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OCCURRENCE OF GRYKES IN CENOMANIAN LIMESTONES OF THE ISLAND OF CRES, CROATIA

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The joints named grykes (or grikes) are karst forms filled with detritic, soil material outwashed from overlying deposits. They were developed by dissolution as a result of the karstification process through several phases. Subsequently joints are brought from the freatic zone into the vadose zone due to changes in the subsurface water regime and circulation of fluids. During this process they change their shape due the influence of tectonics and penetrate downward into underlying limestones. Thus they are subsequently widened by dissolution and in the final phase filled up either with products of surface erosion or by roof collapse.

Key words: karst, gryke (grike), Cenomanian, Adriatic carbonate platform, Cres Island

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Pukotine nazvane grajkovi su krški oblici ispunjeni detritičnim materijalom, ispranim iz pokrovnih naslaga. Te pukotine razvijene su otapanjem kao rezultat procesa okršavanja u nekoliko stadija. Nakon što su pukotine iz freatičkog okoliša dospjele u vadozni okoliš, ovisno o promjeni režima podzemnih voda i cirkulacije fluida, one mijenjaju svoj oblik pod utjecajem tektonike i prodiru naniže kroz podinske vapnence. Nakon toga pukotine su proširene otapanjem, a u zadnjoj fazi ispunjene su ili produktima površinske erozije ili urušavanjem svoda pokrovnih naslaga.

Ključne riječi: krš, grajk, cenoman, Jadranska karbonatna platforma, otok Cres

INTRODUCTION

In the region around the Koromačno Cove on the Island of Cres there are several dozens bauxite pits. The underlying deposits predominantly consist of recrystallized micritic limestones with thin-shelled radiolitids, nerineid gastropods, bivalves and various but stratigraphically insignificant benthic foraminifera. Sometimes, however, pelagic facies elements (small-sized ammonites, calcispheres) also occur. According to MAGAŠ (1973) and MAMUŽIĆ et al. (1982) these underlying limestones are of Cenomanian - Lower Turonian

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age. This is in general agreement with more recent results of GUŠIĆ and JELASKA (1990) who, more precisely, showed that the pelagic influence on the Adriatic carbonate platform first became more pronounced toward the end of the Cenomanian and, in most parts, continued into the Lower Turonian. These underlying limestones are heavily disjected which is not surprising in view of a contiguous, N - S striking fault zone, and, perhaps even more important, the overthrust contact of the Lower Cretaceous over the Upper Cretaceous, situated eastward (**Fig. 1**).

