Geotouristical values of the Pieniny Klippen Belt and Tatra Mountains regions (Poland)

Michał Krobicki, Jan Golonka[1]

M. Krobicki

J. Golonka

The Poland prime geotouristic attractions are the Pieniny Klippen Belt and the Tatra Mountains located in the Podhale region within the Carpathians range in southern Poland at the Polish-Slovak Republic border (Figs. 1, 2, 3). The European Union Schengen Agreement allows visiting geotouristic localities on both sides of the border without any formalities. Podhale is accessible by many routes; the most convenient one is road Cracow–Nowy Targ (Fig. 1) from the Cracow city centre or from Balice airport. The route leads southward and after few kilometers it passes over the frontal thrust-faults of the Outer Carpathian flysch belt (see Malata — page 688). Crossing the Subsilesian and Silesian nappes route is reaching the Magura Nappe within Myślenice town limits. From Myślenice the road is leading up the Raba River valley crossing the thrust-faults of the Magura Nappe. The inverted structure of the Magura Nappe forms isolated forested mountains of the Beskid Wyspowy (Island Beskid) and Gorce Mountains. The 18th century wooden Holy Cross Church and the location of the borehole Obidowa IG-1 are situated in the Gorce Mts., on the slope of the Obidowa Mt. The beautiful panorama of the Tatras with the highest peak of Gerlach (2655 m a.s.l.) and an isolated cone of the Babia Góra Mt. (1725 m a.s.l.), the highest mountain of the Polish Outer Carpathians is visible from the Obidowa parking lot. From Obidowa the route is descending to Nowy Targ which is a gateway to both the Pieniny and Tatra Mts. (Fig. 1).

Pieniny Klippen Belt

The Northern Carpathians are subdivided into an older range known as the Central Carpathians and the younger one, known as the Outer or Flysch Carpathians. The Pieniny Klippen Belt (PKB) is situated at the boundary of these two ranges. The Central Carpathians nappes contact along a Tertiary strike-slip boundary with the Pieniny Klippen Belt.

The relationship between the Pieniny Klippen Belt and the Magura Nappe changes along the PKB strike. In the Vah and Orava valleys (Slovakia) these two units are divided by the Miocene sub-vertical strike-slip fault and both units are involved in the complex flower structure. Present day confines of the Pieniny Klippen Belt are strictly tectonic. They may be characterized as (sub)vertical faults and shear zones (Fig. 2), along which a strong reduction of space of the original sedimentary basins took place (Birkenmajer, 1986). The NE-SW striking faults accompanying the Klippen Belt have the character of lateral slips. It is indicated by the presence of flower structures on the contact zone of the Magura Unit and the Klippen Belt, or by the structural asymmetry of the Central Carpathian Paleogene Basin.

The tectonic character of the Polish section of the PKB is mixed. Both the strikeslip and thrust components occur here (e.g., Książkiewicz, 1977; Birkenmajer, 1986; Golonka et al., 2006 and references therein). In general the Jurassic-Lower Cretaceous basinal facies display the tectonics of the diapir character originated in the strike-slip zone between two plates. The ridge facies are often uprooted and display thrust or even nappe character (e.g., the so-called Niedzica Succession is thrust over the Czorsztyn Succession) (e.g., Książkiewicz, 1977; Birkenmajer, 1986; Golonka et al., 2005b, 2006 and references therein). The PKB tectonic components of different age, strike-slip, thrust as well as toe-thrusts and olistostromes mixed together, are giving the present-day melange character of the PKB, where individual tectonic units are hard to distinguish.

The major geotouristic attraction of the Pieniny Klippen Belt region is rafting through the Dunajec River

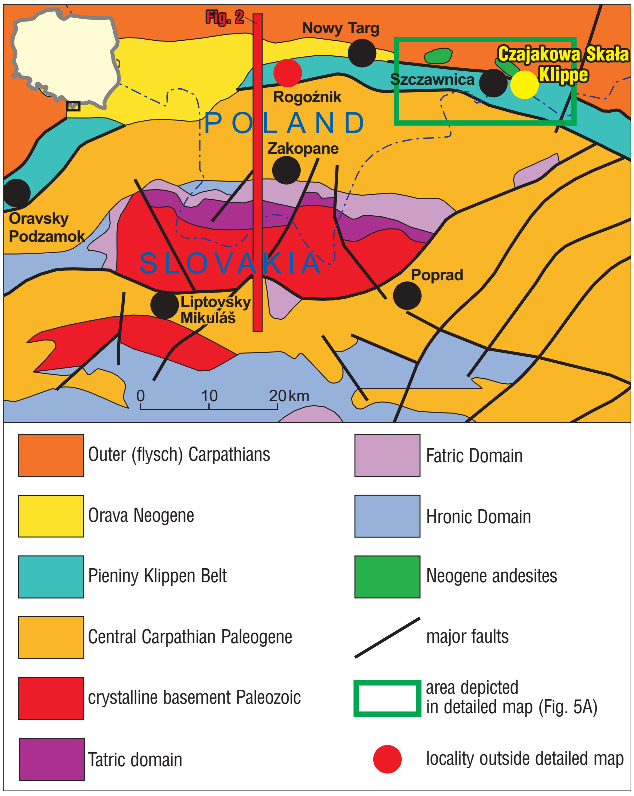

Fig. 1. Simplified geological sketch of the Tatra Mts., Pieniny Klippen Belt and surrounding regions (from Jurewicz, 2005; modified)

[1]AGH University of Science and Technology, Department of General Geology, Environmental Protection and Geotourism, al. Mickiewicza 30, 30-059 Kraków, Poland; krobicki@geol.agh.edu.pl; jan_golonka@yahoo.com

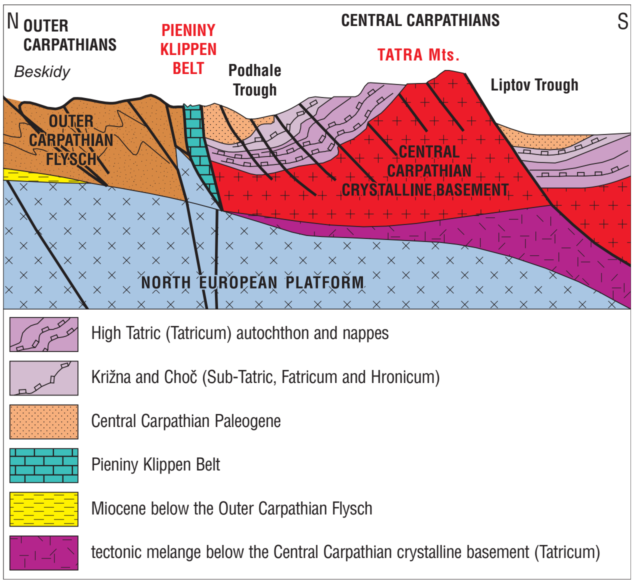

Fig. 2. Generalized cross-section across trans-bordering Polish-Slovakian Carpathians (from Jurewicz, 2006; modified). Not to scale. Length of the area approximately 70 km. The highest summit of the Tatra Mts. is 2655 m, elevation of the Beskidy, Podhale and Liptov Troughs approximately 700–1300 m, elevation of the Pieniny Klippen Belt approximately 700–1000 m

