

PALEOCLIMATIC RECORD OF CAVE SEDIMENTS FROM POSTOJNA KARST

by

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(3 figures)

ABSTRACT.- In the NW of Dinaric Karst, Yugoslavia, chemical and clastic sediments accumulated in the caves (Križna jama, Postojna cave system, Škocjanske jame, Divaška jama) between Mindel age and Holocene epoch. The studied sediments reflect the local paleohydrological and regional paleoclimatic conditions in the area of Black Sea - Adriatic Sea watershed between the Alps and the Mediterranean. The inference on karstification of the treated classical Karst can be connected to glacio-eustatical oscillations of the Adriatic Sea and the global paleoclimate in the Pleistocene epoch.

RESUME.- Enregistrement paléoclimatique des sédiments de grotte du Karst de Postojna. Dans la partie NW du Karst dinarique de la Yougoslavie, des sédiments chimiques et détritiques se sont accumulés dans les grottes (Križna jama, système des grottes de Postojna, Škocjanske jame, Divaška jama) depuis le Mindel jusqu'à l'Holocène. Les sédiments étudiés reflètent les conditions paléohydrologiques locales et paléoclimatiques régionales dans la région de ligne de partage entre la Mer Noire et l'Adriatique, entre les Alpes et la Méditerranée. Les conclusions sur la karstification du karst classique étudié ici peuvent être liées aux oscillations glacio-eustatiques de l'Adriatique et au paléoclimat global durant le Pléistocène.

I.- INTRODUCTION

The classical karst of the Postojna vicinity belongs to the NW part of the Dinaric karst, limited northwards by the promontory of Julian Alps and southwards by the Adriatic Sea. The watershed between the Black Sea and Adriatic Sea is passing here. The karst region has a changeable climate under the mediterranean, alpine, and panonian influences. Different climatic conditions have transformed the karst surface and underground also in the Quaternary period.

Geological history of the classical karst is very interesting (Gospodarič, 1986). In Thethys, Mesozoic and Paleogene carbonate and clastic rocks were deposited, and tectonically deformed and uplifted during Neogene. In the Quaternary the paleore-

lief karstified, which is proved by the sediments with Tegelen vegetation and fauna (Šercelj, 1962, 1965 ; Malez, 1968 ; Rakovec, 1975). In karst caves the clastic and chemical sediments were preserved, reflecting geological, paleohydrological and paleoclimatic conditions of the Pleistocene epoch. The stages of karstification processes and paleoclimatic interpretations are based on chronostratigraphy of cave sediments, which in several cases are not yet explained enough (Brodar, 1952, 1956 ; Gospodarič, 1976, 1981a, 1985a).

† This article was in the press when we sadly heard of the death of Rado GOSPODARIČ on February 12, 1988 (The editorial board).

II. CHRONOSTRATIGRAPHY OF CAVE SEDIMENTS

In classical karst, several thousands of karst caves of different dimensions are known (Habič, 1982). Among them, there are some cave systems with active and passive channels in several levels, wherein deposits, the paleoclimatic memory, are preserved. Križna jama, Postojna cave system, Skocjanske jame and Divaška jama are treated here. The caves are located on both sides of Black Sea - Adriatic Sea watershed within an area of 60 km² (fig. 1) and we suppose that they developed during the Pleistocene epoch.

similar to actual ; analyses by W. Stichler, München), Riss and Riss-Würm flowstone which originated between 200 000 and 104 000 B.P. (U/Th analyses by D. Ford, Hamilton), Würm 1 and Würm 1/2 sinter, where the majority of cave bear bones were found. In Late Würm the Medvedji rov was out of his active function ; the flowstone originated only during Holocene.

Postojna cave system (the length of known channels is 19 km) discharges the water from Postojna basin to karst Planina polje. It is composed by ponor channels of Postojnska jama (511-540 m a.s.l.) and spring channels of Planinska jama (470-500 m a.s.l.). In these channels, petrographically and stratigraphi-

