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JAROMÍR DEMEK

PLANATION SURFACES OF THE MORAVIAN CARPATHIANS (CZECHOSLOVAKIA)

1. Introduction

Of the extensive mountain arc of the Carpathians only its western part extends to Moravia. The Western Carpathians on Moravia's territory consist of dissected highlands and mountains of the Outer Western Carpathians and lowlands and hilly lands of the Inner Carpathian Depressions. The Outer Western Carpathians are built of flysch deposits with small limestone blocks of the outer cliff zone (Štramberk, the Pavlovské vrchy Hills). The flysch sandstones, shales and claystones were folded at the turn of Paleogene and Neogene into overthrusts and shifted from southeast northwestwards. In Neogene and Quaternary the tectonic movements continued, mainly those of different blocks along faults. The Inner Carpathian Depressions represent a foredeep with a faint relief on a sedimentary fill of Neogene and Quaternary deposits.

In this paper attention will be paid above all to the planation surface in the Outer Western Carpathians in Moravia.

2. General geomorphological conditions

The Outer Western Carpathians consist of a system of ridges bordered by hilly lands. In the eastern part — mainly on the frontier between the Czech Socialist Republic and the Slovak Socialist Republic — the ridges exhibit a mountainous character (the Bílé Karpaty Mts., the Javorníky Mts., the Moravskoslezské Beskydy Mts.). In the Moravskoslezské Beskydy Mts. the ridges reach their greatest heights by Mt. Lysá hora (1323 m). Westwards they become lower displaying a highland character (the Žďánický les Highland, the Chřiby Highland). The ridges are bordered by hilly lands. The hilly lands border the Outer Western Carpathians not only on their margins (for instance the Podbeskydská pahorkatina Hilly land, the Litenčická pahorkatina Hilly land, the Kyjovská pahorkatina Hilly land) but penetrate bay-likely even into the higher central parts. The hilly lands are connected morphostructurally both with tectonic depressions — grabens (e. g. Jablunkovská brázda Furrow) and areas of less resistant rocks (mainly shales and claystones).

3. Present knowledge concerning surfaces of planation

The occurrence of subaerial planation surfaces in the Outer Western Carpathians was described as early as at the end of the past century and the beginning of this century. Mainly in the mountainous parts of the Moravian Carpathians occurrences of planation surfaces in various altitudes above sea level have been established. The flats of the planation surfaces often have a step-like aspect.

A general survey of the former knowledge of surfaces of planation in the Outer Western Carpathians in Moravia can be found in T. Czudek — J. Demek — O. Stehlík's paper of 1965.

The basic problem of the study of planation surfaces in the Moravian Carpathians is the question

- if in this region only one regional surface of planation of Neogene age is developed broken by later neotectonic movements with its parts occurring in various altitudes above sea level (J. Krejčí's Post-Badenian peneplain, 1944) or
- if several planation surfaces of Neogene and Quaternary age developed in this region.

The Moravian Carpathians are a part of a region with a very active neotectonic period. The forty metres thick Upper Pliocene sediments filling a graben in the Dřevnice River valley (J. Krejčí 1955) and the uplift of these deposits up to even 400 m a. s. l. in the Chřiby Mts. (E. Menčík, V. Pesl, 1961) indicate a considerable intensity of Neogene and Quaternary tectonic movements. When analyzing the surfaces of planation of the Moravian Carpathians this fact should be taken into consideration.

