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MINOR KARST LANDFORMS AS AN INDIRECT METHOD FOR DATATION- THE CASE STUDY VALLEY POD KOŠUTO (SLOVENIA)

DROBNE KRAŠKE DENUDACIJSKE OBLIKE NA KARBONATNEM GRADIVU V DOLINI POD KOŠUTO

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Irena Mrak: Minor karst landforms as an indirect method for datation- the case study valley Pod Košuto (Slovenia)

The paper presents the Pleistocene morphogenesis research in the valley Pod Košuto. The area was one of the detailed studies in the wider research of the Pleistocene morphogenesis in Tržiška Bistrica river basin. Ice movements influenced the formation of valley Pod Košuto, but the research deals more with the genesis of the carbonate material that fills the right side of the valley. Researching the lithologic characteristics of the material, the measurements of particle roundness and with the help of the minor karst landforms measurements we offer the new view of the material deposition in the secondary – present location.
Key words: Pleistocene morphogenesis, minor karst landforms, moraines, rock fall material, valley Pod Košuto, Karavanke mountains, Slovenia.

Izvleček: UDK: 551.435.8(234.323.61)

Irena Mrak: Drobne kraške denudacijske oblike na karbonatnem gradivu v dolini Pod Košuto

Prispevek obravnava pleistocensko morfogenezo doline Pod Košuto, ki je bila eno od območij detajlnega preučevanja pleistocenske morfogeneze porečja Tržiške Bistrice. Dolina izkazuje ledeniško preoblikovanje, genetsko problematično pa se je izkazalo karbonatno gradivo, ki se v večjem obsegu pojavlja na desni strani doline. S pomočjo litološke analize gradiva, meritev zaobljenosti gradiva ter z meritvami drobnih kraških denudacijskih oblik – mikrožlebičev ocenjujemo obdobje odložitve gradiva na sedanjem, sekundarnem mestu.
Ključne besede: pleistocenska morfogeneza, drobne kraške denudacijske oblike, morensko gradivo, podorno gradivo, dolina Pod Košuto, Karavanke, Slovenija.

INTRODUCTION

The valley Pod Košuto is located in the Karavanke Mountains, in the north of Slovenia. The research area encounters the Geben stream watershed. The stream is the left tributary of Mošenik stream and Mošenik is the right tributary of Tržiška Bistrica river. The highest point of the researched area is Veliki vrh (2086 m); the lowest is the settlement Plaz (650 m). Among the geomorphologic processes nowadays the linear denudation and erosion prevails (the most common inclination of the surface is between 21-32° in 33-55°). The study area is covered by spruce with the forest line being at 1700 m a.s.l. Above it follows the zone of alpine dwarf pine and up to the Košuta ridge the zone of alpine grassland. Bare rock surface is located west of Veliki vrh where in form of the active scree below the vertical southwest face. Minor surface denudation is present at the valley bottom.

Between the settlement of Plaz and the Zajemen farm immense amounts of bare carbonate material are present. In the research we have studied the minor karst landforms on these carbonate blocks in order to reconstruct the process and time of the deposition of the material.

The deposition of the material is crucial in the reconstruction of Pleistocene morphogenesis in the valley, especially the existence of the valley glacier. The area was one of the case studies in a wider Pleistocene morphogenesis research of the Tržiška Bistrica river basin.

PREVIOUS RESEARCHES IN THE AREA

Melik in his book The Slovenian Alps mentions the Pleistocene existence of a glacier in the Mošenik valley. The glacier was deriving in the area of Zelenica and was joined with a side glacier from the valley Pod Košuto at today's settlement Podljubelj. Terminal moraine was defined at Plaz settlement, and ground moraine and boulders to the south of settlement Deševno. Big rock blocks