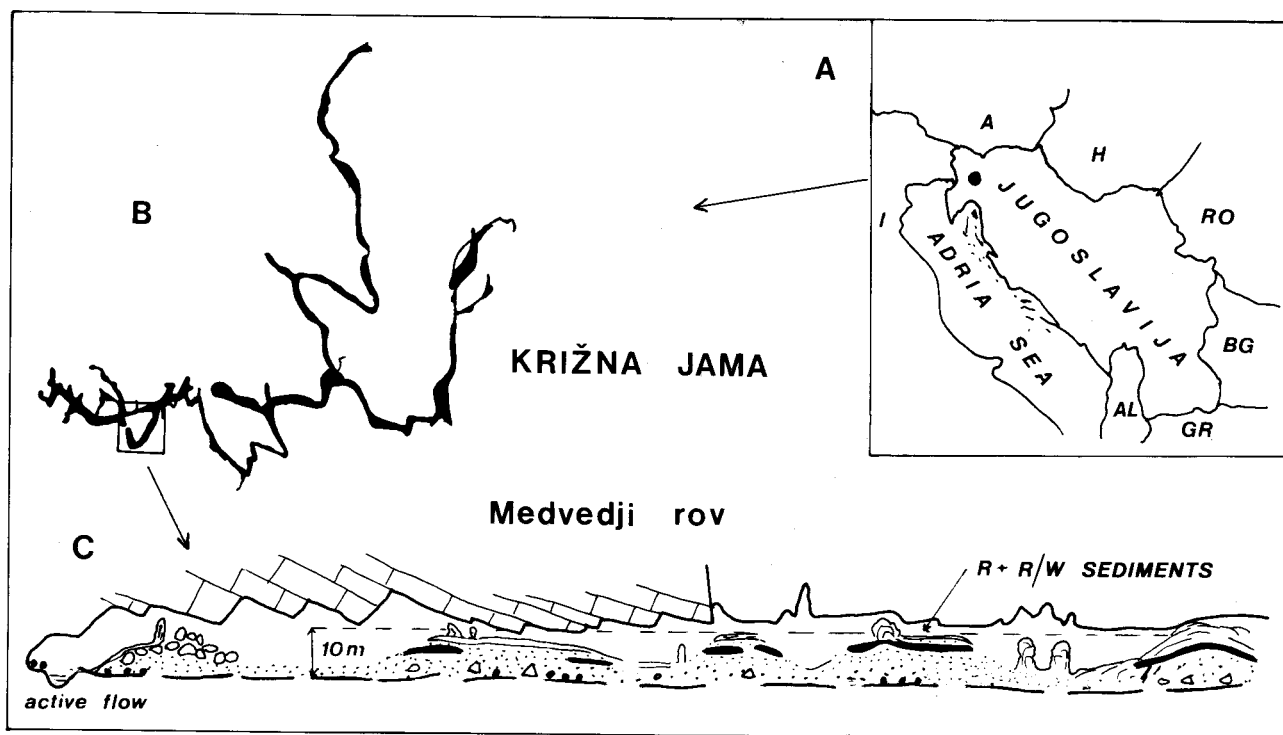


Fig. 1.- Geographical position of Postojna karst area (A), map of Križna jama (B) and longitudinal section (C) of its Medvedji rov (Bear Passage), with Riss and Riss-Würm Flowstone layers dated by D. Ford, Hamilton.

Križna jama is the best known and one of the longest (9 km) cave of the classical karst. Through active channels (610 m a.s.l.) water flows from Bloke to Cerknica karst polje ; in passive galleries (615-635 m a.s.l.) there are different allochthonous and autochthonous fills preserved, where a lot of cave bear remnants were found (Gospodarič, 1974).

The main chronostratigraphical spots were stated in the dry Medvedji rov (Bear Passage). Here (fig. 1) we have Mindel-Riss sandy loam with cave snails ($^{18}\text{O}/^{16}\text{O}$ of snail houses shows the life in a climate

cally different sediments and flowstones from Middle and Upper Pleistocene were found (Brodar, 1966 ; Gospodarič, 1976).

On rocky base there is gravel and conglomerate of coloured chert, passing to 2-5 m thick unit of laminated loam. These lacustrine sediments were probably deposited, according to finding of *Hippopotamus antiquus* (Rakovec, 1975), during the passage from Mindel to Mindel-Riss age, at the surface as in the caves.

In filled up ponor channels, gravel, sand and

loam — up to 10 m thick — were discovered. This material was deposited on the eroded base of basal laminated formation. Weathered and limonitised pebbles and the remains of warm climate *Rhinoceros D. kirchbergensis* Jäger and *Dicerorhinus etruscus* Falconeri (Brodar, 1970) prove, that the material originated on the surface in the Mindel-Riss age and was resedimented into the caves during Riss age. At the same time, the flowstone originated (ESR data-tion 200 000 B.P. ; Ikeya *et al.*, 1982). Cross sections of stalagmites and stalactites show several flood events in humid and cold climate of Riss age, while ice wedges reveal periodical gusts of dry and cold event in this periglacial area.

In Riss-Würm age, the fills were covered by re-sedimented *terra rossa* and bedded reddish flowstone. In Planinska jama, a 90 000 year old flowstone was dated (U/Th analyses by R.S. Harmon, Hamilton).

