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Predslov

Milé kolegyne, vážení kolegovia, ctení účastníci ŠVK PriF UK 2019,

keď pred vyše dvomi tisícročiami prenikol veľký Herodotos z Halikarnassu svojimi myšlienkami a sprostredkovanými informáciami ďaleko na sever od vtedajšej kolísky civilizácie, ostal len pri skromných slovách: „Ako hovoria Tráci, v tom kraji za Dunajom žije toľko včiel, že sa cez ne nedá ani krok ďalej dostať“. A tak trošku úsmevne dostávame my prírodovedci o tom našom kraji slovami naozaj prvého významného geografického kompendia do vienka tradíciu prírodovedného vzdelávania. Tradíciu, ktorú v neskorších dobách budovali v tomto regióne mnohí velikáni myslenia a poznávania. Možno v tejto súvislosti aj slávny Johannes Müller von Königsberg, inak slovutný profesor našej bratislavskej Istropolitany, jednej z najstarších stredoeurópskych univerzít, ktorého prelomové prírodovedné dielo *De triangulis omnimodus libri quinque* s nádychom heliocentrizmu dávno pred Kopernikom si pre svoje zámorské objavné cesty objednal aj sám Kolumbus.

Dnes na Regiomontanovom odkaze a tradícii stoja aj základy Univerzity Komenského. Iste sa príliš nevzdialim od pravdy, keď zdôrazním, že jej Prírodovedecká fakulta patrí k tým najprestížnejším vedecko-pedagogickým inštitúciám, na ktoré sme na Slovensku právom hrdí. Áno, i napriek 8 desatinám HDP, ktoré naša republika ročne delimituje na vedu a výskum, čo predstavuje na obyvateľa štyrikrát menšiu dotáciu ako priemer EÚ a sedemkrát nižšiu, ako je tomu v susednom Rakúsku. Ale dovoľte mi zároveň podčiarknuť tézu, že v dobe keď sa k nám míľovými krokmi približujú skvalitnením svojej publikačnej činnosti aj naše sesterské inštitúcie (počet vedeckých publikácii na Slovensku na obyvateľa vzrástol za posledných 10 rokov nevídane dvojnásobne), no počet citácií na ne zastagnoval a predstihol len Rumunsko, ostáva jasnou víziou dôraz na kvalitu publikačných výstupov.

Ste na správnom mieste s tou najvyššou koncentráciou inventívneho potenciálu, intelektu, talentu a objaviteľského entuziazmu v prírodných vedách na našom území. Na mieste, ktoré sa napriek

nepriazni doby a tak trošku až zvrátenému rebríčku hodnôt a priorít spoločnosti, v ktorom sa úcta k múdrosti a vzdelaniu prepadla takmer na jeho samé dno, drží prísnych a nekompromisných štandardov vedy a výskumu. Pokiaľ ste si ho vybrali pre prezentovanie svojich iste cenných a zaujímavých výsledkov, držíte sa tej pravej cesty.

Študentská vedecká konferencia na našej fakulte je nesporne prestížnym podujatím pre prestížnych študentov. Aj tento rok zaznamenalo vysoký záujem zo strany 275 účastníkov, z ktorých 222 aktívne vystúpia na našej akademickej pôde, aby príslušné tematické fórum informovali o podnetných výstupoch svojej práce. Veľmi ma teší, že popri domácich študentoch prijalo naše pozvanie aj takmer 60 účastníkov z externého prostredia, predovšetkým zo Slovenskej akadémie vied, Univerzity P.J. Šafárika v Košiciach, Prešovskej univerzity, Masarykovej univerzity v Brne, Českého vysokého učení technického v Prahe, Ostravskej univerzity či Veterinárnej a farmaceutickej univerzity v Brne. A prakticky v intenciách minulých rokov zavítali na našu fakultu aj stredoškolskí účastníci podujatia. Tematický profil jednotlivých príspevkov už tradične definuje najmä biológia (108) a chémia (67) s nezanedbateľným podielom geografie, geológie, environmentalistiky a didaktiky prírodných vied.

Úprimne sa teším z každého podujatia, ktoré spája talent mladých ľudí a predznamenáva trendy napredovania prírodných vied do najbližších rokov, veď v dnešnom uponáhľanom čase si prírodovedci nedokážu už odkrojiť veľa momentov na vzájomne motivačnú diskusiu. Možno aj z tohto dôvodu by som rád poďakoval osobitne organizačnému výboru ŠVK s vierou, že všetci účastníci nájdu na tomto podujatí mnoho inšpirácie a prírodovedného entuziazmu. Majú totiž na čom stavať.