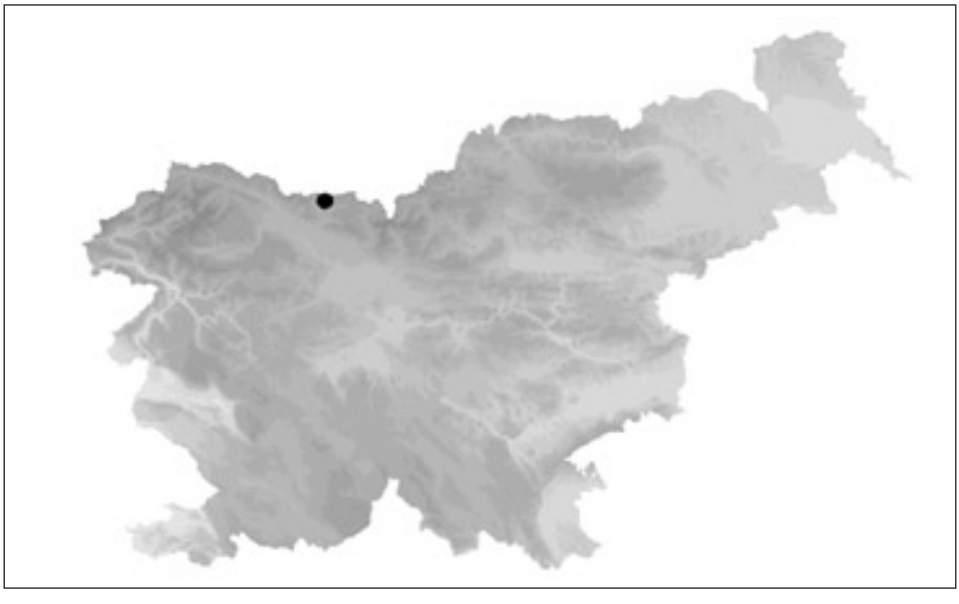

Fig1: The location of the research area in Slovenia.

were defined as remnants from the Riss glaciation. The name of the settlement Plaz (avalanche, rock slide…) by the authors' opinion derives from the large amounts of rock particles and blocks that belong to the moraine (Melik, 1954, 91, 94).

Šifrer writes about huge amounts of rock material in the valley Pod Košuto that look like ablation moraine. The retreating glacier was soaked with ablation moraine and was therefore slowed down in its retreat. The amounts of rock material were coming down in form of rock falls and slides form the SW face of Košuta, preventing the melting of the ice (Šifrer, 1969, 154).

Buser in the description by the Geologic map of Yugoslavia (sheet Celovec) determines large areas of moraines on the southern slopes of Košuta, between the high alpine pastures of Pungart, Šija and Kofce, and also in the valley Pod Košuto. The big rock blocks at the settlement of Podljubelj were defined as glacier boulders (Buser, 1980, 34).

GEOLOGIC CONDITIONS OF THE VALLEY POD KOŠUTO

The Košuta ridge is formed by Dachstein limestone and Triassic reefy limestone. Underneath them is the zone of Carnian limestone with hornfels. Under the carbonate rock layers there are Paleozoic

