THE DEVELOPMENT OF GEOTOURISM AND GEOEDUCATION IN THE HOLY CROSS MOUNTAINS REGION (CENTRAL POLAND)

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Abstract: The development of geotourism in the Holy Cross Mountains region has a long tradition based on the scientific and educational geological values of this area. In order to evaluate geotourism resources and their development in three representative areas of Świętokrzyskie voivodeship – the Holy Cross Mountains UNESCO Global Geopark (GGp), the central part of the Holy Cross Mountains and the Kamienna River Valley – a review of the literature and statistical data, and field studies of geosites and educational units were carried out. The Holy Cross Mountains UNESCO GGp is a first-rate geotourism region, which plays a leading role in geotourism and geoeducation, promoting geological values and infrastructure development. The central part of the Holy Cross Mountains and the Kamienna River Valley are classified as second-rate regions. The remaining areas of Świętokrzyskie voivodeship, with its unique geodiversity and biodiversity, are still waiting for their geological attractions to be discovered and shared with the broader public.

Key words: geotourism development, geoeducation, geoheritage, geodiversity, the Holy Cross Mountains region

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Introduction

The Holy Cross Mountains region is famous for its beauty originating from its diversified landscapes, with the Holy Cross Mountains at the forefront and as a main feature at its centre. The natural and cultural landscapes are a result of complex geological structures, landform evolution and centuries-old mining traditions, as well as rural landscape changes that are an effect of long-lasting settlement in the Holy Cross Mountains region. According to tourists and representatives of the tourism industry, the region's landscapes are the main reason for tourists to visit. What is more, Świętokrzyskie voivodeship is a good place for discovering history and geotourism, and is interesting in terms of nature and active recreation (Smętkowski et al. 2021). The geological uniqueness of the Holy Cross Mountains stems from the occurrence of Lower and Upper Palaeozoic, Mesozoic and Cainozoic sedimentary rocks modified by the Caledonian, Variscan and Alpine tectonic movements, which has resulted in a heterogeneous geological structure.

According to Statistics Poland, about 65% of Świętokrzyskie voivodeship is under different types of nature protection, twice as much as the average for the whole country. Geotourism development in this region is based mainly on exploitation and post-exploitation sites and natural

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exposure – protected geosites in the form of the Holy Cross Mountains UNESCO Global Geopark (GGp), the Holy Cross National Park, landscape parks, numerous Natura 2000 areas, and protected landscapes, as well as nature reserves, natural monuments and documental sites. Visitors can become acquainted with the geological structure of this region in educational institutions, by visiting geological objects, following educational paths and geotourism trails, or taking part in thematic events. Next to the development of tourism, the unique geological history of the Holy Cross Mountains, widely described in scientific papers, is also the main reason for current scientific research and students' field trips. Numerous studies and geotourism guidebooks are devoted to various aspects of the region's geology (Kotański 1959, 1968, Stupnicka, Stempień-Sałek 2001).

In the Świętokrzyskie region, we can distinguish three main areas important from the point of view of geotourism: The Holy Cross Mountains UNESCO GGp, The Holy Cross Mountains (central part) and the Kamienna River Valley. In 2011, the main geotourist route was built through the most representative and valuable geological objects of the three above-mentioned regions – The Holy Cross Archaeo-Geological Route. The second thematic motor trail – The Holy Cross Path of Technical Monuments – was opened in 2020 and is devoted to post-industrial sites connected with the mining, metallurgy and other industries. This trail also comprises geological sites located in the area in question.

The main aim of this article is to describe the geotourism development and attractiveness of the most majestic areas in the Holy Cross Mountains region, which are valuable from the point of view of geotourism.

