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**DIAGENETIC CONCRETIONS FROM THE CAVE CLASTIC  
SEDIMENT, CAVE IN TOUNJ QUARRY, CROATIA**

DIAGENETSKE KONKRECIJE IZ JAMSKIH KLASTIČNIH  
SEDIMENTOV NA PRIMERU JAME  
V KAMNOLOMU TOUNJ, HRVAŠKA

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**Izvleček**

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**Damir Lacković: Diagenetske konkrecije iz jamskih klastičnih sedimentov na primeru Jame v kamnolomu Tounj, Hrvaška**

Prispevek podaja rezultate preučevanja diagenetskih konkrecij iz Jame v kamnolomu Tounj (srednja Hrvaška). Konkrecije se pojavljajo v nestrjenem in nesortiranem klastičnem jamskem nanosu. Sestavljajo jih delci različne velikosti (od gline do prodnikov) in različnega izvora. Del kalcitnih in glinastih mineralov izvira iz kapnikov in apnenčevih jamski sten. Detritični delci, kot so roženec, kremen, muskovit, klorit, ilmenit, magnetit in večji del glin, so verjetno nanešeni v jamo s površja, s triasnih in pleistocenskih klastičnih sedimentov. Avtohtone sestavine konkrecij so limonitni pizoidi in nekaj kalcitnega veziva. Sestava konkrecij je podobna sestavi okoliškega nevezanega sedimenta.

**Ključne besede:** jamska konkrecija, jamski sediment, Jama v kamnolomu Tounj, Hrvaška.

**Abstract**

UDC: 551.44(497.5)

**Damir Lacković: Diagenetic concretions from the cave clastic sediment, Cave in Tounj quarry, Croatia**

Diagenetic concretions from Cave in Tounj quarry (central Croatia) are studied. Concretions are found in non-cemented unsorted clastic cave deposit. They consist of particles of different size (clay to pebble) and from different provenance. One part of calcite and clay minerals are coming from speleothems and cave walls limestone. Detrital particles: chert, quartz, muscovite, chlorite, ilmenite, magnetite and most of clay, are probable transported into the cave from Triassic and Pleistocene clastic sediments from the surface. Autochthonous constituents of concretions are limonitic pizoids and some calcite cement. Composition of concretion is similar to the composition of surrounding non-cemented sediment.

**Key words:** cave concretions, cave sediment, Cave in Tounj quarry, Croatia.

## INTRODUCTION

Cave in Tounj quarry is situated in Ogulin area in central Croatia (Fig. 1). The first geological investigation of the cave started because of the evidence of specific phreatic speleothems (Lacković, 1993; Babić et al., 1996).

The cave channels represent a part of an underground conduit system that drains a karst depression with the sinkholes of the Zagorska Mrežnica river situated to the SW (Fig. 2). To the north, cave channels are connected with the springs of the Tounjčica river. The cave channels penetrate Cretaceous limestones that form the middle portion of a tectonically segmented syncline in the central part of the cave.

Concretions are found in hydrological inactive channel in northern part of the cave (Fig. 3 and 4).

## METHODS

Concretions were studied microscopically. One sample was stained to identify carbonate minerals. The  $\text{CaCO}_3$  content was determined by dissolving the sample in hydrochloride acid (1:8). Insoluble residue was studied optically.

## DESCRIPTION OF CONCRETIONS AND SURROUNDING SEDIMENT

Concretions are of different size, from less than 1cm to more than 20 cm in diameter. They are spherical, ellipsoidal, sometimes flattened and irregular. They could appear individually or grow together forming irregular feature. Some of them are accreted on the cave limestones walls. In clayey sediments, besides concretions, there are also fallen blocks of phreatic speleothems.

The concretions and surrounding sediment consist of unsorted clay to over 1 cm large particles. Larger particles are mainly speleothems clasts. The arenitic particles are matrix supported. Matrix contains also some very fine probably diagenetic calcite.

