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GEOMORPHOLOGY OF THE POHORJE MOUNTAINS

GEOMORFOLOGIJA POHORJA

Ivan Gams

IVAN GAMS

The boundary between western valley-like and eastern plateau-like Pohorje with the Šiklarica pass, 1299 m.
Meja med slemenasto-dolinastim zahodnim in planotastim vzhodnim Pohorjem. Vmes je preval Šiklarica, 1299 m.

Geomorphology of the Pohorje mountains

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ABSTRACT: The Pohorje mountain range, young mountains with prevailing metamorphic rocks and dacite, continues to uplift above the igneous laccolith in the area of the rapid rising asthenosphere in the transition to the Pannonian basin also due to changes in temperature and, resultantly, of the density of uplifting dacite- and other intrusions which have not metamorphosed the surrounding sediments. On the Pohorje by the river Drava (hereinafter the Drava Pohorje), the drainage network does not match the orography, because, between the Vuzenica-Radlje basin and Fala, the Drava epigenetically deepened its gorge into the marginal range of Kobansko. Modest plateaus on the ridge of the Pohorje originate from the time when the base level maintained a cover of the so-called Eibiswald strata between the Karavanke and the Kobansko in the upper Miocene. The originally larger ridge plateau in the centre of the Pohorje was lowered by erosion and periglacial processes; it has been preserved as an inclined plateau on the Eastern Pohorje. Explained through the recent tectonic shifting, established by means of GPS in the years 1996–2002 at the peak Velika Kopa, is the southeastwards curving of the five valleys above the Legen terrace where, supposedly, original headwaters of the Spodnja Mislinja came from. Due to its geological, geomorphological and hydrological peculiarities the Legen Quaternary terrace deserves that it should be declaired the 'geopark', the first one in Slovenia. Even more explicit and extensive is the westwards curving of the valleys on the northern slope of the Pohorje, and their northeastward orientation in the Ribnica-Lovrenc-Selnica valley system. In the east section of the Lovrenc valley system above Fala the brook Rečnikov potok has not adjusted its course to the recent tectonic subsiding, so that its valleys run obliquely to the slope inclination. The up to 700 metres deep Mislinja rift lowered the central ridge of the Pohorje to 1299 metres. Blowing intensely across it, the northeastern Pleistocene cold winds made possible the origination of two smaller glaciers in the upper drainage basin of the Radoljna. The gently sloping Pohorje landforms are not the result of the old age but of the disintegration of granular rocks to permeable sand, above which the thick cover of continuous roots of grasses and prevailing spruce reduces the erosion.

KEY WORDS: Geomorphology, geomorphogenesis, Quaternary geomorphological processes, glaciers, Pohorje, Central Alps, northeastern Slovenia.

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Contents

1 Introduction

The Pohorje is a medium-high mountain range in northeastern Slovenia. In view of geology it is the southeasternmost part of the Eastern Alps. It mainly consists of metamorphic rocks and dacite.

Until the Second World War, also Slovenian geomorphologists advocated the theory of cyclic relief development according to which, after the tectonic uplift, the mountainous surface continuously and gradually lowered due to erosion with the intermittent stagnation phases which are identifiable in the ever lower levels and terraces. In view of this theory geomorphology used to interpret the origin of the ridge Pontian (Pannonian) levels also on the ridge of the Pohorje. Lower and younger planations were established on the side ridges. But there are no such planations on the evenly lowering Pohorje ridges and the uplifting of the Pohorje continues. This was corroborated by the recent repeated nivelman points and GPS measurements (of relative surface shifts by means of satellite radars).

Most of the used Slovenian topographic names are taken from the Atlas Slovenije (the Atlas of Slovenia) in the scale 1 : 50,000 and partly also from topographic section maps in larger scale.

2 Delineation and division of the Pohorje

Within the Eastern-Alpine (earlier name: Central Alpine) mountains the Pohorje with its 770 sq km belongs to the larger ones. Its delineation in the present paper equals its delineations in the hitherto monographs on the Pohorje (Hiltl 1893; Koprivnik 1923; Melik 1957; Gams 1959). It borders on the following areas: the Drava valley in the north, the Dravsko polje plain in the east, the Pohorje foothills in the southeast, the Vitanje valley system in the south, and the Mislinja valley in the northwest.

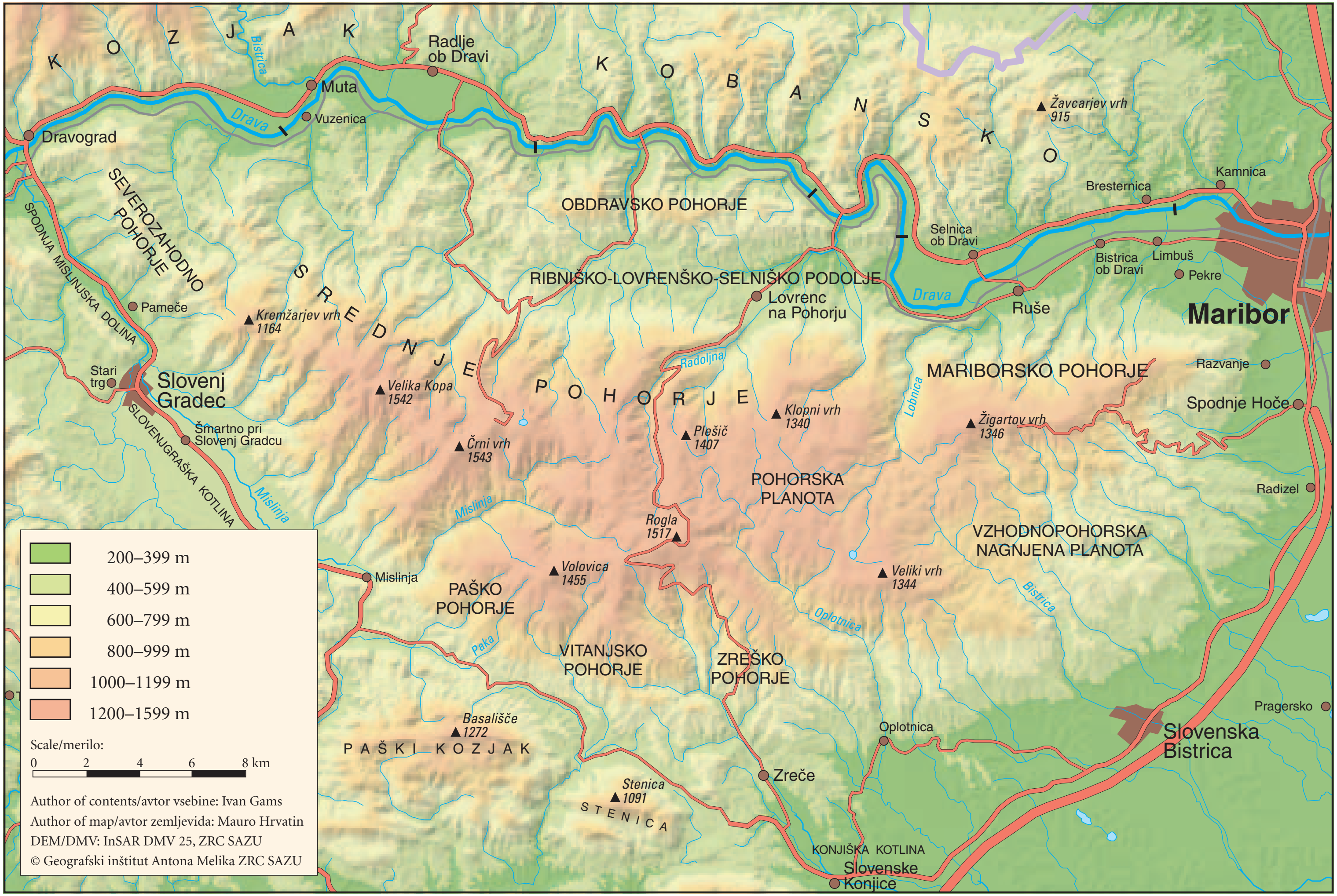
The names of geomorphological units given on the map are also used in the present text. We adhere to the traditional division, i. e. to the Eastern Pohorje with less inclined slopes, and the Western Pohorje which is typical for a greater number of ridges and valleys. The contact line between the two sections runs along the Mislinja rift–Šiklarica–the Radoljna valley. A detailed geomorphological division has been made of each of the two sections. The geomorphologically and genetically diverse Pohorje is further analysed by relief characteristics of individual more homogeneous units:

- 1 Western Pohorje
- 1.1 The northwestern Pohorje is the area lying northeast of the lower Mislinja valley and west of the (Trbonje) Reka valley, with the highest peak Jesenkov vrh (933 metres). It belongs petrographically to the Kobansko series (Mioč, Žnidarčič 1972). Almost all the rocks occur here which constitute the rest of the Pohorje and the Kobansko in particular, and also the upper-Miocene (Eibiswald) strata occur above the average.
- 1.2 The central Pohorje is the system of the northwest oriented central and the highest watershed ridge between Kremžarjev vrh (1164 m) and Šiklarica (1299 m), and the ridges between the valleys of the Mislinja tributaries in the south, and the Drava tributaries in the north. It mainly consists of metamorphic rocks and dacite. This section of the Pohorje is typical for the high broad watershed ridge Mala Kopa (1524 m)–Velika Kopa (1543 m)–Jezerski (Ribniški) vrh (1537 m). The wooded northern slope mainly consists of granodiorite (formerly called granite and later on tonalite) and andesite, and the ridges of the promontory to the Vuzenica-Radlje basin consist of the upper-Miocene conglomerate, marl and sandstone. On the southern, i. e. the Mislinja slope gneisses and micas prevail.
- 2 The eastern and southeastern Pohorje is the area lying east of the deep valleys of the Lobnica and the Mislinja rift. It is the most massive section of the range and represents a half of the Pohorje. This section is less rugged than the rest of the range.
- 2.1 The Maribor Pohorje is the area with the highest ridge Planika–Klopni vrh (1340 m)–Žigartov vrh–Ledinekov vrh (1182 m)–Bolfenk. Towards the bottom of the Drava valley its steep northern slope transforms into the Neogene vinegrowing Limbuš hills, which geologically do not belong to the Pohorje.
- 2.2 The corner peaks of the Pohorje plateau are Veliki vrh (1303 m), Travni vrh (1273 m), Klopni vrh (1340 m) and the eastern slope of the ridge Pesek (1423 m)–Plesič (1407 m).

Figure 1: Altitudes above sea level. ➤ str. 191

Figure 2: Surface inclinations of the Pohorje. ➤ str. 192

Figure 3: Division of the Pohorje surface with the drawn-in selected geomorphological elements: geomorphological unit, ridges, extent of drainage basins, extent of Plio-Quaternary marginal basins, typical slope bends (continuous line), strike-slip fault at the valley bottom (dashed line), moraine, ring structure. ➤ str. 193



K O Z J A K
Bistrica
Radlje ob Dravi
Muta
Vuzenica
Drava
Dravograd
K O B A N S K O
Žavcarjev vrh 915
Kamnica
Bresternica
OBDRAVSKO POHORJE
SEVEROZAHODNO POHORJE
SPODNJA MISLINJSKA DOLINA
Selnica ob Dravi
Bistrica ob Dravi
Limbuš
Pekre
RIBNIŠKO-LOVRENŠKO-SELNIŠKO PODOLJE
Lovrenc na Pohorju
Drava
Ruše
Maribor
Pameče
Kremžarjev vrh 1164
S R E D N J E P O H O R J E
Radoljna
Lobnica
MARIBORSKO POHORJE
Razvanje
Stari trg
Slovenj Gradec
Velika Kopa 1542
Klopni vrh 1340
Spodnje Hoče
Žigartov vrh 1346
Plešič 1407
Šmartno pri Slovenj Gradcu
SLOVENJGRAŠKA KOTLINA
Črni vrh 1543
POHORSKA PLANOTA
Radizel
Mislinja
Mislinja
Rogla 1517
VZHODNOPOHORSKA NAGNJENA PLANOTA
Volovica 1455
Veliki vrh 1344
Mislinja
PAŠKO POHORJE
Bistrica
Oplotnica
Paka
VITANJSKO POHORJE
ZREŠKO POHORJE
Pragersko
Basališče 1272
P A Š K I K O Z J A K
Oplotnica
Slovenska Bistrica
Zreče
Stenica 1091
S T E N I C A
KONJIŠKA KOTLINA
Slovenske Konjice
200–399 m
400–599 m
600–799 m
800–999 m
1000–1199 m
1200–1599 m
Scale/merilo:
0 2 4 6 8 km
Author of contents/avtor vsebine: Ivan Gams
Author of map/avtor zemljevida: Mauro Hrvatin
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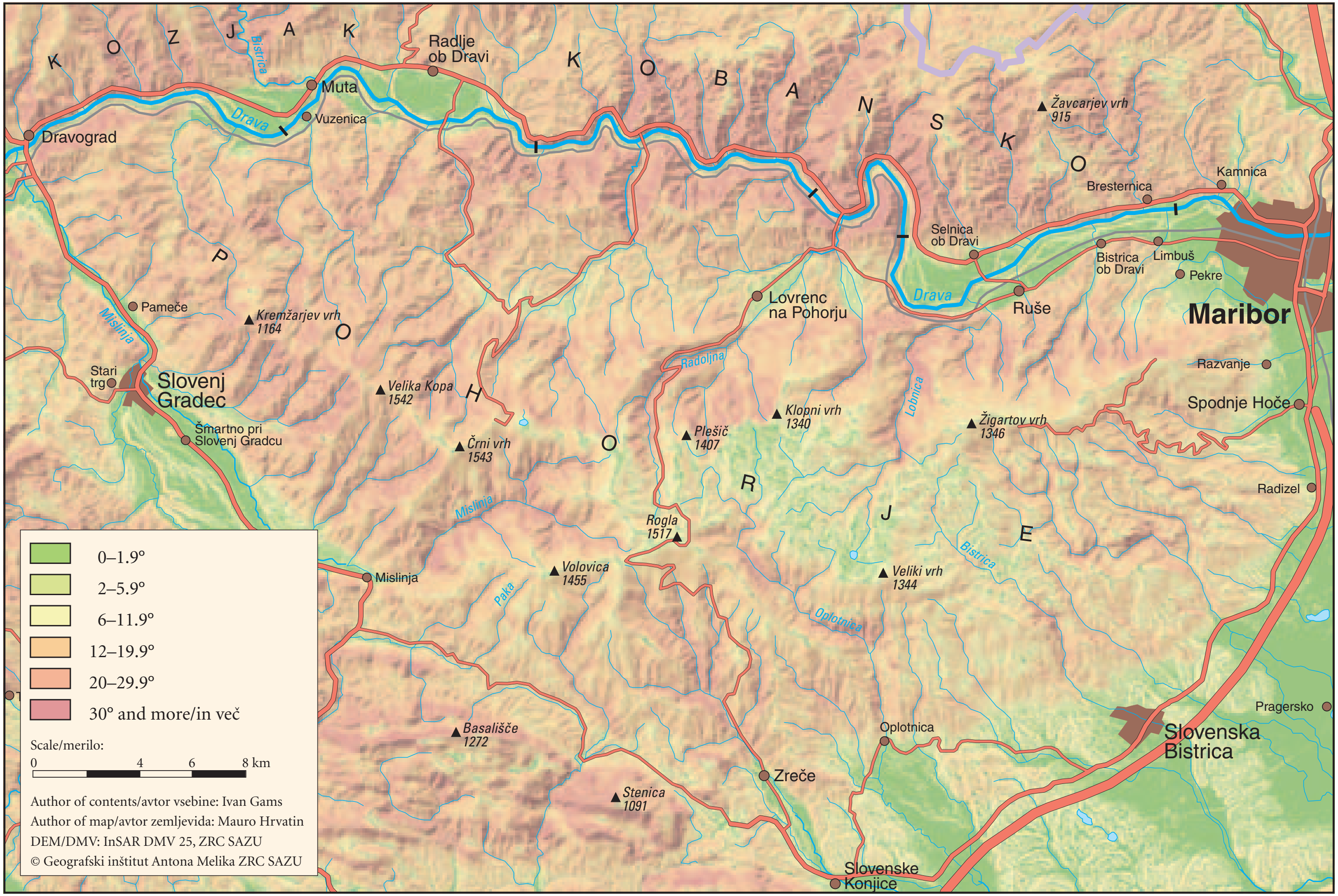
KOZJAK
KOBANSKO
POHORJE
Radlje ob Dravi
Muta
Vuzenica
Dravograd
Drava
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Lobnica
Žigartov vrh 1346
Razvanje
Spodnje Hoče
Radizel
Rogla 1517
Volovica 1455
Paka
Veliki vrh 1344
Oplotnica
Pragersko
Slovenska Bistrica
Basališče 1272
Stenica 1091
Zreče
Slovenske Konjice
0–1.9°
2–5.9°
6–11.9°
12–19.9°
20–29.9°
30° and more/in več
Scale/merilo:
0
4
6
8 km
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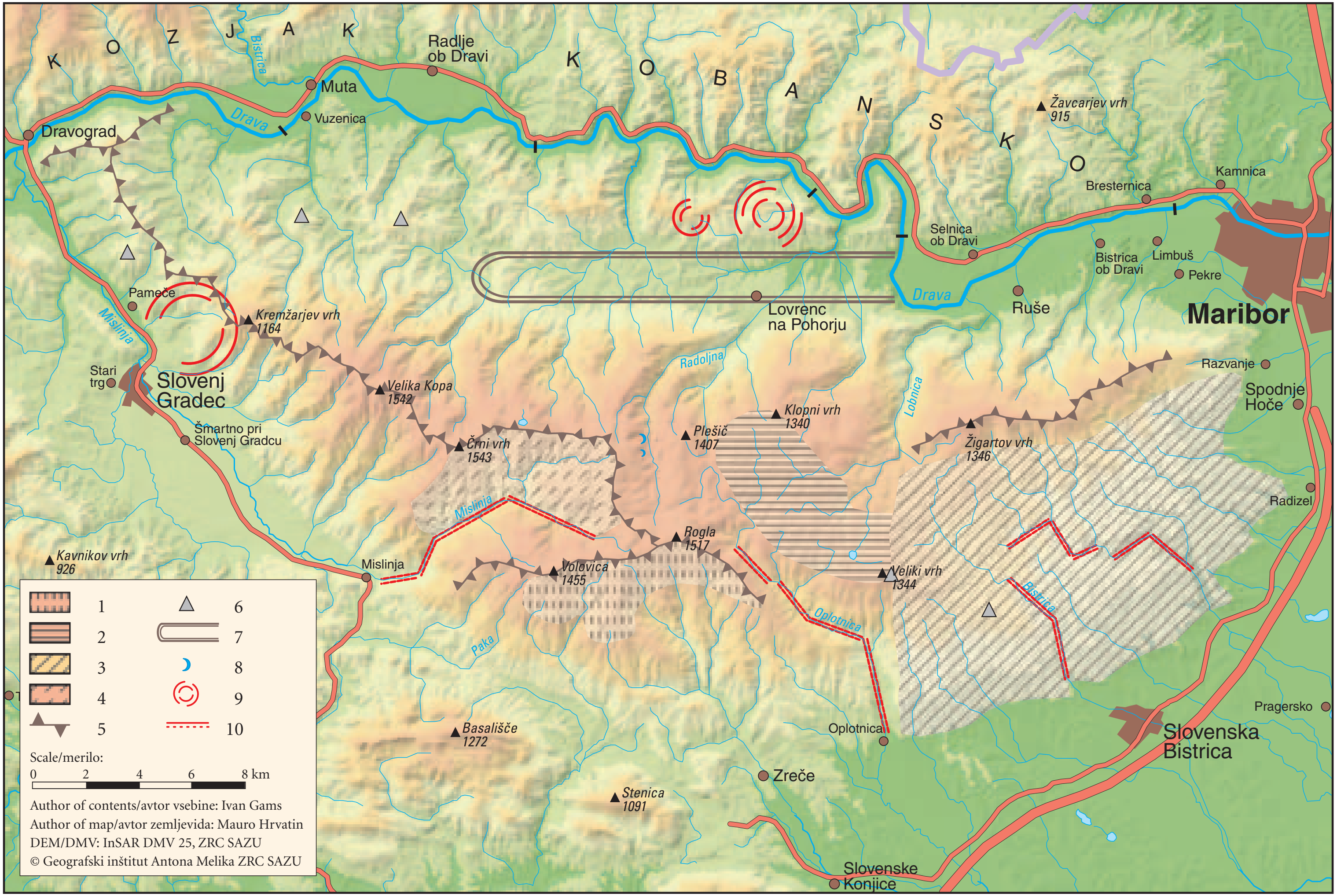
K O Z J A K
Bistrica
Radlje
ob Dravi
Muta
Vuzenica
Drava
Dravograd
K O B A N S K O
Žavcarjev vrh
915
Kamnica
Bresternica
Selnica
ob Dravi
Bistrica
ob Dravi
Limbuš
Pekre
Ruše
Maribor
Pameče
Mislinja
Kremžarjev vrh
1164
Lovrenc
na Pohorju
Radoljna
Lobnica
Razvanje
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Slovenj Gradcu
Klopni vrh
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Plešič
1407
Črni vrh
1543
Žigartov vrh
1346
Radizel
Mislinja
Rogla
1517
Kavnikov vrh
926
Mislinja
Volovica
1455
Veliki vrh
1344
Bistrica
Oplotnica
Paka
Pragersko
Oplotnica
Slovenska
Bistrica
Basališče
1272
Zreče
Stenica
1091
Slovenske
Konjice
1
2
3
4
5
6
7
8
9
10
Scale/merilo:
0
2
4
6
8 km
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- 2.3 The eastern and southeastern Pohorje is less rugged than the rest of the range. Discerned by different relief features within this area are the units of the eastern Pohorje inclined plateau, i. e. the Zreče Pohorje, the Vitanje Pohorje and the Paka Pohorje, but the differences are minor only.
- 3 The Pohorje in the wider sense of the word also includes two units which are closely related to the origin of the Pohorje. These are the Ribnica-Lovrenc-Selnica valley system and the Drava Pohorje.
- 3.1 The Ribnica-Lovrenc-Selnica valley system extends over about 2–3 km wide, mainly undulated landforms ranging between 300 and 700 m a. s. l. between the settlements Ribnica and Limbuš. It consists of the upper-Miocene conglomerates, sandstones and marls, and also of the Drava alluvia in its direct continuation in the Drava valley.
- 3.2 The Drava Pohorje lies between the Drava valley and the Ribnica-Lovrenc-Selnica valley system, and has not been given an official name so far. The above-mentioned name is used for the first time in this paper. It is a series of ridges high up to 913 m a. s. l., which extend in the east–west direction between the Vuhreščica valley and Fala or, to put it otherwise, between the Ribnica-Lovrenc-Selnica valley system and the Drava valley.
- 4 The Drava valley between Dravograd and Maribor is not entirely part of the Pohorje. Since the Drava drains waters from the major area of the Pohorje, it is also a subject of this paper dealt with together with the Vuzenica-Radlje basin.

3 The impact of rock structure

Recent geophysical and geological investigations into global composition of the Earth under the oceans and under the continents have contributed a lot to the explanation of the origin of metamorphic rocks also in the Eastern Alps that reach from the southeast of Austria to Slovenia in the Drava drainage basin on the Pohorje. In view of the tectonics the Pohorje consists of thrusts that were generated in the subduction zone of the Palaeotethys between the Ordovician and the Devonian. In the Varistic and the Alpidic orogenesis they were metamorphosed with varied intensity (Premru 2005, 206; Hinterlechner-Ravnik, Moine 1977). Let us examine, for example, eclogite that occurs on the Pohorje. It is generated at the pressures of about 3 Gpa and temperatures 760–820 °C. Such conditions prevailed in the Silurian-Caledonian period 500–435 million years ago during the subduction of the Palaeotethys ocean plate under the edge of the continental plate. The Pohorje rocks underwent another metamorphosis during the younger tectonic phases.

In the sense of the delamination theory, intrusions of magma into the asthenosphere caused extra uplifting of veined rocks to the surface of the Earth, due to the low-pressure and low-temperature metamorphoses. Geology has established several intrusions of magma into the asthenosphere, which caused such diversity of rocks. According to Premru (2005), there are traces on the Pohorje, in the wider sense of the word, of eight joint systems running in diverse directions which originate from the time between the upper middle Pliocene and the Holocene. It is not reasonable to discuss on this point the different geological interpretations of the origin of palaeorelief, because the issue here is of geomorphological analysis of the present relief and of the differences in it in particular.

According to geologists, the Pohorje metamorphic and igneous rocks are the eastern continuation of the so-called Periadriatic Lineament shifted northwards (Mihevc, Vrabec 2005). Mioč and Žnidarčič (1972) divide the Pohorje and the Kobansko metamorphic rocks into 28 units. Nevertheless, some of them are not homogeneous as to their chemical composition and compactness; granodiorite, for example. The analysis of three samples (Faninger 1973, p 35) established percentages of silica between 25.2 and 30.6%. Rare limestones occur as elevations at some places, but, in general, the relief does not reflect the differences in the composition of metamorphic rocks. It also applies to the upper-Miocene strata, i. e. conglomerates, sandstones and marls. They form the undulated Ribnica-Lovrenc-Selnica valley system which is, according to Melik (1957), supposedly made of less resistant sediments. A wider area than this one is occupied by the equally old sediments in the up to 845 m high mountains between the western surroundings of Ribnica and the Vuzenica-Radlje basin, but the medium-high ridge-and-valley relief of that place does not differ significantly from the adjacent territory of metamorphic rocks in the Drava Pohorje. The contact zone of granodiorite with other metamorphic rocks, which runs along the Pohorje watershed ridge between the Mislinja and the Drava drainage basins, or between the peak Velika Kopa and the pass Šiklarica, is mainly not reflected in the relief forms. However, along this contact runs the highest watershed ridge between the peaks Mala Kopa and Rogla, conditioned by lesser resistance to tectonic uplifting. But east of Sedovec (1232 m), which belongs to the Maribor Pohorje, the higest watershed ridge consists of muscovite-biotite gneisses with transitions to mica, while the lower lying granodiorite area moves off ever more to the south. It was not the petrographic composition but the tectonics that determined the relief here. The eastern Pohorje valleys became deeper at some places after crossing the granodiorite-gneiss contact. Located at such a contact is the upper fall of the brook Bistrica (Šušteršič et al. 2005, 17).

The great petrographic diversity of metamorphic rocks does not have a stronger influence on the small surface forms, because the metamorphic rocks, except for rare cases, as well as the magmatites are more or less grained and, when once on the surface, disintegrate into sand rather quickly (an old local term for them in the western Pohorje is »grained stone«). Sand occurs in a thicker subsoil layer in the central Pohorje on less rugged areas, called »planje« (planes) by the locals. The usual inclinations there range between 11° and 19°, and 20–33° on the slopes of deeper valleys.

The inclinations in the above-the-average steep Mislinja drainage basin on the Pohorje above Dovže, amount to 22° 40' (Gams 1976, 188). The influence of rocks on the relief is slightly more evident in the eastern Pohorje slope between the settlements Božje and Spodnje Prebukovje, where the river valleys are shallower and wider in the zone of transition of granodiorite to gneiss. Between Črni vrh and Jesenkov vrh the Pohorje seems as if shot through with circles and belts of dacite, and the surface inclination of Kremžarjev vrh (1164 m) is slightly above the average, of its northern slope in particular. At the transitions of dacite to dark phyllitoid schist on the saddle Pungart near Grmovškov dom, there is about one hundred metres wide grass shelf on phyllitoid schist, which is an exception on the Pohorje.

Steep above the average are the isolated mountains of Cretaceous limestone amidst metamorphic rocks (Jesenkov vrh, 933 m; Golek, 769 m; Brinjeva gora, 520 m in the vicinity of Zreče). Some crashed carbonate rocks got embedded in between metamorphic rocks in such positions that they are not exposed in the relief. Bigger islands of carbonate rocks, especially the one with the church of the Holy Spirit at Ostri vrh (903 m) on the Kobansko, and the other one at Jesenkov vrh (933 m) in the northwestern Pohorje, both on the top of the ridge, rise steeply above the surroundings. They are supposedly the remains of the thrust from the Karavanke (Mioč, Žnidarčič 1972). This helps to interpret most conveniently the origin of the 863 metres high mountain Loška gora, which lies only two-to-three kilometres away from the northern edge of the carbonate Mt. Sténica in the Karavanke.

Until recently, the humans exerted the greatest impact on soil erosion by ploughing parallel to the contour lines; due to the ploughing translocation of soil it accumulated at the bottom edges of those fields where landslips occurred. The linear erosion is still intense at the lower side of asphalt roads where they interrupt the flows of groundwater which has been collected higher up in relief depressions. On the Pohorje, too, the soil erosion is more intense on steeper locations (comp. Komac 2005, Figures 4 and 7).

Prior to the Plio-Quaternary, an extensive cover of upper-Miocene sediments had spread from the Graz basin across the Pohorje to the Karavanke (Sölva, Stuve, Straus 2005). These sediments on the Pohorje (in a wider sense of the word) also contain pebbles of metamorphic rocks, among others also those of granodiorite and dacite. This fact supposedly proves that they had already been dismantled on the ridge of the Pohorje (in a narrower sense of the word) as early as the upper-Miocene. However, in the same Eibiswald strata similar admixture also occurs in the Kobansko area (Mioč, Žnidarčič 1972, 40–41). Dismantled just below the Kobansko pass Radelj are the Radlje layers with pebbles of metamorphic rocks, up to one metre long. The Eibiswald strata have survived in the form of circles or stripes in the relief depressions (e. g. the Ribnica-Lovrenc-Selnica valley system) and in mountains as well, all in tectonic basins that have protected them from erosion. At such locations their total depth amounts to, for example, 420 m in the Kaplja syncline, 500 m in the Ribnica-Selnica tectonic rift, and 1110 m in the area of Radlje and Remšnik (Mioč, Žnidarčič 1978, 38, 63). Preserved in the tectonic depressions, they indicate their original thickness and extent.

4 Relief units

4.1 The Drava valley

Concurrently with the uplifting of Golica (the Koralpe), the present Drava, as the outflow from the Lawamünd basin, was sliding along the Lavanttal/Labot fault towards the southeast to Dravograd. However, it did not break its gorge through the western Pohorje at its lowest ridge, i. e. the saddle Cvitrško sedlo (677 m) which consists of Helvetic sediments, but on the chlorite-amphibolite schist, amphibolite and ultrabasic diabase which occur on both sides of the Dravograd breakthrough valley between Mežnarjev vrh (800 m) on the Pohorje and the long ridge of Košenjak in the settlement Ojstrica. The valley slope is steep on the Pohorje side, but gently sloping under the higher Košenjak (1522 m) whose uplifting was quicker and, consequently, the latter pushed the river to the south. In the continuation of the valley to Trbonje both the Kobansko and the Pohorje sides are equally steep. The valley along the onetime Styrian-Carinthian border is the narrowest halfway from Dravograd to the Vuzenica basin, which points to the onetime watershed between the tributaries to the Lawamünd basin and those to the Vuzenica basin.