Peter Fedor
dekan
Prírodovedeckej fakulty UK v Bratislave

Obsah

Neotectonic evolution of the Poprad River valley in the eastern part of the Popradská kotlina Basin based on the river terraces analysis

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Abstract

The Poprad River terraces in the eastern part of the Popradská kotlina Basin were studied in order to identify the neotectonic evolution within the study area. The focus was put on the investigation of trend and intensity of vertical movement of particular block. As the research was focused on the Poprad River terraces analysis, geological map of the study area, drilling analysis and field survey as well, were applied to identification of their spatial distribution and vertical extent. To quantify the intensity of movements, the rate of tectonically induced downcutting was calculated based on relative altitude of gravel bases and presumed age of terraces. Six levels of unpaired terrace (T V – T I) with separate gravel bases were identified. The average rate of downcutting is 0,119 mm/y since the T V formation (~ 680 ka) with its maximum 0,213 mm/y between T III and TIIb formation. Despite of relative subsidence in relation to the adjacent mountains, the partial block of the study area is asumed to be tilted and uplifted.

Keywords: *river terrace; morphotectonics; the Poprad River; the Popradská kotlina Basin*

Introduction and Objectives

The Poprad River rises in the Mengusovská valley from the confluence of two Tatra streams, from Hincov and Krupá creek at the altitude 1302, 3 m asl. Subsequently, the river flows through the Popradská kotlina Basin, where it deposited glacifluvial and fluvial sediments predominantly in terrace development. River terraces formation was caused by changing river activity in cyclic alternation of accumulation and erosional phases. The processes that formed the terraces were influenced by climatic changes and tectonic movements [1].

The Popradská kotlina Basin is formed by Paleogene infill of the Subtatric Group which is covered by Quaternary sediments of various thickness, genetic types and age. From neotectonic point of view, the basin as a whole is a subsided graben which consists of several partial block with different intensities of relative vertical movements. In relation to the adjacent morphostructures, the basin is separated by Quaternary active faults [2, 3].

The aim of the article is to identify the neotectonic evolution of the Poprad River valley based on river terraces analysis focusing on the character (uplift/subsidence) and intensity of vertical movement trends. The study area is situated in the junction of the eastern part of the Popradská kotlina Basin and Levočské vrchy Mts (fig. 1).

Materials and methods

The research was focused mainly on the analysis of the Poprad River terraces, as the river deposits are generally applied for identification of sedimentary/tectonic history of river valleys [e. g. 4]. The analysis of the terraces was based on the identification of their sedimentary bodies and their atributes from the geological map [5], analysis of drills from geological reports and field survey as well. The ArcGIS 10.4 was used to store, analyze and visualize the data. The terraces were studied in the representative valley reach of the Poprad River where the most of the terrace levels remain preserved.

Each terrace base level was identified on the basis of relative height of its gravel base above the floodplain. Subsequently, according to relative altitude of the gravel base of particular terrace and assumed age of accumulations [6, 7], the uplift rate was calculated in line with [8]. The calculation supposes a tectonically induced downcutting between the formation of particular gravel base and the base of T I (total downcutting E_t) and between the formation of particular gravel base and the base of subsequent terrace (partial downcutting E_p).

Results and discussion

Totally 6 levels of predominantly unpaired terraces of the Poprad River were identified (T I – T V) within the study area (fig. 1, tab. 1). In line with terrace system of the Western Carpathians [Halouzka, 1986], the terraces were divided into group of low (T I), middle (T IIa, T IIb, T III) and upper (T IV, T V) terraces. Each terrace consists of fluvial or glacifluvial gravel accumulation and its subjacent rock base. According to morphoposition, the area where the Poprad River or its tributaries had predominant control over the deposition was delineated.

The low terrace (T I) is built by the sediments of the valley floor as well as floodplain. The terrace body is formed by stream-bed facies (1,1 – 2,6 m thick) built by gravel, sandy gravel and sand, covered with 1 – 2,6 m thick fine-grained flood Holocene deposits (clayey to sandy loam or sandy clay). The total thickness of the valley floor deposits within the floodplain area is ~ 3,2 – 4,6 m with its average 4,2 m. The horizontal extent of this terraces can be regarded as a recent