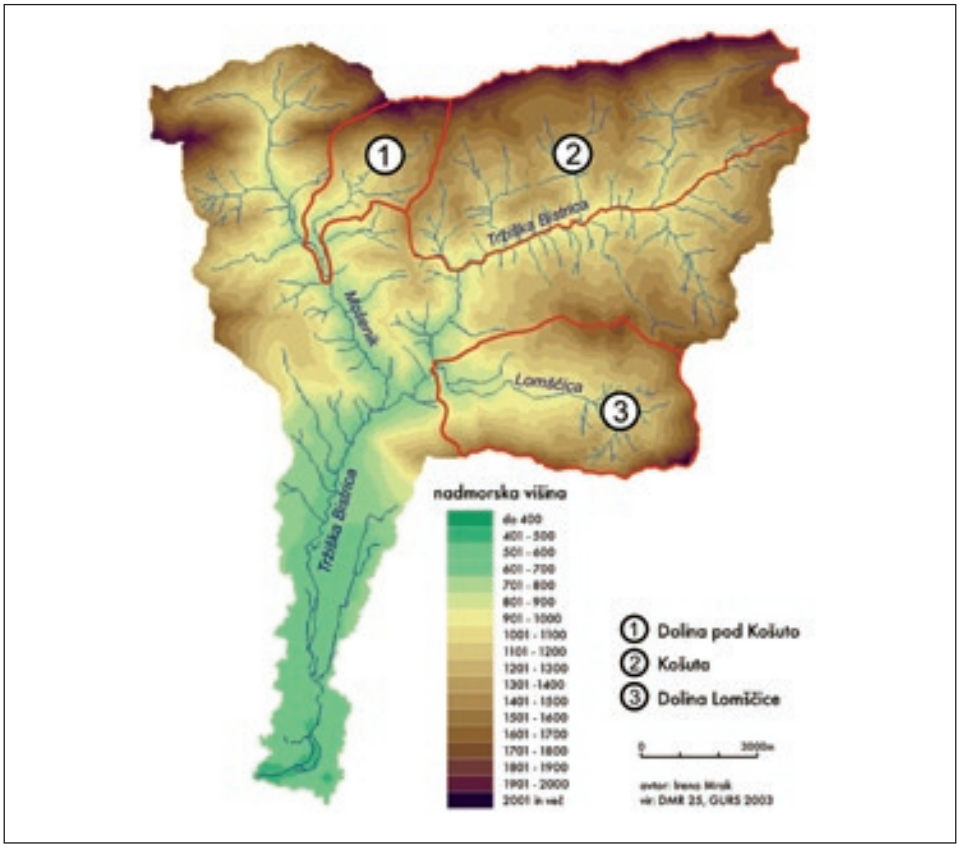

Fig 2: The location of the research area in the Tržiška Bistrica river basin.

Fig 3, 4: Large amounts of carbonate material lie only on the right side of the valley Pod Košuto. The material has sharp edges and is lacking small fractions.

rock formations on the left side of the valley Pod Košuto (mainly quartz sandstone, conglomerates, breccias and siltstones).

Major fault is defined at the base of Košuta Mountain and goes through the valley Pod Košuto (Buser, 1980).

CLIMATIC CONDITIONS

In the vicinity of the researched area there used to be one precipitation station (Podljubelj, 1026 m). The station existed already in the second part of the 19th century, under a different name – Sv. Ana under Ljubelj pass. The data for the mean annual precipitation in the period 1931 – 1960 was 1930 mm (Pučnik, 1980). The annual distribution of rainfall shows two culminations, with the higher one in the autumn months and the second one in spring. The driest months were February and March.

The data of mean temperatures was never measured. Since the temperatures mostly depend on the elevation and relief features we have studied the exposition in the area. According to digital elevation model the southern exposition prevails (54.9 % of the area). The western exposition is typical for 32.2 %, the eastern for 8.8. % and the northern for 4.2 % of the area.

Fig 5: The particle roundness.

GEOMORPHOLOGIC CONDITIONS

The cross-section of the valley Pod Košuto shows the glacier impact on slopes and valley bottom. The moraine material in the valley as well as on its slopes can't be reliably defined. Morphologically the moraine accumulation can be observed at the lowest point of the valley Pod Košuto, just before it reaches the valley of Mošenik. The accumulation is 10 – 20 m high and there are large carbonate blocks on its top. Through the accumulation the Geben stream made its riverbed.

The left side of the valley Pod Košuto has big carbonate rock blocks (up to 20 x 20 m). There are some landforms that could be moraine accumulation but due to the vegetation cover material analysis is not possible. Large areas of bare carbonate material cover the right side of the valley. The biggest amounts are in the lower part of the valley and smaller, separated areas just under the Blejec farm and above the Geben farm.

The material is lithologically homogeneous – contained of Triassic Dachstein and reefy limestone that forms the Košuta ridge. There are no other lithological units present even tough the Paleozoic rock formations are typical for the upper parts of the valley.

According to Šifrer (Šifrer, 1969) and Buser (Buser, 1980) the material is a moraine. Since lithologically the area is so differentiated one would expect the same for the moraine material. Our research showed the opposite – the material is homogeneous and lacking fine particle fractions, that are typical for moraine material.

On carbonate blocks we could define minor karst forms. Their shape and size were used as an indirect method to estimate the process and time of the material deposition on the present location.

THE MEASUREMENTS OF MINOR KARST FORMS

The corrosion intensity depends primarily on the rock type, water outlet, air temperature and biologic activities in soil (Gams, 1963). Minor karst landforms are formed by corrosion of rain and in the high altitudes also by corrosion of melted snow (Gams, 2003). According to Kunaver the minor karst landforms in the area of Kaninski podi (W Slovenia) are present as corrosion holes, solution pans, corrosion shelves, corrosion stairs, microkarren, limestone pavements, different types of solution runnels and grikes, dolines and karst trenches (Gams, 2003).