4. The analysis of the planation surface of the Moravian Carpathians

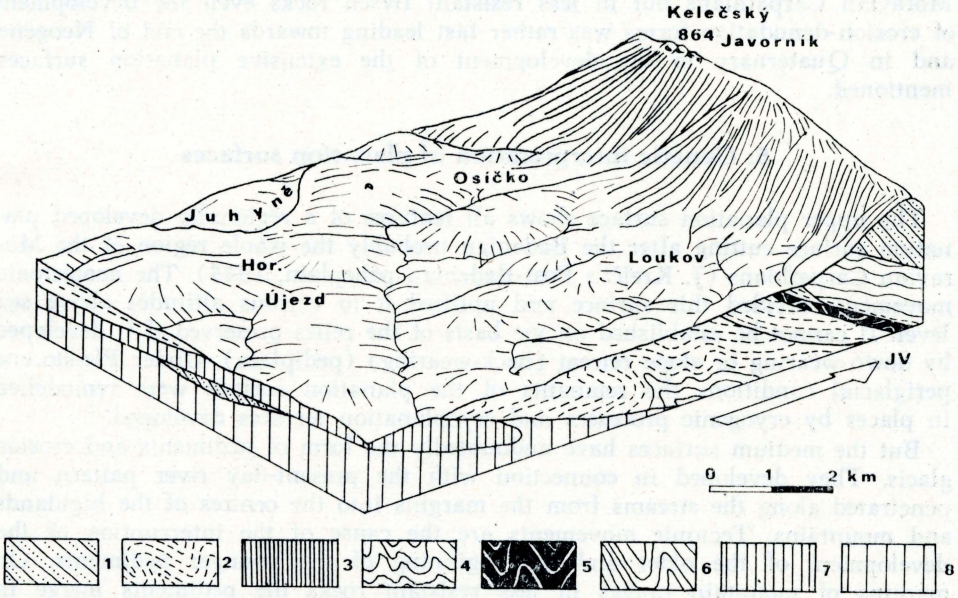
In greatest altitudes above sea level flats of the planation surface occur in the Moravskoslezské Beskydy Mts., where it was found on the main ridge in the surroundings of Mt. Lysá hora (1323 m), on Mt. Smrk (1276 m), Kněhyně (1257 m) and Mt. Travný (1203 m). The flats occur even on the ridge of Mt. Radhošť (1129 m) and the so-called Zadní hory Mts. on the frontier between the Czech Socialist Republic and the Slovak Socialist Republic, In the Hostýnsko-vsetínská hornatina Highland the planation surface occurs in the summit parts of the ridges in altitudes of about 800—900 m (Soláň 861 m, Kelečský Javorník 864 m). The main ridge of the Javorníky Mts. is narrow and no planation surfaces can be found there. But there is a surface of planation in the Pulčínská hornatina Highland in altitudes between 750 and 800 m continuing behind the water gap of the Senica River into the Komonecká hornatina Highland. A planation surface occurs even on the ridges of the Bílé Karpaty Mts. in altitudes of 800 up to 970 m (Velká Javořina 970 m).

The surface of planation on the mountain ridges exhibits everywhere the same features. It is a convexly rounded ridge with flats cutting folded rocks of various resistance. The height differences between the lowermost and uppermost places in the individual more extensive parts of the planation surface range between 30 and 40 m. In places tors and monadnocks rise above the flats.

But the same planation surface occurs even on the lower ridges of the Vizovická vrchovina Highland, the Chřiby Mts. and the Ždánický les Mts. in altitudes between 600 and 300 m. The planation surface is in no relation to the present river pattern. Weathering products of a very small thickness occur on the

flats. In places the rocks of the bedrock crop out almost to the ground surface. The differences in the thickness of the weathering products depend rather on the type of bedrock than on the duration of a certain type of weathering. Pleistocene and recent products of weathering prevail.

But the planation surfaces in the hilly lands of the Moravian Carpathians exhibit a completely different character. In the hilly lands and on the edges of highlands and mountains concave rounded ridges occur bordering the valleys of the present-day streams. These concave surfaces penetrate by wide bays from the margins of the highlands and mountains into their parts. In the places of the occurrence of less resistant rocks these surfaces extend reaching widths of even several kilometres. On the slopes of water gaps in predominantly sandstone ridges the surfaces change into narrow ledges on slopes but are distinctly linked to broader surfaces in the wide bays between the ridges. The lower concave planation surfaces are separated from the upper planation surface on rounded sandstone ridges by relatively steep erosion-denudation slopes. Owing to their expressiveness some of these slopes were formerly interpreted as fault scarps. But a detailed analysis has shown that here erosion-denudation slopes are concerned. The concave surfaces bordering the present-day river pattern form



