ROCZNIK POLSKIEGO TOWARZYSTWA GEOLOGICZNEGO
ANNALES DE LA SOCIÉTÉ GÉOLOGIQUE DE POLOGNE

Vol. XLVII — 1: 3—9 Kraków 1977

Andrzej ŁAPTAŚ

DIAGENETIC BRECCIAS IN ZBRZA DOLOMITES, GIVETIAN, VICINITY OF CRACOW

(Pl. I—II and 3 Figs.)

Brekcje diagenetyczne w dolomitach ze Zbrzy, żywet, okolice Krakowa

(Tabl. I—II i 3 fig.)

Abstract: Diagenetic "pudding breccia" consisting of angular fragments were found in Givetian dolomites. The breccia occurs irregularly at contact of two different carbonate strata: microcrystalline dolomite upwards and medium-crystalline calcareous dolomite below. Early diagenetically dolomitized layers were fragmented and sunken in liquefied calcareous mud penecontemporaneously with lithification of sediments.

INTRODUCTION

Numerous types of breccia are known to occur in carbonate rocks. Some of these are diagenetic breccias the origin of which is not yet clear. They frequently occur as horizontal bodies similarly as sedimentary breccias, but their top and bottom surfaces are commonly irregular, apophyses of breccia may project upwards and donwards from the main body. The diagenetic breccia may be laterally discontinous and they may wedge out within short distances.

The diagenetic breccias may originate due to a partial liquefaction of sediment which later forms their matrix.

The investigation of diagenetic breccias in dolomites contributes to the knowledge of the dolomitization processes.

GEOLOGIC SETTING

The breccias discussed here were encountered in the Givetian of the Dębnik Ridge, about 20 km NW of Cracow. The Givetian deposits are dark-grey and black microcrystalline bituminous dolomites with distinct thick bedding.

The investigated section is about 100 m thick. The rocks exposed here are the oldest Devonian deposits known at the surface in the Cracow region. These are so called „Zbrza dolomites". The whole sequence is lithologically monotonous and generally devoid of fossils. The most frequent sedimentary structures are poorly visible horizontal laminations. In few beds containing marls and black shales the submarine slumping are developed, having sharp and slightly undulated bounding surfaces.

DIAGENETIC BRECCIAS

The breccias consist of angular fragments forming „pudding breccias" (Norton, 1916), whose fragments are embedded in a preponderant matrix. One of studied breccias occurs at the contact of two lithologically distinct layers which make up one composite bed about 1,5 m thick. The first layer consisting of light medium-crystalline calcareous dolomite is overlain without any parting surface by the second of dark bituminous microcrystalline dolomite. The latter is followed upwards by analogous dark dolomites. Below the bed with the breccia there occur calcareous dolomites with marls, about 5 m thick, disturbed by slumping. The bottom of the slump is not exposed, the top is slightly undulated with denivelations reaching up to 50 cm.

Both layers in the composite bed formed an unstable system with the upper layer brittle — of Dżułyński (1966). Similar systems were reproduced experimentally (Anketell et al., 1970). The light-coloured calcareous sediment was liquefied when the higher layer of dark dolomite had been just partly lithified. The liquefied sediment last its internal structure, while the layer of dark dolomite was fractured and brecciated, so that some angular fragments sunk deeply into the liquefied sediment. The clasts range in size from a few milimetres to a few centimetres (Pl. I, Fig. 1). The brecciated zone is irregular and laterally discontinuous. Where the breccia is absent the original sharp or gradational contact of the two rock types may be observed. The transition is rapid, whithin a few centimetres the colour and the dolomite content change radically. The thickness of the breccia attains locally 1 m. At the lower limit of the breccia zone isolated angular fragments are scattered. Locally the breccia zone is condensed and only 20 cm thick. The upper limit of the breccia is irregular; close to it the breccia becames a „mosaic breccia" (Norton, 1916), or only a slight tilting of the fractured fragments can be observed without any significant displacement (Fig. 1).

