Paleomagnetic investigation of some Slovak Quaternary travertines

I. Túnyi, E. Köhler
Geophysical Institute of the Slovak Academy of Sciences[1]

A b s t r a c t: Present publication is the first attempt to use Slovak fresh-water limestones for paleomagnetic investigation. Samples were collected from six well-known Slovak localities. The small values of rotation of the main paleomagnetic direction, from the present direction of geomagnetic field, confirm the tectonical stability of Slovak territory during the Quaternary. Paleomagnetic methods are capable to contribute in the future to the precision of Quaternary stratigraphy of Slovakia.

Key words: Slovakia, Quaternary, fresh-water limestones, first paleomagnetic results

1. Introduction

Quaternary fresh-water limestones (travertines) have in the frame of Quaternary deposits particular position by their origin, lithology and morphology. While the majority of sediments is incoherent (gravels, sands, loesses) only travertines build up morphologically limited bodies and crusts, suitable for paleomagnetic investigation.

Slovakia is a country extraordinary rich in the deposits of fresh-water limestones. *Kovanda (1971)* registered 371 deposits of various types. Travertine belonged in 20th century to desirable decorative building material (localities Bešeňová, Dreveník), well-known is also their connection with springs of mineral waters (Vyšné Ružbachy, Čerín) and they became famous also by paleontological and anthropological discoveries (Hôrka). Extensive literature, meanwhile monographies of *Ivan (1941)* and *Kovanda (1971)* is devoted to their investigation.

[1] Dúbravská cesta 9, 845 28 Bratislava, Slovak Republic; e-mail: geoftuny@savba.sk

Tab. 1. Stratigraphic position of studied travertinites

	Holocene	Čerín
0	Würm	glaciation
	Riss-Würm	Hôrka
	Riss	glaciation
	Mindel-Riss	Bešeňová, Lúčky, Vyšné Ružbachy
	Mindel	glaciation
500000	Günz-Mindel	
1000000	Günz	glaciation
1500000	Donau-Günz	
	Donau	Spišské Podhradie-Dreveník
2000000		

The travertines have originated from water solutions comprising dissoluted compounds of calcite prevailingly in the form of calcium carbonate as a result of physical-chemical and biochemical processes.

The Slovak travertines originated during the whole Quaternary period in the time span of 2 million years. The individual localities have different ages (Tab. 1).

Paleomagnetic investigation of Slovak fresh-water limestones is in its beginning and present results are the first from the Slovak territory.

2. The studied localities

From the large number of localities of well known Slovak travertines the next six were selected:

1. *Spišské Podhradie-Dreveník*
   From this locality came the oldiest Slovak travertines. *Vaškovský and Lažek (1973)* dated their time span in 1,5-2 million years (Donau, transition Donau-Günz – Tab. 1). The samples were collected in the south margin of the hill Dreveník.

2. *Lúčky-Skalničky*
   Samples were collected from the outcrops of travertines in the left bank of the brook Teplička near the road in the spa Lúčky. The origin of travertines is estimated in transition the Mindel-Riss (300 000–400 000 years).

3. *Bešeňová - Báňa*
   Abandoned quarry "Báňa" is situated in the western part of the hill Skala (north of village Bešeňová). The travertine body is disintegrated by deep dislocations into separate blocks.
   The travertines in the surrounding of Bešeňová originate also in present time, but travertine from quarry "Báňa" is dated into transition the Mindel-Riss (300 000 – 400 000 years).

4. *Vyšné Ružbachy*
   Samples for paleomagnetic investigation were collected in abandoned quarry over the Ružbašský potok-brook (locality Hrbek). This travertine is dated in the transition the Mindel-Riss (300 000 – 400 000 years).

5. *Hôrka*
   Near the road from Švábovce to Jánovce (8 km SW of Poprad) is exposure of very firm travertine in irregular banks. In this locality were discovered remains of Homo preandertalensis.
   The origin of travertine is dated in transition the Riss-Würm (about 1000 000 years).