Gorge (Golonka & Krobicki, 2007, see also Alexandrowicz & Alexandrowicz, 2004) (Fig. 4). The trip from Nowy Targ to rafting harbor takes us first to the Snozka Pass parking lot, where looking southward, panorama of the Tatras, Pieniny and Podhale trough with Czorsztyn Lake, and looking northward of the Gorce Mts., are visible. The pass is located within the Magura Nappe between Gorce and Pieniny Mts., nearby the ancient andesitic sub-volcano of Wżar Mt. (Fig. 5). From the Snozka Pass we are descending into the Krośnica village across the Magura Nappe and going uphill into the Pieniny Mts., which belong to the Pieniny Klippen Belt. The Pieniny Mts. belong to the Polish Pieniny National Park (Pieniński Park Narodowy) and its Slovak equivalent Pieninský Narodný Park (Golonka et al., 2005a; Golonka & Krobicki, 2006, 2007). The parks fulfill their nature preservation role, conducting also scientific research, education and touristic activities. The rafting trip on the Dunajec River, which starts at Sromowce Kąty harbor (Fig. 4), takes a geotourist through the Dunajec Gorge to Szczawnica. The Dunajec offers magnificent view of the cliffs sculptured in the Pieniny Mts. by the tectonic activity and river's erosion. It offers also the close view of the outcrops of Jurassic and Cretaceous rocks and complex tectonics of the Pieniny Klippen Belt (Fig. 4 A, C–E).

The Pieniny Klippen Belt is composed of several successions of mainly deep and shallow-water limestones, covering a time span from the Early Jurassic to Late Cretaceous (Birkenmajer, 1977, 1986; Golonka & Krobicki, 2004, Golonka et al., 2005b, 2006 and references therein). This strongly tectonized structure is about 600 km long and 1–20 km wide, stretching from Vienna to the west, to Romania to the east.

During the Jurassic and Cretaceous within the Pieniny Klippen Basin the submarine Czorsztyn Ridge („pelagic swell", mainly the so-called Czorsztyn Succession) and surro-

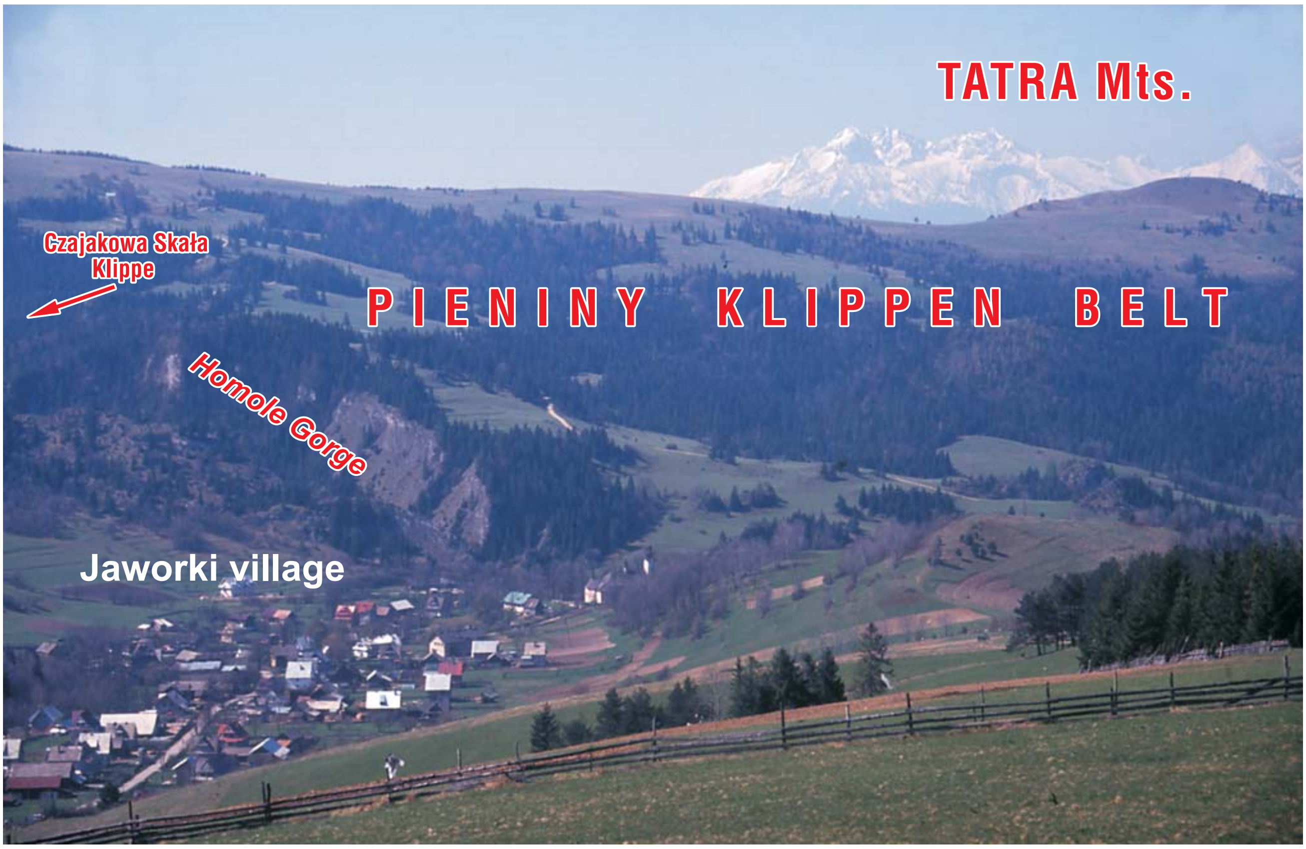

Fig. 3. General, panoramic view of the Tatra Mts. and Pieniny Klippen Belt regions from the vicinity of the Jaworki village. Photo by M. Krobicki


P O L A N D
S L O V A K I A
Szczawnica
Sokolica
E
Trzy Korony
Kąty
Macelowa Góra
Sobczański Gorge
Mnichy
Facimiech
Dunajec
A
D
B
C
Dunajec
Sromowce Średnie
Sromowce Niżne
Červený Kláštor
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D
E
Sokolica

