29 Limestone Klippen of the Pavlov Hills

Tomáš Pánek, Jan Miklín, and Karel Kirchner

Abstract

The Pavlov Hills represent a distinct geomorphological landscape of the Outer Western Carpathians in the South Moravia. They comprise a string of limestone klippen which originated as an interplay of Lower Miocene nappe tectonics and later selective erosion that removed weak Tertiary flysch and morphologically enhanced limestone blocks. Major morphological features are attributed to the lithology and thrust-and-fold tectonics of Late Jurassic-Late Cretaceous limestones which form the core of individual klippen structures. Monoclinal structures with west-facing escarpments and rather gentle eastward-oriented dip slopes have been sculptured chiefly by mass movement and karstification. However, besides structural landforms and karst features related to bedrock geology, immediate surroundings of the Pavlov Hills offer some of the famous Late Quaternary localities in Europe involving worldwide known Upper Paleolithic (Gravettian) excavations. More than 25 ka of human inhabitation established a highly valuable cultural landscape with specific habitats of limestone hills resembling Mediterranean landscape, ruins of medieval castles and vineyards and picturesque villages in the piedmont of limestone hills.

Keywords

Western Carpathians • Pavlov Hills • Limestone klippen • Thrust-and-fold belt • Rock control • Karst • Upper Paleolithic • Loess

29.1 Introduction

Containing limestone cliffs rising above surrounding alluvial plains and low flysch piedmont, the Pavlov Hills form a prominent landscape in the South Moravia (Fig. 29.1). The exceptionally diverse landscape of the area is attributed to specific limestone geomorphology and position of the region within the warmest part of the Czech Republic. It is the reason why the Pavlov Hills host many endangered species of fauna and flora whose origin is in the Mediterranean region and why their foothills produce some of the best wines in Central Europe. In this respect, a string of white limestone klippen with ruins of castles and scenic villages on the hillslopes resembles a landscape of Southern Europe. In 1986, the uniqueness of the Pavlov Hills led to the integration of the area into the network of the UNESCO Biosphere Reserves—one of the six of these in the Czech Republic. Pronounced limestone terrain with many thrust-and-fold structures, karst phenomena and famous Paleolithic localities revealing more than 25 ka of human settlement makes the Pavlov Hills first-order geosite in the European context.

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T. Pánek and J. Hradecký (eds.), *Landscapes and Landforms of the Czech Republic*, World Geomorphological Landscapes, DOI 10.1007/978-3-319-27537-6_29

Fig. 29.1 The highest part of the Pavlov Hills (with the Děvín Hill in the centre) rising above subdued flysch landscape with vineyards (*Photo* J. Miklín)

29.2 Geographical and Geological Setting

The Pavlov Hills (*Pavlovské vrchy* or *Pálava* in Czech) are an approximately 12-km-long range of klippen formed by Late Jurassic-Cretaceous limestones between the Dyje River and Czech-Austrian border near the town of Mikulov (Fig. 29.2). Isolated limestone hills named Leiser Berge continue to Austria having their southern limit at the town of Falkenstein, some 8 km beyond the Czech border. From the perspective of the whole Carpathian mountain arc, the Pavlov Hills represent its westernmost promontory or the transition zone between the Western Carpathians and the Eastern Alps.

Regarding the local relief and altitude, the height of the area rises in the northward direction and culminates with the Děvín Hill (549 m a.s.l.) (Fig. 29.2). However, the size (i.e. massiveness and height) of individual klippen varies. Looking from the north, the elevation of the Pavlov Hills with rocky escarpment at the NW slope of the Děvín Hill resembles true mountainous landscape with the local relief of more than 200 m. On the contrary, some of the klippen structures (e.g. Šibeniční vrch or Kočičí skála Hills) rise only a few metres above the surrounding landscape. The klippen structures are mostly overgrown with grasslands, forest steppes and forests (e.g. oak-hornbeam and shrubs), which contrast with cultivated gentle footslopes mostly used as vineyards and orchards (Fig. 29.1).

The klippen of the Pavlov Hill consist of Jurassic and Cretaceous limestones tectonically embedded within weak Tertiary flysch sequences (Fig. 29.2, Stráník et al. 1999; Poul et al. 2011). Mesozoic formations are arranged in four main Late Jurassic-Cretaceous lithostratigraphical units. The oldest is the Klentnice Formation (Oxfordian/Kimmeridgian to Lower Tithonian) consisting predominantly of claystones with some limestones in its topmost section. The basal part of this formation is of tectonic origin and corresponds to thrust plane (Poul et al. 2011). The Klentnice Formation passes (with intercalation of the so-called nodular limestones) to overlying massive Ernstbrunn Limestone (Upper Tithonian) which forms the core of individual klippen structures. An extremely long hiatus ($\sim$55 Ma) followed the sedimentation of the Ernstbrunn Limestone during which erosion and karstification prevailed. Stratigraphically, the uppermost Mesozoic sequences of the Pavlov Hills thus span the Late Cretaceous and involve predominantly claystones (and secondary limestones) of the Klement (Turonian to Coniacian) and Pálava (Coniacian to Campanian) Formations (Stráník et al. 1999; Poul et al. 2011). Tertiary flysch involving mainly claystones, sandstones and conglomerates of the Paleocene-Lower Miocene age are observed mostly in the piedmont positions and in some depressions between limestone klippen structures (Fig. 29.2).