Geotourism development in the Holy Cross Mountains UNESCO GGp

The first essential stage of geotourism development and the aerial form of protecting geoheritage, geodiversity and biodiversity in this region came with the establishment of the Chęciny – Kielce Landscape Park in 1996 (Urban, Wróblewski 1999, 2004, Wróblewski 2000). In 2003, the first Geoeducation Centre in Poland was built there and in 2007 it was renamed as Geopark Kielce. Since 2021, this has been the main administrative institution of the geopark. In 2021, the geological values of the Holy Cross Mountains region were internationally appreciated by establishment the Holy Cross Mountains UNESCO GGp (Wróblewski 2021). The Holy Cross Mountains UNESCO GGp was established in order to protect, manage and promote both geological and cultural resources in the towns of Kielce and Chęciny and their surrounding areas (Poros et al. 2021).

This area represents the diverse geological, tectonic and geomorphological heritage in the following forms: outcrops of interesting geological formations of Middle and Upper Devonian limestones; dolomites and marls representing mainly biogenic deposits of shallow seas; outcrops of tectonic forms representing Caledonian, Variscan and Alpine movements; hydrothermal veins with calcite-barite-galena mineralisation and copper ore deposits; numerous remnants of historical mining and quarrying; numerous karst forms representing Permian-Triassic and Cainozoic terrestrial periods; and Quaternary deposits and glacial forms of relief ridges (Urban, Wróblewski 2004, Wróblewski 2014).

The most important geosites adapted for geotourism purposes are the post-exploitation areas located within Kielce's borders protected in the form of geological nature reserves: Wietrznia (inactive mining area after Devonian limestone and dolomite extraction, geoeducational centre, educational trail); Kadzielnia (Devonian limestones, tectonic forms, numerous fossils and karst forms, numerous caves, underground route, educational trail); Biesak-Białogon (outcrops of Cambrian and Ordovician rocks, tectonic forms); Karczówka (Devonian limestones, historical lead ore mines, educational trail); the Jan Czarnocki Rock Reserve Ślichowice (exposed folded layers of Upper Devonian limestone with representative tectonic folds, traces of mining, information boards). Outside the city limits, educational functions are played by nature reserves: Góra Rzepka with the European Centre of Geological Education (ECEG), with its elevation made of local stone and an educational trail (Devonian dolomites, historical lead ore mines, calcite veins, palaeokarst); Góra Miedzianka with educational trail and museum opened in

2008, devoted to copper mining traditions (rocky hill ridge formed of Devonian limestones, caves, Pleistocene glacial accumulation); Góra Zelejowa with its newly opened geotourism trail (Devonian limestones, hill ridge with recent karst karrens, calcite veins, Variscan/Alpine discordance, palaeokarst); Moczydło (Devonian limestones, historical lead ore mines, karst); Chelosiowa Jama (Devonian limestones and Permian/Triassic clastics, Variscan/Alpine discordance, Permian–Triassic and Cainozoic palaeokarst, and one of the longest caves in Poland, the Chelosiowa Jama–Jaskinia Jaworznicka, with its unique calcite forms); Milechowy (rocky crags formed of Jurassic limestones, caves); Góra Żakowa (Devonian limestones, open shafts of historical lead ore mines) and Paradise Cave, with the most recognisable cave in Poland, developed within Devonian limestones, where Late Pleistocene palaeontological findings and archaeological artefacts were found and exposed. In 2022 alone, the Paradise Cave received 105,729 visitors.

In 2022, as many as 556,078 tourists visited Geonatura Kielce sites, which placed this educational unit among the leading tourist organisational units in the region (Geonatura 2023). The most famous geological attractions of the Holy Cross Mountains UNESCO GGp are the Kadzielnia nature reserve, with its underground route, the Geoeducational Centre with Wietrznia nature reserve, Ślichowice nature reserve (Fig. 1) and the Botanical Garden.