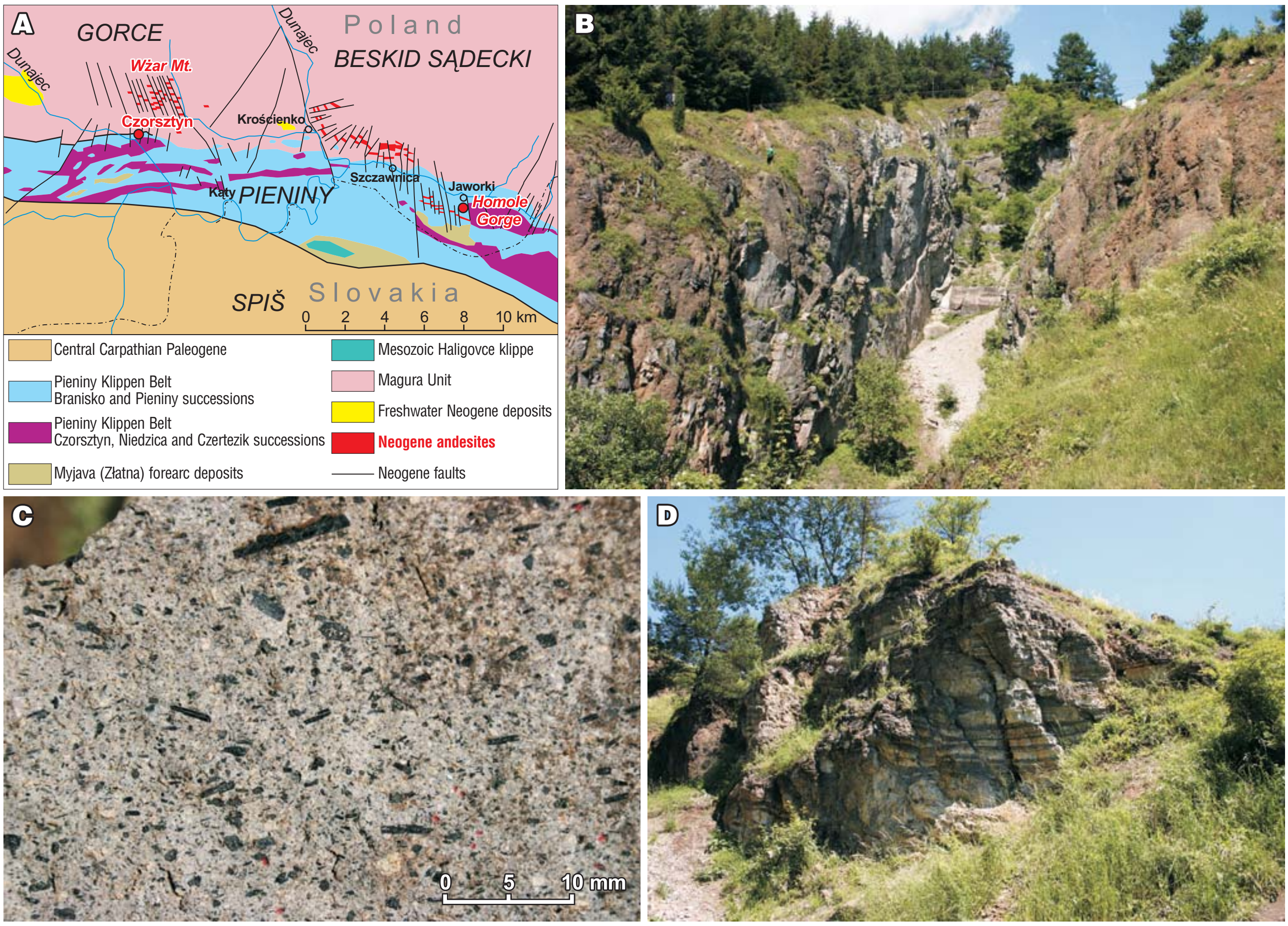

Fig. 5. Geological position of Miocene andesites: A — geological sketch of the Pieniny Klippen Belt (Polish sector) and surrounding regions (after Birkenmajer, 1979; simplified); B — main entrance to abandoned quarry; C — andesites with piroxenes and amphibolites; D — thermally changed flysch deposits of the Magura Unit (Outer Carpathians). Photo by M. Krobicki

unding zones formed an elongated structure with domination of pelagic type of sedimentation (Birkenmajer, 1977, 1986; Wierzbowski et al., 1999; Golonka & Krobicki, 2004; Golonka et al., 2005b, 2006 and references therein). The Pieniny Klippen Basin trends SW to NE (see discussion in Golonka & Krobicki, 2001, 2004). Its deepest part shows the presence of deep water Jurassic-Early Cretaceous deposits (pelagic limestones and radiolarites) (Golonka & Sikora, 1981; Golonka & Krobicki, 2001, 2004). Sedimentary zones known as the Pieniny, Branisko (Kysuca) successions have been located close to central furrow. Transitional slope sequences between basinal units and ridge units are known as Czertezik and Niedzica successions (Podbiel and Pruské successions in Slovakia) near the northern (Czorsztyn) Ridge, and Haligovce-Nižná successions near the southern so-called Exotic Andrusov Ridge (Birkenmajer, 1977, 1986; Golonka et al., 2005b, 2006 and references therein). The strongly condensed Jurassic-Early Cretaceous pelagic cherty limestones (*Maiolica* – type facies) and radiolarites of the Grajcarek Unit were also deposited in the northwestern Magura Basin. The basinal successions are visible along the rafting trip (e.g., Fig. 4 D), while the Czorsztyn Succession is best exposed at the Rogoźnik Klippe (Fig. 6), Homole Gorge (Figs. 3, 7) and Czorsztyn Castle (Fig. 8).

The Rogoźnik (or Rogoża) klippen (Alexandrowicz et al., 1997) lies within the nature reserve, located south of the village of Rogoźnik, and of the Wielki Rogoźnik stream. The locality comprises a small klippe as well as the neighboring abandoned quarry (Fig. 6). The former is the type locality of the Rogoźnik Coquina Member, the latter of the Rogoża Coquina Member (Birkenmajer, 1977). Both these lithostratigraphic units constitute a special ammonite coquina-type development of the Upper Jurassic deposits (cf. Kutek & Wierzbowski, 1986). The klippen at the Rogoźnik village are well known since the 19th century, as the Pieniny Klippen Belt the richest Upper Jurassic ammonite locality with very detail biostratigraphic documentation (Kutek & Wierzbowski, 1986; Wierzbowski et al., 2006), and with rich brachiopod fauna as well (Krobicki, 1994; Wierzbowski et al., 2006).

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Fig 4. Aerial view of the central Pieniny Mts. and Dunajec River Gorge with points of photos: A – Upper Cretaceous red marls of the *Scaglia Rossa*-type facies (Macelowa Mt.); B – close to beginning of the rafting in Sromowce-Kąty harbor in the Pieniny Mts., boat full of tourists; C – Trzy Korony Mountain built of *Maiolica*-type well-bedded cherty limestones usually strongly tectonically folded (D); E – Sokolica Mt. over the Dunajec River Gorge. A–E photo by M. Krobicki

