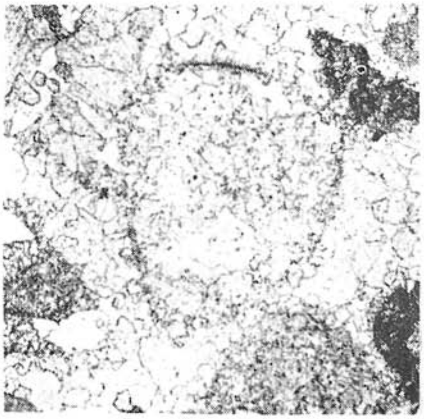

Fig. 12. Relics of micrite envelopes in dedolomitized (calcified) rounded dolomite clasts of arenite fraction. Middle Cretaceous coarse-grained lithic sandstone pebble in Coniacian conglomerates of the Kysuca unit. H. Vadičov — a. Thin. section No. 9573. Magn. 23 ×.

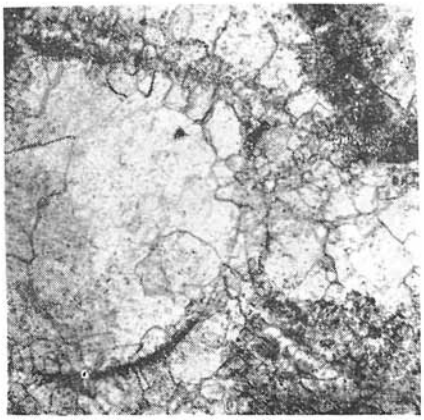

Fig. 13. As in the preceding. Thin section No. 10016. Magn. 30 ×.

that were filled with clear calcite scalenohedrons. The formation of the calcite filling was interrupted by inner sedimentation with polymict clasts (Figs. 21, 22) among which are also minor dolomite clasts unaffected by the dedolomitization. Into the hollow of the pebble were washed also the microorganisms *Pieninia oblonga* BORZA et MIŠÍK and *Globigerina* sp.

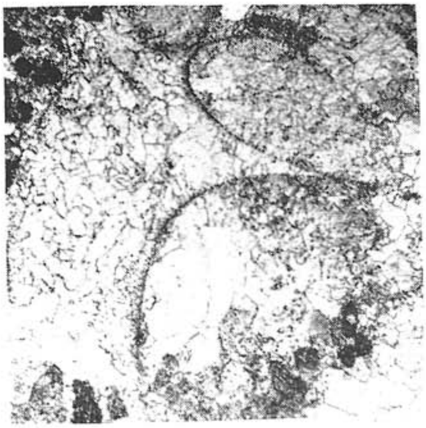

Fig. 14. Partial preservation of micrite contours. The other parts of contours of rounded clasts were destructed during recrystallization. As in the preceding. Thin section No. 9573. Magn. 20 ×.

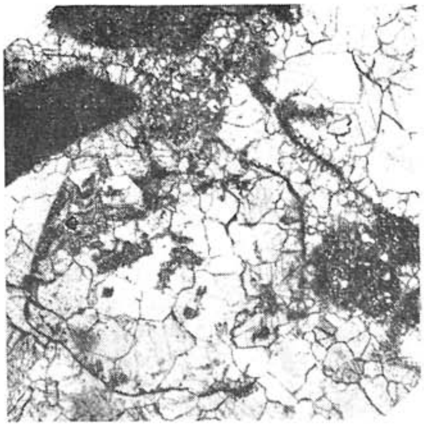

Fig. 15. As in the preceding. Kubíkovia — e. Thin section No. 8716. Magn. 23 ×.