In the valley between Trbonje and Spodnja Vižinga lies the combined Vuzenica-Radlje basin. During the construction of the hydropower plant at Vuzenica 80 metres of the Quaternary Drava alluvia were bored from it (Mioč, Žnidarčič 1972). Judging from the Quaternary terraces we have established that the centre of the subsidience lay on the southwest edge of this basin between the settlements Vuzenica and Dravče. In this direction, i. e. southwards, also the largest Quaternary terrace of the Vuzenica basin intensely slopes down, but it has only a slight vertical drop above the southern end of the Kobansko Bistrica valley from Zgornja Gortina to Muta, although the Drava gravel prevails on the top as well. It seems that the Drava was kept back by the Bistrica. At the same altitude on the southern side of the basin a part of the terrace has still been preserved at Zgornji trg in Vuzenica. It belongs to accummulation terraces at the beginning of the valley of the Cerkvenica. The largest one occurs at Trbonje and also reaches the height of 380 metres at the northern section of the settlement. Both the above-mentioned terraces are the remains of the Pleistocene Drava accumulations at the mouths of its tributaries from the Pohorje, including the terrace of the (Mežica) Dobrova (Kislinger 1929; Gams 1995). Before this terrace the (Trbonje) Reka turns right and runs for the following 1.5 km in the southeast direction between the elongated dropping Trbonje terrace and the Pohorje phyllitoid schists with the outcropping islands of dacite. The bedrock of the gravel terrace is deeper at Vuzenica than by the river at the eastern part of the Radlje basin downstream of Vuhred. On the Kobansko above Vuzenica seismologists installed the station Pernice in 1991; they established the epicentre in the depth of 15 kilometres and the earthquake endangerment of Richter Scale magnitude 5 (Vidrih 1992).

In the southern hinterland of the basin near Vuzenica there are numerous dacite outcrops which probably merge in the depth into a bigger laccolith. This may be the cause of the seismic activity of this area. At Vuzenica above Spodnji trg, there is a deposit of dacite tuff (Mioč, Žnidarčič 1972). According to Premru (2005, 457), the Vuzenica depression is a ring structure which occurs on the surface with the spirally curved ridges and/or valleys above the plutonite. According to the same source, faults in the NW–SE, NE–SW, W–E and N–S directions were established in this basin.

To the east, the Vuzenica basin joins the 6 km long Radlje basin, where east of the Bistrica mouth the largest, i. e. the Radlje terrace is gross 10 metres lower than the Muta terrace, but is less inclined southwards than the former and it is all used for fields, in contrast to the Muta terrace. The unestablished depth of the bedrock makes it impossible to guess the intensity of tectonic subsidience, which could be presumed from the curved edges both to the north and to the south. With the length of 5 km and the width of up to 5 km it has a similar extent as the Vuzenica basin. According to Premru (2005), either basin is a ring structure. By subsiding, they both furthered the erosion of the Reka, the Cerkvenica and the Vuhreščica which made long valleys in the upper-Miocene Eibiswald sediments, with intermediate high ridges that begin at the Pohorje watershed ridge.

The Drava valley between the Drava Pohorje and the Kobansko is a gorge and consists of muscovite-biotite gneisses with transitions to mica. The number of Pleistocene gravel terraces decreases eastwards. The remains of a mastodon, found in the 5th terrace level at Brezno, were dated into the Riss by Rakovec (1955). By their relative heights above the bottom of the valley five gravel terraces were possible to be established along the Drava. The highest terrace has only survived on rare locations in the form of narrow conglomerate remains (Gams 1959). East of Brezno there remains only a rocky gorge with gushing water.

The gradient of the Drava was changed with the construction of reservoirs before the hydropower plants after the Second World War. Prior to this, the flow of the Drava was intervened at Fala only. Hiltl (1893) reports that, in order to clear the way for rafts, the obstructing rocks were shot off on this point in 1818, in the total volume of over 15,000 m^3. In the 19th century, the Austro-Hungarian Military Geographical Institute performed gradient measurements of the river Drava on ten sections. In the 60-kilometre-long

Figure 4: The breakthrough valley of the Drava beyond Dravograd (an eastward view). Right, a slope on the Pohorje; left, the slope under higher Košenjak is less steep; left rear is Kobansko.

river course, between Dravograd and Mariborski otok, the vertical drop of 92 metres was measured, which makes the average gradient of 1.53 m/km (Hiltl 1893, 70). On the map of Slovenia in the scale of 1 : 50,000, made before the construction of the hydropower plant, the still winding course of the Drava to Fala was 49 kilometres long, which means the gradient of 1.09 m/km. In the Vuzenica-Radlje basin, the gradient to the confluence with the Vuhreščica is small, and in the next section to the homestead Šturm (on the top of the turn north of Fala) it amounts to 3.1 m/km and 2.66 m/km from here to Laznica. It seems that the Drava gradient as to its water abundance and the coarse stones deposited in the gorge by the direct Drava tributaries is rather big and the river would still be able to deepen its riverbed, had there be no human interventions.

4.2 The Drava Pohorje

The Drava Pohorje is 19 km long and 3–4 km wide range of metamorphic rocks between the Vuhreščica valley and the turn of the Drava above Fala. Up to 913 m high and mainly eastwards oriented ridges with frequent level top ridges at the altitude between 800 and 900 metres a. s. l. are most intensely rugged by the valleys of the brooks running from the ridge of the Pohorje.

The Drava Pohorje is the southern wing of the Kobansko anticline. Ridges and valleys on the Kobansko southern slope mainly do not continue in a straight line on the other side of the Drava into the Drava Pohorje and the left Drava tributaries are much more numerous. Between the settlements Brezno and Ožbalt the following tributaries from the Kobansko flow into the Drava: the brooks of Remšeniški potok, Brezniški potok, Potočnikov potok, Javniški potok, Grgasov potok and the Črmenica. Their up to 7 km long valleys with steep slopes are up to a hundred or even more metres deep in their central and/or lower sections. With their average spacing of one kilometre their density is the highest in Slovenia, which points to their recent origin. At Podvelka, the ridge curve rises to Hlebov vrh (913 m) and then starts dropping in the form of a crescent towards the Drava at Ožbalt.

Figure 5: A view from the hill Sv. Anton towards the Pohorje (in the rear) embraces the southern part of 6-km-long mountainous area where, according to some geomorphologists, the Drava supposedly ran in old times and its course continued towards the east.

A proof to the fact that the Drava Pohorje has undergone continuous uplifting without major interruptions, just like the Pohorje, is the absence of slope terraces. The epigenesis of the Drava valley was advocated also by Melik (1957) and Sölva (2005). Also the thesis, that the old Drava first accumulated gravel in the Graz basin or in the western Slovenske gorice, is old (Winkler 1944, 145–168). All of the quoted authors, Mioč and Žnidarčič (1972) as well as Melik (1957, 74–75), believed that in the succeeding phase the Drava ran along the Ribnica-Lovrenc-Selnica valley system, but they did not give the explaination of when and why the up-to-854 m high range was uplifted in the river basin of the Velka and the Plavžnica, both of which run towards the Vuzenica-Radlje basin. This range is of the same height as the Drava Pohorje.

No more traces remain on the Kobansko of the transversal valley of the Drava towards the Graz basin. On the contrary, the configuration of the Črmenica, which is the longest river on the Kobansko running towards the southwest, points to a recent piracy by the Drava. Its valley is 0.8 km wide at the outflow to the Drava; 3.5 km upstream, at Spodnja Kapla, it is 2.5 km wide, and in the Eibiswald strata in the watershed area before the state border, at the settlement Gradišče na Kozjaku, it is 6 km wide. There, on the Kobansko ridge, the piracy occurred, due to the Črmenica, of the headwaters of two western tributaries to the Drava, i. e. of the Grgasov potok and the Ožbaltski potok. The piracy by the Črmenica corroborates the thesis that downstream of Maribor, in contrast to the Mura, the Drava has greater erosion power than the Mura, since its left tributaries are longer than the right ones (Melik 1957).

4.3 The Ribnica-Lovrenc-Selnica valley system

In terms of geology, the Ribnica-Lovrenc-Selnica valley system is made of upper-Miocene conglomerates, sandstones and marls. In the basis they consist of clastic material of fluvial origin, those lying higher are of fluvio-limnetic origin, and those on the top are brackish (Mioč 1977). The surface is mainly undulated with the altitudes between 400 and 700 metres. The Selnica valley system, which is the continuation of the Lovrenc valley system, occupies the bottom of the Drava valley from Fala downstream to Maribor.

Below Fala, the Holocene alluvium reaches the rocky bottom at the depth of 100 m. According to Šercelj's pollen analysis (quoted from Mioč, Žnidarčič 1978) the fluvioglacial alluvial fan at Lovrenc na Pohorju proceeds from the middle Würm. Between Lovrenc and Fala, in the Lamprehtov potok drainage basin,

Figure 6: The Rečnikov potok stream is oriented north-eastwards.

there is a separate little basin with uneven bottom filled with sand clay in which Šercelj established the pollen of the last Würm climax (Mioč 1977).

In the tertiary hills at the eastern end of the Lovrenc valley system, there is a singular case of the recent tectonics impact on the drainage network. Some 50 metres above the Drava near Fala, there is the ridge at 420–450 metres a. s. l. oriented northwards, with the settlement Činžat at its top. At the contact of the Neogene with metamorphic sediments at Rute, there is a 5 km long narrow dacite stripe running in the east–west direction. Hiltl (1895, 75), the Fala mansion forester, quotes two earthquakes in the Pohorje, those of 1791 and 1794. The relief forms on the eastern slope of the ridge with the settlement Činžat are not consistent with the general inclination of the slope in which two valleys begin under the settlement. Into one of them, water from the brook Lamprehtov potok was artificially drawn off at the homestead Rečnik, horizontally across the slope and along the ridge to the opposite, i. e. the eastern slope of the ridge. The locals still call the entire stream after this homestead, the Rečnikov potok, all to its outflow into the brook Murkov potok. With this divertion the water power increased for the needs of saw mills that have long been abandoned by now. Recently, a part of this water from Činžat was channelled straight down through pipes for the needs of a new local hydropower plant on the Drava when it is in operation. If the Rečnikov potok would also run to this point, its course would be by a half shorter than it is now, when, due to its transversal course, it is 3 km long to its mouth at the Murkov potok. The two north-northeastwards oriented slope valleys converge a short distance before the asphalt road Puščava–Fala, at the point where the restaurant Falski dvorec is located. Years ago, before the road Puščava–Ruše was asphalted, the constructors metalled there the bottom of the valley for several metres. The rubble was obtained during the lowering of the pass by 10 metres in the right valley slope; in this way the upward gradient of the road towards Ruše was eliminated. Water now runs through the pipes under the metalled bottom into the deep gorge, oriented north-northeastwards and 800 m long and up to 50 m deep, between the ridge Karolina (357 m)–Kogel (343 m) and the ridge Činžat–Lobnikov vrh. At the end of the gorge, the brook Rečnikov potok flows into the brook Ugov potok which runs evenly with the inclination of the slope towards the east-southeast directly to the Drava. The slope valleys oriented northeastwards are the residue of the time when the subduction of the Drava valley had not yet reached Fala and the precursor of the Drava presumably ran in the narrow valley along the fault at the present northern edge of the Selnica valley system in the direction Fala–Črešnjevec–Selnica. Along this fault, the rocks that had been causing the above-mentioned rapids in the Drava were removed in order to make rafting trade easier. On its way through Fala, the Drava has the north–south direction in the distance of 4 kilometres, from the turn on the Kobansko at Žavcar to the Pohorje. It can be concluded that this is a longer tectonic fault and a slope bend, if compared to the 2.5 km long Lobnica valley at the northern slope of the Pohorje, which is equally oriented before the turn towards Ruše. We presume that in the past the narrower Drava valley in the higher altitudes a. s. l. extended merely to Ruše.

4.4 The northern slope of the Pohorje

The major morphological particularity of the Pohorje between Ribnica and Ruše is the northeastern deviation of the course of brooks, valleys and ridges from the general northwards inclination of the slope. In the upper part of the Pohorje, the valleys are curved westwards, but in the lower part they turn eastwards, which means the lower they are, the more to the east they turn. Their outflows shift in comparison with their sources, for example, by 35° in the case of the brook Bistrica, by 22° in the case of the Velka, and by 23° in the case of the Vuhreščica. Above the Selnica valley system the Pohorje brooks run northeastwards in a straight line.

A belt of ridge valleys curving westwards lies east of the peak Velika Kopa. On the latter, the recent shifts of the surface points were established by means of the GPS technique. The Pohorje – more precisely Velika Kopa – was included in this measurement campaign as a part of the tectonically unstable Periadriatic Lineament. Registered by means of this technique in the years 1996–2002 were the following shifts: by 0.53 mm/year to the south, which is interpreted as the shift along the Lavanttal/Labot fault towards the south-east, and by 0.48 mm/year to the north, which is interpreted as the shift in the northeastwards direction (i. e. towards Graz) (Vrabec 2006). However, our drainage basins north of the Pohorje ridge curve westwards, so the tectonic thrusting is supposedly equally directed (Premru 2005). The brooks in the

Ribnica-Lovrenc-Selnica valley system run straight to the northeast, and also the Velka, the Radoljna, and the intermediate brook Kapusov potok in the Drava Pohorje run in the same direction.

On the northern Pohorje, there is a narrow, steep and partly rocky valley of the Lobnica. It is only in this river that the rapids occur; they are the Mali (Little) Šumik and the Veliki (Big) Šumik. Its drainage basin extends over the largest portion of the Pohorje plateau. Its right tributary, the Verna, coming from between Peršetov vrh (1231 m) and Žigartov vrh (1361 m), runs evenly towards the southwest for the first 2 km. One kilometre before reaching the Drava valley the Lobnica turns at a right angle towards Ruše and, at the end of the gorge Kluža, where the tributary of the same name runs into the Lobnica, the latter runs into the Drava from the south. Parallel to the main river, at the altitude of about 700 m a. s. l., the-up-to-one-kilometre wide ridge on the left side of the lower Lobnica valley turns towards the east at the south edge of the Drava valley. Its lower and narrower slope above the Drava consists of the Eibiswald strata, and the remaining wider part of the Paleozoic schists, diabase and amphibolite. The two zones are separated by the tectonic thrust (Mioč, Žnidarčič 1978). The cause of the turn to the right is supposedly the above-mentioned recent (Neogene) elongation of the Drava valley to Fala.

We can conclude on the basis of its uneven longitudinal profile that the Lobnica valley is younger than the rivers on the Pohorje more to the west. It is the Lobnica drainage basin alone that significantly extends on the Pohorje plateau. Between the peaks Klopni vrh and Mizni vrh the watershed between the Lobnica and the brook Lamprehtov potok runs across a true plain. Even a slight tectonic change in the inclination could already cause that waters would start draining to the other side. The plateau slopes very gently eastwards. There, the Bistrica, oriented southwards in its initial course of 4 kilometres, did not succeed in making its valley deeper.

Proceeding from the circumstances under the Pohorje watershed ridge between Kremžarjev vrh and Velika Kopa (see paragraph 4.6.2!), we have established that the laccoliths of dacite in the depth are the most probable cause of the tectonic shifts on the whole of the Pohorje. On our map of surface inclinations curved slope bends also occur on the Zreče Pohorje, where the magmatic core lies deeper down under the surface and has intrusions of amphibolite and eclogite with transitions to amphibolite. This also applies to the inclined eastern-Pohorje plateau between the Maribor Pohorje and Oplotnica, where the brooks curving westwards occur at higher altitudes in the area of granodiorite, including the Zgornja Bistrica.

4.5 The eastern and southeastern Pohorje

East of the peak Peršetov vrh (1242 m), the highest Pohorje watershed ridge diverges ever more away from the continuous granodiorite eastern-Pohorje area, especially after the ridge of the Ruško Pohorje turns towards the east-northeast, i. e. towards Maribor. In the triangle Žigartov vrh – Poštela and Žigartov vrh – Zgornja Polskava, the slopes on the wide tops of the ridges slope gently, with prevailing inclinations of 6–12°. The slopes of the valleys are steeper, 12–20°. The hills in the place called Čreta, south of the brook Polanski potok, have a typical name, Brda (hilly land).

The brooks from that place sink into the gravel ground of the Dravsko polje plain, where a classical area of aggraded riverbeds used to be. This feature has gradually vanished, because the locals have already levelled them. They were a proof to the faster increase in alluvium than the rate of tectonic subsiding of the Dravsko polje. This subsiding fostered the deepening of the valleys in the hinterland Pohorje rim which is, consequently, more intensely ravined. Only in this part of the Pohorje the alluvial fans of the brooks are deeply indented into the hilly world, so that the Pohorje rim of metamorphic rocks is indented, too.

Between the upper course of the Polskava and the lower course of the Oplotnica the metamorphic margin of the Pohorje is modified by a wider hilly rim, the dense intermediate valleys are narrower, the hilly ridges are more inhabited, and the margin of the Pohorje is less explicit because some of its ridges turn in a less continuous way to the 20–35 m high Neogene Pohorje foothills (and the latter, further on to the SE, to the Dravinja hills). In the surroundings of Slovenska Bistrica, the Pohorje foothills consist of Plio-Quaternary sand, sand clay, clay- and sand-clay marl, clay gravel and individual up to 40 cm long pebbles of the Pohorje rocks (Žnidarčič, Mioč 1989). In the hills more to the southwest, siliceous admixture prevails among gravels, sands and clays, and in the hills between Ložnica and Zreče larger portions of upper-Miocene sediments from under the Karavanke are admixed to Plio-Quaternary sediments (Mioč, Žnidarčič 1972). It was Šifrer (1974) that called attention to the significant percentage of periglacial rubble from the Pohorje in Plio-Quaternary foothill alluvia, and on the rubbly periglacial cover in the hinterland Pohorje. In this crescent margin of the Pohorje the slope bend is drawn on our inclination map. The term »slope bend« (*pregibnica*) was introduced into Slovenian geomorphology by Habič (1984), and it denotes a visible, rather long typical transition to a different inclination in the relief, which can also be locally interrupted.

The third part of the eastern-Pohorje slope, which is the Bistrica drainage basin above the waterfall Bistriški Šum, is the most abundant with plateaus, and the name of the inclined eastern-Pohorje plateau suits it best. Prevailing are the inclinations of 6–12°, which is within the angle of repose for rubble. The explicitly narrow and long Bistrica drainage basin turns northwards at its waterheads, and the drainage basin of that place represents the transition between the Pohorje plateau and the inclined eastern-Pohorje plateau.

Since the inclination of 4–20° is also typical of the wide ridges between the rather narrow valleys of the hitherto described eastern-Pohorje slope between Hoče and the lower Oplotnica valley oriented southwards, this whole area can be classified as the inclined eastern-Pohorje plateau.

In the Plio-Quaternary period, the erosion by bigger rivers, i. e. of the Bistrica, the Oplotnica and the Dravinja, and the neotectonic subsiding made little basins at the foot of the hills. Also the Konjice depression (basin) is of this kind; it is filled with Quaternary and Plio-Quaternary sediments that were transported from the Pohorje and also from the Karavanke (Žnidarčič, Mioč 1989).

The depositing of river transport in the subsiding basins fostered the erosion and the deepening of the Pohorje rivers, in the lower section of the Bistrica and along the whole course of the Oplotnica; the valley of the latter acts as the western border of the inclined eastern-Pohorje plateau.

Between the brook Hočki potok and the Bistrica headwaters the valleys in the altitude above 350–450 m on the eastern-Pohorje slope bend to the southwest, supposedly as the result of tectonic shifts into this direction. Of particular interest is the assymmetric drainage basin of the upper Polskava. Its longer tributaries, i. e. the Velika Polskava, the brook coming from Frajhajm, the Mala Polskava and the Brunik above Loka pri Framu, run towards the southeast, but they are from one to three kilometres apart, while the collective brook runs towards the east-northeast. Thus, its upper drainage network resembles a broken hay fork with its fourth or the rightmost tine broken off, i. e. the tributary Brunik. The latter still avoids the fault line and also the isolated hill with the settlement Gradišče on its top; its confluence with the Polskava takes place downstream, after the turn. The main course of the Polskava between Šmartno na Pohorju and Gradišče runs practically at a right angle to the direction of the general lowering of the slope. This particularity in the drainage network can be accounted for by the strike-slip fault.

Of all the longer rivers on the Pohorje, the Bistrica has the shortest tributaries. The river runs to the southeast from the waterfall Bistriški Šum where harder granodiorite contacts mica (Šušteršič et al. 2005). The up to 250 m deep Oplotnica valley runs between Cezlak and Rogla in the marginal area of granodiorite close to the contact with the mica area; the cause of such a direction of the valley has not been established yet. If this river ran from its source at Črne mlake on the northern side of the peak Rogla straight in the direction of the highest gradient of the Pohorje slope, i. e. towards Zreče, its course to the settlement Oplotnica would not be 16 km long as it is now, but only 9 km. Except for the headwaters, the 250–300 m deep valley, extending down to Cezlak, has no larger tributaries on the left. At Veliki vrh (1344 m), three kilometres east of its riverbed, a residue of the onetime cover layer of micas has been preserved. It can serve as a proof that the river, after breaking through the mica cover which extends today uninterruptedly 5 km more to the north, was caught while deepening its bed in the harder rock basis. The valley between the settlements Jurgovo and Cezlak curves westward, and downstream of Cezlak the bottom turns to the SE and finally towards the south. Judging by the broken directions, we can conclude that the strike-slip fault runs on the bottom of the valley.

The valley of the lower Oplotnica and the Oplotišnica with the tributaries appear as the fanlike slope bend on the Pohorje. Similar deviation from the general inclination of the slope occurs with the Dravinja: its source is situated at a 6-km airdistance from Vitanje, and its course in the east-southeast direction is 15 km long. Similar is the case with the neighbouring river Hudinja. Its initial 3.7 km long course under Kragulišče (1454 m) runs to the south-southwest. After the confluence of the Paška voda tributary with the Hudinja, the latter turns to the southeast for the following 2.2 km, then it turns to the southwest and under Vitanje, near Goležev grad at the altitude of about 450 m a. s. l., it enters a deep gorge between the

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Figure 7: The western Dolíč valley system, where three relief types converge at Spodnji Dolíč: broad dolomite hills (in the middle) as part of the Dolíč valley system, the southern Pohorje slope (leftmost) and pointed limestone hills in the middle under the mountain Paški Kozjak (rightmost).

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Figure 8: The broken-through left slope of the Mislinja valley at the settlement Mislinja. On the southern side of the settlement, under the church, it was lowered to the bottom of the valley at the altitude of 600 metres by the Savinja tributary, the Paka, which made the road connection easier between the Drava region (Podravje) and the Sava region (Posavje).

ridge Paški Kozjak and Mt. Sténica. The valley of the Jesenica between Lošperk and Vitanje is of a crescent shape.

The explanation of the upper valleys directed obliquely down the slope, and of the small drainage basins of the Dravinja and the Hudinja can be found in the relatively recent break of these two Savinja tributaries through the uplifting Eastern Karavanke. It was most probably due to intense corrosion that the Savinja tributary, the Tesnica, in the altitude of about 410 m between the peaks Sténica and Konjiška gora above the settlement Beli Potok at the bottom of the Socka breakthrough valley, does not run on the continuous narrow belt of the prevailing non-carbonate upper-Miocene sediments but very close to it, on the slightly lower belt of limestone. For this reason the Tesnica has not prolonged its source near Stranice deeper into the Pohorje. Did the forerunner of the Savinja run through the Socka gorge in ancient times, and therefore did not leave abundant Würm rubble in the Celje basin? According to Meze (1963), it ran through the Eastern Karavanke towards the Dravsko polje plain in that time.

The former southwards drainage from the southern Pohorje slope to the Savinja hollowed a few-hundred-meter wide blind valley in the crystalloid Triassic limestone between the settlements Spodnji (Lower) Brezen and Zgornji (Upper) Brezen. Its bottom begins 220 metres above the Dolič valley system, slightly above the Tertiary Eibiswald strata near the homestead Strmečnik at the altitude of 740 m a. s. l. The bottom gradually rises and turns to the southwest, under the peak Basališče. The valley is the deepest there, at the settlement Zgornji Brezen, even up to 200 metres. Its origin is attributed to the contact corrosion between a brook running from the Pohorje on the surface of the Eibiswald strata in which the Dolíč valley system lies, and the carbonate rocks of the Paški Kozjak (Gams 1999, p 458). The watershed between the Hudinja and the Paka remained in the Dolič valley system at the altitude of this blind valley, on the road acclivity with the local name Lošperk (703 m). The vertical drop (over 700 m) between the above-mentioned blind valley and Lošperk on the one side, and the Pohorje plateau on the other can be attributed to the younger tectonic uplift of the Pohorje.

Due to intensified river erosion after the formation of the Hudinja breakthrough valley near Vitanje, a dense network of periodical brooks emerged on the valley slopes below the plains, whose numerous little valleys have prevented agricultural settling and land use, so that the forest cover has remained there. The situation is similar in the undulating drainage basin of the Dravinja.

East of the highest mountain, Basališče (1272 m), the Paški Kozjak ridge retreats towards the south, as does the whole of Mt. Sténica, while the entire Konjiška gora lies at a distance of a few kilometres towards the south.

North of the Paka breakthrough valley at Huda luknja, Triassic dolomites compose the hills of the Dolíč plate, on which the erosion residue of the upper-Miocene layers occurs sporadically. At the northern end of one of these hills, there is the broken-through southern slope of the terminal Mislinja valley. This is exploited for the road Velenje–Slovenj Gradec which reaches the bottom of the Mislinja valley at the altitude of 600 metres a. s. l., only 170 metres away from the 2–3 metres lower Mislinja stream. The breakthrough is the result of the erosion by the tributary Paka. If this slope had been broken through by the Mislinja at the church of Sv. Jedert (St. Gertrude's), the river would have undoubtedly irreversibly run towards the 2.7 km distant and 150 metres lower Paka at Huda luknja.

The recent stretching of the Paka drainage basin at the cost of the Mislinja is indicated southeast of the settlement Mislinja by a short dry valley on the slope at the altitude of 720 m a. s. l., which lies in the Triassic dolomite and reaches across the homestead Turjak towards the southeast.

In the isolated mountain Tisnik (785 m) there are the caves Huda luknja (2175 metres long), Špehovka (91 metres) at the altitude of 575 m, Pilanca (252 metres) at the altitude of 670 m, and the short cave Klet on the very top of the mountain; hypothetically, they were all hollowed by the Palaeopaka (Mihevc, Vrabec 2005). However, the possibility has not been excluded of the onetime higher lying sinking of the water, drained from the Miocene patch of the upper-Miocene conglomerate, sandstone and loams in the blind valley of the Ponikva. Mentioned so far have only been local divergences of the valley orientation from the average inclination of the broader slope.

4.6 The Mislinja Pohorje

With its length of 10 km and the depth of up to 700 metres under Črni vrh, the Mislinja rift, in which the Mislinja rises, greatly surpasses the rest of the Pohorje valleys, and it divides the Pohorje into two parts.

According to Premru (2005, 310), the Gail fault reached into the rift from the west in various times and under different names. The rift assumed its exceptional dimensions also due to the strike-slip faults in its bottom, where five plane sections of diverse directions can be discerned; the initial direction runs towards the east-northeast, then it changes to the east–west direction, and finally to the southeast–northwest direction. In the latter direction the stream named Mislinja runs from under mount Rogla in a rather shallow slope rift. From its confluence with the Glažuta near Pustotnik the main Mislinja rift continues three kilometres northwards into the valley of this tributary. Its two source rivulets encompass Skrivni vrh (1436 m) claws-like and indicate the ring structure in the centre of the Pohorje range. In the 7 km long final section, before the settlement Mislinja, the rift is 5.5–8 km wide. To the south, it is limited by the ridge Volovica (1455 m)–Rogla (1517 m).

The Mislinja rift, sunk mainly in diaftorite, is surrounded by about 1500 m high watershed ridge crescent with the summits Črni vrh, 1543 m, Mali črni vrh, 1533 m, Jezerski vrh, 1537 m, and, after the interspace at Šiklarica, a 2.5 km long ridge with the Ribniško jezero area in the altitudes between 1500 and 1540 m. The undoubtedly younger rift than the mountainous rim of the surprisingly even altitudes between 1500 and 1540 m leads to the conclusion that the Mislinja tributary the Glažuta dissected the up to 3 km wide plain in the altitude slightly above 1500 m, and south of this area the Mislinja itself, by means of erosion, lowered the narrow plain at the altitude of about 1450 m. Reaching up to this altitude on the south side of the drainage basin is the broad ridge which is 4.5 km long, lying west-southwest from the tourist settlement on Rogla, where the summits Volovica, 1455 m, Turn, 1463 m, Kraguljišče, 1454 m are situated. West of the Pohorje plateau, the two kilometres long ridge Pesek (1423 m)–Lasina (1412 m) rises above 1400 m, which enables the conclusion that, formerly, a little plateau existed at the altitude of about 1450 metres also more to the east of the ridge of the Lovrenška jezera area, but was lowered by the periglacial processes of the nearby glaciated area and by the river erosion, while its eastern continuation in the Eastern Pohorje was uplifted by the tectonics to the present height, i. e. between 1300 and about 1400 m.

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Figure 9: The unified gravel fan of the Dovžanka and the Turičnica, undissected by erosion. In the rear, Velika Kopa. The Razborca, the ridge between the valleys, is a good example of the ridge without horizontal interspaces which rather evenly rises towards Velika Kopa (in the rear).

At the settlement Mislinja, the broad and long ridge below Črni vrh, named Planjave (planes in English), can be identified as a specific relief type, i. e. planes, which is most typically developed also 10 km to the east on the southern side of the ridge Volovica (1455 m)–Rogla (1517 m)–Gradišče (1278 m). Moderate inclinations have still been preserved in between the initial brooks of the Paka, the Hudinja and the Dravinja (see the altitude map!).

The Pohorje watershed ridge along the line Kremžarjev vrh–Kopa–Mali Črni vrh runs in the Dinaric direction, i. e. northwest–southeast, which is also the direction of the Lavanttal fault. It is closer to the Mislinja valley than to the Drava valley.

The two Pohorje valleys more to the west, those of the Dovžanka and of the Turičnica rivers, up to 200 m deep and 5 km long, follow the general inclination of the Pohorje slope and run at a right angle to the direction of the upper Mislinja valley. The rivers running from half a kilometre to one kilometre apart are rare examples of water streams without bigger tributaries (an exception to this is the Dovžanka tributary the Jamovica, which indents into Črni vrh and Planjave). The intermediate ridge of Razborca, dropping evenly southwards, is a proof of uninterrupted uplifting of the range and the concurrent subsiding of the foothills in the Slovenj Gradec basin. On the unified Quaternary gravel fan the Dovžanka and the Turičnica failed to deepen significantly the riverbed they have in common, which is a rarity in the western margin of the Pohorje.

The Lavanttal fault at the rim of the area made of the Pohorje metamorphic rocks and at the same time of the range is not straight throughout. Slight divergences occur near the settlements Bukovska vas, Dovže, Šentilj, Spodnji Dolič and Vitanje, which indicates the strike-slip fault (see the map Mioč, Žnidarčič 1972).