In the research area only microkarren forms were defined. The corrosion intensity can be measured by different methods. In geographic literature the most commonly used method seems to be the calculation with water outlet and water hardness (Gams, 1966). The method of measuring the limestone pedestal of boulders Bogli estimated the rate of surface lowering in Swiss Alps to be 1.51 cm +/- 10% per 1000 let (Ford & Williams, 1992). Kunaver did the field measurements of karst denudation in Slovenia on Kaninski podi. The measurements were done by micro erosion meter, on bare rock surface, where he was able to measure the direct surface karst denudation. The results show 0.035 mm of surface lowering per year. This is approximately one third of overall karst denudation, which is 0.094 mm/year in the same area. The author calculated the overall karst denudation by different already used equations. The results were comparable and the differences very small (Kunaver, 1976). Beside that Kunaver emphasizes the inevitable separation of overall and surface karst denudation (Kunaver, 1979).

	AREA AND THE AUTHOR	*MEAN ANNUAL PRECIPITATION (mm)*	*OVERALL KARST DENUDATION* [1]	*SURFACE KARST DENUDATION* [1]
1	**KANIN**, KUNAVER, 1976	3400	94	31
2	**KAVKAZ**, PULINA, 1974	3000	130	43
3	**TRIGLAV**, PULINA, 1974	2166	60	20
4	**DACHSTEIN**, BAUER, 1964	1500 – 2000	-	20[2]
5	**HAGENGEBIRGE**, HASERODT, 1965	2000 cca	-	20[2]
6	**SCHWYZER KALKALPEN**, BOGLI, 1970	> 2000	-	15-20[2]
7	**DESERT DE PLATE**, MAIRE, 1976	2500	92	30
8	**TATRE**, PULINA, 1974	1532	46	15
9	**BRENTA, GROSTEDI**, NICOD, 1976	1200	-	15+
10	**MARGUAREIS**, JULIAN, ARTIN, NICOD, 1978	1500	40	13
11	**DEVOLUY**, NICOD, 1978	1300	36	12

[1] *m^3/km^3/year or mm/1000 years*

[2] *the height of karst table pedestal*

Fig 6: The karst denudation data in high altitude karst areas (Kunaver, 1979).

Fig. 7: Minor karst landforms on one of the bare rock blocks under the SW face of Veliki vrh.

Fig. 8: Non-carbonate fossil remnants above the carbonate block surface in the valley under the Blejec farm.

Fig. 9: Rock fall area in the SW face of Veliki vrh.

In the research area of the valley Pod Košuto we have measured the sizes of minor karst landforms – microkarren (their depth and length). Beside that we also measured the height of non-carbonate fossil remnants above the carbonate block surface. The surface of blocks is exposed to rain and snowfall and the direction of microkarren shows that they were formed on the present (secondary) location.

The results were compared to data from the chart of karst denudation in high altitude karst areas (fig. 6). On that basis we estimated the time of material deposition.

MEASUREMENT RESULTS

The measurements were taken place on two different locations of bare carbonate rock blocks. One was under the southwest face of Veliki vrh (Birški plaz, 1200 m) and the second was in the valley, below the Blejec farm (780 m). On both locations 200 measurements of length and depth were done, accompanied by measurements of non-carbonate fossil remnants above the carbonate block surface.

The hypothesis was that the rock blocks are exposed to corrosion from the time of deposition at the present location and that with the measurement results we will be able to estimate how long the material is at the present location. The corrosion intensity is 20 mm/1000 years in the areas with the precipitation of 2166 mm per year (Kunaver, 1979). The data is for the area around Triglav (2863 m). It has to be taken into the account that the research area is lower and has less precipitation (1930 mm).

The measurements on our first location showed the average microkarren depth of 5 mm. The same value was measured for non-carbonate fossil remnants above the carbonate block surface. On the second location the result was 4 mm. The average length of microkarren on both locations was 5 to 10 cm.

Considering the data we propose that the material deposition on the present location was taking place in historical period, could be few to 500 hundred years ago but definitely not in the Pleistocene.

The material origin is with no doubt the SW face of Veliki vrh that is influenced by strong mechanical weathering. The consequences are seen as active scree (Birški plaz). The material in the valley Pod Košuto was deposited by many rock falls. There is no reliable historical data available, only the legend of the establishment of the Tržič settlement, which describes the catastrophic rock fall in the SW face of Veliki vrh.