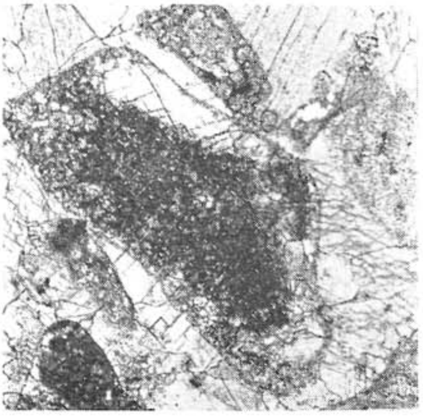

Fig. 16. Calcite crystal intergrows from the cement to dedolomitized clast; in the middle of the clast are abundant dolomite inclusions. Oravský Podzámok — I. n. Thin section No. 8579 (alizarin-coloured) Magn. 43 ×.

Fig. 17. As in the preceding.

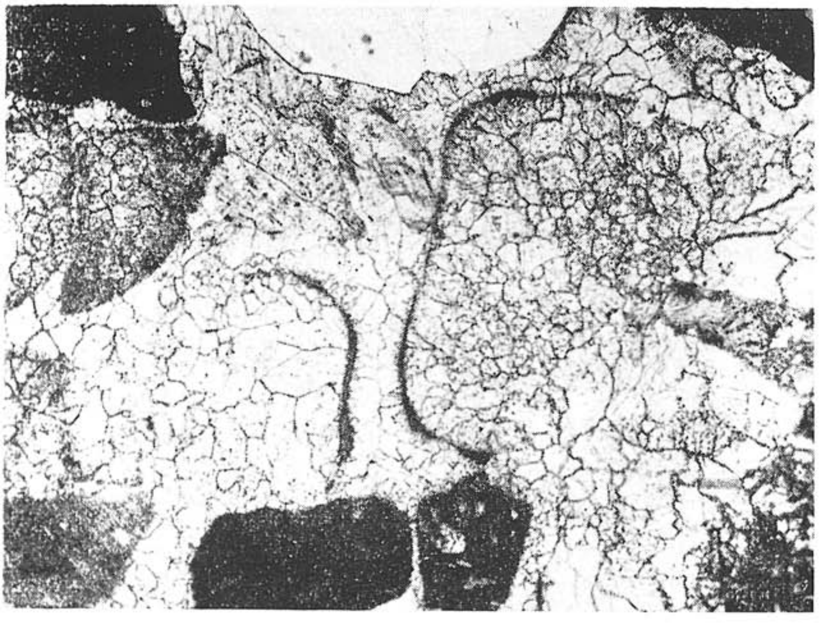

Fig. 18. Remains of micritic contours of dedolomitized arenite clasts, other pebble contours were destroyed in the course of recrystallization. Pebble of coarse-grained lithic sandstone. Teplička n. V. Thin section No. 8550. Magn. 43 ×.

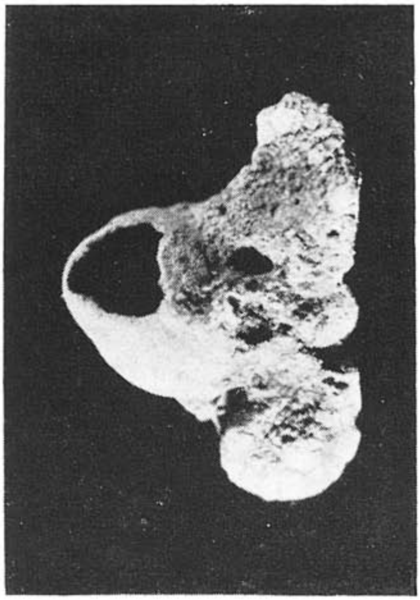

Fig. 19. Hollow (leached) dolomite pebble. Dedolomitization of pebbles described in the preceding text probably went through this stage. The Jablonica Conglomerates of the Vienna Basin Neogene (Karpatian). Mníšek. Slightly magnified.