As it was mentioned above the breccia is developed at the contact between the dark dolomite above and the light calcareous dolomite below. The relics of the original transition between the two rock types can

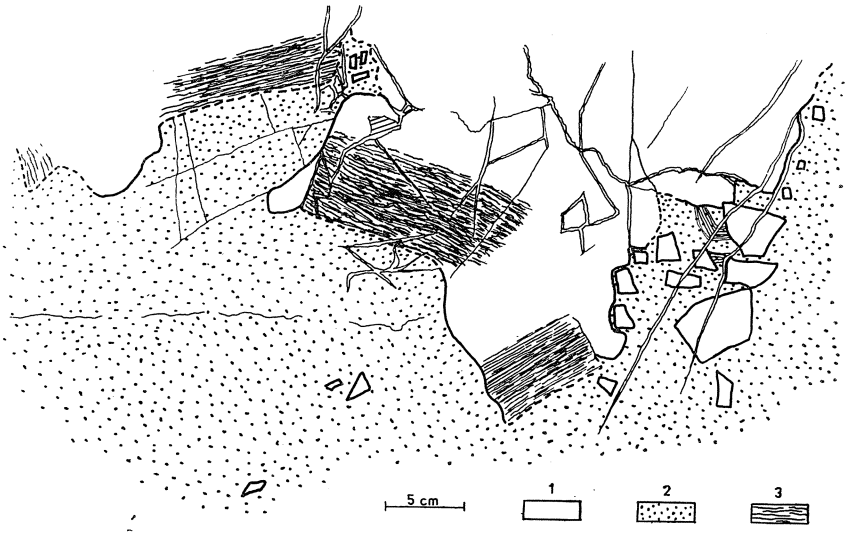


Fig. 1. Detail of dark dolomite — light calcareous dolomite contact. Tilted fragments of dolomite with original lamination preserved and sunken fragments of dark dolomite within light matrix are visable. 1 — dark microcrystalline dolomite, 2 — light calcareous medium-crystalline dolomite; 3 — remnants of original lamination at dark dolomite — light calcareous dolomite contact

Fig. 1. Szczegół granicy ciemny dolomit — jasny dolomit wapnisty. Widoczne przechylone partie dolomitu z zachowaną laminacją pierwotną, oraz pogrzęźnięte fragmenty ciemnego dolomitu w jasnym tle. 1 — ciemny dolomit mikrokrystaliczny, 2 — jasny dolomit wapnisty, 3 — ślady pierwotnej laminacji na granicy dolomit wapnisty jasny — dolomit ciemny

be discerned within some fragments. In Fig. 2 laminated fragments are visible with laminae becoming gradually darker towards the original top of the layer; a displacement and rotation of the sunken laminated fragments is also to be seen.

The light layer now forming the matrix of the breccia was recrystallized and probably dolomitized after the liquefaction and distortion (Fig. 3, Pl. II Fig. 2).

Another breccia similar with the described one has been revealed 20 m up in the section. It occurs in composite bed about 50 cm thick. As the breccia is developed with various intensity along the contact surface the initial state of the system can be reconstructed. Before brecciation the bed consisted probably of the following layers, approximately 5—15 cm thick:

4— grey microcrystalline dolomite
3— grey laminated calcareous dolomite (or limestone)
2 — white or light-grey dolomite (or limestone)
1 — dark bituminous microcrystalline dolomite.

The layers 2, 3 and 4 formed and unstable system, within which the layer 3 was liquefied, the layer 2 was plastically deformed and the upper

