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# Archeogeological Trail



The Świętokrzyskie Mountains is a unique location on the geological map of Poland. Here, in a comparatively small area, one can find rocks illustrating the geological history of how the region of Central Europe was formed during the last ca. 544 million years - that is - since the beginning of the Paleozoic era. The mineral sediments record the changes in the organic world. The creation of sea sediments, over 10 seas, was interrupted by emersion, erosion and the formation of sediment on land. The processes that took place during the transformation of these sediments into rock complexes that totalled several thousand meters can be observed. Traces of tectonic movements from four orogenies can also be found. They led to the uplift of terrain and the folding of rock layers. They are responsible for the formation of berms, i.e. faults in the earth's crust in relation to which the rock masses were displaced. This applies to faults as deep as several hundred meters as well as „small” surface cracks no deeper than several meters. The crevices of the faults were used by the hot, mineralized hydrothermal waters that got out of the interior of the earth's crust. From these waters minerals crystallized, mostly common ones, but of highly regarded decorative and ore-bearing values. In several regions the crevices were filled with volcanic rocks uncommon in our region.

Traces of dinosaurs and fossil reptiles that have been discovered in the last decades, especially the traces of the tetrapod - the oldest four-limbed animal to walk on land - make Świętokrzyskie Mountains all the more unique. When the first humans arrived in the region, the Świętokrzyskie Mountains proved to be a real treasury for them. The oldest traces of human settlement date back to 50 thousand years ago, when the nomadic hunters inhabited the Raj cave and the valley of the Kamienna river. The occurrence of resources

important in the culture of the primitive people - such as haematite and flint or iron ore, copper and lead which were sought after in the later ages - became, in addition to agriculture, an important reason for settling in this region. Both the Łysogóry and the Kielce-Chęciny regions constitute one giant book about the mining of resources accumulated in this region. Traces of mining activity can be found everywhere. These are old excavation sites where lead was once mined, dormant adits, marble quarries or mining tunnels that cut through whole hills.

Many of the resources found in the Świętokrzyskie region are a recognizable landmark of our region. The most noteworthy of these are striped flint, limestone and dolomite, also known as „Kielce marble”, as well as lead and copper ore. Veins of magma rocks are related to uranium deposits which were once mined here. A new symbol associated with the Kielce region is the tetrapod, whose footprints were found in Zachemie near Kielce.

With so many unique sites of enormous educational value it was decided that they should be promoted by the creation of the Archeogeological Trail. The idea to create the trail is expected to improve what the region has to offer for the new and rapidly developing form of active tourism - geotourism. The trail encompasses sites that have been gems on the region's tourist maps for years as well as museum expositions and other places where geological knowledge is being promoted.

A special place on the trail is the Geoeducation Center that is being erected next to the Zbigniew Rubinowski Wietrznia rock reserve in Kielce. This site, whose custodian is Geopark Kielce, will also be the site of the exposition on the history of the planet Earth recorded in rock and the main centre for general geological education in the Świętokrzyskie region.

The archeogeological trail begins in the north-eastern part of the Świętokrzyskie region starting from Bałtów Jurassic Park, Krzemionki and leads through the lands of the tetrapod and Kielce to the Chęcińsko-Kielecki Landscape Park, which has all the characteristics of a geopark. Let's get to know these places.



# Archeogeological Trail

# BALTÓW



Źródło: Archiwum ROT WŚ

We can reach this location by going north-west from Ostrowiec Świętokrzyski, taking the road to Solec nad Wisłą. Baltów will greet us with its picturesque location in the gorge of the Kamienna river, between the calm, winding river and the lofty white calcareous rocks from the late Jurassic period. Their resemblance of the rocks found in the small valleys near Cracow is not coincidental; they are the sediment of the same sea, they represent the same age (ca. 160 million years) and a very similar type of sediment. The calcareous rock walls on the banks of the Kamienna river valley are intertwined with small valleys, which in their higher parts cross over to picturesque, dark gorges and ravines that are often cut out in Pleistocenian loess that was formed in the last tens of thousands of years.