4.6.1 The Mislinja valley

The Mislinja valley consists of four different geomorphological units. The nine kilometres long Lower Mislinja valley is separated from the Drava valley at the confluence of the Meža with the Drava by the 400 m a. s. l. high Quaternary gravel-sand terrace of the (Meža) Dobrova, on which the Drava gravel and conglomerate mostly cover the broken rock basis. The Meža with its tributary the Mislinja runs through the sole open eastern window towards the Drava. Before Dobrova, the Mislinja valley triangularly widens to form a small basin with two settlements, Šentjanž and Otiški Vrh. After a prolonged excavation of the gravel-sand road metal, only little of the lymnetic Würm fossil delta of the Meža, with the onetime summit slightly under 400 m, remained in this basin at Šentjanž under the hill Selovec.

Between Šentjanž and Slovenj Gradec, the 18 km long Lower Mislinja valley of the Dinaric direction is rather evenly up to one kilometre wide. Before the earliest regulation of the Mislinja, the larger portion of the level alluvial bottom of the Lower Mislinja valley had been exposed to floods. Judging by this we can conclude that the valley is a tectonic rift, subsiding between two parallel fault lines and side slopes. The Pohorje brook Lakužnica all until recently used to deposit alluvium in the valley bottom and thus hindered the traffic there. The locals made a dyke which has already been removed by now. Only at Pameče and at Troblje the brook Trobeljščica accumulated a gravel terrace during the existence of the Würm dammed-up lake. The southeastwards continuation of the Mislinja rift is closed up by the hill Gradišče (517 m). South of it, at the transition of the lower Mislinja valley into the Slovenj Gradec basin, the Mislinja runs in rapids between the steep slope of the ridge Rahtelov hrib (677 m), sporadically rocky in its lower part, and the 100–150 m distant slope scarp of the Legen terrace.

4.6.2 The Slovenj Gradec basin

In the Slovenj Gradec basin, there are two accumulation terrace formations, the Legen and the Dobrova terraces, and two valleys, the Mislinja and the Suhadolnica valleys. The 5 km long and up to 350 m wide Legen terrace, being unique at the foothills of the Pohorje, receives five brooks from the Pohorje at the northwestern edge of the basin. Below the watershed ridge between Velika Kopa and Kremžarjev vrh, the slope ridges and the intermediate brooks the Porodnica, the Reka, the Barbarski potok and the Brezniški potok (the latter with a bigger tributary the Kremžarjev potok) began to turn southwards from the initial southern direction at the altitude between 600 and 700 m – the lower the altitude the more intense the turning – and then, on the Legen terrace, in the joint brook Barbara, northwestwards. The ridge below Velika Kopa begins to turn likewise under Vrhnjakov vrh (936 m) at the settlement Golavabuka, and begins

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Figure 10: The Slovenj Gradec basin, a view towards the southeast (from the altitude of 630 m). To the left, under the Pohorje (out of view), the grassy terrace with the settlement Legen. The upper and the lower sections of the Mislinja valley meet between the end of the terrace and the slope of Rahtelov hrib. In the rear, wooded mountains between the Paški Kozjak (left) and Uršlja gora.

to drop towards the west, and finally towards the northwest, building the slope scarp of the Legen terrace which consists of sand, clay, rubble and gravel, and becomes rocky west of the church of Sv. Jurij (St. George's). In Zgornji (Upper) Legen at the beginning of the Legen terrace by the brook Svarina, there are two gravel terraces, the higher one is wooded and the lower one is mainly covered with fields and it is the only one to continue uninterruptedly to Spodnji (Lower) Legen and reaches all to Slovenj Gradec. Due to its geological, geomorphological and hydrological peculiarities the Legen terrace deserves that it should be declared the geopark, the first one in Slovenia

The Legen terrace rises faster towards the southeast than the adjacent alluvial plain along the Mislinja, therefore the terrace is already 55 metres high above Šmartno. There, the Miocene clays are dismantled in spots on the slope scarp, while at Slovenj Gradec, Tičnica (459 m) and Borovnik (454 m) rise on the top of the same slope scarp, both made of phylitoide schist. This also composes the southeastern rim of the neighbouring Rahtelov hrib, which has here as well as under the entire Gmajna the same direction as the Legen slope scarp. Between Tičnica and the church of Sv. Jurij (St. George's) the gravel-sand alluvium at Legen extends at places beyond the top of the slope scarp, so that the Legen metamorphic and dacite pebbles drift towards the 8–30 metres lower Holocene terrace along the Mislinja. Thus, the upper Legen terrace was formed to the present height concurrently with the gravel-sand accumulation of the same height along the Mislinja, since the brook Barbara would otherwise have flown directly into the Mislinja by making a shortcut across the slope scarp. The vertical drop between the two terraces, that of Legen and the Mislinja Holocene terrace, should thus be ascribed to younger tectonic subsidience in the part of the Mislinja valley. North of the ridge Kremžarjev vrh–Velika Kopa, there is no uniform turning of the valleys similar to that on the southern slope above the Legen terrace.

Above the Legen terrace and under the ridge Kremžarjev vrh–Velika Kopa, the circles and stripes of dacite intrusions bulge towards the south, but the valleys do not follow them but rather break through

Figure 11: The Legen and Dobrava terraces.

them, just as they break through the intermediate phyllitoid schists, and maintain the southern direction in the higher altitudes and the western direction in the lower altitudes. The above-mentioned circumstances can be explained in the light of the measurements of recent tectonic uplifting performed on Velika Kopa by means of the satellite (GMS). Established in the 1996–2002 period was the shifting towards the southeast with the speed of 0.53 mm per year (Vrabec, 2006). The intrusions can most probably be related to the origin of the valleys that are curving southeastwards.

On the geological map (as can be seen on the section of Slovenj Gradec), the Lavanttal fault runs obliquely across the Quaternary Legen terrace (Mioč, Žnidarčič 1972). If here too it followed the edge of the range of metamorphic rocks, it should turn round the Legen terrace slope scarp. East of Golavabuka two straight valleys of the Turičnica and the Dovžanka run again in accordance with the inclination of the slope directly towards the south.

Located two kilometres away from and parallel with the Legen terrace is the 6 km long Plio-Quaternary wooded terrace, the Dobrova. It rises 30 metres above the valleys of the Mislinja and the Suhadolnica with


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Figure 12: Selective erosion of the Mislinja on the Holocene plain: left – the newly eroded riverbed on the Holocene plain during the flood after the Second World War.


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Figure 13: Right – the old riverbed in which the remaining bigger pebbles are visible, after the smaller particles were swayed away by the flood. The new regulation moved the river into the old bed.

its tributary the Jenina. The geological map in the scale of 1 : 100,000 (the section of Slovenj Gradec) shows that the Dobrova terrace consists of Plio-Quaternary sand clay and clay gravel with rare intermediate bulky pebbles of the Pohorje rocks. Its southeastern part is 2 km wide and flat on the top. Located there are a hamlet Mislinjska Dobrava and an airfield. Further northwestward the Dobrova terrace, which is narrowed to one kilometre only, rises above the Suhadolnica valley with a very steep slope scarp of upper-Miocene sandstones, marl and cemented rubble. On the opposite side, i. e. the Mislinja side, it gradually lowers towards the bottom of the Mislinja valley (in the narrower sense of the word).

There are significant differences between the Legen and the Dobrova terraces. In the whole length of the 7 km of the Dobrova terrace the inclination of the broad ridge amounts to 1.07 m/km, and in the Legen terrace 12 m/km. They are similar in the fact that in their slope scarps older sediments are dismantled, phyllites in the Legen terrace and the upper-Miocene sediments in the Dobrova terrace.

The Pohorje pebbles that are intermingled in the Dobrova terrace were originally deposited also on the lower southwestern marginal Pohorje slope. Years ago, in the cart track on this slope between the farms Črnivnik and Mrzel at Golavabuka, a patch of this gravel was dismantled under the slope colluvium, which can serve as a proof to the highest Pleistocene gravel accumulation of the Mislinja in the altitude of the Dobrova terrace (Gams 1976).

The Mislinja valley (in the narrower sense of the word) extends between the Dobrova terrace and the Legen terrace. Under the Legen terrace, there is a Holocene gravel-sand plain in the valley, where the Mislinja used to flood after the 2nd World War upon the abandoning of wheat-mills and saw-mills so that the alluvium accumulated before the dams was transposed. During this process it deposited bigger pebbles in the old riverbed, while it eroded mainly sand and clay in the new riverbed on the higher Holocene plain and thus performed the selective erosion. The river thus lowered the higher gravel terrace of the Šmartno plain downstream of Šmartno by 2–3 m, where the Pleistocene Mislinja deposited sand mixed with


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Figure 14: The Lower Mislinja valley (a view from the southeast); to the right of it, the northwestern Pohorje and Košenjak (1522 m) behind it. The straight course, the rather even width and the onetime flood-exposed bottom bear witness to the subsiding tectonic rift. The valley slightly widens at the end at Otiški vrh. At the height of the Würm lake (about 400 m a. s. l.), the (right) Pohorje slope slopes more gently and is also more populated on the terrace at Pameče.

Figure 15: Near the settlement Otiški Vrh the Pleistocene gravel accumulation of the Drava dammed the Pohorje brook from the rift Bavhov graben. Less carbonate and more metamorphic pebbles and sands in it cause poorer solidity. Resultantly, a landslide occurred after the heavy storm of 1986 and damaged one house and buried the lady of the house beneath.

the Pohorje pebbles long up to 38 cm. The length of the largest pebbles consistently decreases between the settlements Mislinja and Šmartno parallel to the decreasing river gradient (Gams 1976).

At the end of the Lower Mislinja valley up to the altitude of about 395 m a. s. l. the Mislinja was dammed by the Drava with the gravel from the Klagenfurt basin, forming a gravel terrace at the (Mežica) Dobrova (Kieslinger 1929; Gams 1995). The resultant lake extended to Slovenj Gradec. At the end of the Legen terrace the tributary Barbara with its alluvium raised the lake level to the altitude of 409 m, which means up to the altitude of the central town area around the church. The medieval town was protected in the west by a steep slope scarp at the end of the Šmartno plain terrace and above the valley bottom of the dammed Suhadolnica. The Šmartno plain terrace was accumulated by the Pleistocene Mislinja. As disclosed by recent excavations in the town, the Mislinja in that time deposited finer gravel and a greater amount of sand and gray clay in the area of the town before the lake at the end of the terrace.

Similar circumstances as those at Legen occurred in the Suhadolnica valley. During the Würm climax this brook also accumulated a gravel fan, i. e. the Podgorje fan, at its outlet from the narrow valley Suhi dol, in the villages Srednje (Middle) Podgorje and Spodnje (Lower) Podgorje, in the altitude between 425 and 440 m a. s. l. The river washed away finer fractions from this gravel fan and deposited them at the edge of the lake before the town of Slovenj Gradec. Only a narrow terrace remained of this accumulation in the suburbs under Štibuh, after larger amounts of it had been carted away. After a long-term exhausting only a short promontory has remained on which the new cemetery of Slovenj Gradec is located. The sandy and fine gravel alluvium in it is similar to that in the onetime much bigger delta of the Meža at the bottom end of the same lake at Šentjanž, where the excavations were also ended due to the exhaustion. The final section of the Holocene Suhadolnica valley between the settlement Raduše and the Legen terrace is slightly curved westward and rather wide. Proceeding from the supposed fault, as drawn on the geologic map (the section of Slovenj Gradec), we may conclude that the valley originated as a curved tectonic rift.

The surface at the contact of the Šmartno gravel terrace and the Dobrova terrace is slightly lower and the waters from the terraces are gathered there in the brook Homšnica. In its upper section, the onetime railway embankment and the present main road obstructed its drainage towards the nearby Mislinja. The present artificially prolonged brook resultantly floods downstream the fields and cellars even more frequently (Gams 1992).

The rather poor knowledge of geology of the Slovenj Gradec basin was improved by The Geological Survey of Slovenia by means of a 1000 m deep well that proved to be a failure as to the pumping of thermal water near the abandoned town heating plant at the northern end of the Dobrova terrace. To the south of this well, there is a bigger plane on the top of the terrace at the altitude of 450 m a. s. l. which steeply rises above the settlement Curava vas. With a steep slope scarp it lowers towards the south, the northwest and the north; at the latter location the above-mentioned well was made. According to the detailed report of the Geological Survey of Slovenia (Poročilo 1990) the well in the Štibuh terrace revealed (to put it simply):

- 2–56 m: gravel with clay cement; the Plio-Quaternary;
- 57–208 m: sandstones, strata of conglomerates, marls and silt; the Miocene;
- 209–264 m: light-gray dolomite, the Anisium or the upper Trias;
- 265–378 m: dark-gray dolomite, clay schist and tuffa; the Paleozoic, the lower Trias;
- 379–1000 m: metamorphic complex; the Paleozoic.

Based on the composition of the well, an attempt is presented here, to make the chronology of the geomorphological development of the triangular Slovenj Gradec basin. The Triassic sediments, mainly the 169 m thick dark-gray Triassic dolomite, are thrusted on the Paleozoic metamorphic rocks 400 m from the present northern rim of the upper-Miocene strata from the foothills of the Karavanke under which, in the nearby Podgorje and in the surroundings, the thrusting of the Karavanke towards the north has been proved by coal excavation in the mine at Leše, too.

The 151 m thick upper-Miocene strata indicate the intensive subsiding of the Slovenj Gradec basin. They are dismantled at Dobrova in the terrace slope scarp only along the valley of the Suhadolnica and its tributary Jenina; furthermore, they compose a wide belt in the valley system at the foot of the Karavanke and of the Pohorje all the way to Slovenske Konjice. Also on the ridge of the northwestern Pohorje in the Reka drainage basin they have remained as a 5 km long belt. This corroborates the thesis that the Eibiswald strata of the Kobansko were linked across the Pohorje with the strata of equal age at the foot of the Karavanke (Sölva 2005). To the west of Stari trg, there is the lowest, one hundred metres high saddle in the hills which links the basin with the Selčnica valley. In this direction the Mislinja supposedly ran in the time when the present upper and lower sections of the Mislinja valley were not yet connected with a single river. The 54 metres of the Plio-Quaternary sediments in the well indicate the continued subsiding of the basin.

4.7 The northwestern Pohorje

The northwestern Pohorje belongs to the Kobansko geological series as to the sediments, and is the most variegated part of the Pohorje in terms of lythology. In the higher altitudes of the (Trbonje) Reka drainage basin the Eibiswald strata occupy the 5 km long island, and all other Pohorje rocks occur here. At the watershed, too, the elevations are semicircular without a straight divide between the Mislinja and the Reka, and without the features typical of the rest of the range. The range between the Mislinja and the Reka widens towards the northwest, where it ends above the Drava valley with a long and undissected ridge.

4.8 The Pohorje plateau

The Pohorje plateau is about 10 sq km large plateau on the ridge of the Pohorje in the altitude between 1150 and 1300 m a. s. l. Its origin might date from the time of the surrounding equally high base level. The latter could have been sustained at its northern and southern sides of the range by the cover of the upper-Miocene strata, at the eastern side possibly also by the area of muscovite-biotite-gneiss of which the isolated mountain Veliki vrh (1344 m) has remained. The Lobnica, into which the majority of water from the plateau drains at present, was not capable of a more intensive regressive erosion, because its outflow in the Lovrenc valley system had been higher before the westward sinking of the Drava valley reached it. Erosion in the Bistrica drainage basin is paralysed by scarce precipitation. Else, the erosion along the watershed is poorer as a rule. Running across the plateau is the watershed between the Plesiščica being a tributary to the Radoljna, the Lobnica and the Oplotnica.

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Figure 16: The wooded eastern edge of the Pohorje plateau, a view from the peak Rogla. Right: upper end of the Oplotnica rift and Veliki vrh (1344 m); left: the ridge of the Maribor Pohorje in the rear.

5 The intensity of geomorphological processes

Chemical erosion is significantly lesser than denudation and erosion. In its upper horizon, the moderately to very acid soil on the metamorphic rocks has the values of pH between 4.6 and 5.5, in the northeastern section of the range partly below 4.5, in the Western Pohorje, 5.6 to 6.5, and the soil here is of the rendzina type (Grčman 2004). Lying on the andesite is ranker with shallow soil. The acid soil could provide good conditions for chemical solution, but the carbonates are only scarce there; as much as they do occur, they are mainly tiny intrusions in the metamorphic rocks. Igneous and metamorphic rocks contain, on the average, only 1.5 to 4% of MgO (Hinterlechner-Ravnik 1973; Faninger 1973; Mioč, Žnidarčič 1972).

Also on steep slopes, metamorphic and veined rocks on the Pohorje are covered with thick sandy soil with little clay admixtures, so precipitation water easily permeates through it down to the rock basis. Its erosion is obstructed on the surface by densely interlaced roots of grass and trees, mainly of spruces which cover the surface now. The conclusion that the roots of deciduous trees were shallow under the surface in the geological past even before the phase of spruce is possible on the grounds that the largest amounts of humus occur there. Rill erosion occurred on the slopes until recently in places where people destroyed the cover turf and roots along the timber transport ruts. Timber transport down the steep slopes has significantly declined since the motorways were constructed. However, rill erosion on cart tracks still occurs on the gently sloping Quaternary terraces. On the steep slopes of the higher Quaternary terraces in the Drava valley landslips occur and, after the storms, landslides as well (Gams 1987). Downward translocation of soil during the ploughing of the slope fields on the Pohorje used to result in landslips and steep bottom edges, the steepnes of which has been mainly reduced by now. However, also at some places on the Pohorje, like elsewhere (see Komac 2005, Fig. 4 and 5), the increased impact of steepness on erosion is evident, especially on steep meadows and on the rare remaining fields (Gams, 1959). Landslips are more

Figure 17: Stones of granodiorite in the cart track west of, and 30 m below, the peak Jezerski vrh (1537 m). Granodiorite contains 2–3% of aluminium oxide (Mioč, Žnidarčič, 1972).

Figure 18: The polished oviform boulder – the photo was taken in the 1950s by the then not yet asphalted road 2 km northwest of Šmartno na Pohorju. The boulder was familiar to the locals, but was later removed. Its polished surface might have been the result of solution at the contact with acid soil.

frequent on fine-grain sediments of the Eibiswald strata. Only six landslides are drawn on the geological map in the scale of 1 : 100,000 (the section of Slovenj Gradec), all in the hills between Lovrenc and Fala, where the rock basis is tectonically shattered due to the progressing Selnica rift.

The speed of the recent uplifting of the surface on the highest part of the Pohorje, as calculated from the repeated measurements of nivelman points, is exceeded in Slovenia, according to Jovanović (quoted in Premru 2005, 338), only in the Triglav mountains and in the centre of the Kamnik Alps. On the Pohorje, it amounts to 4.3 mm/year up to the altitude of 1200 m, and 6 mm/year in higer altitudes. The age of the mountain uplift can be calculated from these data, provided that the uplifting was even all the time and began at the altitude of 300 m a. s. l. According to this calculation, the uplift of the mountains is about 260,000 years old, which means that it began in the Mindel-Riss interglacial stage. However, a slower uplifting at the beginning and its uneven speed throughout should also be taken into account.

The Hydrometeorological Institute of Slovenia has so far been the only one that measured the bearing away of the sediments on the Pohorje, but without suspension in the water and river gravel. The measurements were performed in the years 1971 and 1972 on two locations, in the Hočki potok and in the river Bistrica. The validity of findings was prolonged by establishing the following issues at the surrounding precipitation-measuring stations: the average frequency of years as dry as was the year 1971, and the frequency of years as wet as was the year 1974, as well as the annual average number of days with over 40 mm of precipitation and the number of days with over 20 mm of precipitation per day (measured in the 1961–72 period). Kolbezen (1979) states that there is but little suspension in the measured brooks and there is also but little gravel in the riverbeds. The average lowering of the surface in five drainage basins, calculated on the above-stated basis, amounts between 0.11 and 0.21 mm per year. In the Hočki potok drainage basin, which consists of gneiss and where many houses, gardens and other things related to tourism on the Maribor Pohorje have been built in recent years, the calculated lowering amounts to 0.27 mm/year, while in the Bistrica drainage basin it amounts to only 0.02 mm/year. Proceeding from this the conclusion is that in a million years the surface would lower by 110 m on the average, and specifically by 270 m in the Hočki potok drainage basin and by 20 m in the Bistrica drainage basin. Not taken into account in this calculation was the transport of gravel which was strongly intensified in the ice-age.

According to the table of the hitherto measurements in Slovenia, the erosion measured in the Hočki potok is similar to the highest erosion measured in Slovenia so far, which was in a vineyard (the Rokava drainage basin). And the stated amount for the Bistrica matches the average loss of soil due to erosion on the agricultural areas of Slovenia (Komac, Zorn 2005, 79). In the narrow upper section of the Bistrica drainage basin, the surface of the eastern Pohorje inclined plateau in the zone of granodiorite is more densely wooded and sloping more gently than on average in the mountains, according to the stated measurement.

The transport of dissolved minerals, which was more abundant in the warm Pliocene, is not taken into account in the above-mentioned calculations. Besides amphybolites, there are some other slightly soluble minerals (e. g. eclogite – Mioč, Žnidarčič 1972, 20) on the Pohorje. In the headwaters of the Polskava brooks there are stripes of marble from which rocks break off and roll down the slope (Žnidarčič, Mioč 1988). Corrosion is reduced on the eastern Pohorje by the small precipitation amount (1179 mm, Šmartno na Pohorju), of which 650–700 mm evaporate annually, so that only 529 to 579 mm remain for drainage. Also for this reason, of all of the parts of the Pohorje the eastern Pohorje slope has retained to the greatest degree the original altitude and the image of tectonically obliquely inclined plateau.

Erosion was increasing parallel to the uplifting of the Pohorje. In view of the fact that a great portion of the present erosion occurs on the cleared, non-wooded and agricultural areas, the calculation of erosion-caused lowering on the grounds of the current conditions is questionable in establishing the relief lowering in the time before the human settling. Denser settling on the southern Pohorje took place in the Neolithic and the Eneolithic, i. e. 7000–3500 years B. C. (Šercelj 1996, 72).

The gradient of the Pohorje streams, which indicates the erosion potential, is influenced by many factors, among them also by the yearly precipitation amount and the speed of tectonic uplifting of the mountains and/or the subsiding of the basins.

It is evident from the table and Figure 19 that the gradient, as an important factor of erosion, essentially depends on the length of the stream (and thus, indirectly, also the discharge). A short course means a high gradient. The gradients are the highest in the Polenica, i. e. in the Paka headwaters, and on the northwestern Pohorje in the short but torrential Lakužnica which, a few decades ago, still endangered the road transport at the bottom of the Spodnja (Lower) Mislinja valley with its alluvia in the form of aggraded riverbed.

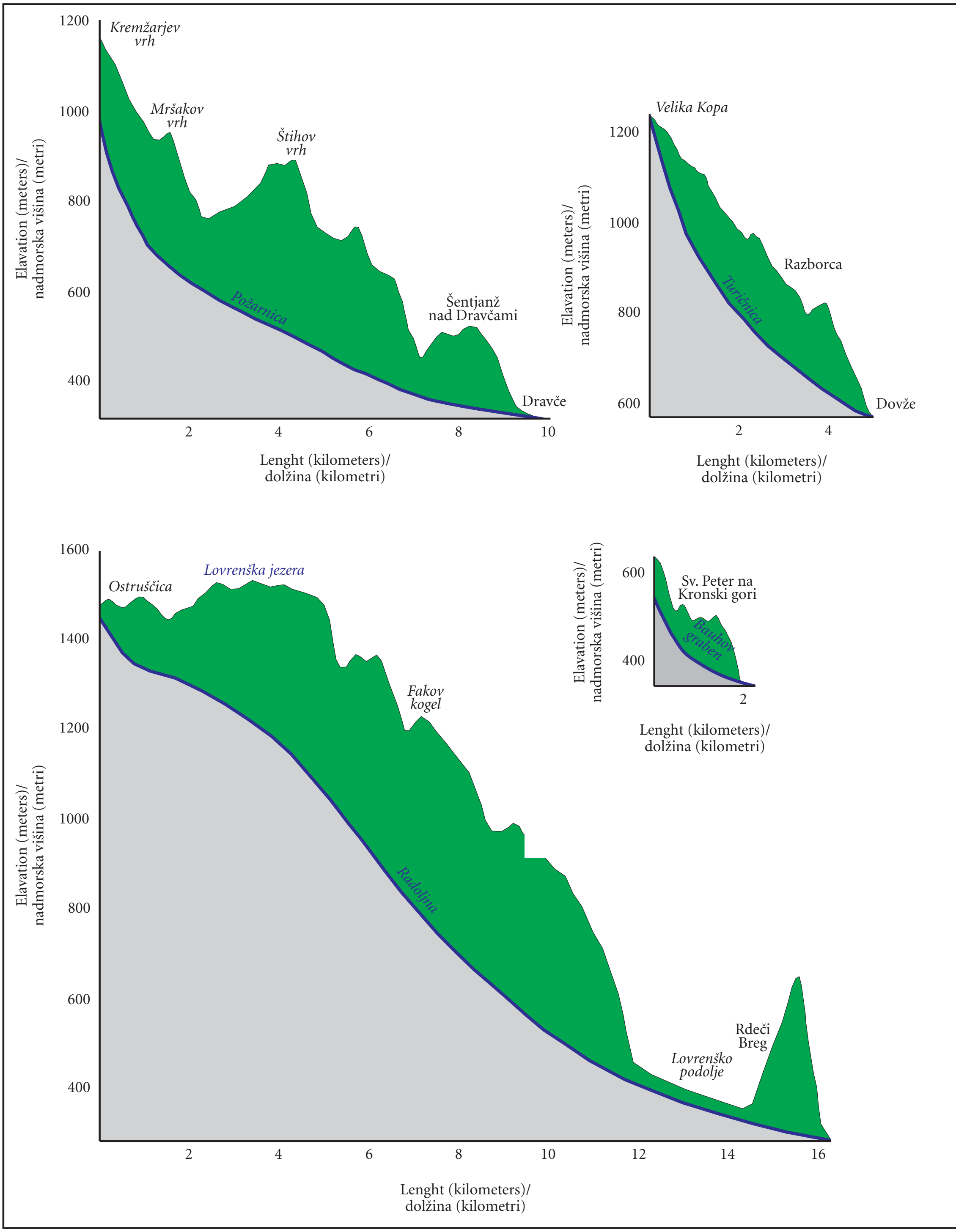
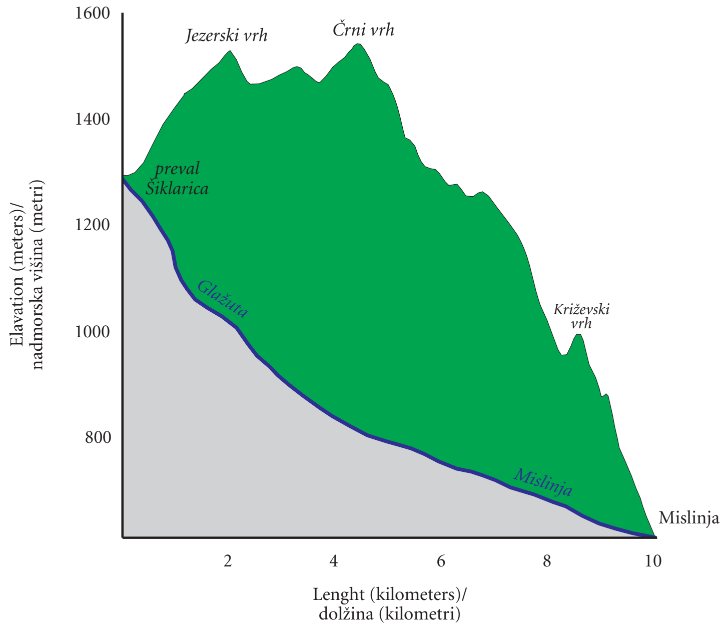
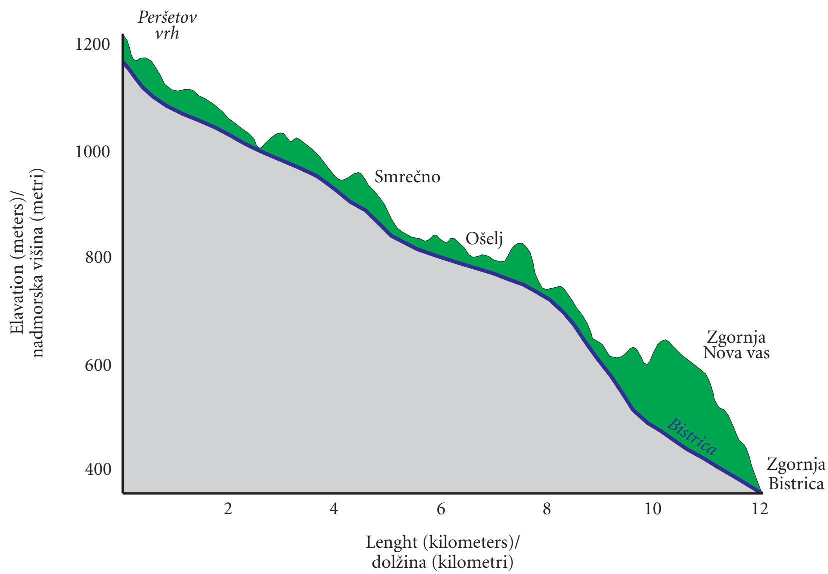


Figure 19: Graphical presentation of the selected Pohorje brooks.



1600
1400
1200
1000
800
Elavation (meters)/
nadmorska višina (metri)
Jezerski vrh
Črni vrh
preval
Šiklarica
Glažuta
Križevski
vrh
Mislinja
Mislinja
2
4
6
8
10
Lenght (kilometers)/
dolžina (kilometri)



1200
1000
800
600
400
Elavation (meters)/
nadmorska višina (metri)
Peršetov
vrh
Smrečno
Ošelj
Zgornja
Nova vas
Bistrica
Zgornja
Bistrica
2
4
6
8
10
12
Lenght (kilometers)/
dolžina (kilometri)

Table 1: Gradient of selected streams and precipitation

Water stream	Altitude a. s. l. of the source	Altitude a. s. l. of the mouth	Length in km	Gradient in m/km	Yearly precipitation in mm	Period	Meteorolo-gical station
Polskava	1000	294	14,5	55,6	1179	1961–1990	Šmartno
Devina	830	277	9,5	66,6	1043	1961–1980	Slovenska Bistrica
Oplotnica	1420	379	15,0	70,0	1174	1961–1990	Tinje
Hudinja	1380	482	9,5	94,5	1517	1961–1990	Rogla
Paka – Polenica	1280	600	3,6	188,0	1245	1961–1990	Mislinja
Mislinja – Mislinjski jarek	1440	605	19,5	69,1	1245–1527		Mislinja, Rogla, podatki za 10 let
Turičnica	1325	560	6,0	126,7	1245	1931–1960	Mislinja
Lakužnica	695	370	2,8	420	1334	1931–1990	Gradišče
Vuzeniška Reka	935	335	10,5	57,1	1132	1961–1990	Šemprimož
Radoljna	1460	400	12,0	88,3	1627	1925–1940	Stara Glažuta
Črnava – Lobnica	1260	1100	3,6	44,4	1627	1925–1990	Stara Glažuta
Lobnica*	1100	275	11,2	73,7	1627	1925–1990	Stara Glažuta
Mislinja – Mislinja	600	332	21,0	12,8	1156	1961–1990	Šmartno pri Slovenj Gradcu
Drava between Dravograd and Fala	337	288	(49)	1,09	1135	1961–1990	Dravograd

* The initial Lobnica tributaries on the Pohorje plateau have much lower gradient than the river on the northern slope. The gradient of the tributary Črnava to its confluence with the Majland amounts to 36 m/km, and of the Lobnica on the steep slope to its confluence with the Drava, 96 m/km. The length of the stream means the air distance between the beginning of a temporary or permanent stream and the edge of the range.