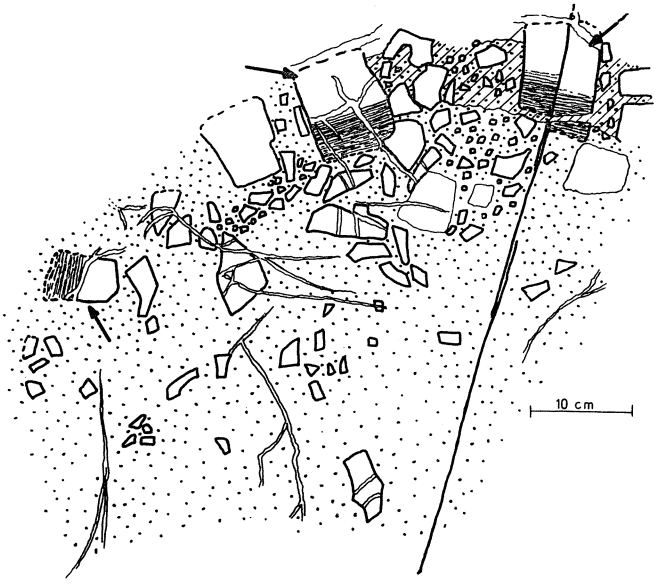


Fig. 2. Breccia of dark dolomite in light calcareous dolomite. Top of breccia is not visible. Arrows indicate fragments with preserved remnants of original laminated transition zone between dolomite and lighter calcareous sediment. Legend as in Fig. 1

Fig. 2. Brekcja ciemnego dolomitu w jasnym dolomicie wapnistym. Strop brekcji niewidoczny. Strzałki wskazują fragmenty z zachowanymi śladami pierwotnego laminowanego przejścia dolomitu w jaśniejszy osad wapnisty

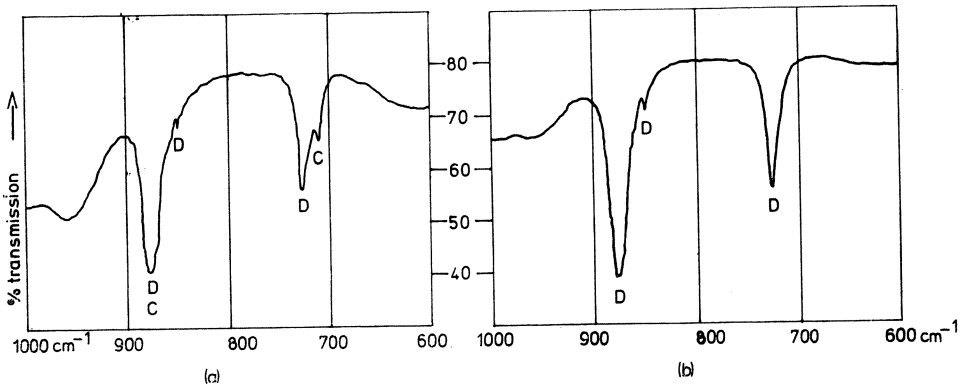


Fig. 3. IR spectra of breccia matrix (a) and of breccia fragment (b). Note presence of calcite in the matrix

Fig. 3. Widma w podczerwieni tła brekcji (a), oraz fragmentu brekcji (b). Zauważ obecność kalcytu w tle brekcji

layer 4 was brittle. The grey microcrystalline dolomite 4 was fractured and locally brecciated as a result of the liquefaction of the lower layers. The fragments of the fractured layer sunk in the matrix formed of both disturbed layers 2 and 3 (Pl. II Fig. 3). The top of the lowermost layer

1 is at places plastically deformed and follows the disturbances of the layer 2. The light layer 2 and the grey layer 3, now medium-crystalline dolomites, were recrystallized and possibly dolomitized after deformation.

DISCUSSION AND CONCLUSIONS

Similar breccias developed in dolomites were repeatedly described (Bonet, 1952 — fide Walper, 1960; Mazullo, Friedman, 1975). They were variously interpreted but their origin still seems to be not satisfactory explained.

In the case described here the brecciation was caused by the liquefaction of the more calcareous layers. At the same time when the calcareous layers were still susceptible to liquefaction the upper layers were already dolomitized and partially lithified (rigid). This proves that the dolomitization was taking place penecontemporaneously with lithification.

After the deformation the liquefying layers, originally probably calcareous, undergone strong recrystallization accompanied by a second phase of dolomitization. This might be caused by a mobilization of the dolomitizing solutions due to liquefaction.

It is not clear why the calcareous layers were more susceptible to liquefaction then the layers of „primary" dolomite. It is possible that the dolomitization itself advanced hardening of the dolomitized layer.

Acknowledgements. The author wishes to thank Professor Dr. St. Dżułyński for his helpful comments in both the field work and the preparation of the manuscript.

Polish Academy of Sciences, Institute of Geology
ul. Senacka 3, 31-002 Kraków, Poland

REFERENCES
WYKAZ LITERATURY

Anketell J. M., Cegła J., Dżułyński St. (1970) On the deformational structures in systems with reversed density gradients. *Ann. Soc. Géol. Pol.* 40, 1, pp. 3—39.