Apart from the Geoeducational Centre of the UNESCO GGp, the geological merits of the Holy Cross Mountains region are presented in the branch of the Polish Geological Institute located in Kielce. At the Jan Kochanowski University of Kielce, a lapidarium with a collection of Upper Devonian limestones, Late Permian Sigismundus conglomerate, Lower Triassic sandstones and Upper Jurassic limestones, Scandinavian erratic boulders and other kinds of the Holy Cross Mountains region rocks (50 specimens) have been open for science workshops and open-air lessons with students and school children since 2019 (Górska-Zabielska 2021). Palaeontological findings gathered mainly by the famous regional geologist Jan Czarnocki (1889–1952) are accessible to tourists in the National Museum in Kielce.

Regional resources of industrial, building and decorative stones, as well as iron, copper

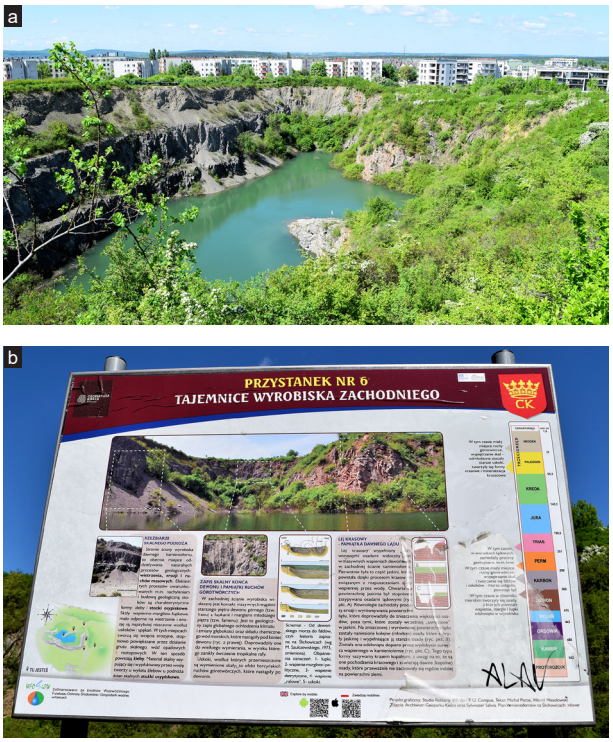

Fig. 1. Ślichowice nature reserve: a – general view of the site and b – example of an information board explaining the geology of the inactive Upper Devonian limestone quarry.

and lead ore mineral deposits, formed the basis for urban and economic development. Kielce city was built using easily accessible diversified stones (Jędrychowski 2008, 2014, Wróblewski 2012, Barcicki 2014, Złonkiewicz, Fijałkowska-Mader 2018a), whereas Chęciny's wealth and development from the 16th to 19th centuries was due to the local mining activity (Kalina 2009, Wardzyński 2014).

The most popular geo-events organised at the Holy Cross Mountains UNESCO GGp region are Kielce Geological Picnics, Lead Melts at the Kielce Countryside Museum in Tokarnia, Chałupkowe Garncynki in Chałupki, the Mining Picnic in Miedzianka, the Mining Picnic in Nowiny and the Open Days of the Mine Nordkalk Miedzianka.

Geotourism development in the central Holy Cross Mountains region

The Central Łysogóry range and encircling areas of the Holy Cross Mountains are protected as a national park rich in diversified geosites. These are regions geologically predisposed for

geotourism development and the creation of a geopark (Fijałkowska-Mader, Malec 2013, Urban et al. 2020). Being one of the oldest areas of geological research, it is also one of Poland's oldest places of worship. Situated on Łysa Góra summit, it is visited by 300,000 pilgrims annually, and is connected with the relics of the Holy Cross housed in the Benedictine Monastery (Święty Krzyż 2022).