From the tectonic point of view, the area is situated in the frontal part of the Carpathian accretionary wedge, more specifically in the Ždánice Nappe, which originated during the younger phase of the Alpine orogeny in the Lower Miocene (Stráník et al. 1999; Poul et al. 2011). The nappe is thrust in the W and NW direction and overlies another nappe stack (Pouzdřany Nappe) and clastic deposits of the Neogene Carpathian Foredeep. Thrust tectonics was responsible for uplift, dislocation and folding of the originally continuous Mesozoic limestone platform which formed the

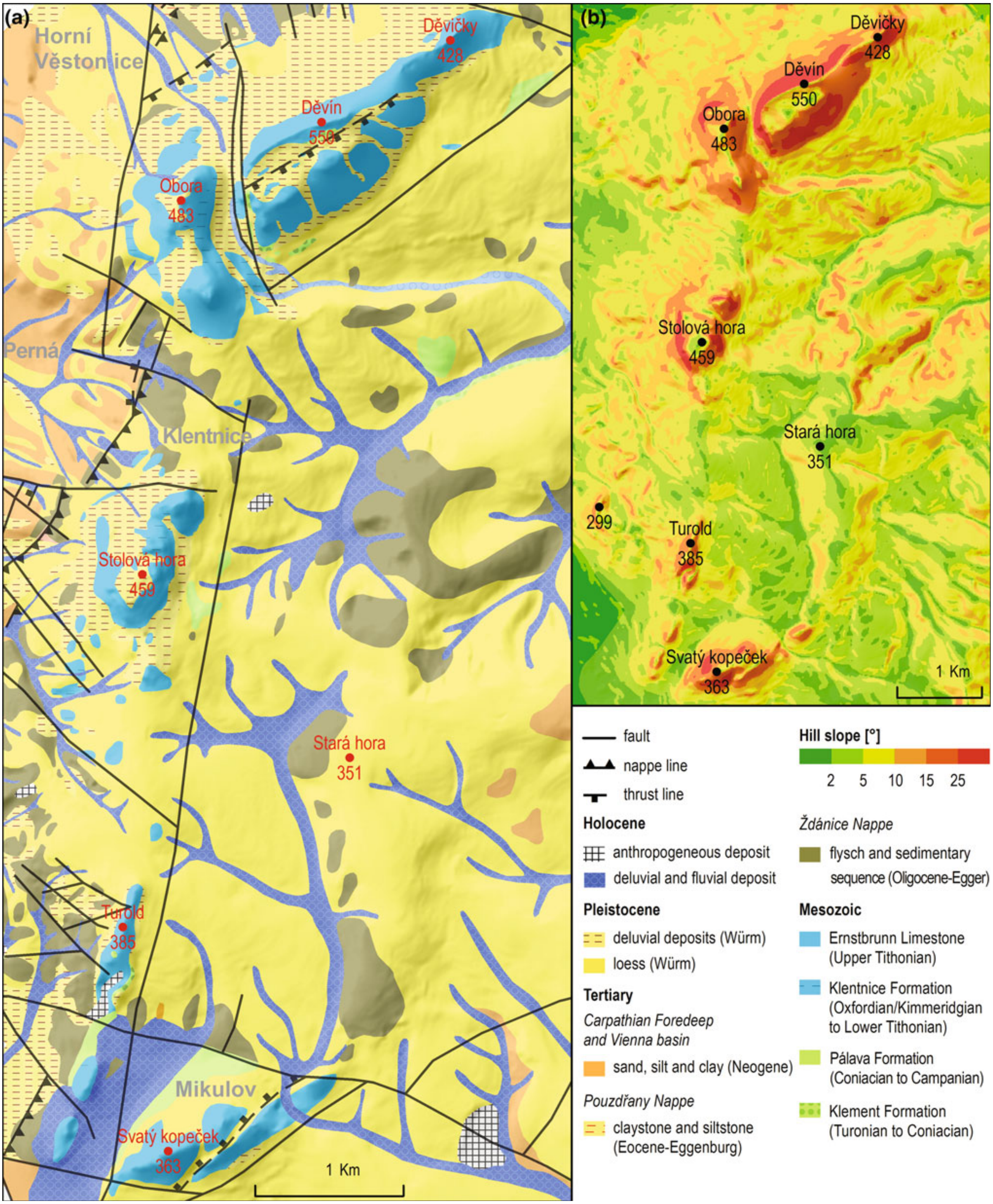

Fig. 29.2 Geology of the area placed over a shaded relief (**a**) and an inserted slope gradient map (**b**) revealing highly contrasting topography of limestone klippen structures in comparison with adjacent flysch foothills (*source* Czech Geological Survey)

basement for establishing nappes. According to a new tectonic model of the Pavlov Hills (Poul and Melichar 2009; Poul et al. 2011), klippen structures are formed by several thrust-related anticlines plunging slightly to the NE. The anticlines are interpreted as a part of flat-ramp-flat geometry which originated due to fault-bend fold mechanism (Poul et al. 2011). The whole area is cross cut by several generations of faults. Besides thrust faults striking in NE–SW and NNE–SSW directions in accordance with the front of the Ždánice Nappe, very important is a system of transverse "en echelon" sinistral strike-slip faults trending in NW–SW direction (Fig. 29.2, Poul and Melichar 2009). These faults dislocated Ernstbrunn Limestone to blocks and prepared weaker zones of rock massif for subsequent selective erosion and morphological separation of individual klippen structures (Poul and Melichar 2009).