For the same reason as mentioned above, the gradient of the short brook Črnava is also low. The Turičnica and the Dovžanka have high gradients due to the neotectonic subsiding of the Slovenj Gradec basin and concurrent uplifting of the Pohorje. The gradient of the Lobnica (without its tributaries from the plateau) is high. If the Oplotnica tributary from under Rogla is not taken into account, the gradient of the Oplotnica between Jurgovo and the settlement Oplotnica amounts to 69 m/km, which is less than the gradient of the Radoljna slope stream which receives a greater amount of precipitation. The low gradient of the Mislinja in the upper and the lower Mislinja valley results from both the more abundant water and the neotectonic subsiding of the valley.

The analysis of forms of drainage basins as they are drawn on the isohypse map shows the unambiguous difference between the wide and long drainage basins on the northern Pohorje slope between the valleys of the (Trbonje) Reka and the Oplotnica, and the drainage basins lying on the younger southern Pohorje slope. The valleys are the narrowest above the lower section of the Mislinja valley, which was subsiding parallel to the Lavanttal fault in the Plio-Quaternary, and in the Slovenj Gradec basin in the continuation of the sub-Karavanke rift or the Kotlje valley system. The erosion of the Pohorje brooks in the Dolič valley system was intensified by two recent breakthrough valleys, one at Huda luknja and the other below Vitanje, while before that the high base level was maintained by the Paški Kozjak. The area of narrow valleys also includes the inclined eastern-Pohorje plateau and the Maribor Pohorje above the Selnica valley system. Prevailing north of the central Pohorje are the narrow drainage basins of the Drava tributaries within the scope of the Drava Pohorje.

5.1 The Pleistocene glaciation on the Pohorje

There were no substantiated proofs to the Pleistocene glaciation on the Pohorje ridge all untill recently. Melik (1957, 36) wrote, that »… moors with lakes (author's note: i. e. gently sloping locations below mountain summits on the Pohorje plateau and the ridge to Jezerski vrh) … were here the result of the diluvium glaciation; on gently sloping locations below mountain summits short lateral glaciers developed, and shallow slope depressions were formed under them, and in the latter, lakelets and moors developed … Possibly, the peri-glacial processes contributed considerably to the formation of this surface …«.

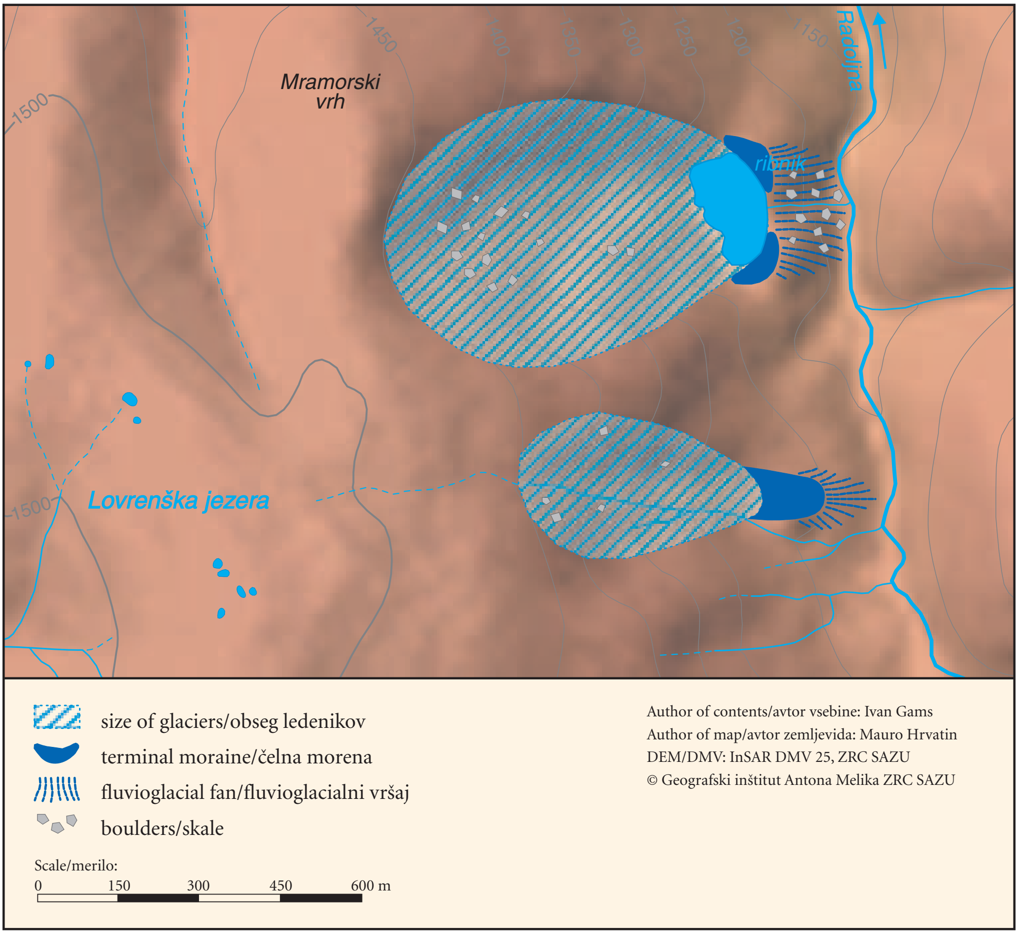


Figure 20: Graphical presentation of the Pohorje glaciers.

According to Kunaver (2000, 49) »below the Lovrenška jezera moor on the slope of the Radoljna ravine, there are small depressions, similar to cirques, which might have been hollowed by ice …«.

The statements by Melik and Kunaver's hypotheses were corroborated during the conference of the Slovenian geomorphologists held on the Pohorje in 2005 (Gams, Kunaver, Natek 2005). K. Natek established the existence of a moraine of rough rocks by the road about 50 m above the upper course of the Radoljna, at the altitude of 1220 m a. s. l. In the depression at the onetime glacier's end, there had been a marsh until the anglers from Lovrenc na Pohorju dammed and raised the outflow of the Radoljna and thus made a fishpond, Jezerc (on the maps the name Ribnik can also be found). From each side of the depression in the direction towards the dam, two big moraines descend and approach each other pincers-like; up to one metre or even more long rocks occur in them. In the wood on the slope above Jezerc, under the ridge of Mraveljski hrib (1480 m), which is not far away from the northern edge of the Lovrenška jezera, there is about 600 metres long depression in the steep slope under the altitude of 1400 metres a. s. l. It is scattered with bigger rocks under 1300 m a. s. l., and higher up the slope is undissected up to the top of the ridge.

On the higher, wooded slope one kilometre south of Jezerc at the altitude of 1271 m a. s. l., there is another moraine. Its crescent of rock boulders is about 5 m high and lies on the top of a bigger periglacial fan around which, lower down, the valley road has to make a detour. The slope brook cut with its ravine through the right flank of the moraine crescent. More than one metre long boulders of which the moraine consists are clearly distinct from the lower-lying finer periglacial gravel.

Figure 21: A little under the altitude of 1300–1400 m a. s. l., above the southern glacial depression, the cover of periglacial rubble begins, from which here and further to the south numerous brooks take their source which, downstream, deepened their riverbeds in places to the rock basis.

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Figure 22: More to the south and higher up, above the new cart-track on the western slope of the ridge Lasina (1412 m)–Pesek (1423 m), there are the dismantled, supposedly cryoturbatic folds of the weathered sandy material.

The answer to the question of why the big rocks, accumulated in the about 70 m wide depression on the slope above Jezerc, have not rolled down into the moraine depression and filled it is offered by the course of the last ice age. At the beginning of the Würm glaciation, precipitations were more abundant and snow in the mountains was more abundant, too. Between the years 35,000 and 12,000, dry climate prevailed in Central Europe, with the temperatures lower by 10 °C and lesser precipitation by about 500 mm (Frenzel, Velicko 1992). Consequently, the glacial transformation of the Pohorje surface was replaced by periglacial transformation. The rocks above Jezerc might have originated in this time and were soon prevented from rolling down by the trunks of forest trees. The depression above the southern moraine is shallower and narrower and it is rather a deepened and widened long valley of a brook which takes its source higher up in the slope and still runs permanently. Both here and in the wider southern slope, in the altitude of about 1400 m a. s. l., several periodical brooks take their source from the bottom edge of the slope cover of coarse periglacial gravel. The shallowness of the depression above the southern moraine, as it is above Jezerc, is also the result of the short-lasting existence of the glacier.

Above the valley-depression of the two glaciers is a slope, up to 150 m high and covered with grass at present, which was not corrugated by glacial or periglacial processes.

It is believed that the cause why only the eastern slope at the northern end of the 5 km long and almost evenly high ridge northwest of Ostruščica (1498 m) was glaciated lies in the more abundant snow precipitation in the proximity of the saddle Šiklarica (1299 m).

The composition of periglacial gravel on the western slope of the ridge with the peaks Lasina (1412 m) and Pesek (1423 m) is most clearly seen on the new roadway towards Jezerc, which branches from the main road from Lovrenc south of its juncture with the local road. The macadam road runs on the valley slope of the right Radoljna tributary. In the recently dismantled gravel, up to one metre big stones initially occur, equally rounded as those in the vicinity of the Radoljna riverbed. This means that the upper valley of the Radoljna was filled with gravel up to this height at that time, and on this gravel an ever thicker cover of periglacial sand was deposited which lies directly on rock basis in higher altitudes. Where the sandy soil on the slope more to the south is moist, the cryoturbatic folds have been formed in places. The road ascending towards the south along the valley of the Radoljna and leading to Koča na Pesku soon reveals ever

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Figure 23: A view from the northeast of the 2.5 km long fluvioglacial fan and on it, above the terrace slope scarp, the prolonged settlement Lovrenc na Pohorju. Above the remote northern slope in the drainage basin of the Radoljna the clouds seem to start gathering first.

shorter pebbles. Between Mulejev vrh and the Sedlo Komisija, there is a vast terrace made of sand and once transformed into meadows; the sand also gave the name to Koča na Pesku (means Hut on the sand).

That the glaciers were formed only on the eastern slope of the northern end of the ridge with the Lovrenška jezera on the top, most probably resulted from the local climatic conditions. The deep valleys of the Radoljna and its tributary Plesiščica, separate the Pohorje ridge slope by several kilometres and unite the prevailing winter northeastern cold air masses from the Pannonian basin – where the loess steppe prevailed during the coldest Pleistocene periods – and direct them towards the southwest, i. e. towards the lowest saddle, the Sedlo Komisija, in the direction towards the Mediterranean basin. Heavy rainstorms in the Radoljna drainage basin still cause floods and damages (Šeme 1994). Glaciers were not formed on the Sedlo Komisija at the northern end of the Mislinja rift, because the altitude was too low (1299 m). The Šiklarica between Jezerski vrh (1537 m) and Planinka (1420 m) is the lowest saddle in the 18 km long Pohorje ridge between Mala Kopa and Rogla. The closest to it was the meteorological station Stara Glažuta which recorded the greatest annual precipitation amount on the Pohorje (1925–1940: 1627 mm), which is more than on the higher Rogla above the southern edge of the Pohorje plateau (1517 mm).

Poorly rounded, up to half a metre long boulders were deposited by the Radoljna also in the area of the settlement Lovrenc na Pohorju, which extends with its buildings and cultivated areas over the 2.5 km long gravel-sandy fan. Regrettably, the longest boulders in the entire Pohorje foothills are no more dismantled in the onetime gravel pit above the tributary Slepnica.

5.2 Peat bogs and lakes on the Pohorje

Peat bogs on the Pohorje plateau are another Pohorje particularity. The area of peat bogs lies between Adamov vrh (1260 m) and Pesek (1427 m). In between the wet little valleys round elevations rise, where periglacial rubble base is dismantled locally on the slope from under the soil in the road cuts as a proof to the statement that the periglacial geomorphological processes dominated on the plateau in the Pleistocene cold periods.

IVAN GAMS

Figure 24: In the marshy basin named Radovina, two spruces were uprooted and thus the remains of the former tree in the peat basis on the Pohorje plateau were disclosed. Despite the lee position in between the surrounding woods, wind-devastations are obviously efficient here, on the marsh.

In such circumstances the slid slope gravel can raise the water table at the transition to the plain, and causes that the area becomes boggy. According to another hypothesis, the boggy area is the result of the so-called periglacial nivation basins, which are frequent now in the sub-Arctic climate (Gams, Kunaver, Natek 2005). But these are bigger than those on the Pohorje plateau. On a more detailed map peat bogs in stripes can also be established in the planes. Such cases can be found especially in the northwestern and eastern rims of the plateau. In places, the longitudinal profile of the brooks is divided to sections on mossy basis in between a few spans high dams of the accumulated moss below which pools lye. The largest peat bogs occur in the basin-like beginnings of the confluent brooks. There, they were most intensely changed by people. The marsh of Tiho jezero has another name on the maps, Falski ribnik (the Fala fishpond), which points to the anthropogenic damming of the outflow, just as centuries ago the Lovrenc anglers dammed the marsh in the above-mentioned moraine basin Jezerc. A marsh was also dammed with earth dam to become the lake Črno jezero in order to obtain more abundant water for wood rafting along the shoot in the Lobnica valley on the northern slope of the mountain (Gams, 1962). General marshiness and the resultant development of peat bogs on the plateau increase towards the northwest, i. e. towards Klopni vrh, which means in the direction of increasing precipitation amount.

The warmer Pliocene and Holocene boreal climates with deciduous trees were most likely not favourable for peat generation because deciduous trees need more water than conifers that grow in the area now. The human impact on the change of the forest has not been established yet. Apparently, the bogginess has increased after the present cover of conifers prevailed, especially after the forest was cleared and pasturing invented, and after the earliest burning of forest caused by lightnings and shepherds. In the past, the Pohorje locals used to burn forests on mountains to gain pasture lands. Due to the remoteness of the ridge plateau from the valley transport routes wood was not worth felling and being transported to the foothills all until the end of the 19th century. In the 18th and the 19th centuries the cheap wood for charcoal production on the top of the mountains attracted iron foundries (at Mislinja and at Lovrenc) and more recently on the northern slope glass-works in particular. Slightly below the Pohorje plateau six glass-works operated which required huge amounts of charcoal. On the plateau's clearances, they have left behind grassy and boggy lands. There and in other thin forest associations in the surroundings mainly the farmers from the Vitanje- and the Zreče Pohorje used to pasture their cattle. In the feudal times and later on, the Pohorje plateau was owned by the Fala manor lords, who leased, for example, in the year 1886 more than 600 hectares of lands for the pasturing of 678 head of cattle. Later on, when the lords of the manor tried to prevent pasturing because it had supposedly increased the bogginess, the farmers appealed to the old right (Hiltl 1993). The lawsuit between the farmers and the present forest management has not been thoroughly settled yet. On the tops of the ridges on both sides of Črni vrh (1543 m), Jezerski vrh (1537) and east of Šiklarica the forests have not overgrown mountain meadows yet, because farmers from the Lovrenc surroundings still pastured there all until recently. Occurring on the maps for the top of the ridge east of Šiklarica are two names, Planinka and Črna mlaka (Black pool), where cattle was watered. Improved knowledge about the peat bogs on the Pohorje plateau can be expected from the forthcoming modern dating of peat.

There is another particularity on the Pohorje: the lakes in the area of Lovrenška jezera and the lakes in the area of Ribniško jezero, both on the top of the ridge. Palinological researches were done into both of the areas. At Lovrenška jezera, Budnar (1958) established a 60 cm thick layer of sand under the 240 cm thick peat, and she found out that the moor began to be formed in the Holocene early warm or boreal phase, or in the hazel tree phase, approximately 6000 years ago. With the C_{14} dating method the age of a hundred years was recently attributed to the sediments in the depth of 14 cm, considering the balanced growth of the surface peat (Brancelj, 1999). More thorough pollen researches revealed the following development by layers: –260–240 cm: hazel, spruce and fir; –240–220 cm: beech, fir, spruce; –220–150 cm: beech, fir, spruce; –150–130 cm: spruce, fir, less beech; –130–60 cm: peat mud; –60–0 cm: peat moors, lake sediment, spruce pollen increases. The early sediments supposedly date from the Atlantic phase 7000–8000 years ago (Culiberg, 1986). The same author has also published the pollen analysis of the Ribniško jezero: depth 300–290 cm: peat with tonalite gravel, spruce and over 50% of hazel; 290–255 cm: hazel phase, alder; 255–200 cm: increase in fir and especially beech and hornbeam; and at 245 cm: grasses, age 4080 ± 130 years; 200–100 cm: increase in spruce and fir, beech; 100–50 cm: intensified spruce and fir; 50–0 cm: increase in pine.

According to these measurements, the area of Lovrenška jezera is about 3720 years old, and the moor around Ribniško jezero about 4080 year. Responsible for the decline in the share of beech and fir seems to be the human impact. The common finding is: the two moors are not the result of the Pleistocene, since the two accumulations began in the Atlantic phase (7000–8000 years ago) or later (Culiberg, 1986). Forests of beech and fir still prevailed on the Pohorje 7000 years ago, while spruce has supposedly prevailed in the recent times only. Visible local anthropogenic impacts on the Pohorje forest can be traced from the Neolithic onwards (Culiberg, M., A. Šercelj, 2000). The finding that the formation of peat began in the Holocene early warm or boreal phase is surprising, because the evapotranspiration of vegetation is also higher with higher temperatures, which means lesser ground moisture.

The area of Lovrenška jezera and the area of Ribniško jezero do not have quite equal positions. The former lies at the northern rim of the rounded ridge Rogla–Planinka in the altitude of slightly above 1500 m. Without the forest or grass cover, as was the case in the time of glaciation, sand in the basis would have been blown off by the wind. Up to 40 cm deep depressions in the areas of Lovrenška jezera and Ribniško jezero lie on the very watershed ridge, where the underground water from the peat surroundings can flow from all the sides. Due to such a position the lakes do not dry out in summer. The largest lake, Ribniško jezero, is also on the plain but, in contrast to the lakes of Lovrenška jezera, it lies on the about 150 m wide plateau east of Jezerski vrh (1537 m), so that on the southern side, amidst dwarf pine, there can also be some minor water »windows« (Gams 1962). On the top of the ridge Rogla (1517 m)–Planinka the marshiness intensifies in the direction of precipitation increase, i. e. towards the north. Above Šiklarica, there is a marshy grass ridge rising eastwards, called Planinka and marked on the maps as Črna mlaka.

6 On the special feature of the geomorphological researches into the mountains of the Pohorje type

6.1 Ridges and valleys as indicators of geomorphological development

Longitudinal profiles of the ridges between two neighbouring valleys were made in order to assess to what degree they still reflect the original surface level into which erosion had deepened the valleys. On the non-rocky ground, the precipitation water does not run off on the surface but under the surface through the weathered material and, thus, the top of the ridge is lowered by soil processes mainly. The more intensive bearing away of rock mass begins lower down on the slope where the sources of temporary and permanent streams occur and erosion comes into force.

The tops of the ridges of metamorphic rocks run much straighter than those of the Eibiswald strata between Ribnica and the Vuzenica basin, because they consist of the petrographically mixed materials (see longitudinal profiles of the ridges). The table below shows only a sample case of each geomorphological unit.

Table 2: Length and gradient of the selected Pohorje ridges, typical of the mountains

The Pohorje region	Beginning of ridge (altitude in m)		End of ridge (altitude in m)		Length km	Gradient m/km
Northeastern Pohorje	Kremžarjev vrh	1164	Dravče	380	12,6	62,2
Lovrenc Pohorje	Klopni vrh	1340	Lovrenc	436	8,0	113,0
Eastern Pohorje	Peršetov vrh	1242	Zg. Bistrica	242	14,1	71,4
Vitanje Pohorje	Kragulišče	1454	Vitanje	460	10,0	99,4
Upper Mislinja Pohorje	Velika Kopa	1543	Dovže	575	7,2	134,4
Lower Mislinja Pohorje	Golarjev vrh	834	Šentjanž	358	3,8	125,3

The peaks of the ridges in the longitudinal direction are the steepest: Razborca above the upper Mislinja valley, (Velika Kopa–Dovže, 134 m/km), the lower Mislinja valley (Golarjev vrh–Šentjanž, 125 m/km), the ridge above Lovrenc (Klopni vrh–Lovrenc, 113 m/km). The three above-mentioned cases manifest the tectonic subsiding at the foothills. Therefore, the final part is also the steepest, which means the bottom section of the profile above the fault in the valley at the rim of the mountains. Moderate gradient occurs on the Vitanje Pohorje (Kragulišče–Vitanje), with the average inclination of 99 m/km, which is slightly

Figure 25: In the upper Legen, the rock at the bottom of the valley, running parallel to the strike-slip fault, is tectonically broken to pieces and the barren slope is unstable.

less than above Dovže and above Lovrenc. The profile Kremžarjev vrh (1154 m)–Dravče (by the Drava, 372 m) runs along the ridge between the brook Požarnica, which is the Plavžnica tributary, and the (Trbonje) Reka. It is long, the least steep and runs initially on dacite, then on flint sandstones, and finally on phyllitoid schysts. Its heights above the two valleys oscillate the most in the Eibiswald strata, which consist of hard cemented sandstone, marl and conglomerate. Located on sandstones, or just near the mound made of them, are two parish churches with a fine view, Sv. Primož (St. Primus's) and Sv. Anton (St. Anthony's). The average gradient of the Vuzenica brook Plavžnica is 134 m/km. Low gradients also occur on the eastern Pohorje plateau Peršetov vrh–Zgornja Polskava. We can draw a conclusion that of all the landforms the Pohorje ridges are the least lowered and altered surface.

On the Drava Pohorje, the peaks in between the breakthrough valleys along the brooks from the Pohorje reach the following altitudes: Janževski vrh 912 m, the western Hlebov vrh 913 m, the eastern Rdeči breg 793 m. This fact points to the origin of the majority from the ridge with the summits between 800 and 900 m a. s. l. The lower Ruta (Lobnikov vrh, 705 m) is closer to the subsiding end of the valley system above Fala.

Until Razborca in the southeast of the Mislinja drainage basin, the Pohorje ridges begin at 200–300 m below the watershed ridge. But there are no side ridges on the Pohorje along the 2.3 km long and wide ridge with the highest peak Mežnarjev vrh (861 m), which rises semicircularly over the breakthrough valley of the Drava between the settlements Meža and Trbonje. This is the only Pohorje slope which approaches the limit of instability or the crumbling of rocks. The ridge spans between the settlement Meža and the elevation with the point 792 m under Mežnarjev vrh (861 m); it consists of phyllitoid schist. On the map in the scale of 1 : 50,000, a sole torrent ravine is drawn on the higher slope, while the rest is mainly a rocky slope with the average inclination of 40° with the prevailing mechanical weathering of rocks. During extreme rainstorms and at high snow, the fallen stones and avalanches used to block the traffic on the railway Maribor–Dravograd.

The development of a drainage basin is also influenced by the ground water capacity, resistance to erosion and specific run-off, therefore the usual establishing of its development or its age from the ratio between the tributaries of different ranks is not the best criterion. Of particular importance in our case of the rather homogeneous resistance to erosion is the ratio between the length and width of the drainage basin. Parallel to the increase in the depth of the river valley, the tributaries are also longer, which widens the drainage basin. So, older river basins are therefore wider. According to this criterion, the oldest Pohorje drainage basins occur on the northern slope between the (Trbonje) Reka in the west and the Lobnica in the east, and on the southern Pohorje they are also the Mislinja rift and the Dravinja drainage basin. The youngest in this respect are the drainage basins of the Mislinja tributaries northwest of the settlement Mislinja and those on the Maribor Pohorje between the (Drava) Bistrica and the brook Framski potok. The cause of it can also be searched in the subsiding of the Mislinja valley, the Drava valley and the Dravsko polje plain, and the young uplifting of the watershed ridge on the Maribor Pohorje.

The absence of erosion- and/or accumulation slope terraces on the Pohorje and the Drava Pohorje is the result of the continuous uplifting of the range. The slopes in metamorphic rocks are convex with the increasing inclinations towards the bottoms of the valleys that were supposedly deepened by the Holocene erosion which began after the Pleistocene accumulation, the height of which is indicated by spurs at some places on the slope. The intensified erosion is also noticeable in the outer margin of the mountains above the subsiding marginal basins, valley systems and above the Drava in the Selnica valley system.

Since the Pohorje metamorphic rocks all offer quite similar resistance to erosion of brooks and rivers, it might also be expected that the depths of the valleys be similar. But the analysis of six sample valleys showed that one valley can be even more than ten times deeper than another. The valleys are the shallowest on the inclined eastern Pohorje plateau. At its margin, only the Oplotnica valley is outstanding for its great depth (up to 250 m). In the central Pohorje, the Mislinja valley in the Mislinja rift under the highest surrounding ridge (Črni vrh–Jezerski vrh) reaches the depth of up to 700 m and divides the entire Pohorje. In either case the cause of the great depth lies in the strike-slip fault along the valley bottom. Deep above the average are also other valleys that were formed at the uplifting of the range and the concurrent subsiding of the Quaternary basin in the foothills.

Along the border with the southern rim of the Ribnica-Lovrenc-Selnica valley system, the Pohorje in a narrower sense of the word rises above 700 m in the 24 km long and rather straight line in the east–west direction between Zgornje Radvanje and Ribnica, or more precisely, in the Vuhreščica valley at Hudi Kot,

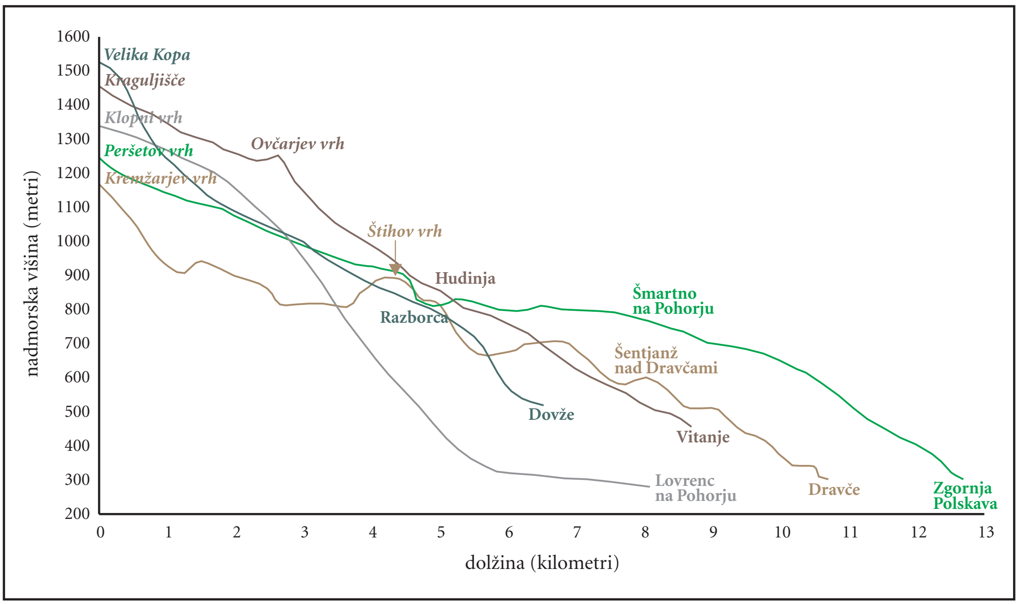

Figure 26: Longitudinal profiles of the tops of the ridges.

which means mainly along the tectonic fault line there at the southern margin of the Eibiswald strata and concurrently along the slope bend. At the southwestern, or the upper Mislinja side, such a line is less explicit and more dissected. Further on, at the southern and southeastern margins, the ridge is more minutely, fluvially dissected mainly in the lower margin, and less so higher up on the slope. Outstanding by intense dissection into valleys and ridges is mainly the higher range between Kremžarjev vrh and the Mislinja rift. This is most probably the result of tectonic subsiding of the upper Mislinja valley.

6.2 Delamination impact

In the simultaneously subsiding Ribnica-Lovrenc-Selnica valley system, up to 500 m thick Eibiswald strata remained in the tectonic depressions. An explanation of the subsiding of this valley system and the concurrent uplifting of the Pohorje (in the narrower sense of the word), which is still going on, and of the Drava Pohorje is offered by the conception of the delamination type origin of the mountains. According to it, the earth surface is uplifting above the intrusion of the magma through the bottom layer of the lithosphere, and subsiding under the cooler and less viscid, right-deviating bottom layer of the lithosphere (Summerfield 1991, 91). Thus, this theory can account for the origin of the Pohorje ridge and the subsided Ribnica-Lovrenc-Selnica valley system on the north side. The latter begins in the west under the western end of the highest Pohorje ridge, i. e. in the area of Hudi Kot. However, this statement is valid only if the location of Hudi Kot is defined as perpendicular to the Dinaric orientation of the ridge Črni vrh–Mala Kopa. This line is indicated by two parallel valleys of the Vuhreščica tributaries. The eastern end of the valley system at Fala lies on the same meridian as the eastern rim of the Pohorje plateau at the higher altitude. Thus, the very locations of these two units corroborate the connection between the highest uplifted mountains and the most deeply subsided Eibiswald strata in the valley system.

On the Pohorje, between Kremžarjev vrh and Velika Kopa, the largest amounts of dacite in the form of the broadest intrusions and thick islets have been uplifted to the surface. Otherwise, dacite occurs in little islands and belts north of the Pohorje ridge from Dravogad to Pekrska gorca and on the southern side to the Mislinja rift, and along the watershed ridge from Vrhovski vrh (642 m) on the northeastern Pohorje to Velika kopa. Since these intrusions did not metamorphose the surrounding rocks, they – according to the delamination theory – broke through to the surface due to the low-pressure- and low-temperature-related changes of the densities of some minerals. Mica and gneiss, surrounding the granodiorite area on the eastern Pohorje, are especially densely »shot-through« with narrow veines of pegmatite and aplite (in the Lobnica valley also of cizlakite), long up to a kilometre or even more in places, and with the density of several intrusions in the distance of one kilometre. Neither these did metamorphose the surrounding sediments. The widest intrusions occur between Kremžarjev vrh and Velika Kopa, where on the northern slope a connection has been substantiated between the recent tectonic shifting of the surface and the curving of the valleys. The valleys are even more strongly curved on the northern slope of the Pohorje in the valley system east of the brook Plavžnica.