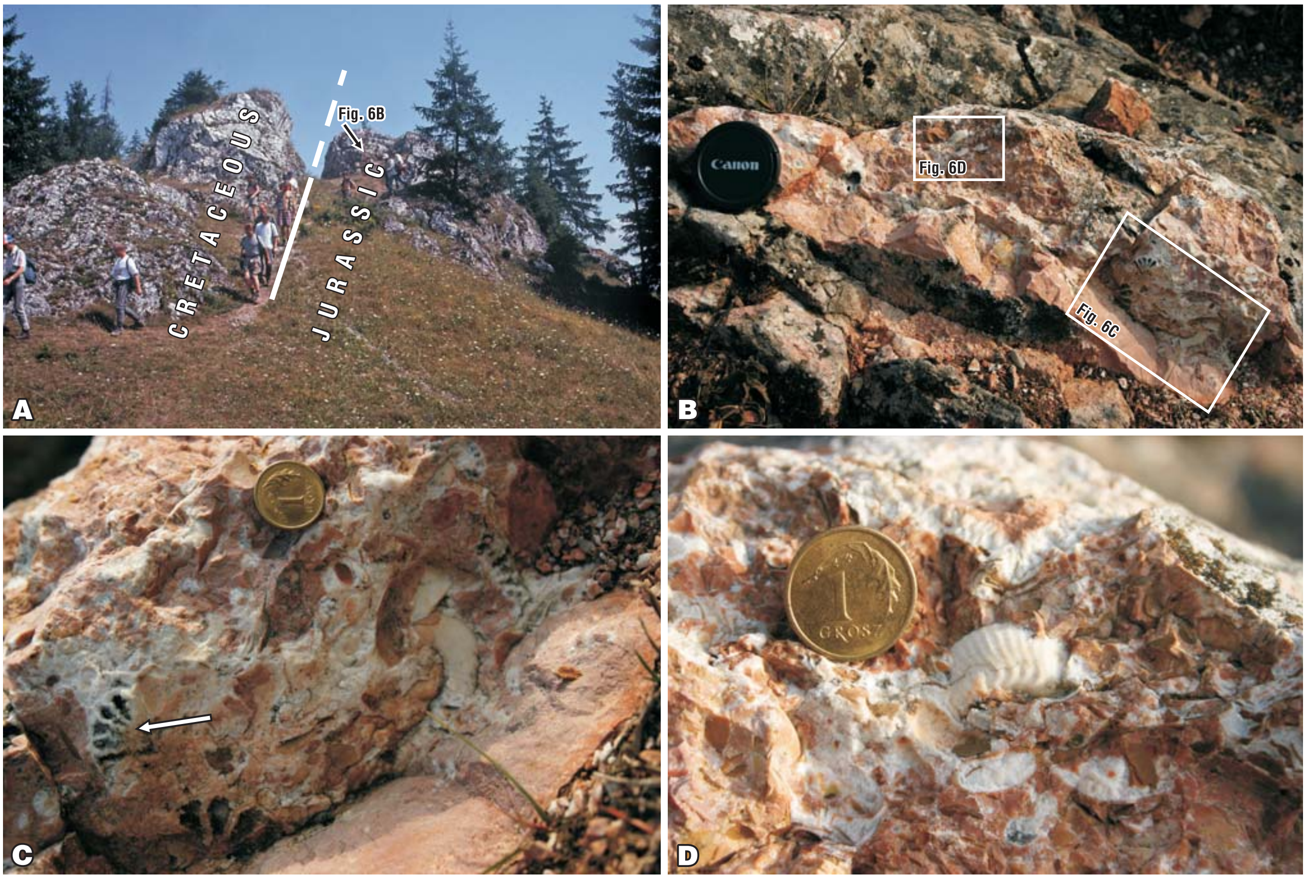


Fig. 6. Jurassic-Cretaceous boundary in famous Rogoźnik ammonite coquina: A — boundary between Jurassic and Cretaceous beds in the Rogoźnik Klippe; B — typical ammonite sparry coquina full of ammonites usually filled by sparry calcite (C — arrow) with typical ornamentation of uppermost Jurassic ammonite *Simocosmoceras* (D). Photo by M. Krobicki

South of the Jaworki village (Fig. 3), the Homole tectonic block is cut through with famous deep gorge. Up to near 100 m thick section of white crinoidal limestones of the Smolegowa Limestone Formation of the Czorsztyn Succession is exposed (Birkenmajer, 1963, 1977). These deposits are overlain by red crinoidal limestones (of the Krupianka Limestone Formation) and *Ammonitico Rosso* – type nodular limestones (of the Czorsztyn Limestone Formation) which reach maximum 20 m in thickness. Both crinoidal units are the Bajocian (Middle Jurassic) in age whereas condensed nodular limestones of the Czorsztyn Limestone Formation can be dated as the Middle and Late Jurassic. The succession reflects the deepening-upward sequence, showing decrease of sedimentation rate in pelagic sedimentation regime during late Mid-Late Jurassic time. In the higher part of the Homole Gorge one of the

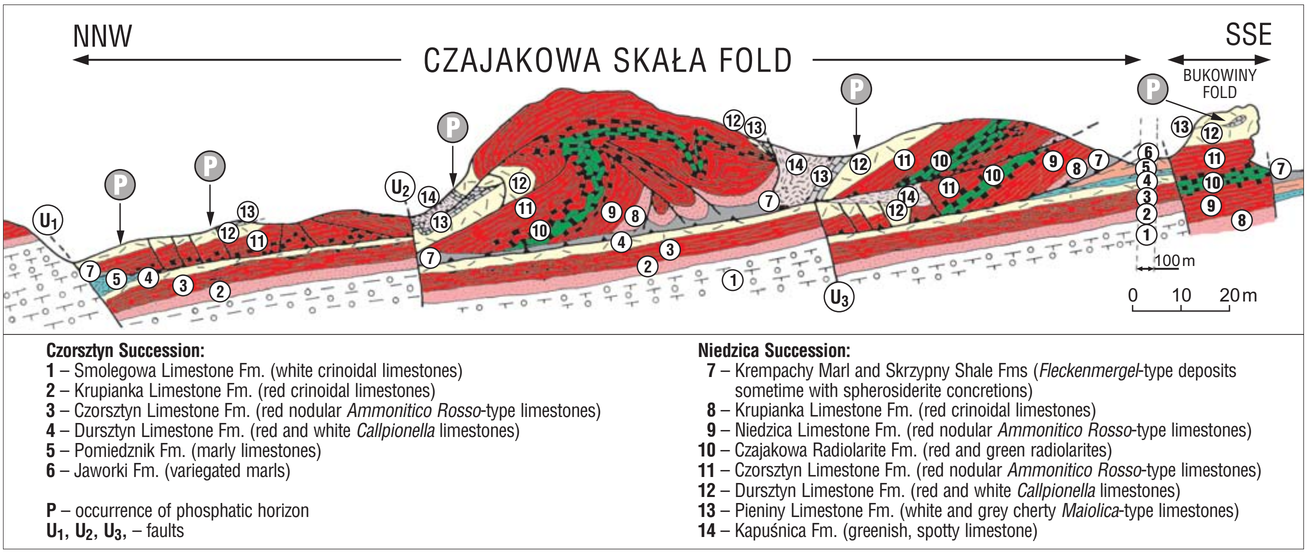
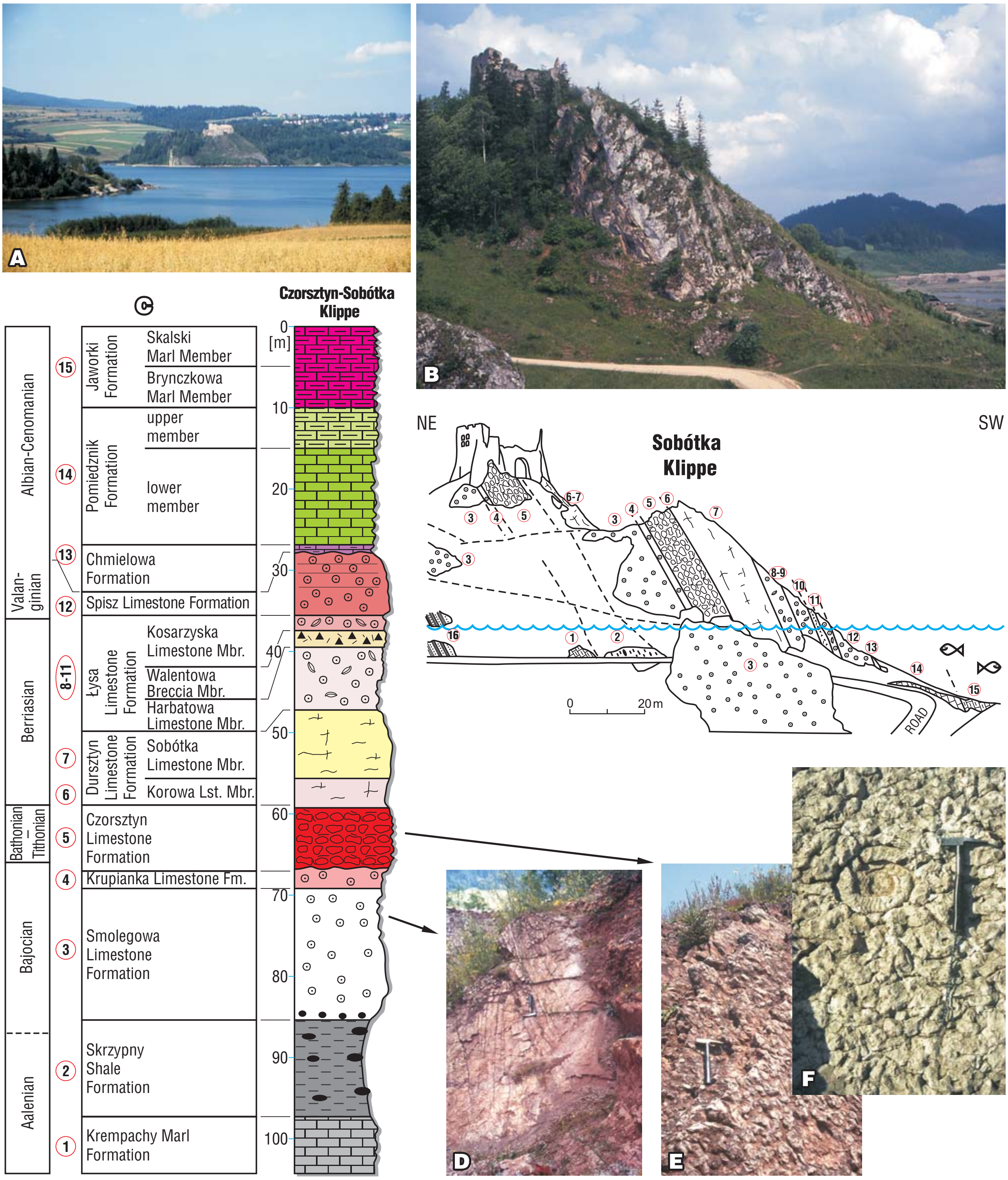