Tab. 2. Results of paleomagnetic measurements from the Quaternary travertines of Slovakia. n – number of specimen; J – mean magnetization; κ – mean magnetic susceptibility; k, α_{95} – Fisher statistical parameters *(Fisher, 1953)*; D, I – declinations and inclination of paleodirections; CW - clockwise; CCW – counterclockwise

No.	Locality	Age Ma	n	J[nT]	$\kappa \cdot [10^{-6} u{\cdot}\mathrm{SI}]$	k	α°_{95}	D°	I°	Rotation
1	Sp. Podhradie	1.5 - 2	5	0.029	−15.76	12	23	6	58	6° CW
2	Lúčky	0.3 - 0.4	8	0.140	16.86	101	6	2	41	2° CW
3	Bešeňová	0.3 - 0.4	3	0.042	4.43	46	18	13	69	13° CW
4	Vyš. Ružbachy	0.3 - 0.4	8	0.184	−0.31	70	7	6	66	6° CW
5	Hôrka	0.1	9	0.025	−16.60	14	14	351	52	9° CCW
6	Čerín	0.025	3	0.037	8.13	8	47	15	46	15° CW

6. *Čerín*
   Between the villages Dolná Mičiná and Čerín (9 km SE of Banská Bystrica) in the place named "Hornie Saly" in present time precipitate the crusts of travertine from mineral spring. Samples were collected from the most firm parts of crusts, their age is estimated to 25 000 years (Würm).

3. Paleomagnetic measurements

Paleomagnetic measurements were performed in Paleomagnetic laboratory of the Geophysical Institute SAS Bratislava. Thermal demagnetization for magnetic cleaning was used on the MAVACS demagnetizing instrument. All investigated rock samples were weakly magnetized. Into some of them is strong diamagnetic component with negative magnetic susceptibility (Tab. 2). During thermal demagnetization the magnetic susceptibility was measured after each step together with magnetization. It was measured on kappa-bridge KLY2. Both mentioned equipments are of production AGICO comp., Brno. Examples of demagnetization characteristics present Figs 1

