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In the footsteps of the ice sheet in the area of the planned geopark postglacial land of the Drawa and Dębnica rivers (the Drawskie Lakeland, Poland)

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Abstract: The article presents 20 geosites located on five geotourist paths and their closest vicinity, constituting the initial part of the planned geopark Postglacial land of Drawa and Dębnica. Geosites represent the most valuable abiotic resources, proving the large geodiversity of the studied area. These are: 1. glacial and fluvioglacial accumulation forms (e.g.: terminal end-moraine of the Parsęta lobe, undulating moraine uplands, glacial deposits including erratic border boulders, esker ridges), 2. glacial and fluvioglacial erosive forms (e.g.: channel and melt-out-depressions), 3. other (like e.g.: deep erosive and erosional-denudation valleys, erosive forms of groundwater or 1st order watershed between the Odra and Parsęta catchments). The purpose of the geosites characteristics in this paper is to support the development of geotourism in the peripheral tourist area.

Key words: geosite, geodiversity, geotourism, geopark, glaciomarginal zone, Drawskie Lakeland, north-western Poland

Introduction

The idea of establishing a geopark in the Drawskie Lakeland dates back to 2008, when Ryszard Dobracki presented a project of its creation at the 9th West Pomeranian Science Festival, organized in Połczyn Zdrój by the Szczecin Scientific Society. Earlier, he discussed (Dobracki 2006) issues related to geodiversity and protection of geological heritage in landscape parks in Western Pomerania, including the Drawsko Landscape Park, and on this basis he made plans for the development of geotourism in this area. In order to designate areas with geotourist potential, R. Dobracki presented in 2011 in Lublin, at a conference entitled *Geoparks – Geodiversity – Geotourism*, results of the geodiversity evaluation analysis of national and landscape parks in Western Pomerania.

A geopark is defined as an area of particular geological heritage and a strategy for sustainable territorial development (McKeever, Zouros 2005). It is an area of geotourist activity (e.g. Dowling, Newsome 2005, Farsani et al. 2017, Ateş, Ateş 2019, Ólafsdóttir 2019), which supports the development of tourism infrastructure enabling the sharing of geo-resources that exist within its borders (Tverijonaite et al. 2018) mainly for educational purposes (Dobosik 2013, Moskwa, Miraj 2018, Wolniewicz 2019, Roca, Garcia-Valles 2020, Urban et al. 2021).

The aim of this article is to promote the geological and geomorphological heritage of the planned Post-Glacial Land of Drawa and Dębnica geopark by presenting selected geosites. The term geosite (or geological site) refers to site of geological interest. A geosite is a natural feature that testifies the relationship between processes that have formed and shaped the Earth and the resulting products acted in the past and still affect the present. Geosites generally represent geoheritage resources which should be studied, surveyed, conserved, and developed to ensure that future generations can continue learning the geological history of the Earth, to enjoy the natural beauty of the sites, and to empower socioeconomic development (Bruno 2015).

All activities (including transfer of information about valuable abiotic elements of a region for lay public in form of understandable by them text, as the current one) aimed at promoting geodiversity as an important part of the natural natural heritage are not without significance (e.g. Wolniewicz 2021). According to Kubalikova et al. (2021), they may lead to better acceptance of the proposed activities in the field of territorial and general nature and landscape protection, including the protection of geological elements and phenomena. As a consequence, greater public awareness of the need for geo-conservation will translate into more effective planning and adequate provisions in strategic documents of the local self-government.

The geosites, under consideration in the current text, are characterized by a high evaluation of geotourist attractiveness, which was obtained in the valorization analyses (Kamieńska, Giemza 2013, 2014, Górska-Zabielska, Kamieńska 2017). The article is also a response to the appeal of Trela (2021) and Urban et al. (2021) to interest readers in interesting geological sites, which are *an essential element of the abiotic part of the ecosystem*.

Study area

The geopark Post-Glacial Land of the Drawa and Dębnica Rivers (pol. *Polodowcowa Kraina Drawy i Dębnicy*) is situated within the range of the former lobe of the Parsęta river (Fig. 1), that is, the glacial outlet of the glaciomarginal zone of the last Scandinavian ice-sheet in this area, operating during the Pomera-

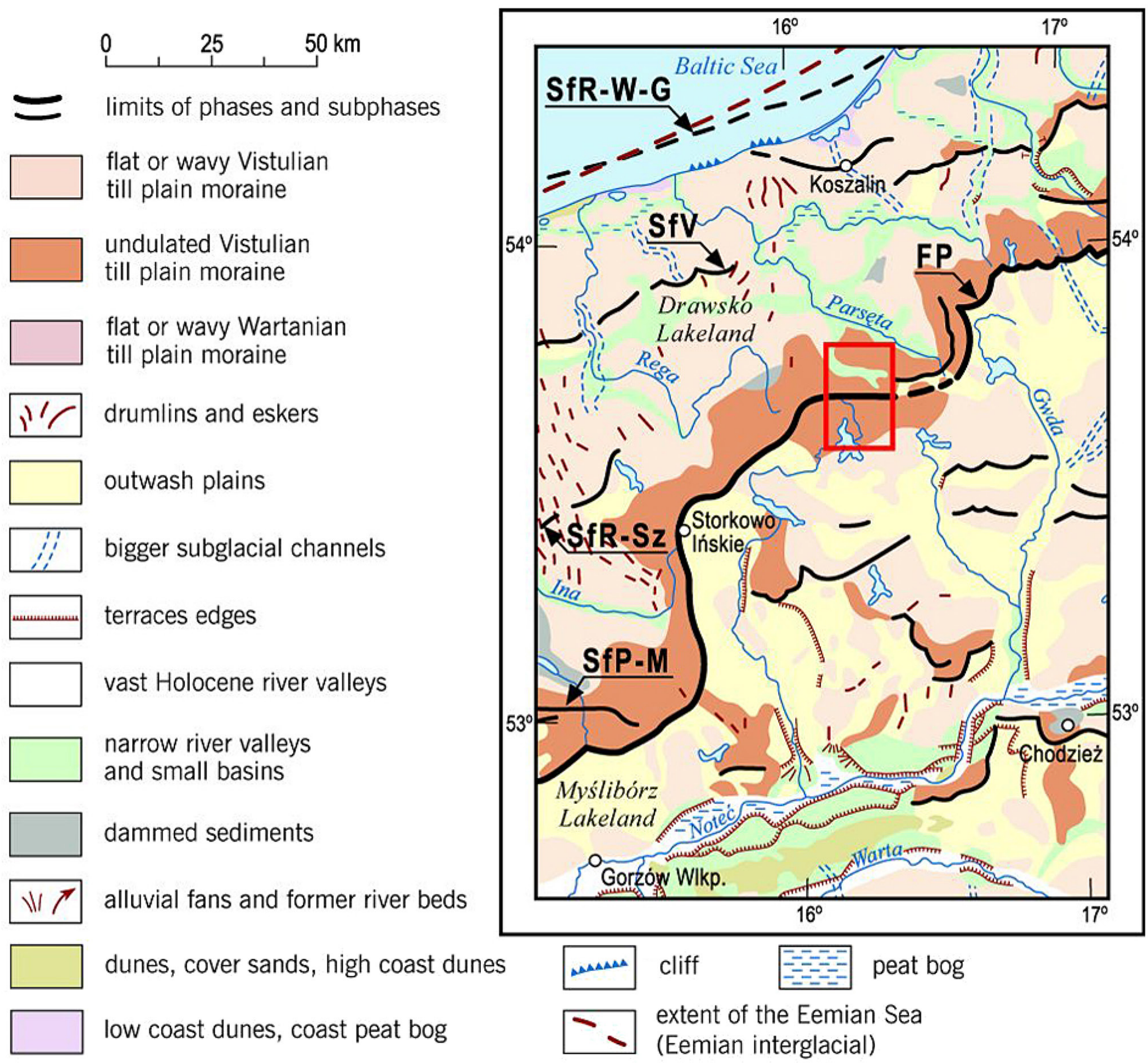

Fig. 1. The location of the planned geopark Post-Glacial Land of the Drawa and Dębnica rivers (within the red rectangle) on the geomorphological map of the north-western Poland (based upon Liedtke 1981, Bremer 1994). Ice-sheet margins: FP – the Pomeranian Phase, SfP-M – the Penkun – Mielęcin Subphase, SfR-Sz – Rosenthal – Szczecin Subphase, SfV – Velgaster Subphase, SfR-W-G – Rügen – Wolin – Gardno Subphase (Górska-Zabielska, Kamieńska 2017)

nian Phase of the Vistulian glaciation (16.5 ka ^{10}Be, Tylmann et al. 2019).

The geopark stretches between the maximum and the main route of accumulative end moraines (Dobracka, Lewandowski 2002). Besides these forms, in the area of the geopark other elements of the relief can be distinguished, connected with the accumulative activity of the ice-sheet (Fig. 2). These are belts of end moraine of the Parsęta lobe (*Wzgórza Chłopowskie* – Chłopowskie Hills), a belt of pushed moraine (*Skąpa Góra* – Skąpa Mt., 135 m a.s.l., northward from the village of Brusno), a morainic plateau, kame hummocks (*Skowrończe Góry* – Skowrończe Mts in the northern part of the geopark, *Piaskowa Góra* – Piaskowa Mt. near Barwice), esker ridges, glacial deposits as mineral resources (gravel-pits, sandpits, e.g. Ostrowąs, Kołacz, Kluczewo, Prosino) as well as numerous erratics. Among glacial erosional forms in the area of the geopark the following should be enumerated: deep tunnel valleys, filled with water in places (e.g. *Dolina Pięciu Jezior* – Five Lakes Valley), a marginal depression (Dobracka, Lewandowski 2002) of lakes: Komorze, Żerdno, Drawsko, known also by the name of marginal tunnel valleys (Bartkowski 1972, Marsz 1964, 1995), melt-out depressions (e.g. Wierzchowo, Radacz, Wielimie, Trzesiecko) as well as small kettle holes, formed by dead ice blocks, without drainage on the hilly morainic plateau.

