Geo TOURISM

GEOTURYSTYKA

ISSN 1731-0830

Wydawnictwa AGH Kraków 2014

Stowarzyszenie Naukowe im. Stanisława Staszica

International Association for Geotourism

1 (36) • 2014

Geo TOURISM
GEOTURYSTYKA
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GeoTOURISM

(Geoturystyka)

"Geotourism / Geoturystyka" is a scientific magazine published by AGH University of Science and Technology (Krakow) and Stanislaw Staszic Scientific Association (Krakow).

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The printed version of the journal is the primary one.
Printed version: ISSN 1731-0830
Electronic version: ISSN 2353-3641
DOI: http://dx.doi.org/10.7494/geotour
Circulation: 140 copies

Geotourism 1(36) 2014: 3–14
http://dx.doi.org/10.7494/geotour.2014.36.3

Klimkówka Lake in Beskid Niski – geotouristic aspects

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Abstract: *The Klimkówka Lake geotouristic site is one of the greatest attractions of the Beskid Niski Mountains of the Polish Carpathians Mts. Nearly 20 years of existence of the artificial dam lake generated the development of tourism in the area. The great advantage of Klimkówka Lake region is the presence of a number of spectacular surface rock outcrops situated in convenient locations for visitors, in which crop out the youngest rocks of the Rača Zone of the Magura Nappe. The area around the Klimkówka Lake is a great training ground to acquire knowledge of the geology of the Outer Carpathians, as well as different varieties of sedimentary rocks, and sedimentary and tectonic structures.*
Key words: *dam lake, Klimkówka, Outer Carpathians, geotourism*

Introduction

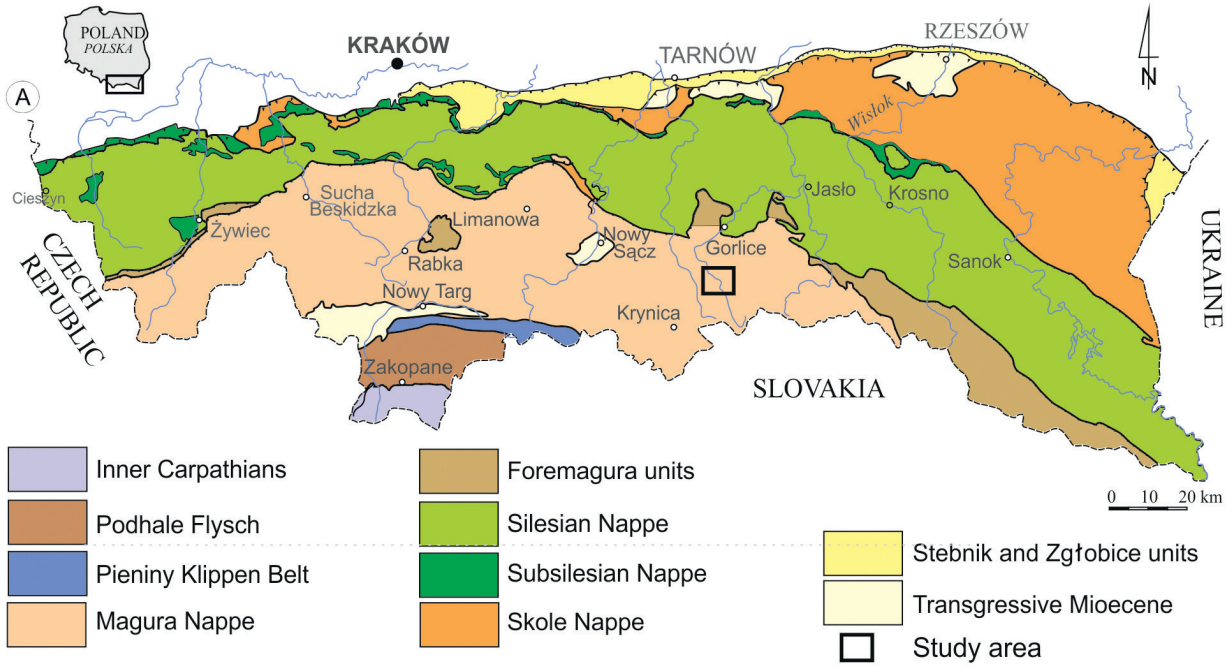
There are over 100 artificial reservoirs in Poland with a total capacity of more than 1 million cubic metres of water. Their main purpose is to regulate the flow of the rivers. The latest such reservoir is located at Świnna Poręba village close to Sucha Beskidzka town in the Carpathians. Despite the fact that these lakes are of anthropogenic origin, they are well etched into the Beskid landscape becoming an integral part of it. The creation of reservoirs is important for the environment.

New artificial lakes, in a short time of existence, generate new geological processes in their vicinity. One such process is the activity of destructive waves, which is a major factor creating and modelling the coastal zone.

In the first period of the dam functioning, the edges of the lakes are under intense destructive processes, which favour the formation of new exposures. Dam reservoirs should be considered as good geotouristic areas, where these processes could be observed. The numerous exposures provide insight into the geological structure of the substrate.

One of the earliest of such lakes is the Klimkówka Lake (also known in the nomenclature as Klimkowskie Lake, Klimkowieckie Lake) which for nearly 20 years enhances landscape features of the Beskid Niski Mountains (Fig. 1).

Fig. 1. Panorama of Klimkówka Lake a view from the dam, photo A. Waśkowska



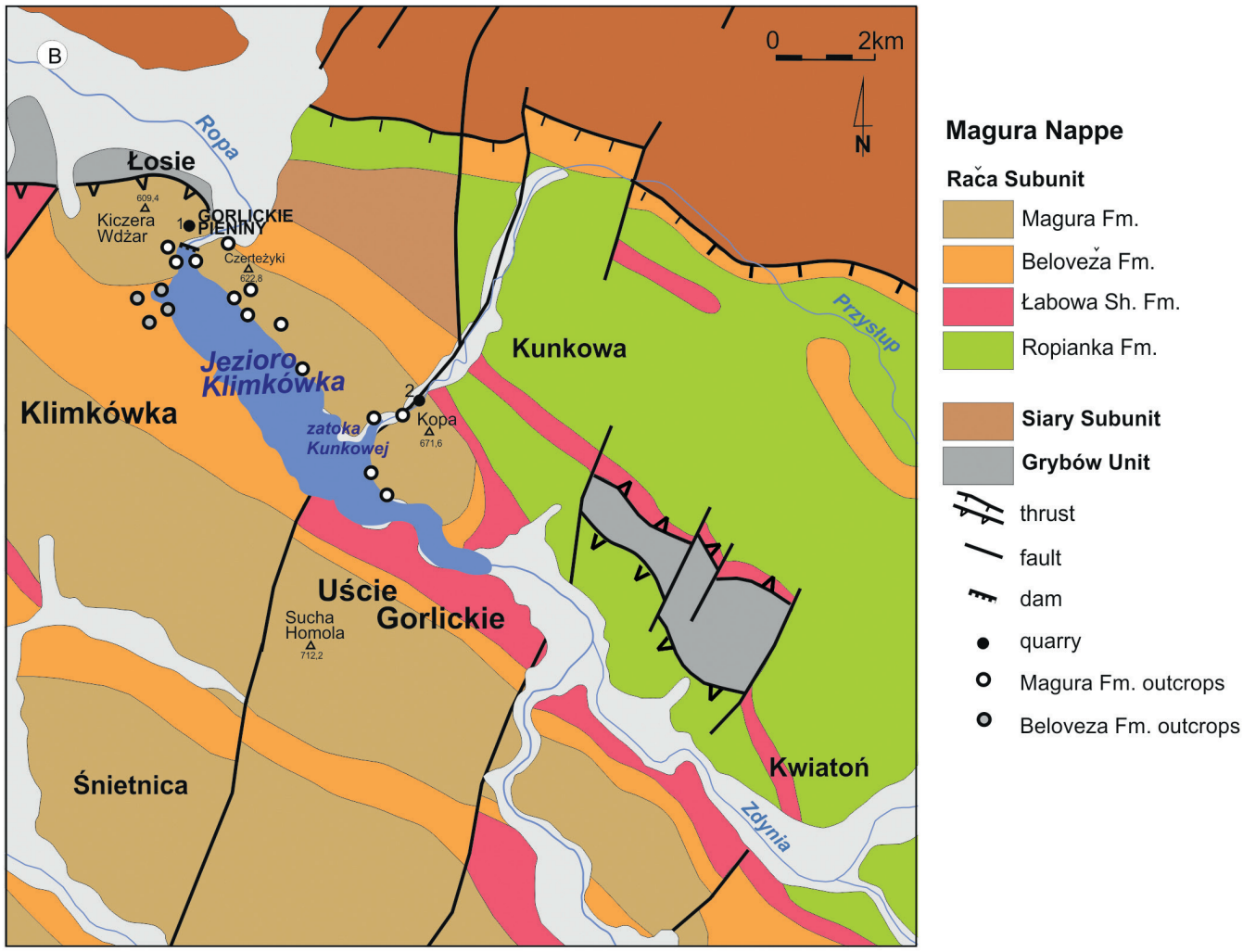


Fig. 2. Location of the studied area on the background of geological structures. A – area of the Łosie-Uście Gorlickie against structural--tectonic units of the Polish Carpathians, B – Geology of the Klimkówka Lake region (based on Rączkowski *et al.*, 1992 – modified and supplemented)

The main goal of this paper is a brief geological outline of the lake area and an indication of the geotouristic objects in its immediate vicinity.

Study area

Klimkówka Lake is located in the Beskid Niski Mts. of the Polish part of the Northern Carpathians, in Hańczowskie Rusztowe Mts., about 20 km south of Gorlice town. This lake was created by damming the Ropa mountain river by a semi-concrete dam, situated in the village Klimkówka (Fig. 2A, B). This relatively narrow (800–200 m) reservoir, of length approximately 6 km (Fig. 2B, Fig. 3) spreads from Klimkówka to Uście Gorlickie villages. It is surrounded by forested mountains (altitudes of about 600–700 meters above sea level), from which numerous mountain streams flow down, now having an outlet into the lake. The system of the surrounding hills is characteristic of the Rusztowe Mts. that create long, heaped and relatively steep hills with small amplitudes within the top parts of the mountain ranges stretching SE- NW. From the SW the reservoir is surrounded by Sucha Homola Mt. range (the culmination of 712 m a.s.l.) from NE by Czerteżyki Mt. (622 m asl) and Kopa Mt. (671 m asl) mountain ranges separated by the Przysłupianka valley. Klimkówka Lake is a typical mountain reservoir. Its coastline is diversified by numerous bays associated with zones of the estuaries (Fig. 4); the largest of them Kunkowa Bay, located in the NE part of the lake is created by Przysłopianka creek estuary, the largest and most important tributary of Klimkówka Lake (Fig. 2B).

Fig. 3. Winter view on Klimkówka Lake, photo A. Waśkowska

Fig. 4. Bay estuary zone of a lake in the creek at low lake water level, photo A. Waśkowska

Origin of the lake, parameters and functions

In historical times, the variable water flow regime of the Ropa river and the corresponding water overflowing periods caused flooding of urban areas along the valley, as well as water deficiency during periods of drought. In the 70's the Polish authorities took the decision to construct the reservoir, which will regulate the flow of the river.

Fig. 5. The dam and the hills Kiczera-Zdżar towering around, photo A. Waśkowska

The narrowest part of the Ropa valley forming part of the so-called Gorlickie Pieniny (Fig. 5) was chosen for the dam placement. In this area the Ropa River, over a distance of less than 1 km, forms a picturesque gorge and flows in a narrow trough between steep Kiczera Żdżar (610 m a.s.l.) and Ubocz (617 m asl) hills. A soil dam with the crown length of 210 m and a height of 33 m was constructed at the 54.4 km of the Ropa river (Henning, Martyniak, 1992). The project was completed in 1994, after 19 years of construction, and the process of stacking water and functioning of the Lake Klimkówka started. The maximum surface of the lake reservoir is 266 ha, its average depth is 13m and a maximum depth reaches to 30 m (Łagosz, 2000). The bowl of the lake can hold 43.5 million m^3 of water: capacity – 2.5 million m^3, capacity of 33 million m^3 of compensatory and flood capacity – 8 million m^3 (Gawlik). Since its inception the reservoir water level in the lake reached the expected maximum state in the year 2010 (Wojciech Waśkowski, oral communication). The level of water raised by the dam is normally located at an altitude of 395.8 m asl; the depth of the reservoir close to the dam is 31.80 m (Łagosz, 2000). The dam is closed to tourists.

Fig. 6. Hydroelectric power station and the Ropa river valley (Gorlice Pieniny) – view from the dam crest, photo A. Waśkowska

Fig. 7. The wide terraced coastal zone of the lake at low water level, during the rainfall deficit – February 2011, photo A. Waśkowska

The dam construction and creation of the lake permanently changed the natural environment of the Beskid Niski Mts., by transforming many of its components. Changes affected morphology of landforms, local climate, geological processes, vegetation and fauna as well as influencing on the cultural landscape and the related economic development. Previously, the urbanized area in Klimkówka village and part of Ujście Gorlickie had flooded. The creation of the lake was connected with carrying out expropriations and evictions, construction of new road infrastructure, implementing technology and so on. Klimkówka Lake is a typical mountain reservoir that affects greatly the hydrological system of the area. Ropa River is a typical mountain river, which is characterized by the flow variables associated with weather seasonal changes. The presence of an artificial reservoir regulates the supply of water through its controlled outflow. In times of drought the reservoir secures continuous supply, in times of surplus it stores water, reducing its flow and floods, which consequences are often catastrophic. The construction of Klimkówka Lake is of great importance for Jasło and Gorlice urban areas located in the lower part of the Ropa valley. Since the existence of the artificial lake the flow of the river has improved significantly, especially during dry periods, reducing deficit in water supply for agglomerations. Both agglomerations supply water to inhabitants and industrial plants, where the demand is high. The average 2 m^3/s flow is maintained. This value is about 20-times higher than the minimum flow reaches 0.08 m^3/s (Henning, Martyniak, 1992). Maximum flood flows may be reduced by one third, from 420 m^3/s to 140 m^3/s (Łagosz, 2000).

The Klimkówka Lake adjusts the flows in periods of drought and improving water quality by diluting pollutants. Increase of tourism activity in this region is one of the important functions of the Klimkówka Lake, which is used as a facility for recreation. The functioning of Lake Klimkówka is also associated with acquisition of green electricity. The energy derives from the flow of water and a small hydroelectric power plant in Łosie (Fig. 6). It is located at the foot of the dam on its north side, connected by the 110 m steel pipe with the dam bottom output, which is transmitting a stream of water directly to the turbine. The hydroelectric power plant has 1.1 MW capacities; the average annual production is estimated at 5.4 GWh. In the memorable year 2010, when intense and prolonged precipitation caused flooding and flood conditions, the reservoir on the Ropa River did its job well and protect the region. However, during the exceptionally dry season of the 2011 and 2012 years, the Beskid Niski Mts region suffered from severe water shortages. Controlled flow, securing water supply for the valley of Ropa River region, extensively used water inventory of the lake. Therefore, the area of the lake significantly decreased (Fig. 7) and the bottom was exposed in its distal part (Uście Gorlickie).

Geological background

The Klimkówka Lake is located in the Outer Carpathians, which are built of Mesozoic and Cenozoic rocks. These rocks were deposited between 200 and 15 million years ago during Jurassic-Miocene times, within the Carpathian deep sea, which constituted part of ancient ocean called Tethys.

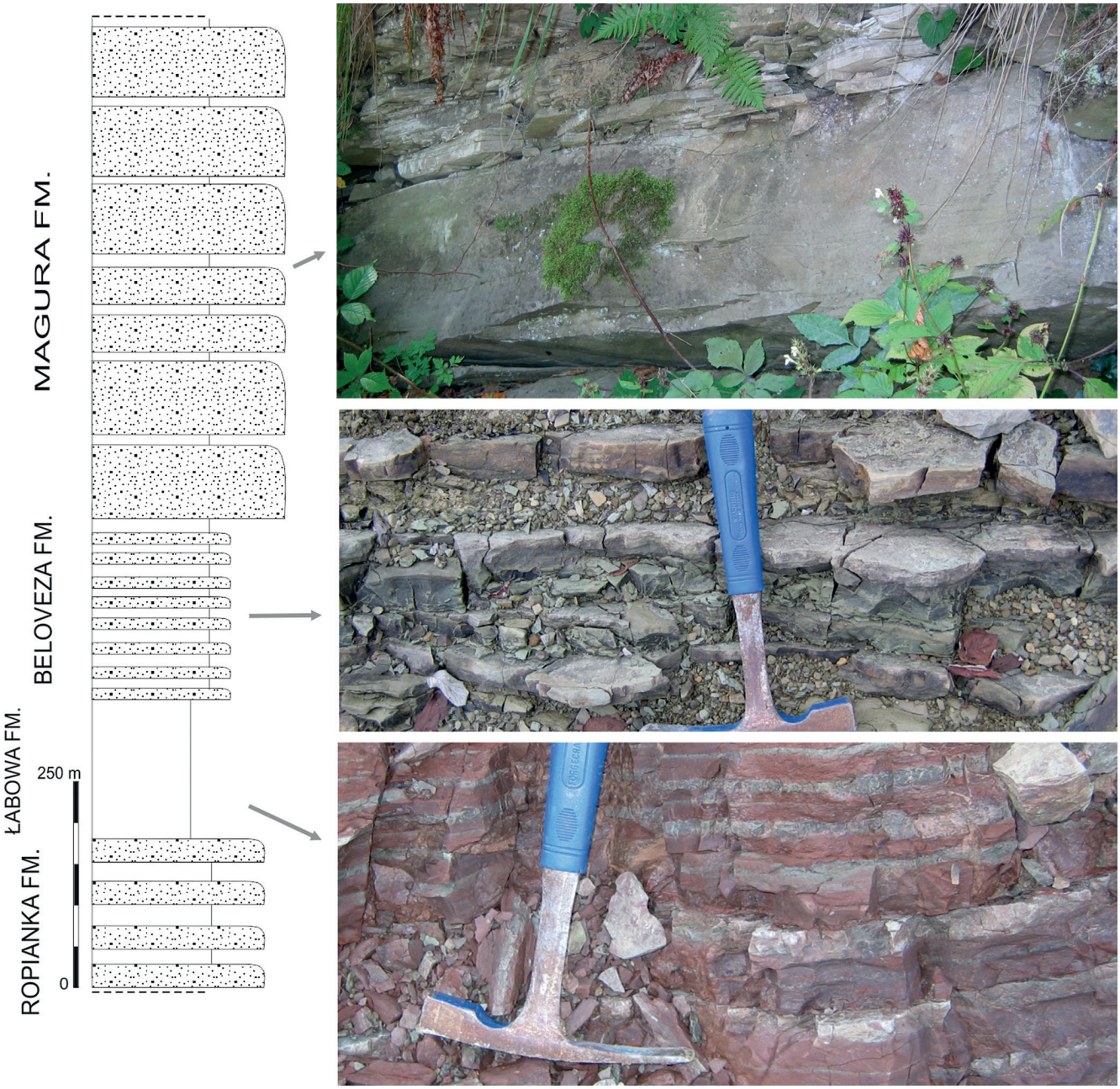


Fig. 8. Lithology of the Magura Nappe, Racza Unit, in the region of Hańczowskie Rusztowe Mountains (Beskid Niski, Outer Carpathians), photo A. Waśkowska

This sea consisted of smaller basins, which were separated from each other by underwater ridges called cordilleras. The Magura Basin was the largest one. Carpathian deep seas were filled with sediments called a flysch, which today form the thick series of rocks in the Beskid Niski Mts. Flysch is composed of sandstone layers and/or sandstones and conglomerates intercalated with shales, siltstones and claystones. These deposits are the result of sedimentation of material supplied to the basin and transported by gravity on its slopes into deep areas.

Strong tectonic movements of the Alpine Orogeny resulted in tectonic deformations, caused the origin of the Carpathian orogen, which include Beskid Niski Mts. These movements took place during the Miocene stages – about 14 million years ago. The Outer Carpathian rock complexes consist of sediments deposited within the Carpathian basins, were thrust over each other and arranged into the characteristic imbricated structure. These complexes are known as nappes (Fig. 2A).

Klimkówka Lake is geologicaly located in the Magura Nappe (Fig. 2A, B), which is divided into several tectonic-facies zones as Krynica, Bystrica, Rača and the outermost Siary zones. Hańczowskie Rusztowe Mts. are located in the Rača Zone, and are built of Senonian-Paleogene deposits including several rock-formations such as Ropianka, Łabowa, Beloveža and Magura formations (Golonka & Waśkowska, 2012; Rączkowski et al., 1992; Węcławik, 1969a, b, and literature therein) (Fig. 8). The last three stratigraphic formations form the bedrock of the Klimkówka Lake.

Fig. 9. The diversified fraction and the degree of roundness of the stones of the sand beaches at the lake – gravels of varying morphology, photo A. Waśkowska

Fig. 10. Deposits of the Beloveža Formation exposing at the cliffs of Klimkówka Lake, photo A. Waśkowska

The southernmost part of the Klimkówka Lake and areas that are directly adjacent to the south consist of Łabowa Shale Formation, which is characterized by the occurrence of relatively soft red shales and claystones, intercalated with green, grey and bluish shales (so-called – variegated shales) (Fig. 3B, Fig. 8). These deposits are intercalated with very fine-grained and thin-bedded Lower Eocene quartzitic sandstones.

Change of the sedimentation' nature and the increase of the supply of coarser clastic material occurred during middle Eocene times. Sandstones become more common within flysch sediments. Variegated shales deposits were replaced by gray and green mudstones, partly calcareous, commonly intercalated by fine-grained thin- and mediumbedded of grey quartzitic sandstones. These thin-bedded flysch deposits belong to the Beloveža Formation (Fig. 8), which occurs in the western part of the Lake Klimkówka basement (Fig. 2B). Sandstones are characterized by a large concentration of hieroglyphs both mechanical and organic in origin, located on bottom surfaces of the bed. Variegated shales represent the dominant lithotype, which is present in the complexes up to several meters thick, with co-occurrence of bentonitic layers. Towards the top the number and thickness of sandstone intercalations increases. This type of sedimentation continued upward, in which the rocks of Magura Formation were deposited (flysch sandstones mostly). These are complexes dominated by thick and very thick-bedded grey sandstones (Fig. 8) separated by thick and medium-bedded sandstones with very thin intercalations of gray mudstone. Magura Formation build the eastern part of the lake, and being erosion-resistant it also builds the surrounding hills (Fig. 3B). The geological structure determines the asymmetry of the Ropa valley in the vicinity of the lake. At the west side, where there are a lot of soft mudstones in the ground, not resistant to erosion, the banks of the valley are gently sloping (Fig. 3).

This side is also covered by the tourism infrastructure, which includes swimming areas and areas covered by summer resort, as well as main roads running along the lake towards Wysowa and energy networks. The opposite eastern shore of Klimkówka Lake is undeveloped because of its morphology, steeply descending to the lake, consisting of resistant sandstone of Magura Formation.