Concretions contain 91% soluble carbonate material and 9% insoluble particles.

Insoluble particles are mainly quartz, chert grains, muscovite, ilmenite, magnetite, chlorite, and limonitic pisoids.

Most of quartz grains are detrital, angular to rounded and some grains are perfectly round with polished surface.

Interesting are euhedral Quartz crystals, mostly long prismatic and doubly-terminated.

Only few crystals may have a slight rounded corners. Some of crystals are crowded with inclusions of carbonate mineral, probably calcite, which are known in carbonate rocks of Croatian karst area (Tučan, 1911; Crnjaković, 1994).

## CONCLUSIONS

Concretions are formed by diagenetic cementation of unsorted cave sediments.

Their forms probably depend on the surrounding sediments. Isolated clay supported concre-

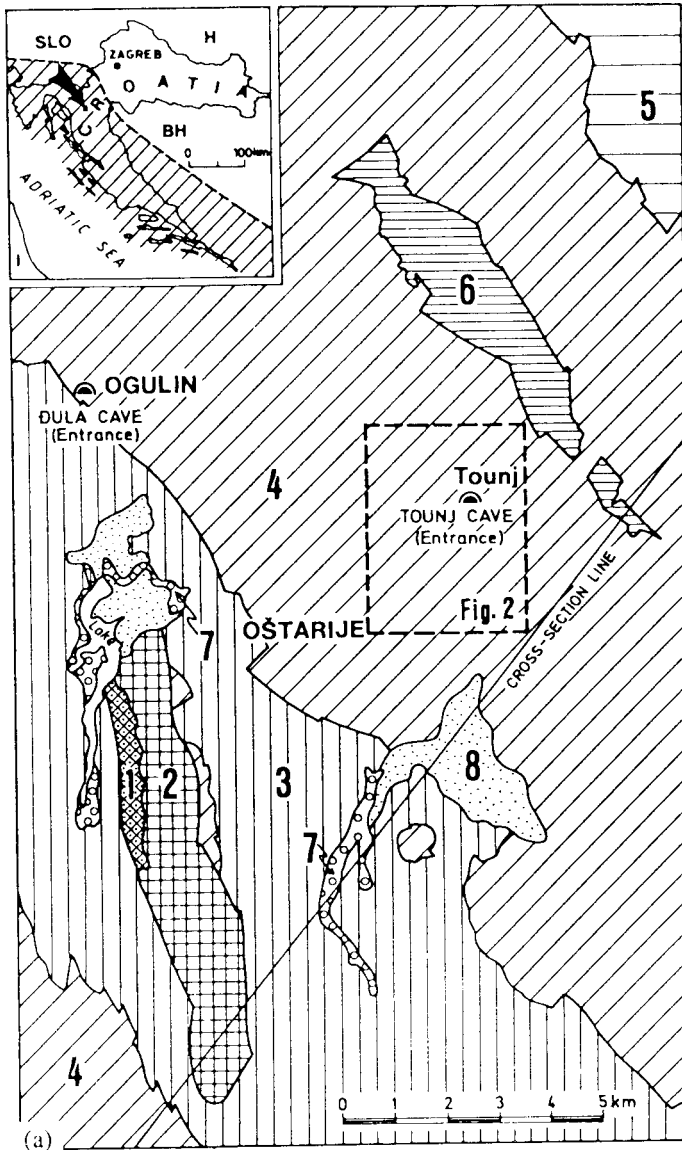


Fig. 1: General geological situation of Cave in Tounj quarry. 1: Triassic clastics (locally dolomites); 2: Triassic carbonates; 3: Jurassic dolomites and limestones; 4: Early Cretaceous limestones, occasionally dolomites; 5: Late Cretaceous limestones; 6: Miocene and Pliocene marl and sand, locally gravel and coal; 7: Late Pleistocene alluvium; 8: Holocene alluvial clastics, and swamp deposits. Simplified after Velić and Sokač (1982). Framed is the area shown in Fig. 3. The insert map shows the Outer Dinaric Belt (oblique lines), which is dominated by thick carbonate rocks and related karst. After Babić et al. (1996) (simplified).

tions are mostly spherical, while irregular concretions were formed by cementation of larger sometimes laminated material and at the contact of the concretion materials and blocs or limestone walls.