Bonet F. (1952), La facies Urgoniana del Cretácio Medio de la région de Tampico. *Bol. Assoc. Mexicana de Geol. Petrol.* 4, 5—6, pp. 153—260.

Dżułyński St. (1966), Sedimentary structures resulting from convection-like pattern of motion. *Ann. Soc. Géol. Pol.* 36, pp. 3—21.

Mazullo S. J., Friedman G. M. (1975), Conceptual model of tidally influenced deposition on margins of epeiric seas: Lower Ordovician of E New York and SW Vermont. *Am. Assoc. Petr. Geol. Bull.* 59/11, pp. 2123—2141.

Walper J. L. (1960), Geology of Cobán-Purulhá area, Alta Verapaz, Guatemala. *Am. Assoc. Petr. Geol. Bull.* 44/8, pp. 1273—1315.

STRESZCZENIE

Praca niniejsza dotyczy brekcji diagenetycznych występujących w żywecie grzbietu dębnickiego, w tzw. dolomitach ze Zbrzy. Brekcje te występują na granicy pomiędzy dwoma rodzajami skał węglanowych — czarnymi mikrokrystalicznymi dolomitami w górze i jasnymi średniokrystalicznymi dolomitami wapnistymi w dole.

Brekcje składają się z ostrokrawędzistych fragmentów ciemnego dolomitu tkwiących w jaśnieszym krytalicznym tle („pudding breccia" — Norton, 1916). Miąższość strefy zbrekcjonowanej jest zmienna, może sięgać 1 m, a lokalnie brekcja może zanikać. Spąg brekcji wyznaczają pogrzęźnięte odosobnione fragmenty. Ku górze zbrekcjowanie przybiera charakter „mozaikowy" lub też obserwujemy przechylenie pewnych partii wyższej warstwy, bez ich większego przemieszczenia. Tam gdzie brekcja się nie rozwinęła, można obserwować pierwotną granicę między dwoma warstwami węglanowymi — jest ona ostra lub niekiedy przejściowa na krótkim dystansie. Brekcja zawiera lokalnie fragmenty, w których zachowały się ślady tej pierwotnej granicy przejściowej.

Brekcje badane powstały w wyniku upłynnienia osadu wapnistego leżącego poniżej dolomitu, który zachował się łamliwie (zaburzenie układu niestatecznie warstwowanego — por. Dżułyński, 1966; Anketell et al., 1970). Obserwacja ta jest dowodem na dolomityzację współczesną lityfikacji badanych utworów.

Warstwy upłynniające się były prawdopodobnie pierwotnie całkowicie wapniste; uległy one po upłynnieniu silnej rekrystalizacji połączonej prawdopodobnie z drugą fazą dolomityzacji.

Praca wykonana w ramach problemu MRI-16 PAN
Pracownia Geologii Złóż, Zakład Nauk Geologicznych PAN
ul. Senacka 3, 31-002 Kraków