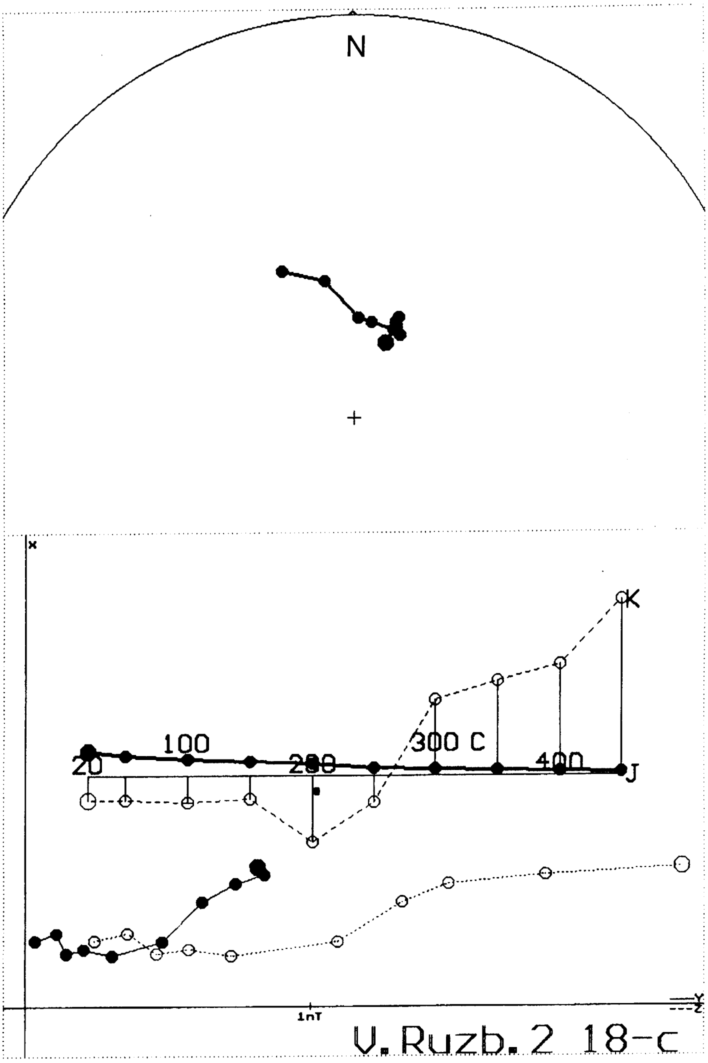

Fig. 1. Graphs of thermal demagnetization of sample nom. 218-c from loc. V. Ružbachy. J – magnetization, K – magnetic susceptibility. Zijderveld diagrams of the xy and xz components. Up – stereoprojection of paleodirections after each step of demagnetization. Large dot – start of demagnetization. N – North.

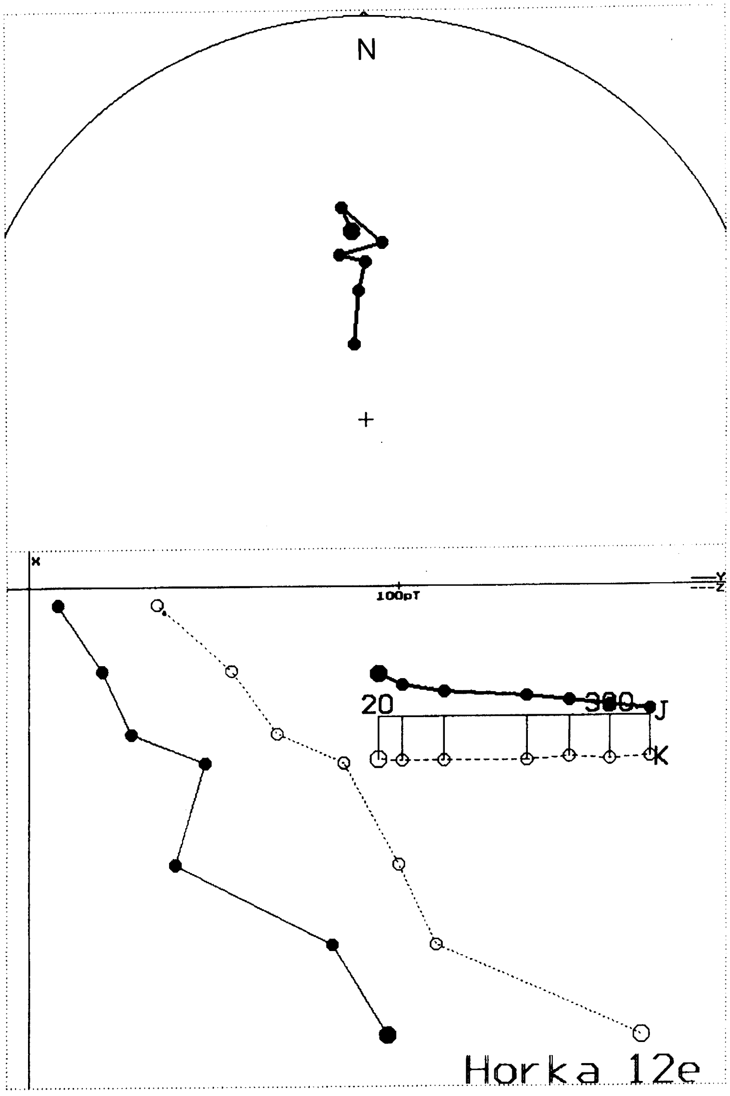

Fig. 2. Graphs of thermal demagnetization of sample nom. 12e from loc. Hôrka (exp. see Fig. 1).