The idea of creating the Jurassic park at this location stemmed from the karst structures found here which resemble the footprints of dinosaurs. Even though research indicates that, due to the depth of the Jurassic sea located here at the time, dinosaurs could not have made any footprints, they surely visited this place after the sea had withdrawn, only several million years later. The Jurassic Park located in the Kamienna river valley has a collection of models of organisms that inhabited the earth throughout its history. The most impressive of these is a group of dinosaurs. The replicas were made with great accuracy and

attention to detail and illustrate the high variety and gradual development of this animal group in the different geological periods. In the Jurassic Park we can also see a unique collection of minerals and fossils as well as a collection of rock chunks with authentic early-Jurassic dinosaur footprints that were found near the town of Szydłowiec.

The Baltów park is a place of high educational value that captures the imagination not only of the younger visitors. In addition to learning about the world of the dinosaurs one can also visit the zoological garden which is located in very interesting terrain and offers professional guided tours, take a raft or a canoe down the Kamienna river, ride horses or ski. The Baltów Jurassic Park operates under the patronage of the Polish Geological Institute.



Źródło: Archiwum ROT WŚ



# KRZEMIONKI

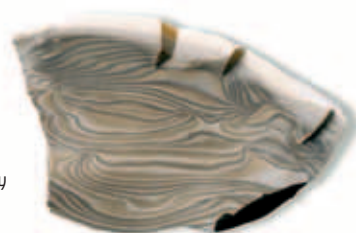


fol. Archiwum ROT WŚ

To see the site where the largest amount of striped flint was mined we head to Krzemionki, 8 kilometres north-west of Ostrowiec Świętokrzyski. The Krzemionki mines were discovered in 1922 by the renowned geologist Jan Samsonowicz. The tunnels that are open to visitors are just a part of several thousand sites found in this location and, spanning 460 metres, are the largest museum route of this type in Europe. Here one can observe the mining techniques used by neolithic miners 5 - 1.6 thousand years ago. Striped flint had been a much sought after mineral for the last millennia. Its exceptional hardness, ways it can be cleaved and the possibility of producing thin, sharp chips made it the material of choice for producing all kinds of tools - axes, scrapers, arrowheads and spearheads.

Local limestone that bears flint concretions formed in the late Jurassic period (157-155 Ma), at a time when dinosaurs were at the height of their development. Calcareous mud, which was compacted into hard limestone settled in the shoals at the coast of a shallow sea, in conditions similar to those found today off the coast of Florida. The tunnels that shrimp bored in the calcareous mud were filled with substance rich in silica. What followed was a series of long chemical processes that led to the formation of flint.

Items made of striped flint were not only tools of everyday use but also magic items or insignia of power and strength. They are often found in graves



Krzemień pasiasty  
fol. P. Pierściński

as a sign of the owner's high social status. Recently, there has been a renewed interest in striped flint. It has been called the "optimism stone" or the "Świętokrzyski diamond". This time it is making its appearance as a jewellery stone worn throughout European fashion centres.



## WĄWÓZ W SKAŁACH

Wąwóz w Skalach is located north-east of Nowa Słupia. We arrive there by turning west in Czajęcice, leaving the road that connects Waśniów with Nowa Słupia. After driving ca. 2.5 km, we turn left, taking a narrow road leading to a dormant quarry. In the past it was a mining site for middle Devonian dolomites (395 million years old), similar to those found in the famous Zachętnie. Just beside the excavation are two places that cannot be missed when visiting the Kielce region.

One of the most charming places in the Świętokrzyskie Mountains - the "Wąwóz w Skalach" ("Stone Canyon") reserve is located nearby, on the south-eastern side of the quarry. On the sides of the canyon one can observe steep slopes of dolomite layers. On the surface of what was once the bottom of a sea, weathering has exposed domed colonies of cyanobacteria. The sides of the canyon are covered with xerothermic vegetation, which is very adaptable and can thrive on the calcareous substratum. In some places, white rock outcrops peep out from behind the plants, and a small stream at the bottom of the valley tops up the impression of a "magic spot". The other site is located between the quarry and the canyon, on the bank of the small river Dobruchna. Here, one can observe exposures of limestone and marl (rocks that are an intermediate stage between limestone and loam) that are younger than dolomites (by 1-2 million years) and are extremely rich in fossil fauna, including Anthozoa, Trilobites, Crinoidea and, most importantly, Spiriferid Brachiopods. This site has been a proving ground for geologists dealing with palaeontology - the science related to the study of extinct organisms and stratigraphers, who group rock layers into formations composed of rocks that have similar age and formation characteristics. By comparing the rock formations they can recreate the geological history of a given region.