EXPLANATION OF PLATES
OBJAŚNIENIA TABLIC

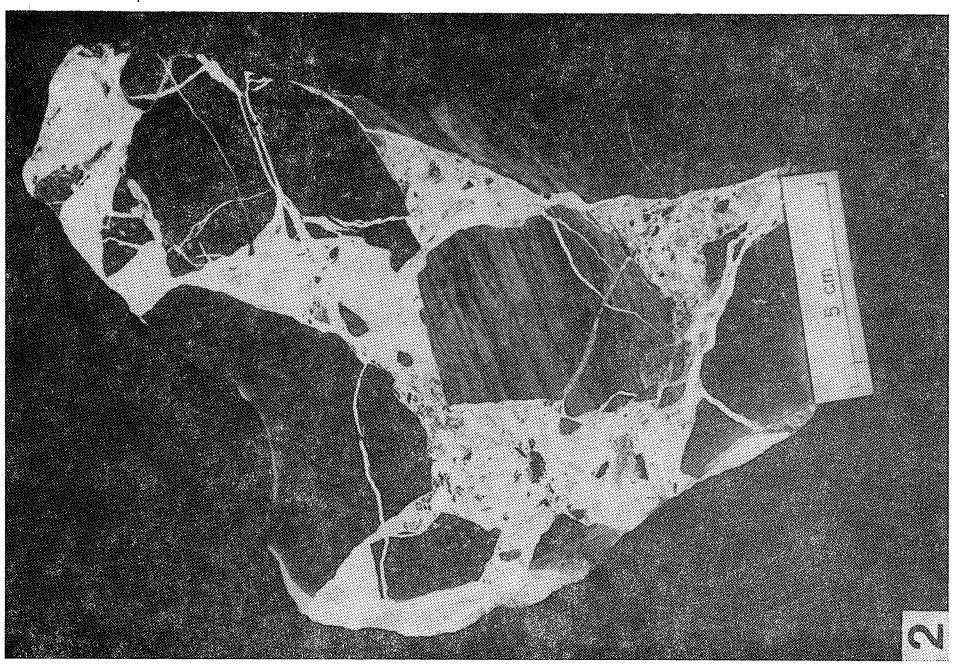
Plate — Tablica I

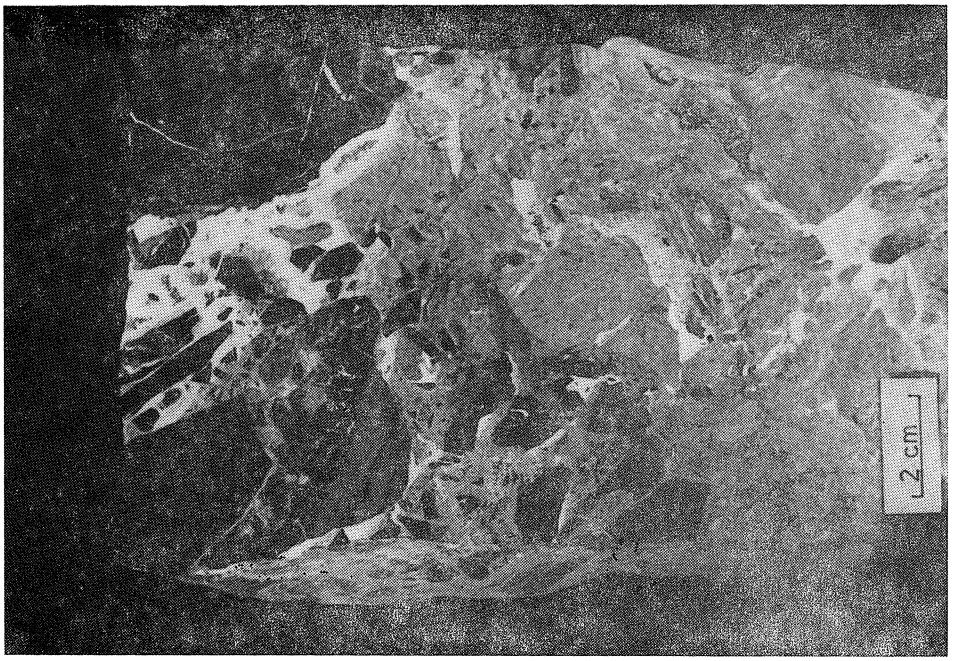
Fig. 1. Polished section of lower limit of breccia. Original lamination is preserved in some dolomite fragments. In upper central matrix is brecciated by calcite recrystallization.

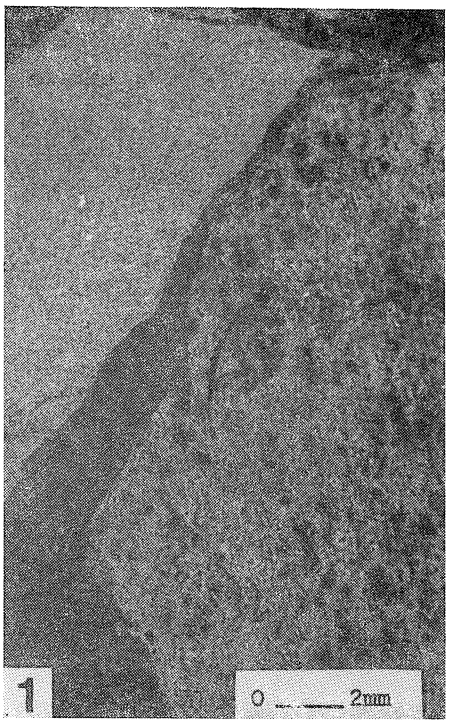
Fig. 1. Powierzchnia polerowana przedstawiająca dolną granicę brekcji. Niektóre fragmenty dolomitu mają zachowaną pierwotną laminację. U góry w środku widoczne zbrekcjonowanie spoiwa brekcji przez rekrystalizację kalcytu.