According to relief features of the valley Pod Košuto and with the results of minor karst landforms measurements we define the material in the valley to be of rock fall origin. Only at the very end of the valley, just before it reaches the main valley of Mošenik stream we define the moraine accumulation, also covered by rock fall debris.

With the definition of the moraine accumulation we were able to calculate the height of local snow line in Würm glaciation, which was at 1360 m above sea level.

The map of geomorphologic processes in Pleistoen and Holocen (Fig. 13) proposes the possible extent of glacier. Since the side moraines are eroded we can only estimate the glacier size. The accumulation zone of the glacier was in a cirque, under the Veliki vrh ridge, at 1600 – 1700 m a.s.l. The cirque itself is shallow but has a well-defined rock bend on the side, where the glacier was

Fig. 10: The Košuta ridge consists of Dachstein limestone, Triassic reefy limestone and Carnian limestone with hornfels.

Fig. 11: Carbonate material is located only on the right side of the valley Pod Košuto.

moving down the valley. The glacier length was 4.5 km. Glaciated were also the southern slopes of Veliki vrh.

The major rock falls occurred in Holocen, when the slopes were already non-glaciated. There is still one problematic fact to be looked into - the material is emerging only on the right side of the valley. One hypothesis is that a bigger rock fall happened at the end of Pleistocen when the valley was still partially filled with the stagnant ice. Between the ice and the right slope the side depression was formed. Since the rock fall derives from the face above the right side of the valley the falling material filled mostly this depression. This fact is still to be studied more in details since the hypothesis is overthrown by the size of minor karst landforms.

CONCLUSION

The research on Pleistocen morphogenesis in the Tržiška Bistrica river basin encounters the detailed study of valley Pod Košuto in the Karavanke Mountains. The shape of the valley shows the glaciation impact in the Pleistocen. The core of the study was a large amount of carbonate material that is located on the right side of the valley. Former researchers defined the material as a moraine. The thorough study of the material showed that despite the various lithologic units in the researched area, the material is totally homogeneous. It consists only of Triassic Dachstein limestone and reefy limestone that form the Košuta ridge. The sizes of rock particles are different – from big blocks (up to 10 x 10 m) to granule. The smaller grain sizes that are typical for moraines (fine sand, coarse silt…) are missing. The grain edges are sharp. For further reconstruction of material deposition we

Fig. 12: Minor rock falls are nowadays mostly present in spring due to mechanical weathering.

studied the minor karst landforms on bare rock blocks surface. The measurements were done on two locations – under the SW face of Veliki vrh (Birški plaz, 1200 m) and in the valley, below the Blejec farm (780 m). The microkarren are shallow and short on the basis of which we propose that the material was deposited on present location in Holocen, by various rock falls from the SW face