Within the boundaries of the planned geopark, forms concerned with water-heads (channel head of rivers, groundwater outflows such as springs or seeps) and fluvial areas (ravines, gorges, river gaps, first-order water divide) can also be found. The signs of geological heritage elements merging with cultural

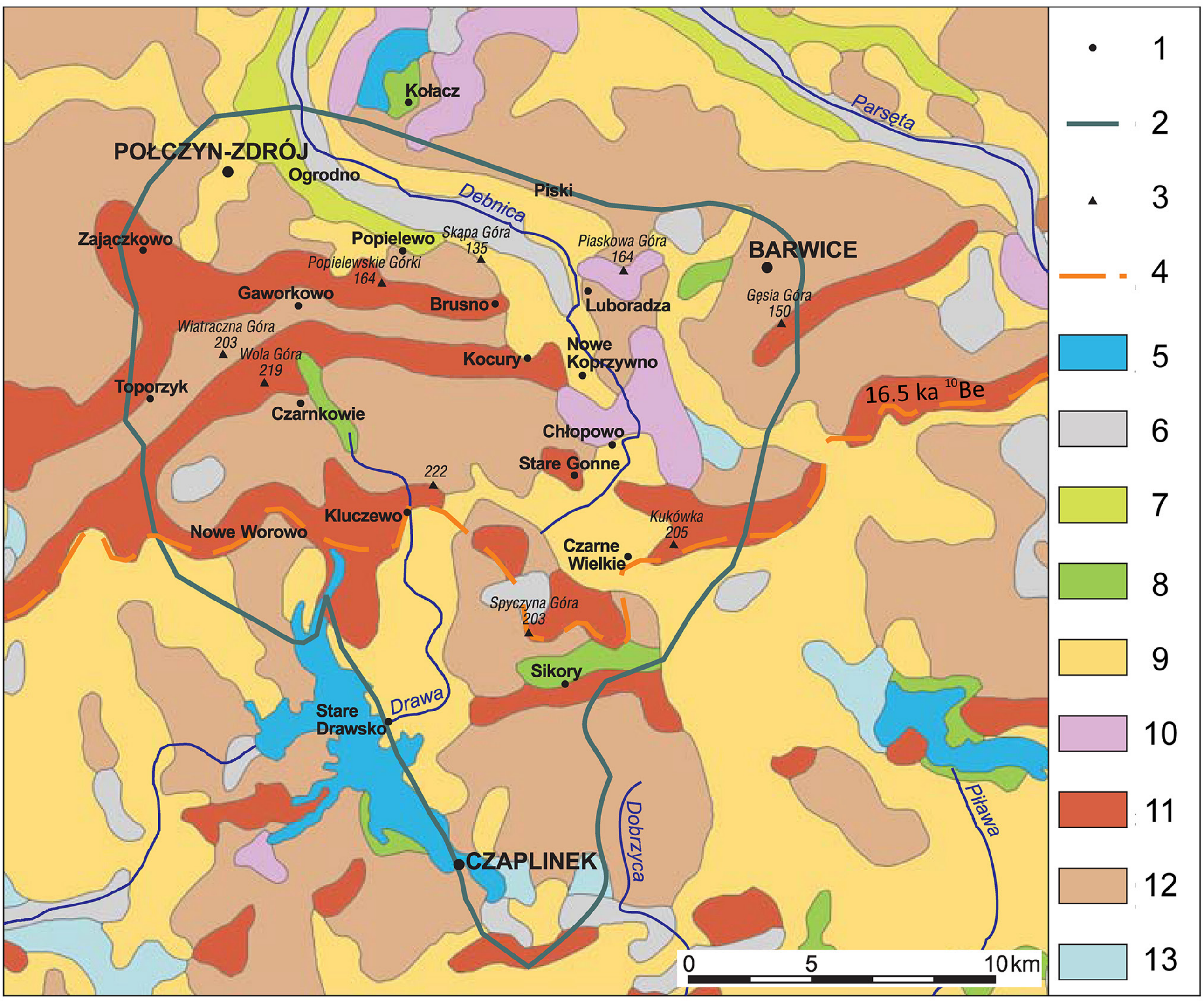

Fig. 2. A simplified geological sketch of the designed geopark (Kamieńska, Giemza 2014, amended). The age of the Pomeranian Phase acc. to Tylmann et al. (2019)
1 – villages, 2 – border of the projected geopark, 3 – elevation points, 4 – maximum glacial extent of the vistulian glaciation, 5 – lakes, 6 – fluvial sands, gravels and mud and peats and silts, 7 – fluvial sands, gravels and silt, 8 – lacustrine sands, mud, clay, gytija, 9 – outwash sands and gravels, 10 – kame sands and mud, 11 – terminal moraine gravels, sands, boulders and tills, 12 – tills, glacial sands and gravels, 13 – clays, silts and stagnant sands

assets include: ancient archaeological objects, sacred and secular stone objects as well as technical management (mills) of rapid streams.

In the relatively small area of the planned geopark Post-Glacial Land of the Drawa and Dębnica Rivers (about 330 km^2) there is a big concentration of genetically differentiated inanimate forms and accompanying deposits. This geoheritage treated as a value-neutral concept describing the diversity of inanimate nature is associated with geodiversity (Gray 2005, 2013, 2018, Serrano, Ruiz-Flano 2007, Coratza et al. 2018, Reynard and Brilha 2018, Zwoliński et al. 2018, Santangelo and Valente 2020, Crofts et al. 2021, Kubalíková et al. 2021, Pasquaré and Bonali 2021). Gray (2004) and Zwoliński (2004) define it as *the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (land form, physical [also chemical – added by the author] processes) and soil features. It includes their assemblages, relationships, properties, interpretations and systems.*

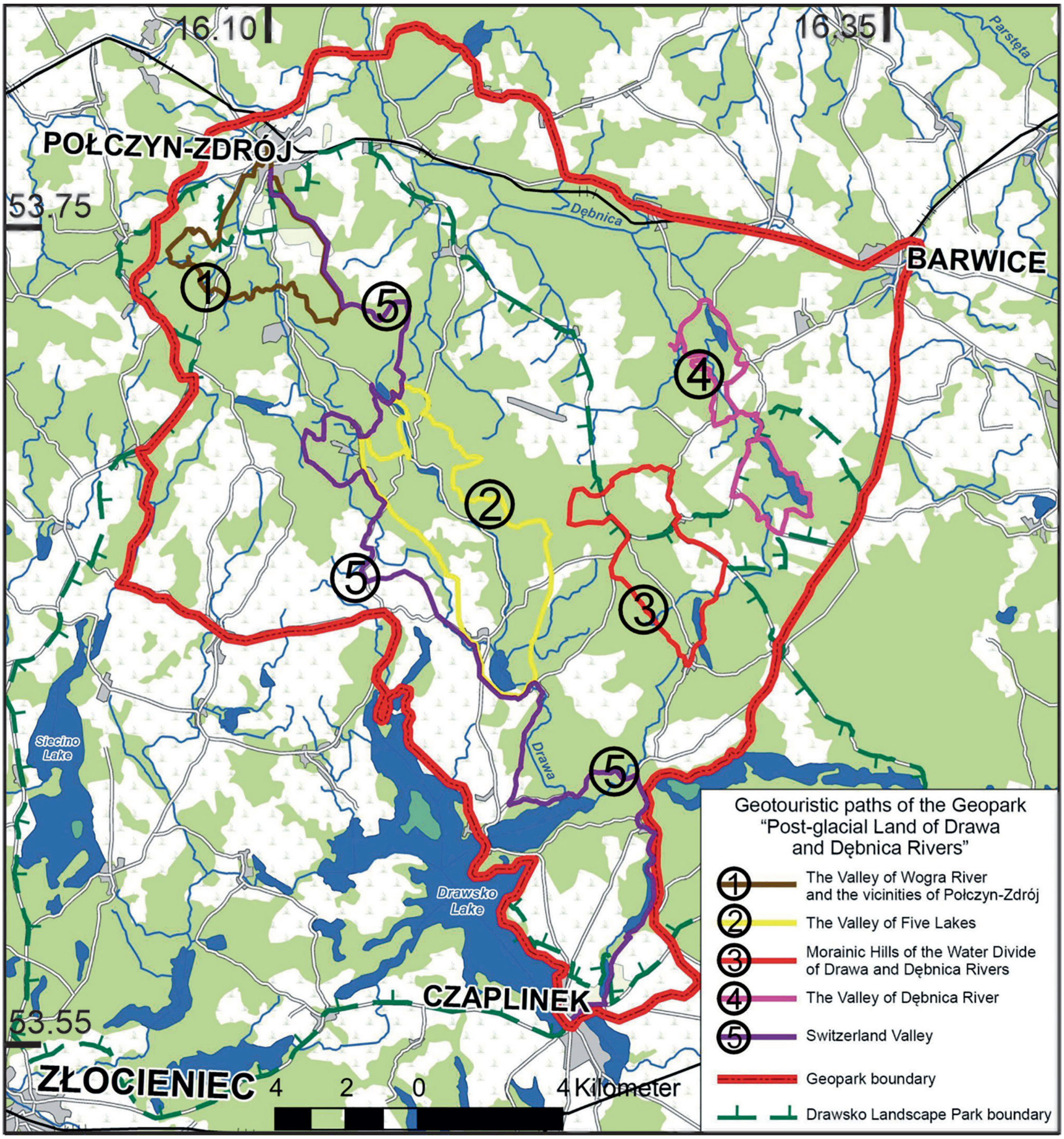

Fig. 3. Geotouristic paths of the planned geopark Post-Glacial Land of the Drawa and Dębnica Rivers (acc. to V-map level 2; Kamieńska, Giemza 2013, amended)

Recently the vast area of the geopark was analysed by Mazurek et al. (2010) and Mazurek and Paluszkiewicz (2013), who studied the formation and development of the first-order valley network in the Dębnica catchment area. The same area was analysed by Najwer et al. (2016) in terms of geodiversity and biodiversity of the postglacial landscape.