1. Blockdiagram of planation surfaces of the Hostýnské vrchy Hills and the Podbeskydská pahorkatina Hilly land. On the summit parts of Mt Kelečský Javorník and the adjacent ridge of the Hostýnské vrchy Hills relics of a Post-Badenian planation surface occur remodelled by Pleistocene cryogenic processes. In the Podbeskydská pahorkatina Hilly land a younger Pliocene planation surface of pediment type can be found. Drawn by Dr. J. Raušer, geological structure according to Dr. Z. Stráník CSc.
Explanations: Magura unit: 1. Soláň beds (sandstones, Paleogene).
Silesian unit: 2. Krosno beds (sandstones, claystones, Paleogene), 3. menilite beds (sandstones, claystones, Paleogene), 4. sub-menilite Paleogene — claystones, 5. claystones (Upper Cretaceous).
Subsilesian-Ždánice unit: 6. Ždánice-Hustopeče beds, Paleogene, 7. menilite beds (cornstones, claystones), 8. clay-sands (Miocene).

several levels. The uppermost level is developed on the slopes of sandstone ridges as a relatively narrow ledge. It is separated by a steep slope from the ridges, and a denudation slope from the broad concave surface above the upper edge of the river valleys. The broad surfaces are on the lower reaches about 100 km above the present-day floodplain. But their relative height decreases upstream.

The lowermost concave surfaces were studied in detail in the Mikulovská vrchovina Highland and the Central Moravian Carpathians (T. Czudek — J. Demek, 1968, 1970, B. Balatka et cons., 1974). These concave surfaces are immediately linked to medium and in places even low accumulation river terraces. Their width is usually several tens up to hundreds of metres. They are often developed in two levels separated by a rather low (about 25 m) erosion-denudation slope.

The surfaces of planation of the medium and low levels penetrate from the main valleys into the valleys of the tributaries. And it is this circumstance which can be considered one of the proofs that these planation surfaces are of different age and not parts of one Neogene broken planation surface. Another evidence i. e. the form and genesis of slopes separating the surfaces was already mentioned. There is no doubt of the considerable extent of neotectonic movements in the Moravian Carpathians but in less resistant flysch rocks even the development of erosion-denudation forms was rather fast leading towards the end of Neogene and in Quaternary to the development of the extensive planation surfaces mentioned.

5. Genetic interpretation of planation surfaces

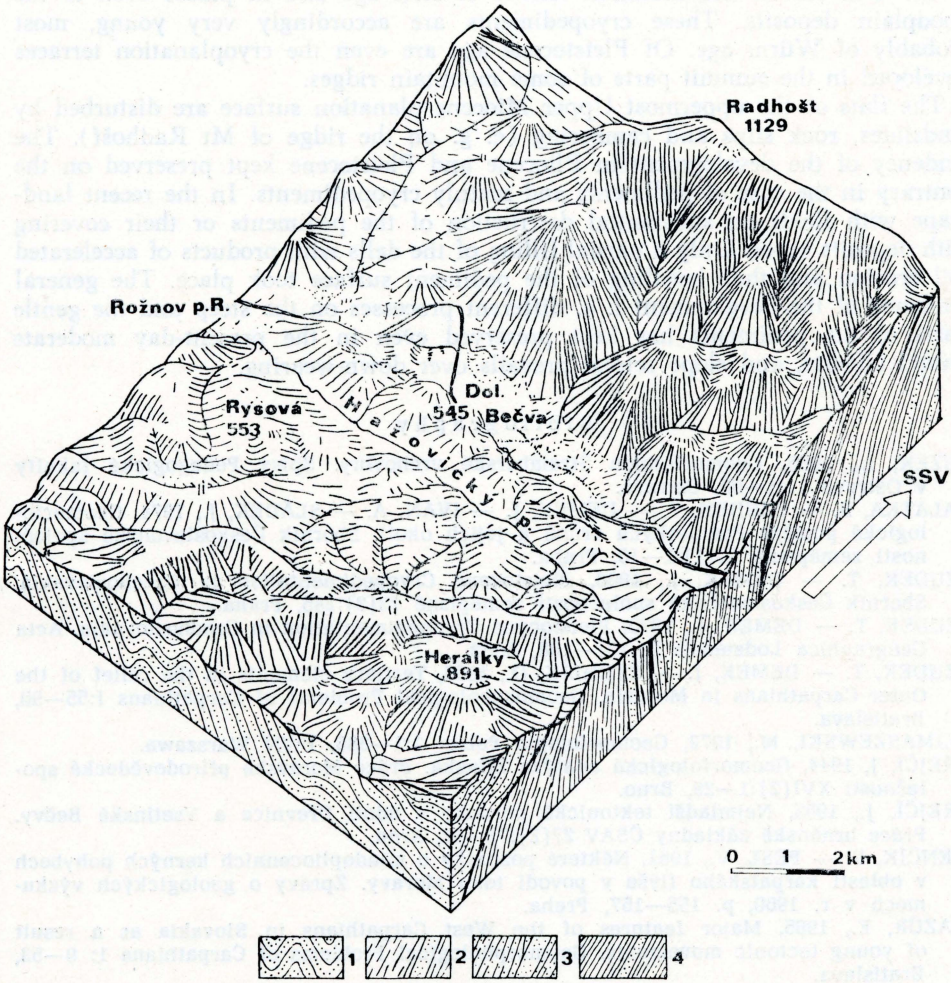
The upper planation surface shows all features of a regionally developed planation surface cutting after the Badenian probably the whole region of the Moravian Carpathians (J. Krejčí's Post-Badenian peneplain, 1944). The neotectonic movements divided this surface and uplifted it to various altitudes above sea level. It cannot be established on the basis of the relics preserved if it developed by down-wearing or slope retreat (back-wearing) (pediplain). Under Pleistocene periglacial conditions the remnants of the planation surface were remodelled in places by cryogenic processes and cryoplanation terraces developed.