Source of detrital material may be Triassic and Pleistocene clastites from the surface, but partly also undissolved residuum of limestone (quartz crystals with inclusions of carbonate mineral) (Crnjaković, 1994) and speleothems that are shortly transported.

Composition of detrital grains in concretion and surrounding sediment is the same.

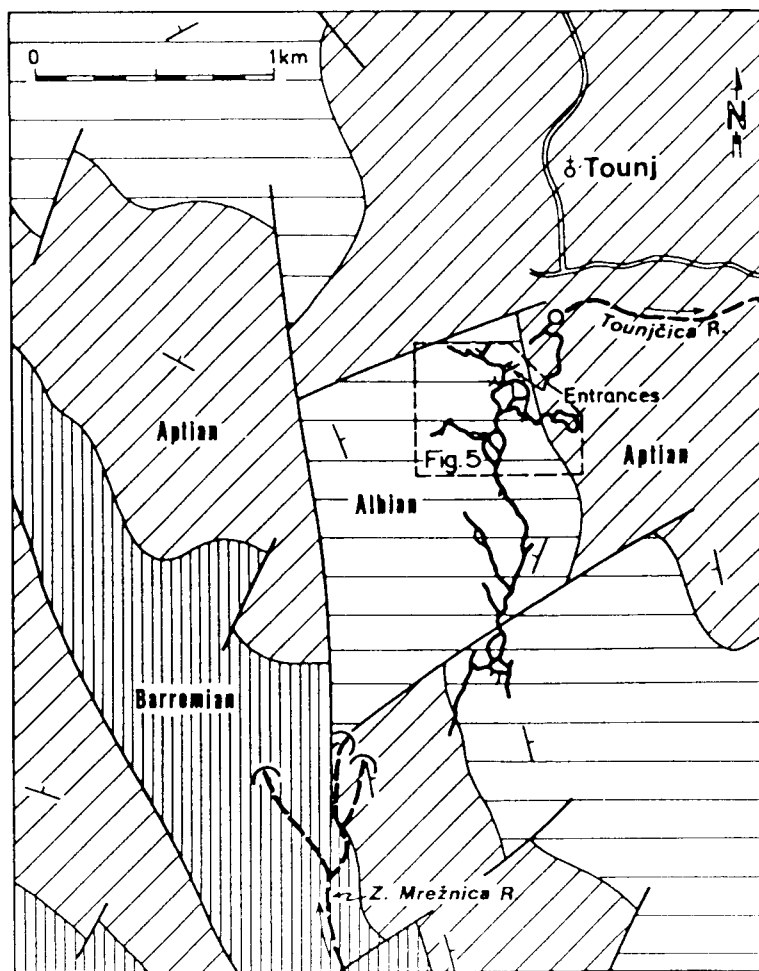


Fig. 2: Situation of the channel network of Cave in Tounj quarry (continuous lines), and related sinkholes (three crescents) of the Zagorska Mrežnica River and spring (circle) of the Tounjčica River. Rivers are represented by dashed lines. For the situation see Fig. 1. All three differentiated stratigraphic units are represented by limestones. Geological map after Velić et al. (1982) simplified). Channel network from Lacković (1993) (highly simplified).