Methods

The research methods used in previous field work were described by Kamieńska and Giemza (2013, 2014). On the other hand, the methodology used to assess the geotourist potential of the planned geopark is given in the work of Górska-Zabielska and Kamieńska (2017). As part of the current research, the state of preservation of selected geosites was examined, especially in terms of geomorphological values, and the data influencing the assessment of the object mainly by the recipients (tourists), i.e. added and use values, were updated.

All actions taken at all levels were aimed at:

– inventory resources and document geosites,
– valorize geo-sites by calculating the average values of tourist, scientific and didactic attractiveness, which make up the assessment of geotourist attractiveness,
– designate geotourist paths based on the most interesting geosites,
– make a geotourist map in a scale of 1: 25,000 with a GIS database,
– disseminate the advantages of the area: publish a guide and brochures, make a film promoting the Geopark, build a website, design educational boards and publish articles in industry scientific journals.

Review of geotouristic paths of the planned geopark and their geosites

In this chapter, five proposed geotouristic paths are characterized; they conduct through the most interesting regions of the Drawskie Lakeland (Fig. 3). Four of them form classic loops – beginning and ending in the same place; the last one is a transit path – it runs along the geopark from Połczyn-Zdrój to Czaplinek. The trails can be walked or ridden on by a bicycle. Most often they lead along the existing tourism walking and biking routes.

The description of each path is accompanied by the characteristic of attractive geosites which can be found along the way. In the course of this paper, 20 geosites will be presented in detail.

The network of geosites put into the inventories is expected to be used for environmental education, instruction at various levels of teaching as well as scientific purposes. The hope for the development of one kind of qualified tourism, namely, the geotourism, is also connected with geovalues. It is based on displaying the geological objects which, having been developed and made accessible, may become a tourism attraction. The advantage of geotourism consists in the fact that it does not require much expenditure and might be organized almost anywhere. Basic conditions, however, require equipping a geosite with professional characteristics – including the explanation of its origins and current condition by an expert. One cannot forget that geotourism is a tool for sustainable development of the region. It can become a flywheel for increasing the quality of life of residents through its impact on the local economy.

Geotouristic path – The Wogra River Valley and the Vicinities of Połczyn Zdrój

The presented geotouristic path offers various sites promoting the geological and geomorphological heritage of the region. Geotourists have at their disposal: crenological objects, river valleys, single erratic boulders and culture buildings built of Scandinavian erratics.

Nine geosites and three other sites worthy of note are on the route (Fig. 4; Table 1).

Chosen geosites of Wogra River Valley and the Vicinities of Połczyn Zdrój

Oak Ravine (8 on Fig. 4; Table 1) and **Wolf Ravines** (9). Deep gorges can be distinguished within erosional valleys. Differences in height in the edge zones as well as the geological structure were favourable to the erosional activity of surface water. This resulted

Table 1. Geosites and places worth seeing on the geotouristic path The Wogra River Valley and the Vicinities of Połczyn Zdrój

Geosites and places
1. The castle in Połczyn-Zdrój
2. Spring Water Park (table)
3. “Three Humps” Hill (table)
4. Exudation in Borkowo
5. Source
6. The gravel-pit Ostrowąs and limestone rock
7. Erratic
8. “Oak Ravine” (table)
9. “Wolf Ravines” (table)
10. Erratics in “Wolf Ravines”
11. Hill fort (table)
12. Kettle holes

Geosites marked in bold are described in the text

in the network of erosional valleys cutting into the marginal zones of the morainic plateau. These valleys happen to be hung 2–5 m above the present bottom of the river channels.

Early medieval hill fort Palupe (11) is situated at the fork of streams which form valleys cut deeply into the land, protecting the hill fort against enemies' access. Surrounding of the hill fort with two earthen and stone ramparts indicates the way of using the relief for the defensive purposes in the prehistory. The fortified settlement was situated on the salt route from Kołobrzeg to Wielkopolska, on which salt and amber were transported from the sea coast into the country.

Three Humps [Trzy Garby] Hill (3) refers to the history of Połczyn-Zdrój, when the grapevine was cultivated on the Three Humps. The significance of this kind of economic activity in the town's development is pointed out by the three hills covered with grapevines depicted in the coat of arms of Połczyn-Zdrój. This geosite draws the attention to the landscape value of the vicinity of Połczyn-Zdrój, namely, the young glacial relief.

In the operational **gravel-pit Ostrowąs** (6) the structural record of rhythmically stratified limnoglacial deposits filling the glaciomarginal reservoir was investigated (Dobracka, Pisarska 2002). Next to the gravel-pit office there is a collection of erratic's

Fig. 4. Map of geotouristic path of *The Wogra River Valley and the Vicinities of Połczyn Zdrój* (*acc. to* V-map level 2; Kamieńska, Giemza 2013, amended)

extracted during the sand and gravel exploitations. This collection is made accessible to the interested (geo)tourists by the gravel-pit owner.

The most valuable item of this private lapidarium is a calcareous rock which originated in the old gravel-pit in the vicinities of the village of Ogrodno. Presumably the rock might be a fragment of glacial rafts, removed and relocated by an ice-sheet from the outcrops of the Upper Triassic and Jurassic, which occur northwards of Połczyn-Zdrój at a relatively high ordinate (40–80 m a.s.l.) (Kamieńska, Giemza 2013). The Mesozoic formations (of the Lower and Middle Jurassic periods) make also small outcrops in the bottom of the fossil valley created in the tectonic ditch of Białogard–Połczyn-Zdrój (Dobracka 2009). The pre-Quaternary formations are heavily glacial-tectonically piled up, sometimes enhanced in a scale-form onto the block elevation of Czaplinek (Dobracka 2009), which is why they occur quite near the surface.

The 21-kilometres long path, which may be covered on foot during ca. 5.5 h, leads through the forests not far from Połczyn-Zdrój (Figs 3, 4). It offers a perfect supplement to the therapeutic stay at Połczyn Zdrój. Due to the appropriate length, location and undemanding nature of the area it is an appealing opportunity for clients who would wish to breathe in a gulp of fresh air and get to know some places nearest the health resort. The trail can be done on foot, by bike or during nordic walking. Five of the twelve geosites have been designed with educational tables. Their presence next to a geosite is necessary – they help in transferring knowledge.

Geotouristic path – Five Lakes Valley

Among the most beautiful and best-known sites of the planned geopark Post-Glacial Land of the Drawa and Dębnica Rivers is Five Lakes Valley (Figs 3, 5). The aim of protection is to preserve the morphological form of the Drawskie Lakeland with a rich flora of forest complexes, water reservoirs and low peat bogs, with Pomeranian beech forest and numerous stands of protected plants.

The landscape (as well as its floristic) reserve (est. in 1987) protects a subglacial tunnel valley with the source section of the Drawa river and five small lakes called, respectively: Krzywe (located the most northward, known also as Górne), Krąg (or Okrągłe), Długie, Głębokie and Małe. Tunnel valley is a category of glaciogenic valley that forms subglacially due to erosion of poorly consolidated substrates by pressurized meltwater (O'Cofaigh 1996; Van der Vegt et al. 2012). They are narrow and elongated depressions a few kms wide, up to tens of kms long, and tens to hundreds of meters deep (typical width/depth ratio = 10) filled by ice-contact to non-glacial sediments (Isbell et al. 2021). Tunnel valleys are oriented parallel to the ice flow and have flanks with high slope values more than 20° (Roattino et al. 2021). The steep and high slopes of the described Five Lakes Valley cut into the morainic plateau more than 70 m deep. The summits of the morainic plateau reach up to 223 m a.s.l. here (Dobracki 2002a). The reserve area, of total 228.78 ha, is covered with old (more than a hundred years old) thick beech trees.

Chosen geosites of Five Lakes Valley

The **Ornithologic reserve Lake Prosino** (4 on Fig. 5; Table 2). The reserve of animate nature with an 81 ha area, protecting the habitats of 26 species of rare and protected avifauna, such as: crane, Eurasian bittern, red kite, common tern, western marsh-harrier, common kingfisher and red-backed shrike. As regards the geomorphology, the lake is an example of kettles, which originated as a result of the melting of the buried dead ice blocks located at the mouth of the Drawa river gully; in the direct neighbourhood a small sand outcrop is situated, where the geological structure of outwash plain can be seen and the course of geomorphologic occurrences on the foreland of the ice-front can be traced.

Ruins of the **hard-labour camp Baugruppe Schlerupp** (5) near Kluczewo. The prisoners of Polish, French and Russian nationalities put here hewed erratics available in the fields and forests, meant for the construction of the highway from Berlin to Królewiec during World War II. They also built embankments for the new road.