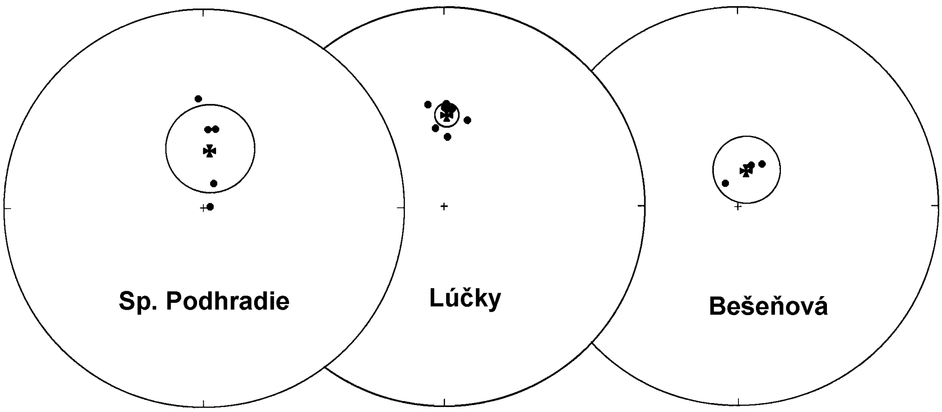

Fig. 3. Stereoprojection of paleodirections from locs. Sp. Podhradie, Lúčky and Bešeňová.

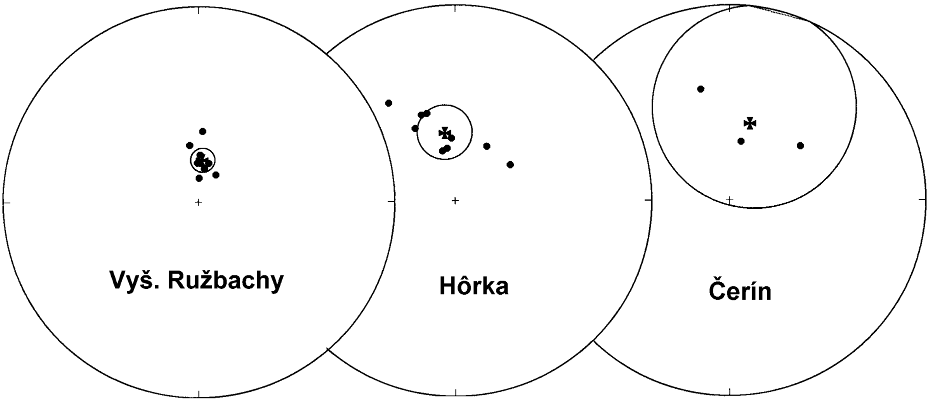

Fig. 4. Stereoprojection of paleodirections from locs. Vyšné Ružbachy, Hôrka and Čerín.