29.3 Main Landforms

The Pavlov Hills are a unique example of a passive morphostructure. Although their geological structure resulted from Lower Miocene thrust tectonics and activity of numerous strike-slip faults, gross morphological features are attributed to Late Tertiary and Quaternary selective erosion of mechanically hard limestones enclosed within weaker flysch sequences. Generally, west- and north westward-oriented emplacement of the nappe stack caused the overall W–E asymmetry of the range and cuesta-like morphology of some klippen structures. Slopes oriented to the west are generally steeper and have a character of escarpments; those facing to the east follow bedding planes and form dip slopes, sometimes with characteristic flatirons (Fig. 29.3). Tectonically and lithologically anisotropic bedrock of the area is additionally prone to mass movements which furthermore increase morphological distinctiveness of the limestone hills.

29.3.1 Two Types of Limestone Klippen

The area involves two geomorphologically distinct types of limestone hills—(1) relatively high and massive structural ridges (cuesta or monoclinal ridges) and (2) small residual limestone hills completely surrounded by smooth flysch terrain.

The first category is represented especially by pronounced ridges of the Děvín (549 m), Kotel (483 m), Stolová hora (459 m), Turold (385 m) and Svatý kopeček (363 m) Hills. The Děvín Hill represents a true textbook example of a monoclinal ridge with steep NW escarpment and gentler dip slopes on the opposite side (Fig. 29.3). Different morphology reveals the Stolová hora Hill near the

Fig. 29.3 Aerial photography of the northern part of the Pavlov Hills showing cuesta-like klippen topography with slope deformations in the foreground (*Photo courtesy* T. Soudek)

Klentnice village. English equivalent of its name is a "Table mountain", owing to extensive (~300 × 300 m) flat surface on its top. Some of the authors (e.g. Ivan 1973) interpreted this flat area as a planation surface which originated due to marine abrasion during the Upper Badenian sea transgression in the Middle Miocene. Although this transgression post-dated thrusting in the area and thus should leave some morphological signatures in the Pavlov Hills, further research is needed for the evaluation of its geomorphic importance. Common features of all "high" klippen structures are rock forms, sometimes with a character of continuous vertical cliffs, rock towers and pinnacles. Some of these rocks (e.g. on the NW escarpment of the Děvín Hill, in the Soutěska Gorge or rock group around the Martinka Rock) exceed 50 m in height.

End members in the geomorphic decay of tectonically fragmented Upper Jurassic-Cretaceous limestone body are small residual limestone hills and knobs. Although such features rise only a few metres above the landscape, it is

Fig. 29.4 Small limestone residual hill (Kočičí skála Rock) protruding only a few metres above a rounded flysch ridge (*Photo* J. Miklín)

their presence that definitely completes the picturesque scenery of the Pavlov Hills (Fig. 29.4). Like tors in granite landscapes, they attract visitors and form local geodiversity "hot spots". Most expressive examples of such small klippen structures are the Kočičí skála Rock (~10 m high) and Kočičí kámen Stone (~5 m high) between the Mikulov town and Klentnice village and the Šibeniční vrch Hill (~20 m high) in the vicinity of the Austrian border.

29.3.2 Tectonic Landforms

Landforms related to active tectonics are not presented in the landscape of the Pavlov Hills, yet there are numerous features which resulted from selective denudation of Alpine tectonic structures—especially those associated with Lower Miocene thrust tectonics and activity of transverse sinistral strike-slip faults. Selectively denuded fronts of thrust structures are expressed in the contemporary landscape as pronounced escarpments with vertical cliffs, particularly at the western slopes of klippen. The thrust fault cutting the Děvín Hill contributes to its double-ridge character with the main ridgeline situated in the western part of the elevation and the secondary one in the eastern part of the elevation (Fig. 29.3).

An important role in the morphological individualisation of klippen structures was played by transversal sinistral strike-slip faults cutting the elevation of the Pavlov Hills in NW–SE direction on several sites (Poul and Melichar 2009). These faults led to the occurrence of deep corridors between particular limestone hills and associated fault-line slopes. Some rock outcrops on slopes reveal polished surfaces with sub-horizontal striations associated with strike-slip tectonics. The most expressive of these corridors is more than 100 m deep "Soutěska" depression (Eng. "Gorge") dividing the Děvín and Kotel elevations (Fig. 29.5). It consists of two opposing valleys trending in NNW–SSE direction and a saddle in the central part. The eastern part of the "Soutěska" is flanked by a 400-m-long and more than 20-m-high cliff on the Ernstbrunn Limestone which represents one of the most important rock forms in the area.