Boulderground (6) on the history Salty Route (pol. *Szlak Solny*) consists of Scandinavian erratics which could have been taken down from the neigh-

Table 2. Geosites and places worth seeing on the geotouristic path Five Lakes Valley

Geosites and places
1. Erosion valley at the edge of the channel
2. Kettle holes in Czarnków
3. Boulder in Kolonia Bolegożyn
4. The Ornithologic Reserve Prosino Lake
5. Hard labour camp (table)
6. Boulderground (table)
7. Strengthened stream bed
8. High bog
9. Four erratics
10. Erratic
11. Boulder-debris (table)
12. Grodzisko Zbójów (Bandits' Hill Fort) in Brzękowice
13. Two erratics (table)
14. Kettle holes on the plateau
15. Lake Krzywe (Crooked)
16. Viewpoint Five Lakes Valley (table)

Geosites marked in bold are described in the text

bourhood (forests or fields), needed for the construction of the aforementioned old German highway. The provenience analysis of these Scandinavian erratics enables to determine a few indicator erratics (Korn 1927, Lüttig 1958, Meyer 1983, Czubla et al. 2006, Meyer, Lüttig 2007) from the south-eastern Sweden – Småland granites and from the Dalarna – Siljan granites.

It should be mentioned here that, according to (Brox, Semeniuk 2017), the objects erected from erratics (or simply rocks/stones) belong to both the cultural and geological heritage. Similarly, Migoń (2012) states that the objects of stone architectural monuments are ready-made, though unexplained, exhibitions showing the diversity of rocks and their various forms. Based on information boards or the message given by an expert, they serve the perfect transfer of knowledge.

The route of the geotouristic path Five Lakes Valley, 27-kilometres-long, can be walked during about 8.5 hours. There are 16 geospots on the route, including 12 geosites and 4 other interesting places (Figs 3, 5; Table 2). The didactic tables are planned at five spots.

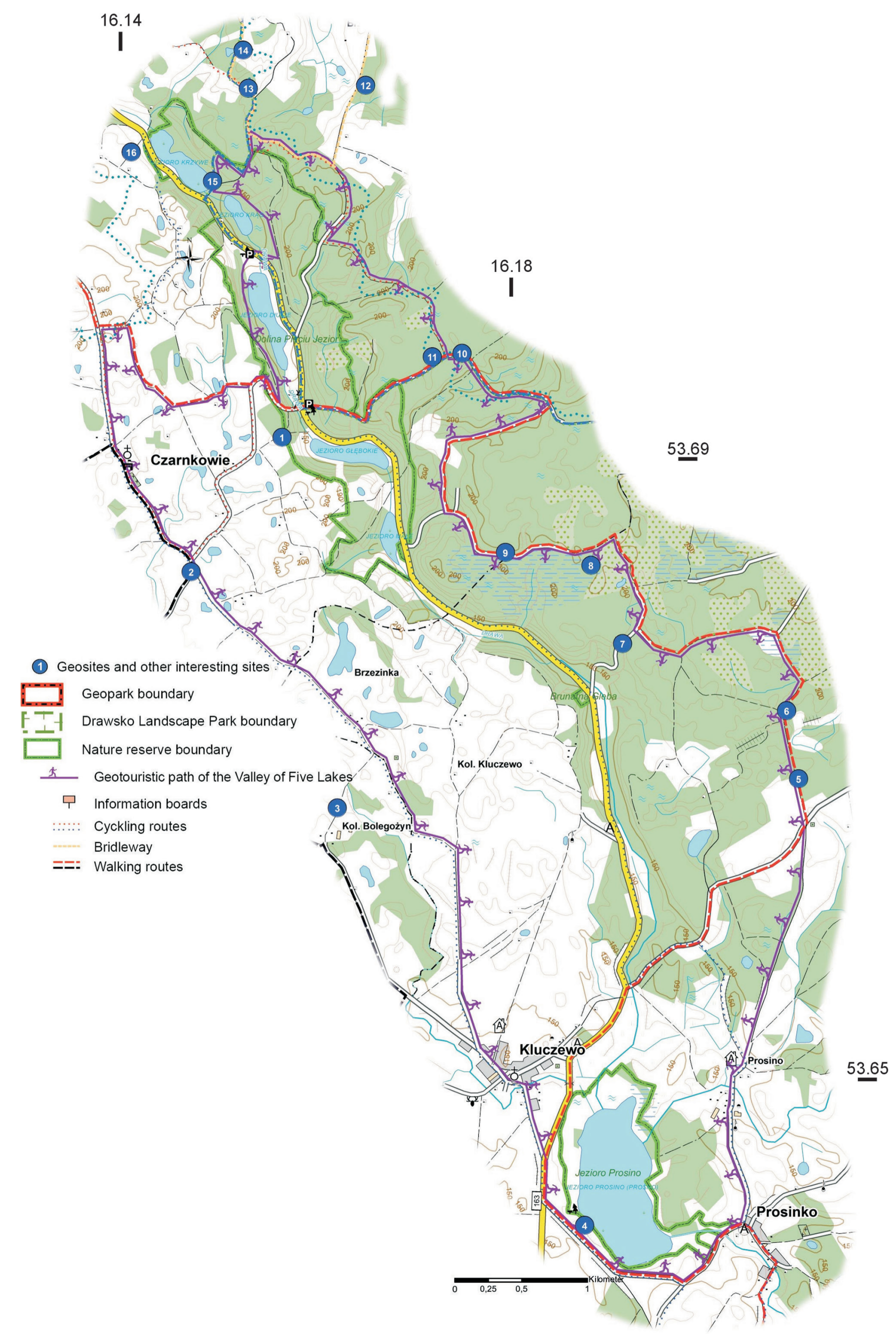

Fig. 5. Geotouristic path *Five Lakes Valley* along with the geosites and places worth seeing (acc. to V-map level 2; Kamieńska, Giemza 2013, amended)

Geotouristic path – Morainic Hills of the Water Divide of the Drawa and Dębnica Rivers

The first-order water divide (Figs 6, 7, 8) separating the catchment of the Odra river (Drawa) from the rivers of the seaside area called Przymorze (Parsęta, Rega) runs along the crests of the highest morainic hills of the planned Geopark Post-Glacial Land of the Drawa and Dębnica Rivers. Drawa begins in the Five Lakes Valley and runs southward to the Noteć river, supplying the Odra river catchment. In contrast, the Dębnica goes northward to the Parsęta river, which flows directly to the Baltic Sea.

Morainic hills of the Geopark, called Wzgórza Chłopowskie, form a fragment of the front-morainic zone of the Parsęta lobe. It was the outlet glacier of the glaciomarginal zone of the last Scandinavian ice-sheet, which operated in the discussed area during the Pomeranian Phase of the Vistulian glaciation (16.5 ka ^{10}Be, Tylmann et al. 2019).

Chosen geosites of Morainic Hills of the Water Divide of the Drawa and Dębnica Rivers

The **boulder that marked the border** (5 on Fig. 6; Table 3) between the Margraviate of Brandendburg and the Kingdom of Poland in 14–18 C. (Koch 1978; Fig. 10) is a flat Jotnian sandstone. It belongs to so called auxiliary erratics, since it could have been extracted from different Scandinavian parent regions.

Two letters (P and B) are furrowed on the boulder, with a cross with all its arms of equal length resembling the medieval symbolism, between them

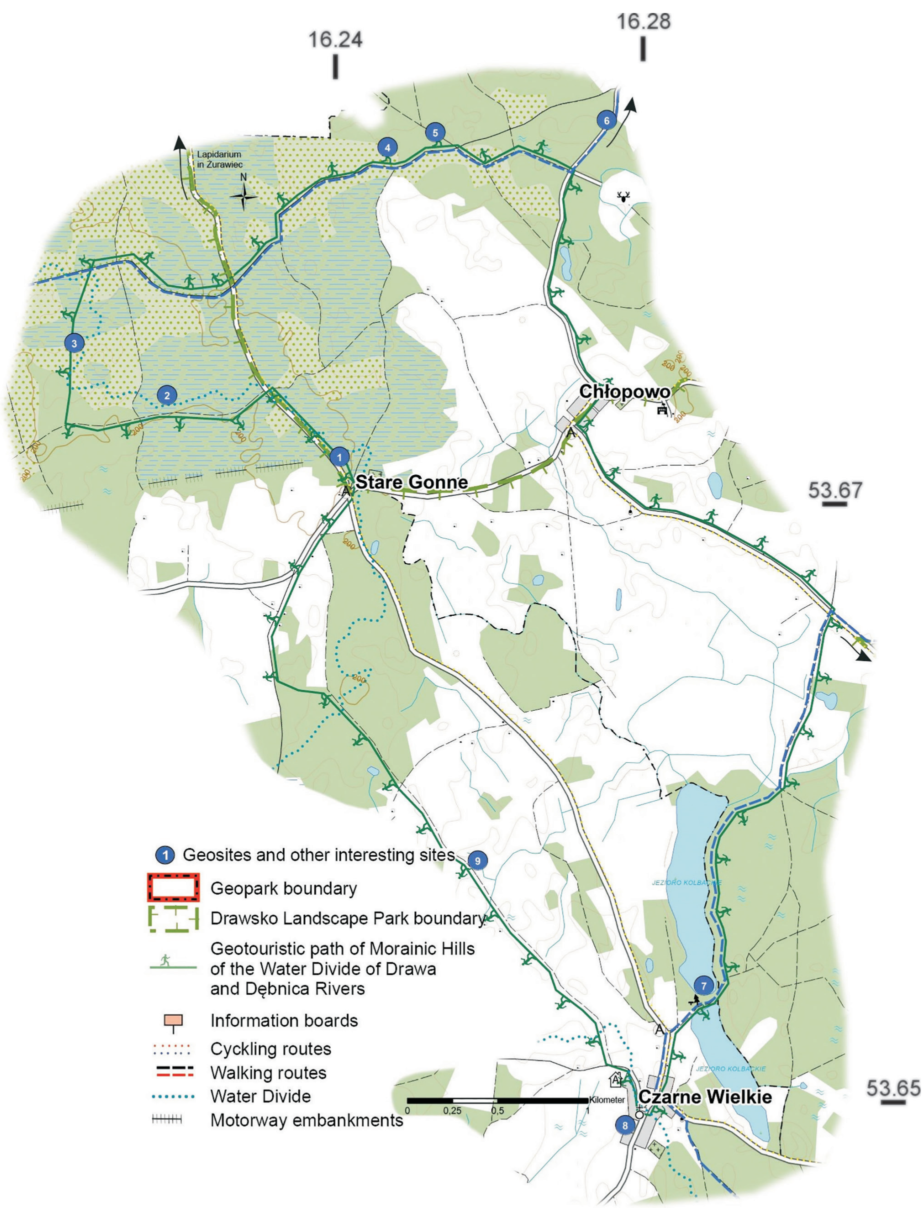

Fig. 6. Course of the geotouristic path *Morainic Hills of the Water Divide of the Drawa and Dębnica Rivers* with marked geosites (acc. to V-map level 2; Kamieńska, Giemza 2013, amended)

(Fig. 9). Being located on the top of the hill near the Kocury village, it must have been a mark of the frontier towards the end of the sixteenth century.