The main tectonic dislocation in this area – Kunkowa fault, cuts across the geological structures from SW to NE, constitutes an important element of the lake's bottom surface. The footwall is located on the lakes' south side in the region of Uście Gorlickie. The Kunkowa Bay is located directly on the fault line (Fig. 2B).

The geological objects

On first sight monotonous flysch deposits are increasingly valued and promoted as interesting objects for geotouristic (e.g. Słomka *et al.*, 2006; Miśkiewicz *et al.*, 2011; Bartuś *et al.*, 2012 and literature therein). There is quite a lot of flysch outcrops in the Polish Carpathians, but their accessibility is limited. Usually the outcrops are located in valleys of streams and rivers, with no suitable routes nearby.

Klimkówka Lake has existed for already several years. During this time, its coastal zone has been changed under the influence of abrasion processes. These processes involved coastal erosion and landslides, that led to the exposure of the bedrock in many places, and created numerous outcrops. Around 5 m^3 of the material eroded from each linear meter of the lake shore during 13 years of the lake's existence (Wiejaczka, 2009). Analysis of the shores of the lake indicates that the active processes are dominating by erosion, because 53% of the coastline displays abrasive edge, and 43% represents the abrasive-accumulation type. Up to 2m high cliffs constitute a common structure of the coastline (Fig. 9), while the wide pebble beaches are rare (Wiejaczka, 2008). Numerous landslides developed on the lake's slopes causing problems for roads and buildings construction and maintenance.

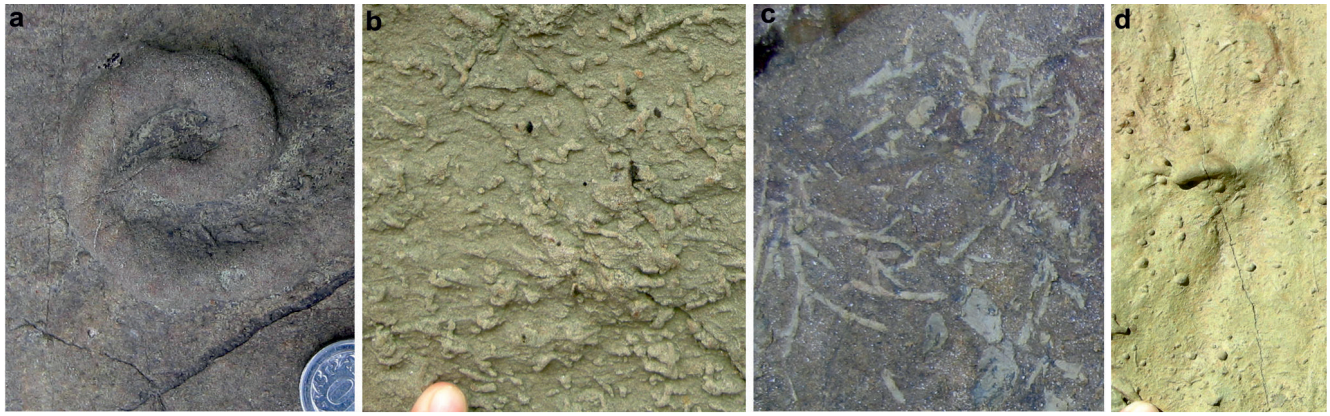


Fig. 11. Examples of biogenic structures preserved in sandstone of Beloveža Formations, photo A. Waśkowska

The rocks of Łabowa Shale Formation (Fig. 10) are poorly exposed here. They form a substrate in the distal part of the lake and its backwaters. This formation is often covered directly by thick Quaternary sediments. Small outcrops at the banks that existed in the first phase of the lake functioning are now covered by reddish mud. The outcrops of Łabowa Formation deposits can be seen in the close vicinity of the reservoir, in the Ropa River, in Uście Gorlickie village.

Outcrops of the Beloveža Formation are located along the beaches and in the streams flowing into the lake (Fig. 2B). High cliffs, up to 1.5 m, have been formed within the deposits of Beloveža Formation. They reveal the variety of thin-bedded flysch, typical for this formation (Fig. 10). Sandstones are especially interesting for tourists displaying educational sedimentological features like parallel straight, wavy, and less often diagonal bedding and lamination, with muscovite and bioglyphs, which reflect traces of deep-sea fauna living on the seabed during the Middle Eocene times (Fig. 11). Bioglyphs of fossil organisms are very diversified. It is also one of the characteristic feature of this formation. Younger visitors are particularly fond of outcrops of Beloveža formation. They used to have fun using mudstones, like plasticine, for construction of various decorative elements (Fig. 12). Beloveža Formation mudstones contain a significant amount of clay minerals, which are plastic and swell when exposed to water. Usually within the outcrops minor tectonic structures can be observed, such as faults with small amplitudes and folds of different geometry, as well as joint systems manifested mainly by regular cracks intersecting each other at a similar angle, well visible in sandstones (Fig. 13). The cracks are often filled with crystal calcite.

An interesting rock sequence crops out at one of the beaches in the NW part of the shores of Klimkówka Lake. This sequence encompasses the boundary between Magura and Beloveža formations displaying dynamic sedimentary transition. Magura Formation begins with a thick sandstone bed (Golonka, Waśkowska, 2012) overlying thin- and medium-bedded flysch of the Beloveža Formation. This bed begins with a sequence of medium- to thick- bedded shale-sandstone flysch, in a short distance passing into the -sandstone dominated flysch. The deposits of the Magura Formation are resistant to erosion, forming the best outcrops in the Klimkówka Lake region.

Fig. 12. Work of art made of Beloveža mudstone, photo A. Waśkowska

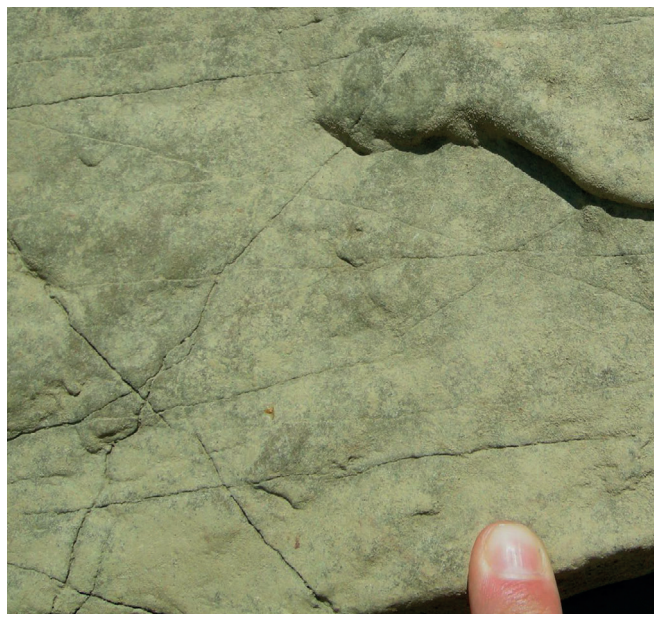


Fig. 13. Tectionic structures in Beloveža sandstones, photo A. Waśkowska

Fig. 14. Magura Formation outcropping at the dam, photo A. Waśkowska

Fig. 15. Łosie Quarry, photo A. Waśkowska

Fig. 16. "Devil's egg" of Phallus impudicus – fungus protected, photo A. Waśkowska

Fig. 17. Bearing fruit Daphne mezereum – protected plant species, photo A. Waśkowska

Fig. 18. Panorama of the dam and Gorlickie Pieniny from the vantage point along the path of education, photo A. Waśkowska

Gorlickie Pieniny Gorge, which landscape resembles the world-wide known Dunajec Gorge in the Pieniny Mts. (Golonka, Krobicki, 2012) provide a perfect example of the rock outcrops serving as geotouristic objects. The gorge, in which the dam is situated, constitutes a v-shaped valley cut into the Magura Formation rocks (Fig. 5). The Ropa River deeply cuts into the Beskid Niski Mountains using tectonic faults. The narrow Ropa River valley was formed at the site of thick and compact complex of thick- and very thick-bedded sandstones. Many outcrops of the formation are located along the road leading to the dam (Fig. 14) in an abandoned quarry in the Łosie village, along the shores of the lake and in the tributary streams valleys. While natural outcrops are characterized by poor accessibility, this collection of artificial outcrops is located very conveniently. The very large area of observation, with a wide range of educational features constitutes a very important asset. These objects belong to the best geotouristic places for studies of the lithology of the Carpathian rocks.

Therefore Łosie quarry was for many years used as a teaching facility for students, recommended as a prime geotouristic object (Doktor *et al.*, 2005) and entered into the Central Registry of Geosites of Poland (Fig. 15). The quarry is located on the left bank of Ropa river, below the dam, close to the hydroelectric power plant (Fig. 2B). Asphalt road leads to the quarry. It is a fairly extensive exposure 300m long, being a continuation of the outcrop in the escarpment road to the dam. For several years, these outcrops have been combined with the educational path – Gorlickie Pieniny, which runs over the dam, through NE slope of Zdżar Mt. The route is short and neat; the leading issues are botanical subjects, like Beskid Niski Mts.' beech and other dendroflora of the forest. On the slopes of Kiczera-Wdżar, many rare species appear along the route, there are several positions of plant and fungi species protected in Poland (Fig. 16, Fig. 17). In addition to small outcrops of the Magura Formation, this is the route with several panoramic viewpoints to Gorlickie Pieniny and Klimkówka Lake (Fig. 18).

Fig. 19. Flutes on the Magura sandstone bottom surface, photo A. Waśkowska

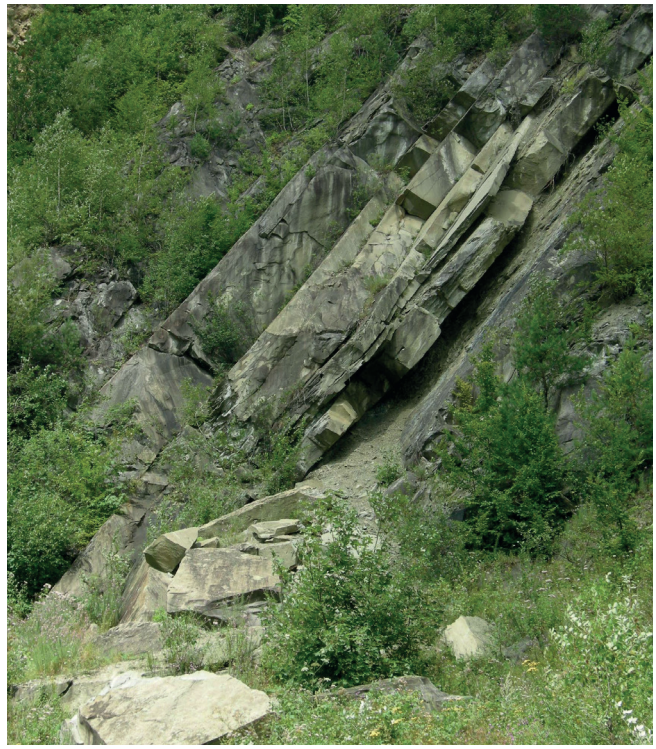


Fig. 20. Layers of the Magura sandstone formations in Łosie, photo A. Waśkowska

Deposits of the Magura Formation are characterized by diversity in lithology. They contain widespread massive thick-bedded sandstones often amalgamated with submarine slumps and structures with numerous petals sludge, a variety of parallel, cross and convolute laminations, clastic dykes, structures from escape of water, cup-shaped structures, and a variety of hieroglyphs, mainly flutcasts, indicating sea-bottom currents (Fig. 19) and other traces. The rock layers are deflected by tectonics at an angle 50^0 in the dam area (Fig. 20, 21). Small scale tectonic structures are represented mainly by joints and by the fault-type discontinuous deformations. A large fault is exposed in the south-western part of the quarry. Blocks of sandstones moved by gravity to the bottom of the quarry excavation provide a kind of sedimentological field museum (lapidary). The walls of the quarry are not protected, so the approach is associated with the risk of falling loose rock blocks. The quarry has retained a residual infrastructure related to the extraction of stone represented, among the others by a bunker located at the northern side of the quarry a few feet above the highway. A forestry Bulletin Board is present, in the quarry informing of bats, which are quite common in the area of Gorlickie Pieniny. They favour rock shelters and caves, which are typical for Magura sandstone outcrops and known also from the area of the excavation in Łosie. Sandstones of the Magura Formation called "Magura Sandstone" are known as the best building materials originating from Outer Carpathians. Stone used in the local constructions was collected by local people from natural exposures, that were extended and converted into quarries. Several pits exist in the close vicinity of Klimkówka Lake. One of the biggest is in the valley of the Przysłopianka stream. Magura Formation is developed there in the form of a thick and medium- bedded flysch, in which the layers of sandstone are rich in a variety of sedimentary structures and intercalated with mudstone shale packages.

On steep slopes made of Magura Formation series of small waterfalls and cascades were formed on thick and very thick sandstone beds. One of these waterfalls is present at the periodic stream flowing through educational path Gorlice Pieniny, close to the hydroelectric power and Łosie village. Easily accessible numerous outcrops, can be seen in the valley of the Przysłup stream. This lazy streams transforms into a rushing river of high erosive power in periods of increased atmospheric water supply. The Magura Formation deposits crop out also in several locations along the escarpment of road linking Klimkówka and Uście Gorlickie villages, as well as at the banks of the lake cliffs. Occurrence of deposits with a predominance of siltstone and/or mudstone (Łabowa and Beloveža formations) on the slopes of valleys is associated with the generation of the landslide slopes. Landslide morphology is visible in the eastern coastal zone of the reservoir (Fig. 22). Its forms displaying various stages of development, different slope dynamics are visible in this area, although the creation of the reservoir in Klimkówka greatly reduced the development of landslides, which previously existed in the Ropa valley (Rączkowski, 2007).

It should also be noted that this is the area of special historical and cultural significance, associated with the presence of the Łemko ethnic group. Many architectural objects like valuable churches, shrines, cemeteries, and historic residential buildings exist in the vicinity of Klimkówka Lake.

Fig. 21. Panorama of the Łosie Quary, photo A. Waśkowska

Fig. 22. Colluvium landslide at NW shore of Klimkówka Lake, photo A. Waśkowska

This is the area of the occurrence of mineral waters, which are used in balneological medicine (Miśkiewicz *et al*., 2011). Hańczowskie Rusztowe Mts. have their own unique atmosphere, being far from the cities and in the natural environment, with large areas of woodland.

Discussion and summary

Klimkówka Lake belongs to the greatest attractions of Beskid Niski Mts. It is an object that attracts tourism, mainly due to the high aesthetic and a wide range of recreational values associated with relatively large water reservoir. Nearly 20 years of existence of the lake generated the development of tourism infrastructure securing both the accommodation and the realm of sports and recreation.

Another advantage of Klimkówka Lake is the presence of a number of spectacular surface rock outcrops located in convenient locations. Special educational value posses the quarries, which in the Beskid Niski Mts. are objects that are rarely encountered and providing a large range of observations.

The area around the lake is a great training ground to get acquainted with the geological structure of the area, the geological history of the Carpathians, as well as with different varieties of sedimentary rocks, and sedimentary and tectonic structures.

Rocks on the rocky beaches and quarries are of tourist interest. The message they bring is highly diversified, and therefore providing an important element is to raise awareness of geology, especially geologic history and origin of deep water geological formations that built Beskid Niski Mts.

Acknowledgments: The authors would like to thank Wojciech Waśkowski – retired Manager of Hydro Power in Łosie for sharing information about Klimkówka Lake. Krzysztof Bąk and Marek Cieszkowski is thanked for reviving a manuscript. This work was supported financially by AGH grant no. 11.11.140.173.

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Geotourism 1(36) 2014: 15–20
http://dx.doi.org/10.7494/geotour.2014.36.15

Active forms of tourism among lower and higher secondary students in Cracow

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Abstract: *The purpose of this paper is to determine organizational forms (formal, non-formal) and the level of tourism activity among young people of secondary schools in Cracow depending on gender, the type of school and the education of the parents. The study included 1472 students of schools in Cracow. Physically active forms of tourism are undertaken mostly by girls – 63% rather than by boys – 52%. With increasing levels of education of the parents, the number of young people practicing active forms of tourism also increases. The undertaking of active forms of tourism varies, depending of the type of school attended. Young people in secondary (63,9%) and primary (65,7%) schools most often chose to go for tourism. In primary (50,1%) and secondary (39,4%) vocational schools they go least often. Active forms of tourism usually take the form of informal practice among friends and acquaintances (mostly hiking – 47%).*
Key words: *young people, active forms of tourism*

Introduction

Recreational physical education is "the providence with the skills, needs and habits of self-conscious filling of leisure time by various forms of physical activity" (Nałęcka, Klawender, Thiel, 1988, p. 147). According to their origin, factor determining behavior in leisure time are divided into: biological (including health or physical fitness of the organism), socio-demographical (including gender and age structure, education, profession), economical (including the level of prosperity or amount of leisure time) as well as psychological ones. The last group is represented by the factors related to the habits and personality (Nałęcka, Klawender, Thiel, 1988). Among general trends of social changes, a return towards a healthy lifestyle can be observed. Together with the growing level of social prosperity, an active lifestyle and taking care of physical development and fitness become increasingly important. The leisure time will be filled by different interest and hobbies (Alejziak, 1999).

In physical education, the tourism plays a very important role. Moreover , it seems, that its role will grow. Among the many forms of tourism almost every participant can choose something for himself or herself. The distinguishing feature of active tourism against other forms of tourism is participation in all forms of physical recreation (Różycki, 2006; Dąbrowski P. – notes from "Active Tourism" lecture). Active forms of tourism combine the possibilities of physical and intellectual development with obtaining the knowledge about the country visited.

At the same time, it should be noted that tourism, particularly its active form, can have a great impact on health through a variety of dealings with the local climate of different regions (Łobożewicz, Zahajkiewicz, 1988). There are many types of active tourism. The most common is referred as hiking (lowland and mountain), canoeing, skiing, cycling, sailing, riding, climbing, trekking, paragliding, and many other new forms, such as hydrospeed, canyoning, windsurfing (Różycki, 2006). Although there are well-known theories according to which man is active by nature and is rational, practice shows that despite the awareness of the advantages offered by the movement, the society usually chooses passive, not active recreation (Winiarski, 1989).

Physical activity education is taught mainly in schools and families, and supported by social and commercial entities. At this point, the role of the media must be mentioned, which has an increasing impact on our lifestyle (Winiarski, 1989).

The concept of "Hard & Soft Tourism" defined by Krippendorf (in Alejziak, 1999) , depicts the trends in tourist demands. Among the many trends, substituting convenience and passivity by activity combined with physical effort is most common. Leisure is becoming increasingly popular. The dominant model in tourism – 3S (sun, see, sand) is replaced by 3E (entertainment, excitement, education). In addition to increasing interest in active forms of recreation, attention is also paid to individual travelling or desire to experience new sensations and experiences (Alejziak, 1999).

Research on participation in tourism and its determinants have been carried out for many years. The areas of interest is undoubtedly include tourism of children and youth. However, researchers indicate that tourism occupies an important place in free time management (Alejziak, 1999) and statements of young people, at the level of 38,3% support this conclusion (Jurczak 2000). Factors affecting participation in tourism are: gender (18% boys and 32% girls (Różycki, 2000) and the type of school attended (Wartecka-Ważyńska, 2007; Różycki, 2001; Jurczak 2000).

Physical recreation is an important aspect of people's life. Its realization may take place within a physically active forms of tourism. According to the assumption of this work, the active forms of tourism are all those forms, which are characterized by participation in any form of physical recreation.

Purpose

The purpose of this paper is to determine organizational forms (formal, non-formal) and the level of tourism activity among young people in secondary schools in in Cracow depending on gender, type of school attended and the education of the parents.

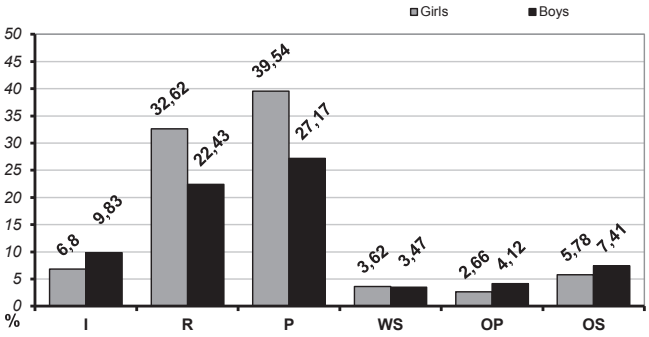

Fig. 1. Forms of participation in tourist activity by girls and boys from lower and upper secondary schools (in total; own research)
SYMBOLS – forms of participation in tourist activity: informal: I – individually ($p < 0,05$), R – with family ($p < 0,001$), P – with friends ($p < 0,001$); formal: WS – school trips, OP – trips with out-of-school organizations, OS – trips with school organizations

Material and methods

In the analysis of the results, two groups of variables are defined. The dependent variables include physically active forms of tourism in particular its level expressed by the participation frequency of four categories: high (1 time per week), medium (1–2 times a month), low (1–2 times a year) and lack of tourist activity; the type based on different forms of tourism: the form, which is indicated as non-formal (individual, family, group tourism) and formal (school or non-school organizations, organized excursions) and the method of realization.

Independent variables do not indicate the cause of the studied phenomenon and cannot answer the question why their nature is merely structural; they iclude gender, type of school and educational level of the parents of the young people. The educational level of parents is an indicator estimated on the bases of the opinion of the young people, concerning the educational background of the father and mother. Teenagers indicated the educational level of the parents as following: 1 – basic, 2 – professional, 3 – average, 4 – higher.

During the categorization, the responses were combined in pairs according to father's and mother's education. The result is a global indicator of the level of education of the parents (father and mother together). On this basis, three categories of parents' educational levels were established: low (1 + 1, 1 + 2, 1 + 3, 1 + 4, 2 + 3, 2 + 2, and respondents who have not marked one or both of parents), medium (3 + 3, 3 + 4, 4 + 2), and high (4 +4). The type of school – an indicator concerning four types of schools: primary schools, vocational and secondary schools and technical schools.

The study used the methods of diagnostic surveys (Łobocki, 2000). The surveys were carried out during school lessons and were anonymous. The nature of the sample selection was random. The draw was the nature of the group, a two-stage. The study included 1472 students of schools in Cracow (boys – 865, girls – 616). Within the sample collected, there were: primary school pupils (boys – 330, girls – 295), secondary school pupils (boys – 136, girls – 162), vocational school pupils (boys – 164, girls – 54) and technical schools pupils (boys – 235, girls – 105). The level of education included: 411 families of low level, 715 families of medium level, and 211 of high level of education. In the remaining 89, families did not provide data about educational attainment of the parents.

In Cracow, in the school year 2008/2009, in the year in which the test was performed, in primary and secondary high school in total 264 475 pupils, of which in the gymnasiums – 124 014, in secondary schools – 63 068, in vocational schools – 23793 and techniques – 53 600 pupils studied (Rocznik statystyczny województwa małopolskiego, 2010).

The selection of young people from the area of Cracow was made in accordance with the assumption, that this city represents a typical metropolitan environment. Social phenomena and processes comparable with other large Polish cities appear here. Generalizations and conclusions of the studies may be, therefore, extended to other similar metropolitan populations in the country.