29.3.3 Mass Movement-Induced Landforms

Klippen structures are found in an advanced stage of gravitational disintegration. Many fascinating landscape sceneries such as vertical limestone cliffs, rock towers and blocks originated as a result of mass movement—mainly rotational

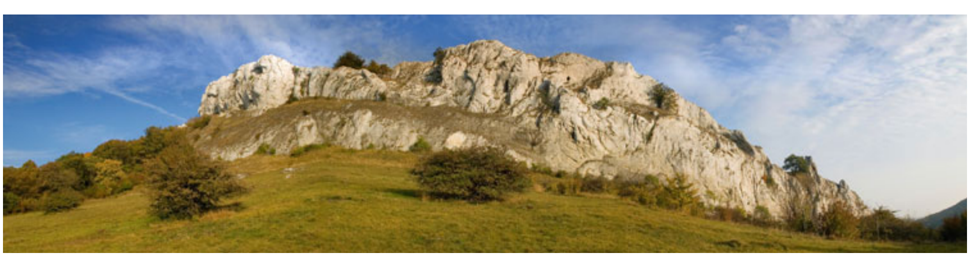

Fig. 29.5 Fault-related escarpment forms of the pronounced NW slope of the Soutěska Valley (*Photo* J. Miklín)

landslides, toppling and rockfalls. The occurrence of landslides in the Pavlov Hills is facilitated by (1) an abundance of clay-rich rocks (e.g. Klentnice, Klement and Pálava Formations together with Tertiary flysch), (2) position of competent beds easily breaking up overlying plastic claystones (e.g. rigid Ernstbrunn Limestone overlying Klentnice Formation) and (3) existence of a thick cover of limestone debris resting on impermeable flysch layers at the foot of klippen. Rockfalls together with toppling contribute to the morphology of limestone cliffs (e.g. on the Stolová hora Hill and Obora and Děvín Hills) and lead to the evolution of vast scree slopes, which can be seen in their typical form along the NW slopes of the Děvín Hill (Fig. 29.6).

Spectacular landslide morphology with numerous rock forms is revealed by the NW part of the Kotel klippe, ~1 km SE from the Horní Věstonice village. There, an approx. 70-m-high limestone block of the local name "Martinka" was gravitationally detached from the massif and rotated backward by 20–25° (Fig. 29.7, Poul et al. 2010). The frontal (NW) face of the rotated block was additionally affected by toppling along the bedding planes, which formed a 3–4-m-wide and ~20-m-deep "gorge", partly roofed by collapsed boulders. Martinka Rock and adjacent cliffs demonstrate how mass movement increases the geodiversity of limestone terrain. Besides its scientific value, the site has been a popular target for climbers since the mid-twentieth century.