For ages the areas of the Geopark constituted the borderland of three powers: the Crown of the Kingdom of Poland, the Margraviate of Brandenburg and the Duchy of Pomerania (Fig. 10). Wars for influence had been conducted here for many years. Until 1368 the border between New Marchia and the Pomeranian principalities ran there. After 1368 (the annexation of Czaplinek, Drahim and the surrounding area to the Kingdom of Poland by Casimir the Great), it was the border between the Kingdom of Poland and the Pomeranian principalities. Polish rule over this part of the Drawskie Lakeland was consolidated by Polish king Ladislaus Jagiello when his army in 1407 seized Drahim and frightened away the Knights of the Order of St John of Jerusalem conducive to the Teutonic Knights and Brandenburg. After 1648 (the partition of the Griffin state between Brandenburg and Sweden) there was a border between Brandenburg and the Kingdom of Poland. After another 9 years, in 1657 (the Welaw-Bydgoszcz treaties) and the loss of Drahim with the surrounding area, the boulder was only on the inner administrative border of Brandenburg and later - the Kingdom of Prussia.

The border boulder (Fig. 9) is one of the most important and appealing historic attractions of the Geopark. It belongs both to the cultural and geological heritage.

Table 3. Geosites and spots worth seeing on the geotouristic path Morainic Hills of the Water Divide of the Drawa and Dębnica Rivers

Geosites and places
1. Embankments of the “Berlinka” highway
2. Water divide (table)
3. High bog
4. Erratic
5. Bordering boulder (table)
6. High bog Misiołki (table)
7. Lake Kołbackie
8. Church in Czarne Wielkie
9. Erratic

Geosites marked in bold are described in the text

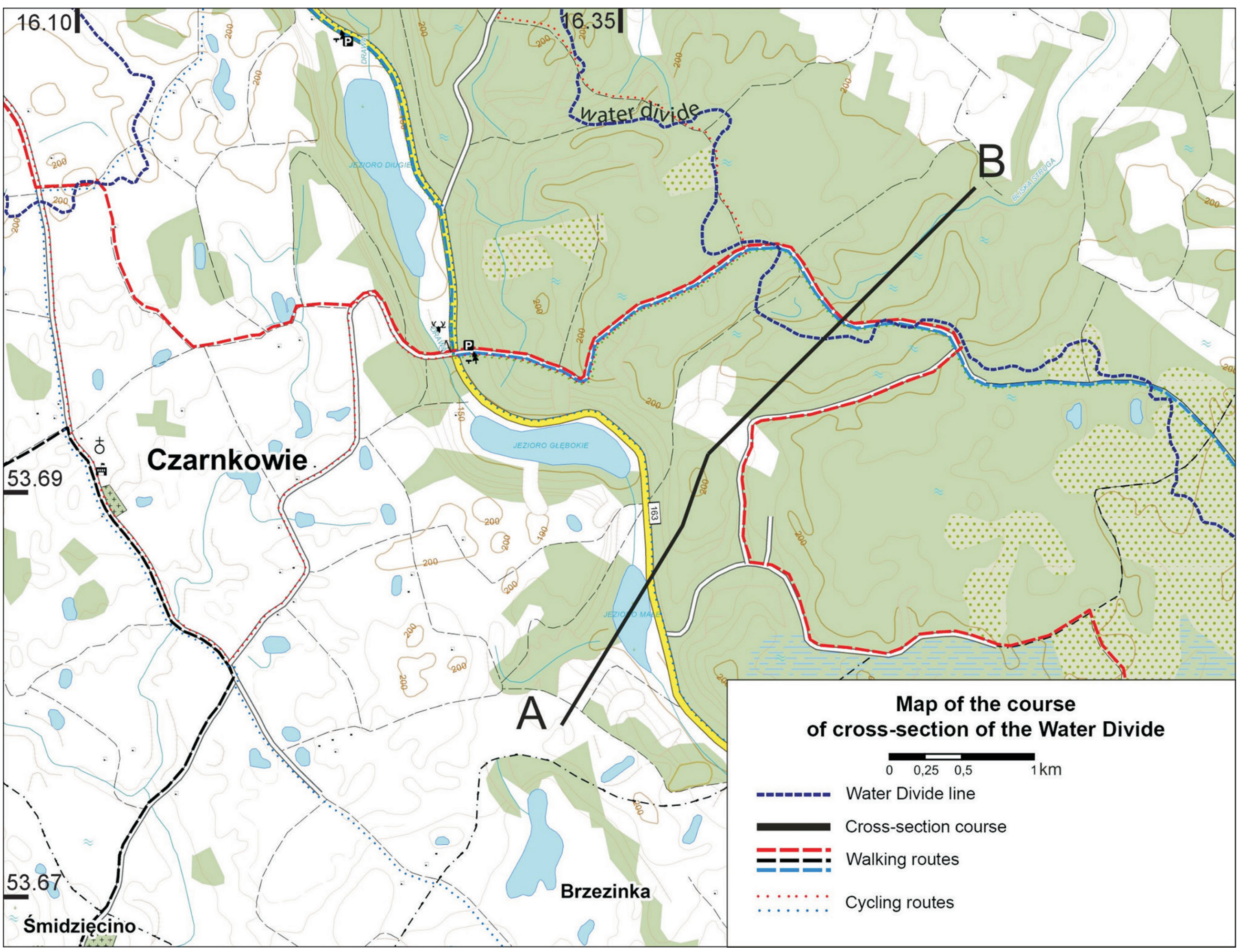

Fig. 7. Map of the course of the geological cross-section (Fig. 8) through the first-order water divide of the Drawa and Dębnica rivers (acc. to V-map level 2; Kamieńska, Giemza 2013, amended)

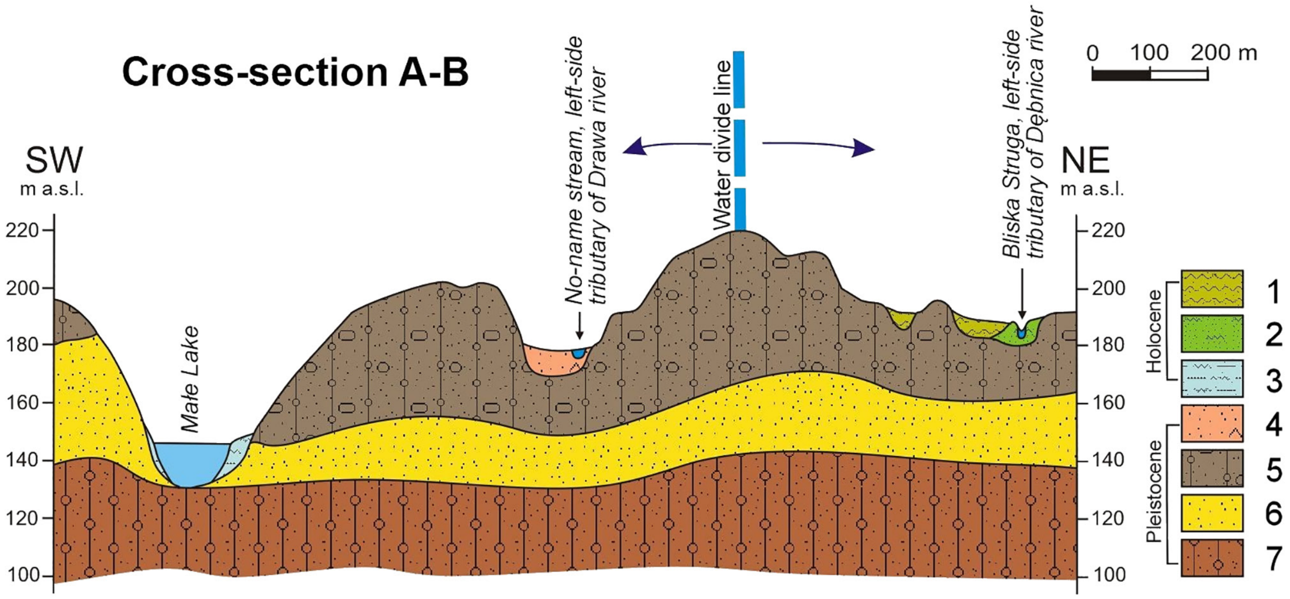

Fig. 8. Geological cross-section through Wzgórza Chłopowskie parallel to the first-order water divide of the Odra (Drawa river) and Parsęta (Dębnica river) catchment areas. (acc. to V-map level 2; Kamieńska, Giemza 2013, upon Dobracka 2009)

1 – silts and sands of no-outlet-depressions, 2 – river sands and silts, 3 – lake sands, silts and clay, 4 – sands and silts of melt-out depressions, 5 – glacial tills of end moraines, 6 – glacial sands, 7 – glacial tills

High bog (6) near the forester's lodge Misiołki. In conditions of hardly permeable bed deposits like the glacial tills composing the morainic hills of the water divide of the Drawa and Dębnica rivers, a bog originates easily in any hollows. Quite often, protected species of plants can be found in such places.