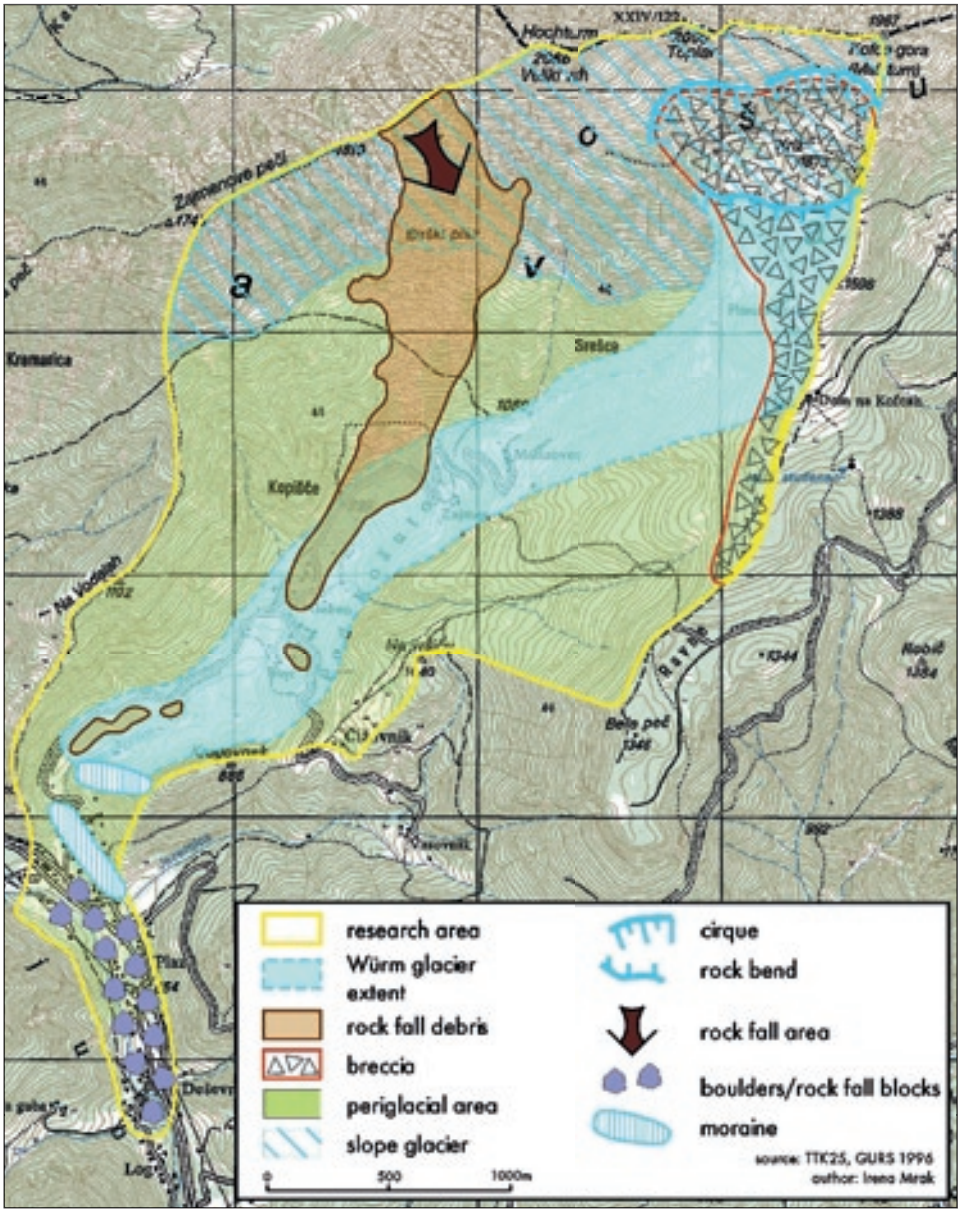

Fig. 13: Geomorphologic processes in the researched area in Pleistocene and Holocen.

of Veliki vrh. The fact that the material is located exclusively on the right side of the valley Pod Košuto should be still studied further on.

DROBNE KRAŠKE DENUDACIJSKE OBLIKE NA KARBONATNEM GRADIVU V DOLINI POD KOŠUTO

Povzetek

V okviru raziskave o pleistocenski morfogenezi v porečju Tržiške Bistrice smo detajlno preučili dolino Pod Košuto, v Karavankah. Dolina izkazuje ledeniško preoblikovanje, kar je posledica procesov v pleistocenu. Kot problematično se je izkazalo karbonatno gradivo, ki se v velikih količinah nahaja na desni strani doline. Pretekla preučevanja območja so gradivo označila za morensko. Z natančnim pregledom gradiva smo ugotovili, da kljub pestri litološki zgradbi območja gradivo v celoti sestavlja triasni dachsteinski in grebenski apnenec, ki gradi greben Košute. Velikosti kosov so zelo različne – od velikih skalnih blokov višine nekaj metrov, do drobirja, niso pa prisotne drobne frakcije, kot so melj, mulj in glina, ki so značilne za morensko gradivo. Ob opazovanju zaobljenosti delcev smo ugotovili, da so delci zelo oglati. Za nadaljnjo opredelitev geneze odložitve gradiva smo uporabili meritev drobnih kraških oblik na golih skalnih površinah, in sicer na dveh merilnih mestih – na Birškem plazu in pod kmetijo Blejec. Mikrožlebiči so zelo slabo razviti, plitvi in kratki, kar nakazuje na dejstvo, da je bilo apnenčasto gradivo na to mesto odloženo v holocenu. Menimo, da gradivo ni morensko, ampak je posledica večih zaporednih skalnih podorov z jugozahodne stene Velikega vrha, ki so se zgodili pred nekaj sto leti. Dejstvo, da se gradivo nahaja zgolj na desni strani doline nekoliko zaplete razlago geneze in to dejstvo bo potrebno z bodočimi nadaljnjimi raziskavami natančneje obdelati.

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