The results of the research will be developed on the base of percentages values with the accuracy of two decimal places. The second measure will test the interdependence of two variables, chi-square for multi-way tables. Statistically significant correlations will be only those with hich p-values are < 0,05 or less.

Analysis of the results

Self-organized tourist activities, or those organized by school and non-school organizations among the pupils from primary and secondary schools in Cracow include about 56,6% of pupils. Nearly 63% of girls engage in tourism-related physical activity. Activity of the boys is lower and amounts to little more than 52%. Thus, gender is a differentiating factor of participation in active forms of tourism ($p < 0,001$).

Trying to answer the question how school and extracurricular institutions involve the pupils in the organization of active forms of tourism and indirectly determine their condition, it was found, that these institutions involve only 6,5% of respondents. In this case, there was no statistically significant dependence between the activity of girls and boys 7,5% – 5,8%.

The most popular form of tourism are trips with friends – 32,3%. Family tourism was also often referred to – 26,6%. The individual tourism is much less popular – 8,3%. Young people rarely mentioned the activity within the class trips (3.5%), trips organized by the school (6,5%). Non-school organizations offer opportunities of tourist activity for only 3% of young people. It seems that school activities should set a good example of physical education through tourism. Unfortunately this role is not carried out in an appropriate way.

Forms of tourism activity are different for girls and boys ($p < 0,05$–$0,001$). Among the forms mentioned in Figure 1, the only formal ways of tourist activity did not show differences between the genders. However, the girls take part much more often than boys ($p < 0,001$) in the trips organized by friends (P) and family (R). On the other hand boys are more individualistic than girls ($p < 0,05$).

Popularity of particular forms of practiced tourism is fairly typical. Hiking dominates (47,2%). Cycling has much smaller range of participation (11,5%), but occupies a prominent place on the background of other types of tourism.

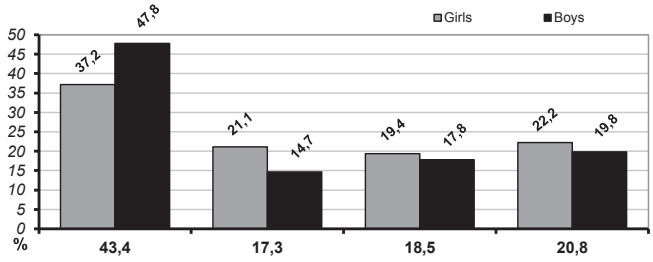

Fig. 2. Undertaking a tourist activity at different levels by young people from lower and upper secondary school in Cracow (in total). SYMBOLS: The level of tourist activity: 43,4 – lack; 17,3 – low; 18,5 – average; 20,8 – high

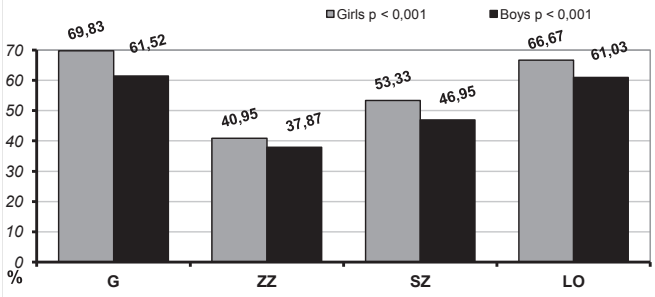

Fig. 3. Undertaking a tourist activity by boys and girls from lower secondary school and three other types of upper secondary schools in Cracow. SYMBOLS: The types of schools: G – lower secondary schools; ZZ – basic vocational schools; SZ – average vocational schools; LO – upper secondary schools

Other forms of tourism include, among others, hiking, canoeing, sailing or riding in total amounted to 5,1% of the sample. Significantly more girls (55%) than boys (42%) hike – $p < 0{,}001$. In the case of cycling, the gender does not differentiate the results (boys – 11,5%, girls – 11,5%). If we take into account other forms of tourism they are also realized at a similar level, taking gender into account.

The study of formal methods of making the tourism activity shows that the most respondents take part in tourist activity once a week – almost 20 % of total number of respondents. If we add to this number the respondents with a frequency of tourist activity of 2 times (5%) and of once a month frequency (about 14%), then we receive a total amount of about 40% of respondents, who are active once a month. The remainder of the youth take part in sporadic tourist activity.

The examined persons participate in tourism 2 times (about 13%) and 1 time (approx. 5%) in a year. When categorizing the frequency the appropriate levels of tourist activity were established. Four categories of the activity level defined: high (1 time per week), average (1–2 times a month), and low (1–2 times a year). The last category was the "lack" of tourist activity. In assessing the level of tourist activity defined in such a way, it can be noted that the largest group are non-active persons. They were placed in the category "lack" (43,4%). The other 3 categories are distributed rather evenly: low (17%), average (18,5%), high (20,8%).

The level of tourist activity depends on the gender of the young people ($p < 0.001$) – Fig. 2. Boys are characterized by a higher percentage of the absence of tourist activity (47,8% to 37,2%). Low level in turn is more typical for girls (21,1% to 14,7%). In the other two categories of tourist activity, the level of the differences between the genders is small (about 2%). Differences in the level of tourist activity expressed by the declarative character of responses are not too large. Partly, this is e result of error in measurement and partly – well known and described in the literature, of the tendency for the best creation of self image.

The arising conclusions are the following: the level of tourist activity for girls and boys is fairly balanced, the boys would rather not undertake the tourist activity than take it at a low level, but they prefer – together with the girls – the activity of medium and high level. It seems that the desire to create a better image is therefore more typical for girls than boys.

Asking the young people from four different types of schools if they participate in the tourist activity, it was found that the answer to the question in the category of "yes/no" depends on the type of school ($p < 0.001$). It appears that tourist activity of primary and secondary school students is very similar (ca. 65%). It cannot be assumed in this case, that the change in the education stage in the direction "primary-secondary school" reduces participation in active forms of tourism. Unfortunately, such a reduction is seen on the line "primary school – secondary vocational school" – 48,3%. On the other hand, a larger reduction is observed on the line "primary school – primary vocational school" – 38,8%.

Undertaking tourist activity among the boys depends on the type of school attended ($p < 0.001$) – Fig. 3. A similar relationship was found for girls ($p < 0.001$). Among the respondents of both genders, the most number of respondents attend primary and secondary schools, and the least – to the secondary vocational schools. In all types of schools the activity of girls dominated over boys' activity. The differences are constant, almost even and placed within 3–8%.

The level of tourist activity estimated on the basis of frequencies of its undertaking also depends on the type of school – $p < 0.001$ (Fig. 3). In primary schools, zero level is observed in 34,6%, but as the youth gets older and goes to the next stage of education, the level rises to 51,2% in secondary schools and to 61,8% in vocational schools. The tourist activity at almost the same level is maintained only in secondary schools. Comparing the youth of primary and secondary schools, a reduction of high level activity and undertaking the activity of average and low levels continues.

Similar conclusions cannot be established in the case of vocational schools. In this case – apart from 25,8% of high activity level which is difficult to explain – one can observe a clear trend of reduction in tourist activity of low, medium and high levels. The reduction in tourist activity on 3 levels results in the increase of non-active persons. It is worth asking about reasons for this. Unfortunately, the results collected do not answer this question. One can only guess that they are: a lack of time, changing of interests, different impact of people of the same age, weaker influence of the school environment. These are only speculations and suppositions. To obtain true reasons one has to conduct further research.

The level of tourist activity depends on the type of school both in the case of girls – $p < 0{,}001$ as well as boys – $p < 0{,}001$ (Fig. 4). In each of the analyzed types of schools, a lack (0) of tourist activity is greater among boys than among girls. However, as the pupils of both genders become older and go to the next stage of education, the level increases. This applies only to male and female students of vocational schools. Similar level of tourist activity is maintained only in secondary schools.

Comparing the youth of primary and secondary schools, it can be observed a tendency in the reduction of the high level of activity for the benefit of the average level, more typically for girls, and less typically for boys. Similar conclusions cannot be established in the case of vocational schools. In those schools, a clear trend can be observed in the reduction in tourist activity at low and average levels in the same rate for girls and boys. A strong resemblance of this interval of tourist activity level was observed in secondary and vocational schools.

Comparing high level of girls' tourist activity from primary and vocational secondary schools it can be observed an unprecedented trend of increasing activity level from 25,1% to 33,3%. Among the boys, the maintenance of unchanged activity levels is reported – 24% .

Most non-active young people attend vocational schools – more often primary than secondary ones. In each of the analyzed types of schools rather boys than girls are affected by this issue. High level of tourist activity in each of the analyzed types of schools donot show major differences between the genders. However, if such differences exist, then high level of tourist activity is more typical for girls than boys. In particular, this dependence is evident in the case of secondary vocational schools. An interesting relationship is evident among the boys from primary schools. It can be suggested, that they will undertake the activity at average or high level or will not undertake it at all.

The highest percentage of participation in active forms of tourism represent the children of high educated parents (70%). Less active are children of parents with secondary education (57%), while the least are the children of parents with low levels of education (47%), therefore higher the educational level of the parents, the higher the percentage of young people undertaking tourism. Analysis of the dependence of participation in active forms of tourism in dependence on the level of education of parents (Fig. 5) indicates a strong variation ($p < 0{,}001$).

The gender of respondents affects the participation in active forms of tourism among children of the parents representing various levels of education. It can be concluded that gender determines the undertaking of most active forms of tourism in the group of young people, whose parents have a low level of education (girls – 54%, boys – 42%). At the most similar level, are boys (67,5%) and girls (74%) from

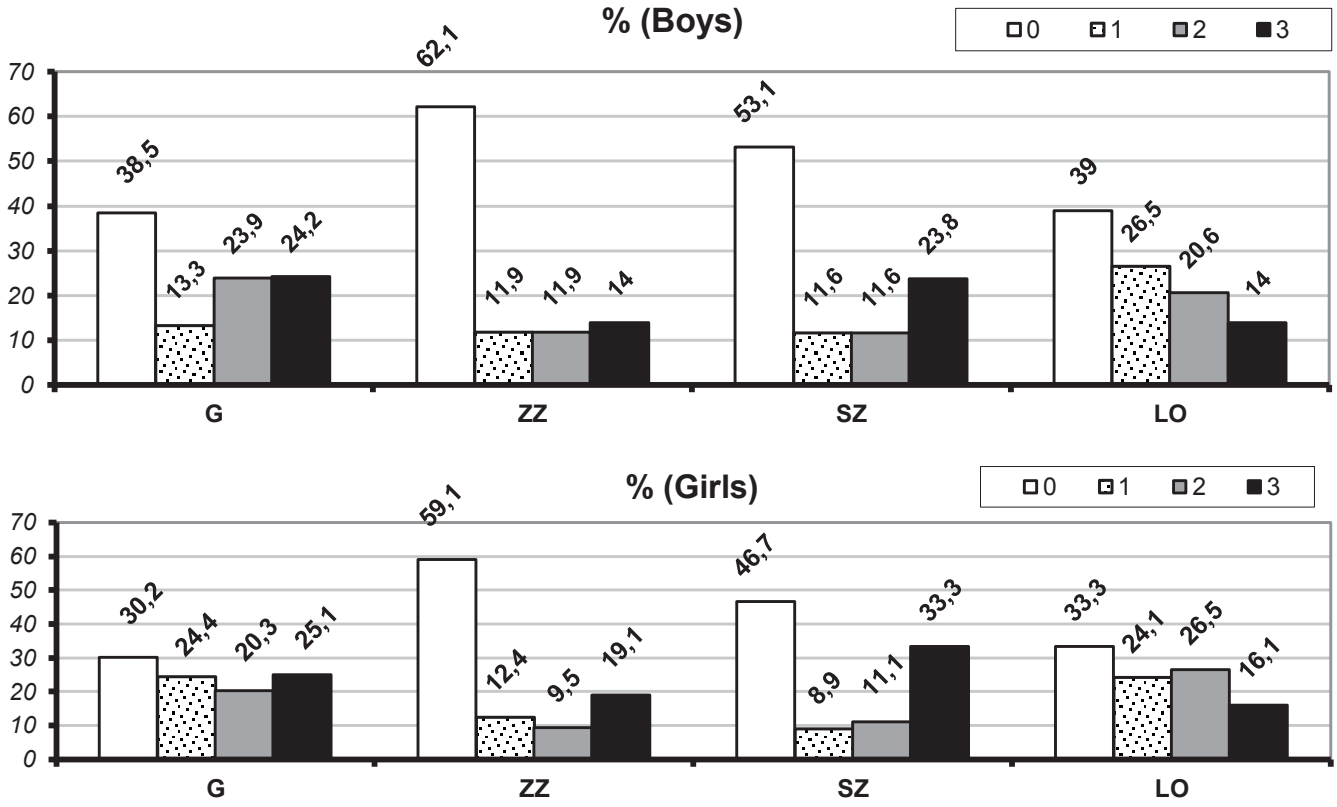

Fig. 4. Undertaking a tourist activity at different levels by boys and girls from lower secondary schools and three other types of upper secondary schools in Cracow

SYMBOLS:

The level of tourist activity : 0 – lack , 1 – low, 2 – average, 3 – high. The types of schools: G – lower secondary schools, ZS – basic vocational schools , SZ – average vocational schools, LO – upper secondary schools

the group of low educated parents. Unfortunately the obtained results of the researches do not explain such a relationship. It can be only supposed, that girls are more affected by the parent's influence than boys in every group of educational levels.

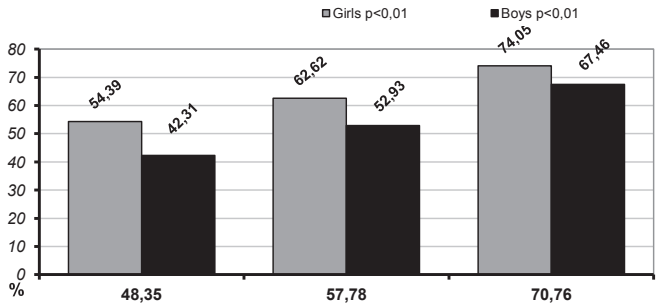

Fig. 5. Undertaking a tourist activity by boys and girls depending on the level of education of parents. SYMBOLS: The level of tourist activity: 48,35 – low; 57,78 – average; 70,76 – high

Discussion

As the studies show, the percentage of young people in Cracow undertaking active forms of tourism is 56%. This value is higher compared to the studies of secondary schools in Krakow, which involved the broad participation in tourism (43,5%), and therefore of a broader concept (Różycki 2001). Statistics, obtained on the basis of studies, seem to indicate that the respondents most likely to identify tourist activity with all forms of movement for recreational purposes, not necessarily related to leaving of the permanent residence. While the researches of Institute of Tourism throughout the country among the people at the age of 15–19 years show a higher percentage of young people involved in tourism (in 2005 – 61%), it must be noted, that tourist trips were defined as trips with one accommodation for the night in Poland or abroad (Łaciak, 2006). It is worth to point out, the fact of that higher participation of young people in tourism was evident in 1980–1990 – about 94 and 88% correspondingly (Wartecka-Ważyńska, 2007). Active forms of tourism are undertaken mostly by girls – 63%, than by boys – 52%. It appears that other research concerning the broad issues of participation in tourism show the same trends (Łaciak, 2006; Różycki, 2001).

Education of the parents determines the participation in active forms of tourism. The largest percentage of young people are the children of parents with higher education levels (70%), the least with a low (47%) education levels. The average percentage is 57%. A similar relationship within the broad participation in tourism show the other studies, according to which a higher percentage of children of people with higher education (management personnel, engineers, liberal professions) are involved in tourism (Wartecka-Ważyńska, 2007; Jurczak 2000).

The study shows that the type of school differentiates the participation in active forms of tourism. Interestingly, the pupils of primary school (65%) – the stage preceding the secondary schools, far more likely participate in active forms of tourism, than youth going to the next stage of education (not applicable to students of general secondary schools). Reduction of active participation in tourism when coming from a lower to a higher stage of education (in this case, from primary to secondary school) also was described in other research in Poland (Jurczak 2000). Differences between secondary schools show that the highest level of participation reaches the students of secondary schools (64%), and the lowest – the students of secondary vocational school (38,8%). In terms of the broad participation in tourism among the youth from secondary schools, the students of general secondary schools dominated (Wartecka-Ważyńska, 2007; Różycki 2001). After graduating primary school and choosing the studies in vocational schools, youth definitely stop tourist activity. The group of pupils which continues tourist activity, does so at the lowest level. The level of tourist activity is also differentiated for boys and girls in dependence on the school type.

Teenagers usually go to tourist trips with friends (32,3%) and family (26,6%), as confirmed by other studies (Różycki 2001). The results of the Institute of Tourism of the long-term trips of young people aged 15–19 in 2005 also show that the family (parents – 26,7%, other persons from the families – 20,7%) and colleagues or friends (42,4%) are most often the company of choice. The percentage of young people indicating individual trips – is 26,5% (Łaciak, 2006). In our studies, the information concerning the organized participation in active forms of tourism in the frames of class trips (3,5%) or other organizations cooperating with schools (6,5%) was also obtained. It remains to be asked: if school plays its role properly? However, that physical activity in the tourism in schools is often ignored (Sobolewski, 1998). It seems that the level of participation of young people in active forms of tourism could be greater. It is possible, that closer cooperation with organizations experienced in the organization of tourist activity, such as PTTK or ZHP, as well as travel agencies specializing in interesting proposals can improve the existing situation.

The tendency to seek the company of other people in tourist practice is reflected primarily in family tourism and in the circle of friends (girls declared it more often). Almost the same participation of girls and boys in a school trips seems natural due to the fact that the classes are mixed. Interesting differences shows a summary of participation in active forms of tourism in dependence on the educational level of families – here the highest participation (40,3%) is characteristic by higher levels of education, lower – for the average educational level (28,4%) and low – for low educational levels (14,95%). Maybe it is true that "intellectual workers much more take into account the necessity of traveling" (Wartecka-Ważyńska, 2007).

Research shows that the most popular is hiking. The percentage of the value of 47% is high. Biking also received a significant result compared to other types of tourism with 11,5%. Other forms of tourism, among which dominated the following canoeing, riding and sailing were declared, by each twenty-tested. The high participation in hiking can be explained by wide accessibility of this type of tourism, primarily because of its cost.

In addition, a tourist does not need a large amount of specialized equipment and knowledge – especially if he moves in a lowland area or in the lower parts of the mountains. It is worth noting, that the surroundings of Cracow are attractive for hiking. Analysis of participation in hiking shows that this kind of activity is more popular among girls than boys.

Conclusions

1. Physically active forms of tourism are undertaken mostly by girls – 63%, boys – 52%. At the low level of tourist activity, the girls dominate , on average and high levels the differences are negligible.

2. Together with the increase of the level of education of parents, the number of young people practicing the active forms of tourism also increases.

3. The undertaking of active forms of tourism varies depending on the type of school. Most of the young people in secondary (63,9%) and primary (65,7%) schools participate in tourism. Least pupils participate in primary (50,1%) and secondary (39,4%) vocational schools.

4. After leaving primary school and undertaking further education in vocational schools, both primary and secondary, young people clearly stop participating in tourist activity. The part that continues, does so at a lower levels.

5. Active forms of tourism usually take the form of informal practice individually among friends and acquaintances (mostly hiking – 47%). Less commonly are the organized class trips (3,5%) and other school and extracurricular activities (6,5% and 3%).

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Geotourism 1(36) 2014: 21–24
http://dx.doi.org/10.7494/geotour.2014.36.21

The outcrop of the Menilite Beds in Kobielnik village – its geoeductional significance and an example of determining structural position based on clastic dykes

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Abstract: *The location and most interesting geological features of the outcrop of the Menilite Beds in Kobielnik village were described in the text. However, the main subject is the problem of determining the structural position in the absence of typical indicators of the bed's top and bottom. The proposed solution is based on the observation of clastic dykes and their structural relationship to the surrounding layers. In addition, some sedimentary structures and natural bitumen's seepages were described.*

Key words: *Menilite Beds, clastic dykes, geotourism*

Introduction

The annual program of field training for students of the Faculty of Geology and Geotourism includes visits to selected geological outcrops with the assistance of the Faculty lecturers'. One of these exposures is the Menilite Beds in Kobielnik. Among other subjects, this particular exposure is usually used to demonstrate and discuss the phenomenon of the overturned position of the beds. However, the typical indicators of top and bottom of the bed, like hieroglyphs or Bouma sequence elements, are not present or developed in the Menilite Beds as in the case of other divisions of the Flysch Carpathians. A general knowledge of the Menilite Beds profile provides evidence that the beds in Kobielnik are overturned, but having this knowledge should not be immediately expected from the first year students. The authors propose an alternative method to explicitly demonstrate the overturned position of the beds. It is shown further in this paper that the particular features of clastic dykes observed in the exposure indirectly determine the situation of the beds.

Geographical location, description of the exposure and brief characteristics of Menilite Beds

Kobielnik village is in the South-Eastern part of the Makowski Beskid known also as the Middle Beskid. The subject exposure can be found in the right bank of the Kobielnik creek cutting into the West slope of Świnia Góra. The exposure can be reached by walking from the PKS Kobielnik Pocekaj bus stop and across the bridge over the creek. Just behind the bridge one should turn right onto the dust path that leads directly to the outcrop (around 70 m).

Geologically, Menilite Beds are one of lito-stratigraphic divisions within the Śląska nappe (Fig. 1, Fig. 2), and were deposited in the Krosno basin (Golonka, Waśkowska-Oliwa, 2007).

The age of Menilite Beds is determined as Oligocene, yet it is worth noting that, in other units of Flysch Carpathians the sedimentation in the Krosno basin could continue until the Early Miocene.

In the stratigraphic profile, the Globigerina Marls can be found below the Menilite Beds, while above them – thick Krosno Beds. The research indicates that depositional environment was most likely an outer shelf and the depth was varying between normal and storm wave base (Dziadzio *et al*., 2006; Olszewska 1984). The characteristic feature of the beds is the high content of organic matter. Because of this they are seen as one of the most significant source rocks in the Outer Carpathians (Dziadzio *et al.,* 2006; Krobicki *et al*., 2012).

Description of the exposure

The profile of the Menilite Beds can be investigated in a relatively large outcrop (around 30 m) (Fig. 3). The beds are steep (deep 50º, dip direction 218º) and mainly mudstones showing shale type cleavage. Several layers of polimictic conglomerates, with grain size varying from several millimeters to several centimeters, are also observed in the profile. The conglomerates often contain exotic elements, mainly fragments of coal up to 10–15 centimeters in size (Fig. 4A). In the shale layers, seepages of bitumens can be found (Fig. 4B).