Fig. 7. Czajakowa Skała fold and Bukowiny fold, western wall of the Homole Gorge (geology after Birkenmajer, 1970; modified by Jurewicz, 1994)



Czorsztyn Succession in the Czorsztyn-Sobótka Klippe and the Czorsztyn Castle Klippe (after Birkenmajer, 1977):
1 – Krempachy Marl Fm. (spotty limestones/marls of *Fleckenkalk/Fleckenmergel*-type facies)
2 – Skrzypny Shale Fm. (black shales with spherosiderites)
3 – Smolegowa Limestone Fm. (white crinoidal limestones)
4 – Krupianka Limestone Fm. (red crinoidal limestones)
5 – Czorsztyn Limestone Fm. (red nodular limestones of the *Ammonitico Rosso*-type facies)
6-7 – Dursztyn Limestone Fm.:
6 – Korowa Limestone Mbr. (pink micritic limestones)
7 – Sobótka Limestone Mbr. (white micritic limestones)
8-11 – Łysa Limestone Fm.:
8-9 – Harbatowa Limestone Mbr. (brachiopod-crinoidal limestones)
10 – Walentowa Breccia Mbr. (sedimentary limestone breccia)
11 – Kosarzyska Limestone Mbr. (crinoidal-brachiopod limestones)
12 – Spisz Limestone Fm. (red crinoidal limestones)
13 – Chmielowa Fm. (violet limestones)
14 – Pomiedznik Fm. (marls/limestones)
15 – Jaworki Fm. (variegated marls)

Magura Succession (Grajcarek unit):
16 – Szlachtowa Fm. (black flysch)

Fig. 8. A — panoramic view of the Czorsztyn Castle over artificial Czorsztyn Lake; B — a vast view of the Sobótka Klippe (state — 1992) with geological sketch of this section and the Czorsztyn Castle Klippe (Czorsztyn) (after Birkenmajer, 1963, 1979, modified). C — lithostratigraphic column of the Czorsztyn Succession in the Czorsztyn-Sobótka Klippe and the Czorsztyn Castle Klippe (after Birkenmajer, 1977); D — cross-bedded structure within white crinoidal limestones of the Smolegowa Limestone Formation (Czorsztyn Castle Klippe); E — typical nodular feature of red *Ammonitico Rosso*-type limestones with large ammonites (F). Photo by M. Krobicki