Interlocking geological and cultural merits are the result of numerous exhibitions of Cambrian and Younger Palaeozoic rocks, a metallurgy centre developed in Roman and historical times, as well as landscape evolution based on glass production in Huta Szklana and forest management as an effect of encroaching settlements, whose traces were recorded on the slopes of the mountains (Orzechowski 2005). Visitors can acquaint themselves with the geological history and human activity in the Natural Museum of The Holy Cross National Park, situated in the monastery building (geological structure development from the Palaeozoic to the Cainozoic era, palaeontology, landscape evolution), as well as in Nowa Słupia museum, modernised and opened to public in 2021, with exhibitions devoted to the ancient metallurgy centre (Fig. 2). Dymarki Świętokrzyskie as a regional branded tourist geoproduct has been organised since 1967 in Nowa Słupia in order to reconstruct the settlement of the ancient metallurgy centre and its everyday customs, especially demonstrations of smelting iron in a primitive smelting furnace and the advance of the Roman and barbaric legions.

Numerous legends are connected with the geological sites of the Holy Cross Mountains region and these are presented together with tourism resources in the Park of the heritage of the Holy Cross Mountains Łysa Góra, which is located next to the metallurgy centre. Visiting the Medieval settlement in Huta Szklana, tourists can move back in time into the world of the settlement, its beliefs, everyday customs, professions and legends. The local private museum named The Mysteries of Jewels, located in Święta Katarzyna, offers tourists its own collection from over the world, and wares and workshops connected with jewellery production.

The most valuable geological sites are the natural outcrops and the viewpoint on the boulder field of Upper Cambrian quartzite sandstones from the Wiśniówka Formation at Łysa Góra summit (112,752 visitors in 2022), the monastery buildings (stones in architecture), and pagan ramparts built of the same rocky Cambrian material around the monastery (Szczepanik 2015). Boulder fields are located also within the national park limits on Łysica summit and bear witness to Pleistocene climate change.

According to statistics compiled by the national park every year, the Holy Cross Mountains are visited by around 250,000–350,000 domestic and international tourists (organised groups, pilgrims, individual tourists), which makes this region a branded tourist geoproduct (Dryglas, Miśkiewicz 2014).

Fig. 2. Mieczysław Radwan's Museum of Ancient Metallurgy of the Holy Cross region in Nowa Słupia: a – virtual reconstruction of the slag-pit furnace and b – 3D cinema displaying the movie Genesis of Iron.

Geotourism development in the Kamienna River Valley

The Kamienna River Valley separates morphologically different landscapes, among other the varied loess relief of the northern periphery of the Sandomierz Upland and the moraine landscape situated north of the river valley (Jersak 1965). The geological settings and geodiversity of this region are connected with Devonian, Triassic, Jurassic and Quaternary sedimentary rocks of the north margin of the Holy Cross Mountains, represented by numerous palaeontological, mineralogical and tectonic geosites (Pieńkowski 2008). Although proposals for establishing a geopark within this region have appeared and a ready plan for establishing a geopark also exists, the lack of agreement between local authorities and plot owners prevents its establishment. Since 2013, when a letter of intent was signed, no actions have been undertaken to include this region in the network of geoparks. Cultural merits are connected with early settlement development from the Palaeolithic to the Roman period, represented by numerous archaeological sites distributed along the main escarpment and confluences of the Kamienna River Valley, especially within the Sandomierz Upland and the Iłża Foreland; the development of an industrial area based on locally extracted iron resources in Roman times within the Holy Cross Mountains region, and a Romanesque, medieval and later settlement. Mining and metallurgy traditions were revived in the 19th and 20th centuries and continued along the Kamienna River Valley, where the Old Industrial Centre developed. The post-industrial sites of Old Polish Industrial District are well preserved and protected in the form of the thematic motor trail The Holy Cross Path of Technical Monuments opened in 2020, among other forms of preservation.