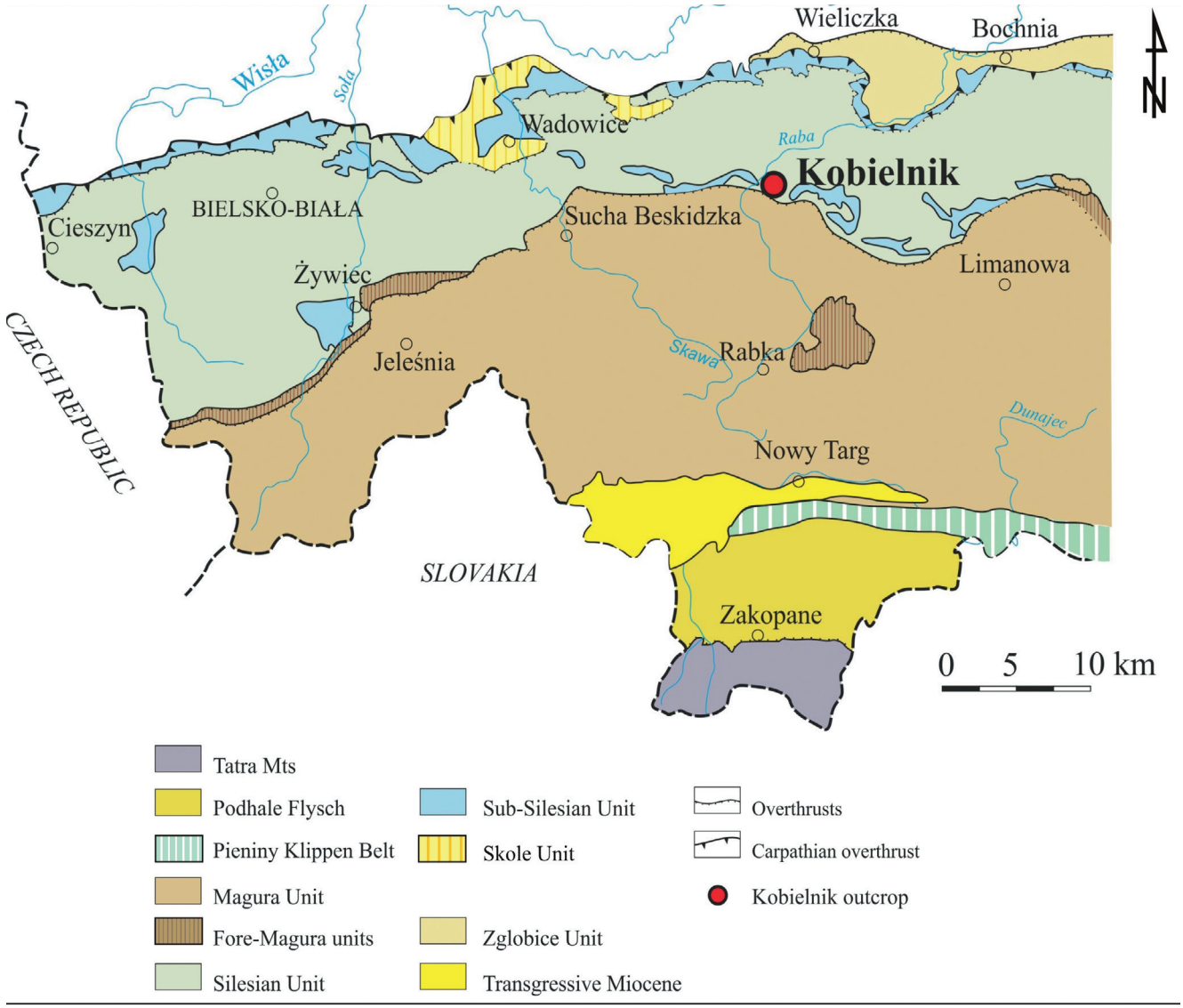

Fig. 1. Geologic map of the western part of the Polish Outer Carpathians with location of the Kobielnik outcrop (after Lexa et al., 2000)

The presence of bitumens and abundance of fish fossils within the shale beds make the exposure particularly suitable for explaining and presenting the genesis of hydrocarbons and elements of oil and gas geology, e.g. source rock and reservoir rock. Going further up along the creek, thin layers of cherts and beds of sandstone up to 50 cm thick can be found in the outcrop. The cherts are brownish black resulting from the content of a dark brown form of opal (menilite). The small waterfall, that can be seen nearby in the creek is apparently formed by highly resistant siliceous marls. Apart from the mentioned exotic fragments, seepages of bitumen and fish fossils many, interesting sedimentary structures can be found in the exposure. There are several clearly defined load casts on one of the conglomerate beds (Fig. 4c). The fact that they are seen on the upward facing plane also indicates an overturned position of the beds. In addition, one of the conglomerate beds shows reversely graded grains. Another point of interest is a small concentration of calcite crystals found on the conglomerate layer. Yet, the paramount feature of the exposure is the presence of numerous clastic dykes. The largest one is located on its right side (Fig. 3, Fig. 5). The dyke consists of material entirely different from material that can be found in conglomerate or shale beds. It is characterized by relatively good sorting (equigranular), iron staining on the weathered surface, psammitic fraction and less variable composition compared to conglomerates. The rock of the dyke is also very brittle. About 10 m further up the creek, along its right bank, there are more clastic dykes that form tail-like shapes along the slope. Several sandstone beds are also exposed there. Considering the macroscopic similarity of the material found in sandstones and dykes, it was determined that the sandstone beds were the source material for the dykes. Another interesting structure observed between two clastic dykes is a small fold of around 50 cm amplitude (Fig. 6). Its shape resembles a chevron fold, yet most likely it is of post-sedimentary origin. The genesis of this fold will be explained further in this paper.

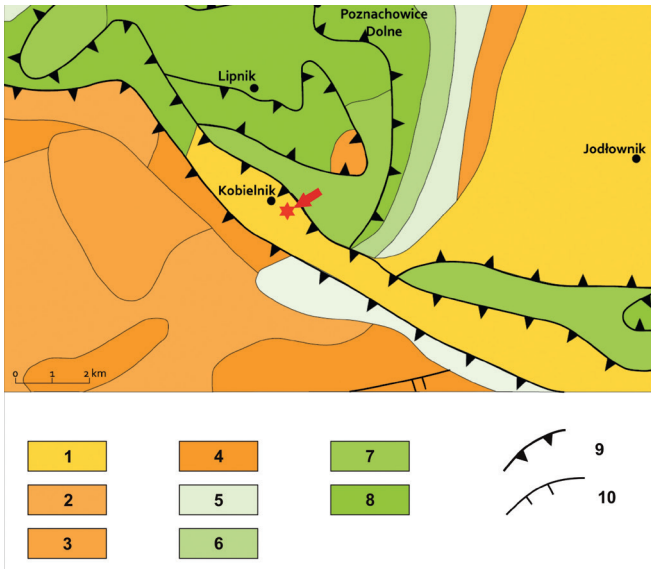

Fig. 2. Geologic sketch of the Kobielnik outcrop (after Lexa et al., 2000). Red arrow indicates the outcrop location. Explanations: 1 – Menilite and Krosno formations, 2 – Pasierbiec and Osielec Sandstones; 3 – Hieroglyphic Formation; 4 – Beloveza Beds; 5-6 – Istebna Formation; 7-8 – Cieszyn-Hradište formations; 9 – first order overthrust lines; 10 – second order overthrust lines.
Szkic geologiczny odsłonięcia w Kobielniku (na podstawie Lexa et al., 2000). Czerwoną strzałką wskazano położenie odsłonięcia. Objaśnienia: 1 – warstwy menilitowe i warstwy krośnieńskie, 2 – piaskowce pasierbieckie i piaskowce osieleckie, 3 – warstwu hieroglifowe, 4 – warstwy belowezkie, 5-6 – warstwy istebnieńskie, 7-8 – warstwy cieszyńskie i warstwy grodziskie, 9 – główne nasunięcia, 10 – podrzędne nasunięcia.

Fig. 3. Outcrop in the Kobielnik village. The location of the biggest clastic dyke (shown later on Fig. 5) is marked by white rectangle (photo M. Barmuta)

Fig. 5. Contact zone between clastic dyke and shale layers. Bending on the shale layers is underline by red lines (photo J. Barmuta)

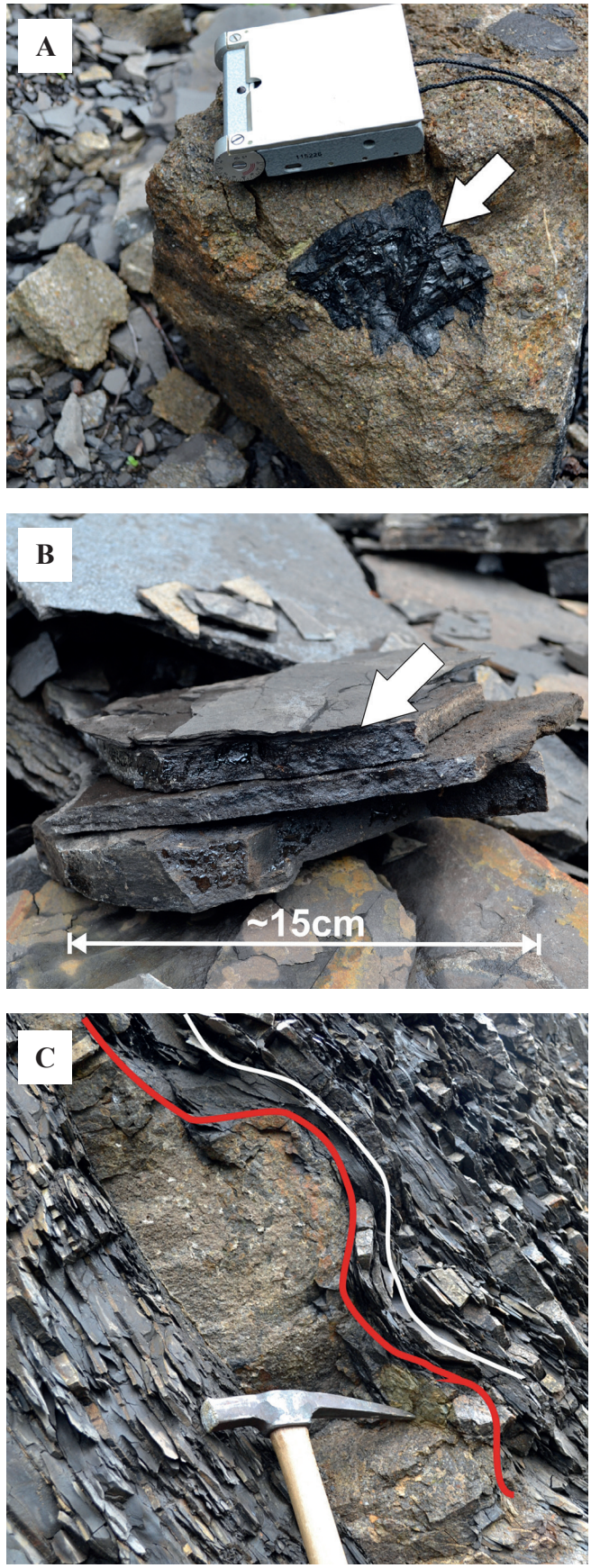

Fig. 4. Some geological phenomenon observed within Menilite Formation; A – large fragment of coal (~10 cm), B – bitumen seepage from fragment of shale layer, C – load casts found in the conglomerate (photo J. Barmuta)

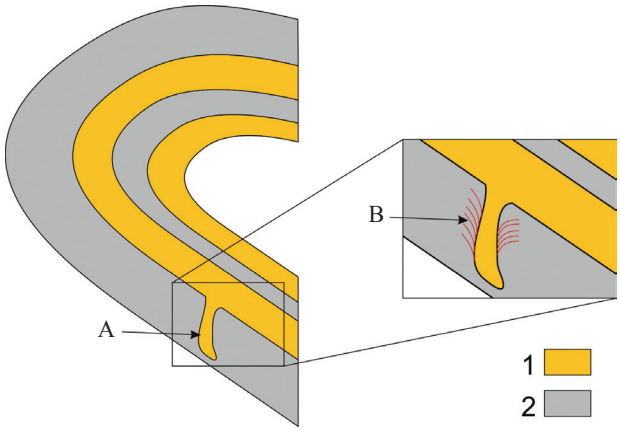

Fig. 6. Schematic sketch of clastic dyke position in the Kobielnik outcrop. 1 – shale layers, 2 – sandstone layers, A – clastic dyke, B – shale layers' bending around clastic dyke (own compilation)

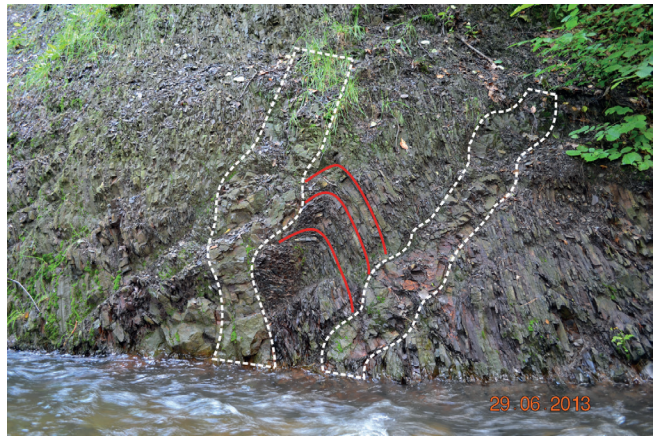

Fig. 7. Small fold (~50 cm height) located between two clastic dykes (photo M. Barmuta)

Structural position of the clastic dykes in relation to surrounding beds

Generally, clastic dykes are defined as sedimentary structures in form of the veins oriented discordantly to bedding and intersecting the beds. The formation of dykes is explained by high water pore pressure in loose sediment under a lithified overburden. When pressure exceeds the critical fracturing pressure, the saturated material breaks through the overlying beds usually following the local weakest zones and paths (e.g. faults). By filling up the fractures it forms the characteristic clastic dykes. The direct impulses for the formation of dykes (abrupt increase of water pressure) can also be earthquakes and other violent events. The size of these structures varies within a range of meters to tenths of kilometers. Occasionally, regional size intrusions of sandy material, in the form of sill, may later become a reservoir for hydrocarbons (e.g. Balder oil field, Norway) (Imbert, 2011). Obviously, the material fracturing and intruding into the overlying beds causes the beds in the nearest vicinity of the dyke to bend in the direction of the intrusion; usually upward. However, when examining this zone of shale beds between two clastic dykes it appears the beds are bent downward (Fig. 5). Based on this observation, it becomes evident then that the whole packet of Menilite Beds was overturned after upward deformation of shale beds (Fig. 6). The earlier described folding took place during the shale beds fracturing and the dyke material moving upward. As located between two closely spaced dykes it became a syncline. What we observe now is an anticline because the beds were subsequently overturned. The non-tectonic origin of the fold is also implied by the curvature of the bend diminishing together with the direction of the intruding material (Fig. 7).

Conclusions

The exposure in Kobielnik is certainly a very attractive and useful for the purpose of promoting teaching of geological science. It allows for a demonstration and a discussion of many topics from various fields of geology of which only few have been described in this paper. The authors presented the exposure to a group of a dozen or so visitors generally unfamiliar with geological science. The observation proves that this particular location invokes high interest especially in the origin and migration of hydrocarbons, fossilized fragments of fish and the mechanisms for the formation of clastic dykes.

The authors suggest the reasoning based on the genesis of clastic dykes and their effect on the surrounding layers, that leads to the conclusion of the overturn of beds, can be an additional and interesting example of geological analysis to be presented on site to geology students and a general audience.

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Geotourism 1(36) 2014: 25–32
http://dx.doi.org/10.7494/geotour.2014.36.25

Selected economic factors impacting tourist travel in Poland between 2000 and 2012 and a forecast for 2013–2017

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Abstract: *The paper presents an analysis of tourist travel in Poland during the 2000–2012 time period and predictions for years 2013–2017. Since 2000 the amount of travelling Polish citizens has declined. Various factors may have impacted this state of matters e.g. the economic crisis or increasing the VAT rate. The biggest decline in tourist travel was observed between 2007 and 2009 and in 2011. On the other hand, the factor which increased the number of visits between 2007 and 2009 may have been the Euro 2012 championship, organized by both Poland and Ukraine. The paper presents a "eurosensitivity" factor, which describes the increase in people visiting selected voivodeships during 2012, primarily due to the Euro 2012 championship. According to the calculations, the voivodeship which benefited from the highest increase was Małopolska. The article also presents an estimation of travel for years 2013–2017.*

Key words: *tourism travel, trip prediction, economic conditionality, Euro 2012*

Introduction

Tourism is one of the key sectors of the economy, especially in developing countries. Right now, because of numerous changes, it's being subjected to many fluctuations. Tourism is highly dependent on the wealth of citizens, therefore one of the factors of profound impact on the stagnation of both Polish and global tourism has been the economic crisis. During recent years there has been a steady decline in travel among the Polish people. In 2000 the combined number of visits in various voivodeships (province) was 64,1 million whereas in 2011 it was only 30,1 million (Łaciak, 2004, 2008, 2012). Further in the article a detailed analysis is presented including the regression of tourist visits of Polish people along with the causes. The decline may be connected with the economic crisis which is considered to has begun in 2008 (Rechela *et. al*., 2011), although some scientists point to 2007 (Shahrokhi, 2010). Many researchers work on similar topics. The examples include an analysis describing how the decline of tourism affects a country's economy (Steiner *et. al*., 2013) or a paper pointing to a sharp decrease of global tourist visits in 2009 (Kapiki, 2012). In 2011 the worst result in 12 years in Polish tourism was recorded, 30.1 million visitors which corresponds to about 47% of the result observed in 2000. The reason behind this phenomenon may be the increase in the VAT tax. Along with factors that negatively impacted Polish tourism, we can recognize a few key facts which had been beneficial. 2012 was the best year in terms of Polish travel since 2004. In this case the sharp rise in travel may had been due to organization of the biggest sporting event of the old continent – the Euro 2012 championship.

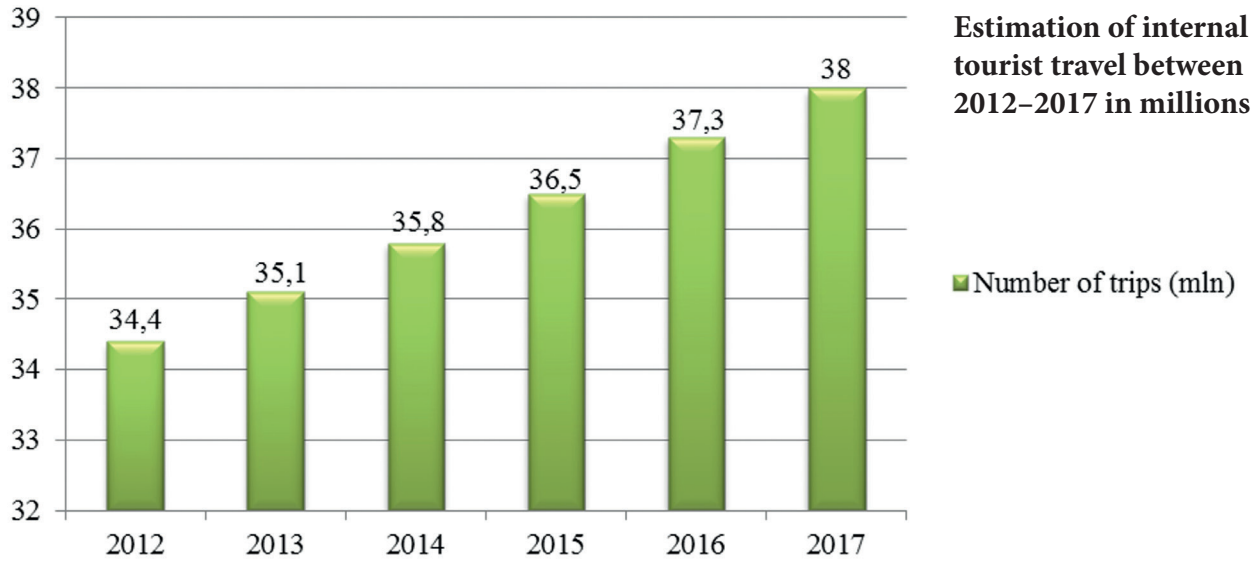

Fig. 1. Estimation of internal tourist travel between 2012–2017 in millions – see legend in Table 2 (source: http://www.intur.com.pl/images/wykresy/high/podrozepolakow.htm)

Fig. 2. Polish voivodeships with respective regression coefficients

Research material

The research was based on data regarding Polish internal tourist travel analyzed between 2000 and 2012 by the Institute of Tourism of the School of Tourism and Recreation in Warsaw. These data depict the number of short-term (from 2 to 4 days) and long-term (5 and more days) visits (each voluntary trip outside the place of residence accompanied by at least one overnight stay) of Polish people categorized into voivodeships, and the overall number of trips (one trip may include many visits) of Polish people in a given year. These data are presented in Table 1. Along with the data, the article uses the estimates created by the Institute of Tourism concerning the combined number of Polish trips for 2012–2017 presented in Figure 1.

Tourist travel data analysis

Statistical travel and economic factors between 2000 and 2012

The data in Table 1. points to a steady decline in travel since 2000 with the exception of 2010 and 2012, where in comparison to the previous year, the number of trips had increased by 3.1 million and 11.1 million respectively. The smallest number of trips occurred in 2011 with 29.6. The decline may be interpreted through the economic conditions at the time. In to 2011 the vat tax was increased by 1 percentage point. Even though the increase is relatively small, it caused the raise in product and services costs. It directly influenced a decline in the number of trips, due to that fact that people living on a constant home budget prioritize the essential products and services over tourism. Furthermore Poland is still being subjected to the results of the economic crisis which began in 2008. It had a profound effect on the state of tourist travel observed by analyzing the number of trips between 2007 and 2010.

Further in the article regression coefficients are presented for each voivodeship. These coefficients describe the dependency between the number of visits and time. Figure 2 shows the map of Poland divided into voivodeships along with individual regression coefficient values. The highest absolute value of the coefficient belongs to the Mazowieckie voivodeship (0.468), which means that between 2000 and 2011 the voivodeship was subject to the highest decline in people visiting the region.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
dolnośląskie	5.2	3.5	3.9	2.8	3.1	2.9	3	2.2	3.2	2.8	2.8	2.7	3.7
kujawsko-pomorskie	4.1	2.7	3.1	3	2.7	2.7	2.7	2	2.2	1.8	1.6	1.6	2.2
lubelskie	3.3	2.3	3.2	3.2	2	1.6	2.1	1.5	2.1	1.7	1.3	1.8	1.8
lubuskie	1.4	1.5	1.3	1.3	1.9	0.9	1.1	1.4	1.4	0.9	1	0.8	1
łódzkie	4.3	2.5	2.7	1.8	1.4	1.3	1.6	1.3	0.9	1.2	1.4	1.2	1.5
małopolskie	6.6	5.6	5.3	4.8	3.8	3.8	3.8	3.6	3	2.4	2.8	2.8	5.2
mazowieckie	9.9	6.5	7.3	6.4	5.1	5.8	5.5	4.4	4.4	3.5	3.9	3.4	5.5
opolskie	1.4	1.8	1.6	1.2	0.8	0.4	0.7	0.6	0.6	0.7	0.5	0.4	0.5
podkarpackie	2.4	1.7	3.1	2.7	3	2.5	2.1	2.2	2.1	1.7	1.5	1.4	2.4
podlaskie	1.1	2.8	1.9	1.9	1	1	1.4	1.7	0.8	0.8	1.4	1.5	0.9
pomorskie	4.4	4.6	4	4.8	3.5	3.2	3.2	3.7	3.7	3.7	4.5	2.8	5.2
śląskie	7	4.9	5	4	3.6	2.8	3.1	1.9	2.4	1.8	2.6	2.5	3.3
świętokrzyskie	2.2	2.4	2.6	1.6	1.3	1	0.9	1.1	1.1	0.9	1.3	1	1.2
warmińsko-mazurskie	2.4	2.6	2.6	2.6	1.9	1.6	2.1	2.4	2.1	2	2.1	1.8	2.2
wielkopolskie	4.5	4.2	3.5	3.7	3.4	3	3.2	2.1	2.4	2.4	2.4	1.6	3.1
zachodniopomorskie	3.9	4.2	3.5	3.6	2.6	2.4	3	3.3	3.3	3.5	3.9	2.8	3.1
Combined number of visits	64.1	53.8	54.6	49.4	41.1	36.9	39.5	35.4	35.7	31.8	35	30.1	42.8
Combined number of trips	63.9	53.8	54.2	48.4	39.6	35.9	38.5	34.9	34.9	30.8	33.9	29.6	40.7

Tab. 1. Overall numbers (in millions) of internal Polish travel between 2000 and 2012 by voivodeships (source: Łaciak, 2004, 2008, 2012)

The majority of tourists usually pick Warsaw. On the other end of the classification is the Zachodniopomorskie voivodeship, which is also subject to a steady decline in people traveling, but with a much lower intensity which is represented the linear regression coefficient 0.468±0.07. The full classification is presented in Table 2.