7 Conclusion

In the upper Miocene, a peneplain stretched on the top of the upper-Miocene strata from the Graz lowlands to the Karavanke across the present Kobansko and the Pohorje. In the course of time, these strata were removed by erosion in most of the discussed area, while they have been preserved in the thickness of several hundred metres in the depressions of tectonic origin, in a continuous form mainly in the north-Karavanke foothills and in the Ribnica-Lovrenc-Selnica valley system and as an island also on the northwestern Pohorje. The present hydrografic network, incongruous with the present orography, is explained by means of the inherited primary drainage network on this peneplain. The up to 6 km long and 3–4 km wide Pohorje plateau, the only one in the whole of the area, presently at the altitude of 1150–1330 m, was formed on the island of metamorphic rocks dismantled in the centre of the Eibiswald strata in the height of the surrounding base level along the watershed of the Pohorje rivers. Its westward continuation in the altitude around 1430 m in the drainage basin of the Radoljna was later dissected by recent periglacial and fluvial processes, and the one at the altitude of around 1500 m within the present upper Mislinja rift by river erosion. In similar circumstances the watershed ridge between Rogla and Mala

Figure 27: The surface is more levelled on the higher southeastern Pohorje slope at Skómarje (the hamlet with a church). To the left, uphill, the highest lying isolated homesteads under the wooded Ovčarjev vrh. In between the cultivated areas wood was preserved only in the shallow, hardly noticeable narrow little valleys.

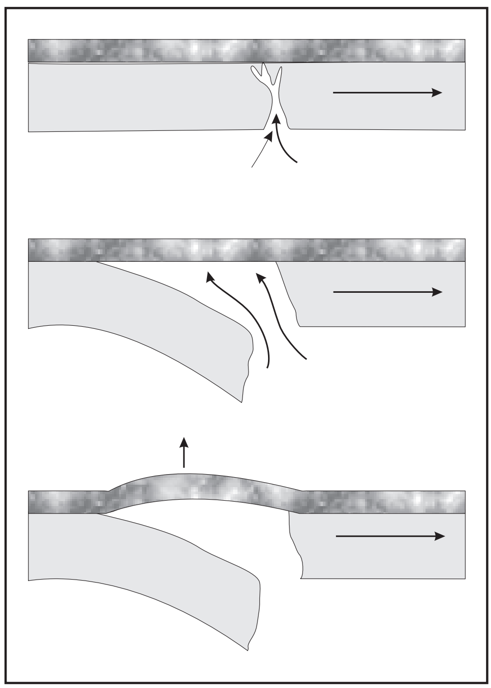

Figure 28: Schematic representation of delamination showing initial cracking, sinking of the lithosphere into astenosphere and crustal uplift, associated by the replacement of lithosphere with less dense sub-lithospheric mantle (after Summerifeld 1991).

Kopa was formed which slightly surpasses the altitude of 1500 m at several places. The relief in the remaining area is the result of tectonic shaping of the surface and its subsequent lowering due to river erosion, conspicuously intensified due to the subsiding surrounding basins and the Ribnica-Lovrenc-Selnica valley system. On the southeastern higher slope, the least dissected are the typical planes.

During the tectonic uplifting of the Kobansko the river Drava epigenetically stranded along the southern margin of the Kobansko anticline and hollowed the present Drava gorge. The uplifting of the Pohorje, which is still going on, and the concurrent tectonic subsiding of the up to 500 m thick upper-Miocene (Eibiswald) strata in the Ribnica-Lovrenc-Selnica valley system and in the northern foothills of the Karavanke is explained by means of the hot spot conception (Summerfield 1991).

Significant is the fact that the Ribnica-Lovrenc valley system is sunk only north of the highest Pohorje ridge (taken into account is also the margin of the Pohorje plateau). The western margin of the Ribnica valley system at Hudi Kot area runs perpendicularly to the Dinaric direction of the ridge Mala Kopa–Črni vrh. The hot spot conception on the Pohorje is corroborated by the dense intrusions of dacite, eclogite, amphibolite, and singularly of cizlakite, which did not additionally metamorphose the surrounding rocks. The rivers running from the Pohorje hollowed the deepest valleys along the strike-slip faults. Due to tectonic pressure the valleys on the northern Pohorje slope are curved westwards in the centre, and more to the north, in the Ribnica-Lovrenc valley system, they are oriented towards the northeast. The turning of the ridges and the brooks above the Legen terrace under the Pohorje ridge between Kremžarjev vrh and Velika Kopa from the southeast towards the southwest is supposedly related to the recent tectonic shifts towards the southeast with the annual speed of 0.53 mm, measured with the RMS method in the 1996–2002 period at Velika Kopa (Vrabec 2006). The straight Lavanttal fault, well-known in geology, exceptionally »cuts off« a portion of the Pohorje phyllitoid schist on the slope scarp of the Legen terrace. For this reason and because of the Pohorje brooks which turn westwards above the slope scarp, and finally towards the northwest, it can be concluded on the basis of the relief that the original headwaters of the (lower) Mislinja were located in this section of the Pohorje.

The longest, 10 km long and up to 700 m deep Mislinja rift which ends at the saddle Šiklarica (1299 m) divides the range into two parts. Unexpectedly, there are practically no intrusions in it. Is it due to the laccolith, being cleft under it? During the coldest Würm glacial phase, the cold snow-bringing NE winds, blowing across Šiklarica and directed towards the Mediterranean, caused with their rising the formation of two, up to one kilometre long slope glaciers in the upper valley of the Radoljna.

The repeated nivelman points measurement for the Pohorje ridge above 1200 m established the annual tectonic uplifting of 6 mm. The Plio-Quaternary origin is also indicated by the calculation on the basis of two-year measurements of river transport (except for suspension and gravel) in the eastern Pohorje brooks and by the absence of erosion- and accumulation slope terraces. The gently sloping Pohorje relief is not the result of old age but of the faster mechanical weathering of mainly granular rocks into water permeable sand, covered with thick intertwined grass and spruce roots, which slows down the surface river erosion. The result is the prevalence of moderate inclinations (12–30°).

Of the applied geomorphological methods, it was the morphometric analysis of drainage basins and depths of valleys that proved to be useful. Narrow drainage basins occur on the northern slope of the Maribor Pohorje and above the subsiding Slovenj Gradec basin, in which 54 m of Plio-Quaternary sediments were bored; wide and long drainage basins occur on the northern side of the Pohorje between Dravograd and Fala, due to the epigenetic origin of the Drava valley. The deepest Pohorje valleys occur along the strike-slip faults.

The depth of the Mohorovičić discontinuity is known under Pernice only, north of the Vuzenica basin, and amounts to 15 km. Although the uplifting of the Pohorje still continues, the seismic activity is weak, supposedly due to the less compact earth crust.

On the Vitanje Pohorje the slope in the higher section of the drainage basins of the Hudinja and partly also of the Dravinja drops southwards, while the brooks run towards the southeast, since the Savinja tributaries broke through the Karavanke area of the Paški Kozjak only in the recent era. The older and higher drainage left a trace in the form of a blind valley in the Paški Kozjak with the settlement Zgornji Brezen.

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Geomorfologija Pohorja

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IZVLEČEK: Pohorje, mlado gorovje s prevlado metamorfnih kamnin in dacita, se še vedno dviga nad magmatskim lakolitom, tudi zaradi sprememb toplote in s tem gostote dvigajočih se dacitnih in drugih žilnin, ki niso metamorfirale okoliških sedimentov. V Obdravskem Pohorju je rečna mreža neskladna z orografijo, ker je Drava svojo deber med vuzeniško-radeljsko kotlino in Falo epigenetsko poglobila v robno gorovje Kobanskega. Skromne planote na vrhu Pohorja so iz časa, ko je v zgornjem miocenu med Karavankami in Kobanskim erozijski nivo vzdrževal pokrov tako imenovanih ivniških skladov. Prvotno večjo vršno planoto v osredju Pohorja so zmanjšali periglacialni in erozijski procesi; kot nagnjena planota je ohranjena na Vzhodnem Pohorju.
Z recentnim tektonskim premikanjem, ugotovljenim z GPS v letih 1996–2002 na Veliki Kopi, razlagamo izbočenost začetnih petih dolin proti jugovzhodu nad legensko teraso, kjer je bilo domnevno prvotno povirje Spodnje Mislinje. Še očitnejša in obsežnejša je izbočenost dolin proti zahodu na severnem pohorskem pobočju in njihova usmerjenost v ribniško-lovrenškem-selniškem podolju proti severovzhodu. Mlademu tektonskemu ugrezanju na vzhodnem kraju lovrenškega podolja nad Falo še ni prilagodil svoje smeri Rečnikov potok, ki poteka v dolinah prečno na naklon pobočja. Do 700 m globok Mislinjski jarek je znižal osrednji pohorski greben na 1299 m. Čez njega osredotočeni severovzhodni hladni ledenodobni vetrovi so omogočili nastanek dveh manjših ledenikov v zgornjem porečju Radoljne. Zložni pohorski relief ni posledica velike starosti, temveč razpadanja zrnatih kamnin v vodno prepustni pesek, nad katerim erozijo zavira pokrov iz sklenjenih travnih in pretežno smrekovih korenin.

KLJUČNE BESEDE: geomorfologija, geomorfogeneza, kvartarni geomorfološki procesi, ledeniki, Pohorje, Centralne Alpe, severovzhodna Slovenija.

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Vsebina

1 Uvod

Pohorje je sredogorje v severovzhodni Sloveniji. Geološko je najbolj proti jugovzhodu pomaknjen del Vzhodnih Alp. Zgrajeno je pretežno iz metamorfnih kamnin in dacita.

Do druge svetovne vojne so tudi slovenski geomorfologi prevzemali teorijo cikličnega razvoja reliefa Williama Morrissa Davisa, po katerem se je po tektonskem dvigu v mezozoiku gorsko površje neprekinjeno in postopno erozijsko zniževalo z zastoji, ki so prepoznavni v vedno nižjih nivojih in terasah. V tem smislu je geomorfologija tolmačila nastanek vršnih pontskih (panonskih) nivojev tudi na vrhu Pohorja. Nižje in mlajše uravnave so ugotavljali na stranskih slemenih ali v nižjih terasa. Toda teh uravnav na enakomerno se znižujočih pohorskih slemenih ni in Pohorje se še vedno dviga.

To so dokazali novejši ponovljeni geodetski nivelmani in meritve GPS (relativnih premikov površja s pomočjo satelitskih radarjev).

Večina uporabljenih topografskih imen je posneta po Atlasu Slovenije v merilu 1 : 50.000 in deloma po topografskih sekcijah večjega merila.

Slika 1: Nadmorske višine.
Glej angleški del prispevka.

Slika 2: Nakloni površja na Pohorju.
Glej angleški del prispevka.

2 Členitev Pohorja

Med vzhodnoalpskimi (starejše ime: centralnoalpskimi) hribovji je Pohorje s 770 km^2 med večjimi. Tu je omejeno tako kot v dosedanjih monografijah (Hiltl 1893; Koprivnik 1923; Melik 1957; Gams 1959). Na severu je meja Dravska dolina, na vzhodu Dravsko polje, na jugovzhodu Podpohorske gorice, na jugu Vitanjsko podolje in na severozahodu Mislinjska dolina.

Na karti zapisana imena za geomorfološke enote bodo uporabljena tudi v nadaljnjem tekstu. Ohranjamo tradicionalno delitev na bolj planotasto Vzhodno in bolj slemenasto-dolinasto Zahodno Pohorje s stikom na črti Mislinjski jarek–Šiklarica–dolina Radovne, znotraj njih pa smo naredili podrobnejšo geomorfološko členitev. Geomorfološko in genetsko raznoliko Pohorje v nadaljevanju analiziramo po reliefnih značilnostih bolj homogenih delov:

- 1 Zahodno Pohorje
- 1.1 *Severozahodno Pohorje* je območje severovzhodno od spodnje Mislinjske doline in zahodno od doline (Trbonjske) Reke, z najvišjim Jesenkovim vrhom (933 m). Petrografsko spada h kobanski seriji (Mioč, Žnidarčič 1972). Zastopane so skoraj vse kamnine, ki gradijo ostalo Pohorje in zlasti Kobansko, nadpovprečno tudi zgornjemiocenski (ivniški) skladi.
- 1.2 *Srednje Pohorje* je sistem osrednjega in najvišjega razvodnega, proti severozahodu usmerjenega hrbta med Kremžarjevim vrhom (1164 m) in Šiklarico (1299 m), ter slemen med dolinami pritokov Mislinje na južni in neposrednih pritokov k Dravi na severni strani. Sestavljajo ga pretežno metamorfne kamnine in dacit. Za ta del Pohorja je značilen visok in kopast razvodni hrbet Mala Kopa (1524 m)–Velika Kopa (1543 m)–Ribniški (Jezerski) vrh (1537 m). Gozdnato severno pobočje gradita pretežno granodiorit (nekdaj imenovan granit in pozneje tonalit) in andezit, slemena v podaljšku do Vuzeniško-Radeljske kotline pa zgornjemiocenski konglomerat, laporovec in peščenjak. Na južnem, mislinjskem pobočju prevladujejo gnajsi in blestniki.
- 2 *Vzhodno in jugovzhodno Pohorje* je območje vzhodno od globokih dolin Lobnice in Mislinjskega grabna. Je najbolj masiven del hribovja in zavzema polovico Pohorja. Je reliefno manj razčlenjeno kot ostalo gorovje.
- 2.1 *Mariborsko Pohorje* z najvišjim slemenom Planika–Klopni vrh (1340 m)–Žigartov vrh–Ledinekov vrh (1182 m)–Bolfenk. Njegovo strmo severno pobočje prehaja proti dnu Dravske doline v neogeno vinogradniško Limbuško gričevje, ki geološko ne pripada Pohorju.
- 2.2 Ogelni vrhovi *Pohorske planote* so Veliki vrh (1303 m), Travni vrh (1273 m), Klopni vrh (1340 m) in vzhodno pobočje slemena Pesek (1423)–Plesič (1407 m). (slika 2)

- 2.3 *Vzhodno in jugovzhodno Pohorje* je reliefno manj razčlenjeno kot ostali deli gorovja. V njegovem okviru ločimo po reliefnih razlikah enote vzhodnopohorska nagnjena planota, Zreško Pohorje, Vitanjsko Pohorje in Paško Pohorje, a so razlike manjše.
- 3 K Pohorju v širšem smislu besede pripadata še dve enoti, ki sta z nastankom Pohorja ozko povezani, in sicer Ribniško-lovrenško-selniško podolje ter Obdravsko Pohorje.
- 3.1 *Ribniško-lovrenško-selniško podolje* zavzema okoli 2–3 km širok pretežno gričevnat relief med 300 in 700 m n. v. med Ribnico in Limbušem. Sestavljen je iz zgornjemiocenskih konglomeratov, peščenjakov, laporjev in v premem nadaljevanju tudi iz dravske naplavine v Dravski dolini.
- 3.2 *Obdravsko Pohorje* je med Dravsko dolino in Ribniško-lovrenško-selniškim podoljem in še nima ustaljenega imena. Tu ga s tem imenom uporabljamo prvič. Je niz slemen do višine 913 m n. v., ki se razteza v smeri vzhod–zahod med dolino Vuhreščice in Falo oziroma med ribniško-lovrenško-selniškim podoljem in Dravsko dolino.
- 4 *Dravska dolina* med Dravogradom in Mariborom sicer ni več v celoti del Pohorja. Ker pa Drava odvaja vode z velike večine Pohorja, je predmet naše obravnave skupaj z vuzeniško-radeljsko kotlino.

Slika 3: Členitev pohorskega površja z vrisanimi izbranimi geomorfološkimi prvinami: geomorfološka enota, hrbti in slemena, obseg porečij, obseg pliokvartarnih robnih kotlin, značilne pregibnice (s polno črto), zmični prelom v dnu doline (črtkano), morena, obročasta struktura.
Glej angleški del prispevka.

3 Vpliv kaminske sestave

Novejše geofizikalno in geološko raziskovanje globalne sestave zemlje pod oceani in celinami je mnogo prispevalo k pojasnitvi nastanka metamorfnih kamnin tudi v Vzhodih Alpah, ki iz Avstrije na jugovzhodu segajo v slovensko Pohorsko Podravje. Pohorje v tektonskem oziru sestavljajo narivi, nastali v subdukcijski coni Paleotetisa. V varistični in alpidski eri so bili različno intenzivno metamorfirani (Premru 2005, 206; Hinterlechner-Ravnik, Moine 1977). Poglejmo si kot primer na Pohorju prisotni eklogit. Nastaja pri tlakih okrog 3 Gpa in temperaturah 760–820 °C. Take razmere so (bile) v silursko-kaledonski dobi pred 500–435 milijoni let med subdukcijo oceanske plošče Paleothetisa pod rob kontinentalne plošče. Dodatno metamorfozo so pohorske kamnine doživele med mlajšimi tektonskimi fazami.

Prodori magme v astenosfero so v smislu teorije o ekstenzijski ekshumaciji povzročali dodatno dviganje žilnin na zemeljsko površje zaradi nizkotlačnih in nizkotemperaturnih sprememb. Geologija govori o večkratnih prodorih magme v astenosfero, zato so kamnine tudi tako različne. Na Pohorju v širšem pomenu besede so po Premruju (2005) sledovi osmih prelomnih sistemov v različnih smereh, ki so nastali v času od zgornjega dela srednjega pliocena do holocena. Razpravljanje o različnih geoloških tolmačenjih nastajanja paleoreliefa tu ni smiselno, ker je v ospredju geomorfolška analiza sedanjega reliefa in predvsem razlik v njem.

Pohorske metamorfne in magmatske kamnine so po mnenju geologov vzhodno nadaljevanje proti severu premaknjenega tako imenovanega perijadranskega prelomniškega sistema (Mihevc, Vrabec 2005). Mioč in Žnidarčič (1972) delita pohorske in kobanske metamorfne kamnine na 28 enot. Nekatere kljub temu kemijsko in glede kompaktnosti niso homogene. Na primer granodiorit. Analiza treh vzorcev (Faninger 1973, s. 35) je ugotovila deleže silicija med 25,2 in 30,6 %. Redki apnenci ponekod predstavljajo vzpetine, a razlike v sestavi metamorfnih kamnin se v glavnem ne odražajo v reliefu. To velja tudi za zgornjemiocenske plasti, to je konglomerate, peščenjake in laporovce. Iz njih je pretežno gričevnato ribniško-lovrenško-selniško podolje, ki naj bi bilo po Meliku (1957) zgrajeno iz manj odpornih sedimentov. Širše ozemlje kot tu zavzemajo enako stari sedimenti v hribovju z vrhovi do 854 m med zahodno okolico Ribnice in vuzeniško-radeljsko kotlino, a tamkajšnji sredogorski slemenasto-dolinasti relief se ne razlikuje bistveno od sosednjega ozemlja iz metamorfnih kamnin v Obdravskem Pohorju. Stik granodiorita in drugih metamorfnih kamnin, ki poteka po vrhu pohorskega razvodnega hrbta med porečjema Mislinje in Drave oziroma med Kopo in prevalom Šiklarico, se v glavnem ne odraža v oblikovanosti reliefa. Tega stika pa se drži najvišji razvodni hrbet med Malo Kopo in Roglo. Menim, da je tektonsko pogojeni stik nudil manj odpora tektonskemu dviganju. Toda vzhodno od Sedovca (1232 m), ta je na mariborskem Pohorju, je najvišje razvodno sleme zgrajeno iz muskovitno-biotitnih gnajsov s prehodi v blestnik, nižje ozemlje iz granodiorita pa se vse bolj oddaljuje proti jugu. Tu višinskih razmerij ni določevala petrografska sestava, temveč tektonika. Vzhodnopohorske doline se po stiku granodiorita z gnajsom ponekod poglobijo. Na taki meji je zgornji slap na potoku Bistrica (Šušteršič in ostali 2005, 17).

Velika petrografska pestrost metamorfnih kamnin v drobni oblikovanosti površja ne pride do večje veljave, ker so metamorfne kamnine, razen redkih izjem, skupno z magmatiti bolj ali manj zrnate in na površju razmeroma hitro razpadajo v pesek (star domači izraz zanje na Zahodnem Pohorju je ržen kamen). Ob prevladujočem mehaničnem preperevanju na površju nastaja pesek, ki je v debelejšem sloju na srednjem Pohorju na manj razčlenjenih površinah, ljudsko planjah. Tam so običajne strmine 11–19°, na pobočjih v globljih dolinah pa 20–33°

V nadpovprečno strmem pohorskem porečju Mislinje nad Dovžami znašajo nakloni 22° 40' (Gams 1976, 188). Vpliv kamnin na relief je nekoliko bolj opazen na vzhodno pohorskem pobočju med naselji Božje in Spodnje Prebukovje, kjer so na prehodu iz granodiorita v gnajs rečne doline plitvejše in širše. Med Črnim vrhom in Jesenkovim vrhom je Pohorje kot prestreljeno z otoki in pasovi dacita in naklon površja na Kremžarjevem vrhu (1164 m) je nekoliko nadpovprečen, zlasti na severnem pobočju. Na prehodih dacita v temen filitoidni skrilavec na Pungartu pri Grmovškovem domu je v slednjih približno sto metrov široka travnata polica, kar je izjema na Pohorju.

Nadpovprečno so strmi osamelci krednega apnenca sredi metamorfnih kamnin (Jesenkov vrh, 933 m, Golek, 769 m, Brinjeva gora (520 m) v okolici Zreč). Nekaj karbonatnih kamnin je zdrobljenih ostalo uklešćenih med metamorfnimi in v taki legi v reliefu ne izstopajo. Večje krpe karbonatnih kamnin, zlasti ta s cerkvijo Sv. Duha na Ostrem vrhu (903 m) na Kobanskem, in Jesenkov vrh (933 m) na Severozahodnem Pohorju, oba na vrhu slemena, se strmo dvigajo iznad okolice. Domnevajo, da so ostanki nariva s Karavank (Mioč, Žnidarčič 1972). S tem je najlažje tolmačiti nastanek 863 m visokega hriba Loška gora, ki je od severnega roba karbonatne karavanške Stenice oddaljen le dva do tri kilometre.

Človek je do nedavna na erozijo prsti najbolj vplival z oranjem v smeri izohips, ki je zaradi plužnega prelaganja zemlje navzdol nakopičilo zemljo na spodnjem robu njiv, kjer so se pojavljali usadi. Linearna erozija je še močna na spodnji strani asfaltnih cest, kjer te prekinjajo tokove podtalne vode, zbrane više v reliefnih depresijah. Tudi na Pohorju je več erozije v strmih legah (prim. Komac 2005, sl. 4 in 7).

Pred pliokvartarjem je iz Graške kotline v Pohorsko Podravje segal obsežni pokrov iz zgornjemiocenskih sedimentov (Sölva, Stuve, Straus 2005). Ti na Pohorju (v širšem smislu besede) vsebujejo tudi prodnike iz metamorfnih kamnin, med njimi tudi granodiorita in dacita. To naj bi dokazovalo, da so bili že v gornjem miocenu razkriti na vrhu Pohorja (v ožjem smislu besede). Vendar je v istih ivniških plasteh podobna primes tudi na ozemlju Kobanskega (Mioč, Žnidarčič 1972, 40–41). Tik pod kobanskim prevalom Radelj so ob cesti razgaljene radeljske plasti s prodniki iz metamorfnih kamnin v dolžini do enega metra. Ivniške plasti so se ohranile v otokih ali pasovih v reliefnih depresijah (npr. Ribniško-Lovrenško-selniško podolje) kot tudi v hribih, vse v tektonskih ugrezninah, ki so jih obvarovale pred erozijo. V takih legah je njihova skupna debelina na primer v kapeljski sinklinali 420 m, v Ribniško-Selniškem tektonskem jarku 500 m in v območju Radlja in Remšnika 1110 m (Mioč, Žnidarčič 1978, 38, 63)! Ohranjeni v tektonskih ugrezninah nakazujejo prvotno debelino in razprostranjenost.

4 Reliefne enote

4.1 Dravska dolina

Današnja Drava kot iztok iz Labotske kotline je sočasno z dviganjem Golice drsela vzdolž labotske prelomnice proti jugovzhodu do Dravograda, a zahodnega Pohorja s sotesko ni prebila na njegovem najnižjem hrbtu, ki je v Cvitrškem sedlu (677 m, ta je iz helvetskih sedimentov), temveč po kloritno amfibolovem skrilavcu, amfibolitu in ultrabazičnem diabazu, ki so na obeh straneh dravograjske predorne doline med pohorskim Mežnarjevim vrhom (800 m) in dolgim slemenom Košenjaka v kraju Ojstrica (907 m). Njeno pobočje je strmo na pohorski strani in zložno pod višjim Košenjakom (1522 m), ki se je hitreje dvigal in odrival reko proti jugu. V nadaljevanju doline do Trbonj sta enako strma kobanska in pohorska stran. Na nekdanji štajersko-koroški meji je dolina sredi med Dravogradom in Vuzeniško kotlino najožja, kar govori za nekdanje razvodje med pritokoma k Labotski in vuzeniški kotlini.

Slika 4: Prebojna dolina Drave onstran Dravograda (pogled proti vzhodu). Desno pobočje v Pohorju, levo pod višjim Košenjakom je manj strmo, zadaj levo Kobansko.
Glej angleški del prispevka.

V dolini med Trbonjami in Spodnjo Vižingo je sestavljena vuzeniško-radeljska kotlina. V njej so pri gradnji HE pri Vuzenici navrtali 80 m kvartarnih dravskih naplavin (Mioč, Žnidarčič 1972). Sodeč po kvartarnih terasah je bilo središče ugrezanja ob jugozahodnem robu te kotline med naselji Vuzenica in Dravče. Tja, proti jugu, se pospešeno znižuje tudi največja kvartarna terasa vuzeniške kotline, ki pa ima nad južnim koncem doline kobanske Bistrice od Zgornje Gortine do Mute malo padca, čeprav tudi na vrhu prevladuje dravski prod. Vtis je, da je Bistrica zadrževala Dravo. V enaki višini je na južni strani kotline ostanek terase v Zgornjem trgu v Vuzenici. Spada med zajezitvene terase na začetku doline ob Dravi. Največja je v Trbonjah, ki ima v severnem delu naselja prav tako višino 380 m. Obe zadnji terasi sta ostanek pleistocenskih zajezitvenih dravskih akumulacij na ustju pohorskih pritokov, vključno s teraso mežiške Dobrove (Kislinger 1929; Gams 1995). Pred to teraso (Trbonjska) Reka zavije v desno in teče proti jugovzhodu 1,5 km daleč med podaljšano in znižujoče se trbonjsko teraso ter pohorskimi filitoidnimi skrilavci, iz katerih v polkrogu molijo otočki dacita. Pri Vuzenici so pri gradnji HE z vrtino naleteli na skalnato podlago prodne terase v globini 80 m, kar je globlje kot je ob reki na vzhodnem kraju radeljske kotline niže Vuhreda.

Nad Vuzenico so na Kobanskem seizmologi l. 1991 postavili postajo Pernice; ugotovili so potresno žarišče v globini 15 km in potresno ogroženost VI. stopnje po Richterju (Vidrih 1992).

Pri Vuzenici so v južnem zaledju kotlinice številni čoki iz dacita, ki se v globini verjetno strnejo v večjo lakolitno gmoto. Njej bi lahko pripisali seizmičnost okolice. Nad Spodnjim trgom Vuzenice je nahajališče dacitnega tufa (Mioč, Žnidarčič 1972). Po Premruju (2005, 457) je vuzeniška udorina obročasta struktura, ki se na površju pojavlja s spiralno zakrivljenimi slemeni in (ali) dolinami nad plutonitom v globini. Po istem viru so v tej kotlini ugotovljeni prelomi smeri severozahod–jugovzhod, severovzhod–jugozahod, zahod–vzhod in sever–jug.

Na vzhodu se vuzeniška kotlinica povezuje s 6 km dolgo radeljsko kotlino, toda v njej je vzhodno od izliva Bistrice največja, radeljska terasa, dobrih 10 m nižja od mučke, a manj visi proti jugu kot prva in je, v nasprotju z mučko teraso, tudi vsa v polju. Neznana globina skalne podlage onemogoča sklepanje o intenzvinosti tektonskega ugrezanja, na katero bi lahko sklepali po ločnatem severnem in južnem robu. Z dolžino 5 in širino do 5 km ima podoben obseg kot vuzeniška kotlina. Po Premruju (2005) sta obe kotlini ločnati strukturi. Obe sta z ugrezanjem pospešili erozijo Reke, Cerkvenice in Vuhreščice, ki so v zgornjemiocenskih ivniških sedimentih izdelale dolge doline in vmesna visoka slemena, ki se začenjajo na pohorskem razvodnem hrbtu.

Dravska dolina je med obdravskim Pohorjem in Kobanskim debrska in je zgrajena iz muskovitno-biotitnih gnajsov s prehodi v blestnik. Tu je pleistocenskih prodnih teras vedno manj. Rakovec (1955) je datiral ostanke mastodonta, najdenega v 5. terasnem nivoju pri Breznu, v riss. Ob Dravi je bilo mogoče po relativni višini nad dolinskim dnom ugotoviti pet prodnih teras, najvišja je ohranjena le redkokje v obliki ozkih konglomeratnih ostankov (Gams 1959). Vzhodno od Brezna je samo še skalnata deber z deročo vodo.

Strmec Drave so spremenila po drugi svetovni vojni zgrajena akumulacijska jezera pred hidroelektrarnami. Prej so v tok Drave posegli le pri Fali. Hiltl (1893) poroča, da so tam za vožnjo splavov leta 1818 odstrelili ovirajoče skale, skupno čez 15.000 m^3. Avstroogrski vojnogeografski inštitut je v 19. stol. stoletju izmeril padce Drave na desetih rečnih odsekih. Med Dravogradom in Mariborskim otokom so na 60 km rečnega toka namerili višinsko razliko 92 m, kar da povprečen strmec 1,53 %/km (Hiltl (1893, 70). Še vedno vijugasta dravska struga na slovenski karti 1 : 50.000, narejeni pred gradnjo HE, je bila dolga do Fale 49 km, kar pomeni strmec 1,09 m/km. V Vuzeniško-Radeljski kotlini je strmec do izliva Vuhreščice majhen, na nadaljnjem odseku do domačije Šturm (na vrhu okljuka severno od Fale) znaša 3,1 m/km, od tu do Laznice pa 2,66 m/km. Ostaja vtis, da je dravski strmec glede na vodnatost in grobo kamenje, ki ga odlagajo neposredni pritoki v Dravo v soteski, precejšen in da bi bila reka brez človekovega posega še sposobna poglabljati strugo.