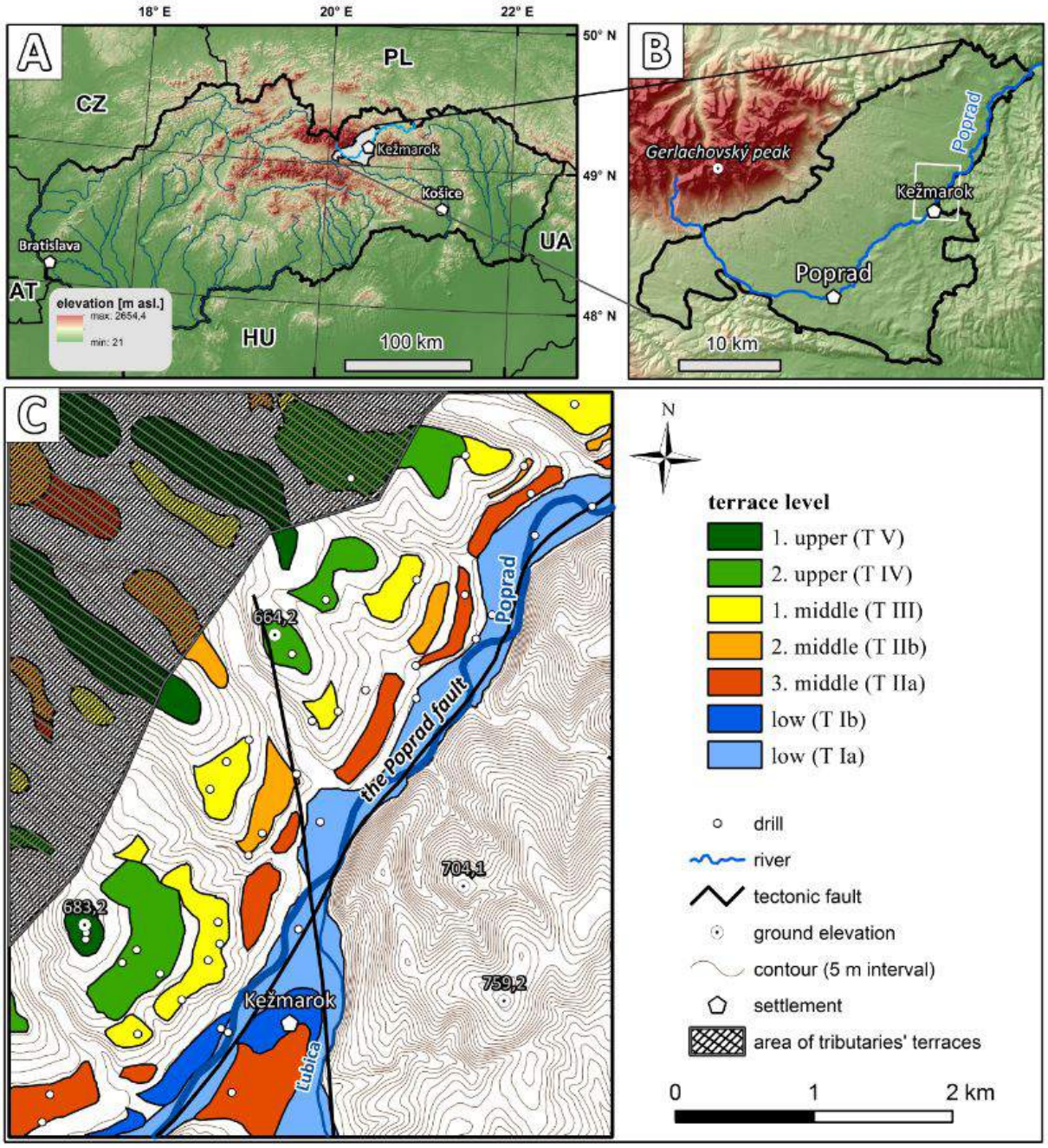

Fig. 1. **A: The Popradská kotlina Basin within Slovakia. B: Study area within the Popradská kotlina Basin. C: River terraces within the study area.** Terrace surfaces are based on geological map [5], partially altered according to drilling data, field survey and.surface morphology.

floodplain together with low terrace (senzu Gross et al., 1999). Therefore, two sub-levels can be recognized within this terrace: the high level T Ib (constituting the paleo surface of the terrace from the end of accumulation phase) and low level T Ia (with horizontal extent of the floodplain). The both have the same gravel base. The width of the terrace varies along the valley reach from ~ 430 m in the confluence of the Poprad River and Ľubica River to ~ 170 m north of town Kežmarok. Its width is in general 200 – 250 m for the study reach.

Considerable part of the terrace area consists of the middle terraces. The terrace T IIa occupies the left side of the valley and the confluence area in town Kežmarok as well. The relative elevation of gravel base of the terrace T IIa ranges from 3,1 to 7,7 m. The thickness of the accumulation is 2,8 to 6 m. The terrace T IIb has its gravel base at relative elevation 12,4 to 15,4 m. The accumulation is 2 – 7,6 m thick. The highest terrace level within the middle group of terraces, T III, has the gravel base at relative altitude 27,3 – 35,7 m. The thickness of its accumulation ranges from 2,1 to 10 m.