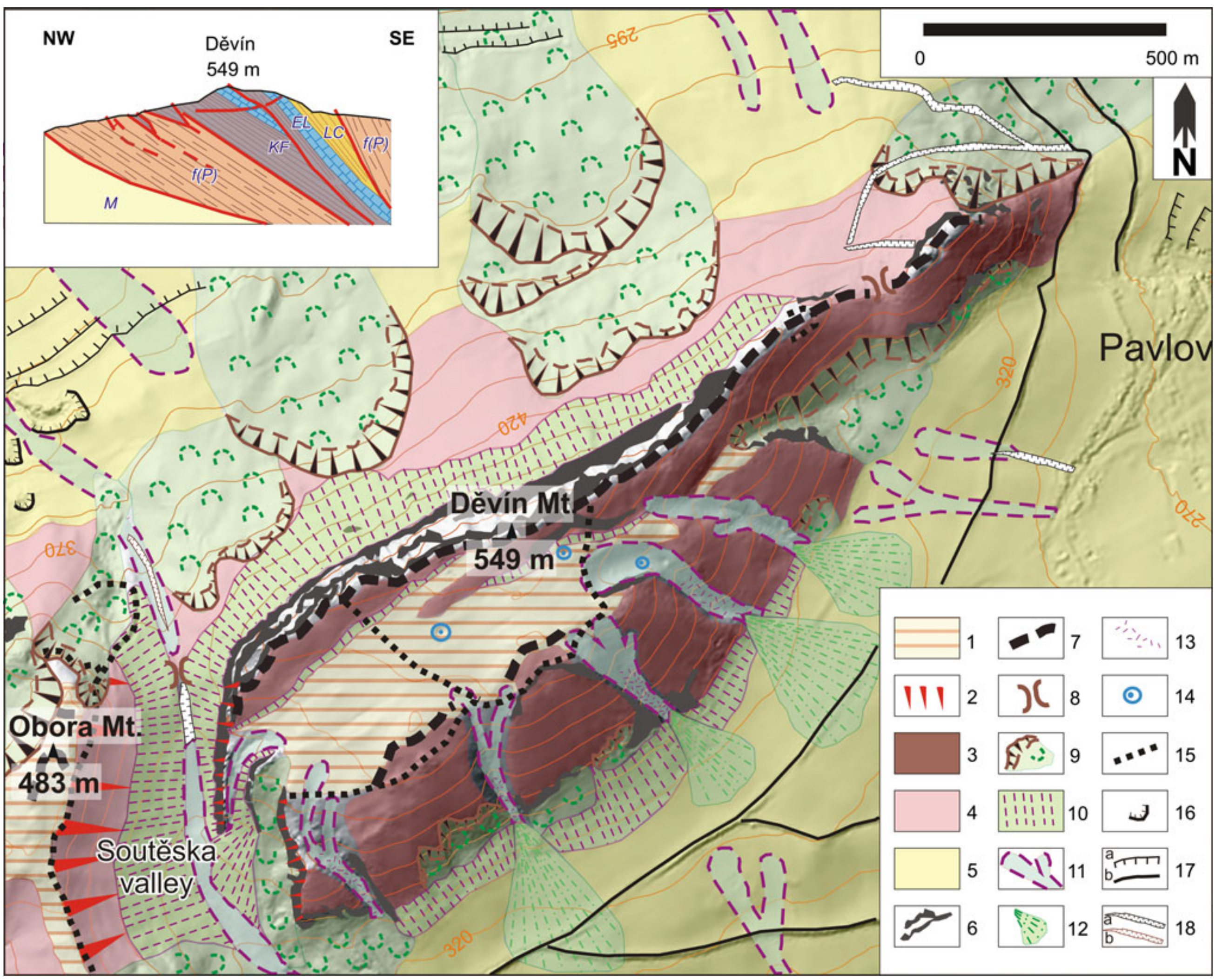

Fig. 29.6 Geomorphological map of the Děvín Hill (LIDAR-derived shaded relief used as a background). *1* Planation surface (Miocene?), *2* fault-line scarp, *3* dip slope ("flatiron"), *4* erosion-denudation slope, *5* loess slope, *6* rock wall, *7* structural ridge, *8* saddle, *9* landslide, *10* scree slope, *11* dell and dry valley, *12* dejection cone, *13* boulder deposit infilling valley floor, *14* sinkhole, *15* late Bronze Age fortification, *16* abandoned brickyard, *17a* agricultural terrace, *17b* road, *18a* hollow way, *18b* gully (inserted cross-section of the Děvín Ridge is modified after Poul 2004; *M* Miocene (Eggenburg-Baden) deposits, *f(P)* flysch deposits of the Paleogene age, *KF* Klentnice Formation, *EL* Ernstbrunn Limestone, *LC* Late Cretaceous deposits)

Fig. 29.7 Martinka Rock (*left side of the photo*) is a huge detached and backward-rotated limestone block (*Photo* T. Pánek)

However, mass movements also pose a significant hazard in the region, especially for the villages (e.g. Klentnice and Pavlov) situated at the footslopes of klippen. Several rainfall-triggered catastrophic failures (esp. shallow landslides) were recorded here in the years 1900, 1906, 1910, 1911, 1915, 1916, 1917 and 1919 and during a humid period in the first half of the 1940s (Špůrek 1972).

29.4 Karst Phenomena

Although not being so expressive as in the Bohemian Karst or Moravian Karst (see Chaps. 6 and 20 in this book), karst features play an important role in the geodiversity of the Pavlov Hills. Despite the fact that exo-and-endokarst landforms are not presented in their whole spectrum and some characteristic landforms are almost missing, for instance, sinkholes that are only represented by a few individuals on the Turold and Děvín Hills (Fig. 29.6), the area contains one of the most developed karren structures in the Czech Republic and the "Na Turoldu" Cave at the town of Mikulov points to extremely long evolution, which started minimally in the Miocene epoch.

29.4.1 Karren

According to Vítek (2013), the diversity of karren structures that can be found in the Pavlov Hills is pronounced with at least 13 different types of the structures. The most frequent ones include grikes (joint karren), pit karren, slaggy karren, rillenkarren, solution pans and especially cavernous karren. Some of the most expressive forms are also karren rock ridges, several metres high rock forms occurring at the upper edge of vertical cliffs (e.g. Děvín and Soutěska) or on the top of rock towers (e.g. Tři panny Rocks near the Děvičky Castle). Extensive areas are covered by karrenfields, which are documented especially on inclined and jointed bedding planes of the Ernstbrunn Limestone forming "flatirons" sloping to the SE from the Děvín Ridge (Vítek 2013).

By far the most interesting and scientifically explored exokarst features are cavernous karren forms that evolved on the eastern rock wall of the Soutěska Valley (Vítek 2013). The southern part of the 8–15-m-high cliff is sculptured by several tens of such microforms (Fig. 29.8). The microforms whose shape varies between nearly perfectly circular to "egg-like" are elongated sub-horizontally in accordance with the bedding planes or sub-vertically along the joints. They occur in various stages of evolution (e.g. isolated versus intersected composite features) and diverse morphologies (hollows, niches etc.) (Fig. 29.8). Most developed forms reach about 1 m in diameter and 0.5 m in depth (Vítek 2013). During almost 100 years of research (e.g. Jüttner 1922; Demek and Macka 1953; Ivan and Kirchner 1996), several interpretations of their genesis have been proposed (e.g. turbulent action of the sea water during the upper Badenian transgression; Jüttner 1922), but the most convincing is the corrosion of limestone by seeping water. This idea is supported by the existence of small channels (playing a role of subsurface conduits) which intersect the surface of the rock wall just at the position of individual hollows (Vítek 2013).