## NOWA SŁUPIA

The town is located at the foot of Łysa Góra, halfway between Kielce and Ostrowiec Świętokrzyski. This town, together with the adjoining village of Rudki is considered the cradle of metallurgy in the Świętokrzyskie region.



Fragment kłosa żuźlowego - pozostałość po wytopie żelaza w prymitywnym piecu tzw. dymarce.

The ancient "ironworks" started producing iron in the 2nd and 1st century BC and reached the height of development in the 3rd and 4th centuries AD. The traces of ancient furnaces - bloomeries i.e. single-use furnaces for smelting of iron, can be seen at the Mieczysław Radwan Museum of Ancient Metallurgy in Nowa Słupia. 300 thousand bloomeries have been discovered in this region. The furnace is made of clay with added chaff and filled with alternating layers of ore and charcoal. Bellows were also used in the smelting process. This method was brought to the foothills of the Łysogóry mountain range by the Celts. The smelting of such large quantities of iron was possible thanks to the existence of rich iron ore deposits in this area.

The museum, located at the foothills of the Świętokrzyski National Park is accompanied by the famous "Pilgrim" also known as "Emeryk" - a statue cast in stone, whose origin and date of creation are a mystery.





# GOŁOBORZE



fol. P. Pierściński



fol. P. Pierściński

Gołoborze is one of the most recognizable landmarks of the Świętokrzyskie Mountains. One can reach it by taking the Royal Road from Nowa Słupia to Łysa Góra or from the other side, starting at Huta Szklana. The peaks of Pasma Główne (Main Range) are formed from banks of hard Cambrian quartzitic sandstone (ca. 500 million years of age).

Gołoborza are rubble-block sheets and stone runs covering the sides of a hill. They were formed in the Pleistocenic epoch (in the last 1 million years). In the glacial periods, during the subsequent glaciations, the Scandinavian glacier had not always covered the highest parts of the Świętokrzyskie mountains. The rocky ridge of the Łysogóry Range, as a so-



called "nunatak", rose above the endless glacier. The sandstone that formed the ridge weathered and was submitted to fragmentation in the harsh periglacial conditions, after that it crawled down the slopes, forming characteristic sheets. Contemporary climatic conditions favour the progressive overgrowing of the stone runs. The recently built viewing terrace allows tourists to enjoy a splendid view of the Świętokrzyskie landscape.

While at Łysa Góra, visit the Święty Krzyż church-monastic complex located there, as well as the Natural Museum, where you can learn about the geological structure of the entire region, as well as about the plants and animals that inhabit it.

Another interesting landmark of Łysa Góra are the circles surrounding the sites of pagan worship dating back to 8th - 10th century that can be found in the uppermost part of the hill.



## BUKOWA GÓRA



We reach this location by driving north along the Kielce-Radom road. In the town of Łączna we turn south-east and go through Zaskale to the village of Zagórze. We reach the north-eastern limits of Bukowa Góra where a large excavation site can be seen against the forest background. "Bukowa Góra" is one of the largest operating quarries in the region. It mines quartzitic sandstone that formed in the shallow early-Devonian sea (ca. 400-407 Ma). In the upper part of the quarry one can observe layers of so called "Spirifer sandstone". They bear many traces of Brachiopod - Spirifer shells, whose quantity led to the formation of a very characteristic and distinctive rock - the shell limestone.



Just under the summit, on the northern side of the hill, one can find a curiously formed row of sandstone rocks. They are preserved as a monument of inanimate nature.



# ZACHEŁMIE



fol. J. Jedruchowski

Leaving Kielce in the direction of Radom, we pass Kajetanów and after driving for another ca. 2 km we turn west in the direction of Zagnańsk. From the point where the road crosses the railway line one can see the church in Zachełmie, built from red Triassic sandstone. Just behind it, in the western part of Góra Chelmowa, a vast dormant dolomite quarry is located. Up until now it has been visited because of its contact featuring mid-Devonian dolomite with Permian-Triassic sandstone and conglomerate (395 million and 251-255 million years of age respectively) which is exposed on the northern face. This exposure is a monument of inanimate nature.