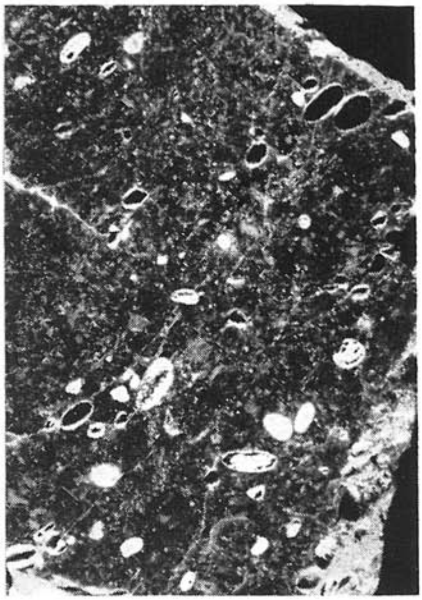

Fig. 20. Hollows (mouldic porosity) originated by leaching of dolomite pebbles in Central Carpathian Paleogene conglomerate of the Liptovská kotlina Basin (material of G r o s s), Východná-3 (Hrubý Grúň). Polished section. Diminished.

In this case, the Senonian coral reefs with incorporated dolomite pebbles formed an uplifting coast of the Pieniny exotic ridge. The dolomite pebbles were leached and gradually filled with secondary calcite. The olistolith was broken off prior to the completion of the dedolomitization process and the inner sediment identical with the paraconglomerate matrix penetrated to the residual hollow of the peripheral pebbles.

Most difficult is to explain the dedolomitization of the type B (imperfect radiaxial calcite aggregates with deep brown colour). As it has already been noted, the microanalyser results suggest that the brown colour is not due to

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Fig. 21. Hollow after leached dolomite pebble filled with initial calcite cement. Its growth was interrupted by the deposition of inner sediment equal to the matrix of the Maastrichtian conglomerate, in which is situated this block of slightly older conglomerate. Vrtižer — II. Thin section No. 7071. Magn. 13 ×.

Fig. 22. Initial calcite cement started growing into the hollow after a leached dolomite pebble. Its growth was interrupted by the deposition of internal mud sediment (micrite). The upper part of the hollow is filled with calcite cement. Below is a clast — dedolomite of transitional type. As in the preceding. Thin section No. 7591. Magn. 20 ×.

Photographed by L. O s v a l d

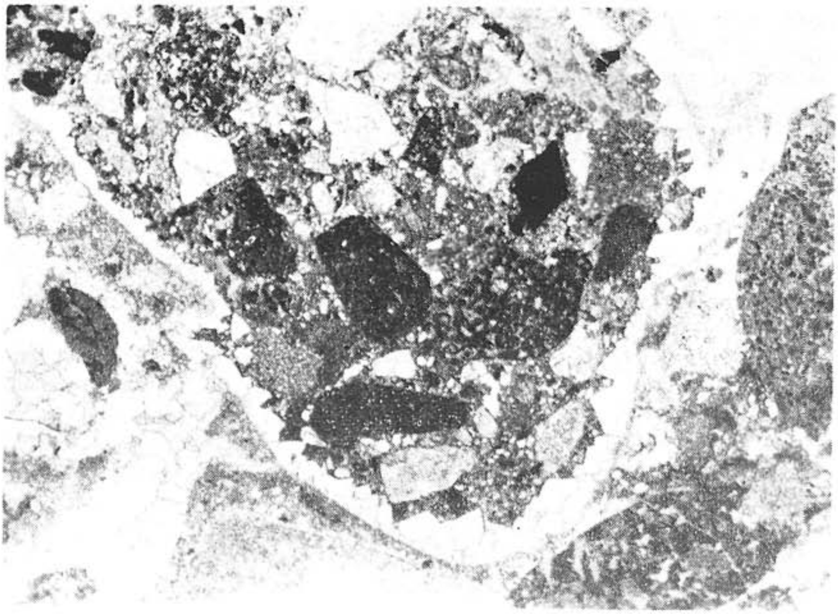

Fig. 21.