The upper terraces (T IV and T V) are represented only by the accumulation bodies with small horizontal extent.as they record the oldest part of history of the valley formation. The gravel base of T IV was identified by drillings in relative elevation 38, 9 – 43,3 m. Its accumulation varies from 2,4 to 11,1 m. The base of terrace T V was identified by drilling only at 1 locality in relative altitude 67,7 m with only thin residual glacifluvial accumulation (0,8 m).

River terraces of the Poprad River are assymetrically preserved only on the left side of the valley (besides of the T IIa in the confluence area). Regarding the tectonic fault (the Poprad fault) with general NE – SW striking [5] on the junction of the Popradská kotlina Basin and the Levočské vrchy Mts, with a general dip to the NW, the tectonic tilting of the basin can be considered.

On the basis of previously mentioned attributes of the terraces, the simplified reconstruction of morphotectonic evolution of the study valley reach could be conducted. As the Poprad River terraces before the T V formation hasn't preserved, the reconstruction can be carried out since its formation. After the erosional phase of the river during the interglacial period, the deposition of river sediments during the glacial period took place. Subsequently, river downcut passing through its accumulation (climatically induced erosion). Then, the tectonically controlled downcutting expressed with average rate 0,14 mm/y. It lasted untill the phase of lateral erosion started and then next accumulation phase began. After the accumulation of sediments of T IV, climatically and then tectonically induced downcutting took place with the average rate of 0,10 mm/y. The cycles repeated with different rate of downcutting. Between the T III and T IIb formation (during the Preriss/Lower Riss interglacial) the highest rate of downcutting occurred (0,21 mm/y). During the next cycle it rapidlly reduced to 0,08 mm/y. For a period of the last interglacial the average value of tectonically induced downcutting reached only 0,08 mm/y. The average rate of downcutting/uplift for the studied period is 0,12 mm/y.

In regard of river sediments in terrace development and their assymetry, as well as

slope assymetry of the valley and the course of the Poprad fault, a regional tilting can be considered as a absolute movement trend of the particular tectonic block. In spite of assumed vertical uplift (in form of tilting) recorded by the river sediments in terrace development, the basin block undergone relative subsidence in relation to adjacent morphostructure of the Levočské vrchy Mts. This is in line with the previous neotectonic research [3].

The calculated rate of erosion/uplift can be compared to the rate of erosion/uplift calculated for the Liptovská kotlina Basin [8]. The similarity can be seen in the general conformity of the values (values ranging ~ 0,03 – 0,2 mm/y) as well as in expressive increasement of the values during the younger part of the Middle Pleistocene (before the 2nd middle terrace for the Poprad River (0,21 mm/y) and before the 1st middle terrace fo the Váh River (0,18 mm/y)). The relative synchronicity of the increasement can be caused by similar neotectonic movement trend within the entire Podtatranská kotlina Basin. The average uplift rate of the basin (0,12 mm/y) can be compared also to the adjacent Kozie vrchy Mts, where the value (0,8 – 1,0 mm/y) is much higher [9], but to the lowland area as well [4], where the average value is lower (~ 0,03 mm/y). The various rates result from different intesities of vertical movements of particular morphostructures within the Western Carpathians and Panonian Basin.

Tab. 1. The terrace system characteristics of the Poprad River in the Popradská kotlina Basin – Selected attributes of the terraces within the study area. Relative altitude is compared to the altitude of low terrace gravel base. A_t is a time period between the formation of particular gravel base and the base of T I. A_p is a time period between the formation of particular gravel base and the base of subsequent terrace.

Name of terrace		Relative altitude of base [m]	Age of accumulation [Ma]	A_t [Ma]	A_p [Ma]	Rate of erosion [mm/y]	
						Total [Et]	Partial [Ep]
T V	1. upper	71,9	0,680 – 0,525	0,605		0,119	
T IV	2. upper	44,6	0,480 – 0,425	0,405	0,200	0,110	0,137
T III	1. middle	35,1	0,380 – 0,340	0,305	0,100	0,115	0,095
T IIb	2. middle	18,1	0,300 – 0,225	0,225	0,080	0,080	0,213
T IIa	3. middle	10,3	0,200 – 0,140	0,125	0,100	0,082	0,078
T I	low	0	0,075 – 0,0117		0,125		0,082

Conclusion

The 6 levels of unpaired terraces (in various state of preservation) of the Poprad River were identified and analysed.

According to the elevation and pressumed age of the terraces, the tectonically induced

downcutting was calculated in order to identify the neotectonic evolution of the Poprad River valley in the study area since the terrace T V formation (~ 680 ka).

During the studied period, the total erosional effect of the Poprad River is ~ 70 m resulting in average rate of downcutting 0,12 mm/y, which points to the presumed uplift with variable intensity during the study period. In spite of the presumptiom that tilting and uplift have controlled the evolution of particular block, the Popradská kotlina Basin as a whole, undergone a relative subsidence in relation to adjacent mountains.

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