Based on the calculated regression coefficients, the prognosis of the numbers of trips was created for the 2012–2017 period. For the total amount of trips, the regression coefficient is 2.794±0.36. The prognosis was created based on the statistical data gathered between 2000 and 2011 with the exclusion of 2012.

According to the estimations based on the linear regression coefficient presented on Figure 3. The number of trips in 2012 was between 14 million and 36 million. According to the Institute of Tourism's prognosis, the total number of trips was predicted to amount to about 34.4 million. After gathering the 2012 data, the actual number of trips was 40.7 million which is 4.7 million more than the maximum estimation from the regression coefficient, due to the fact of not taking the economic factors into account. Their prognosis shows that during the persisting, decreasing trend the maximum number of trips may fall below 24 million in 2017. According to the Institute of Tourism prognosis, the number of trips in 2017 will amount to about 38 million. The difference in results is probably due to the fact, that the Institute of Tourism takes into account other factors (not only the number of trips), because events which draw large numbers of people from Poland and abroad may have a profound effect on the trend. Raw statistical data does not take this into account. Comparing the prognoses up to 2000 (63.9 million of trips), we observe a decline of about 60%. Analyzing the total amount of visits, the decline is similar, also around 60%.

In the further part of the analysis a prognosis was presented for individual Polish voivodeships. We analyzed and compared the results estimated for 2017 with the results for the year having the maximum number of visits for every voivodeship between 2000–2011 (Table 3). Several voivodeships were chosen for interpretation.

	Voivodeship	Regression coefficient [milion trips per year]	Color on map
1	zachodniopomorskie	0.047±0.05	
2	lubuskie	−0.051±0.02	
3	warmińsko-mazurskie	−0.055±0.02	
4	podlaskie	−0.066±0.05	
5	pomorskie	−0.089±0.05	
6	podkarpackie	−0.099±0.04	
7	opolskie	−0.113±0.02	
8	świętokrzyskie	−0.134±0.03	
9	dolnośląskie	−0.147±0,04	
10	lubelskie	−0.149±0.04	
11	kujawsko-pomorskie	−0.184±0.02	
12	łódzkie	−0.206±0.05	
13	wielkopolskie	−0.231±0.02	
14	małopolskie	−0.339±0.04	
15	śląskie	−0.369±0.07	
16	mazowieckie	−0.468±0.07	
Combined number of visits		−2.748±0.35	
Combined number of trips		−2.794±0.36	

Tab. 2. Voivodeships classified by the regression coefficient

In Małopolska the estimated maximum number of visits in 2017 is about 1.5 million. Compared to 2000 (6.6 million) it gives a decline of about 80%. The estimated maximal number of visits in the Śląskie voivodeship in 2017 is about 1.9 million. It is a 70% decline compare to the year 2000. The aforementioned voivodeships will probably have the highest decline in the number of visits compared to the year 2000 – about 10% higher than the estimated country-wide decline. The only voivodeship in which, according to estimates, there will be an increase in visits is the zachodniopomorskie voivodeship. The increase is estimated to be around 5%. Table 4 shows the prognosis for the total number of visits for individual voivodeships in 2014.

The paper also presents a second variation of estimation which takes into account the data between 2007 and 2012. It's an interval between the start of the economic crisis and the date of the Euro Football Championship, in which an increase of tourist travel was observed. Figure 4 presents the total amount of trips made by Polish people taking into account the data from 2007–2012.

Contrary to the previous analysis, the plot shows an increasing trend. The prognosis for 2017 is 14–62 million trips, with the average at about 38 million. In the prognosis (taking into account the economic crisis), we can tell that the Euro Championship in 2012 will have a profound effect on the number of trips in successive years.

In 2012 Poland and Ukraine were the hosts of the Euro 2012 football championship. It resulted in a sharp increase of tourist travel in Poland. For the purpose of investigating the increase in tourist travel a coefficient was proposed. The coefficient determines which voivodeship gained the most due to the Euro 2012 event. The coefficient is called "eurosensitivity":

$$E = \frac{3 \cdot N_{2012}}{N_{2009} + N_{2010} + N_{2011}}$$

N – number of visits during the specific year

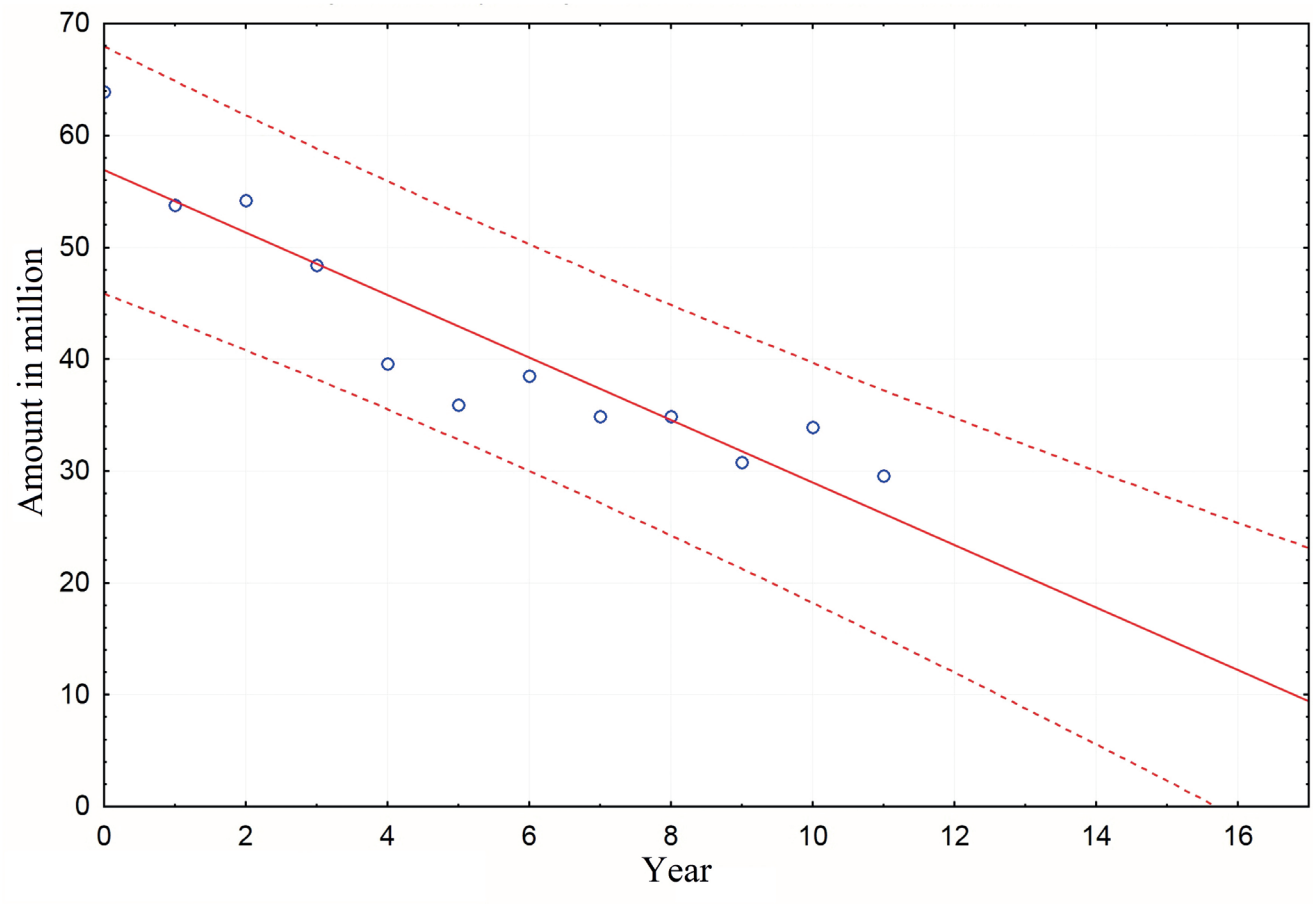

Fig. 3. The regression plot of the amount of trips as a function of time with a 95% confidence interval

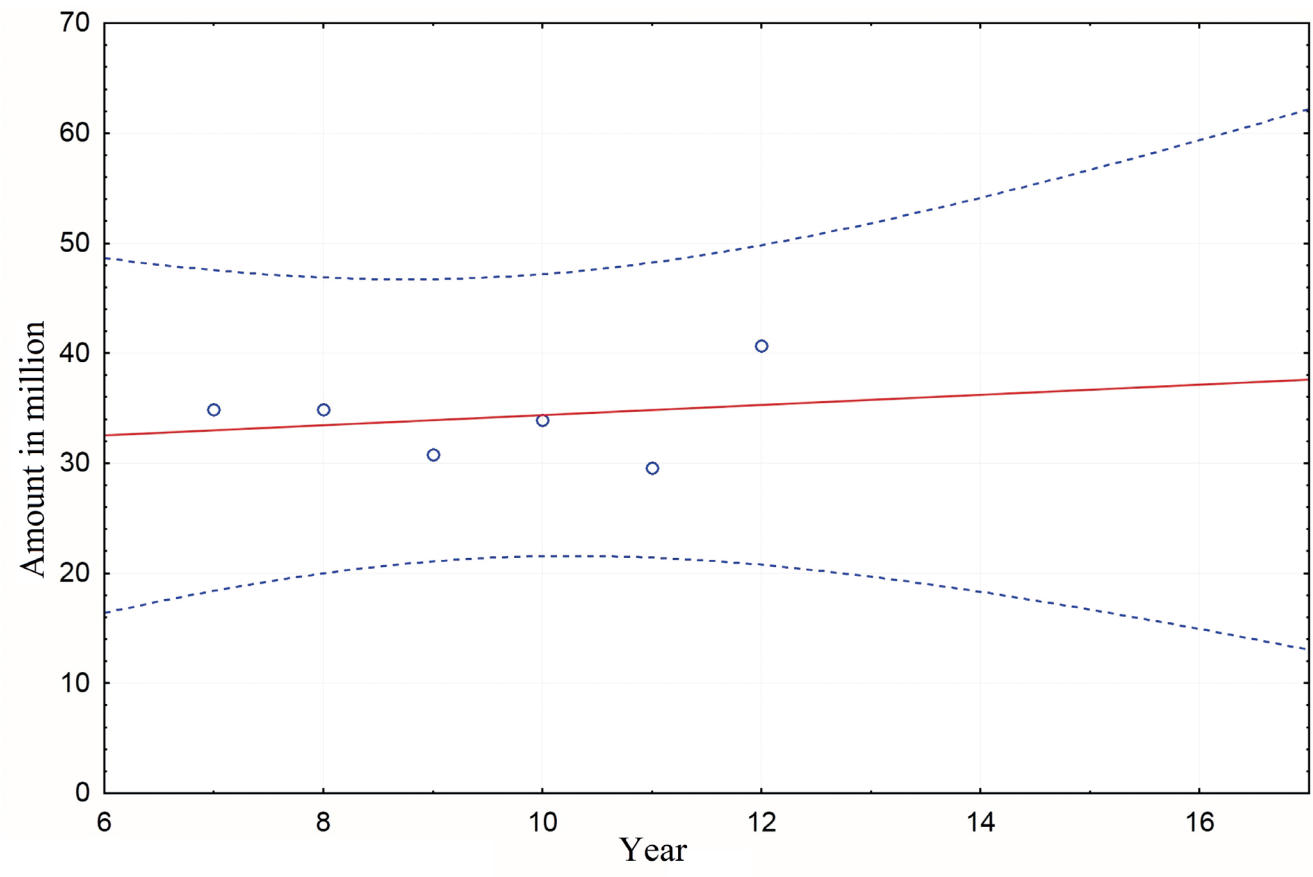

Fig. 4. The regression plot of the amount of trips as a function of time with a 95% confidence interval for 2007–2017

	Voivodeship	Max from 2000-2011 (million)	95% confidence interval prognosis in 2017 (million)	Expected value in 2017 (million)
1	małopolskie	6.6	0–1.5	0.1
2	śląskie	7	0–1.9	0
3	opolskie	1.8	0–0.5	0
4	wielkopolskie	4.5	0–1.3	0.4
5	mazowieckie	9.9	0–3	0.1
6	łódzkie	4.3	0–1.4	0
7	kujawsko-pomorskie	4.1	0–1.4	0.4
8	świętokrzyskie	2.6	0–1.2	0
9	lubelskie	3.3	0–1.9	0.5
10	dolnośląskie	5.2	0–3.3	1.5
11	podkarpackie	3.1	0–2.3	1
12	lubuskie	1.9	0–1.5	0.7
13	podlaskie	2.8	0–2.5	0.7
14	warmińsko-mazurskie	2.6	0.7–2.4	1.6
15	pomorskie	4.8	1–4.5	2.9
16	zachodniopomorskie	4.2	1–4.4	2.9

Tab. 3. Comparison of prognoses for 2017 with the maximal number of visits for individual voivodeships between 2000–2011

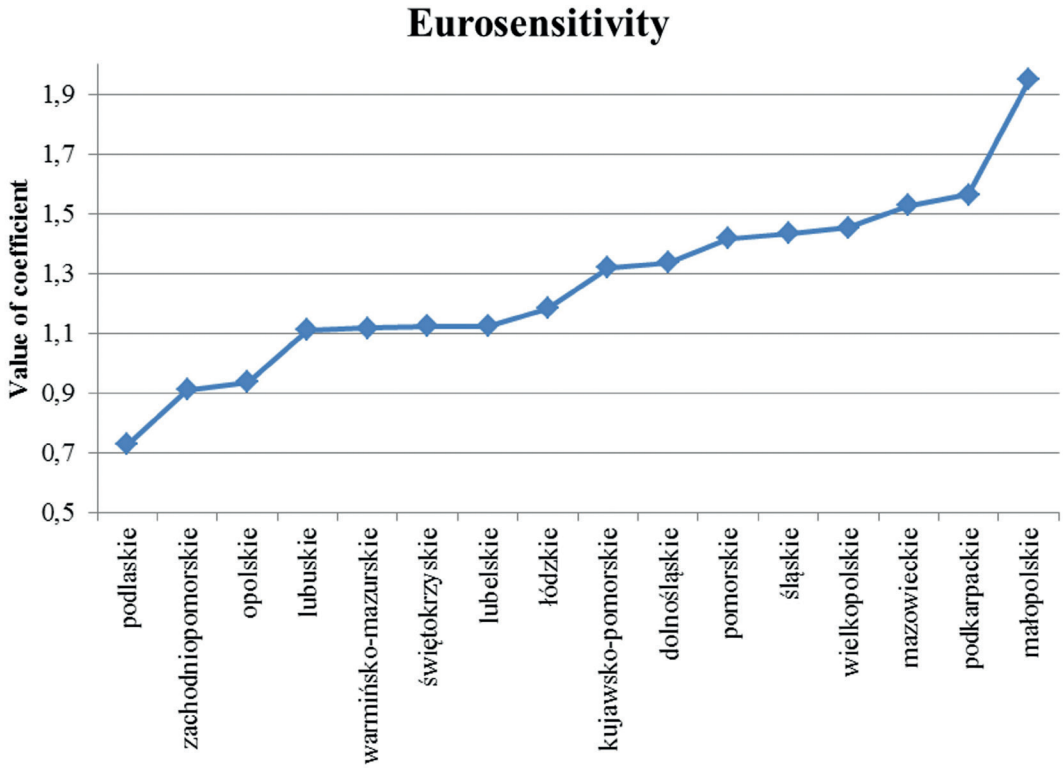

Fig. 5. Eurosensitivity plot

	Voivodeship	95% confidence interval prognosis (million)	Average value (million)
1	dolnośląskie	0.2–3.6	1.9
2	kujawsko-pomorskie	0.1–1.8	0.9
3	lubelskie	0–2.2	0.9
4	lubuskie	0.1–1.5	0.8
5	łódzkie	0–1.7	0.1
6	małopolskie	0–2.4	1.2
7	mazowieckie	0–3.9	1.8
8	opolskie	0–0.7	0
9	podkarpackie	0.1–2.7	1.4
10	podlaskie	0–2.7	0.9
11	pomorskie	1.5–4.7	3.1
12	śląskie	0–2.6	0.3
13	świętokrzyskie	0–1.4	0.3
14	warmińsko-mazurskie	0.9–2.5	1.7
15	wielkopolskie	0.2–1.9	1.1
16	zachodniopomorskie	1.4–4.5	2.9
	Combined number of trips	6–30	18

Tab. 4. Visit amount prognosis for individual voivodeships in 2014 (million)

The "eurosensitivity" plot (Fig. 5) with voivodeships sorted according to the coefficient indicates the voivodeships which gained the highest number of travelers in 2012.

According to research, the highest increase resulting from the Euro 2012 event was observed in the Małopolskie voivodeship. The result may be interpreted through the location of the training base of 3 national teams taking part in the tournament. Despite the fact that Cracow was not among the cities hosting the championships, it attracted tourists wanting to spectate the 3 high-tier national teams training, free of charge. Furthermore, Cracow is one of the main transport nodes in Poland. Tourists, both from west and north Poland traveling to Ukraine, often picked Cracow as an intermediate station. A significant number of tourists returning from Ukraine took a stop at Cracow, the city of Polish kings, full of wonderful, historical landmarks. Podkarpackie is the second ranked eurosensitivity voivodeship with a result of about 1.5. The high number is a result of the voivodeship's location. Most tourists going through Ukraine, traveld through podkarpackie. Furthermore, the Polish south-east region is rich in tourist atractions, which promote tourism there, for example Bieszczady. The other voivodeships which placed high in the ranking are Mazowieckie, Wielkopolskie, Dolnośląskie and Pomorskie. In each of those Euro 2012 matches took place.

Summary

The article presents an analysis of tourist travel in Poland between 2000 and 2012 and a prognosis for 2013–2017. The conducted research indicates a steady decline in travel and visits in Poland. The highest decline was observed from 2007 to 2009. The decline is probably caused by the effect of the global economic crisis. 2011 is the year with the lowest number of trips. In this case, we can assume that it is the result of the increased VAT tax in Poland. According to the estimated forecasts, the decline will continue reaching below 24 million trips by 2017.

The paper also presents the eurosensitivity coefficient which shows the effect of the Euro 2012 on tourist travel in Poland. According to the ranking based on eurosensitivity, małopolskie and podkarpackie voivodeships gained the most through the Euro 2012 when it comes to the number of tourists.

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Geotourism 1(36) 2014: 33–42
http://dx.doi.org/10.7494/geotour.2014.36.33

Geotouristic attractions of the Danakil Depression

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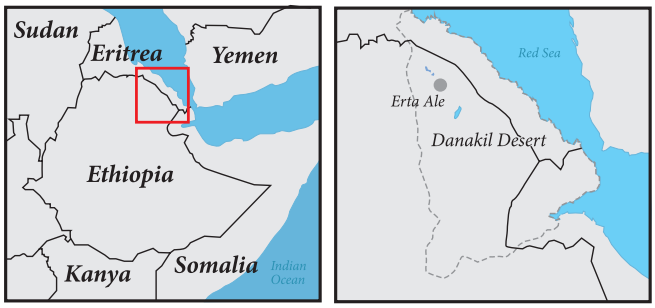

Abstract: *Geotourists and unconventional tourists will be definitely interested in the Danakil Valley. It is rarely visited place but absolutely extraordinary in many ways. It is in an area of divergence of lithosphere plates and, therefore connected to that, seismic and volcanic activity can be observed. Stunning terrain forms, geological structures, colours and diversity seem to be unreal. This desert is very inhospitable due to poisonous exhalations, omnipresent salt, an extremely hot climate, water deficiency and the fact that fauna and flora don't exist here. Despite all of these inconveniences, the Danakil Valley is inhabited by the Afars, a population thriving mainly on primitive salt production. Their rare culture is worth attention too. Not so long ago they were hostile and even now natives can be unpredictable and dangerous. Additionally, visitors should remember other difficulties: legal, organisational, financial and, above all, natural and climatic ones.*

Key words: *Ethiopia, Danakil, Danakil Desert, Afar, Afrera Lake, Erta Ale, volcanos, salt*

Introduction

The Danakil Valley occurs in The Afar Triangle, within The Great Rift Valley, on north-east Ethiopian, south-east Eritrean and west Djiboutian territories. It is an enormous unsettled area with barren soil. From the North to the South it is about 570 km long, and its width varies from 80 to 400 km (covering an area~200000 km^2 – Beyene, Abdelsalam, 2005). Most of it lies below sea level. It also has the deepest depression of the African continent, the shoreline of lake Asal reaching 155 m b.s.l. (Waltham, 2010, but Morell, 2012–156 m b.s.l.). Its geological, climatic, cultural and landscape features are unique on a global scale. Hot sulphur springs, multicolour salt and mineral crusts, rifts, faults, black lavas, vaporous geysers and active volcanos create one of the most weird and beautiful landscapes on Earth.

Fig. 1. Location of Danakil Depression: A – Location in Africa; B – Detailed location with reference to the plates of the lithosphere and the national borders (after Morell, 2012, simplified); C – Schematic diagram of triple junction, showing the two active arms that form an ocean basin and the failed arm that forms an aulacogen. The East African Rift System is the failed arm (after Ritchie, Gates, 2001, simplified)

Nowhere else can so many unusual phenomena and geological processes be observed: plate divergence, tectonic rifts, faults, earthquakes, volcano eruptions, lava outflows, a lake of hot lava in a crater, hot springs, steam and gas exhalations, evaporation, deflation, corrasion, saline lakes, colourful salt crust and sand dunes. It is the hottest place on Earth, where during the dry season (in July and August) thermometers can read 50 ˚C (Harris, 2008). Average temperature for the whole year is 34 ˚C (Briggs, 2010). Considering how inhospitable Danakil is for its inhabitants, the place seems to be even more interesting and worth visiting (Fig. 1).