Layers of dolomites were uplifted and steeply sloped during the Variscan (Hercynian) orogeny in the late Carboniferous period (ca. 299-325 Ma). On the erosion surface of the grey dolomites, red Permian-Triassic river, lake and shallow sea sediment lies almost horizontally. Dolomites are a sediment formed in tidal plane and shallow sea areas. Vast exposures of the domed structures of cyanobacteria colonies and cracks formed during the drying of the exposed sea bottom that can be seen on the surface

of layers on the southern faces of the quarry are some of the best in the world. Once this was a site where haematite - an iron oxide with a characteristic cherry-red tint - was mined. However, what made the news in the geological milieu in recent times was the discovery of tetrapod footprints in this quarry. The discovery of the oldest footprints of the tetrapod, which was an intermediate link between fish and four-legged animals, led to the shift of the estimated date of vertebrates coming out of the sea by ca. 18 million years back. This could be determined because conodonts - jaws of primitive Chorea that are considered index fossil - were also found in the rock. Index fossils refer to short lived species, whose finding allows to determine accurately the age of the rock.

The fact that the footprints of the tetrapod were found here, in Zachełmie, affirmed our region's status as a "geological paradise" of European importance. Next to the "Bartek" oak tree (the oldest tree in Poland) in nearby Bartków, the old quarry in Zachełmie has a chance of becoming another gem on the map of tourist attractions of the Świętokrzyskie region.



## GÓRA GRODOWA - KAMIENNE KRĘGI

This site can be reached by taking the road from Kielce to Łódź and turning north in Miedziana Góra in the direction of Samsonów. In the middle of the village of Tumlin we turn west and take the road leading to the peak of Góra Grodowa. We arrive at the archaeological-geological-forest reserve of "Kamienne Kręgi" ("Stone Circles"). In the 8th and 9th centuries this was a site of pagan religious cult. The remaining fragments of earth and stone circles are testimony to that. It is also supposed that an early medieval castle was located at the top of the hill. The northern part of Grodowa Góra is occupied by the Tumlin – Gród quarry, one of the oldest still operational quarries in the region. The mineral mined here is the red Triassic (250 Ma) "Tumlin sandstone", which can often be found on elevations of buildings and stairs. Also worthy of note are the characteristic rock beds that can be observed on the faces of the quarry. They indicate that these sandstones are a sediment of fossil dunes. Colonies of small streams and mid-dune ponds can also be found here. These are indicated by the abundance of ripple marks and signs of desiccation. On the surface of the layers, footprints of Triassic fossil reptiles have been found. The stones owe their rusty colour to the presence of iron compounds that weathered in the hot semi-desert conditions that prevailed in our region in the Triassic period. Sandstone blocks are cut out from the face of the excavation by driving a line of steel wedges into it. This is an old mining technique that allows to obtain large, regularly shaped stone blocks.



fol. J. Jędruchowski

## GÓRA CIOSOWA

This site is also located by the Kielce-Łódź road. We drive through Miedziana Góra and just after the last buildings we turn west for the village of Ciosowa. The quarry is located north of the road, on the slope of Góra Ciosowska. Excavation has exposed red Triassic "Tumlin sandstones" with a finely preserved layering typical for dune sediment. The quarry merges with the surrounding forest because of intensive overgrowth.



fol. Archiwum ROT WS

# KIELCE



fol. Archiwum ROT WŚ

Kielce - Kadzielnia zimą

Kielce - the capital of the Świętokrzyskie region - a true gem on the geological map of Europe, an open-air geological museum. All these terms apply to this city - a unique, unequalled site with no counterparts anywhere else in Europe. It is here that four geological reserves are located within city limits: Kadzielnia, Wietrznia, Ślichowice and Biesak Białogon, as well as one landscape reserve - Karczówka.

In the city and in a radius of 20-30 km one can observe rocks that represent the whole stratigraphic table from the Cambrian period to Pleistocene, untouched by metamorphic processes. They belong to four structural floors - rock complexes formed by the tectonic movements of subsequent orogeneses: Cadomian, Caledonian, Variscan and Alpine. In many places one can even touch the surfaces that separate the rocks of the neighbouring floors. One can observe the karst phenomena that took place during the two stages of karst formation: the Permian-Triassic and the Cenozoic.