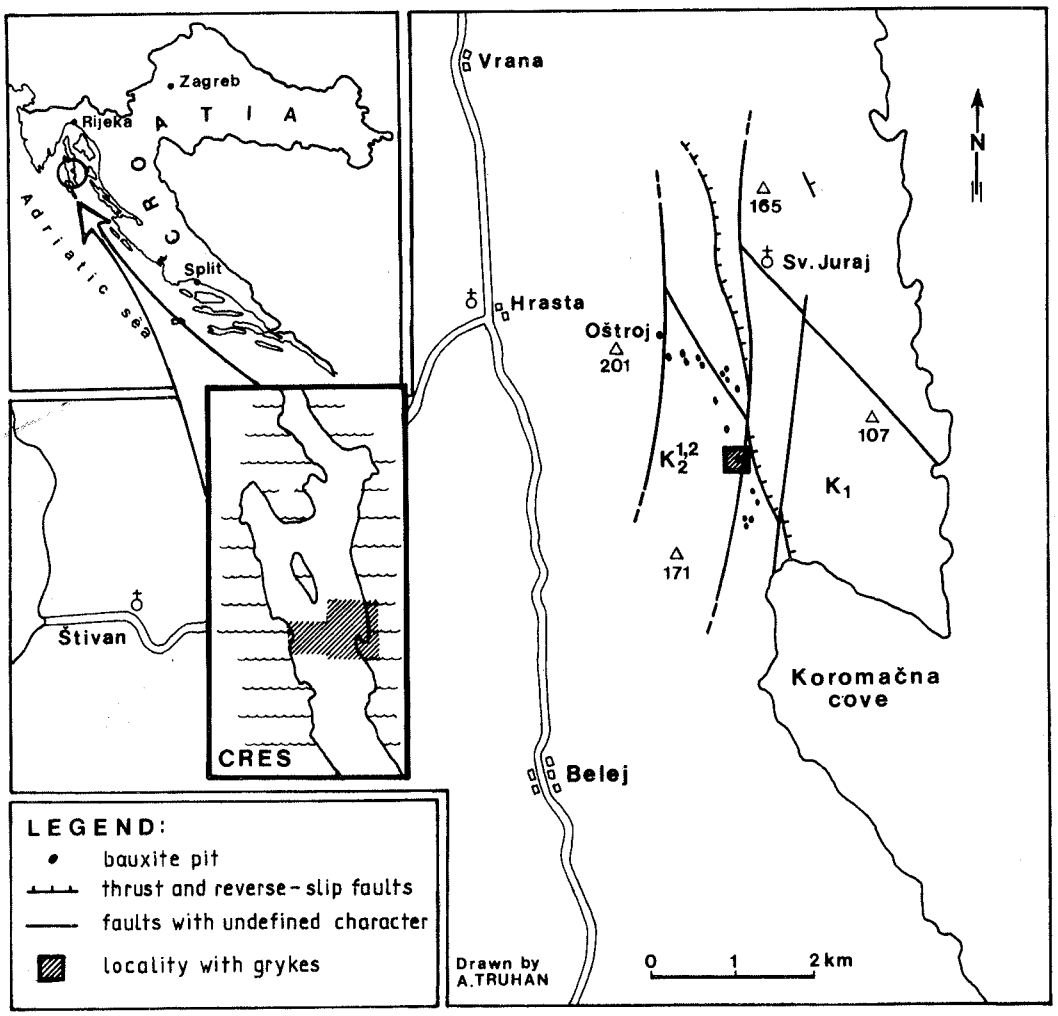

Fig. 1 Situation map

The overlying, or cover, deposits are mostly represented by alveolinid limestones, which are, according to MAGAŠ (1973) and ŠINKOVEC and SAKAČ (1981) of Lower-to-Middle Eocene age or after HOTTINGER and DROBNE (1980) and MAMUŽIĆ et al. (1982) congruent with the Cuisian age. However, older Paleocene limestones are preserved at a few localities. They are represented by Girvanella-bearing micrites, which, according to I. Gušić (personal communication, 1992) are indicative of the Paleocene at several places on the Adriatic carbonate platform.

The term gryke or grike describes karst forms, i.e. joints widened by subsequent dissolution processes. They may also, develop, under soil cover, in which case they are filled up with the clastic material from the overlying deposits. Such a system of joints is restricted to the upper 10 m or so of the karst profile below the surface, and in some cases, i.e. when it is connected with synsedimentary tectonics even deeper (KERANS and DONALDSON, 1988). In the Croatian geological literature, grykes do not seem to have been mentioned up to now.

DESCRIPTION OF JOINTS

At places, the underlying limestones show a series of joints filled up with the clastic material. The joints developed on an older tension fracture filled up with calcite (**Fig. 2, Plate 1**). They have an oval (elliptic) shape, the orientation of their longer axis being N-S, i.e. parallel with the direction of strike of one of a more recent joint set. The longer axis is, on average, about 3.5 cm long, apart from the eroded part. The shorter axis is between 1-3 cm long. Judging by the preserved part, the original depth of the joints may be estimated to amount to more than a dozen centimetres. The joints widen in their upper part, while in their lower part they narrow, resembling an inverted cone with elliptical base.

Joints and zones of crushed material enabled the subsurface circulation of vadose water, that dissolved the carbonate substrate. While any joint set would be suitable for these processes, in the case studied we are specifically dealing with joints on a calcite vein. From the phreatic zone, the joints are brought into the vadose zone due to changes in the subsurface water regime, whereby they change their shape and penetrate deeper downward (BÖGLI, 1978). During the older phase of the joint formation, which mostly takes place in the vadose zone, the roof of the joint collapses into the joint void. Of course, the final shape of the fissure depends in a large measure on its shape in the incipient stage of formation (BÖGLI, 1978). In the case studied, the detritic material which fills up the fissures comes from the overlying deposits. It consists of soil globules which came rolling down into the soil voids and thus remained preserved. One globule contains a fragment of Microcodium (Plate II, fig 1). Microcodium is well known to frequently occur in the contact zone between the cover deposits and paleokarst relief with bauxite pits. Admittedly its genesis was elucidated by KLAPPA (1978, 1980) to represent calcified mycorhizal associations, and therefore it is now considered to indicate the existence of a

paleosol, hence being a valuable criterion for recognition of continental conditions, cessation of sedimentation, and subaerial exposure.