Fig. 2. Afar window – view from the Ethiopian highlands to the Afar rift (Gemasa Gedel near Debre Sina), photo M.T. Karasiewicz

Tectonics and geological structure

The Danakil Depression is a tectonic depression, visibly lowered in comparison to neighbouring areas (Fig. 2). Most of its bottom lies below sea level.

The Danakil Depression lies in the system of The East African Rifts, associated with the world-wide mid ocean rift systems. It is a unique sequence of basins, about one hundred kilometers long, tens of kilometers wide, which can be filled with sediments and/or volcanic rocks. The system is several thousand kilometers long, a series of rift valleys, separated by shoals and bordered by uplifted shoulders (Żaba, 2005). There are two main rift valleys (the eastern and the western) and the smaller southeastern branch – Mozambique Channel (Chorowicz, 2005; Omenda, 2007).

During global plate reorganisations, the East African rift system moved northward from the Mesozoic Anza rift system into the Afar depression and cut across rift structures of the Red Sea and Gulf of Aden. The Red Sea, Gulf of Aden and Ethiopian rifts intersect in a complex zone within the central Afar depression, creating the typical rift-rift-rift triple junction zone (Wolfenden *et al*., 2004; Waltham, 2005). Originally in a different position, the Afar triple junction migrated north-eastward, because of along-axis propagation of rifting in each of the three arms (Fig. 1A, B, C). That caused a change in the orientation of the Red Sea rift. The present one is from the north-west to the south-east. Strong cross-rift dislocations also cause the margins of the main Ethiopian rift to continue southwards, which gives its north-east to south-west orientation (Wolfenden *et al*., 2004; Schlüter, 2006; Hammond *et al*., 2011). Incipient divergence was along the line of the Red Sea until the breaking away of the Danakil Microplate which then started to move independently of the Nubian Plate since about 11 Ma. The Afar Triple Junction accommodates the divergent motions between the Arabian, Nubian and Somalian plates (Beyene, Abdelsalam, 2005; Waltham, 2005).The volcanic and tectonic activity in the rift started about 30 million years ago. The eastern branch is characterised by stronger geothermal activity. The Afar part, which lies above the Afar Hot Spot (McClusky *et al*., 2010), is the most active segment of the entire rift system. The potential energy production of Eastern Africa is 2500 to 6500 MW using today's technologies, which would mean from 1/4 to 3/4 of current worldwide energy from geothermal power (Omenda, 2007). The Afar Hot Spot also results in voluminous volcanic activity, high elevation and, because of interaction with tectonic extension, spatially distributed and temporally evolving deformation around the Triple Junction, even though the Arabia-Nubia-Somalia relative plate motions have remained quite constant since 11 Ma (McClusky *et al*., 2010). The East African rift system was already described by Żaba (2005) in the journal Geotourism.

As mentioned before, the Afar Triangle is characterised by strong seismic activity. In this region a quarter of all active African volcanoes can be found as well as frequent and strong earthquakes. One of the strongest earthquakes took place in 2005 (Beyene, Abdelsalam, 2005; Bojanowski, 2006; Morell, 2012). The Afar Triangle lies among The Red Sea and Ethiopian highlands: Abyssinia to the West and Somali to the East. It is a very special place, one of a very few on our planet, where an underground oceanic ridge can be found on the surface. This jagged volcanic seam of magma soaks through and creates a new sea bottom. Here, geologists have an opportunity to study geological processes which usually occur underneath the ocean bottom. Three tectonic plates contact here: Nubian, Arabic and Somali (Fig 1, 3, 4). The central meeting place for these three pieces of the Earth's crust is around Lake Abbe. They constantly move away from one another at a speed of about 12–13 mm per year (Waltham, 2005, 2010; Morell, 2012) and create tectonic rift. Magma flows out from tectonic fissures, then cools down, increases its density and as it falls it creates falling forms, e. g. the Red Sea basin, the Gulf of Aden and the Danakil Depression. The same processes cause a constant decrease of the Afar Triangle level (Fig. 3, 4). In the future (over millions of years) this region will probably be flooded with water and will become a new sea. Consequently, the Somali Peninsula is going to be cut off from the rest of the African continent (Chorowicz, 2005; Waltham, 2005, 2010; Bojanowski, 2006; Asrat *et al.,* 2008; Morell, 2012). The Afar Depression, along with Iceland, is one of two places on Earth where a mid-ocean ridge can be studied on land. In the east part of the Afar Triangle, on the borders of Djibouti, the dominant landforms are four great rift valleys. The deepest and most active of them contains Lake Asal (Asalie) and the marine bay of Ghoubet.

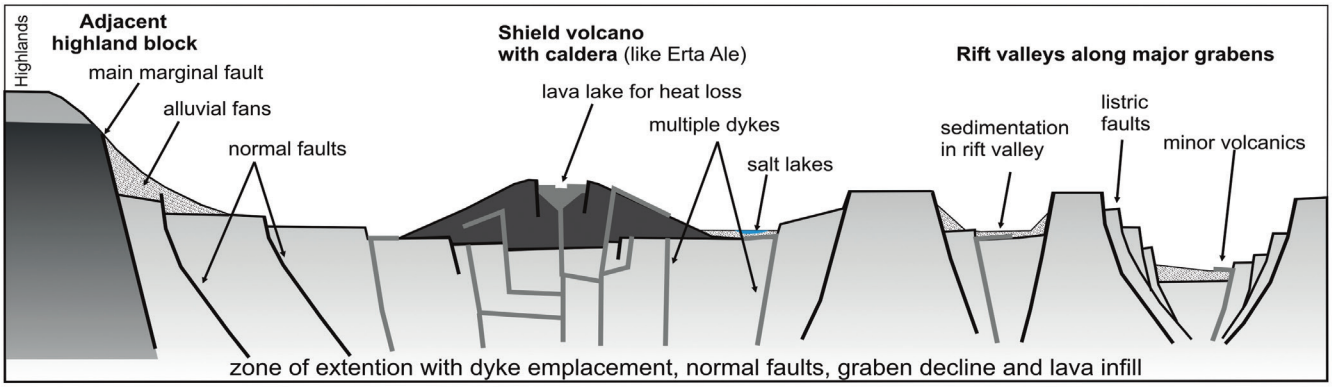

Fig. 3. Diagrammatic and greatly simplified profile showing the main features of ground extension in the Afar, incorporating features of both the Erta Ale volcano in the Danakil Depression and the main grabens in the Djibouti sector (after Waltham, 2010, slightly modified)

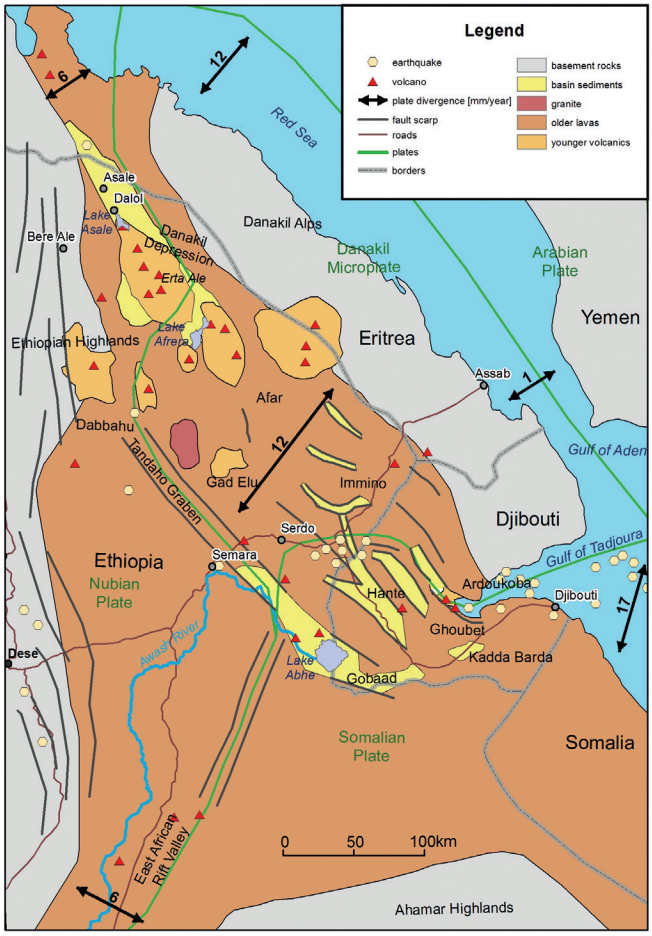

Fig. 4. Geological and tectonic sketch of the Afar Triangle (after Waltham, 2010, slightly modified)

Fig. 5. Lava lake in volcano Erta Ale crater, photo Z. Preisner

The salinity of Lake Asal exceeds 34%. The length of the rift is 70 km, its width is 15–20 km with cliffs up to 600 m high. The most southerly rift valley has been largely filled with sediments brought by the Awash River (the only river in the Afar Triangle). This is also the place where Lake Abhe (more than 200 m above sea level and now only 15 m deep) is situated. This region is best known for its hundreds of splendid travertine towers. Each tower was formed where a carbonate-saturated, geothermal spring emerged in the contemporary lake floor and deposited the calcite due to reaction with lake water (Waltham, 2010).

In the northern part of the Afar Triangle, there is the Danakil Depression – a massive rift valley between the fault scarps of the Ethiopian Highlands and the Danakil Alps (Fig. 4 and 17). Cut off from the sea since the Pleistocene, the Danakil Depression has lost its water because of desert evaporation and is dry down to Lake Dalol (acid water), 126 m below sea level. Lake Afrera is another salt lake which lies 118 m b.s.l. Between these two lakes, there is the multiple shield of volcano of Erta Ale, occupying most of the depression floor. It is the largest and most active of all 34 volcanoes (5 active) situated in the Afar Triangle. The Erta Ale is a typical shield volcano with gentle slopes and elliptical shape due to its location over a major fissure zone along the axis of the Danakil Depression both the central vents and the main parasitic vents. Its perimeter lies more than 100 m below sea level and the summit rises to 613 m above sea level. The Erta Ale is an unusual volcano because of the lake of hot, liquid lava in its crater (Fig. 5). It has been active permanently, for at least 100 years. Currently the lake of lava lies within the central vent, very spectacular pit crater – which is now 150 m wide and 80 m deep (Briggs, 2010; Waltham, 2010). The Erta Ale is the most frequently visited volcano chain in the region (Briggs 2010). The least common volcano in this site is Dallol, which is very flat and only 34 m higher than the surroundings lying in the depression. It covers an area of 3.2 x 1.6 km. Dallol is the lowest situated active volcano in the world, and its peak is at 46 m below sea level.

Fig. 6. Small salt lake located about 5 km south of the Dallol Volcano, photo Z. Preisner

Fig. 7. Gentle saline balloons in Dallol Volcano, photo Z. Preisner

Fig. 8. Salt lake with water-saturated acids and sulfur compounds, photo Z. Preisner

Fig. 9. Salt-minerals walls on the western edge of the Dallol volcano are subject to weathering processes, photo Z. Preisner

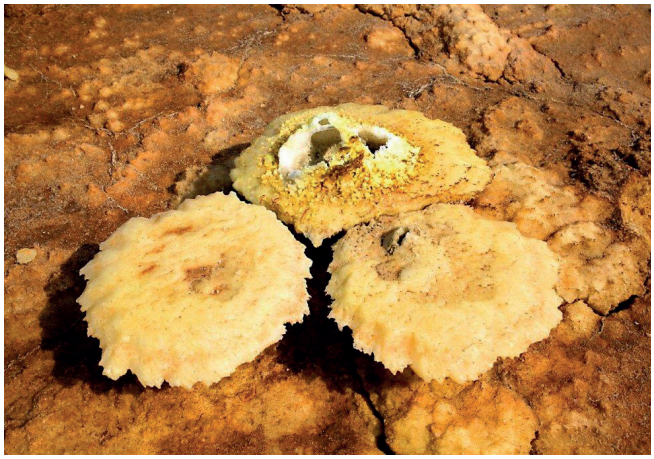

Fig 10. Salt mushrooms structures near the Dallol Volcano, photo Z. Preisner

Fig. 11. Lava from Erta Ale Volcano, photo Z. Preisner

The last eruption (1926) created a large cavity in the central part of the volcano (http://volcano.si.edu/). Layers of salt up to 2500 m thick lie in the ground of Danakil Basin. They were deposited for millions of years in a sea basin, which was still connected to the Red Sea. The magma chamber lays relatively shallow here, and it causes, heat to rise through the ground. Also gases and hot water supersaturated with salt rise through the ground. The effect of this is creating exceptionally colourful crystals and stalagmite structures on the surface of the crater of the Dallol volcano, which makes tens of hectares of the region geologically extraordinary. It is an iridescent miracle of nature (Fig. 6).

There are countless salt structures: mounds, towers like cut trees 4 m high or salt mushrooms with caps with about 2–3 m diameters. Next to them smaller forms are also located. This place resembles field of salt brushes and meandering rollers covered with crystals. White salt precipitates out of small, gurgling geysers. It creates small mounds, and cones and below, where water flows slowly there are small terraces composed with numerous levels. Where structures are dead, their colours change from yellows and oranges, through red, to deep red and browns. In places there are also delicate white „*balloons*". They precipitated out of salt gases, which create sensitive edging, so thin that they often pop in the wind (Fig. 7). Remnants of the balloon are only the base of the hole, by throwing gases got out – it creates some kind of net. Very hot and saturated with acid compounds water gathers in bigger hollows. Above them sulphuric fumes lift. They are dangerous to humans and make breathing difficult. Still they are very beautiful because of their unusual colouring and so is the water – it sparkles with many tints of green (Fig. 8). Within these ponds long garlands of small salt dikes run rising above the surface of the water and some of them just below it. It is better not to swim there – the liquid is very hot and is more acid than water.

Near the west side of the volcano base there are fantastic salt walls several meters high. It is easy to see their several centimeters thick layers of salt divided by dusty dark brown sand (matter). These brown layers were created during rainy seasons, when the salt surface was flooded, dust carried by the wind fell onto it and then sunked to the bottom (Fig. 9). During the dry season water evaporated and another layer of salt was precipitated. Nowadays, we can see the beautiful structure of the salt layers and silt here. It is even more fascinating because of the erosion which created the salt world (towers, pillars, ravines, choppy surfaces).

To the south, there is a plain area with fine polygons created by white salt surrounded by brown thorns and flat „bowls" with diameters of several centimeters and slightly erect brims. In this scenery we can find another unusual place. It is gurgling water basin about 50 m in diameter. Here and there small yellow fountains rise, the colour is given by compounds of sulphur from the ground. In places, especially near lakesides, the water is blood-red. The basin's shores are made of different tints of brown and yellow salt in shapes of crystals, icicles (reminiscent of cave stalactites) or laces. Nearby, a region of circular structures can be found. Their diameters are about 2–3 m (Fig. 10). Some are filled with water and some are dry and full of small beautiful terraces.

The dominant rocks within the Afar Triangle are flood basalts and fresh volcanic lavas (Fig. 11). The oldest layers of these are dated from about 24 millions years. Locally, these lavas have a thickness of 4 km (Beyene, Abdelsalam, 2005; Waltham, 2005, 2010; Schüter, 2006). To the East of the Danakil depression, in the Danakil Alps mesozoic limestones are found. To the West and South the Ethiopian Highlands consist of Precambrian metamorphics and granites. Around them there are Mesozoic sandstones and limestones or Eocene and Oligocene alkaline basalts. These lavas are examples of outpourings, which were precursor to the rifting of plate divergence (Waltham, 2005; Schüter, 2006).

Fig. 12. Salt flowers in Danakil Depression, photo Z. Preisner

Fig. 13. Danakil desert – western part of Danakil Depression, photo Z. Preisner

Away from the lava flows, the Danakil is covered with plains of sand or mud and evaporates. In the past these regions were regularly flooded with sea salt water and nowadays are vast, flat areas where barchans wander. The barchans are formed by the wind with sand and can be 2 m high and 6–9 m wide. Other territories are covered with layers of salt – an afar "white gold", which were formed after evaporation of water (Melvin, 1991; Waltham, 2010; Morell, 2012). Littoral and reef marine limestones of the mid-Pleistocene age survive in places around the margins of the Depression, remnants of its occupation by an arm of the Red Sea 65 000 years ago (Waltham, 2005, 2010; Schüter, 2006).

The surrounding of Lake Dalol is distinguished by numerous hot mineral springs and fumaroles, which have created unusually colourful crystals and evaporite formations, i.e. compound of sulphur, potassium, iron, phosphorus or salt (Fig. 12), which were precipitated from gases and hot waters (Melvin, 1991; Schüter, 2006; Preisner and Preisner, 2010; Waltham, 2010). Colourful mineral crusts and colourful water of the thermal springs (because of sulphur and algae) make the landscape almost unreal and very beautiful. Afrera Lake, compared to Dalol, is less spectacular but it is also surrounded by lots of geothermal springs. Its brines are being exploited by extensive salt pans, where precipitation is very rapid because of the high temperatures (Waltham, 2010).

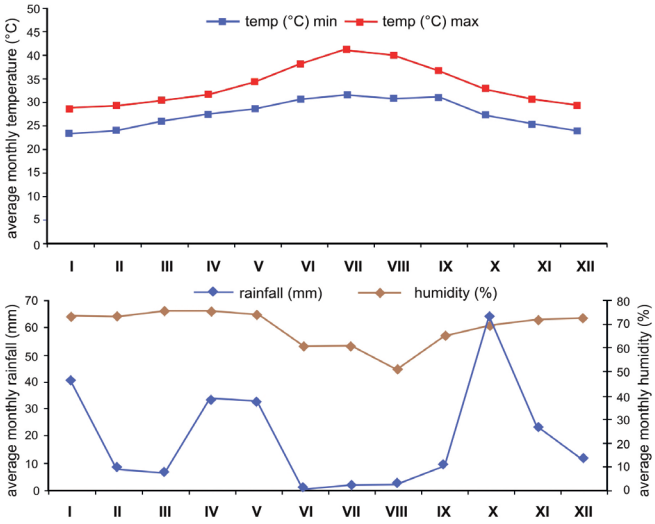

Fig. 14. The average monthly temperature, humidity and precipitation in Djibouti from 1992–1998 (Harris, 2008)

Climatic conditions – the hell on earth

The Danakil Depression characterises with hot, desert climate and a name "hell on earth" is absolutely not mistaken here (Fig. 13). There are two main seasons here: cool (from October to April) with high humidity and hot (from May to August). The cool season is characterised with average temperatures of higher than 25 ˚C, that means it is still hot from the European (Polish especially) point of view. The heat is even worse during the hot season (Fig. 13). In May, June, August, and October wind blows from the North-East. In summer very impetuous, dry, hot carrying dust winds called *Gara* (The Fiery Wind) are common. They intensify the feeling of heat, which is heavy because of lack of shadow, high humidity (40% in summer, about 90% in winter) and high temperatures (Fig. 14). The average annual temperature is between 34 and 35 ˚C but it can raise to even 50 ˚C (Briggs, 2010). Rainfall is very variable and irregular, various in different years. For example in 1996 the sum of precipitation was only 23 mm and in 1993 was 773 mm. Most of it falls in very short time (Harris, 2008) creating torrential rains (Fig. 14).

The Afars

The Afar Triangle is absolutely one of the most inhospitable places on the Earth. Most of its area is covered with desert. In many places, it is harmful for living creatures as fumes i.e. compounds of sulphur escape from cracks in the dried up ground. Along with seismic and volcanic activity and extremely hard climatic conditions it does not encourage settlement. In the Danakil Valley it rains seldom, there is shortage of water and food. There is no vegetation/greenery and no shadow. It is easy to think that this region is unsettled. But this is not true. It turns out that for centuries Afars have been living in the desert lands of the Danakil (Fig. 15).

The Afars, with over one million inhabitants, are an indigenous African population (Fig. 16). Their language, afar-saho, is part of the Cushitic branch of the Afro-Asiatic family. They probably came from the highlands of the south-eastern Ethiopia, but about 2,800 years ago, during pastoral wanderings, they settled desert lands of the Afar. The name is derived from the region, given by their neighbors'. Sometimes they are also called "the Danakils", but they do not accept this name because of its pejorative and contemptuous undertone in the Arabic language. Afars perceive themselves as the first residents of this part of Africa. There may be a grain of truth, because on this land one of the oldest australopithecus remains "Lucy" was found (Popiel, 2007; Briggs, 2010). The discovery was made in the valley of the Awash River, in the National Park of Yangudi, to the South of the city of Semara and to the East from the city of Mille (Fig. 17). The remains of our primeval mother can be seen in the National Museum in Addis Ababa.

There are two groups of the Afar society: a dominant class, called *Asaemara* (in Afar language– reds) living in the surrounds of Asajta and a working class *Adaemara* (whites) living in the middle of the desert. The traditional occupation of Afars was nomadic herding, and a part of them are still nomads. Some of them pasture goats, camels, and sometimes cattle. The others excavate and trade in salt, which is in abundance in the Danakil Basin. There are lots of open-cast mines in the surroundings of the salty Lake Asale (Karum) (Fig. 16), located in a depression, over 100 m below sea level. In this place, where the sun is merciless and where there is no shadow, Afars with only primitive hatchets only, chop out salt tablets – *amoles* from the ground (Fig. 15B). Then the tablets are shaped into blocks 30 x 40 x 10 cm in size and about 6 kg in weight. Afterwards they are combined into packages of 20 pieces (one package is about 120–150 kg in weight) and mounted on the back of a camel. A caravan of several dozen of these animals travels west for a few days to Mekele, about 100 km away. Salt tablets can be sold there or traded in other necessary goods. The further the mine the higher the price is. So it rises from 2 to 15 birrs (ETB- Ethiopian currency, 100 ETB is about 3,72 EUR, 5,2 USD or 15–16 PLN). Work in salt transport is very hard and exhaustive. Each camel is able to do only 3 routes during one season, which lasts from November to the beginning of March. Working in other months is not possible because of the heat. The value of salt is very high in this climate – it keeps water in an organism – surviving without it is very difficult. That is why salt is called "the white gold of the desert" here. In the past centuries lumps of salt (*amoles*) were country-wide legal tender in Ethiopia, in some areas they still are, for example in Afars' lands (Popiel, 2007; Preisner, 2010). The "white gold" excavations becomes an extremely hard and exhausting place to work which causes health problems. The sun reflecting from omnipresent white crust of salt severely damages eyesight (Fig. 16) (Harris, 2008; Podsiadła, 2011).

The salt is one of the reasons why Afars guard their territory and are distrustful of visitors. Controlling foreigners' wanderings is easy for them, because of the fact that only the Afars truly know this inhospitable Danakil desert's secrets and are able to travel across it freely.