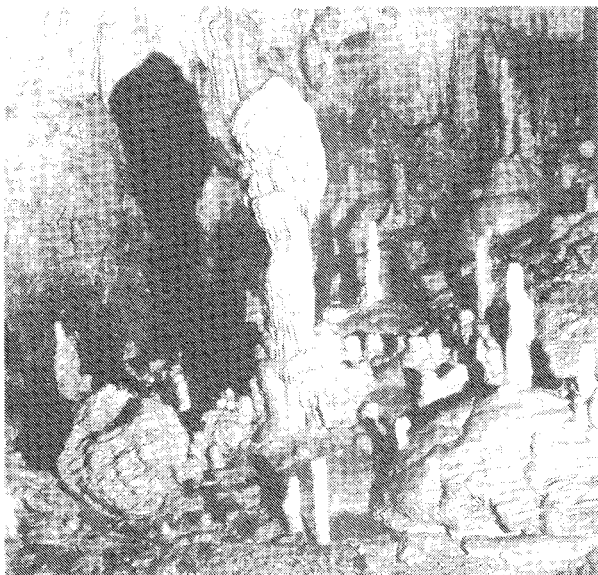


Fig. 2.- Flowstone scenery of the Postojna Cave : candle-like stalagmites cover thick broken stalagmites of Würm and Riss-Würm ages (Photo P. Habič).

In water channels of Planinska jama, Würm stage is expressed by limestone rubble fan and younger laminated loam. In dry channels of Postojnska jama there are parallel units of rubble, flowstone (fig. 2) and loam, deformed by cryoturbation (Brodar, 1966 ; Osole, 1968). In these sediments there are several remains of cave bear and other mammalia and paleolithic remnants. Würm sediments are covered by Holocene flowstones (Gospodarič, 1972, 1981b). In the Postojna cave system the fills were deposited between Mindel age and Holocene epoch too, as in Križna jama.

Škocjanske jame (5 km) include vast channels in several inclined levels between 320 m and 410 m above the sea level. In lower active channel Notranjska Reka sinks, flowing to 40 km distant springs of Timavo near the Adriatic Sea. Ponor waters can be uplifted for 100 m nowadays, flooding upper lying passages where clastic and chemical sediments are preserved (Gospodarič, 1984).

On the bedrock lie gravel, sand and loam deposits, and above them flowstone and loams of flood events up to 350 m a.s.l. Dated Postglacial flowstones are lying beyond the flood levels. Mixed sedimentation was going on within the frame of an oscillating sinking river water table, in all probability in Early Würm. Erosional processes were important in Middle and Upper Würm age which is connected to glacio-eustatical conditions of the near Adriatic Sea and to changeable hydrologic and climatic oscillations on the land.

Divaška jama on Trieste-Komen karst is a part of a fossil channel of Notranjska Reka (Paleotimavo). In a 610 m long passage (350-410 m a.s.l.), there are two units of laminated loam, flowstone and red loam and gravels exposed and then again several flowstone generations in common thickness of 60 m (Gospodarič, 1985b). The cave was filled up by laminated loam of flood type up to 405 m a.s.l. in Early Pleistocene. In Mindel-Riss age it was partly eroded, afterwards covered by rubble, flowstone and red loam of Riss and Riss-Würm ages. In Würm age rubble and flowstones originated only, the karst underground water did not reach the cave any more. Similar sedimentation was going on in the near lying cave Vilenica.

III.- CAVE SEDIMENTS AND PALEOCLIMATIC CONDITIONS

In chosen cave systems around Postojna we got comparable chronostratigraphical units of cave sediments. They reflect paleoclimatic conditions in periglacial area between the Alps and the Mediterranean in the Upper Quaternary period (fig. 3).

In the humid cold climate of the transition from Mindel to Mindel-Riss age, sediments of lacustrine type were deposited. This sedimentation can be connected to the uplift of Mediterranean Sea level from Rissian regression (– 100 m) into Tyrrhenian transgression (+ 32 m) or by stages 11 and 10 in paleoclimatic curve of deep sea core (Woldstedt, 1958 ; Nilsson, 1983 ; Bowen, 1978).