All this is very rare not only in Poland but the whole European continent and the concentration of such phenomena in such a small area is truly exceptional.



fol. K. Pęczalski

Kielce - Kadzielnia



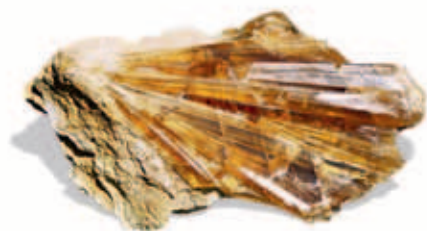
fol. Archiwum ROT WŚ

Kielce - Pałac Biskupów Krakowskich





# KADZIELNIA



Kalcyt miodowy - Kadzielnia  
fot. J. Jedrychowski

The Kadzielnia quarry is located in the central part of the city, on the left bank of the Silnica river, between the Krakowska, Pakosz and Aleja Legionów streets. During excavation work a very interesting geological profile as well as some caves and rock voids were exposed here.

Kadzielnia is the main height in the series of hillocks known as the Kadzielnia Range. In the late Devonian period (ca. 380 Ma) the area of Kadzielnia was submerged in a warm sea, periodically in the shallows, in the direct vicinity of Stromatoporoidean-Anthozoan reefs. In their fossil form, their sediment formed the "Kadzielnia

limestones". Local rocks contain a rich, often shattered fossil fauna represented by Anthozoa, fossil Coelenterata (Stromatoporoidea and Amphipora), Crinoidea, Brachiopoda, Gastropoda, Cephalopoda and Placodermi. Some of the species were first discovered at Kadzielnia, which made this exposure even more famous and earned it a place amongst the most important educational sites in Poland.

A geological reserve was created in the middle section of the excavation and the stone monolith called the "Geologists' Rock" was placed under legal protection. Miocenic (5-20 Ma) and Pleistocenic (youngest from 1.8 Ma) karst formations have also been exposed here and are some of the best preserved phenomena of this type in the country. Moreover, 14 caves have been found here, the longest of which is 140 metres long. Right now works are taking place to connect three caves - the Prochownia, the Szczelina and the Wschodnia in order to create an underground tourist route. What makes this place even more unique is the modern amphitheatre which merges with the surrounding rocks in a very interesting way and is the only such scene in Poland.



# ŚLICHOWICE

## Jan Czarnocki reserve

An interesting rock reserve with a high educational value. Located in the former Ślichowice quarry, this was the first geological reserve in Poland.

It is located in the north-western part of Kielce on the western limit of the Ślichowice residential area. In the faces of the quarry, exposed by mining work, one can observe narrow banks of limestone and marl sediment that formed in the late Devonian sea (ca. 365-385 Ma), outside the Kadzielnia reefs.

The perch that has been preserved between the eastern and the western excavation is under legal protection. It is here that a recumbent fold formed

during the tectonic movements of the Variscan (Hercynian) orogeny (ca. 251-325 Ma) was exposed. The structures of the fold can also be observed on the sides of the mining ramp that goes down to the bottom of the larger excavation and on its western face. Faults of various sizes as well as small caves are also prevalent here.

For years, the Ślichowice exposure has been a classic site used in the education of Polish geologists. Recently, the reserve was surrounded with a comfortable walking path with vantage points and the fold on its main face was illuminated with special lights so it can be admired even at night.



foto: A. Drzewiecka

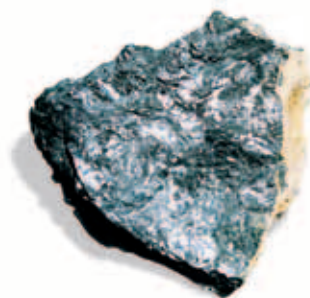


## KARCZÓWKA landscape reserve

The Karczówka hill, which belongs to the Kadzielnia Range, is located in the western part of the city, between the Bernardyńska, Podklasztorna and Krakowska streets.