But the medium surfaces have undoubtedly the form of pediments and erosion glacis. They developed in connection with the present-day river pattern and penetrated along the streams from the margins into the centres of the highlands and mountains. Tectonic movements are the cause of the interruption of the development of the older and the beginning of the younger pediments. On margins of mountain ranges in less resistant rocks the pediments merge in a pediplain.

The lowermost surfaces developed under permafrost conditions in the Pleistocene. These surfaces have also the form of pediments and can be called cryopediments. They are related to middle and in places even to low Quaternary river terraces. In places they occur between the higher and middle river terraces of Pleistocene age.

Cryopediments are developed even in non-consolidated Neogene and Quaternary deposits of the Outer Carpathian Depressions. They penetrate along valleys from the Outer Carpathian Depressions in the highlands of the Outer Western Carpathians. In periglacial climate frost-weathering, solifluction, sliding and above all nivation were acting on the steep slopes of the cryopediments. It was

mainly nivation which was the decisive agent in the retreat of steeper slope sections and the cause of the development of these planation surfaces. On the gentle slopes of the cryopediments mainly transport acted which was concentrated in the dense network of dells. The higher humidity in the axes of the dells allowed a faster removal of the material descending the steeper upper slope. The activities of running water and deflation cannot be omitted either. Permafrost created an impermeable layer so that surface run-off was possible even in well permeable rocks.



2. Blockdiagram of the central part of the Rožnovská brázda Furrow with planation surfaces. On the right, on the ridge of the Moravskoslezské Beskydy Mts. (Radhošť 1128 m) relics of the Post-Badenian planation surface remodelled by slope movements occur. Lower on slopes Pliocene up to Lower Pleistocene planation surfaces of pediment type can be found. Contructed by Dr. J. Raušer, CSc., geological structure according to Dr. Z. Stráník, CSc.
Explanations: 1. Magura nappe, Soláň beds (substantial prevalence of sandstones), 2. Silesian Paleogene with beds of Ciężkowice — sandstones. 3. beds of Istebné, 4. Godula beds.

6. Age of planation surfaces

There is little evidence available for the establishment of the age of the surfaces of planation in the Moravian Carpathians. According to analogy with the Slovak and Polish Carpathians (cf. E. Mazúr, 1965, M. Klimaszewski, 1972) the upper planation surface is supposed to be of Upper Miocene age. The middle level of the pediments is of Pliocene up to Lower Pleistocene age.