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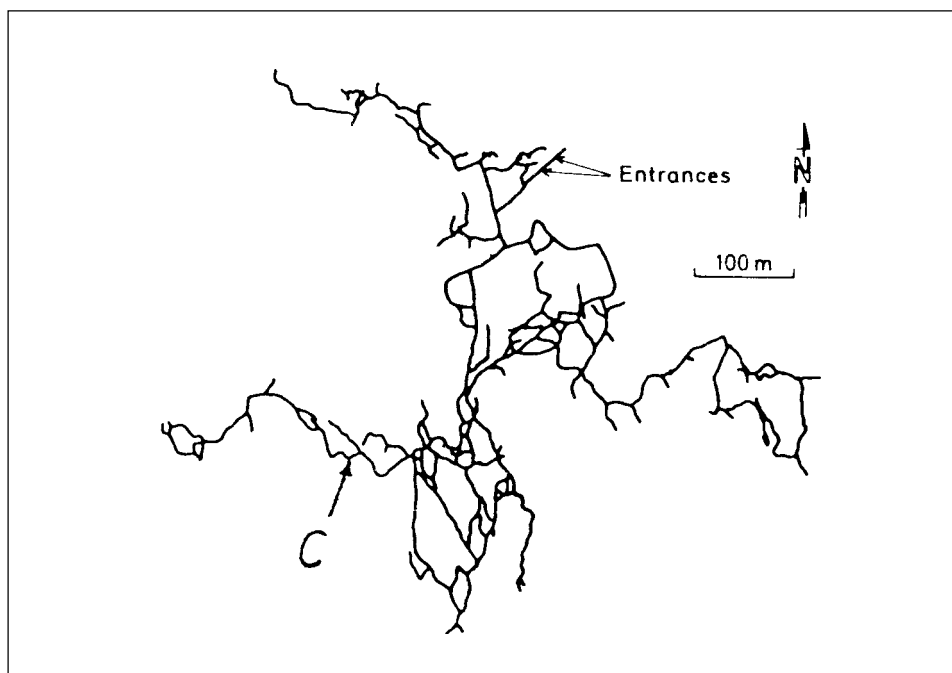


Fig. 3: The channel network of the northern part of Cave in Tounj quarry (plan) with location of investigated concretions (C). For the general situation see Fig. 1. Channel network from Lacković (1993).

## **DIAGENETSKE KONKRECIJE IZ JAMSKIH KLASTIČNIH SEDIMENTOV NA PRIMERU JAME V KAMNOLOMU TOUNJ, HRVAŠKA**

### **Povzetek**

Prispevek podaja rezultate preučevanja diagenetskih konkrecij iz Jame v kamnolomu Tounj (srednja Hrvaška). Konkrecije se pojavljajo v nestrjenem in nesortiranem klastičnem jamskem nanosu. Sestavljajo jih delci različne velikosti (od gline do prodnikov) in različnega izvora. Del kalcitnih in glinastih mineralov izvira iz kapnikov in apnenčevih jamski sten. Avtohtone sestavine konkrecij so limonitni pizoidi in nekaj kalcitnega veziva.

Konkrecije so nastale z diagenetsko cementacijo nesortiranega jamskega sedimenta. Njihova oblika je verjetno odvisna od sedimenta, v katerem se nahajajo. Konkrecije v glini so najpogosteje kroglaste, medtem ko so konkrecije nepravilnih oblik nastale s cementacijo debelejšega, včasih laminiranega gradiva, in na stiku z apnenčevimi bloki ali jamskimi stenami.

Izvor detritičnega gradiva, kot so roženec, kremen, muskovit, klorit, ilmenit, magnetit in večji del glin, je verjetno v površinskih triasnih in pleistocenskih klastitih, deloma pa v netopnem ostanku apnenca (kremenovi kristali z vložki karbonatnih mineralov) (Crnjaković 1994) in odpadlih kapnikih, ki so bili prenešeni na kratke razdalje. Sestava konkrecij je podobna sestavi okoliškega nevezanega sedimenta.



*Fig. 4: Concretions in clastic sediment. Cave in Tounj quarry. (Photo: D. Lacković)*