4.2 Obdravsko Pohorje

Obdravsko Pohorje je 19 km dolgo in 3–4 km široko hribovje iz metamorfnih kamnin med dolino Vuhreščice in zavojem Drave nad Falo. Do 913 m visoka in pretežno proti vzhodu usmerjena slemena s pogostimi slemenskimi nivoji na vrhu v n. v. med 800 in 900 m najbolj brazdajo doline potokov, ki pritekajo z ovršja Pohorja.

Obdravsko Pohorje je južno krilo kobanske antiklinale. Slemena in doline na južnem kobanskem pobočju se na drugi strani Drave praviloma ne nadaljujejo premočrtno v Obdravsko Pohorje in levi dravski pritoki so precej številnejši. Med krajema Brezno in Ožbolt se v Dravo izlivajo kobanski pritoki Remšniški, Brezniški, Potočnikov, Javniški, Grgasov potok in Črmenica. Njihove do 7 km dolge doline s strmimi pobočji so v srednjem in spodnjem delu globoke do sto in več metrov. S povprečnim razmikom en kilometer so najbolj goste v Sloveniji, kar kaže na njihovo mladost. Pri Podvelki se v ločnati strukturi slemenski lok dvigne v Hlebovem vrhu na 913 m in nato v polkrogu znižuje proti Dravi pri Ožbaltu.

Da se Obdravsko Pohorje dviguje brez večjih prekinitev, tako kot Pohorje, dokazuje odsotnost pobočnih teras. Epigenezo Dravske doline sta zagovarjala med drugimi že Melik (1957) in Sölva (2005). Tudi trditev, da je stara Drava sprva nasipavala prod v Graški kotlini ali v zahodnih Slovenskih goricah, je stara (Winkler 1944, 145–168). Vsi navedeni, Mioč in Žnidarčič (1972) ter Melik (1957, 74–75) so bili mnenja, da je v naslednji fazi Drava tekla po ribniško-lovrenško-selniškem podolju, ne da bi pojasnili, kdaj in zakaj se naj bi do 854 m dvignilo hribovje v porečju Velke in Plavžnice, ki tečeta proti vuzeniško-radeljski kotlini. To hribovje je enako visoko kot v Obdravskem Pohorju.

Na Kobanskem zdaj ni več sledov prečne dravske doline proti Graškemu nižavju. Nasprotno, oblika najdaljše kobanske, proti jugozahodu tekoče reke Črmenice govori celo za mlajšo pretočitev k Dravi. Njena dolina pri izlivu v Dravo je široka 0,8 km, 3,5 km više v Spodnji Kapli 2,5 km in v ivniških skladih na razvodju pred državno mejo v kraju Gradišče na Kozjaku 6 km. Tam, na vrhu Kobanskega, je Črmenica celo pretočila povirje dveh zahodnih dravskih pritokov, Grgasovega in Ožbaltskega. Pretočitev Črmenice je v skladu s trditvijo, da ima Drava niže Maribora v nasprotju z Muro večjo erozijsko moč kot Mura, saj ima daljše leve pritoke kot desne (Melik 1957).

Slika 5: Pogled s hriba sv. Antona proti Pohorju (to je v ozadju) zajema južni del 6 km dolgega hribovskega ozemlja, kjer naj bi po mnenju nekaterih geomorfologov nekdaj tekla Drava in tok nadaljevala proti vzhodu.
Glej angleški del prispevka.

4.3 Ribniško-lovrenško-selniško podolje

Ribniško-lovrenško-selniško podolje je geološko iz zgornjemiocenskih konglomeratov, peščenjakov in laporovcev. V podlagi jih sestavlja klastično gradivo rečnega nastanka, više so rečno-jezerski in na vrhu brakični (Mioč 1977). Površje podolja je povečini gričevnato, v višinah med 400 in 700 m. Selniško podolje, ki je nadaljevanje lovrenškega, zavzema dno Dravske doline od Fale naprej do Maribora. Pod Falo sega holocenska naplavina do skalnatega dna v globini 100 m. Po Šercljevi pelodni analizi (cit. iz Mioč, Žnidarčič 1978) je fluvioglacialni vršaj pri Lovrencu na Pohorju iz srednjega würma. Med Lovrencem in Falo je v porečju Lamprehtovega potoka ločena manjša kotlinica z neravnim dnom, zapolnjena s peščeno glino, v kateri je Šercelj ugotovil pelod iz zadnjega würmskega viška (Mioč 1977).

Na vzhodnem koncu lovrenškega podolja je v terciarnem gričevju edinstveni primer vpliva recentne tektonike na rečno omrežje. 50 m nad Dravo pri Fali je v n. v. 420–450 m sleme, usmerjeno proti severu, z naseljem Činžat na vrhu. Na stiku neogena z metamorfnimi sedimenti v Rutah je 5 km dolg ozek pas dacita v smeri zahod–vzhod. Gozdar falske graščine Hiltl (1895, 75) navaja za Pohorje potresa v letih 1791 in 1794. Reliefne oblike na vzhodnem pobočju slemena z vršnim naseljem Činžat niso v skladu s splošnim naklonom pobočja. Pod naseljem se na njem začenjata dve dolini. V eno od njiju so od kmetije Rečnik vodoravno po pobočju in po vrhu slemena umetno speljali odvod iz Lamprehtovega potoka na nasprotno, vzhodno pobočje slemena. Po tej kmetiji domačini še zdaj imenujejo ves vodni tok do izliva v Murkov potok Rečnikov potok. S pretočitvijo so povečali vodno silo za zdaj že dolgo propadle žage. Pred nedavnim so del te vode s Činžata po ceveh speljali naravnost navzdol do nove lokalne električne centrale ob Dravi, kadar ta deluje. Če bi tja tekel tudi Rečnikov potok, bi imel za polovico krajši tok kot zdaj, ko je ob transverzalnem toku dolg do izliva v Murkov potok okoli tri kilometre. Proti severu-severovzhodu usmerjeni dve pobočni dolini se združita malo pred sedaj asfaltirano cesto Puščava–Fala, kjer stoji gostišče Falski dvorec. Tam so pred leti graditelji pred asfaltiranjem ceste Puščava–Ruše več metrov na debelo nasuli dolinsko dno. Grušč so dobili z 10 m globokim znižanjem prevala v desnem dolinskem pobočju; s tem so odpravili cestni klanec na poti proti Rušam. Voda zdaj teče po ceveh pod nasutim dnom v globoko, proti severu-severovzhodu usmerjeno 800 m dolgo in do 50 m globoko sotesko med slemenom Karolina (357 m)–Kogel (343 m) in slemenom Činžat–Lobnikov vrh. Na koncu soteske se Rečnikov potok izliva v Ugov potok, ki teče skladno s strmcem pobočja proti vzhodu-jugovzhodu naravnost v Dravo. Proti severovzhodu usmerjene pobočne doline so ostanek iz časa, ko ugrezanje Dravske doline še ni doseglo Fale in je predhodnica Drave tekla verjetno po ozki dolini vzdolž prelomnice na sedanjem severnem robu selniškega podolja na črti Fala–Črešnjevec–Selnica. Ob tej prelomnici so v Dravi za olajšanje splavarstva odstranili skale z že omenjenimi brzicami

Skozi Falo teče Drava, ki ima od zavoja na Kobanskem pri Žavcarju do Pohorja na razdalji 4 km smer sever–jug. Da gre tu za daljšo tektonsko prelomnico in pregibnico, sklepamo po enako usmerjeni 2,5 km dolgi dolini Lobnice na severnem pohorskem pobočju pred zavojem proti Rušam. Sklepamo, da je ožja Dravska dolina v višjih nadmorskih višinah nekdaj segala le do Ruš.

Slika 6: Rečnikov potok teče proti severovzhodu.
Glej angleški del prispevka

4.4 Severno pobočje Pohorja

Največja morfološka posebnost Pohorja med Ribnico in Rušami je odklon smeri potokov, dolin in slemen od splošnega naklona pobočja proti severu v smer severovzhod. V zgornjem delu so na Pohorju doline izbočene proti zahodu, v spodnjem pa zavijejo čim niže tem bolj proti vzhodu (slika 2). Njihov izliv je premaknjen v primerjavi z izvirom v primeru potoka Bistrice za 35°, v primeru Velke za 22° in Vuhreščice za 23°. V selniškem podolju pa tečejo pohorski potoki proti severovzhodu v ravni črti.

Pas proti zahodu izbočenih vrhnjih dolin leži vzhodno od Velike Kope. Na njej so s postajo ugotavljali recentne premike točk na zemeljskem površju z metodo satelitske tehnike (GPS). Pohorje, točneje Velika Kopa, je bilo v to meritev zajeto kot del tektonsko nestabilnega perijadranskega prelomnega sistema. S to tehniko so v letih 1996–2002 registrirali premike za 0,53 mm/letno proti jugu, kar tolmačijo kot premik ob labotski prelomnici proti jugovzhodu, in za 0,48 mm letno proti severu, kar tolmačijo kot odmik v smeri proti severovzhodu (Gradcu) (Vrabec 2006). Toda naša porečja so severno od vrha Pohorja izbočena proti zahodu in tja naj bi bilo torej usmerjeno tektonsko narivanje (Premru 2005). V ribniško-lovrenško-selniškem podolju tečejo potoki premo proti severovzhodu in v to smer tečejo tudi Velka, Radolja in vmesni Kapusov potok v Obdravskem Pohorju.

Na severnem Pohorju je ozka, strma in deloma skalnata dolina Lobnice. Samo na njej so brzice – Mali in Veliki Šumik. V njeno porečje spada največji del Pohorske planote. Njen desni pritok Verna med Peršetovim (1231 m) in Žigartovim vrhom (1361 m) teče sprva 2 km celo proti jugozahodu. Kilometer pred Dravsko dolino Lobnica pravokotno zavije proti Rušam in se na koncu soteske Kluža skupaj z istoimenskim desnim pritokom od juga izlije v Dravo. Hkrati z glavno reko zavije v n. v. okoli 700 m proti vzhodu na južnem robu Dravske doline tudi do kilometer široko sleme na levi strani spodnje doline Lobnice. Njegovo nižje in ožje pobočje nad Dravo je iz ivniških skladov, ostali širši del pa iz paleozojskih skrilavcev, diabaza in amfibolita. Oba pasova ločuje tektonska prelomnica (Mioč, Žnidarčič 1978). Vzrok za zavoj v desno je domnevno omenjeno mlado podaljšanje Dravske doline do Fale.

Po neizenačenem podolžnem profilu sodeč je dolina Lobnice mlajša od zahodnejših pohorskih rek. Samo Lobnici se na Pohorski planoti bistveno razširi porečje. Med Klopnim in Miznim vrhom poteka razvodje med Lobnico in Lamprehtovim potokom po pravcati ravnini. Že rahla tektonska sprememba naklona planote bi povzročila njeno odtekanje v drugo smer. Planota prehaja proti vzhodu zelo zložno. Tam proti jugu usmerjena Bistrica v prvih 4 km dolgem toku ni uspela poglobiti globlje doline.

Po razmerah pod razvodnim pohorskim hrbtom med Kremžarjevim vrhom in Veliko Kopo (glej poglavje 4.6.2!) sklepamo, da so najbolj verjeten vzrok za tektonske premike na vsem Pohorju globinski lakoliti dacita. Na naši karti naklonov površja nastopajo zavite pregibnice tudi na Zreškem Pohorju, kjer je magmatsko jedro globlje pod površjem in z žilninami iz amfibolita in eklogita s prehodi v amfibolit. To velja tudi za vzhodnopohorsko nagnjeno planoto med Mariborskim Pohorjem in Oplotico, kjer so ločnato proti zahodu zaviti višji potoki v območju granodiorita, tudi zgornja Bistrica.

Slika 6: Rečnikov potok teče proti severozhodu.
Glej angleški del prispevka.

4.5 Vzhodno in jugovzhodno Pohorje

Vzhodno od Peršetovega vrha (1242 m) se najvišje pohorsko razvodno sleme vedno bolj odmika od sklenjenega granodioritnega vzhodnopohorskega ozemlja, še zlasti potem, ko se sleme Ruškega Pohorja usmeri proti vzhodu-severovzhodu, to je proti Mariboru. V trikotu Žigartov vrh–Poštela in Žigartov vrh–Zgornja Polskava je pobočje na širokih vrhovih slemen zložno, prevladujejo nakloni 6–12 stopinj. Pobočja dolin pa so bolj strma, 12–20°. Gričevje v kraju Črete južno od Polanskega potoka ima značilno ime Brda.

Tamkajšnji potoki ponikajo v prodna tla ravnega Dravskega polja, kjer je nekdaj bilo klasično območje izgonov. Ta značaj se izgublja, odkar so številne izgone domačini zravnali. Bili so dokaz hitrejše rasti naplavine kot znaša tektonsko ugrezanje Dravskega polja. To ugrezanje polja je pospeševalo poglabljanje dolin v zalednem robnem Pohorju, ki je zato bolj grapasto. Samo v tem delu Pohorja se vršaji potokov globoko zajedajo med gričevnat svet, tako da je rob Pohorja iz metamorfih kamnin nazobčan.

Med Zgornjo Polskavo in spodnjim tokom Oplotnice spreminja metamorfni rob Pohorja širši gričevnat rob, vmesne goste doline so ožje, gričevnata slemena bolj poseljena, rob Pohorja pa manj izrazit, ker nekatera njegova slemena manj sklenjeno prehajajo v 20–35 m visoke neogene Podpohorske gorice (in te dalje na JV v Dravinjske gorice). Slednje v okolici Slovenske Bistrice gradi pliokvartarni pesek, peščena glina, glinast in peščeno glinast laporovec, glinasti prod in posamezni, do 40 cm dolgi prodniki iz pohorskih kamnin (Žnidarčič, Mioč 1989). Jugozahodneje prevladuje v goricah med prodi, peski in ilovicami kremenčeva primes, med Ložnico in Zrečami pa je v gričevju med piokvartarnimi sedimenti primešanih več zgornjemiocenskih sedimentov izpod Karavank (Mioč, Žnidaršič 1972). Na pomemben delež periglacialnega grušča s Pohorja v pliokvartarnih podgorskih naplavinah in na gruščnato periglacialno odejo na zalednem Pohorju je opozoril Šifrer (1974). Na tem polkrožnem robu Pohorja je na naši karti naklonov vrisana pregibnica. Ta izraz je v slovensko geomorfologijo uvedel Habič (1984) in pomeni v reliefu viden daljši, lahko tudi lokalno prekinjen značilni prehod v drugačno strmino.

Tretji del Vzhodnopohorskega pobočja, ki je porečje Bistrice nad slapom Bistriški Šum, je najbolj planotast in najbolj zasluži ime nagnjena vzhodnopohorska planota. Prevladujejo nakloni 6–12°, kar je manj kot znaša posipni kot za grušč. Izrazito ozko in dolgo porečje Bistrice v povirju zavija proti severu in tamkajšnje njeno porečje predstavlja prehod med pohorsko planoto in vzhodnopohorsko nagnjeno planoto.

Ker je naklon 4–20 značilen tudi za plečata slemena med razmeroma ozkimi dolinami doslej opisanega vzhodnopohorskega pobočju med Hočami in spodnjo, proti jugu usmerjeno dolino Oplotnice, ga smemo v celoti uvrstiti med nagnjeno vzhodnopohorsko planoto.

V pliokvartarju so v podnožju hribovja erozija večjih rek Bistrica, Oplotnica in Dravinja in neotektonsko ugrezanje izdelali kotlinice. Taka je tudi konjiška depresija (kotlina), ki je zapolnjena s kvartarnimi in pliokvartarnimi sedimenti, prinesenimi s Pohorja in tudi s Karavank (Žnidaršič, Mioč 1989).

Odlaganje rečnega transporta v ugrezajočih se kotlinah je pospešilo erozijo in poglabljanje pohorskih rek spodnje Bistrice in celotne reke Oplotnice, dolina slednje namreč predstavlja zahodno mejo vzhodnopohorske nagnjene planote.

Med Hočkim potokom in porečjem Bistrice so doline na vzhodnopohorskem pobočju nad 350–450 m nadmorske višine izbočene proti jugozahodu, domnevno kot posledica tektonskih premikov v to smer. Pozornost vzbuja nesimetrično porečje zgornje Polskave. Njeni daljši pritoki Velika Polskava, potok iz Frajhama, Mala Polskava in Brunik nad Loko pri Framu potekajo proti jugovzhodu, a so razmaknjeni za en do treh kilometrov, zbirni potok pa teče v smeri vzhod-severovzhod. S tem je njeno zgornje rečno ožilje podobno polomljenim vilam, ki imajo odlomljen četrti, desni rogelj – pritok Brunik. Ta se pred izlivom še ogne prelomnici in osameli vzpetini z naseljem na vrhu – Gradiščem; Polskavi se pridruži nižje po ovinku. Glavni tok Polskave med Šmartnom na Pohorju in Gradiščem poteka domala pravokotno na smer splošnega zniževanja pobočja. Razlago za to nenavadnost rečnega ožilja lahko iščemo v zmičnem prelomu.

V porečju zgornje Bistrice so nakloni površja najmanjši, 4–20°. Bistrica ima od vseh daljših pohorskih rek najkrajše pritoke. Od slapa Bistriški Šum, kjer se stika trši granodiorit z blestnikom, reka zavije proti jugovzhodu (Šušteršič in ostali 2005). Do 250 m globoka dolina Oplotnice poteka med Cezlakom in Roglo po robnem ozemlju iz granodiorita blizu stika z blestniškim ozemljem; vzrok za takšno usmerjenost doline pa še ni pojasnjen. Če bi ta reka od izvira v Črnih mlakah na severni strani Roglje tekla naravnost v smeri največjega strmca pohorskega pobočja, to je proti Zrečam, bi bil njen tok dolg ne 16 km, kot je zdaj do naselja Oplotnica, temveč 9 km. 250–300 m globoka dolina do Cezlaka, razen v povirju, z leve strani ne dobiva večjih pritokov. Tri kilometre vzhodno od njene struge je v Velikem vrhu (1344 m) ohranjen ostanek nekdanje krovnine iz blestnikov. Lahko bi ga uporabili za dokaz, da se je reka pri poglabljanju v tršo podlago ujela po preboju skozi blestniško odejo, ki je danes sklenjena 5 km severneje. Med krajema Jurgovo in Cezlak je dolina izbočena proti zahodu, niže Cezlaka pa dno zavija proti JV in končno jugu. Sodeč po razlomljenih smereh poteka po dnu doline zmični prelom.

Dolina spodnje Oplotnice in Oplotišnica s pritoki na Pohorju predstavljajo pahljačasto pregibnico. Podobno odstopanje od splošnega naklona pobočja je pri Dravinji: njen izvir je zračno oddaljen od Vitanja 6 km, njen tok proti vzhodu-jugovzhodu pa je dolg 15 km. Podobno je s sosednjo reko Hudinjo. Njen začetni 3,7 km dolg tok niže Kragulišča (1454 m) teče proti jugu-jugozahodu. Po izlivu pritoka z imenom Paška voda zavija 2,2 km proti jugovzhodu, potem pa se obrne proti jugozahodu in pod Vitanjem pri Goleževem gradu zaide n. v. okoli 450 m v globoko sotesko med Paškim Kozjakom in Stenico. Dolina Jesenice med Lošperkom in Vitanjem je polkrožne oblike.

Razlago za poševno po pobočju usmerjene zgornje doline ter za majhno porečje Dravinje in Hudinje lahko iščemo v razmeroma mladem predoru savinjskih pritokov Dravinje in Hudinje skozi dvigajoče se Vzhodne Karavanke. Verjetno je intenzivna korozija povzročila, da savinjski pritok Tesnica nižje naselja Beli potok nad naseljem Beli Potok v dnu globoke prebojne doline Socke v n. v. približno 410 m med Stenico in Konjiško goro ne teče po sklenjenem ozkem pasu iz pretežno nekarbonatnih zgornje miocenskih sedimentov, temveč tik zraven po le malo nižjem pasu apnenca. Zato Tesnica svojega izvira pri Stranicah ni podaljšala globlje v Pohorje. Je skozi sotesko Socko nekdaj tekla predhodnica Savinje, ki v Celjski kotlini v zadnji ledeni dobi ni zapustila izdatnejšega würmskega proda? Po mnenju Mezeta (1963) je tedaj tekla skozi Vzhodne Karavanke proti Dravskemu polju.

Prvotni odtok z južnega pohorskega pobočja proti jugu k Savinji je v kristalastem triasnem apnencu izvotlil nekaj sto metrov široko slepo dolino med krajema Spodnji in Zgornji Brezen. Njeno dno se nad Dolíškim podoljem začenja malo nad terciarnimi ivniškim skladi pri domačiji Strmečnik v n. v. 740 m. Dno se počasi dviguje in zavija proti jugozahodu pod Basališče. Tam je v kraju Zgornji Brezen dolina najgloblja, do 200 m. Njen nastanek pripisujemo kontaktni koroziji pohorskega potoka, pritekajočega na vrhu ivniških skladov, v katerih je Dolíško podolje, s karbonatno kamnino Paškega Kozjaka (Gams 1999, s. 458). V višini te slepe doline je v Doliškem podolju ostalo razvodje med Hudinjo in Pako na cestnem klancu z domačim imenom Lošperk (703 m). Višinsko razliko (nad 700 m) med omenjeno slepo dolino in Lošperkom ter Pohorsko planoto lahko pripišemo mlajšemu tektonskemu dvigu Pohorja.

Ob pospešeni rečni eroziji po nastanku prebojne doline Hudinje pri Vitanju je nastala na dolinskih pobočjih niže planj gosta mreža obdobnih potočkov, ki z gostimi dolinicami preprečujejo kmetijsko naselitev in rabo, tako da so ostali pod gozdom. Podobno je v hribovitem porečju Dravinje.

Vzhodno od najvišjega vrha Basališča (1272 m) se greben Paškega Kozjaka umika proti jugu, tako kot tudi vsa Stenica, Konjiška gora pa je v celoti za nekaj kilometrov odmaknjena proti jugu.

Slika 7: Zahodno Dolíško podolje, kjer se v spodnjem Dolíču stikajo trije tipi reliefa: kopasti dolomitni griči (sredi) kot del Dolíškega podolja, južno pohorsko pobočje (skrajno levo) in koničasti apneniški hribi (sredi) pod goro Paški Kozjak (skrajno desno).
Glej angleški del prispevka.

Triasni dolomiti sestavljajo severno od prebojne doline Pake v Hudi luknji hribe Doliške plošče, na katerih so erozijski ostanki zgornjemiocenskih skladov. Na severnem koncu enega od njih je predrto južno pobočje končne doline Mislinje. To izkorišča cesta Velenje–Slovenj Gradec, ki v n. v. 600 m doseže dno Mislinjske doline le 170 m daleč od nekaj metrov nižjega toka Mislinje. Predor je delo erozije pritoka Pake. Če bi to pobočje pri cerkvi sv. Jedert predrla Mislinja, bi nedvomno nepovratno stekla proti 2,7 km oddaljeni in 150 m nižji Paki v Hudi luknji.

Mlajšo razširitev porečja Pake na račun Mislinje nakazuje jugovzhodno od naselja Mislinja kratka stranska suha dolina v n. v. 720 m, ki poteka v triasnem dolomitu v n. v. 720 m čez domačijo Turjak proti jugovzhodu.

V osamelem hribu Tisnik (785 m) so 2175 m dolga jama Huda luknja, v n. v. 575 m 91 m dolga jama Špehovska, v n. v. 670 m 252 m dolga jama Pilanca, na samem vrhu hriba pa kratka jama Klet; vse naj bi izvotlila Paleopaka (Mihevc, Vrabec 2005). Ni pa še izključena možnosti nekoč višjega ponikanja odtoka z miocenske zaplate zgornjemiocenskega konglomerata, peščenjaka in ilovic v slepi dolini Ponikve.

Doslej so omenjeni predvsem lokalni odkloni dolinske usmerjenosti od povprečnega naklona širšega pobočja.

Slika 8: Predrto levo pobočje Mislinjske doline v Mislinji. Pod cerkvico ga je na južni strani naselja do dna doline in višine 600 m znižal pritok savinjske Pake in olajšal cestno povezavo med Podravjem in Posavjem.

Glej angleški del prispevka.

4.6 Mislinjsko Pohorje

Mislinjski jarek, v katerem izvira Mislinja, z dolžino 10 km in pod Črnim vrhom z globino do 700 m močno presega druge pohorske doline in razpolavlja Pohorje. Po Premruju (2005, 310) je vanj od zahoda segal Ziljski prelom v raznih obdobjih in z raznimi imeni. Jarek je dobil izjemne razsežnosti tudi zaradi zmičnih prelomov v dnu. V dnu je mogoče ločiti 5 ravnih odsekov različnih smeri, ki prehajajo od začetne vzhodno-severovzhodne v vzhodno–zahodno v končno smer severozahod–jugovzhod; v zadnji smeri priteka v razmeroma plitvem pobočnem jarku pritok izpod Rogle, ki ima ime Mislinja. Glavni jarek se od sotočja z Mislinjo pri Pustotniku nadaljuje tri kilometre dalje proti severu v dolino pritoka Glažuta. Njeni povirnici kleščasto obdajata Skrivni vrh (1436 m) in nakazujeta obročasto strukturo v sredi pohorskega gorovja. V 7 km dolgim končnem delu pred naseljem Mislinja je jarek širok 5,5 do 8 km. Na jugu ga omejuje sleme Volovica (1455 m) – Rogla (1517 m).

Mislinjski jarek, poglobljen pretežno v diaftoritu, obdaja okoli 1500 m visok polkrožni razvodni hrbet z vrhovi Črni vrh, 1543 m, Mali Črni vrh, 1533 m, Jezerski (Ribniški) vrh, 1537 m, in po presledku v Šiklarici 2,5 km dolgo sleme z Ribniškim jezerjem v višinah med okoli 1500 in 1540 m. Nedvomno mlajši jarek od goratega oboda s presenetljivo enakomerno višino med 1500 in 1540 m je osnova sklepa, da je mislinjski pritok Glažuta razčlenil do 3 km široko planotico v višini malo nad 1500 m, sama Mislinja južneje od tod pa erozijsko znižala ožjo planotico v n. v. okoli 1450 m. Tako visoko sega plečato sleme na južni strani porečja, ki je zahodno-jugozahodno od turističnega naselja na Rogli 4,5 km dolgo in kjer se vrstijo vrhovi Volovica, 1455 m, Turn, 1463 m, Kraguljišče, 1454 m. Zahodno od Pohorske planote sega čez 1400 m 2 m dolg hrbet Pesek (1423 m) – Lasina (1412 m), kar je podlaga mišljenju, da je tudi vzhodneje od slemena Lovrenških jezer prvotno obstajala planotica z okoli 1450 m višine, a so jo znižali periglacialni procesi v bližini poledenelega območja in erozija rek, njeno vzhodno nadaljevanje na Vzhodnem Pohorju pa je tektonika dvignila v sedanje višine med 1300 in okoli 1400 m.

Široko in dolgo sleme pod Črnim vrhom z imenom Planjave v naselju Mislinja lahko označimo za posebni tip reliefa – planje, ki je 10 km vzhodneje najlepše razvit tudi na južni strani pod slemenom Volovica (1455 m)–Rogla (1517 m)–Gradišče (1278 m). Zmerne strmine ohranja še med začetnimi potoki Pake, Hudinje in Dravinje (gl. karto nadmorskih višin!).

Razvodni hrbet Pohorja na črti Kremžarjev vrh–Kopa–Mali Črni vrh poteka v dinarski smeri severozahod–jugovzhod, kar je obenem smer labotske prelomnice. Je bližje dolini Mislinje kot dolini Drave.

Zahodnejši, do 200 m globoki in 5 km dolgi in do okoli 200 m globoki pohorski dolini Dovžanke in Turičnice sledita splošnemu strmcu pohorskega pobočja in tečeta pravokotno na smer zgornje Mislinjske doline. Pol do en kilometer oddaljeni reki sta redek primer vodnih tokov brez večjih pritokov (izjema je pritok Dovžanke Jamovica, ki se zajeda v Črni vrh in Planjave). Enakomerno proti jugu se znižajoče vmesno sleme Razborica dokazuje neprekinjeno dviganje gorovja in hkratno zniževanje podgorja v Slovenjgraški kotlini. Na skupnem kvartarnem prodnem vršaju Dovžanka in Turičnica nista uspeli znatneje poglobiti skupne struge, kar je na zahodnem pohorskem obrobju redkost.

Labotski prelom na robu ozemlja iz pohorskih metamorfnih kamnin in obenem gorovja ni povsod premočrten. Rahli odkloni so pri krajih Bukovska vas, Dovže, Šentilj, Spodnji Dolič in Vitanje, kar nakazuje zmični prelom (glej karto Mioč, Žnidarčič 1972).

Slika 9: Združen in erozijsko nerazčlenjen prodnati vršaj rek Dolžanke in Turičnice. V ozadju Velika Kopa. Sleme med dolinama, Razborica, je lep primer dokaj enakomerno in brez vodoravnih presledkov se dvigajočega se slemena proti Veliki Kopi (v ozadju).

Glej angleški del prispevka.

4.6.1 Mislinjska dolina

Mislinjsko dolino sestavljajo štirje geomorfološko različni deli. Devet kilometrov dolgo Spodnjo Mislinjsko dolino ločuje pri izlivu Meže v Dravo in s tem od Dravske doline 400 m n. v. visoka kvartarna prodno-peščena terasa (mežiške) Dobrove, na kateri dravski prod in konglomerat večinoma pokrivata predrto skalno podlago. Skozi vzhodno, edino odprto okno priteka k Dravi Meža s pritokom Mislinjo. Pred Dobrovo se Mislinjska dolina v Otiškem vrhu trikotno razširi v majhno kotlinico z naseljema Šentjanž in Otiški vrh. V njej je v Šentjanžu pod hribom Selovec po dolgotrajnem odkopavanju prodno peščenega gramoza ostalo le še malo v jezeru nastale würmske fosilne delte Meže, z nekdanjim vrhom malo pod 400 m.

Med Šentjanžem in Slovenj Gradcem je 18 km dolga Spodnje mislinjska dolina dinarske smeri dokaj enakomerno široka do enega kilometra. Do regulacije reke, najstarejše na Mislinji, je bilo ravno aluvialno dno Spodnje Mislinjske doline v večjem delu poplavno. Sodeč po tem je dolina tektonski jarek, ki se ugreza med dvema vzporednima prelomnicama in stranskima pobočjema. Pohorski potok Lakužnica je po dolini odlagal naplavino, zato so domačini do nedavna vzdrževali 1–2 m visok, zdaj odstranjen izgon. Samo v Pamečah in Trobljah je potok Trobeljščica v času obstoja würmskega zajezitvenega jezera nasul prodno teraso. Nadaljevanje proti jugovzhodu Mislinjski jarek zapira hrib Gradišče (517 m). Južno od njega, na prehodu Spodnje Mislinjske doline v Slovenjgraško kotlino, teče Mislinja v brzicah med strmim, v spodnjem delu mestoma skalnatim pobočjem Rahtelovega hriba (677 m) in 100–150 m oddaljeno ježo legenske terase.