Covered with a dark green forest and built of late Devonian limestone, the Karczówka hill, on which the white walls of a monastery form a crest, is the cradle of Kielce mineral mining. The whole area of Karczówka, as well as of the adjoining hills - Grabina, Dálnia and Brusznia is covered with "cracks" which are gradually being overgrown. These are the traces of prospecting and mining of nests of deposits of lead sulphide - i.e. the silver-bearing galena. Their discovery lead to the city's rapid development in the 16th and 17th centuries. In the church chapel at Karczówka one can see a unique statue made out of a single galena block. It depicts Saint Barbara - the

patron saint of miners. Two other statues were made of similar mineral blocks - one of these depicts Saint Mary and can be seen in the Lesser Basilica in Kielce and the other, depicting Saint Anthony, is located in the parochial church in Borkowice near Przysucha.



Siarczek ołowiu - galena  
fot. J. Jędrychowski



# Archeogeological Trail





# Świętokrzyskie



# WIETRZNIA

## Zbigniew Rubinowski reserve



fol. A. Drzewiecka

Wietrznia – Zbigniew Rubinowski reserve is the final height in the Kadzielnia Range and is located in the eastern part of Kielce, between the Wojska Polskiego, Daleszycka and Księcia Józefa Poniatowskiego streets.

This is the largest of the Kielce geological reserves, whose shape was influenced by mining and takes the form of a canyon surrounded by rocky faces. It consists of the adjoining excavations of Wietrznia, Międzygórz and Międzygórz Wschodni, whose total length is ca. 800 metres.

Recorded in the ca. 100 metre long vertical profile is the history of the sea's development from the end of the middle Devonian through almost the whole late Devonian period, i.e. 365-386 years ago. It is also one of the largest such exposures in Poland. The thick sediment banks that are found here were formed in a warm sea in the vicinity of a shallow shelf, a little deeper than the one at Kadzielnia, which bordered on a reef at that period. The rocky faces are dominated by limestones formed from Anthozoa remains brought from the nearby

Stromatoporoidean-Anthozoan reefs. New species of late Devonian Anthozoa have been found on Wietrznia. They are accompanied by the remains of fossil Coelenterata, Stromatoporoidea, Crinoidea, as well as shells of Brachiopoda and Gastropoda. In the sediment, the periods when the sea was less deep are recorded by a lower amount of organic remains and a larger proportion of loam, which



fol. J. Jędruchowski

Kolonia koralu

led to the formation of marl. The upper parts of the northern faces are made out of younger, narrow limestone-marl banks that were formed after a significant deepening of the late Devonian sea. The rare fossils that can be found here are represented by Cephalopoda and Placodermi remains.

The Variscan tectonic movements in the late Carboniferous and Permian periods (251-325 Ma) made a mark with the formation of faults and the folding of rock layers. Hot mineral waters (hydrothermal waters) were thrust into the crevices. From these waters colourful calcitic veins crystallized – they can be seen in some parts of the northern faces of the quarry and can contain trace amounts of other minerals (lead and copper sulphides). Near the fault crevice that cuts through the southern face of the western excavation, the hot solution rich in magnesium compounds transformed the limestone into dolomites.

In the desert climate of the Permian period (251-299 Ma) weathering covered the exposed Devonian limestone with a layer of tiny rock debris several metres thick. With time, these isolated rock fragments were cemented anew. They make up the upper parts of the southern faces of the quarry. The multi-stage Alpine tectonic movements that took place in the Paleogene and Neogene (5-65 Ma) led

to the opening of a 100 metre wide tectonic cavity that runs along the axis of the whole quarry. It was filled with rubble and debris. It can be seen in the central excavation of the quarry; in a solitary outlier (which is sometimes called the "Elephant") and on a pillar that closes this part of the quarry from the east. The specific blocks reach up to several metres in height. The numerous karstic phenomena that are exposed on the faces of the quarry represent the two stages of the Świętokrzyskie karst development (Permian-Triassic and Cenozoic) which makes Wietrznia the most varied site in the region in this respect. In addition to small caves (the longest of which reaches 60 metres in length and can be found on the bottom of the central excavation), wells, karst chimneys, and even a wide karst crater, silt deposits were formed that varied by type and colour of the sediment. The karst processes that are still taking place are forming a sinter sheet on one of the southern faces of the eastern excavation.