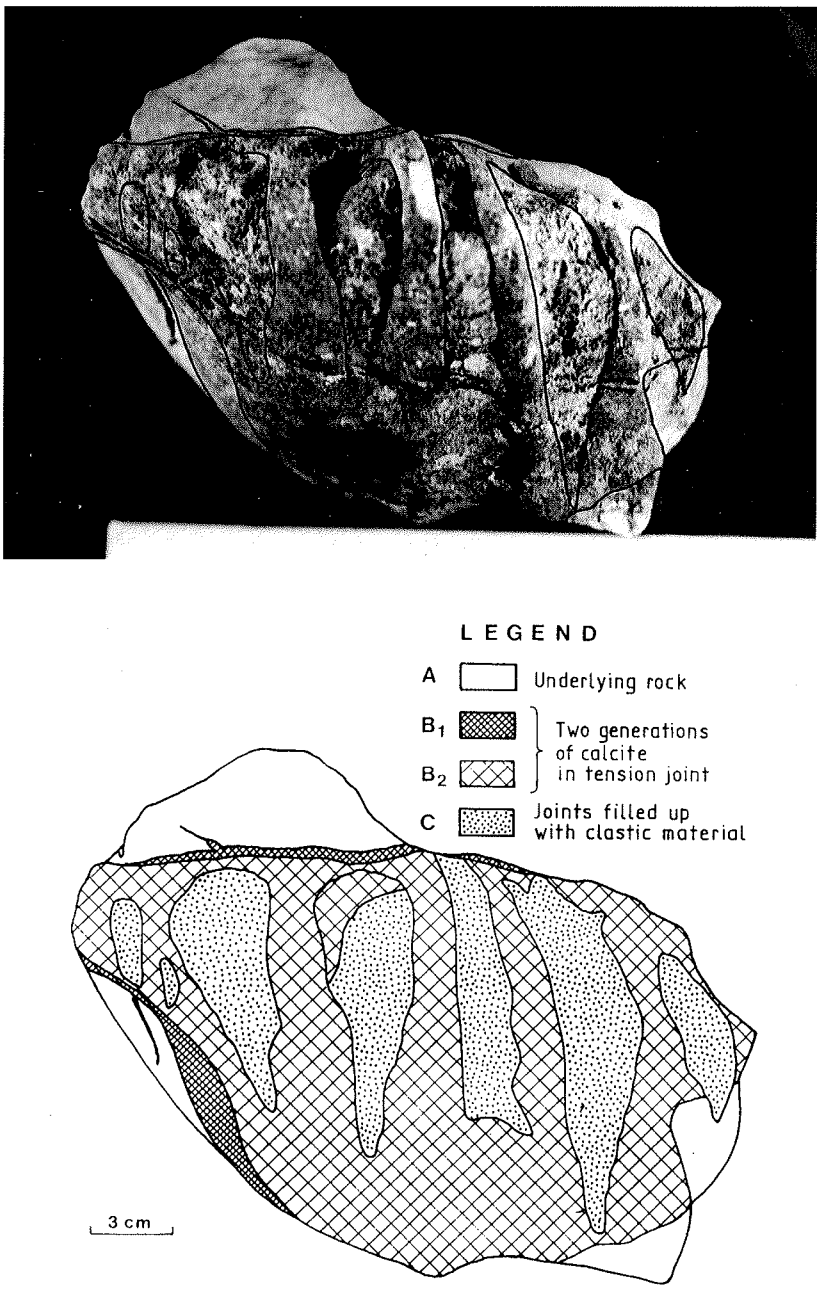

Fig. 2 Underlying rock (A) with solution joints filled up with detritical material (C), developed on tension joint with two generations of calcite crust (B_1, B_2).

CONCLUSION

The above described karst forms probably have had a polyphase origin. After karstification, which was enhanced by tectonically induced joint sets, calcite was precipitated in the voids. On these calcite-filled gaps, new fissures were formed which were subsequently widened by dissolution processes resulting in the formation of "kluftkarren". Eventually, the "kluftkarren" were filled up with detritic material coming either from the transgressively and unconformably overlying cover deposits or because soil particles were outwashed. The later assumption seems more likely, accounting for the fact that the particles making up the fissures filling are, in general, well rounded.

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SAŽETAK

Pojava grajkova u cenomanskim vapnencima otoka Cresa, Hrvatska

M. **Koić**

U području uvale Koromačna na otoku Cresu nalazi se nekoliko desetaka boksitnih jama. Podinske naslage su pretežno rekristalizirani mikritni vapnenci s pelagičkim elementima facijesa. Sadrže fosilnu faunu s gastropodima, radiolitima tankih ljuštura, amonitima, školjkama, foraminiferama i kalcisferama. Starosti su cenoman - donji turon (MAGAŠ, 1973; MAMUŽIĆ & al., 1982). Raspucanost podinskih vapnenaca je izrazita što je moguće povezati s blizinom rasjedne zone pružanja S-J i obližnje navlake donje na gornju kredu, koja se nalazi istočno (vidi sl. 1). Krovinske naslage čine pretežno alveolinski vapnenci donjeg i srednjeg eocena (MAGAŠ, 1973; ŠINKOVEC & SAKAČ, 1981), a prema HOTTINGER I DROBNE (1980) to odgovara kuizijskoj starosti. Ima i pojava starijih (paleocenskih) vapnenaca, označenih prisutnošću girvanela, koji na više lokaliteta na Jadranske karbonatne platforme označavaju paleocen (I. Gušić, usmeno priopćenje).