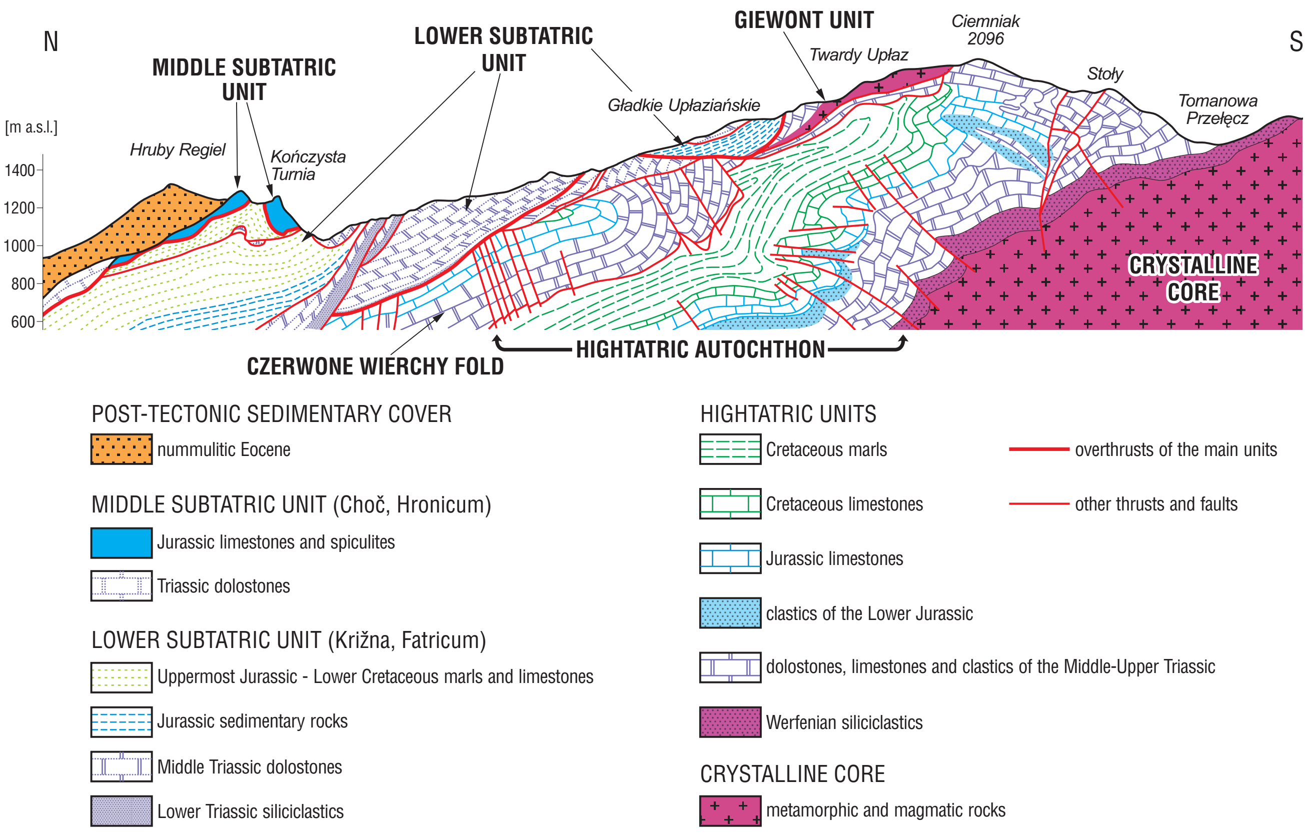


Fig. 9. Geological cross-section along the eastern slopes of the Kościeliska Valley (after Kotański, 1961; Uchman, 2006)

famous fold structure of the Pieniny Klippen Belt known as Czajakowa Skała Klippe occurs (Birkenmajer, 1970; 1979) (Fig. 7). The Niedzica Nappe is there thrust over thick Czorsztyn Unit. Several beds both of red nodular limestones (of the Niedzica Limestone Formation and Czorsztyn Limestone Formation) and intercalated radiolarites (of the Czajakowa Radiolarite Formation — here is the stratotype of the unit) are strongly internally folded (Birkenmajer, 1970; Jurewicz, 1994). The Czajakowa Skała Klippe shows a complete sequence of the Jurassic deposits of the Niedzica Succession (Birkenmajer, 1977; Wierzbowski et al., 1999).

The Czorsztyn Castle was built in medieval times as an important fortification guarding the Polish-Hungarian border. From parking lot, we take a walk to the Czorsztyn Castle Klippen group which includes one of the most famous geological sites of the Pieniny Klippen Belt with full sequence of the Czorsztyn Succession from the Middle Jurassic up to Upper Cretaceous deposits (Fig. 8 B, C), rich in invertebrate fossils such as: ammonites, brachiopods, crinoids, calpionellids, foraminifers, described and illustrated by numerous authors since the beginning of the 19th century (e.g., S. Staszic, L. Zejszner (Zeuschner), E. Suess, M. Neumayr, K. A. Zittel, V. Uhlig et al. in: Krobicki et al., 2006a with literature therein). Unfortunately, the water of present Czorsztyn Lake covered the great part of this sequence (lowermost — lower part of the Middle Jurassic and upper part — the Upper Cretaceous), and only Bajocian-Berriasian interval is available to study (Fig. 8 A, B). The significance of the Czorsztyn Castle klippen first became apparent in the 19th century when the occurring here deposits including nodular limestones of the *Ammonitico Rosso*-type facies (Fig. 8) were described. They are underlain by crinoidal limestones with perfectly preserved cross-bedding structure (Krobicki et al., 2006a) (Fig. 8 D), a rare example of such sedimentological feature in the whole Pieniny Klippen Belt.

Tatra Mountains

The Central Carpathian Paleozoic and Mesozoic rocks crop out in the Tatra Mts. (Figs. 1, 2, 9). North of the Tatras, they are covered by the Central Carpathian Paleogene and are known only from boreholes and geophysical data (Golonka et al., 2005b).

The Tatra Mts. (Fig. 9) are the highest mountain range of the Carpathians, located in their western part and drained by the Dunajec River with tributaries flowing to the Baltic Sea and Vah River with tributaries flowing to the Black Sea. The mountains extend 78 km along the Polish-Slovakian border. The total area of the range is 785 sq. km, with 175 sq. km lying in Poland and the rest in Slovakia. There are thirty-four summits in the range that reach over 2000 m. Of these six reach 2500 m. The highest peak in the range, Gerlach (Gerlachovský štít) (2655 m), is in Slovakia.

The Tatra Mts. form a relatively high elevated asymmetric horst tilted northward, cut off from the south by a major Neogene-Quaternary normal fault and surrounded by sediments of the Central Carpathian Paleogene (Figs. 1, 2). The crystalline core form central and southern part of the Tatra Mts. Western, northern and northeastern parts are covered by autochthonous Mesozoic rocks and several allochthonous thrust sheets and small nappes (Figs. 2, 9). All these units are discordantly covered with a post-nappe trans-