Mazurek and Paluszkiewicz (2013) note that in the Dębnica catchment, which represents a post-glacial relief zone, the network of 1st-order valleys consist landforms initiated by denudational and erosional processes. They might have led to form *shallow wash hollows, solifluction hollows, denudation hollows and valleys, erosional dissections (gullies, badlands), and erosional-denudational valleys (colluvial valleys). Land depressions of this type have the ability to concentrate enough water from overland runoff to initiate the processes of wash and rill erosion. They also determine the direction of water flowing from subsurface levels in the aeration zone. Some of these valleys are now drained only episodically by streams nourished directly by precipitation and local groundwater horizons, and therefore having a variable discharge throughout the year. The deepening of erosional-denudational landforms can lead to the cutting of aquifers and the drainage of groundwater, which allows a steady channel flow to be maintained.*

The stone church in Czarne Wielkie (8) offers a good example of the frequent use of local building material, in the form of erratics so common in the fields. In the neo-Romanesque stone churches characteristic for the region, different stages of the Pomeranian stone masonry workshop development can be noticed. The oldest churches are built of pebbles

Fig. 9. Jotnian sandstone with two letters P and B and the cross with all arms of equal length furrowed on the surface is an old border boulder between the Kingdom of Poland and the Margraviate of Brandenburg (1648–1657)

joined with mortar. In the younger constructions the stone masonry processing draws attention – the walls are like stone pitched of granite squares – smoothly cut stone blocks, placed in horizontal layers of the same height.

There are several excellent examples from Germany and Denmark (Meyer 2006, Bungenstock, Meyer 2003, 2013, Bungenstock et al. 2012a, b), where churches made of boulder blocks are used to tell about the glacial past of the regions where these sacred objects are located. Due to Brocx, Semeniuk (2019) building stones can play a role in studying geological heritage. Migoń (2012) speaks in the same spirit: the walls of stone architectural monuments testify to the geological past of the region and its geoheritage.

The petrographic garden in Żurawiec is not situated directly next to the geotouristic path but at a distance of circa 3 km northwards of its northern fragment and about 4 km northward of the Stare Gonne village.

The collection of erratics in the Lapidarium in Żurawiec consists of 51 boulders originating in the surrounding fields and representing mainly magmatic and metamorphic types of rocks. Among them, the indicator erratics have been identified. Their mother regions are as well as Småland and Blekinge regions in south-eastern part of Sweden as the Åland Islands (Górska-Zabielska 2013).

Erratics assembled at one spot ensure an effective form of their protection against destruction and theft (Górska-Zabielska 2021). Unfortunately, due to the still hardly realized geotouristic role of erratics, many of them disappear irretrievably from the fields and forests, finding their destination via the stone processing plant (Piotrowski 2008, Chrząszczewski 2009) in the cemetery or as a corridor floor, or in a fitted kitchen. The boulders in the petrographic garden in Żurawiec suggest also their value for mass tourism instead and as a supplement to the medical tourism in Połczyn Zdrój.

The geotouristic path, ca. 17-kilometres-long, joins nine spots; six of them are geosites (Figs 3, 6; Table 3); didactic tables are planned at three. Estimated time of walk is ca. five hours.

Fig. 10. Map of Polish-Lithuanian Commonwealth in 1648. The square points to the border boulder, mentioned in the text (Maciej Szczepańczyk based on Atlas of Poland [GNU Free Documentation License], amended)

Geotouristic path – Dębnica River Valley

The Dębnica River is one of the tributaries of the Parsęta River. There is a nature reserve in the place where the path is marked. At this stage, the river is mountainous, characterized by a large water drop and flows along a picturesque gorge. The river may be temporarily deprived of water – then its very rocky bottom is exposed. An interesting species of bird that you can meet here with a bit of luck is the wagtail.

Chosen geosites of the Dębnica River Valley

The **boulder in Nowe Koprzywno** (6 on Fig. 11; Tab. 4) is the biggest erratic within the Geopark; it can be viewed *in situ*. Its measurements are as follows: 5.2 m in length, 4.15 m in breadth, 1.26 m in height, 13.8 m in circumference. Having applied the appropriate formulas (Schulz 1999) 14.22 m^3 of volume and 39.11 t of weight were calculated. It is an indicator erratic – consisting of Karlshamn granite; it comes from Blekinge in the southern part of Sweden. The lack of any information board reduces the educational value of this geosite.

Ruins of the watermill (7) on the Dębnica river near Lake Dębno. The substantial slope (23‰) of the Dębnica river northward of Lake Dębno resulted in the location of a watermill there. Till today only fragments of the foundations, a damming up reservoir as

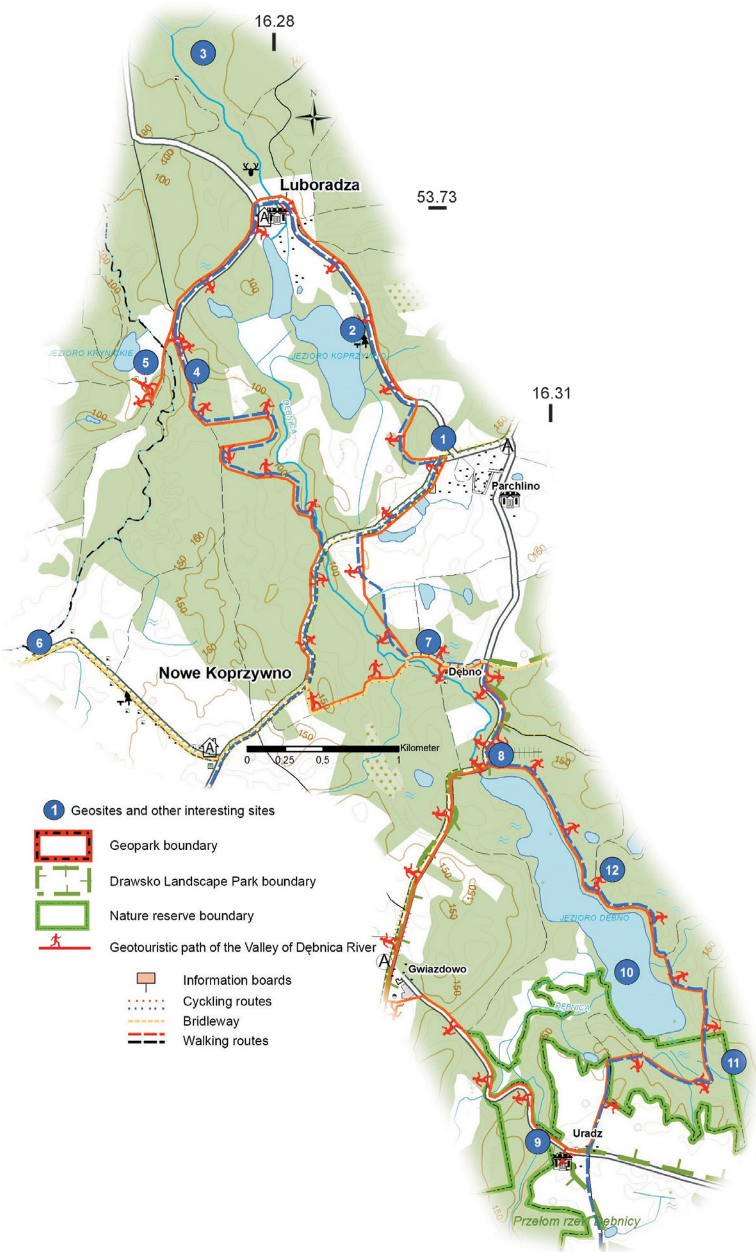

Fig. 11. Course of the geotouristic path *Dębnica River Valley* with geosites marked (acc. to V-map level 2; Kamieńska, Giemza 2013, amended)

Table 4. Geosites and spots worth seeing along the geotouristic path Dębnica River Valley

Geosites and places
1. Parchliński boulder
2. Lake Koprzywno
3. Watermill in Zielony Gaj
4. Karsińskie Ravines
5. Lake Krynickie
6. Erratic in Nowe Koprzywno (table)
7. Watermill on Dębnica river (table)
8. Lake Dębno (table)
9. Reserve "Dębnica River Water Gap" (table)
10. Outlet of Dębnica to Lake Dębno
11. Ruins of the watermill
12. Erosion valley on the slope of the lake

Geosites marked in bold are described in the text

well as strengthened riverbed have been preserved; not a long time ago among the ruins an original mill-wheel and quern could have been also admired. The geosite is an excellent example of using inanimate natural resources in human economy.

The landscape reserve **Dębnica River Water Gap** (9) was established in 2009 and it protects the young glacial landscape with the river water gap through the embankment of the end moraine. Dębnica cuts into the moraine, creating a deeply cut valley with steep slopes 30-metres-high. Besides, the river has a big inclination (0.8–1.2%), hence it is considered to have a mountain river character. The energy of water was used in the past for propelling the watermill in Uradz. The Dębnica riverbed is filled with erratics covered with protected red algae, *Hildenbrandia rivularis*, which is an indicator of its first water quality class.

The geotouristic path Dębnica River Valley leads through picturesque fragments of the Dębnica river valley (Fig. 3). The path consists of two loops, thus making it possible to divide the tour into stages. First, the northern part encompasses the vicinities of Lake Koprzywno, while the second one runs around Lake Dębno. Altogether the distance is 18-kilometre-long which may be walked during ca. five hours. On the route are twelve spots, including nine geosites; four of which are explained with the use of didactic tables (Table 4, Fig. 11).

Geotouristic path – Połczyn Switzerland

The area owes its name to the picturesque surroundings of high (over 200 m) moraine hills covered with pastures and forests. There is one of the highest peaks in Western Pomerania – Wola Góra (219.2 m a.s.l.), on the top of which an observation tower was erected.