Most extensive cryopediments in the Central Moravian Carpathians are linked to the 4 m fluvial accumulation terrace of Riss age and in places even to the floodplain deposits. These cryopediments are accordingly very young, most probably of Würm age. Of Pleistocene age are even the cryoplanation terraces developed in the summit parts of some mountain ridges.

The flats of the uppermost Upper Miocene planation surface are disturbed by landslides, rock slips and cambering (e. g. on the ridge of Mt Radhošť). The tendency of the development in Pliocene and Pleistocene kept preserved on the contrary in the case of pediments and mainly cryopediments. In the recent landscape with fields no substantial destruction of the pediments or their covering with deposits occur. Only a partial filling of the dells with products of accelerated soil erosion and thus levelling of the pediment surface took place. The general tendency of the development i. e. different processes on the steep and the gentle parts of the pediments has kept preserved even in the present-day moderate humid climate, and slope retreat prevails over down-wearing.

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ЯРОМИР ДЕМЕК

ПОВЕРХНОСТИ ВЫРАВНИВАНИЯ В МОРАВСКИХ КАРПАТАХ

Статья посвящена проблематике субаэральных поверхностей выравнивания в моравских Карпатах, составляющих западную часть Карпатской дуги. Моравские Карпаты делятся на расчлененные Внешние Западные Карпаты и плоские Внекарпатские понижения. Внешние Западные Карпаты образованы главным образом флишевыми седиментами со сложным сводчато-сбросовым строением. Внекарпатские понижения представляют собой передовой прогиб с плоским рельефом на неогеновых и четвертичных седиментах.

Главной проблемой Внешних Западных Карпат является вопрос, получила ли в данной области развитие единая региональная поверхность выравнивания неогенового возраста, которая позднее подверглась разломам в ходе неотектонических движений, так что её отдельные части оказались на различной высоте над у. м. (так называемый постбаденский пенеплен Я. Крейчи, 1944) или уже в данной области возникло несколько поверхностей выравнивания неогенового и четвертичного возраста.

Остатки поверхностей выравнивания можно найти на самых больших высотах н. у. м., на горных хребтах Моравскосилезских Карпат, Гостинско-всетинских гор и Белых Карпат на границе между ЧСР и ССР. Поверхности выравнивания на горных хребтах имеют повсеместно одинаковый характер. Они представляют собой овальные выпуклые хребты с площадками, выравнивающими складчатые породы различной твердости. Местами над площадками возвышаются изолированные скалы и останцы.

Такие же площадки можно, однако, найти и на более низких хребтах Визовицкой врховины, Хршиб и Жданицкого леса на высоте 300 – 600 м. Поверхности выравнивания на хребтах не имеют никакого отношения к современной речной сети. Площадки покрыты маломощной плейстоценовой и современной корой выветривания, а местами скальные породы выступают на поверхность.

Совсем другой характер имеют поверхности выравнивания на плоскогорьях моравских Карпат. Здесь они представлены в форме вогнутых овальных хребтов, окаймляющих долины современных водных потоков. Вдоль водных потоков эти вогнутые поверхности заходят от краев возвышенностей и нагорий во внутреннюю часть Внешних Западных Карпат. В местах, сложенных менее твердыми горными породами (напр. илистые сланцы), эти поверхности разширяются до нескольких километров. В долинах, прорывающихся через хребты из песчаников, их поверхности сужаются до узких карнизов, на которых ясно прослеживается связь с более широкими поверхностями в широких заливах между хребтами.

Вогнутые поверхности, окаймляющие современную речную сеть, образуют несколько ступеней. Самая высокая ступень в виде сравнительно неширокого карниза находится на склонах песчаниковых хребтов. От хребта эту ступень отделяет крутой склон, а от широкой овально вогнутой поверхности над верхней бровкой речных долин – сравнительно пологим эрозионно-денудационным склоном. В некоторых областях встречается ещё средная третья поверхность.

На Микуловской врховине и в Среднеморавских горях встречаются низкие поверхности выравнивания, которые переходят в средние, а местами даже в низкие аккумулятивные речные террасы. Часто они представлены в виде двух ступеней.