The most famous geological attractions of this region are Jura Park in Bałtów and Krzemionki flint mine. Europe's biggest neolithic flint mine, in 2019 Krzemionki was listed on the UNESCO Heritage List and its post-industrial landscape preserves traces of surface and underground mining activity. As the first regional educational institution, it has been promoting the archaeological and geological heritage of the Kamienna River Valley since the 1950s. However, at present it is not as popular as the commercial Jura Park in Bałtów. The latter is the first Jurassic park in Poland, opened to tourists in 2004 after the discovery, exposure and broader promotion of areas of palaeontological and geological value, especially dinosaur footprints (Gierliński, Sabath 2002, Pieńkowski 2008, Gierliński et al. 2009). Geotourism functions are implemented in the Jurassic park with models of dinosaurs, in palaeontological and geological exhibitions at the Dinosaur Museum, prehistoric oceanarium, ex-situ footprints exposed within the park area and in-situ Jurassic footprints developed for tourists in the Żydowski Jar gulley (Fig. 3).

Fig. 3. Jura Park in Bałtów: a – Saltazaur model and b – an educational board devoted to different species of dinosaurs.

The first Polish Jura Park in Bałtów was a milestone which initiated commercial geotourism development in the country. It is one of the most popular tourist sites in the whole voivodeship and for several years has ranked among the leaders of the tourism industry. In 2022, it was visited by 515,000 tourists, again gaining the first place.

Palaeontological findings with the collection of Permian, Triassic and Jurassic reptile footprints from geosites such as Sołtyków, Wióry, Baranów and Kopulak, as well as geological collections,

are exhibited at the Jan Pazdur Ecomuseum in Starachowice (Mizerski, Szrek 2017) (Fig. 4), as well as in-situ in the Świślina Valley, the right-hand confluence of the Kamienna River, where a new geoeducational path and guidebook have been developed for tourists (Fijałkowska-Mader, Szadkowska 2021, Fijałkowska-Mader et al. 2022). This collection of fossil tracks is among Europe's biggest.

Fig. 4. Palaeontological exhibition exposed at the Jan Pazdur Ecomusem in Starachowice: a – general view on exhibition, b – general view on exhibition, c – model and footprints of Dicynodontipus from Wióry, d – a footprint of Cryolophosaurus from Sołtyków.

Since the Romanesque period, several stonework centres connected with the Triassic and Jurassic sandstones were developed along the Kamienna River, especially in Kunów, Wąchock (Fig. 5), Doły Biskupie and Nietulisko, which became the main source of stone for local and regional architecture, as well as for stately buildings in the capital city (Urban, Gągol 1994, Gałka 2014, Fijałkowska-Mader et al. 2022). In order to commemorate the 700-year tradition of stonemasonry in Kunów, local authorities are planning to build Kunów Land Museum in the old granary building.

The most popular geoevents which promote the geological, archaeological and cultural resources of the Kamienna River Valley are the Archaeological Picnic in Rydno, Iron Roots

Fig. 5. Romanesque stonework in the Cistercian monastery in Wąchock: a – window of the chapter house from the side of the cloister, b – interior of the chapter house.

at Jan Pazdur Ecomuseum in Starchowice, Archaeological Festival in Krzemionki and the Jurassic Picnic in Jura Park in Bałtów.

Discussion

The Holy Cross Mountains UNESCO GGp in Świętokrzyskie voivodeship is regarded as a first-rate geotourism region (Rogowski 2016, Gałka 2019). It owes its development to its varied geological structure, represented by numerous geosites, diversified natural and anthropogenic landscapes, tourism infrastructure, close cooperation among regional and local authorities, governmental and non-governmental organisations, local institutions, private persons and bottom-up initiatives. Without doubt, the Holy Cross Mountains UNESCO GGp region plays a leading role in geotourism development and the promotion of the geological and cultural value of Świętokrzyskie voivodeship through wide-ranging educational and recreational activities. Geotourism development also provides measurable financial benefits through creating new jobs, generating income and developing the infrastructure.