Naziv grajk (engl. grike, gryke) podrazumijeva krške forme, tj. pukotine proširene otapanjem, koje mogu nastajati pod klastičnim pokrovom, a ispunjene su klastičnim materijalom iz krovinskih naslaga. Taj sustav pukotina zadire u desetak najgornjih metara naslaga, ali to može biti i više ako je vezano uz sinsedimentacijsku tektoniku (KERANS & DONALDSON, 1988). Koliko mi je poznato grajkovi se u domaćoj literaturi do sada nisu spominjali.

Ponegdje se na podinskim vapnencima nalazi niz pukotina ispunjenih klastičnim materijalom. Pukotine su generirane na starijoj tenzionoj pukotini ispunjenoj kalcitom (sl. 2 i tab. I). Ovalnog su (elipsastog) oblika, a orijentacija njihove duže osi podudarna je s jednim od pružanja recentnih pukotinskih sustava (S-J). Pukotine se prema gore šire, a na dolje sužavaju nalik na stožac s elipsastom bazom.

Kroz pukotine i zdrobljene zone cirkulirale su vadozne vode otapajući karbonatnu podlogu. Pukotinski sustavi pogoduju tim procesima, a u promatranom slučaju u pitanju

su pukotine na kalcitnoj žili. Iz freatičke zone, pukotine nakon promjene režima podzemnih voda prelaze u vadoznu zonu, zbog izdizanja mijenjaju izgled i penetriraju prema dolje (BÖGLI, 1978). U starijem stadiju razvoja pukotina, uglavnom u vadoznoj zoni, dolazi do urušavanja pokrova (svoda) pukotina u pukotinsku šupljinu. Naravno krajnji izgled pukotine uvjetovan je dobrim dijelom izgledom pukotine u inicijalnom stadiju (BÖGLI, 1978). U ovom slučaju detritični materijal koji ispunjava pukotine ishodišno je iz krovinskih naslaga. Sastoji se od globula tla koje su kotrljanjem dospjele u šupljine tla i tako se očuvale. U jednom fragmentu vide se ostaci mikrokodija (tab. II, sl. 1), inače čestih u kontaktnoj zoni pokrovnih naslaga s paleokrškim reljefom boksitnih jama, koji ukazuju na stvaranje tla (KLAPPA, 1978).

Opisane krške forme nastale su najvjerojatnije u više faza. Nakon karstifikacije kojoj pogoduju pukotinski sustavi nastali tektonskim djelovanjem, došlo je do izlučivanja kalcita u šupljine. Na tim pukotinama ispunjenim kalcitom dolazi do stvaranja novih pukotina koje se proširuju otapanjem, pa nastaju forme "pukotinskih" škrapa (Kluftkarren u njemačkoj terminologiji). Te se pukotine na kraju ispunjavaju materijalom iz krovinskih transgresivnih naslaga ili spiranjem, tla što je vjerojatnije s obzirom na dobru zaobljenost čestica pukotinske ispune.

PLATE - TABLA I.

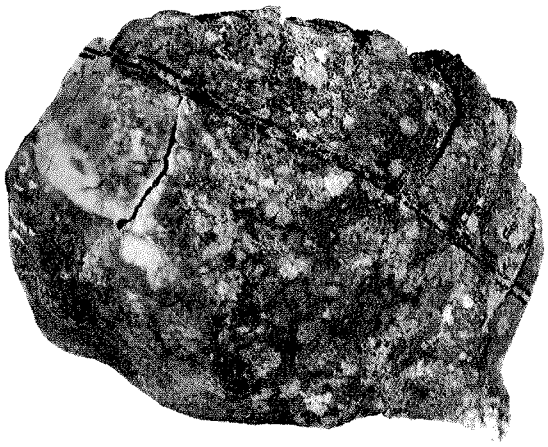
Gryke sample

1. Front view: Solution joints filled up with clastic material.

2. Side view: Solution joints developed on an older tension joint filled up with calcite.

3. Top view.

1



2

3

PLATE - TABLA II.

1. Detail of solution joint infilling. Fragment of Microcodium.

2.a and 2.b (from bottom to top): (A) underlying pelagic limestone, (B) calcite crust rimming the tension joint, (C) detritical infilling (solution joint).