В моравскх Карпатах можно различить следующие поверхности выравнивания:

а) верхная поверхность выравнивания на хребтах, которая имеет черты региональной поверхности выравнивания скорее всего верхнемиоценового (постбаденского) возраста. Неотектоническими движениями эта поверхность расчленена на отдельные части, лежащие на различной высоте над уровнем моря (300 – 1 300 м). Местами эта поверхность была изменена криогенными процессами в плейстоцене и возникли криоплянационные террасы;

б) средние поверхности выравнивания, имеющие форму педиментов и проходящие вдоль водных потоков. Обычно получили развитие два, а иногда и три педимента плиоценового или же нижнеплейстоценового возраста;

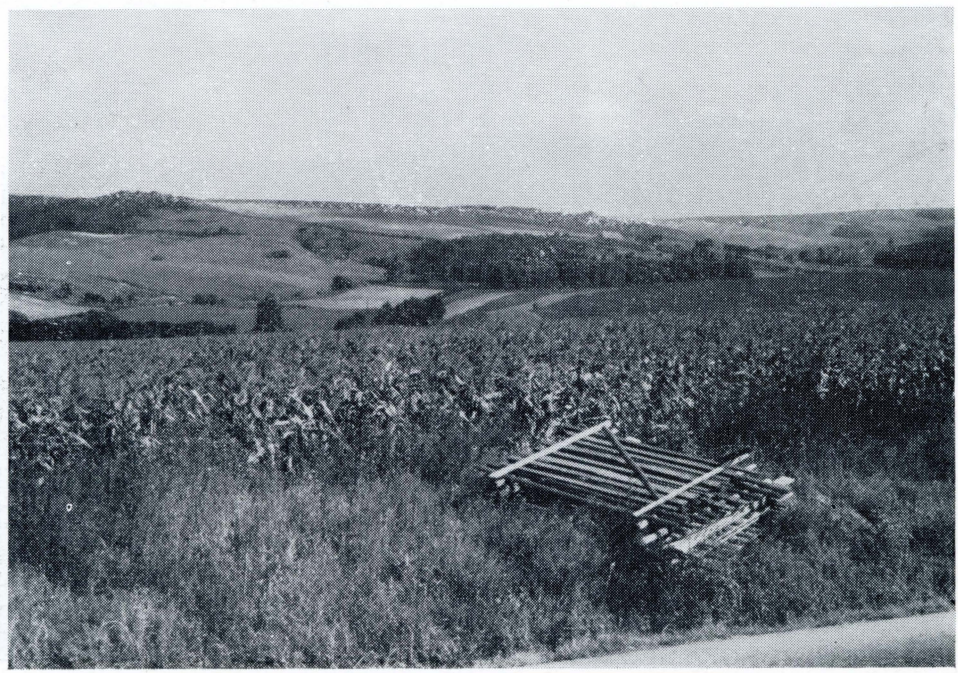
в) самые низкие поверхности выравнивания образованы криопедиментами, которые возникли в верхней плейстоцене в условиях вечной мерзлоты.

Интересным является тот факт, что в условиях современного культурного ландшафта с распаханными полями не происходит существенного разрушения педиментов. Одновременно не происходит и аккумуляция и по существу сохраняется тенденция развития склонов как в плиоцене и плейстоцене.

1. Uppermost planation surface on Mt. Radhošť ridge in the Moravskoslezské Beskydy Mts. destroyed on edges by gravity slope processes (cambering, rock slides).

2. View of the Bílé Karpaty Mts. with the uppermost planation surface on the wooded ridge and concave pediments of Pliocene up to Lower Pleistocene age at the foot.

3. View of the Kláštovský hřbet Ridge in the Vizovická vrchovina Highland with the uppermost planation surface (wooded ridge) partly destroyed by cryogenic processes (cryoplanation terraces) and rock slides. In the foreground pediments of Pliocene up to Lower Pleistocene age.
4. Planation surfaces of the Central Moravian Carpathians.



5. Cryopediments of Upper Pleistocene age at the foot of the marginal slope of the Central Moravian Carpathians.

6. Cryopediment between the communities of Nová Ves and Vlasatice in the Dyjsko-svratecký úval Graben. *Photos J. Demek*