As in Switzerland, the terrain is crisscrossed by hills, lakes and pastures. Rushing streams in the gorges carry crystal clear, refreshing water. As in Switzerland, the area has a multinational legacy in which traces from Germany, Israel, Prussia, the Commonwealth, the former Pomeranian principalities, and today also the Ukrainian and the Roma are mixed up.

Chosen geosites of Połczyn Switzerland

Bliska Struga (5 on Fig. 12; Table 5) and its small tributaries form an impressive deep **ravine**; in places its slopes reach beyond 70 m in height and are almost vertically inclined (Figs 13, 14). The slopes are covered with high beech as well as oak woods.

The headwater area in the Bliska Struga Ravine (6) is an example of numerous spring headwalls of rivers, that are characteristic of many areas of the Drawskie Lakeland (Mazurek et al. 2010). Headwater of rivers and groundwater outflows, located there, drain off waters from erosionally undercut water-bearing lay-

Table 5. Geosites and spots worth seeing on the geotouristic path Połczyn Switzerland

Geosites and places
1. Castle in Połczyn-Zdrój
2. Spring Water Park (table)
3. Kettle holes
4. Valley with boulderground
5. Bliska Struga Ravine and its tributaries (table)
6. Source in the ravine
7. Hollows without drainage on the plateau
8. Two erratics
9. Lake Krzywe
10. Viewpoint over "Five Lakes Valley" (table)
11. Gravel-pit in Czarnków
12. Wola Góra (Ox Mountain, table)
13. Kettle holes
14. Erratic in Kolonia Bolegożyn
15. Museum of the PGR (State-Owned Farm)
16. Lake Prosino
17. Mountain Spycz(y)na
18. Drahim castle (table)
19. Gravel-pit in Żerdno
20. Viewpoint and erratic
21. Viewpoint over lake Komorze
22. Viewpoint over lakes Żerdno and Komorze channels
23. Church in Sikory
24. Pottery settlement in Sikory (table)
25. Erratic over lake Dołgie Wielkie
26. Erratic
27. Lake Dołgie Wielkie
28. Pleistocene rocks in Lipowa Góra (table)
29. Museum chamber in Czaplinek
30. Erratic
31. Sławogród

Geosites marked in bold are described in the text

ers (Fig. 14). Water, percolating through a thick layer of morainic tills, abundant with calcium carbonate, leaches this element out. In the bottom of the riverbed of the flowing source, lots of precipitated calcium carbonate in the form of calcareous tufa can be found. Basic hydrochemical analysis has proved the high hardness ($CaCO_3$) of the water flowing out of the spring (276.0 mg dm^{-3}) as well as huge amounts of hydrogen carbonates (329.4 mg dm^{-3}) (Kamieńska, Giemza 2013).

Observation towers on the mountains Wola Góra (12) and **Spycz(y)na Góra** (17). Considering the two observation towers located here, only the one on Wola Góra (223 m.a.s.l) (Dobracki 2002b), which is a fire observation tower of the Połczyn-Zdrój Forest Inspectorate 48-metres-high (Głąbiński 2009), ensures nowadays (2021) a vast (within a dozen or so kilometres radius) panorama of Połczyn Switzerland.

The view from the renovated tower on Spycz(y)na Góra (203 m a.s.l.) is secured by the care of the surrounding forest. The young glacial relief of the geopark can be admired from this tower, especially the culminating parts of the end moraine of the main limits of the last glaciation during the Pomeranian phase within the Parsęta lobe. The diversified relief of this region is protected within the Drawski Landscape Park and constitutes an area of protected landscape of the Drawskie Lakeland.

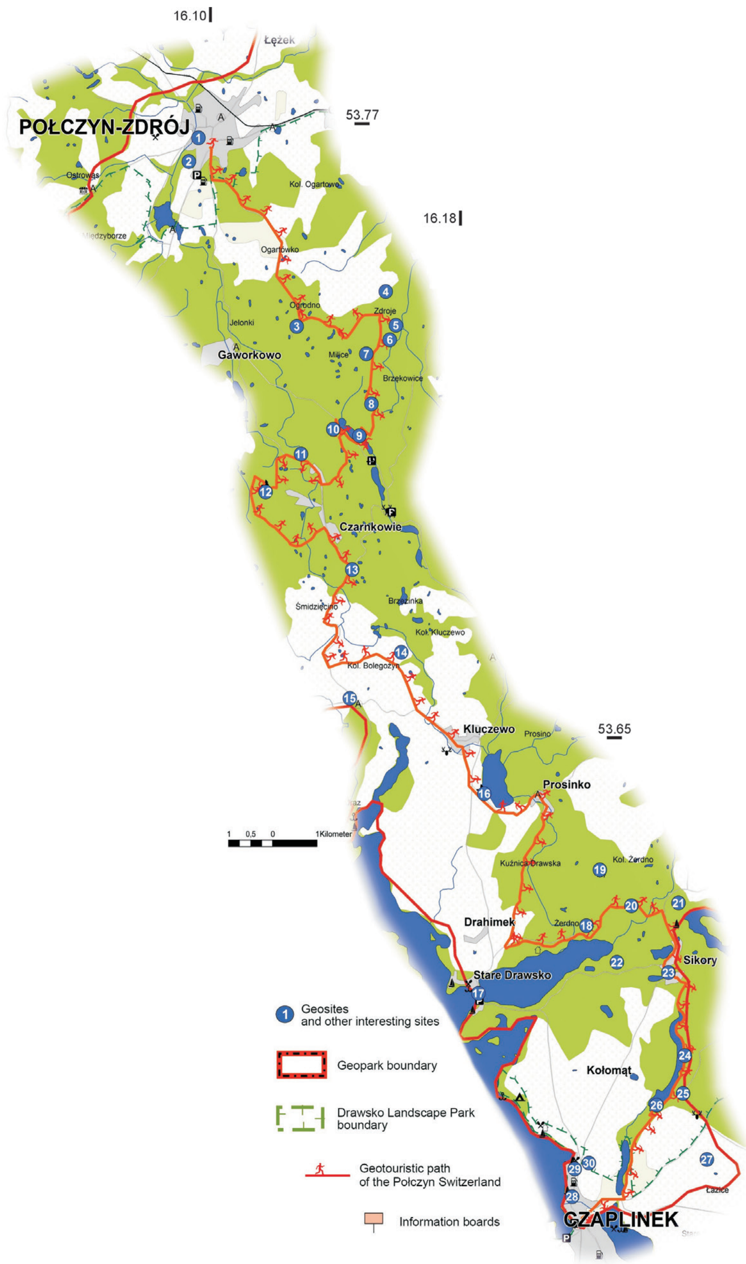

Fig. 12. Course of the geotouristic path *Połczyn Switzerland* with geosites marked (acc. to V-map level 2; Kamieńska, Giemza 2013, amended)

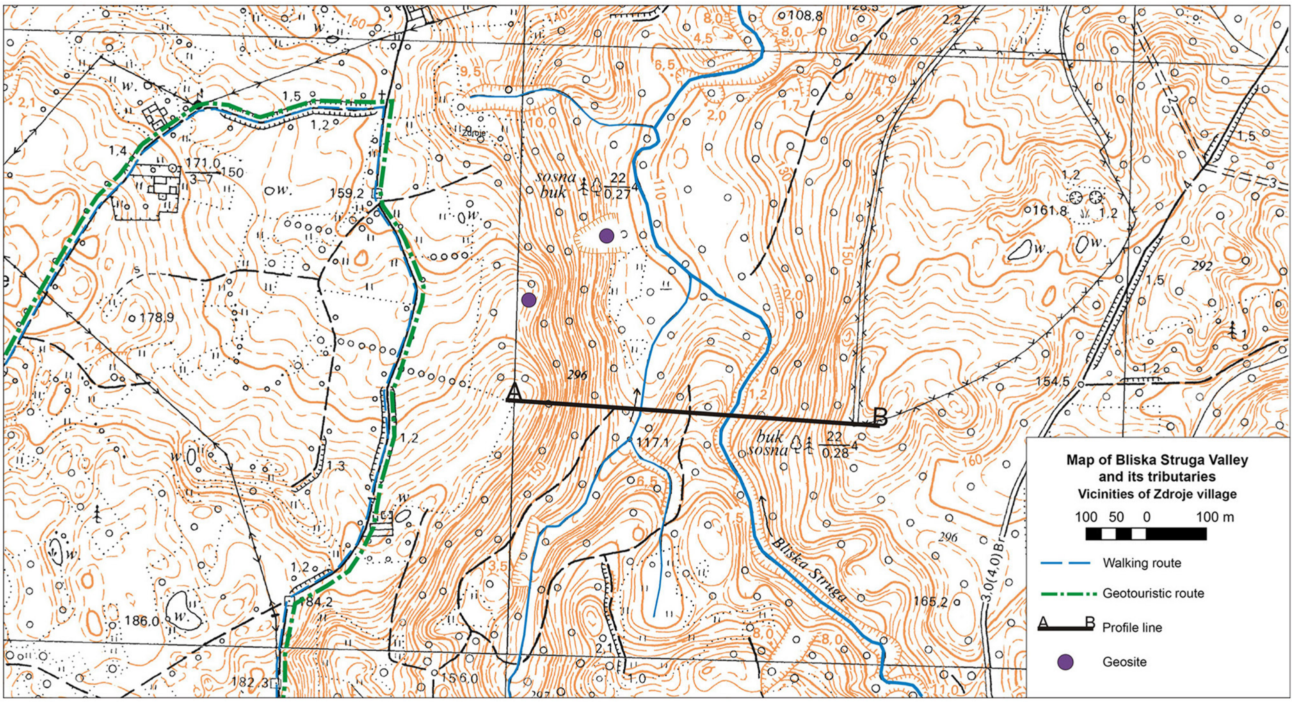

Fig. 13. Topographic map of the course of the geological cross-section (Fig. 14) through the Bliska Struga valley and its tributaries (acc. to V-map level 2; Kamieńska, Giemza 2013)

Spycz(y)na Góra is one of the highest elevations on the Drawskie Lakeland. It is situated in a row of terminal heights of the Pomeranian phase. The culmination of Spycz(y)na Góra rises above the northern shore of lake Żerdno (called also Srebrne), the water table of which is on the ordinate of 128.4 m a.s.l. (Dobracki 2002b).