Fig. 2. Polished section of typical breccia. Calcite veins are cutting through both fragments and matrix

Fig. 2. Powierzchnia polerowana okazu typowej brekcji. Żyłki kalcytu przecinają zarówno fragmenty jak i tło


2 cm
2


2 cm
1


1
0 2mm


2
0 2mm

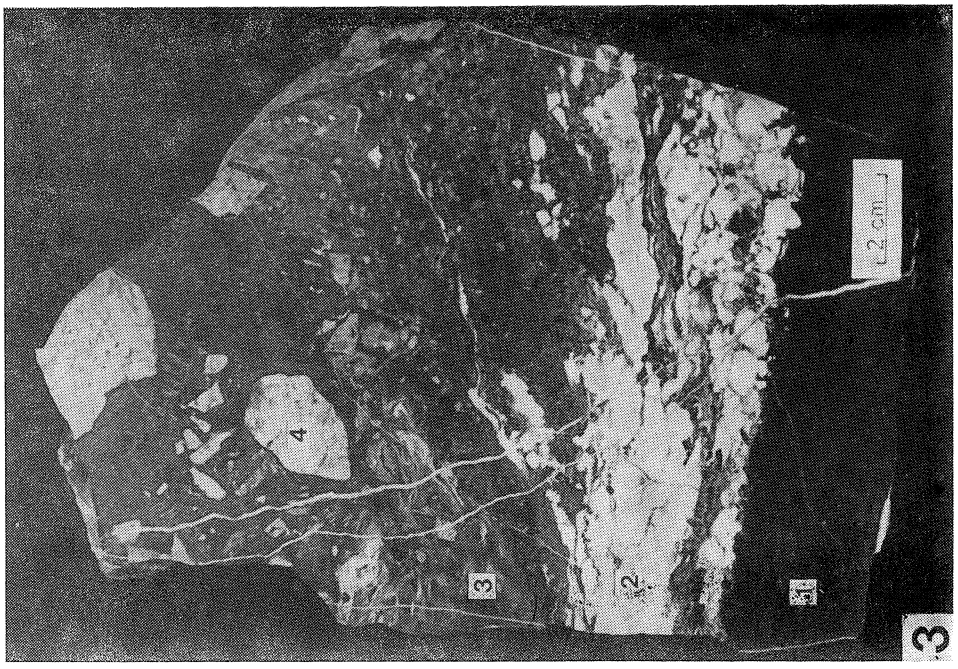

2 cm
3

Plate — Tablica II

Fig. 1. Negative print of thin section with contact of two breccia fragments of different structure divided by crystalline matrix

Fig. 1. Zdjęcie negatywowe płytki cienkiej. Kontakt dwóch fragmentów brekcji o różnej strukturze, rozdzielonych krystalicznym tłem

Fig. 2. Negative print of thin section of disturbed, strongly recrystallized and dolomitized breccia matrix

Fig. 2. Zdjęcie negatywowe płytki cienkiej. Zaburzone, silnie zrekrystalizowane tło brekcji

Fig. 3. Polished section demonstrating breccia in composite bed: 1 — dark microcrystalline dolomite, 2 — and 3 — liquefied and plasticized grey calcareous dolomite (matrix), 4 — grey microcrystalline dolomite fragments

Fig. 3. Powierzchnia polerowana ukazująca brekcję w ławicy o złożonej budowie: 1 — dolomit ciemny mikrokrystaliczny, 2 — i 3 — upłynniony i uplastyczniony dolomit wapnisty szary (tło brekcji), 4 — fragmenty dolomitu mikrokrystalicznego szarego