In the Holy Cross National Park and its surroundings, geotourism development is limited mainly to the Łysogóry Range and its immediate environs, where only representative geosites are well exposed and equipped with information boards that are accessible and understandable for ordinary tourists. The rest of the palaeontological, geomorphological, palaeoenvironmental, petrographic, stratigraphic, tectonic, historic and landscape geosites are visited as a part of field studies, scientific conferences and workshops, but usually by tourists traversing mountain trails. The geotourism potential of the above-mentioned sites could be harnessed effectively through creating the proposed Łysogóry Geopark in the Holy Cross Mountains (Fijałkowska-Mader, Malec 2013, Urban et al. 2020). A similar proposal for a geopark in the Kamienna River Valley has the potential for good development only within the most valuable geosites, which are usually peripherally located. There is still much to be done in terms of the transport network, gastronomy and accommodation infrastructure. These geoparks could be classified as second-rate geotourism regions (Rogowski 2016, Gałka 2019).

In the Holy Cross Mountains region, apart from the UNESCO GGp, the proposed Kamienna River Valley Gp and Łysogóry Gp, there are two other geoparks: first, Tetrapod's and Skamieniałych Wydm (Petrified dunes) and second, Białe Ługi with unique outcrops of Palaeozoic and Triassic rocks, which underline the geological uniqueness of this region (Trela, Fijałkowska-Mader 2013). Local and international scientists believe that geotourist paths could be created here to display the geodiversity and geoeducational value of the Holy Cross Mountains. There are some good examples of such products, for example, the small Łagowica valley, where the creation of a geotourism trail was proposed (Ludwikowska-Kędzia, Wiatrak 2020), the aforementioned, newly opened geological trail in the Świślina River Valley (Fijałkowska-Mader, Szadkowska 2021), or the world-renowned Zachełmie geosite (Złonkiewicz, Fijałkowska-Mader 2018b).

The geological attractiveness of Świętokrzyskie voivodeship is not limited only to the Holy Cross Mountains region. There are many regions with valuable geodiversity and biodiversity, where geotourism development is still in its infancy or even does not yet exist at all. Good examples are the outcrops of the Miocene rocks of the Carpathian Foredeep, mainly gypsum and limestone occurring within the Nida Basin exploited in Gacki and Pińczów quarries, Skorocice nature reserve, the health resorts in Busko-Zdrój and Solec-Zdrój, the loess cover of the Sandomierz Upland and numerous other geosites located within the Palaeozoic–Mesozoic boundary areas of the Holy Cross Mountains.

Conclusions

The Holy Cross Mountains region is regarded as one of the finest geotourism regions in Poland. Geotourism as geology-based cognitive tourism, alongside sightseeing and active tourism, is a leading branch of the tourism industry in this area.

The Holy Cross Mountains UNESCO GGp plays an important geoeducational role. Moreover, Kielce is the only urban area in Poland possessing a geoeducational centre and geological reserves, as well as an underground route adapted for educational and tourism purposes. Numerous

examples of buildings and decorative regional and local stones used in the architecture of Kielce and its surrounding towns reflect geological setting of the Holy Cross Mountains region, and at the same time, along with natural and artificial exposures, these constitute the base for the development of urban geotourism.

Centuries-old mining and industrial traditions based on locally extracted resources have shaped the contemporary cultural landscape, where geological sites are naturally integrated with urban and rural areas. Nowadays, these valuable remnants of the mining heritage are the main geotourism destinations protected as monuments to nature and culture.

New investments in geoeducational units, such as the museum in Nowa Słupia, where metallurgy traditions are presented, the new archaeological exposition in Krzemionki flint mine, or the Nidarium in Umianowice, a centre devoted to the Nida River, the heritage park of the Holy Cross Mountains Łysa Góra, planned educational centre of the Holy Cross National Park in Nowa Słupia, the centre of stonemasonry in Kunów and the modern copper centre in Miedzianka all show that there is a growing demand for these kinds of educational services, as well as for the promotion of environmental and cultural values and the preservation of the regional geological heritage and traditions for future generations in the Holy Cross Mountains region.

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