A majority of karren structures evolved on jointed surfaces of the Ernstbrunn Limestone by selective dissolution. An important factor in the distribution of karren structures is the tectonic and lithological anisotropy of limestone massif (joints, faults, bedding planes and microstructures), its textural properties and removal of the micrite component from the crystals of dolomitic rhombohedrons (Bosák et al. 1984).

Fig. 29.8 Cavernous karren (rock pits) on the rock wall in the Soutěska Valley (*Photo* T. Pánek)

29.4.2 "Na Turoldu" Cave: Evolution Since the Mesozoic?

"Na Turoldu" Cave is the most important endokarst geosite within the Pavlov Hills (Fig. 29.9). Its entrance is situated in an abandoned quarry below the Turold Hill, in the northern suburb of the Mikulov Town. The cave was explored in the early 1950s and the total length of all accessible passages is 2200 m with the depth reaching 50 m below the surface. Contemporary investigations (e.g. Kolařík 2000) have found several interconnections between adjacent smaller caves suggesting a more extensive cave system. The cave is of a multi-level type and it has probably also experienced a prolonged multi-stage evolution (Bosák et al. 1984; Poul 2004). The upper levels are mostly of tectonic/gravitational origin (e.g. "Old" or "Boulder" chambers), while the lower

Fig. 29.9 Lake's chamber situated in the deepest part of the "Na Turoldu" Cave (*Photo* J. Kolařík)

ones (e.g. Lake's chamber) originated predominantly due to corrosion (Poul 2004). Some parts of the cave have even been modified by anthropogenic activity, especially by explosions in the quarry during the first half of the twentieth century (Poul 2004).

What is most important from the geomorphic point of view is the longevity of the cave's evolution (Bosák et al. 1984; Poul 2004). One of possible interpretations is that the onset of the cave evolution was as early as in the Cretaceous period, i.e., during the stratigraphical hiatus between the Late Jurassic and Late Cretaceous, which was connected with subaerial conditions leading to significant corrosion of the Ernstbrunn Limestone. However, there is no convincing sedimentological and geochronological evidence for this theory within the cave system (Poul 2004). The most probable explanation is that the cave originated just after the Late Cretaceous epoch, and mainly during the Miocene (Eggenburg-Badenian), in the period of nappe thrusting and repeated marine transgressions (Poul 2004). A significant marker for this interpretation is the fact that several originally continuous passages and chambers are truncated by faults which originated during the Miocene orogenesis. Some of these faults are of the same type as strike-slip faults which separate the Pavlov Hills into individual klippen structures. The upper levels of the cave have been evolving since the end of nappe emplacements (<15 Ma) in connection with gravitational disintegration of the limestone klippen (Poul 2004).

"Na Turoldu" Cave is open for public and visitors can observe a great diversity of endokarst features (e.g. various types of cave passages related to corrosion, tectonics or gravitational disintegration) and touch polished surfaces of fault planes that are responsible for the genesis of the Pavlov Hills.

29.5 Late Quaternary Landscape Evolution: An Interplay of Climate Changes and Human Activity

The Pavlov Hills and especially their immediate surroundings contain some of the most important European localities showing a nearly continuous record of the Late Quaternary environmental changes. Besides demonstrating paleoclimatic variations and associated changes in the vegetation cover, they reveal a fascinating long-term history of human settlement in the area which started with the Gravettian culture (~28–22 ka) in the Upper Paleolithic and has continued up to the modern times.

29.5.1 Dolní Věstonice Loess Sequence: Late Pleistocene Geosite

Situated in a former brickyard at the NW footslope of the Děvín Hill, the loess sequence of the Dolní Věstonice village is among the most studied in the world. It was uncovered in the 1960s during archaeological excavations and it has been a focus of numerous investigations since (e.g. Kukla 1961; Demek and Kukla 1969; Musson and Wintle 1994; Frechen et al. 1999; Fuchs et al. 2013; Antoine et al. 2013 etc.). The profile shows a nearly continuous record of the Last Interglacial-Glacial cycle and is among key natural archives of climatic variations in Eurasia. Thanks to an excellent insight into the history of landscape changes in the Late Pleistocene, the site is locally called "Calendar of Ages" and has been protected as a National Natural Monument since 2005.

The last detailed OSL and radiocarbon dating of the sequence shows that the loess-paleoseol sequence was deposited between ~110–120 ka (Fuchs et al. 2013) and reveals 22 sedimentary units divided into four sub-sequences (Fig. 29.10, Antoine et al. 2013). The lowest, ~5-m-thick sub-sequence (humid soil complex) is one of the most complete pedo-sedimentary records of the transitional phase between the Last (Eemian) Interglacial and Weichselian Early glacial (~110 and 70 ka) (Antoine et al. 2013). Chernozem soils with intercalated aeolian horizons within this sequence reveal seven interstadial events and six cold phases. The conditions in the site were generally more continental and drier than those of similar sequences in the Western Europe (Antoine et al. 2013). The second sub-sequence (~2-m-thick) is represented by sandy loess and indicates the presence of a typical periglacial landscape of the Lower Pleniglacial (~70–50 ka), with an extremely arid climate and strong winds which drifted fine particles away from sandy and gravely bars of the adjacent braided Dyje River (Antoine et al. 2013). The third, about 1-m-thick sub-sequence is represented by a brown soil complex with evidence of solifluction in the more humid Middle Pleniglacial conditions (~55–40 ka). The topmost sub-sequence involves ~6 m of Upper Pleniglacial (~30–40 ka) sandy loess evidencing the return to extremely arid periglacial conditions with very rapid loess accumulation. Tundra gley soil associated with Gravettian archaeological