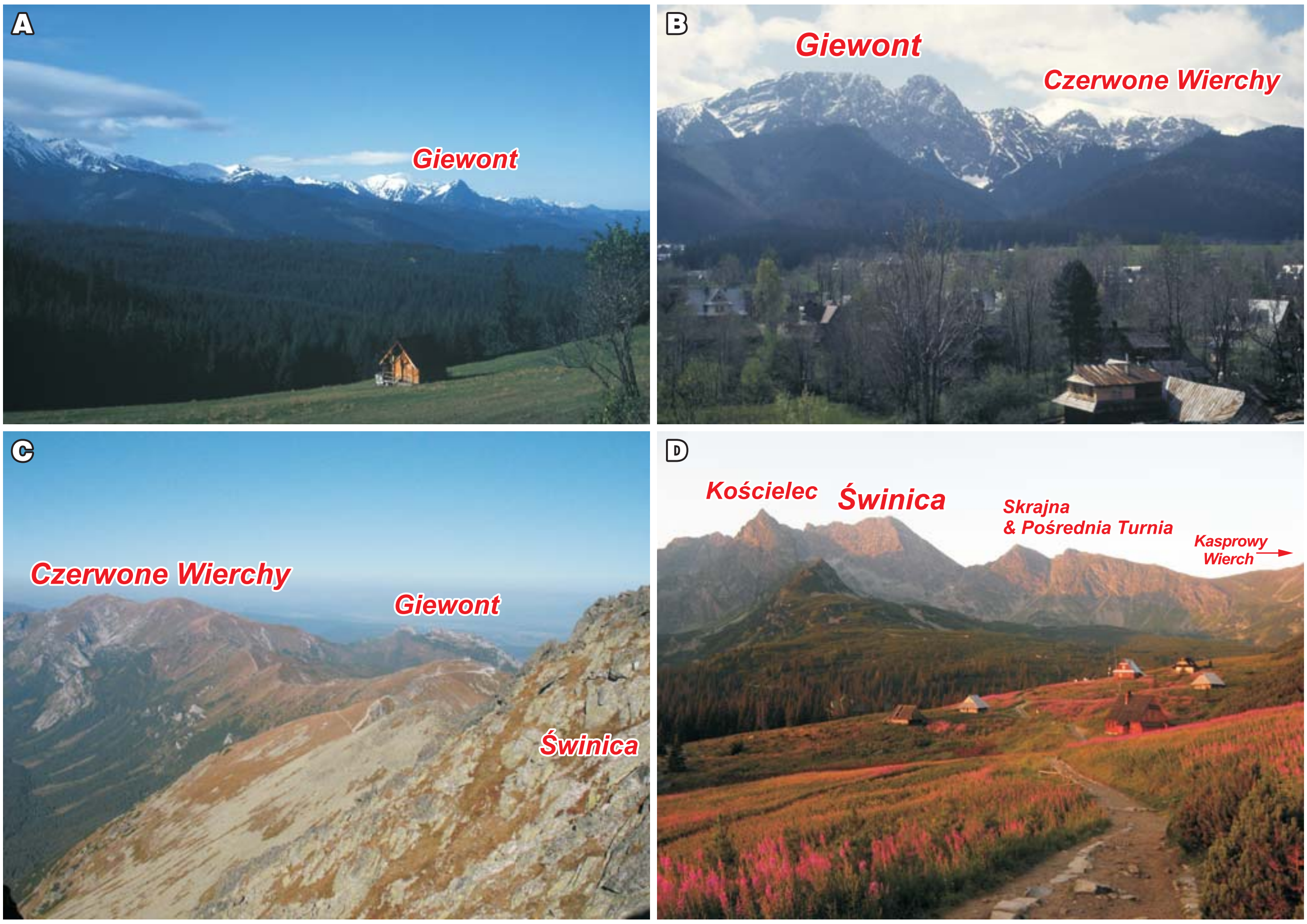


Fig. 10. Panoramic view of the Tatra Mts. with most characteristic shape of the Giewont Mt. (from north — A, B and from south — C) and the Gąsienicowa Hala area during sunrise (D). A, B — photo by M. Krobicki; C, D — photo by K. Krobicka

gressive succession of the Central Carpathian Paleogene Basin (Figs. 2, 9). The crystalline basement consists of granitoids and metamorphic envelope. Granitoids, represented by tonalities and granodiorites with subordinate amount of granites, originated during a continental collision between 360 and 314 Ma (Poller et al., 2001). The metamorphic envelope, composed of two structural units contains migmatites, amphibolites, schists and gneisses. Rocks of the Tatra Mts. were affected by Variscan (Paleozoic) and Alpine (Mesozoic-Cenozoic) tectono-metamorphic events. The best way to examine the Tatras' crystalline core is to take the trip by cable gondola car to Kasprowy Wierch (1.987 m a.s.l.). The cable car constructed in 1936 and remodeled recently covers the distance of about 4.300 m and altitude difference about 900 m within 17 minutes. Kasprowy Wierch is located in the centre of the mountain range so geotourist can enjoy magnificent panorama of both the Western with Giewont, Czerwone Wierchy and Krywań as well as High (Eastern) Tatras is visible. The peak is built of the Paleozoic metamorphic rocks. The hiking trail will take more experienced tourists (Fig. 10) to Świnica (Fig. 10 C, D) and Orla Perć (*Eagle Ridge*) (Fig. 11 A, C[2]) with granitic mountain core. Less experienced geotourists can enjoy the trail downhill toward Gąsienicowa Hala (Fig. 10 D) and Zakopane. On this trail both metamorphic and sedimentary rocks can be observed. The site trip to Czarny Staw Gąsienicowy allows examining granitic rocks (Fig. 11 F[2]).

The Tatras Mesozoic sedimentary rocks were deposited within the Central Carpathian block which was bordered by the Alpine Tethys to the north and Meliata Ocean to the south. The area between two oceans was divided into six paleogeographic domains, partially reflected by present-day tectonic units: Tatric, Fatric, Veporic, Gemeric, Hronic and Silicic (Andrusov et al., 1973). The Tatras' rocks belong to the Tatric, Fatric and Hronic domains. The Tatric domain is represented by the High-Tatric unit (Fig. 9) (Kotański, 1961), which includes the sedimentary cover of the crystalline core and the lower units of the overlying allochthon. The oldest, perhaps Permian conglomerates, crop out in a single locality (Koperšady). The Lower Triassic is characterized by red sandstones, followed by mudstones, which are overlain by the Middle Triassic platform limestones and dolostones and Upper Triassic red beds of the Keuper type and coeval intertidal laminated dolostones, Rhaetian clastics, and shallow-marine fossiliferous limestones (Kotański, 1959, 1979). Lower Jurassic clastics and limestones occur in local troughs formed by block tectonics related to the rifting in the Western Tethys. The Middle Jurassic contains local crinoidal limestones, nodular limestones, commonly with stratigraphic gaps and condensations, stromatolites, and iron crusts, the Upper Jurassic pelagic limestones display locally nodular

[2] Fig. 11 (A–F) see page 711

structures. Locally (Osobitá Mt.), shallow-marine crinoidal limestones with volcanic rocks (limburgite) occur. Shallow-marine platform limestones of the Urgonian-type (Schrattenkalk) facies typify the Lower Cretaceous. The Lower-Middle Albian occurs only locally as condensed deposits with glauconite and phosphates, indicating drowning of carbonate platform. During the terminal basin development (Middle Albian-Cenomanian), marls with turbidites indicate a deepening of facies (Lefeld, 1985).

Fatric and Hronic domains are represented by the Krížna (Lower Sub-Tatric), Choč (Middle Sub-Tatric), and the (Strážov) (Upper Sub-Tatric) units occurring exclusively in thrust sheets, which overlie the High-Tatric units (Lefeld, 1999) (Fig. 9). The Krížna (Fatric) Triassic sequence contains the Lower Triassic red bed clastics, Middle Triassic platform dolostones, and the Carpathian Keuper and Rhaetian fossiliferous limestones (Kotański, 1959, 1979). The Jurassic facies are characterized by gradual deepening from shallow marine-clastics, through spotty limestones and marls (*Fleckenmergel* facies), spiculites and radiolarites, to nodular *Ammonitico Rosso*-type and *Maiolica* limestones. Basinal marls and limestones dominated in the Lower Cretaceous deposits in the western part of the Tatra Mts., while in the eastern part (Belanské Tatry) massive carbonates occurred (Lefeld, 1985; Wieczorek, 2000; Golonka et al., 2005b).

The Choč units (Hronic) comprise typical Alpine Triassic facies, including the Hauptdolomit, the Rhaetian Kössen facies, and the Lower Jurassic encrinites, spiculites, and Hierlatz–type limestones (Kotański, 1973; Iwanow & Wieczorek, 1987; Uchman, 1993). The Upper Sub-Tatric units (also Hronic), represented only by two small thrust sheets, are typified by the basinal Middle Triassic Reifling Limestone, Partnach Marl, and the shallow-marine Upper Triassic Wetterstein facies. All of the allochthonous units were thrust northward in the Late Cretaceous (Kotański, 1986a, b; Iwanow & Wieczorek, 1987; Jurewicz, 2005).