The Pottery Settlement in Sikory (24). Awareness among the medieval inhabitants of the Sikory village of the properties of the durable, easily available in the area and of good quality glacial tills was the cause of the pottery and bricks firing venue famous at that time. The bricks used for the construction of Drahim castle situated nearby must have come from this spot. In order to rebuild the tradition and tourism interest, in 2003 the Pottery Settlement was decided to be re-enacted. Today, the reconstruction of a kiln can be seen here as well as a small chamber for exhibitions and workshops. In the summer, pottery workshops for tourists are organized in Sikory. According to e.g. McKeever, Zouros' (2005), Dobracki's (2008), Migoń's (2012) and Frey's (2021) statements, the specific economic activity of people connected with recognizing these resources, their exploitation and usage, might become within the interests of geotourism.

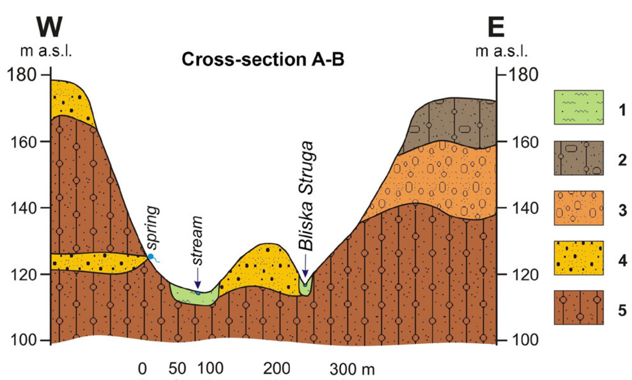

Fig. 14. Geological cross-section through the Bliska Struga Ravine and its tributaries (acc. to V-map level 2; Kamieńska, Giemza 2013, upon Dobracka 2009, amended)
1 – river sands and silts, 2 – Pomaranian glacial tills with boulders of end moraines, 3 – glacial sands, gravel and boulders of end moraines, 4 – glacial sands and gravels, 5 – Leszno-Poznań glacial till

The Pleistocene rocks in Lipowa Góra (28). In the area of the sand-pit in Łazice, in its old, already unexploited part, the real peculiarity of nature within the geopark can be found. These are conglomerates which were formed of sand and gravel deposits cemented with calcium carbonate. The fancy shapes of conglomerates protruding from the sand-pit's wall offer a valuable attraction for a (geo-)tourist. The geosite in Lipowa Góra is of a unique character on the regional scale.

Regarding the geomorphology, Lipowa Góra could be acknowledged as a singular kame form located in the hinterland of the maximum extent of the Pomeranian phase (Gruszka et al. 2002).

Drahim castle (18) belongs to the most valuable objects of the cultural heritage of the geopark. It was built in 1366 by the Knights of the Order of St John of Jerusalem and it provides a good example of using the natural conditions present during the construction of the fortifications. Its elevation, the isthmus between lakes, easy access to the building material (erratics) – altogether enabled the erection in the times of the Drahim starost office of one of the most important fortresses on the northern frontier of Poland (Głąbiński 2009). Next to this treasured historic token, being both an element of cultural heritage and unanimated nature, an information table has been planned.

Tempelburg [German – Czaplinek] boulder

The boulder is situated outside the planned geopark (5 km south of Czaplinek), but this fact in no way detracts from its geotourism potential. As the largest boulder in the Drawski Landscape Park it is often mentioned as one of local tourist attractions.

The boulder is protected by law as an inanimate nature monument due to its size (19 m in circumference, and 3.5 m in height above the ground surface), location *in situ*, and historical importance (Fig. 15). It served as the border stone, marking the south-western extent of the Polish Drahim county (Fig. 10). Unfortunately, this fact has not been reflected in the name of the boulder; even today the boulder does not have an official name. On the old maps (DSI 2016) it is named *Der Geklöbte Stein* or *Der Geklobte Stein*, which rather indicates anthropogenic destruction (attempts to split the stone into smaller pieces).

It is not difficult to get to this erratic border boulder. The route leading to the site is signposted at the intersection of asphalt road Czaplinek – Stare Kaleńsko with dirt road running from Pławno to Cichorzecze. Tourists can also reach the border boulder travelling along the Lobelia Lakes bike trail, which is marked with a stylized bike silhouette in black colour.

The longest geotourist path of the Geopark is 45-kilometres-long (Fig. 3). It can be walked in nine hours. Unlike the remaining four proposed paths, it does not form a loop. It runs along the Geopark from Połczyn-Zdrój in the north to Czaplinek in the south. Thanks to the route being designed like this, the path makes it possible to acquaint oneself with all the key values of the Post-Glacial Land of the Drawa and Dębnica Rivers. Additionally, tourists can get acquainted with the main trade route, the historic Salt Route, which ran through Połczyn-Zdrój and further south. There are 31 spots worth visiting on the route, including the geosites. Didactic tables are planned for eight of these (Table 5; Fig. 12).

Fig. 15. The Tempelburg boulder is the largest monument of inanimate nature located in the buffer zone of the planned geopark (5 km south of Czaplinek) (photo Górska-Zabielska 2009)

Conclusions

Inventory and assessment of the geosites within the area of the planned geopark Post-Glacial Land of the Drawa and Dębnica Rivers has resulted in fifty-nine geosites, whose average geotouristic attractiveness amounts to 5.6 in the ten-grade scale, having been enlisted to the Polish Central Register of Geosites (Kamieńska, Giemza 2013, 2014). Another assessment of geotourism potential of the Drawskie Lakeland (Górska-Zabielska and Kamieńska (2017) confirmed previous analyses that the region is characterized by high geodiversity. The results of Najwer's et al. (2016) research look slightly different. Their investigations, based on five factor maps for the diversity of abiotic elements, showed that the area of Dębnica River catchment, adjacent to the geopark from the north, is characterized by low and medium geodiversity value.

In this article twenty-one geosites have been described; they are situated along, or in the closest vicinity of five geotouristic paths: the Wogra River Valley and the Vicinities of Połczyn-Zdrój, the Five Lakes Valley, the Morainic Hills of the Water Divide of the Drawa and Dębnica Rivers, the Dębnica River Valley, and Połczyn Switzerland. The chosen geosites represent both the heritage of unanimated nature and the culture of the Drawskie Lakeland.

The relief of the planned geopark owes its outline to the last glaciation. Its glaciomarginal zone is unusually varied here, both as regards its forms and its deposits, which provide a record of the various geomorphological occurrences during the Pomeranian phase of this glaciation. Moreover, also other abiotic elements of the environment are diversified here, namely: the area's soils, climate, surface and underground waters. Those aspects of human activity which directly refer to the usage of the existing resources of the abiotic heritage cannot be forgotten, too. The substantial diversification of the surface has influenced the lives of the inhabitants of the region since the most ancient times. Inaccessible places offered the feeling of security; postglacial deposits became the main construction material, while streams, flowing from the plateau like the mountain rivulets, propelled the watermills' wheels. According to the definition announced by e.g. Kostrzewski (1998), Zwoliński (2004), Gray (2005, 2013, 2018), Coratza et al. (2018), Reynard and Brilha (2018), Kubalíková et al. (2021) and Pasquaré and Bonali (2021) it may be safely stated that the land of Drawa and Dębnica rivers is typical of an area with a high geodiversity. The geotouristic potential of this region has concentrated around the extraordinarily differentiated young glacial landscape (compare with Jamorska et al. 2020). Bigger and bigger demand for the cognitive and educational aspects of tourism on the side of the receiver – not a mass tourism but individualized as regards the needs and interests of the individual – causes that this potential is going to be, and already repeatedly is, a stimulus for a balanced social and economic development of a place or a region. Good cooperation of all self-governmental units is obviously necessary. Without the commitment, or on the contrary with a dislike toward mutual activities, the development of tourism may slow down. Let us hope this will not happen to the communes of the Drawskie Lakeland.

The presented descriptions of geosites and geotouristic paths offer interested (geo)tourists answers to the questions: when, why and how elements of the unanimated nature of the land of the Drawa and Dębnica rivers – which fascinate with their beauty, diversity of forms as well as their uniqueness – originate. A tourist will be given more information purchasing the publications promoting values of the planned geopark and popularizing knowledge about the geological structure of the region.

It must not be forgotten that the results of geodiversity analysis can play a significant role in forecasting a holistic and integrated approach to (geo) ecosystems and geosystem services supporting the sustainable management of natural systems, creating (geo)tourism products (e.g. Burlando et al. 2011, Górska-Zabielska, Kamieńska 2017, Górska-Zabielska, Zabielski 2017, Brilha et al. 2018, Albani et al. 2020, Frey 2021) or conscious management of protected areas and geoheritage, (e.g. Reynard, Brilha 2018, González-Amuchastegui, Serrano 2018, Štrba et al. 2020).

Summing up, establishing the geopark Post-Glacial Land of the Drawa and Dębnica Rivers should be emphasized as a good contribution to the effective protection of geological heritage thanks to the efficient securing of geosites, the broad promotion of geological sciences as well as propagating of their educational and touristic functions. The geopark will be a beneficial alternative to the mass tourism and a supplement to the medical tourism.

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