Fig. 29.10 Loess paleoseol sequence of the "Calendar of Ages". The black arrow shows the position of the Gravettian archaeological layer (*Photo courtesy* J. Svoboda)

layer just at the base of the sub-sequence revealed remnants of a mammoth bone, while charcoals within this unit returned the radiocarbon age of 25,760 ± 190 BP (Antoine et al. 2013).

Besides the "Calendar of Ages" loess sequence, the whole surrounding area between the Dolní Věstonice and Pavlov villages is a worldwide-known archaeological locality (protected as a Natural Cultural Monument). Particularly, the investigations performed by Karel Absolon between 1924–1938 brought some of the famous findings such as a ceramic statuette of Venus (The Venus of Dolní Věstonice) or one of the most complete skeletons of early *Homo sapiens* (Klíma 1983).

29.5.2 Limestone Klippen as Human Refuges Since the Bronze Age

Despite the fact that the region of the Pavlov Hills has continuously been inhabited by humans since at least the Late Paleolithic (~30 ka BP), there are two historical periods that influenced the face of the limestone klippen in particular: the Bronze Age and Medieval Period.

The Late Bronze Age (1300–950 BC) was a period in which klippen structures of the Pavlov Hills were substantially deforested by man. Furthermore, fortified settlements were established on some elevations—e.g. on the Stolová

Fig. 29.11 Ruins of the Sirotčí hrádek Castle from thirteenth century represent a landscape dominant in the central part of the Pavlov Hills (*Photo* J. Miklín)

hora and Děvín Hills (Poborský et al. 1993). The position of fortified lines was hidden for a long time, but especially winter aerial photographs show continuous fortification on some hills. For instance, Late Bronze Age settlement on the Děvín Klippe covers 22–26 ha, i.e. a substantial part of the ridge area (Čižmář 2004). New high-resolution LIDAR-based digital elevation model performed by the Czech Office for Surveying, Mapping and Cadastre reveals fortification in a surprising detail and it can be assumed that additional parts of the system will be explored (Fig. 29.6).

However, the scenic appearance of the Pavlov Hills was not completed until the Medieval Period, when a series of castles was built on tops of some klippen structures during the thirteenth and fifteenth centuries. Ruins of some castles (e.g. Děvičky and Sirotčí hrádek) visually enhance the morphology of limestone klippen structures that offered an excellent strategic position for such buildings (Fig. 29.11). The castles survived until the modern times as ruins in various stages of decay—e.g. while the Děvičky Castle was partly restored, the Neuhaus Castle has only been preserved as a few walls on the rock cliff of the Kotel Hill.

29.6 Cultural Value and Touristic Promotion

From the point of view of natural and cultural values, the Pavlov Hills and their immediate surroundings represents one of the richest landscapes in the Czech Republic. Approximately, 50 km^2 of the landscape contain nine specially protected reserves and monuments and one National Cultural Monument. Partly due to its picturesque position, the centre of the Mikulov Town has been declared an Urban Monument Reserve, which is a status given to the most important historic towns in the Czech Republic. The whole territory of the Pavlov Hills is protected both as a part of the Pálava Protected Landscape Area and the UNESCO Biosphere Reserve.

The area is a focus of increasing tourism activities and, without any doubt, a part of this interest is attributed to its unique geological and geomorphological settings. Some of the visitors are motivated by trekking on the limestone hills, some of them admire Upper Paleolithic heritage of “mammoth hunters” in some of the local museums. However, one of the major symbols of the Pavlov Hills is vineyards, which are largest in Moravia, and production of delicious wines, out of which white varieties of Grüner Veltliner, Welshriesling and Pinot Blanc predominate. Wine production in this region has a very long tradition since it dates back to the Roman times. Vineyards are situated predominantly on the piedmont slopes which are formed by flysch formations containing claystones and marls, i.e. a substratum very suitable for wine production. Wine tradition attracts many tourists every year. For instance, bikers may use the famous “Mikulov Wine Trail”, a route around the whole Pavlov Hills with plenty of educational panels and many opportunities to taste local wines.

29.7 Conclusion

Limestone geomorphology with numerous karst features makes the landscape of the Pavlov Hills highly different from other flysch uplands of the Outer Western Carpathians. The area originated as a result of Lower Miocene nappe tectonics which detached the autochthonous limestone body of the Mesozoic (Late Jurassic-Late Cretaceous) age thrusting it together with Tertiary flysch formations over deposits of the Carpathian Foredeep. Exceptionally diverse topography characterised by numerous limestone klippen structures coincides with highly contrasting geology. It was mainly selective erosion that has morphologically enhanced individual limestone klippen structures by the removal of less-resistant flysch and tectonically weakened rocks. However, the area would never get its picturesque scenery without human interference. Deforestation of limestone hills during the Late Bronze Age established the main image of the recent landscape resembling Mediterranean regions and the Medieval Period decorated several klippen structures with castles that survived until modern days in the form of scenic ruins. These attributes together with the presence of worldwide-known loess sequences and famous Paleolithic sites make the Pavlov Hills one of the major geomorphological landscapes in the Czech Republic.