The best way to examine the Tatras' sedimentary rocks is to visit Kościeliska and Chochołowska valleys. From the parking lot and bus stop in Kiry (Kościelisko) about 7 km from the Zakopane town centre, the 6 km long trail will take us through Brama Kantaka, Brama Kraszewskiego, Polana Pisana to mountain lodge at Hala Ornak in the higher part of Kościeliska Valley. The entrance to the valley is built of Eocene Nummulitic limestones, farther up the valley the Mesozoic rock of the Krížna (Lower Sub-Tatric) nappe are exposed. They were beautifully sculptured by karst phenomena (Fig. 9).The Western Tatra peaks south of Hala Ornak are built of Paleozoic metamorphic rocks. The Tatra Mts. belong today to the Tatra National Pak and are well protected, but in the past, until the 19th century, the ores were mined in the Kościeliska and Chochołowska valleys. The old mining road, the so-called Iron Road is now the popular walking trail connecting Kościeliska Valley with Kuźnice, the site of the 19th century steel, today the site of lower station of the Kasprowy Cable car.

The erosion of the Mesozoic units took place in Late Cretaceous-Eocene times. A subsequent transgression took place in the Middle Eocene that resulted in the formation of conglomerates and limestones forming the basal member of the Podhale Paleogene. Sediments of the calcareous Eocene are known from numerous natural exposures situated at the outlets of valleys draining the Tatras massif and from drillings made in the Podhale Basin (Golonka et al., 2005b). Directly on the transgressive deposits of the calcareous Eocene, stratigraphically younger strata of the Paleogene occur, i.e. the Podhale flysch. The oldest part of this flysch — the Zakopane Formation (Lexa et al., 2000) is well exposed in the streams in the marginal part of the Tatra Mts. The uplift of the Tatras, dated using apatite fission tracks, took part probably during the Miocene (15–10 Ma) (Golonka et al, 2005b). Glaciation covered all higher areas of the High Tatras and parts of the Western Tatras. The Tatra Mts. (especially the High Tatras) are known to have undergone four glaciations. The most extensive transformations were caused by a glacier 100–230 m thick. Valleys were gouged by the glaciers into the characteristic U-shape. Hanging valleys were created in subsidiary valleys, the glacial erosion also sharpened the mountain ridges and formed deep cirques, with terminal moraines creating large numbers of glacial lakes after the ice had retreated (Fig. 11 B, D[2]). The most beautiful glacial lakes are located in the broad High Tatra valleys, like the Sucha Woda Valley with aforementioned Czarny Staw Gąsienicowy, Dolina Pięciu Stawów Polskich (Five Lakes Valley) or Rybi Potok Valley with Morskie Oko Lake (Fig. 11 B, D, E[2]). Material carried down by the glaciers to the foreland formed glacial cones, on one of which the Polish town of Zakopane now stands. The glaciers disappeared from the Tatras about 10 000 years ago. There is now no permanent lying snow on the mountains. The karst, which includes karrens, abysses, vauclusive springs and limestone caves play an important role in creating the Tatras sedimantary cover landscape. Six caves are open to public in Poland, including Jaskinia Mroźna (the Frosty Cave) with electric light; however, the most interesting cave accessible to the public is Belianska jaskyna in Tatranska Kotlina in Slovakia.

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[2] Fig. 11 (A–F) see page 711

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Geotouristical values of the Pieniny Klippen Belt and Tatra Mountains regions (Poland) (see page 670)

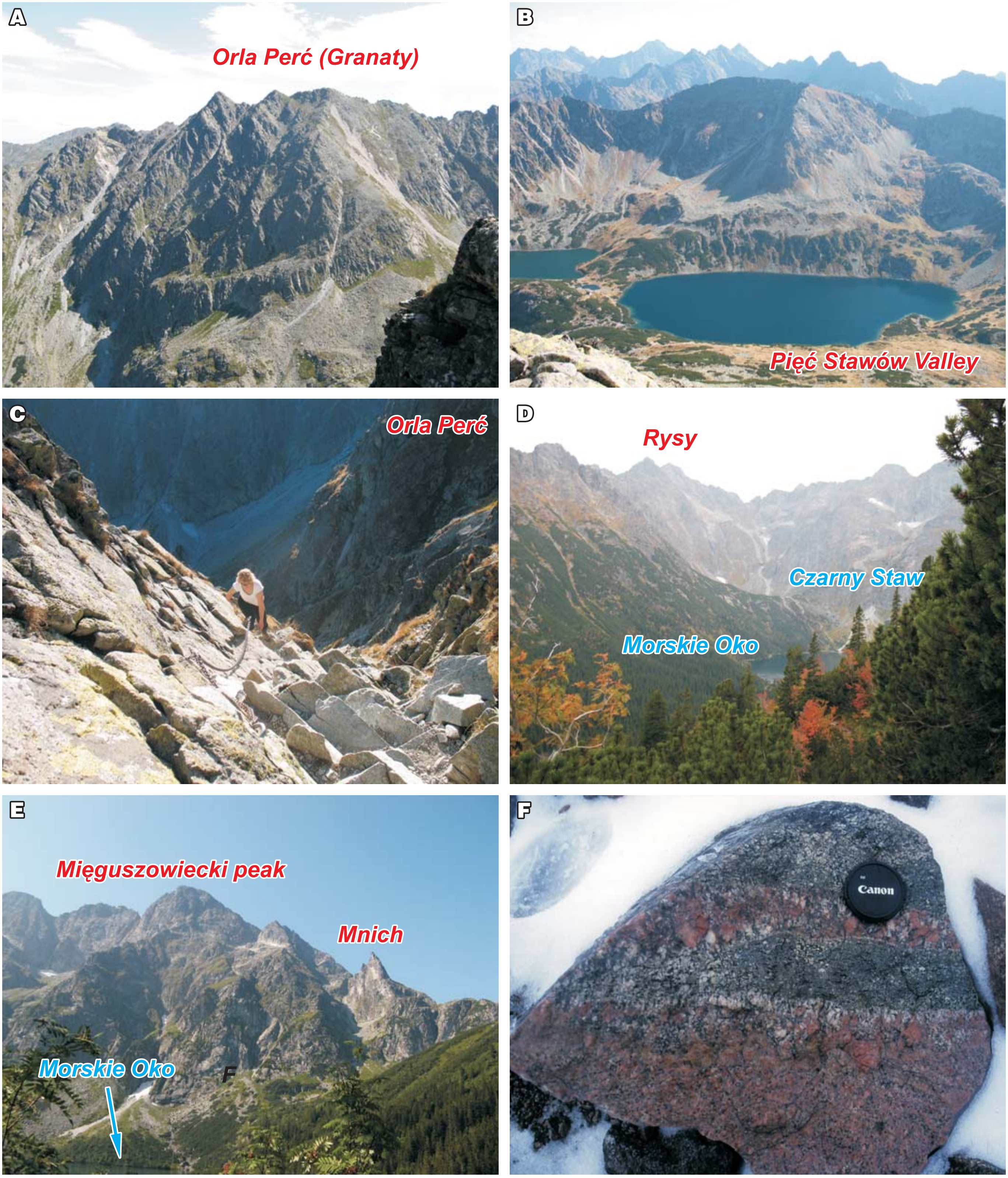

Fig. 11. Central part of the High Tatra Mts. with typical alpine character of ridges , e.g., so-called Orla Perć — A, C; postglacial lakes — B, D; famous climbing walls — E, built of Carboniferous granitoids full of pegmatites (F). Photo by K. Krobicka