Fig. 15. Afars near the Lake Afrer: A – modest huts ari; B – work on the extraction of salt; C – Afars village; D – Afars women, photo Z. Preisner

Fig. 16. Salt field, teepee structure, Asale Lake region, photo Z. Preisner

That is why in the past and even nowadays it is difficult to visit this region. Even until 1932, locals used to rob and murder those who entered their land, especially men (Briggs, 2010). Another reason, why the Afars are very suspicious about the outside world, is their basic will of surviving, which is easy to understand in such hard living conditions. Because of that there are also domestic conflicts – between the Afars and the Issa for example. The Issa are people of a Somali clan, who settle southern Djibouti. A noticeable conflict took place in 1966 when the Issa wanted to annex Djibouti (French Somaliland at that time) to Somalia, and the Afars living there were opposed to it. Unfortunately even the Afar clans and families are not very friendly to each other. Apart from open acts of violence with daggers and recently fire-arms, they steal animals, kidnap women, and fight for water. Not so long ago it was common to practise killing an enemy to marry a woman, massacres between clans, eating opponents' hearts or keeping trophies made of opponents' genitals.

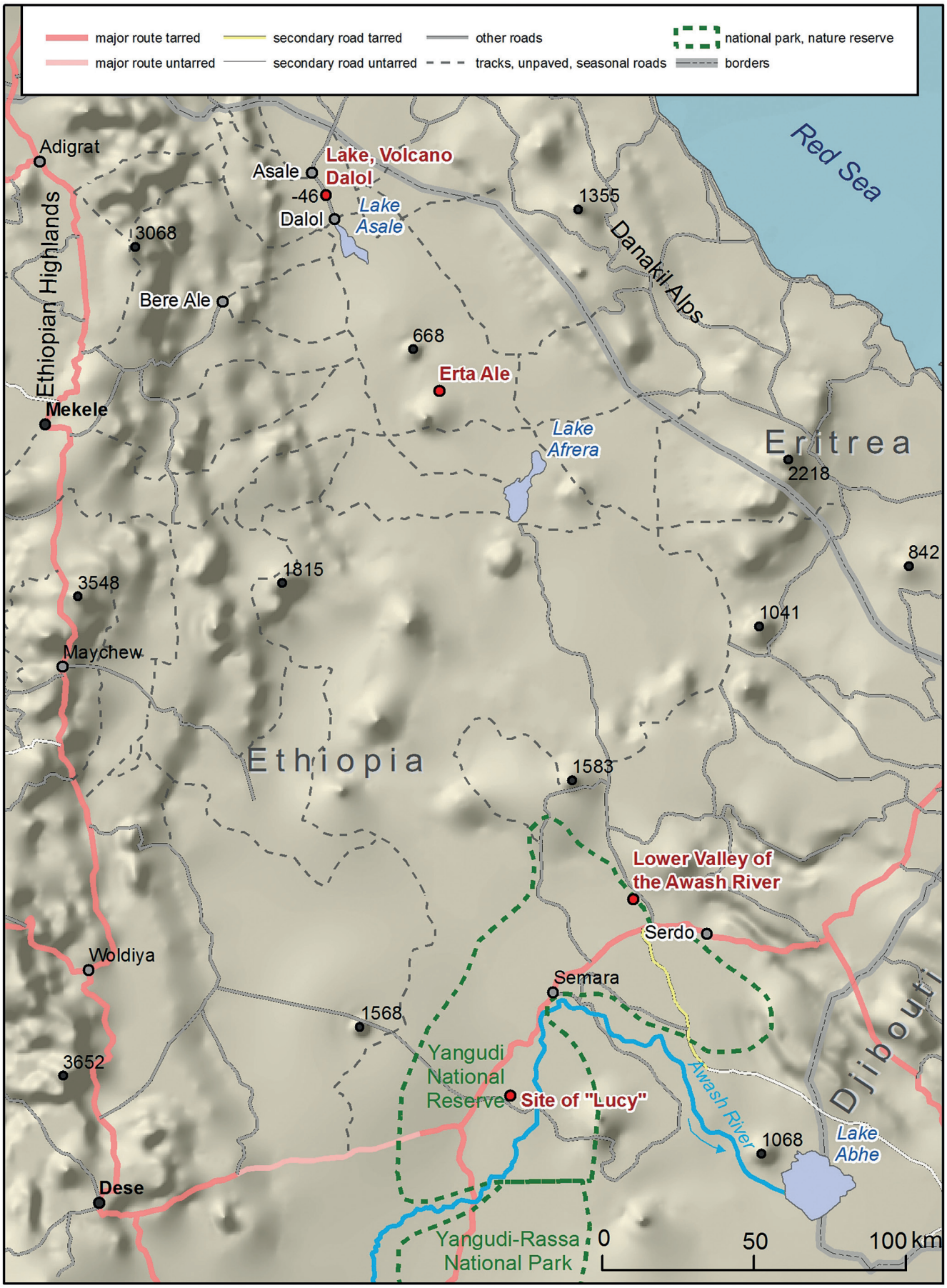

Fig. 17. Roads on the Danakil Depression (after: Etiopia, Somalia, Erytrea, Dżibuti, Mapa 1:1 800 000, 2010, ed. 5, World Mappig Project, Reise-Know_How Verlag, Bielefeld)

All of this makes the Afar people completely misunderstood by Europeans and even by other Ethiopians. For centuries they did not want to accept the state's control and wanted to live in harmony with their own tradition. The Ethiopian government tries to change this situation: in last decades, previous nomads have settled on fertile grounds near Asajta and now occupy it with agriculture (Briggs, 2010). Despite this, most of the Afar still practice traditional nomadic lifestyle. They value their freedom too highly to exist away from their home – the desert – even though living there is very hard (Fig. 15).

During the Afar's migratory wanderings through the desert, they set up temporary settlements, surrounded with thorn fences for protection from wild animals and enemy clans' assaults. Their light and modest huts, called *ari,* are made of palm leaves and mattings. They are easy to carry on camels' backs from one place to another which is usually the women's occupation (Briggs, 2010).

The Afars' diet is very modest and not too varied. There are roasted cereal grains called (in Ethiopia) *kolo*, a very sweat tea or a desert delicacy – a "hot as hell" sauce flavoured with berbere and served with stale rolls. Actually any Danakil bread is stale – suffice it to leave it few minutes in the sun. This basic foodstuff, bread, is made here in quite an unusual way – without using stoves or vessels. It is enough to have round stones, which are in abundance in the desert. They are heated in the fireplace and then stacked with dough. Finally the bread has to be chipped off the stone. The bread made this way is hard but tasty and, what is more important, does not go bad for a long time (Podsiadła, 2011). The other basic foodstuff for Afars are milk and the meat of goats and camels (Popiel, 2007). Milk is also the symbol of hospitality, which is one of the most important features of the Afar's culture, despite the bloody customs mentioned earlier. If anybody is treated with warm milk, it means that he is treated as a family member. If anything wrong happens to him, he is treated by law of revenge like any other clan member. The customary law sanctions bloody revenge but harshly punishes murder or adultery. Every clan leader is personally responsible for everything that happens on his territory, for the safety of family members and travelers. It is very important to respect the Afars' culture and traditional law. The person who does not care about the traditional rules of this society, can expect serious trouble (Popiel, 2007).

The majority of Afars' profess Islam, because of their intense links with the Arabs. Their religion is not devoid of some primeval beliefs and practices, proper to Cushitic people – e.g. animistic conviction about existiance of powerful spirits of trees and shrubs. In spite of permission for polygamy, Afars usually live in monogamous relationships. It js not surprising, because their living conditions do not allow to provide for several wives. Afars look for partners generally among their cousins (mainly paternal ones) mainly when they are very young, very often at the age of 10 (Briggs, 2010).

Comparing to other inhabitants of the plateau, the Afars are very tall and dark-skinned. They usually wear light, cotton togas draped on one shoulder. The women additionally wear long, brown skirts and they often leave breasts naked, in spite of the fact that they are Muslims (Briggs, 2010). To make their appearance more attractive, women often have their teeth filed to triangular shape. Very popular jewellery are garish necklaces, heavy earrings and brass bracelets. Women wear complicated braided hairstyles, and men usually wear traditional afro (Briggs, 2010). Afars generally pay a lot of attention to their hair, not only to its appearance but also its care. Commonly, amongst both women and men, a clarified butter, called *ghee*, is used to lustre hair and protect it from burning sunray. Afars are not very eager to let somebody take a photo of them. Those, who eventually give permission to eternise them with camera, demand even 50 birrs per photo. It is nearly 25 times more than other tribes would do (Popiel, 2007; Briggs, 2010).

Tourism

Until the year of 2000 the Danakil Valley was completely unreachable to tourists. Nowadays it is still not very well known or popular destination. Those who decide to go there come across many difficulties.

One of these is obviously the unbearable climate. The best period to visit the Danakil Valley is between November and March with the lowest temperatures. It is very important to take care about proper protection from the sun and comfortable clothing. The desert nights are quite cold so tourists have to take warm clothes. The Danakil Desert visitors have to be self-sufficient with food and water for a couple of days. Important, they have to provide not only for themselves but also for the guide and the escort. Theoretically, they should take care of it by themselves, but in practice they ask tourists for everything. Camping and cooking equipment is very useful so is firewood (at the Danakil Desert does not grow anything you can make a fire with) and something to protect from the sun while setting a camp (there is no shadow in the Danakil Desert) (Briggs, 2010).

Trying to travel across the Danakil Desert can always be a failure: every mobile network is out of range, calling assistance is impossible, there are no sign posts and even roads. It is necessary to hire guides, cars with spare parts or camels, drivers, mechanics and an escort of soldiers or police. It is also important to remember that having the special permission of the federal authorities or even the Afar government, is not always enough for inhabitants of the desert. They can treat a tourist like an intruder in their territory (Popiel, 2007; Briggs, 2010). The area is under control of the police and military troops but not so long ago Afars kidnapped five British tourists for ransom. They were found a few months later in Eritrea. A few months earlier some French people experienced a similar "adventure" (Preisner, 2011). In January 2012 another tragic incident happened. It took place near the Erta Ale Volcano, according to state Ethiopian television – five tourists died and two wer injured (Krawczyk, 2012). Permission to get into the Afar can be acquired from the tourist information office in Semera (from the South) or in Mekele (from the North-West). In these places hiring a guide is also possible (100 ETB per day, camels (50 ETB per day) or borrowing skins of water (Briggs, 2010).

Entering the Danakil Desert is possible by two roads, through the city of Berahylie (Berahile, Bere Ale) or Serdo (Fig. 16). The north route is shorter, in addition, it is used by caravans carrying salt from Lake Asale. The best option is to make a route around – through Berahylie to Serdo, or in the opposite direction (Briggs, 2010). Berahylie is quite a large town, in an unusual way uniting two cultures and different worlds – the culture of Highlands and of the Desert. The stone Tigre houses can be seen here as well as the modest Afar huts. Additionally, in the suburbs, there are camps of salt traders who stop there on their way from the Danakil Desert to Mekele and can unload their camels and rest. About 50 km of bumpy road to the East from Berahylie, there is a very popular base for people visiting Dallol and the Lake Asale, the Hamed Ela village. After visiting open-cast salt mines it is good to choose the direction to one of the most interesting and the most gruelling attractions of the Danakil – the Erta Ale Volcano. Slopes leading to the peak are quite gentle – climbing them takes about 3–4 hours. Despite that, the way up is exhausting because of the heat, lack of shadow and a bumpy path – it is essential to remember this when preparing for the trip. The effort is rewarded with the unique possibility to admire a lake of lava. Travelling further, one can visit the Afrera Lake with its emerald-green water, fed from thermal springs and surrounded by dormant volcanos: Borale and Afrera. It is also possible to see the Afars excavating salt. The travel can be finished by continuing to Serdo (if one goes from Berahylie). Tourists can also come back using the previous route (Briggs, 2010) (Fig. 17).

Summary

To conclude, the Afar region, within the Danakil Depression is a place worth visiting, which recompenses the traveller all of the difficulties he has met. All one needs are: the patience and respect to the Afar's culture, the submissiveness to them, as to the surrounding nature and obviously proper supplies and funds. It is an extraordinary place considering its nature. There are not so many pieces of animated nature but miracles of the inanimated are so colourful, beautiful and majestic that they provide wonderful attractions by themselves.

It should also be mentioned that the whole region is in theory accessible without any limits, so a number of tourists is slowly on the rise. This can result in slow destruction of salt structures through trampling. Decisions and actions for protecting this area should be undertaken, also by international organizations. The Danakil Dessert should become a national park and be added to the World Heritage List of UNESCO.

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Geotourism 1(36) 2014: 43–50
http://dx.doi.org/10.7494/geotour.2014.36.43

Quarries of the Kunów surroundings as future geotourist attractions within the Kamienna Valley Geopark

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Abstract: *In this paper, Liassic and Triassic sandstone quarries of the Kunów surroundings were described as future geotourist attractions within the planned Kamienna Valley Geopark. The history of sandstone excavation from medieval ages to the contemporary period and their usage in regional/local, sacral, monumental, defense as well as industrial architecture were included. Representative, geological, geomorphological and tourist attractions of the quarries and their surroundings were described, marked out and connected in order to create valuable educational and landscape geotourist trail. After implementation of the proper tourist infrastructure, especially accommodation, as well as undertaking marketing efforts in order to promote the centuries-old quarrying centre, Kunów has a chance to become another, besides Jura Park Bałtów and Krzemionki flint mine, very important geoeducational and recreational centre within the north-eastern margin of the Holy Cross Mts.*

Key words: *Kunów sandstone quarries, ancient mining, geological heritage, geotourist attractions, the Kamienna river valley, loess relief*

Introduction

The northern part of the Świętokrzyskie Voivodeship region was during the last several centuries the most important area of sandstone exploitation in the middle of Poland (Urban, Gągol, 1994). Along the Kamienna river valley, since the Middle Ages, the Kunów quarries played the most significant role. Thanks to good technical properties, sandstone rocks were universally used in everyday life, local and regional, monumental and sacral architecture. Whetstones, for instance, played a large role in national production as well as being an export product. In the18th century, in the reign of King Stanisław August Poniatowski, stones were transported on carts to Piotrawin situated by the Vistula river, and further on, on ships, to Warsaw (Bastrzykowski, 1939). The golden age of the Kunów quarries gradually decreased in the second half of the 19th century. After WWII, the quarries in Kunów were disused and now the old approach roads are hidden among afforested blocks of sandstone. The evidence of historical excavation are man-made, high vertical outcrops with easily visible beds and steps. Simultaneously with Kunów sandstone exploitation in the 17th century, the quarry in Doły Biskupie (Witulin) started to develop. After WWII this quarry was also disused. The quarry in Nietulisko has been active with short breaks until present day.

The ancient and contemporary mining in the Kunów surroundings now has a chance to become one of the most important geotourist attractions within the Kamienna Valley Geopark as proposed by Pieńkowski (2008). Sandstone quarries of the Kunów surroundings occur close to the intersection of three tourist trails. Blue trail for walkers starts at The Holy Cross (Świętokrzyski National Park), runs through Nowa Słupia, Grzegorzewice, the sanctuary of Our Lady and water reservoir in Kałków, Witulin, Nietulisko, Kunów, Archeological Museum and Reserve at Krzemionki flint mine, Jura Park Bałtów and finishes in Pętkowice. The bicycle route connects monuments of the Old Polish Industrial District along the Kamienna river, from Skarżysko-Kamienna to Ostrowiec Świętokrzyski. Another bicycle route is named after Witold Gombrowicz. Good promotion and practical land development taking into account tourist and local inhabitants needs will help to revive forgotten, very precious historical centres of stone mining.

The main objective of this paper is to show the geodiversity and geological heritage of the Kunów surroundings in order to create a geoeducational centre representing ancient sandstone exploitation.

Study area

The area under investigation is situated on the northern margin of the Holy Cross Mts, in the northern part of the Opatów – Sandomierz loess cover, and in the marginal zone of the Kamienna valley (Jersak, 1977). The Kunów region lies on the border line of two Kielce Upland mesoregions distinguished by Kondracki (2001): Sandomierz Upland and Iłża Foreland. The study area encompasses loess valleys of the Kunów region: Ciołek, Stawiska and Świślina river region.

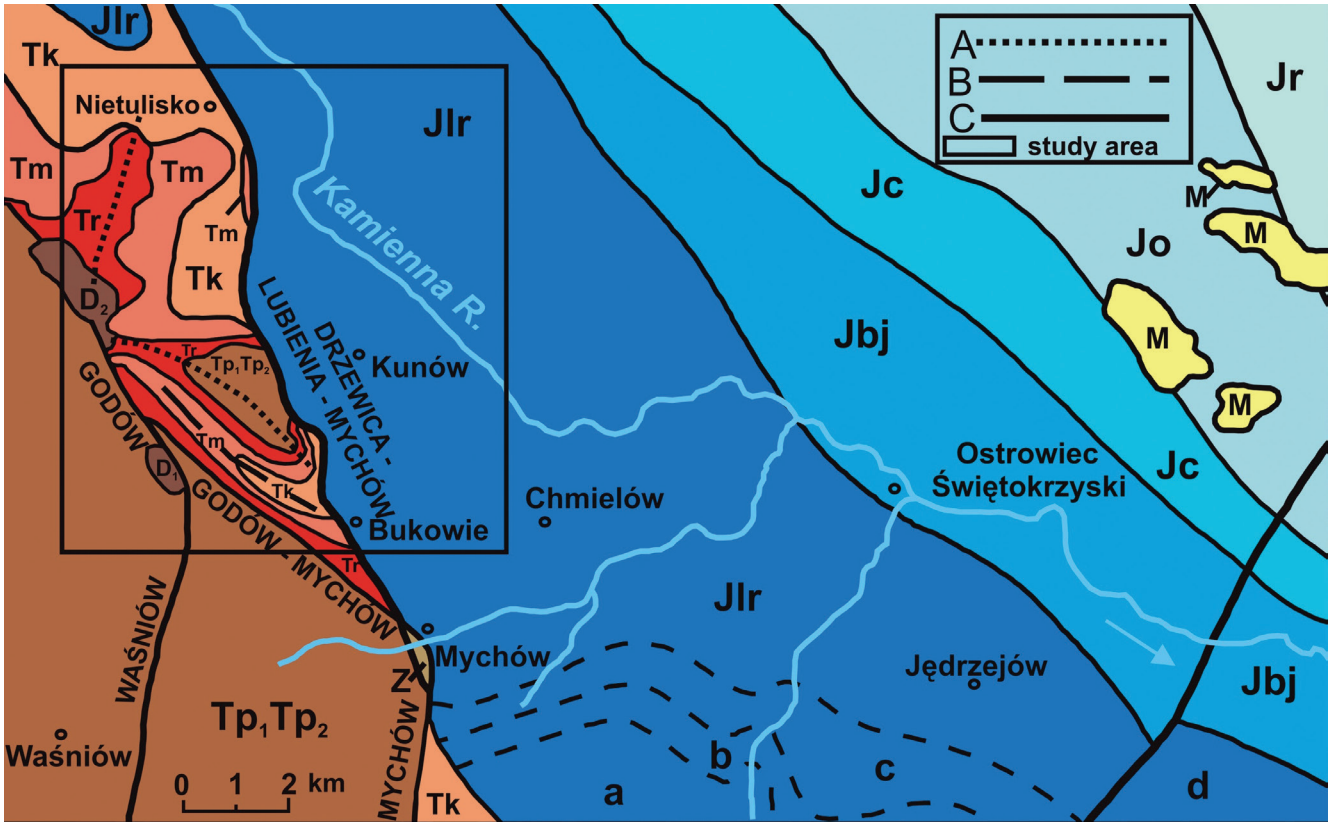

Fig. 1. Extent of the study area on the background of the geological map with tectonic elements. Source: Kosmowska-Suffczyńska (1966), changed: A – elevations, B – depressions, C – dislocation lines, D1 – Lower Devonian, D2 – Middle Devonian, Z – Zechstein, Tp1 – Tp2 – Bunter Sandstone, Tr – Rhaetian, Tm – Shell Limestone, Tk – Keuper, Jlr – Liassic (a - Zagaje level, b – Gromadzice level, c – Zarzecze level, d – Ostrowiec level), Jbj – Bajocian, Bathonian, Jc – Callovian, Jo – Oxfordian, Jr – Rauracian, M – Miocene land deposits

The region consists of two principal parts: Paleozoic Core and the Permian – Mesozoic Marginal Zone (Fig. 1). The area under investigation lies within northern Łysogóry – Radom Unit in the marginal zone of the East – European platform (Urban, Gągol, 2008). The bedrock of the Pleistocene and Holocene sediments is built of the Liassic and Triassic sandstones and siltstones, excavated in the Kunów region since 12th century.

Kunów, Nietulisko and Witulin sandstone quarries – topography and geological properties

The recent topography of the Kunów surroundings is typical for loess relief. Within the Kamienna valley escarpment zone, the average thickness of the loess cover is 12 m (Jersak, 1965). The Kunów region has a wavy appearance strongly cut by dry valleys and gullies and is located at an altitude of 180–280 m a.s.l (Bukowska Mountain 277 m a.s.l.). A dense net of young erosion ravines is the result of the low erosion base of the Kamienna river valley (180 m a.s.l.) and to its side, the Ciołek and the Stawiska, valleys (190 m a.s.l.). Steep slopes and a 40–60 m relative height triggered forming of the anthropogenic terraces. In some places we can distinguish over 20 levels of these loess mesoforms along the slope. Another typical example of anthropogenic loess relief are road gullies. Below the loess cover, Jurassic and Triassic sandstones and siltstones occur and are hidden in the dense net of ravines.

Kunów sandstones are concentrated in the vicinity of the south of the Kunów town. High, vertical outcrops (beds) are easily visible along the Udziców Dolny – Kunów road on the right side of the Kamienna River valley. In the middle part of the Grabutka valley, within Bukowska Mountain and Gródek Hill, there occur, in the form of afforested, disused, quarries, outcrops and stony steps (from the middle of 19th century). Bigger, probably younger excavations are concentrated in the Parzyński ravine between hills. Stretching for several hundred meters, shallower quarries of sandstone on the north and west side of Bukowska Mountain seem to be the oldest region under exploitation (Urban, Gągol, 1994) (Fig. 2). In the Ciołek valley and Udziców ravine they occur in the form of outcrops or stony steps. In Biskupie Doły, they occupy sides of the Świślina river. The quarry in Doły Biskupie (Witulin) is a side excavation 300 m long and 20 m high.

Kunów sandstones in Bukowska Mountain are white, light grey and yellowish, cream coloured with iron dripstones, fine and medium grained with siliceous binding material. They occur in the form of fine, medium or coarse beds. Kunów sandstones of the Early Jurassic Age (Toarcian) are inshore (lagoonal) sediments, from shallow and quiet bodies of water. They are characterized by good block properties: the thickness of the beds can be several meters.

Fig. 2. Old side quarry occurring within Bukowska Góra, photo E. Gałka

Kunów sandstones have good technical qualities, are easy to process, exploit, and have good resistance to atmospheric influence. Sandstones in Nietulisko are similar but have clayey material binding.

Sandstones from Doły Biskupie (called Witulin sandstones) are older, they are light-cream colored and represent the higher part of the Upper Triassic Age (Rhaetian). They are medium grained and are quite easy to process. Sandstones from Doły Biskupie are sea, inshore sediments arisen in shallow waving waters (Urban, Gagol, 2009).