References

Antoine P, Rousseau DD, Degeai JP, Moine O, Lagroix F, Kreutzer S, Fuch M, Hatté C, Gauthier C, Svoboda J, Lisá L (2013) High-resolution record of the environmental response to climatic variations during the Last Interglacial-Glacial cycle in Central Europe: the loess-palaeosol sequence of Dolní Věstonice (Czech Republic). Quatern Sci Rev 67:17–38

Bosák P, Čadek J, Horáček I, Ložek V, Tůma S, Ulrych J (1984) Krasové jevy vrchu Turold u Mikulova. Studie ČSAV, 5, Praha, 108 pp (In Czech)

Čižmář M (2004) Encyklopedie hradišť na Moravě a ve Slezsku. Libri, Praha, 304 pp (In Czech)

Demek J, Kukla J (1969) Periglazialzone Löss und Paläolithikum der Tschechoslowakei. Czechoslovak Academy of Science, Institut of Geography, Czechoslovakia, Brno, 157 pp

Demek J, Macka M (1953) Příspěvek k otázce mísovitých prohlubní ve vápencích Pavlovských vrchů. Sbor. Čs. Spol. Zem 58:54–56 (In Czech)

Frechen M, Zander A, Cílek V, Ložek V (1999) Loess chronology of the LastInterglacial/Glacial cycle in Bohemia and Moravia, Czech Republic. Quatern Sci Rev 18:1467–1493

Fuchs M, Kreutzer S, Rousseau DD, Antoine P, Hatté C, Lagroix F, Moine O, Gauthier C, Svoboda J, Lisá L (2013) The loess sequence of Dolní Věstonice (Czech Republic): a new OSL based chronology of the Last Climatic Cycle. Boreas 42:664–677

Ivan A (1973) Outline of denudation chronology of the Mikulovská vrchovina (Highland). Folia, Facultatis Scientiarum Naturalium Universitatis Purkynianea Brunensis—Geographia 13:35–43

Ivan A, Kirchner K (1996) Nové poznatky o geomorfologii Pavlovských vrchů. Geol. výzk. Mor. Slez 2:11–13 (In Czech)

Jüttner K (1922) Entstehung und Bau der Pollauer Berge. A. Bartosch, Mikulov, 68 pp

Klíma B (1983) Dolní Věstonice, tábořiště lovců mamutů. Academia, Praha, 176 pp (In Czech)

Kolařík J (2000) Nové objevy v jeskyni Na Turoldu. Speleofórum 19:18–20 (In Czech)

Kukla G (1961) Quaternary sedimentation cycle. In: Survey of the Czechoslovak Quaternary. Czwartorzed Europy srodkovej wschodniej. INQUA 6th International Congress, vol 34. Inst. Geol Prace, Warszawa, pp 145–154

Musson F, Wintle AG (1994) Luminescence dating of the loess profile at Dolní Věstonice, Czech Republic. Quat Geochronol 13:411–416

Poborský V, Čižmář M, Dvořák P, Erhart A, Janaák V, Medunová-Benešová A, Nekvasil J, Ondráček J, Pavelčík J, Salaš M, Stuchlík S, Stuchlíková J, Šebela L, Šmíd M, Štrof A, Tejral J, Valoch K (1993) Pravěké dějiny Moravy. Vlastivěda moravská—Země a lid. Nová řada sv. 3. Muzejní a vlastivědná společnost, Brno 543 pp (In Czech)

Poul I (2004) Názor na stáří jeskyně Na Turoldu na základě paleonapjatostní analýzy. In: Bosák P, Novotná J (eds) Český speleologický kongres, ČSS, Sloup 2004. Praha, pp 85–89 (In Czech)

Poul I, Melichar R (2009) Orientace příčných zlomů v Pavlovských vrchách na jižní Moravě (Západní Karpaty). Geol. výzk. Mor. Slez 16:70–74 (In Czech)

Poul I, Bubík M, Krejčí O, Švábenická L (2010) Strukturní interpretace vmístění svrchnokřídových sedimentů do svrchnojurských vápenců skalní stěny Martinka (Pavlovské vrchy). Geol. výzk. Mor. Slez 17:126–128 (In Czech)

Poul I, Melichar R, Janečka J (2011) Thrust tectonics of the Upper Jurassic limestones in the Pavlov Hills (outer Western Carpathians, Czech Republic). Geol Soc Spec Publ 349:237–248

Špůrek M (1972) Historical catalogue of slide phenomena. Studia Geographica 19. Geografický ústav ČSAV, Brno, 180 pp

Stráník Z, Čtyroký P, Havlíček P (1999) Geologická minulost Pavlovských vrchů. Sbor. geol. Věd, Geol. 49:5–32 (In Czech)

Vítek J (2013) Škrapy ve vápencích Pavlovských vrchů. Acta Mus. Moraviae. Sci geol 98:91–109 (In Czech)