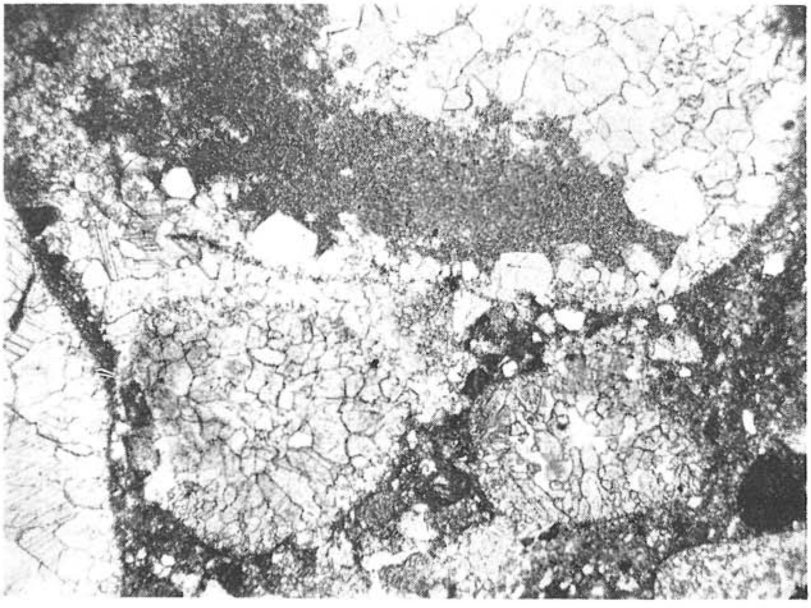

Fig. 22.

iron compounds but a bituminous pigment. The original rock were probably bituminous dolomicrites. The type B does not indicate growth of the calcite druse into an empty space, in such case the original bituminous admixture would have been removed. The organic colloids probably influenced the ultimate shape of the aggregate crystals. The influence of the colloids upon the calcite crystallization is significant (M i š í k, 1968) and so far little investigated. If the type B really originated by the replacement of dolomites it is difficult to explain why it does not contain relics — inclusions of small dolomite grains.

We have to take into account that the ultimate shape of the calcite aggregates in the studied microconglomerate was influenced, to some extent, by their recrystallization. The recrystallization, however, need not have to take place in cases of completely preserved micrite fringes with initial fibrous cement, where the block aggregate of isometric mosaic increases its size into the former pore as well as inside the former dolomite pebble. The recrystallization is likely to have taken place if only a small part of the micrite fringe is preserved and in the rest of the space the pebble filling invisibly passes to equally-grained calcite mosaic, in which the boundary between the former pebble and microconglomerate calcite cement cannot be observed at all (Figs. 14, 18). Inclusions — dolomite relics are removed in the course of recrystallization and a clear calcite aggregate originates.

Summary

In microconglomerate pebbles of Cretaceous flysch conglomerates (bathyal sediments of the upper part of submarine fan) there have been discovered numerous dedolomitized clasts (pebbles and dolomite fragments of arenite fraction replaced by calcite). The microconglomerates represent littoral sediments of the Pieniny exotic ridge margin. In the course of its continued uplift they emerged and were dedolomitized by sulphate ground waters. The degree of dedolomitization depends on the texture of dolomite. In a microconglomerate pebble there occur together affected and unaffected fragments (the latter are always coarser-grained).

On the basis of observations at outcrops of some West Carpathian Tertiary conglomerates we may deduce that in the first stage, central parts of the pebbles were usually leached, resulting in hollow pebbles, the peripheral part of which, except for the surface itself, consisted of highly porous dolomite. In the second stage the calcite block cement grains grew up syntaxially to the pebble. Thus we interprete the dedolomites of the type A with abundant small dolomite inclusions, usually in the peripheral part, and a limpid aggregate in the centre that filled the former hollow. The type B has a radial arrangement of elongated calcite grains and dark-brown pigmentation. It probably originated from bituminous dolomicrites. The contours of the former pebbles are visible because of the pigment ghosts, dolomite inclusions or micritic envelope relics.

Translated by Ľ. Böhmer

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