4.6.2 Slovenjegraška kotlina in Spodnja Mislinjska dolina

V Slovenjgraški kotlini sta dve akumulacijski terasni tvorbi, legenska in dobrovska, in dve dolini, Mislinjska in dolina Suhadolnice. 5 km dolga in do 350 m široka legenska terasa, edinstvena v podnožju Pohorja, na severozahodnem robu kotline prestreže pet pohorskih potokov. Pod razvodnim hrbtom med Veliko Kopo in Kremžarjevim vrhom začnejo slemena in vmesni potoki Porodnica, Reka, Barbarski potok in Brezniški potok (ta z večjim Kremžarjevim pritokom) v n. v. med 600 in 700 m čim niže tem bolj zavijati iz začetne južne v jugozahodno smer, nato na legenski terasi v skupnem potoku Barbari proti severozahodu. Sleme pod Veliko Kopo začenja pod Vrhnjakovim vrhom (936 m) v kraju Golavabuka podobno zavijati in se zniževati proti zahodu in končno severozahodu; zahodno od cerkve sv. Jurija postane skalnata ježa legenske terase, ta je zgrajena iz sprijetega peska in na vrhu proda. V Zgornjem Legnu sta na koncu legenske terase ob potoku Svarina dve prodnati terasi, višja gozdnata in nižja večidel njivska, ki se edina sklenjeno nadaljuje še po Spodnjem Legnu in sega do Slovenj Gradca.

Slika 10: Slovenjgraška kotlina, pogled proti jugovzhodu (z n. v. 630 m). Levo pod (nevidnim) Pohorjem travniška terasa z naseljem Legen. Med terasnim koncem in pobočjem Rahtelovega hriba se v ožini ob Mislinji stikata zgornja in spodnja Mislinjska dolina. Zadaj gozdnato hribovje med Paškim Kozjakom (levo) in Uršljo goro.
Glej angleški del prispevka.

Legenska terasa se proti jugovzhodu hitreje dviguje kot sosednja aluvialna ravnica ob Mislinji, zato je terasa nad Šmartnim visoka že 55 m. Tam so v ježi mestoma razkrite miocenske gline, v Slovenj Gradcu pa se na vrhu ježe dvigata Tičnica (459 m) in Borovnik (454 m), zgrajena iz filitoidnega skrilavca. Iz njega je tudi južni rob sosednjega Rahtelovega hriba, ki ima tu kot pod vso Gmajno enako smer kot legenska ježa. Med Tičnico in cerkvijo sv. Jurija sega na Legnu prodno peščena naplavina ponekod čez vrh ježe, tako da se legenski metamorfni in dacitni prodniki posipajo proti 8–30 m nižji holocenski terasi ob Mislinji. Vrhnja legenska terasa je do današnje višine torej nastala istočasno z enako visoko prodnopeščeno akumulacijo ob Mislinji, saj bi se sicer potok Barbara že prej po bližnjici prelil čez ježo v Mislinjo. Višinsko razliko med terasama moramo torej pripisati mlajšemu tektonskemu ugrezanju v Mislinjski dolini (v ožjem smislu besede).

Severno od slemena Kremžarjev vrh–Velika Kopa ni podobnega enotnega zavijanja dolin kot na južnem pobočju nad legensko teraso. V povirju Velke in Plavžnice se slemena krajevno le hruškasto razširjajo (okoli farnega središča v Šemprimožu in sv. Antonu).

Nad legensko teraso in pod slemenom Kremžarjev vrh–Velika Kopa so otoki in pasovi dacitnih žilnin izbočeni proti jugu, a jim doline ne sledijo in jih predirajo enako kot vmesne filitoidne skrilavce in pri tem ohranjajo v višjih legah smer proti jugovzhodu in v nižjih proti zahodu. Omenjene razmere lahko razložimo v luči meritev recentnega tektonskega dvigovanja s pomočjo satelita (GMS) na Veliki Kopi. V letih 1996–2002 je ugotovilo odmikanje proti jugovzhodu s hitrostjo 0,53 mm letno (Vrabec, 2006). Žilnine smemo po vsej verjetnosti povezovati z nastankom proti jugovzhodu izbočenih dolin.

Labotska prelomnica poteka na geološki karti lista Slovenj Gradec poševno čez kvartarno legensko teraso (Mioč, Žnidarčič 1972). Če bi tudi tu sledila robu gorovja iz metamorfnih kamnin, bi morala zaviti okoli ježe legenske terase. Vzhodno od Golavabuke potekata ravni dolini Turičnice in Dovžanke spet skladno s strmcem pobočja naravnost proti jugu.

Vzhodno od Velike Kope so pod pohorskim hrbtom doline vse do Lobnice izbočene proti zahodu, niže pa bolj premočrtno usmerjene proti severovzhodu. Vzrok za izbočenje lahko iščemo v tektonskih premikih proti zahodu, o katerih poroča Premru (2005).

Slika 11: Legenska in dobrovska terasa.
Glej angleški del prispevka.

Dva kilometra oddaljena od legenske terase je 6 km dolga in vzporedna pliokvartarna gozdnata terasa Dobrova. Dviga se do 30 m nad dolinama Mislinje in Suhadolnice in njenim pritokom Jenino. Po geološki karti 1 : 100.000 lista Slovenj Gradec je Dobrova iz pliokvartarne peščene gline in glinastega proda, vmes pa so redkejši debeli prodniki iz pohorskih kamnin. Njen jugovzhodni del je do 2 km širok in na vrhu raven. Na njem sta zaselek Mislinjska Dobrava in letališče. V nadaljevanju proti severozahodu pa se nad dolino Suhadolnice na en kilometer zožena terasa Dobrova dviguje z zelo strmo ježo iz zgornjemiocenskih peščenjakov, laporja in konglomerata. Na nasprotno, mislinjsko stran pa se zlagoma znižuje v dno Mislinjske doline (v ožjem smislu besede).

Med legensko in dobrovsko teraso so pomembne razlike. V vsej 7 km dolg Dobrovi znaša naklon plečatega vrha 1,07 m/km, v legenski terasi pa 12 m/km. Podobni pa sta v tem, da so v njihovi ježi razgaljeni starejši sedimenti, filiti v legenski in zgornje miocenski v dobrovski.

Pohorski prodniki, ki so primešani v dobrovski terasi, so bili prvotno odloženi tudi na nižjem jugozahodnem robnem pohorskem pobočju. Pred leti je bila na njem v kolovozu med kmetijama Črnivnik in Mrzel v kraju Golavabuka pod pobočnim koluvijem razkrita krpa tega proda kot dokaz najvišje pleistocenske prodne akumulacije Mislinje v višini terase Dobrove (Gams 1976).

Med dobrovsko in legensko teraso je Mislinjska dolina (v ožjem smislu besede). V njej je pod legensko teraso aluvialna holocenska prodno-peščena ravnica, kjer je Mislinja po zadnji svetovni vojni po opustitvi mlinov in žag in med prestavljanjem naplavine, nakopičene pred jezovi, ob povodnji uhajala prek korita. Pri tem je v stari strugi odlagala debelejši prod, v novi, višji na holocenski ravnici pa je erodirala predvsem pesek in ilovico in s tem izvajala selektivno erozijo (slika 11 + 12). Reka je z njo znižala za 2–3 m višjo prodno teraso šmarškega polja niže Šmartna, v kateri je Mislinja v ledeni dobi med peskom odložila do 38 cm dolge pohorske prodnike. Med krajema Mislinja in Šmartno se v strugi Mislinje dolžina najdaljših prodnikov zmanjšuje dosledno skladno z zmanjševanjem rečnega strmca (Gams 1976).

Slika 12: Selektivna erozija Mislinje na holocenski ravnini: na levi sliki na holocenski ravnici ob povodnji po drugi svetovni vojni na novo erodirana struga.
Glej angleški del prispevka.

Slika 13: Na desni stara struga, v kateri so vidni preostali debelejši prodniki, potem ko je drobnejše delce odnesla povodenj. Nova regulacije je reko vrnila v staro strugo.
Glej angleški del prispevka.

Mislinjo je na koncu Spodnje Mislinjske doline do n. v. okoli 395 m s prodom iz Celovške kotline zajezila Drava s prodno teraso v (mežiški) Dobrovi (Kieslinger 1929; Gams 1995). Nastalo jezero je segalo do Slovenj Gradca. Tedanjo jezersko gladino je na koncu legenske terase z naplavino dvignil pritok Barbara na 409 m, to je do višine osrednjega mesta v okolici cerkve. Na zahodni strani je srednjeveško mesto varovala strma ježa na koncu terase šmarškega polja in nad dolino zajezene Suhadolnice. Teraso šmarškega polja je naplavila ledenodobna Mislinja. Kot so razkrile novejša razkopavanja v mestu, je Mislinja tedaj na mestnem ozemlju na koncu terase pred jezerom odlagala drobnejši prod in več peska in sive ilovice.

Slika 14: Spodnja Mislinjska dolina (slikana od jugovzhoda). Desno od nje severozahodno Pohorje in za njim Košenjak (1522 m). Raven potek, dokaj enakomerna širina in nekdaj poplavno dno izpričujejo značaj ugrezajočega se tektonskega jarka. Dolina se nekoliko razširi na koncu pri Otiškem vrhu. V višini würmskega jezera (okoli 400 m n. v.) je (desno) pohorsko pobočje zložnejše in na terasi v Pamečah bolj poseljeno.
Glej angleški del prispevka.

Podobne razmere kot na Legnu so bile v dolini Suhadolnice. Ob višku würma je tudi ta potok na izstopu iz ozke doline Suhi dol v vaseh Srednje in Spodnje Podgorje odložil prodni vršaj – Podgorsko polje v n. v. med 425 in 440 m. Iz njega je reka izpirala drobnejše frakcije in jih odlagala na robu jezera pred mestom Slovenj Gradec. Od tega nasipa je po odvažanju gramoza ostala le ozka terasa v predmestju pod Štibuhom. Zdaj je tam po dolgotrajnem izkoriščanju gramoza ostal le še kratek pomol, na katerem je tudi novo slovenjgraško pokopališče. Peščena in drobna prodnata naplavina v njem je podobna tej v nekdaj mnogo večji delti Meže na spodnjem koncu istega jezera pri Šentjanžu, kjer je zaradi izčrpanosti odkopavanje gramoza prav tako prenehalo. Končna dolina Suhadolnice med krajem Raduše in legensko teraso je rahlo izbočena proti zahodu in razmeroma široka. Da je nastala kot ločnati tektonski jarek, sklepamo tudi po domnevnima prelomnicama, vrisanima na geološki karti lista Slovenj Gradec.

Slika 15: Pri Otiškem vrhu je pleistocenska prodna dravska akumulacija zajezila pohorski potok iz Bavhovega grabna. Manj karbonatnih in več metamorfnih prodnikov in peskov v njej pomeni manjšo trdnost. Zato je po hudem nalivu l. 1986 nastali zemeljski plaz poškodoval hiši in zasul lastnico.
Glej angleški del prispevka.

Na stiku šmarške prodne terase in terase Dobrove je površje rahlo znižano in tam vode s terase zbira potok Homšnica. V njenem zgornjem delu so nekdanji železniški nasip in sedanja glavna cesta preprečili njene odtoke proti bližnji Mislinji. Zdaj umetno podaljšani potok nižje zato še pogosteje poplavlja (Gams 1992).

Razmeroma slabo poznavanje geologije Slovenjgraške kotline je izpopolnil Geološki zavod Slovenije s 1000 m globoko, za črpanje toplice neuspešno vrtino blizu opuščene mestne toplarne na severnem koncu dobrovske terase. Južno od vrtine je na vrhu te terase edina večja ravnica v n. v. 450 m, ki se strmo dviga nad Curavo vasjo. S strmo ježo se naokoli znižuje proti jugu, severozahodu in severu, prav tu je bila omenjena vrtina. Po elaboratu Geološkega inštituta (Poročilo 1990) je vrtina na terasi Štibuha razkrila (poenostavljeno):

- 2–56 m: prod z glinastim vezivom; pliokvartar,
- 57–208 m peščenjaki, plasti konglomeratov, laporji in meljevec; miocen,
- 209–264: svetlosiv dolomit; anizij ali zgornji trias,
- 265–378: temnosiv dolomit, glinasti skrilavec in tuf; paleozoik, spodnji trias,
- 379–1000 m: metamorfni kompleks; paleozoik.

Tukaj je poskus, iz sestave izvrtine časovno razporediti faze geomorfološkega razvoja trikotne slovenjgraške kotline. Triasni sedimenti, predvsem 169 m debel temnosivi triasni dolomit, so narinjeni na paleozojske metamorfne kamnine 400 m od severnega roba podkaravanških zgornjemiocenskih skladov, pod katerimi je v bližnjem Podgorju in v sosedstvu dokazano narivanje Karavank proti severu. Tako narivanje v podgorju Uršlje gore je dokazalo tudi izkopavanje premoga v Lešah.

151 m debeli zgornje miocenski skladi nakazujejo intenzivno ugrezanje Slovenjgraške kotline. V Dobrovi so razkriti samo v ježi terase ob dolini Suhadolnice in njenega pritoka Jenina, sicer pa je iz njih širok pas v podolju pod Karavankami in pod Pohorjem do Slovenskih Konjic. V 5 km dolgem pasu so ostali tudi na vrhu severozahodnega Pohorja v porečju Reke. Potrjuje, da so bili ivniški skladi Kobanskega čez Pohorje povezani z enako starimi pod Karavankami (Sölva 2005). Zahodno od Starega trga je v njih najnižji, sto metrov visok preval v gričevju, ki povezuje kotlino z dolino Selčnice. Tu čez je domnevno potekal rečni odtoka iz kotline v času, ko zgornje in spodnje Mislinjske doline še ni povezala enotna reka. 54 m pliokvartarnih sedimentov v vrtini nakazuje nadaljevanje ugrezanja kotline.

4.7 Severozahodno Pohorje

Severozahodno Pohorje sedimentno pripada kobanski geološki seriji in je litološko najbolj pester del Pohorja. V višjih legah v porečju Trbonjske Reke zavzemajo ivniški skladi 5 km dolg otok, sicer pa so zastopane vse ostale pohorske kamnine. Relief je tudi na razvodju kopast, razgiban, brez premočrtnega razvodja med

Mislinjo in Reko in brez karakteristik ostalega gorovja in do vrha poseljen. Hribovje se med Mislinjo in Reko razširja proti severozahodu, kjer ga nad Dravsko dolino končuje dolgo in nerazčlenjeno sleme.

4.8 Pohorska planota

Pohorska planota je okoli 10 km^2 velika uravnava na vrhu Pohorja v n. v. med 1150 in 1300 m. Nastati je mogla v času enako visoke okoliške erozijske baze. To je lahko vzdrževala na njeni severni in južni gorovja odeja zgornje miocenskih skladov, na vzhodni strani morebiti tudi območje muskovitno biotitnega gnajsa, iz katerega je ostal osamelec Veliki vrh (1344 m). Lobnica, v katero zdaj odteka večina vode s planote, ni bila sposobna intenzivnejše zadenjske erozije, ker je bil njen izliv v lovrenškem podolju prvotno višji, dokler ga ugrezanje Dravske doline proti zahodu še ni doseglo. V porečju Bistrice erozijo hromijo pičle padavine. Sicer pa je na razvodju rek erozija na splošno slabša. Na planoti je razvodje Plesiščice kot pritoka Radoljne, Lobnice in Oplotnice.

Slika 16: Gozdnati vzhodni rob pohorske planote, fotografiran z Rogle. Desno zgornji konec jarka Oplotnice in Veliki vrh (1344 m), levo v ozadju sleme Mariborskega Pohorja.
Glej angleški del prispevka.

5 Intenzivnost geomorfoloških procesov

Kemična erozija močno zaostaja za denudacijo in erozijo. Zmerno do močno kisla zemlja na metamorfnih kamninah ima v gornjem horizontu pH 4,6 do 5,5, na severovzhodu hribovja deloma pod 4,5, na Zahodnem Pohorju 5,6 do 6,5, tu je tipa rendzina (Grčman 2004). Na andezitu je ranker s plitvejšo zemljo. V kisli prsti bi bili dobri pogoji za kemično raztapljanje, a je karbonatov malo; kar jih je, so večinoma drobni vložki v metamorfnih kamninah. Magmatske in metamorfne kamnine vsebujejo v povprečju le 1,5 do 4 % MgO (Hinterlechner-Ravnik 1973; Faninger 1973; Mioč, Žnidarčič 1972).

Slika 17: Kamni iz granodiorita v kolovozu zahodno in 30 m nižje od Jezerskega vrha (1537 m) nimajo ostrih oglov in nimajo gladke površine. Granodiorit vsebuje 2–3 % aluminijevega oksida (Mioč, Žnidarčič, 1972).
Glej angleški del prispevka.

Slika 18: Zglajeni jajčasti balvan, fotografiran v 50. letih 20. stoletja ob takrat še ne asfaltiranem cestišču 2 km severozahodno od Šmartna na Pohorju. Bil je znan okoličanom, a je bil nato odstranjen. S tem je ostal nedognan proces nastanka njegovih gladkih površin.
Glej angleški del prispevka.

Metamorfne kamnine in žilnine na Pohorju prekriva tudi na strmem pobočju debela peščena prst z malo glinenimi primesmi. Zato dobro prepušča padavinsko vodo do skalne podlage. Njeno erozijo zavira na površju gosti splet korenin trav in drevja, zdaj predvsem smrek, ki pokrivajo površje. Da so bile tudi pred fazo smreke v geološki preteklosti korenine listopadnega drevja plitvo pod površjem, sklepamo po tem, ker je tam največ humusa. Do jarkovne erozije je nedavno prihajalo na pobočju tam, kjer je človek v kolovozih za spravilo lesa uničil krovno rušo in korenin. Odvažanja lesa po strmini je bistveno manj, odkar so izgradili avtomobilske ceste. Pod njimi še nastajajo erozijski žlebovi predvsem pod reliefnimi depresijami, v katerih se zbira talna voda, kjer jo asfaltna cesta prisili k površinskemu toku. Do jarkovne erozije v kolovozih pa prihaja še zdaj na zložnih pobočjih kvartarnih teras. Na strmih pobočjih višjih kvartarnih teras v Dravski dolini nastajajo usadi in po nalivih tudi zemeljski plazovi (Gams 1987). Prelaganje prsti navzdol ob oranju na pobočnih njivah je nekdaj tudi na Pohorju zapustilo usade in strme spodnje robove, ki pa so jim doslej v glavnem zmanjšali strmino. Seveda pa je ponekod tudi na Pohorju, tako kot drugod (gl. Komac 2005, sl. 4 in 5) opazen povečan vpliv strmine na erozijo, zlasti na strmih travnikih in redkih preostalih njivah (Gams, 1959). Usadi so pogostejši na drobnozrnatih sedimentih ivniških skladov. Geološka karta 1 : 100.000 lista Slovenj Gradec ima vrisanih le šest zemeljskih plazov, vse v gričevju med Lovrencem in Falo, kjer je zaradi napredujočega Selniškega jarka kamnina tektonsko zrahljana.

Hitrost recentnega navpičnega dvigovanja površja na najvišjem Pohorju, izračunana iz ponovljenih geodetskih nivelmanov, je po Jovanoviću (cit. v Premruju 2005, 338) v Sloveniji večja samo v Triglavskem pogorju in v osredju Kamniških Alp. Na Pohorju znaša do 1200 m nadmorske višine 4,3 mm in višje 6 mm na leto. Iz teh podatkov lahko izračunamo starost dviganja gorovja ob predpostavki, da je bilo dviganje enakomerno ves čas in se je začelo na višini 300 m n. v. Starost dviganja gorovja je po tem izračunu okoli 260.000 let, kar bi pomenilo začetek v riški ledeni dobi. Računati pa je treba s počasnejšim dvigom na začetku in z neenako hitrostjo dviganja.

Doslej je na Pohorju meril odnašanje hribinske gmote, a brez suspenza v vodi in rečnega proda, le Hidrometeorološki zavod Slovenije v letih 1971 in 1972, in sicer na Hočkem potoku in v reki Bistrici. Ugotovitvam je podaljšal veljavo tako, da je po okoliških padavinskih postajah ugotovil: povprečno letno pogostnost tako suhih let kot je bilo leto 1971, in pogostost tako mokrih let, kot je bilo leto 1974, in tudi, kolikšno je povprečno število dni s padavinami nad 40 mm in kolikšno je število dni z več kot 20 mm padavin na dan (izmerjenimi v dobi 1961–1972). Kolbezen (1979) navaja, da je suspenza v merjenih potokih malo in malo je v strugah tudi proda. V petih porečjih znaša na tej podlagi izračunano povprečno zniževanje površja med 0,11 in 0, 21 mm na leto. V porečju Hočkega potoka, ki je iz gnajsa in kjer so zadnja leta v povezavi s turizmom na mariborskem Pohorju zgradili precej hiš, vrtov in drugega, znaša izračunano zniževanje 0,27 mm, v porečju Bistrice le 0,02 mm/letno. Iz tega sledi, da bi se površje v milijon letih v povprečju znižalo za 110 m, v porečju Hočkega potoka za 270 m, v porečju Bistrice za 20 m. Pri tem ni upoštevan transport proda, ki je bil močno pospešen v glacialnih dobah.

Po preglednici dosedanjih meritev v Sloveniji je izmerjena erozija Hočkega potoka podobna najvišji dotlej izmerjeni v Sloveniji in sicer za vinograd (v porečju Rokave). Navedena vsota za Bistrico pa je v višini povprečne erozijske izgube prsti na kmetijskih površinah Slovenije (Komac, Zorn 2005, 79). V ozkem vrhnjem porečju Bistrice je na vzhodnopohorski nagnjeni planoti v granodioritnem ozemlju površje bolj gozdnato in za hribovje skladno z navedeno meritvijo nadpovprečno zložno.

Zgoraj omenjeni izračuni ne upoštevajo transporta raztopljenih mineralov, ki ga je bilo v toplejšem pliocenu več. Razen amfibolitov je na Pohorju rahlo topnih še nekaj drugih mineralov (npr. eklogit – Mioč, Žnidarčič 1972, 20). V povirju potokov Polskave so pasovi marmorja, katerega odlomljene skale se valijo po pobočju (Žnidarčič, Mioč 1988). Korozijo na Vzhodnem Pohorju zmanjšuje malo padavin (1179 mm, Šmartno na P.), ki jih letno izhlapi 650–700 mm, tako da jih preostane le 529 do 579 mm za odtok. Od vseh delov Pohorja je tudi zato vzhodnopohorsko pobočje najbolj ohranilo višino in podobo tektonsko poševno nagnjene planote

Erozija je naraščala skladno z dvigovanjem Pohorja. Ob dejstvu, da zdaj velik del erozije povsod odpade na izkrčene, negozdnate in kmetijske površine, je izračunavanje erozijskega zniževanja iz sedanjih razmer vprašljivo za ugotavljanje zniževanja reliefa za dobo pred naselitvijo človeka. Gostejša naselitev se je na južnem Pohorju pojavila v neolitu in eneolitu, to je 7000–3500 let pr. n. št. (Šercelj 1996, 72).

Preglednica 1: Strmec izbranih vodnih tokov in padavine

vodni tok	nadmorska višina izvira	višina izteka	dolžina v km	strmec v m/km	letne padavine v mm	obdobje	vremenska postaja
Polskava	1000	294	14,5	55,6	1179	1961–1990	Šmartno
Devina	830	277	9,5	66,6	1043	1961–1980	Slovenska Bistrica
Oplotnica	1420	379	15,0	70,0	1174	1961–1990	Tinje
Hudinja	1380	482	9,5	94,5	1517	1961–1990	Rogla
Paka – Polenica	1280	600	3,6	188,0	1245	1961–1990	Mislinja
Mislinja – Mislinjski jarek	1440	605	19,5	69,1	1245–1527		Mislinja, Rogla, podatki za 10 let
Turičnica	1325	560	6,0	126,7	1245	1931–1960	Mislinja
Lakužnica	695	370	2,8	420,0	1334	1931–1990	Gradišče
Vuzeniška Reka	935	335	10,5	57,1	1132	1961–1990	Šemprimož
Radoljna	1460	400	12,0	88,3	1627	1925–1940	Stara Glažuta
Črnava – Lobnica	1260	1100	3,6	44,4	1627	1925–1990	Stara Glažuta
Lobnica*	1100	275	11,2	73,7	1627	1925–1990	Stara Glažuta
Mislinja – Mislinja	600	332	21,0	12,8	1156	1961–1990	Šmartno pri Slovenj Gradcu
Drava med Dravogradom in Falo	337	288	(49)	1,09	1135	1961–1990	Dravograd

* Začetni pritoki Lobnice na pohorski planoti imajo bistveno manjši strmec kot reka na severnem pobočju. Strmec pritoka Črnave do sotočju z Majlandom je 36 metrov/km, toka Lobnice na strmem pobočju do izliva v Dravo pa 96 metrov. Dolžina toka pomeni zračno razdaljo med začetkom občasnega ali trajnega toka in robom gorovja.

Na strmec pohorskih vodnih tokov, ki nakazuje erozijski potencial, vplivajo mnogi dejavniki, med njimi tudi količina letnih padavin in hitrost tektonskega dviganja gorovja in (ali) ugrezanja kotlin.

Iz preglednice sledi, da je strmec kot pomemben dejavnik erozije odvisen v veliki meri od dolžine toka (in s tem posredno tudi količine vodnega pretoka). Kratek tok pomeni velik strmec. Strmci so največji v Polenici, to je v povirju Pake, in na severnozahodnem Pohorju pri kratki a hudourniški Lakužnici, ki je na dnu Spodnje Mislinjske doline z naplavinami v obliki izgona še pred desetletji ogrožala cestni promet.

Slika 19: Grafični prikaz strmcev izbranih pohorskih potokov.
Glej angleški del prispevka.

Iz povedanega razloga ima majhen strmec tudi kratek potok Črnava. Turičnica in Dovžanka imata velikega zaradi neotektonskega ugrezanje Slovenjgraške kotline in hkratnega dviganja Pohorja. Velik strmec ima Lobnica (brez pritokov s planote). Če pri Oplotnici odštejemo pritok izpod Rogle, ima med Jurgovim in krajem Oplotnica strmec 68 m/km, kar je manj kot pri pobočni Radoljni, ki ima več padavin. Majhni strmec Mislinje v zgornji in spodnji Mislinjski dolini je poleg večje vodnatosti tudi posledica neotektonskega ugrezanja doline.

Analiza oblike porečij, ta so vrisana na karto nadmorskih višin, kaže nedvoumno razliko med širokimi in dolgimi na severnopohorskem pobočju med dolinama (Trbonjske) Reke in Oplotnice, in tistimi na mlajšem južnopohorskem pobočju. Doline so najožje nad spodnjo Mislinjsko dolino, ki se je v pliokvartarju v Spodnji Mislinjski dolini ugrezala vzdolž Labotske prelomnice, in v Slovenjgraški kotlini v nadaljevanju podkaravanškega jarka oziroma Hotuljskega podolja. V doliškem podolju so erozijo pohorskih potokov pospešili mladi predorni dolini v Hudi luknji in pod Vitanjem, prej pa je visoko erozijsko bazo vzdrževal Paški Kozjak. Območje ozkih dolin zajema še nagnjeno vzhodnopohorsko planoto in Mariborsko Pohorje nad Selniškim podoljem. Severno od osrednjega Pohorja prevladujejo ozka porečja dravskih pritokov znotraj Obdravskega Pohorja.

5.1 Pleistocenska poledenitev na Pohorju

O pleistocenski poledenitvi vršnega Pohorja do nedavna ni bilo trdnih dokazov. Melik (1957, 36) je zapisal, da so »… *barja z jezeri tu* (o. p.: mišljene so položne lege ob vrheh na pohorski planoti in hrbet do Ribniškega vrha) … *nastala kot učinek diluvialne poledenitve; ob vrhovih so se v položnih legah razvili kratki bočni ledeniki in pod njimi so se izoblikovale plitve pobočne kotanje in v njih so se razvila jezerca in barja … Nemara so k izoblikovanju tega površja nemalo pripomogli tudi periglacialni procesi* …«. Po Kunaverju (2000, 49) so »*pod Lovrenškim barjem na pobočju grape Radoljne manjše, krnicam podobne izdolbine, ki bi jih lahko izdolbel led* …«.

Slika 20: Grafična predstavitev pohorskih ledenikov.
Glej angleški del prispevka.

Melikove trditve in Kunaverjeve domneve so bile potrjene na geomorfološkem posvetovanju na Pohorju 2005 (Gams, Kunaver, Natek 2005). K. Natek je ugotovil moreno iz grobih skal v n. v. 1220 m ob cesti približno 50 m nad zgornjim tokom reke Radoljne. V kotanji, to je v nekdanjih ledeniških vratih, je bilo prvotno močvirje, dokler je niso ribiči iz Lovrenca na Pohorju zajezili in dvignili odtok ter tako ustvarili ribnik Jezerc (na zemljevidih je najti tudi ime Ribnik). Na obeh straneh kotanje se od pobočja proti jezu v obliki klešč znižujeta in hkrati zbližujeta velika obojestranska nasipa, v njem pa so tudi do meter in več dolge skale. Nad Jezercem je v gozdu na pobočju pod slemenom Mraveljskega hriba (1480 m), ki je nedaleč od severnega konca Lovrenškega jezerja, v strmini pod n. v. 1400 poglobljena uleknina, dolga okoli 600 m. Pod n. v. 1300 m je posejana z večjimi skalami, više pa je nad obema ledenikoma gladko, nerazčlenjeno pobočje do vrha slemena.

Kilometer južno od Jezerca je na višjem, gozdnatem pobočju v n. v. 1271 m še ena morena. Njen lok iz skalnatih balvanov je visok okoli 5 m in je na vrhu večjega periglacialnega vršaja, ki se mu niže dolinska cesta v loku izogne. Pobočni potok je polkrožni morenski nasip z grapo prekinil na desnem boku. Več metrov dolgi balvani, iz katerih je morena sestavljena, se vidno ločujejo od nižjega drobnejšega periglacialnega drobirja.

Odgovor na vprašanje, zakaj se v okoli 70 m široki strmi uleknini na pobočju nad Jezercem nakopičene velike skale niso odvalile v morensko kotanjo in jo zapolnile, nudi potek zadnje ledene dobe. Med würmsko poledenitvijo je bilo na začetku več padavin in v gorah več snega. Med leti 35.000 in 12.000 pa je v Srednji Evropi zavladalo suho podnebje z 10 °C nižjimi temperaturami in okoli 500 mm nižjimi padavinami (Frenzel, Velicko 1992). Zato je na Pohorju ledeniško preoblikovanje površja zamenjalo periglacialno. V tej dobi so lahko nastale nad Jezercem skale, ki so jim kmalu nato debla gozdnih dreves preprečevala, da bi se skotalile. Nad južno moreno je uleknina plitvejša in ožja, prav za prav je bolj poglobljena in razširjena daljša rečna dolina potoka, ki izvira više na pobočju in teče še zdaj trajneje. Tu kot v širši južnejši okolici priteka v n. v. okoli 1400 m več obdobnih potokov iz spodnjega roba pobočne odeje iz grobega periglacialne drobirja. Majhna poglobljenost uleknine nad južno moreno kot je nad Jezercem je tudi posledica kratkotrajnejšega obstoja ledenika.