Kunów sandstones in everyday life and regional or local architecture – selected examples

From the very beginning, i.e. from the Middle Ages, throughout centuries, until the first half of the 20th century, excavated sandstones were used in querns, millstones, grinding wheels and whetstone production (Urban, Gągol, 1994). Later Kunów sandstones, thanks to good abrasion, were regularly used in construction as material for columns, sculptures and decorative elements of facades. Since the onset of 12th century, many stony richly ornamented churches appeared, for instance the Benedictine monastery of the Holy Cross and the Romanian Saint Martin Collegiate Church in Opatów (Bastrzykowski, 1939).

In 1430, north-east of Kunów, on the borderline between the Kunów and Iłża demesnes, a gothic Saint Katherine chapel, funded by Bishop Zbigniew Oleśnicki is now the oldest free standing chapel in Poland. The famous sculpture of Saint Emeric in Nowa Słupia is also made from Kunów sandstone.

The growth of intensive sandstone exploitation in the 16th century was connected with the construction of Renaissance residential and the Baroque church buildings. Sandstones were exploited for modern black-and-white combinations (Sygietyńska, 1978). Rocks excavated in the 16th–17th century in Bukowska Mountain and Biskupie Doły quarries attracted many sculptors to Kunów, including among others, from Germany, Italy and Moravia (Bastrzykowski, 1939).

In the 17th century, the Krzyżtopór Castle in Ujazd was built, where 300 m^3 Kunów sandstone was used to build the wall and the Castle's main symbols: cross and battleaxe. In 1683, for the first time in Poland, the street chapel of the Godly Mother Passowska was placed in the Krakowskie Przedmieście street; also the façade of the Discalced Carmelites church in the Royal Route in Warsaw is made from the famous sandstone (Jarmontowicz *et al.,* 1994).

The quarrying boom fell in the 18th and 19th centuries. In 1787, quarries in Kunów were visited by Polish king Stanisław August Poniatowski. He placed an order for figures, monuments and architectural details for buildings raised at that time in Warsaw, for instance: the Łazienki Palace. In 1830, sandstone was used to build the National Theatre in Warsaw (Antonio Carazii) (Bastrzykowski, 1939; Miks-Rudkowska, 1973). In 1834–1836, the Potocki grave was built by Henryk Marconi (Jarmontowicz *et al.*, 1994).

Fig. 3. Historical St Władysław church, bell tower and graveyard in Kunów, photo E. Gałka

Fig. 4. Sandstone walls with gates and the Stations of the Cross around the St Władysław church, photo E. Gałka

Fig. 5. Historical monument in the graveyard in Kunów, photo E. Gałka

In the 19th century, in Kunów and Doły Biskupie, sandstone excavation was connected with the Old Polish Industrial District development along the Kamienna river valley. Defensive building development in Poland was the second reason for lager demand for sandstones during this period (fortresses in Dęblin and Modlin) (Fudalewski, 1900; Bastrzykowski, 1939).

In the second half of the 19th century, after the collapse of the January Uprising and the construction, in 1885, of the railway line Dąbrowa Górnicza – Dęblin next to the Szydłowiec mining centre, Kunów sandstones were exported to different regions of the Kingdom of Poland and Russia but the role of Kunów gradually decreased.

Sandstones from Biskupie Doły (Witulin) were exploited since the beginning of the 17th century. In the first half of the 19th century they were used for the Kamienna river regulation and as a building material for the Nietulisko rolling mill funded by Stanisław Staszic (destroyed by flood in 1903). In 1895, next to the described quarry in Doły Biskupie, Ignacy Kotkowski – grandfather of the famous Witold Gombrowicz, founded a stone factory and started to exploit sandstones. After his death, since 1911 his work was continued by the parents of Gombrowicz. Apart from the quarry, a famous complex of historical buildings, watermills, paper mill and cardboard factory was built. When visiting famous Jagiellonian Library in Cracow, please note that it was made of sandstones from Biskupie Doły (Kamieński, Skalmowski, 1957). After WWII the quarry was disused.

After WWII, the continuously state-owned quarries in Nietulisko played the most important active role. Sandstones were used as elevation material for Warsaw's destroyed Old Town and Warsaw's Palace of Culture and Science also built at that time, as well as ripraps for MDM estate and the W – Z route. In 1992, two years after privatization, deposit excavation became unprofitable, and the Nietulisko quarry was closed. As for the Nietulisko quarry called "Jurassic Sandstones Nietulisko 1 Mine", in 2007, its new owners, Marek Łucki and Konrad Trojanowski, took up the exploitation of the sandstone blocks in the northern and eastern part of the deposit. Sandstone is being processed into small fragments, called ripraps, close to the excavation site, for example for the purpose of wall construction. Permission for deposit excavation provides for the possibility of exploitation of 1000 m^3 annually. Owners of the quarry are planning to construct a new production hall and broaden their production assortment (Kowalska, Kowalski, 2010).

Centuries-old sculpting tradition left behind many traces in Kunów and its surroundings and occurs in various forms; locks on the Kamienna river, beautiful figures, sculptures, monuments on the graveyards in Kunów, Ćmielów and Wszechświęte, in parks, and other places within the whole area. Sandstones were also used to make thresholds, stairs or windows and doors' decorative frames. The most precious sand-

stone monument is St Władysław Church, which was erected in 1638. The most famous sandstone elements in this church are: the altar of Transfiguration of Jesus from 1850 to the design of Franciszek Kacper Fornalski, and made by Jan Wilczyński, St Wojciech and St Stanisław figures made by Antoni Kłosiński in 1867, and the sandstone floor funded by stoneworker Ignacy Kotkowski in 19th century. In 1896, the famous Polish painter and architect, professor Wojciech Gerson designed a bell tower, which was built next to the Kunów church and graveyard (Fig. 3). His daughter, Gersonówna, became the most famous woman who carved sculptures in sandstone in Kunów at the turn of the 20th century. Her most famous sculpture is a nativity play (bow of the Three Wise Men) under the altar of the Mother of God. Around the church, stony walls with gates and the Stations of the Cross were made (Fig. 4).

In the Town of Kunów two restored sandstone monuments stand in the renovated marketplace. The Saint Jan Nepomucen figure from 1755 is situated by the river, and many monuments and figures can be found along the roads or at the intersections of the old trading routes.

In the graveyard in Kunów, there are over 200 sandstone monuments and figures of historic value (Fig. 5). It is one of the oldest graveyards in the region. In 2007, it was entered in the national register of historical monuments. One of the oldest figures in the graveyard is the figure of Jesus carrying the cross dating back to 1747, but the oldest known sandstone figure in the Kunów vicinity is Pieta from 1701, standing in the Nietulisko quarry.

Another, less known graveyard in Wszechświęte, dates from the19th century. There are many interesting epitaphs engraved on the old monuments. Next to the graveyard there is a gothic church,where Witold Gombrowicz was baptized.

Geological attractions of the Kunów region

The quarries in Kunów, Doły Biskupie and Nietulisko described above appear within the Landscape Protection Area of the Kamienna River Valley and the Kamienna Valley Geopark as designed by Pieńkowski (2008). Within the Natura 2000 network of protected areas Special Area of Conservation (SAC) "Kunów Hills" was designed. Within the most attractive ravines of the Kunów region, "Bukowska Mountain" and "Udziców", nature reserves were created. In 2010, in the Natura Shadow List, "Kunów Hills" received the status "the area in need of extension".

But already in 1994 Jan Urban and Jerzy Gągol were the first researchers to propose the creation of a new nature reserve within the sides of Bukowska Mountain area together with the Parzyński Ravine (Urban, Gągol, 1994) (Fig. 6).

According to the article mentioned above (Urban, Gągol, 1994), the distribution and pattern of excavations, the relationship between them and the occurrence of sandstone, as well as size and shape of blocks, and location of slag heaps expresses the methodology of geological survey and sandstones exploitation in the 18th and first half of the 19th century.

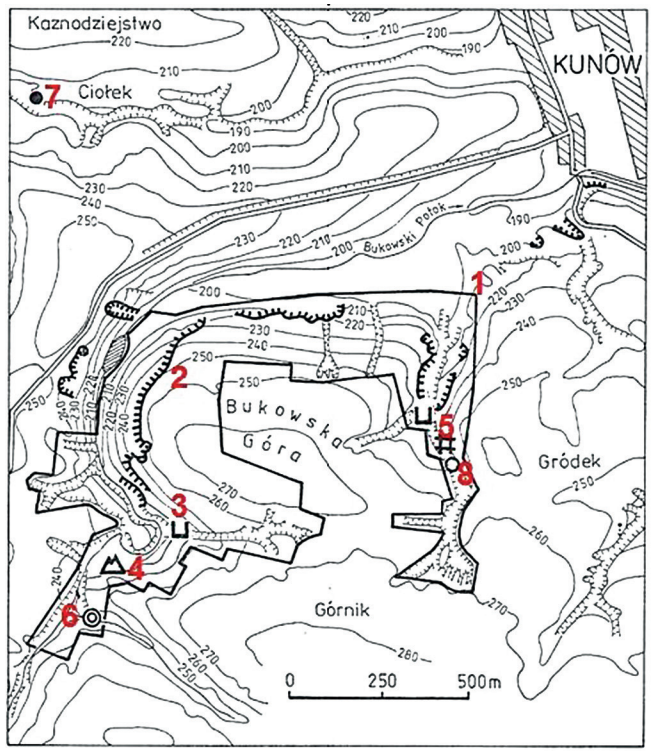

Fig. 6. Nature reserve as designed within Bukowska Mountain. Source: Urban and Gągol (1994): 1 – borders of the designed nature reserve, 2 – Kunów sandstone quarries, 3 – natural steps and thresholds in ravines, 4 – side rocks, 5 – Liassic mudstones outcrop with sphaerosiderites insertions, 6 – condensed Shell-Limestone profile outcrop, 7 – fossil soils and sinters outcrops in loess (Ciołek ravine), 8 – big erratic boulder

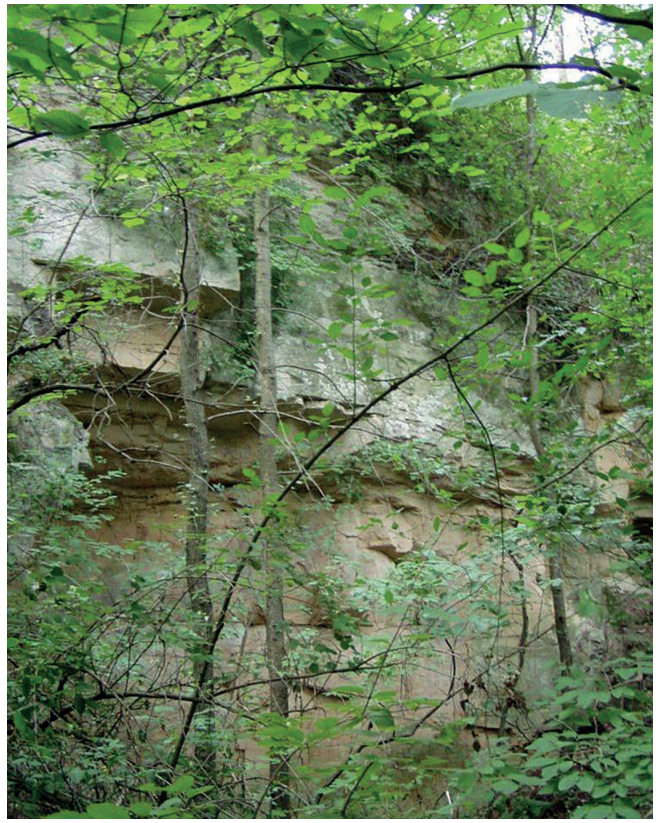

Fig. 7. Sandstone outcrops in the Bukowska Mountain quarry, photo J. Urban (Urban, Gągol, 2009)

Fig. 8. Doły Opacie Quarry – natural monument, photo E. Gałka

Outcrops enable observation of their lithological properties (sedimentary structures, flora remains). Apart from quarries, natural rocks, sandstone thresholds (in some parts of the ravine forming cascades) and sphaerosiderites occurrence are worth noting (Fig. 7).

South of Bukowska Mountain, there is a fragment of the Drzewica-Lubienia-Mychów dislocation zone worthy of protection because of the strong inclination of the Upper Triassic Age sediments occurring in the natural form of rock. Another is the Bukowie anticline with interesting Rhaetian outcrops and a condensed Shell-Limestone profile providing a chronicle of the history of the Earth. The 240–230 million years interval was recorded within the 20 m thick geological profile with sandstones, limestones, and marls with fossil fauna – bivalves, brachiopods, ceratites and fish. Zones of the 19th century brown coal survey in the Triassic sediments are also worth noting (Urban, Gągol, 1994). In Udziców Dolny, opposite the Zimny Dół gully, there is also a spring, which is famous in Świętokrzyskie Voivodeship region.

The Świślina river valley with its mountainous character, side rocks and quarries is one of the most beautiful valleys within the north margin of the Sandomierz Upland. In the Biskupie Doły (Witulin) quarry, in the lower part of the wall, coarse beds of Rhaetian sandstones are visible. In the upper part of the wall, there appear complex limestones of the Lower, Middle and the lowest part of The Upper Shell Limestone. Since 1987 this quarry has been protected as a natural monument. Apart from the quarry itself, the technical expertise connected with exploitation and sandstone processing are also essential (Urban, Gągol, 1994).

In the Świślina river valley, there is also one very important geological quarry in Doły Opacie, disused since 1984 (Fig. 8), in which we can see a structural contact between the Middle Devonian dolomites and the Lower Triassic sandstone rocks (Wariscian discordance, one of the third in the Holy Cross Mts. region, similar as in the case of the famous for tetrapod traces Zachełmie). Since 1987 this quarry has been protected as a natural monument. Nearby in Wióry we can find traces of the Triassic vertebrates (Urban, 1990).

In close vicinity of this area occurs the "Rocks in Krynki" nature reserve. The main tourist attraction are natural outcrops of the Lower Triassic sandstone rocks (river sediments) which occur in the form of: stony ravines, caves, blocks, thresholds, bluffs, ledges, overhangs and mushroom rocks.

Kunów quarries as future geotourist attractions

The quarries described above, which are localized within the borders of the planned Geopark Kamienna Valley, have a chance to become a valuable geotourist product of the Kunów surroundings. At present, due to disappearance of some geosites and their scientific and educational functions as a result of natural plant succession, this area has become inaccessible to ordinary tourists. That is why in order to better promote the geodiversity and geological heritage related to the ancient metallurgy of the Kunów surroundings, it is important to do appropriate research and marketing activities to ensure interest in these future (geo)tourist objects.

The quarries of the Kunów surroundings are important geo-educational objects, that is why, geotourist boards explaining particular geosites should be created with additional information about biodiversity of the Kunów Hills and Pleistocene/Holocene stratigraphy (Fig. 9) on the following geotourist trail: Kunów – Bukowska Mountain – Prawęcin – Doły Opacie – Doły Biskupie – Nietulisko Duże – Nietulisko Małe – Kunów – Krynki (facultative site). It is essential that not only geological heritage, history, ways of sandstone excavating, but also loess relief, fossil soils and flora/fauna species of the Kunów region are popularized. This proposed trail throughout its length would overlapp with the tourist trails described above.

These quarries will constitute a very good way of geotourism promotion. Apart from school excursions on consecutive stages of school education, these objects could also become an obligatory point as part of regional student training within the Holy Cross Mts. and its margin (geological, geomorfological, tourist) including „Tourist attractions of Poland – The Holly Cross Mts." which is carried out by students of AGH. The occurrence of the said geotourist attractions within protected areas is also an excellent chance of promotion of sustainable tourism in the society.

In order to open the quarries to the public it is necessary to build the tourist infrastructure from scratch. According to the previous short-term and current long-term (2011–2020) program of the revival of the Kunów town, Bukowska Mountain will be adapted for local inhabitants and tourist needs. The project comprises: ski lift, ski (snowboard), walk and bicycle routes, as well as routes for pedestrians, approach roads, car parks, football pitches, tennis court, camp places.

Within this quarry, as part of the so-called "small retention", modernization is planned of the body of water on the Garbutka river and its surroundings. During the flood which occurred on 23 May 2007, after heavy rainstorm, the dam was destroyed. It needs restoration in order to be used as a flood-control reservoir and for angling purposes. A rope park will also be a big tourist attraction.

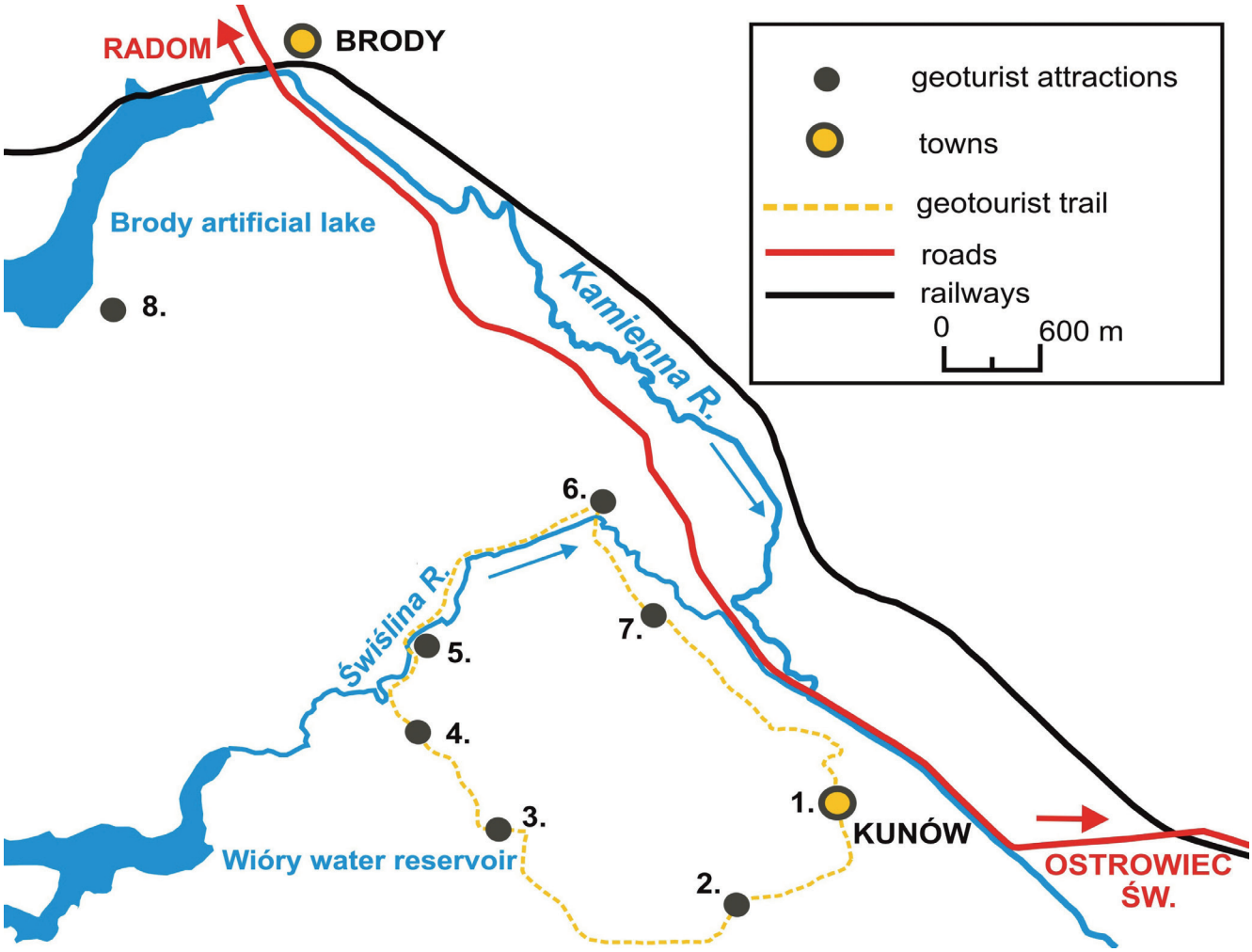

Fig. 9. Proposed geoturist trail: 1. Kunów Town, 2. Bukowska Mountain quarry, 3. Prawęcin view point, 4. Doły Opacie Quarry - natural monument, 5. Quarry and buildings of Gombrowicz cardboard factory in Biskupie Doły, 6. Ruins of the old rolling mill in Nietulisko Duże, 7. Sandstone quarry in Nietulisko, 8. Rocks in Krynki nature reserve

For a better overall view of the Landscape Protection Area of the Kamienna River Valley, including the Bukowska Mountain quarry and the loess landscape of the Kunów surroundings, a properly secured area with viewpoints and safety barriers on the east and west sides of the Bukowska Mountain quarry should be created. There are also plans for opening a Centre of Quarrying in the old granary in Kunów or in the rolling mill in Nietulisko Duże. Apart from static exhibitions connected with the technique of Kunów sandstone mining and processing, the multifunctional halls including multimedia and outside exhibitions could also be of interest. The exhibitions could be connected with the open air sculpture workshops. In Nietulisko Duże, besides open air sculpture exhibitions within an old rolling mill area (Fig. 10), establishing Tourist Recreation Centre, restoration of old water ways and filling a water tank dome for the purpose of creating a safe recreational pool is planned. An old warehouse building will be converted into a hall. The area will be arranged to include tennis courts, car parks and football pitches.

There is also a plan of reconstruction of the remains of the stony workshop in Doły Biskupie dating from 1885 (the potential place of sculpture exhibitions in the open air, a craft exhibition, museum in the director's house).

Fig. 10. Open air sculpture workshops in Nietulisko Duże, photo J. Urban (Urban, Gągol, 2009)

Due to high geomorphological and landscape values, the Kunów surroundings have excellent conditions for active tourism development, including various kinds of qualified tourism, such as rock and ice climbing, bouldering, cycling or fishing. Controlled off-road drives within waterlogged valleys and side gullies area provide a good alternative for spending free time.

In the area of Kunów, there are also good conditions for tourist canoeing on the Kamienna river. Similarly to the famous nearby Bałtów Jurassic Park, the construction of a river harbour and delineating of walk and bicycle routes is planned in close vicinity of the Kamienna. Car parks and camp and fire places will be distributed along the Kamienna river.Unfortunately, although the national road nr 9 runs through Kunów, and there is a railway station, tourist base is still underdeveloped. In Kunów and its surroundings, only three agro farms offer active leisure, one road hotel with restaurant in Rudka offers accommodation, and there is one petrol station with a restaurant. Tourist base needs an urgent enhancement.

Summary

In order for the quarries to be entirely used in geotourism, they should serve at least one of the following purposes: scientific (paleontological, mineralogical, lithological discovery), educational (to have legible geological profiles, legible tectonic elements, sites representing geological formations), visual (well exposed quarry elements in landscape, for instance, walls, outcrops), potential locations (easy access to the site), tourist (interesting beauty spots, water reservoirs, bicycle routes, caves) and recreational (well-prepared places for rest, fishing etc.) (Nita, 2010). After afforested blocks have been cleared, ancient quarries of the Kunów surroundings will meet all natural requirements. Tourist and recreational functions could be fulfilled completely only after realization of the program of the revival of the Kunów district. Then, just as in the case of the nearby Jura Park in Bałtów or flint mine in Krzemionki Archeological Museum and Reserve, good promotion of sandstone traditional mining together with metallurgy centre along the Kamienna river will bring benefits for local inhabitants and tourists.

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