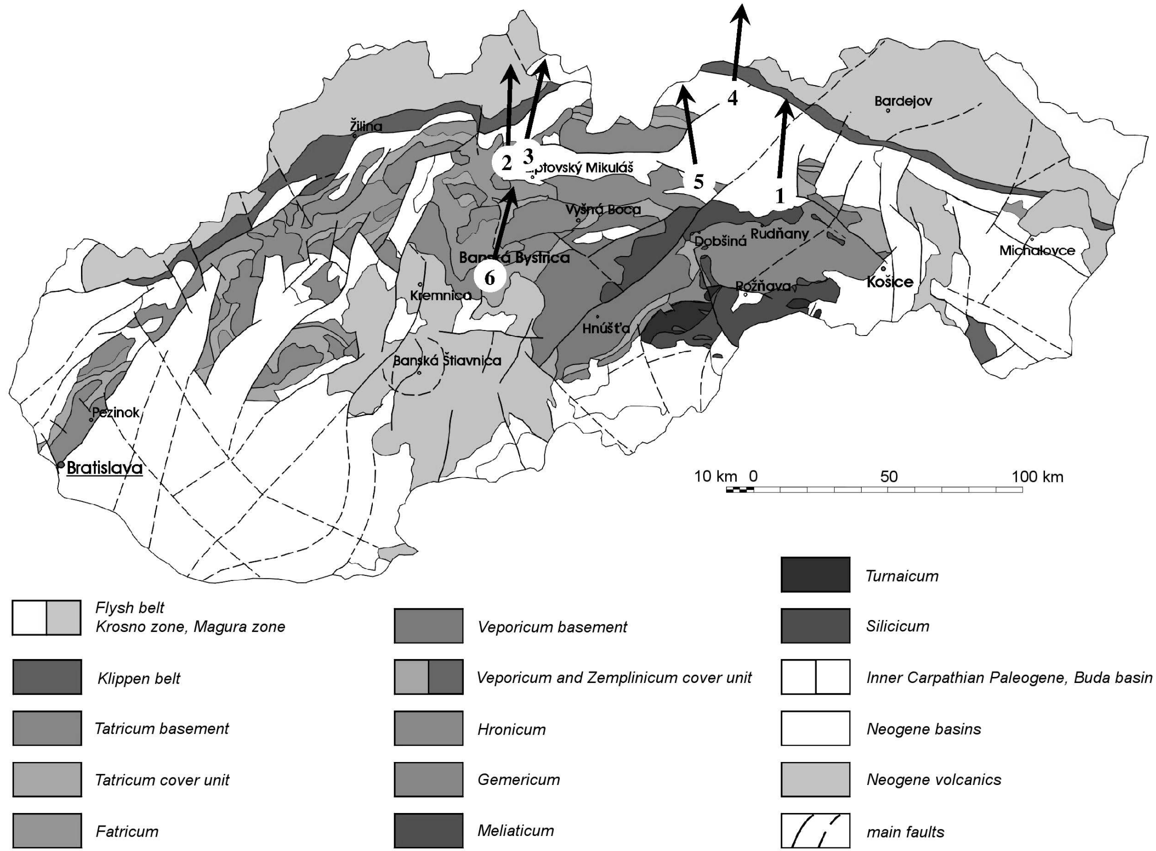

Fig. 5. Paleodirections of the Quaternary travertines of Slovakia: 1 – Spišské Pohradie, 2 – Lúčky, 3 – Bešeňová, 4 – Vyšné Ružbachy, 5 – Hôrka, 6 – Čerín.

and 2. The method of standard elaboration analysis of demagnetization graphs and Zijderveld diagrams as well as Fisher statistics for derivation of paleodirections were used *(Mc Elhinny and Mc Fadden, 2000)*. The results are presented on Figs 3, 4 and 5 and in Tab. 2.

4. Conclusion

While the history of the Western Carpathians before the Quaternary is rich in dramatic events such as orogenetic movements, rotations, lateral shifts and vertical displacements, the Quaternary period is noted for a considerable tectonical stability. As a result of paleomagnetism of this bodies and crusts of travertines (with some exceptions – for example gravitational sliding, see i.g. prolongated dispersion of the paleodirections from loc. Sp. Podhradie in Fig. 3 or loc. Hôrka and part. loc. Čerín in Fig. 4) are on the place of their original position. This fact is confirmed also by small values of rotation of main paleomagnetic direction from the present direction of geomagnetic field (Tab. 1).

Acknowledgments. The authors are grateful to VEGA, the Slovak Grant Agency (grant No. 4042) for the partial support of this work.

References

Fisher R. A., 1953: Dispersion on a sphere. Proc. R. Soc. London, A217, 295–305.

Ivan Ľ., 1941: Výskyty travertínov na Slovensku. Práce Štát. geol. ústavu, Bratislava, 9, 1–71.

Kovanda J., 1971: Kvartérní vápence Československa. Antrhropozoikum, Praha, 7, 52–154.

McElhinny M. W., McFadden P. L., 2000: Paleomagnetism, Academic Res., 386 p.

Vaškovský I., Ložek V., 1973: Korelačná schéma stratigrafie kvartéru na území Slovenska. In: Kvartér Slovenska, Geol. ústav D. Štúra, Bratislava, 247 s.