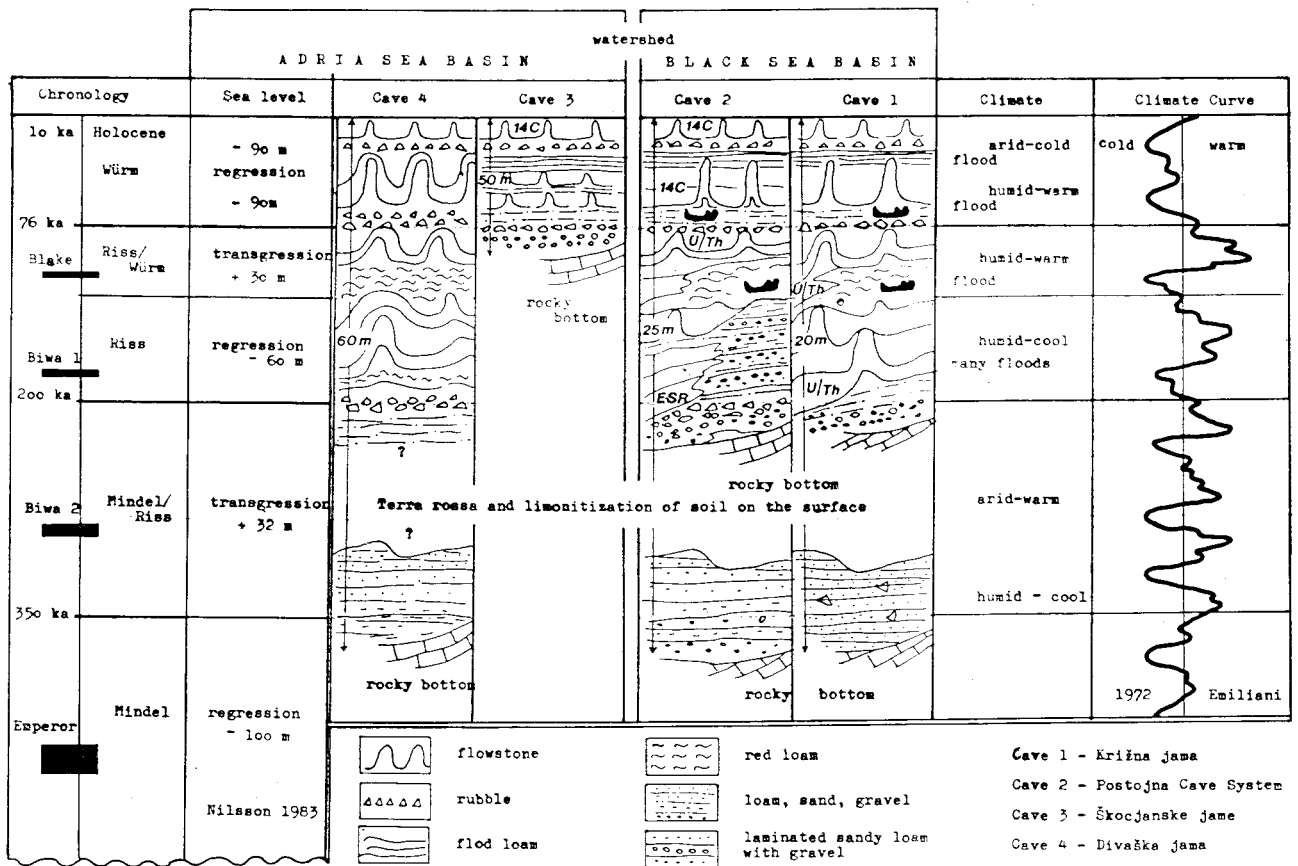


Fig. 3.- Classical Karst of Postojna (YU). Cave Sediments in the Time and Climate Scale. Composed by R. Gospodarič.

Those basal sediments were partly eroded in the caves, while on the surface they were exposed to limonitisation and lateritisation in the arid warm climate of Mindel-Riss age.

In humid and cold climate of Riss age, the ponor waters transported this material to the underground where flowstone originated simultaneously. This flowstone forming phase corresponds, in global view, to a warming, according to the paleoclimatic curve (Emiliani & Shackleton, 1974). The manner of Riss sedimentation continued into humid and warm climate of Riss-Würm age. The warming is connected to isotopic stages 6 and 5 and to a transgression of the Adriatic Sea (+ 30 m).

About 80 000 years B.P., the cold climate of Würm age predominated and autochthonous gravels, ice wedges and sand sediments of fluvio-loess type originated. The caves were flooded several times up to the roof. In Middle Würm, flowstone originated; in Würm 1/2, flood loams were redeposited. The dry and cold climate of Würm 3 is proved by rubble and breakdown flowstone.

The presented examples of the cave sediments show that different accumulation and erosional pro-

cesses were going on in the Upper Quaternary on the classical Karst. Interesting statements about arid and warm climate in Mindel-Riss age, and about flowstone formation in humid and cold climate of Riss age contribute to a new view of the Quaternary geology of the region between the Alps and the Mediterranean.

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