Slika 21: Malo pod n. v. 1300–1400 m se nad južno ledeniško uleknino začenja periglacialna gruščnata odeja, izpod katere tu in dalje proti jugu izvirajo številni potoki, ki so niže svoje struge ponekod poglobili do skalne podlage.
Glej angleški del prispevka.

Nad globeljo obeh ledenikov je do 150 m visoko, zdaj travniško pobočje, ki ga niso razbrazdali glacialni niti periglacialno procesi.

Vzrok, da je bilo poledenelo samo vzhodno pobočje na severnem koncu 5 km dolgega, domala enako visokega slemena severozahodno od Ostruščie (1498 m), so domnevno večje snežne padavine v bližini prevala Šiklarica (1299 m).

Sestava periglacialnega drobirja na zahodnem pobočju slemena z vrhoma Lasina (1412 m) in Pesek (1423 m) je najlepše razkrita v novem cestišču, ki se odcepi od križišča lokalne ceste, ob kateri je niže Jezerc, z glavno cesto iz Lovrenca. Makadamska cesta poteka po dolinskem pobočju desnega pritoka Radoljne. Skraja so v sveže razkritem drobirju do en meter debeli kamni enake zaobljenosti, kot jo imajo tisti v bližnji strugi Radoljne. To se pravi, da je bila tedaj do te višine zgornja dolina Radoljne zasuta s prodom, nanj pa je bila odložena vedno debelejša odeja periglacialnega peska, ki v višji legi leži neposredno na skalni podlagi. Kjer je južneje na pobočju peščena zemlja vlažna, je pesek ponekod krioturbatno naguban. Proti jugu po dolini Radoljne dvigajoča se cesta proti koči na Pesku kmalu razkriva vse krajše prodnike. Med Mulejevim vrhom in Sedlom Komisije je obsežna, nekdaj v travnike spremenjena terasa iz peska, po katerem ima tudi ime Koča na Pesku.

Slika 22: Južneje in višje je nad novim kolovozom na zahodnem pobočju slemena Lasina (1412 m)–Pesek (1423 m) razkrita domnevno krioturbatno zveržena peščena preperina.
Glej angleški del prispevka.

Da sta ledenika nastala samo na vzhodnem pobočju severnega konca slemena z Lovrenškim jezerjem na vrhu, je verjetno posledica lokalnih podnebnih razmer. Globoki dolini Radoljne in pritoka Plesiščica za nekaj kilometrov daleč odmikata vršno pobočje Pohorja in združujeta pozimi prevladujoče severovzhodne hladne zračne gmote iz Panonske kotline, kjer je bila v najhladnejših obdobjih pleistocena puhlična stepa, proti jugozahodu, to je proti najnižjemu prevalu Komisiji, v smeri proti Sredozemski kotlini. Hudi nalivi v porečju Radoljne še zdaj povzročajo poplave in škode (Šeme 1994). Na Komisiji na severnem koncu Mislinjskega jarka ni prišlo do nastanka ledenika zaradi prenizke višine (1299 m). Šiklarica med Jezerskim vrhom (1537 m) in Planinko (1420 m) je najnižji preval v 18 km dolgem hrbtu Pohorja med Malo Kopo in Roglo. Njej je bila najbližja vremenska postaja Stara Glažuta, ki je namerila največ letnih padavin na Pohorju (1925–1940: 1627 mm), to je več kot na višji Rogli nad južnim robom pohorske planote (1517 mm).

Slabo zaobljene, do pol metra dolge balvane je Radoljna odlagala tudi na območju naselja Lovrenc na Pohorju, ki je s poslopji in obdelovalnimi površinami vred na 2,5 km dolgem prodno peščenem vršaju. Žal v nekdanji gramoznici nad pritokom Slepnica niso več razkriti v vsem pohorskem podgorju najdaljši prodniki.

Slika 23: 2,5 km dolgi fluvioglacialni vršaj in na njem nad terasno ježo razpotegnjeno naselje Lovrenc na Pohorju, slikan od SV. Nad odmaknjenim severnim pobočjem v povirju Radovne se oblaki, kot je videti, začenjajo najprej zbirati
Glej angleški del prispevka.

5.2 Šotišča in jezera na Pohorju

Druga pohorska posebnost so šotišča na pohorski planoti. Območje šotišč je med vrhovi Adamov vrh (1260) in Pesek (1427 m). Med mokrotnimi dolinicami so oble vzpetine, kjer je v cestnih golicah pod prstjo lokalno razkrita periglacialna gruščnata podlaga, dokaz, da so na planoti v pleistocenskih hladnih razdobjih vladali periglacialni geomorfološki procesi.

V takih razmerah pobočni grušč lahko na prehodu na ravnico dvigne talno vodno gladino in povzroči zamočvirjenost. Po drugi hipotezi naj bi bila zamočvirjenost posledica t. i. periglacialnih nivacijskih kotanj, ki so v sedanjosti pogoste v subarktični klimi (Gams, Kunaver, Natek 2005). Toda te so večje od teh na Pohorski planoti. Na podrobnejšem zemljevidu lahko ugotovimo močvirna šotišča v pasovih tudi na ravnicah. Take primere najdemo zlasti na severozahodnem in vzhodnem robu planote. Ponekod je vzdolžni profil potočkov na mahovnati podlagi razčlenjen na odseke med nekaj pedi visokimi jezovi iz nakopičenega mahu, pod katerimi so tolmuni. Največja šotišča so v kotanjastih začetkih stekajočih se potočkov. Tam jih je najbolj spremenil človek. Močvirje Tiho jezero ima na zemljevidih tudi ime Falski ribnik, kar kaže na antropogeno zajezitev odtoka, tako kot so lovrenški ribiči pred stoletji zajezili močvirje v že omenjeni morenski kotanji Jezerc. Z zemeljskim nasipom so zajezili tudi močvirje v Črno jezero, da so dobili več vode za splavljenje lesa po riži v dolini Lobnice na severnem pobočju gore (Gams, 1962). Splošna zamočvirjenost in s tem pojav šotišč na planoti narašča v smeri proti severozahodu, to je proti Klopnemu vrhu, to je v smeri naraščanja količine padavin.

Slika 24: V zamočvirjeni kotanji z imenom Radovina sta na pohorski planoti podrti smreki v šotni podlagi razkrili ostanke prejšnjega drevesa. Kljub zavetni leti med okoliškim gozdom vetrolomi tu na močvirju očitno nimajo težkega dela.
Glej angleški del prispevka.

Toplejše pliocensko in holocensko borealno podnebje z listavci za šoto najbrže nista bili ugodni, ker listavci porabijo več vode kot sedanji iglavci. Nedognan je vpliv človeka na spremembo gozda. Očitno se je zamočvirjenost povečala po sedanji prevladi iglavcev, še zlasti po poseku gozda in po paši in po prvih požigih gozda, ki so jih povzročile strele ali pastirji. Nekdaj so Pohorci gozd na vrhovih požigali za pašo. Zaradi oddaljenosti vršne planote od dolinskih prometnih poti se lesa ni splačalo podirati in voziti v podgorje vse do konca 19. stoletja. V 18. in 19. stoletju je ceneni les po vrhu gorovja za izdelavo oglja pritegnil fužine (v Mislinji in Lovrencu) in na severnem pobočju zlasti mlajše glažute. Malo pod Pohorsko planoto je delovalo šest glažut, ki so rabile ogromno oglja. Na planoti so na golosekih zapustile zatravljena in zamočvirjena zemljišča. Tam in v drugih redkih okoliških gozdnih sestojih so pasli živino zlasti kmetje z Vitanjskega in Zreškega Pohorja. V fevdalni dobi in pozneje je bila Pohorska planota v lasti Falske graščine, ki je dala na primer v letu 1886 v najem čez 600 hektarjev zemljišč za pašo 678 goveda. Ko je graščina hotela pašo pozneje preprečiti, saj je povečevala zamočvirjenost, so se kmetje sklicevali na staro pravico (Hiltl 1993). Pravda med njimi in sedanjo gozdno upravo še vedno ni povsem končana. Po vrhovih slemen na obeh straneh Črnega vrha (1543 m), Jezerskega vrha (1537 m) in vzhodno od Šiklarice gozd še ni zarasel gorskih travnikov, ker so na njih do nedavna še pasli kmetje iz lovrenške okolice. Na zemljevidih sta na vrhu slemena vzhodno od Šiklarice vpisani imeni Planinka in Črna mlaka, v slednji so napajali živino. Povečano znanje o šotiščih na pohorski planoti lahko pričakujemo od bodočih modernih starostnih datacij šote.

Pohorska posebnost so tudi **Lovrenško** in **Ribniško jezerje**, obojno na vrhu barja. Na obeh so izvedli palinološke raziskave. Na Lovrenških jezerih je Budnar (1958) pod 240 cm debelo šoto ugotovila 60 cm debel sloj peska in da je barje začelo nastajati v holocenski zgodnji topli ali borealni dobi ozioma dobi leske pred približo 6000 leti. Z metodo radioaktivnih delcev je bila sedimentom pod površjem v globini 14 cm v novejšem času pripisana starost sto let glede na enakomerno rast vrhnje šote (Brancelj, 1999). Bolj temeljite pelodne raziskave so prinesle naslednji razvoji razvoj po plasteh: –260–240 cm: leska, smreka in jelka, –240–220 cm: bukev, jelka, smreka, –220–150 cm: bukev, jelka, smreka, –150–130 cm: smreka, jelka, manj bukve, 130–60 cm: šotno blato, –60–0 cm: šotno barja, jezerska usedlina, narašča pelod smreke. Začetek usedlin je bil predvidoma v atlantski fazi pred 7000–8000 leti (Culiberg, 1986). Ista avtorica je objavila pelodno analizo tudi za Ribniško jezero: globina 300–290 cm: šota s tonalitnim drobirjem, smreka in preko 50 % leske, 290–255 cm: leskova faza, jelša, 255–200 cm: narašča jelka in zlasti bukev, gaber in pri 245 cm trave, starost 4080 ± 130 let, 200–100 cm: porast smreke in jelke, bukev, 100–50 cm: okrepljeni smreka in jelka, 50–0 cm: porast borovca.

Po teh meritvah je Lovrenško jezerje staro okoli 3720 in Ribniško barje okoli 4080 let. Upad deleža bukve in jelke je pripisan vplivu človeka. Skupna ugotovitev: obojno barje ni nasledek ledene dobe, saj se akumulaciji začenjata v atlantiku (7000–8000 let) ali kasneje (Culiberg, 1986). Na Pohorju so bukovo-jelovi gozdovi prevladovali še pred 7000 leti in smreka naj bi prevladala šele v novejšem času. Lokalni vplivi človeka na pohorski gozd so zaznavni od neolita naprej (Culiberg, M., A. Šercelj, 2000). Ugotovitev, da je šota začela nastajati v holocenski zgodnji topli ali borealni dobi, je presenetljiva, saj je pri višji temperaturi večja evapotranspiracija rastlinstva, kar pomeni manj talne vlage. Toda vrtine so razkrile v podlagi več črnkastih humoznih plasti, domnevno nastalih v jezerih pred okoli 3720 leti na Lovrenškem in v Ribniško barje okoli 4080 leti Upad deleža bukve in jelke je pripisan vplivu človeka. Obojno barje torej ni nasledek ledene dobe, saj se začenjata v atlantiku (7000–8000 let) ali kasneje (Culiberg, 1986).

Lovrenško in Ribniško jezerje nimata povsem enake lege. Prvo je na severnem koncu oblega slemena Rogla–Planinka v višinah malo nad 1500 m. Pesek v podlagi bi brez gozdne ali travne zarasti, kot je bilo v času poledenitve, odpihnil veter. Do okoli 40 cm globoke kotanje Lovrenških in Ribniških jezer so na samem razvodnem hrbtu, kjer je podtalni vodni dotok iz šotne okolice možen iz vseh strani. Zaradi take lege jezera poleti ne presušijo. Na ravnici je tudi največje, Ribniško jezero, a je, v razliko s Šentlovrenškim jezerjem, na okoli 150 m široki planotici vzhodno od Jezerskega (Ribniškega) vrha (1537 m), tako da je lahko na južni strani med ruševjem še nekaj manjših vodnih »oken« (Gams 1962). Na vrhu slemena Rogla (1517 m) – Planinka zamočvirjenost narašča v smeri naraščanja količine padavin, to je proti severu. Nad Šiklarico je zamočvirjeno proti vzhodu se dvigajoče travniško sleme z imenom Planinka, kjer je na zemljevidih označena Črna mlaka.

6 O posebnosti raziskovanja geomorfologije v gorovju pohorskega tipa.

6.1 Slemena in doline kot indikatorji geomorfološkega razvoja

Podolžni prerezi slemen med sosednima dolinama so bili narejeni za presojo, v koliko še odražajo izhodiščne površine, v katere je erozija poglobila doline. Na neskalnatih tleh se padavinska voda sprva ne odteka površinsko, temveč pod površjem skozi preperino in tako vrh slemena znižujejo le pedološki procesi. Odnašanje kamninske gmote se začenja nižje na pobočju, kjer so izviri občasnih in trajnih vodnih tokov in se uveljavi globinska erozija.

Slika 25: V zgornjem Legnu je v dolinskem dnu, ki poteka vzdolž zmičnega preloma, kamnina tektonsko zdrobljena in neporaslo pobočje nestabilno.

Glej angleški del prispevka.

Vrhovi slemen iz metamorfnih kamnin potekajo precej bolj ravno kot tisti iz ivniških skladov med Ribnico in Vuzeniško kotlino, ker so iz petrografsko mešanega gradiva (glej podolžne prereze slemen). V spodnji preglednici so upoštevani le vzorčni primeri za geomorfološke enote.

Preglednica 2: Dolžine in strmec izbranih pohorskih slemen, značilnih za gorovje.

pohorska regija	začetek slemena (nadmorska višina v m)		konec slemena (nadmorska višina v m)		dolžina (km)	strmec (m/km)
severozahodno Pohorje	Kremžarjev vrh	1164	Dravče	380	12,6	62,2
Lovrenško Pohorje	Klopni vrh	1340	Lovrenc	436	8,0	113,0
Vzhodno Pohorje	Peršetov vrh	1242	Zg. Bistrica	242	14,1	71,4
Vitanjsko Pohorje	Kragulišče	1454	Vitanje	460	10,0	99,4
Zgornjemislinjsko Pohorje	Velika Kopa	1543	Dovže	575	7,2	134,4
Spodnjemislinjsko Pohorje	Golarjev vrh	834	Šentjanž	358	3,8	125,3

Vrhovi slemen so v podolžni smeri najbolj strmi: nad zgornjo Mislinjsko dolino Razborica (Vel. Kopa – Dovže, 134 m/km), v spodnji Mislinjski dolini Golarjev vrh – Šentjanž, 125m/km, sleme nad Lovrencem Klopni vrh – Lovrenc, 113m/km. V vseh treh navedenih primerih gre za tektonsko ugrezanje v podgorju. Zato je najbolj strm končni, spodnji del profila nad prelomnico v dolini na robu hribovja. Zmerna strmina je na Vitanjskem Pohorju (Kragulišče – Vitanje), njegov povprečni naklon je 99 m/km, kar je malo manj kot nad Dovžami in nad Lovrencem. Profil Kremžarjev vrh (1154 m) – Dravče (ob Dravi, 372 m) poteka po slemenu med potokoma Požarnica, to je pritokom Plavžnice, in (Trbonjsko) Reko. Je dolg, najmanj strm in poteka sprva po dacitu, nato po kremenovih peščenjakih in končno po filitoidnih skrilavcih. Njegove višine nad dolinama najbolj kolebajo v ivniških skladih, ki so iz trdo zlepljenega peščenjaka, laporja in konglomerata. Na peščenjakih ali tik ob kopi iz njih sta razgledni farni cerkvi Sv. Primož in sv. Anton. Povprečni strmec vuzeniškega potoka Plavžnice je 134 m/km. Majhni strmci so še na vzhodnopohorski planoti (Peršetov vrh – Zgornja Polskava). (Slika). Sklenemo lahko, da so pohorska slemena od vseh reliefnih oblik še najmanj znižano in spremenjeno površje, ki ga je pretežno ustvarila tektonika.

Na Obdravskem Pohorju dosegajo hribi med predornimi dolinami ob potokih s Pohorja višine: Janževski vrh 912 m, zahodni Hlebov vrh 913 m, v vzhodnem Rdečem bregu 793 m. To kaže na večinski nastanek iz slemena z vrhovi med 800 do 900 m nv. Nižja Ruta (Lobnikov vrh, 705 m) so bližje ugrezajočega se konca podolja nad Falo.

Do Razborice na jugovzhodu porečja Mislinje se pohorska slemena začenjajo 200–300 m pod vrhnjim razvodnim slemenom. Nima pa na Pohorju stranskih slemen 2,3 km dolgo in široko sleme z najvišjim, Mežnarjevim vrhom (861 m), ki se polkrožno boči nad prodorno dolino Drave med krajema Meža in Trbonje. To je edino pohorsko pobočje, ki se približuje meji nestabilnosti oziroma krušenju skalovja. Sleme je razpeto med krajema Meža in vzpetino s koto 792 m pod Mežnarjevim vrhom (861 m); je iz filitoidnega skrilavca. Na zemljevidu v merilu 1 : 50.000 je na višjem pobočju vrisana ena sama hudourniška grapa, ostalo pa je pretežno skalovito pobočje s povprečnim naklonom 40°, kjer prevladuje mehanično preperevanje skalovja. Ob izrednih nalivih in visokem snegu so zapadlo kamenje in snežni plazovi še v času prometa na železniški progi Maribor–Dravograd prekinjali promet.

Na razvitost porečij vplivajo tudi talna vodna kapaciteta, odpor proti eroziji in specifični odtok, zato običajno ugotavljanje razvitosti oziroma starosti iz razmerja med pritoki različnega ranga ni najboljše merilo. V našem primeru dokaj homogene odpornosti proti eroziji je pomembno zlasti razmerje med dolžino in širino porečja (slika). Obenem z večanjem globine rečne doline se namreč praviloma podaljšujejo tudi dolžine stranskih pritokov, kar porečje širi. Starejša porečja so zato širša. Po tem kriteriju so najstarejša pohorska porečja na severnem pobočju med (Trbonjsko) Reko na zahodu in Lobnico na vzhodu, na južnem Pohorju tudi Mislinjski jarek in porečje Dravinje. Najmlajša so v tem pogledu porečja pritokov Mislinje severozahodno od kraja Mislinja in na Mariborskem Pohorju med dravsko Bistrico in Framskim potokom. Vzrok za to lahko iščemo tudi v ugrezanju doline Mislinje, Dravske doline in Dravskega polja ter v mladem dvigu razvodnega slemena na mariborskem Pohorju.

Odsotnost pobočnih erozijskih in (ali) akumulacijskih teras na Pohorju in Obdravskem Pohorju je posledica neprekinjenega dvigovanja hribovja. Pobočja v metamorfnih kamninah so konveksna, s povečanimi strminami proti dnu domnevno v holocenu erozijsko poglobljenih dolin po ledenodobni akumulaciji; njeno višino ponekod na pobočju nakazujejo obronki. Povečana globinska erozija je opazna tudi na vnanjem robu gorovja nad ugrezajočimi se robnimi kotlinami, podolji in Dravo v selniškem podolju.

Ker nudijo pohorske metamorfne kamnine dokaj podoben odpor proti eroziji potokov in rek, bi pričakovali tudi podobne globine dolin. Analizira šestih vzorčnih dolin (slika) pa je pokazala, da so razlike več kot desetkratne. Doline so najbolj plitve na nagnjeni vzhodnopohorski planoti, Na njenem robu po veliki globini (do 250 m) odstopa le dolina Oplotnice. V Srednjem Pohorju se dolina Mislinje v Mislinjskem jarku pod najvišjim obodnim hrbtom (Črni vrh–Jezerski vrh) poglablja do 700 m in razdvaja vse Pohorje. V obeh primerih je vzrok za veliko globino zmični prelom po dolinskem dnu. Nadpovprečno globoke so tudi druge doline, nastale ob hkratnem dviganju gorovja in ugrezanja podgorske kvartarne kotline.

Slika 26: Potek vrha izbranih pohorskih slemen.

Glej angleški del prispevka.

Pohorje v ožjem smislu besede se na meji z južnim robom ribniško-lovrenško-selniškega podolja nad okoli 700 m n. v. dviguje ob 24 km dolgi in dokaj ravni črti smeri vzhod–zahod med Zgornjim Radvanjem in Ribnico, oziroma točneje: dolino Vuhreščice v Hudem Kotu, torej v glavnem ob tamkajšnji tektonski prelomnici na južnem robu pasu ivniških skladov in obenem ob pregibnici. Na jugozahodni, zgornje mislinjski strani je taka črta manj izrazita in bolj razčlenjena. Dalje na južnem in jugovzhodnem robu je gorovje bolj drobno fluvialno razčlenjeno predvsem na nižjem obrobju, kot je više na pobočju. Po močni in gosti razčlenjenosti v doline in slemena izstopa predvsem višje hribovje med Kremžarjevim vrhom in Mislinjskim jarkom. To je verjetno posledica tektonskega ugrezanja zgornje Mislinjske doline.

6.2 Vpliv ekstenzijske ekshumacije

V sočasno ugrezajočem se ribniško-lovrenško-selniškem podolju so v tektonskih ugrezninah ostali do 500 m debeli ivniški skladi. Razlago za ugrezanje tega podolja, sočasen dvig Pohorja (v ožjem smislu besede), ki še traja in Obdravskega Pohorja, nudi koncepcija nastanka gorovja z ekstenzijo, ob kateri je prišlo do razkritja oziroma ekshumacije (Summerfield 1991). Po njej se zemeljsko površje nad predorom magme skozi spodnjo plast litosferske skorje dviguje, pod hladnejšo in redkejšo, v desno odmikajočo se spodnjo plastjo skorje pa se ugreza (Summerfield 1991, slika 4.8). Tako lahko s to teorijo razlagamo nastanek goratega svoda Pohorja in na severni strani ugreznjeno ribniško-lovrenško-selniško podolje. To se na zahodu začenja pod zahodnim koncem najvišjega pohorskega hrbta, to je v kraju Hudi Kot.

Slednja trditev pa drži samo, če lego Hudega Kota določimo kot pravokotno na dinarsko usmerjeni hrbet Črni vrh – Mala Kopa. To črto nakazujeta dve vzporedni dolini pritokov Vuhreščice. Vzhodni konec podolja pri Fali je v istem poldnevniku kot je više na Pohorju vzhodni rob pohorske planote. Tako že sama lega obeh enot potrjuje povezavo med najviše dvignjenim gorovjem in najbolj ugreznjenimi ivniškimi skladi v podolju.

Na Pohorju je med Kremžarjevim vrhom in Veliko Kopo na površje dvignjenega največ dacita v obliki najširših žilnin in gostih otočkov. Sicer se dacit v otokih in pasovih severno od pohorskega hrbta pojavlja od Dravograda do Pekrske gorce in na južni strani do Mislinjskega jarka, po razvodnem hrbtu pa od Vrhovskega vrha (642 m) na severozahodnem Pohorju do Velike kope. Ker te žilnine niso metamorfirale okoliških kamnin, so po teoriji ekstenzijske ekshumacije do površja predrle zaradi nizkotlačno in nizkotemperaturno spremenjene gostote nekaterih mineralov. Blestnik in gnajs sta okoli granodioritnega ozemlja na Vzhodnem Pohorju posebno gosto »prestreljena« z ozkimi pegmatitnimi in aplitnimi žilami (v dolini Lobnice tudi cizlakita), ponekod dolgimi do enega kilometra in več in z gostoto do več žilnin na razdalji enega kilometra. Te prav tako niso metamorfirale okoliških sedimentov. Najbolj široke žilnine so zdaj med Kremžarjevim vrhom in Veliko Kopo, kjer je na severnem pobočju dokazana povezava med recentnim tektonskim premikanjem površja in izbočenjem dolin. Še bolj so doline izbočene na severnem pobočju Pohorja v podolju vzhodno od potoka Plavžnice.

7 Sklep

V zgornjem miocenu je od Graškega nižavja do Karavank prek današnjega gorovja Kobansko in Pohorja segal peneplen na vrhu zgornjemiocenskih skladov. Ti skladi so bili v dolgem razdobju na večini obravnavanega ozemlja erozijsko odstranjeni, v tektonsko nastalih ugrezninah pa so se ohranili z debelino več sto metrov, sklenjeno predvsem v severnokaravanškem podgorju in v ribniško-lovrenško-selniškem podolju, v otoku tudi na severozahodnem Pohorju. Današnje, s sedanjo orografijo neskladno hidrografsko omrežje je razloženo s podedovano prvotno rečno mrežo na tem peneplenu. Do 6 km dolga in 3–4 km široka pohorska planota, edina na vsem ozemlju, zdaj v višini 1150–1330 m, je nastala na otoku iz metamorfnih kamnin, razkritem sredi ivniških skladov v višini okoliške erozijske baze na razvodju pohorski rek. Njeno nadaljevanje proti zahodu v nadmorskih višinah okoli 1430 m so pozneje v porečju Radoljne razkrojili mlajši periglacialni in rečni procesi, tistega v n. v. okoli 1500 m znotraj današnjega zgornjega Mislinjskega jarka pa rečna erozija. V podobnih pogojih je nastal tudi razvodni hrbet med Roglo in Malo Kopo, ki na več mestih neznatno presega višino 1500 m. Relief na ostalem ozemlju je plod tektonskega oblikovanja površja in zniževanja zaradi rečne erozije, vidno pospešene zaradi ugrezajočih se okoliških kotlin in ribniško-lovrenškega-selniškega podolja. Na jugovzhodnem višjem pobočju so najmanj razčlenjene značilne planje.

Slika 27: Planja na višjem jugovzhodnem pohorskem pobočju v kraju Skómarje (zaselek s cerkvijo). Na levo navzgor se vrstijo najvišje samotne kmetije pod gozdnatim Ovčarjevim vrhom. Med obdelanim površjem je gozd ostal samo v plitvih, komaj opaznih ozkih dolinicah.

Glej angleški del prispevka.

Reka Drava je ob tektonskem dviganju Kobanskega epigenetsko nasedla na južnem robu kobanske antiklinale in izdelala današnjo dravsko deber. Dviganje Pohorja, ki še traja, in sočasno tektonsko ugrezanje do 500 m debelih zgornjemiocenskih (ivniških) skladov v ribniško-lovrenško-selniškem podolju in v severnem podgorju Karavank je razloženo s koncepcijo ekstenzijske ekshumacije (Summerfield 1991).

Slika 28: Mehanizem ekstenzijske eskhumacije, pri kateri nastanejo najprej razpoke v spodnjem delu litosfere, ki potem potone v astenosfero, nazadnje pa pride do dviga zemeljske skorje, ki ga spremlja nadomeščanje s toplejšim in manj gostim podlitosferskim delom plašča (po Summerfield 1991, 91).

Glej angleški del prispevka.

Pomembno je dejstvo, da je ribniško-lovrenško podolje ugreznjeno samo severno od najvišjega pohorskega hrbta (upoštevajoč tudi rob pohorske planote. Zahodni rob ribniškega podolja v kraju Hudi Kot je pravokotno na dinarsko potekajoči hrbet Mala Kopa – Črni vrh). Na Pohorju koncepcijo ekstenzijske ekshumacije podpirajo goste žilnine dacita, eklogita, amfibolita in, osamljeno, cezlakita, ki niso dodatno metamorfirale okoliških kamnin. S Pohorja se raztekajoče reke so izdelale najgloblje doline vzdolž zmičnih prelomov. Zaradi tektonskega pritiska so na severnem pohorskem pobočju doline sredi izbočene proti zahodu, severneje, v ribniško-lovrenškem podolju pa usmerjene proti severovzhodu. Zavijanje slemen in potokov od jugovzhoda proti jugozahodu nad legensko teraso pod pohorskim grebenom med Kremžarjevim vrhom in Veliko Kopo je domnevno povezano z recentnimi tektonskimi premiki s hitrostjo 0,53 mm letno proti jugovzhodu, izmerjenimi z metodo RMS v letih 1996–2002 na Veliki Kopi (Vrabec 2006). V geologiji zelo znana premočrtna labotska prelomnica na ježi legenske terase izjemoma »odreže« kos pohorskega filitoidnega skrilavca. Zato in ker zavijajo pohorski potoki nad ježo proti zahodu in končno proti severozahodu, je po reliefnih razmerah sklepati, da je v tem delu Pohorja bilo prvotno povirje (spodnje) Mislinje.

Najdaljši, 10 km dolg in do 700 m globok Mislinjski jarek s koncem na prevalu Šiklarica (1299 m) razpolavlja gorovje. V njem pa, nepričakovano, domala ni žilnin. Zato, ker je lakolit pod njim razklan? V času najhladnejšega oddelka würmskega glaciala so prek Šiklarice pihajoči hladni in snegonosni severovzhodni vetrovi, usmerjeni proti Sredozemlju, zaradi dviganja povzročili nastanek dveh, do en kilometer dolgih pobočnih ledenikov v zgornji dolini reke Radoljne.

Ponovljena meritev nivelmanov je za ovršje Pohorja nad 1200 m n. v. ugotovila tektonsko dviganje 6 mm letno. Na pliokvartarno starost kaže tudi izračun na osnovi dveletnih meritev rečnega transporta (razen suspenza in proda) na vzhodnopohorskih potokih in odsotnost erozijskih in akumulacijskih pobočnih teras. Zložni pohorski relief ni posledica velike starosti, temveč hitrejšega mehaničnega razkrajanja pretežno zrnatih kamnin v vodoprepustni pesek, pokrit z gostimi koreninami trav in smreke, kar zavira površinsko rečno erozijo. Odtod prevlada zmernih strmin (12–30°).

Od uporabljenih geomorfoloških metod se je za uspešno izkazala morfometrična analiza porečij in globine dolin. Ozka porečja so na severnem pobočju Mariborskega Pohorja in nad ugrezajočo se Slovenjgraško kotlino, v kateri so navrtali 54 m pliokvartarnih sedimentov; široka in dolga so na severni strani Pohorja zaradi epigenetsko nastale Dravske doline med Dravogradom in Falo. Najgloblje pohorske doline so vzdolž zmičnih prelomov.

Globina Mohorovičičeve diskontinuitete je znana samo pod Pernicami severno od vuzeniške kotline, znaša 15 km. Čeprav dviganje Pohorja še traja, je potresnost šibka, domnevno zaradi manj kompaktne zemeljske skorje.

Na Vitanjskem Pohorju se pobočje v višjem delu porečij Hudinje in deloma Dravinje znižuje proti jugu, potoki pa tečejo proti jugovzhodu, ker so savinjski pritoki šele v mlajši dobi prebili karavanški Paški Kozjak. Starejši in višji odtok je zapustil sled v slepi dolini v Paškem Kozjaku z naseljem Zgornji Brezen.

8 Literatura

Glej angleški del prispevka.