Due to the high educational value of the site, Wietrznia was chosen for the location of the Geoeducation Centre. The facility, which will be run by Geopark Kielce, will host permanent and temporary exhibitions covering various geological subjects and will additionally serve as a perfect spot for theme workshops, lectures, presentations and scientific meetings.



foto. A. Drzewiecka



# JASKINIA RAJ



foto: P. Pierściński

If there is any site that deserves to be called the biggest tourist attraction in the Świętokrzyskie region it most definitely is Jaskinia Raj (Paradise Cave). It is located on the northern slope of Malik mountain, which is part of the Bolechowski Ridge. To get there, one must take the Kielce-Chęciny road and turn right (west) just after passing the village of Zgórsko. The road ends with a car park located where the trail that leads to the site begins.

The cave was formed in thick-banked limestone from the middle Devonian period (390 Ma). The total length of the corridors is 240 metres, 180 of which are open to tourists. A huge contribution to the preservation and then the opening of the cave to tourism was made by Tymoteusz Wróblewski and Zbigniew Rubinowski, geologists at the Świętokrzyskie Branch of the Polish Geological Institute. Even before the cave was opened, the silt sediments had been examined. The results indicated that this place was inhabited by humans even 50 thousand years ago, that is - during the last ice age. Tools and other man-made flint items have been found at this site, which supports this theory. Climate change that has taken place since then has also been investigated. Moreover, bone remains of many species of mammals, such as the

cave bear, mammoth, cave hyena and the woolly rhinoceros, have been found in the silt. The cave isn't very extensive, but the unique speleothem formations make this cave worthy of its name - Paradise. Among these formations - which were formed due to the destructive and, subsequently, the building activity of water - one can admire: stalactites - hanging from the ceiling, stalagmites - rising from the cave floor, all types of flowstones, cave pearls, columns formed when stalagmite and stalactite meet, thin, sometimes even see-through harps, and pagodas formed from squat stalagmites. The variety and beauty of local cave formations have given this place a unique value that sets the Paradise Cave apart from other similar sites in Poland. The cave was formed as a result of karst phenomena. Karst is a type of chemical weathering of carbonate rock, such as limestone or dolomite. Rainwater and groundwater enters the rock through cracks, dissolving it. As a result, various karst dolines may be formed (chimneys, caves, wells) that sometimes reach really large sizes. On their surface, speleothem formations are formed from karst waters rich in calcium carbonate. Besides the Paradise Cave, a fragment of the nearby pine forest with vegetation typical for limestone hills is also protected under law.

## BIESAK-BIAŁOGON geological reserve

fot. A. Drzewiecka



Located on the south-eastern outskirts of Kielce in the Dyminy Range, on the slopes of Kamienna Góra, it is known to locals as "Kamionka". We can reach the reserve on foot by taking the extension of the Na Ługach street that runs through Białogon.

When visiting the Biesak-Białogon reserve, we observe the oldest rocks that mining works have exposed in the whole Chęciny-Kielecki Landscape Park and the oldest on our Archeogeological Trail. Here we can find conglomerates, quartzitic sandstones, mudstones and shale. Rocks exposed in the upper parts of the faces and in the canyon located in the northern part of the quarry are from the early Cambrian period (ca. 510-520 Ma).

In the southern and eastern parts of the quarry almost identical rocks were formed in the Ordovician period. (465-480 Ma). As a result of tectonic movements the Cambrian rocks on the northern face of the quarry slid on top of the Ordovician rocks. Another curiosity is the presence of bentonite - a sediment formed from weathering of volcanic ash in marine conditions in the Ordovician period. Its layer, which is ca. 10 centimetres thick, is located on the northern face of the excavation, just above the surface of the water that flooded the lowest section of the quarry.

This is a very charming reserve and the tall spruce and pine trees reflecting on the surface of the water create an intriguing and mysterious impression.



fot. J. Jędruchowski

## SZEWCZ QUARRY

This excavation is located in the eastern part of the Okraglica mountain. To reach the quarry, one has to take the Kielce-Chęciny road and turn westwards in Zgórsko in the direction of Szezwce. There, just before the bypass for Warsaw, we take a dirt road south and walk to the forested hill of Okraglica.

This site is one of eleven so called "ore hills" located near Chęciny. Between the 14th and the beginning of the 20th century lead and copper ore was prospected and mined here, found in crack-vein deposits.

In the Szezwce quarry a unique Devonian limestone characterized by a very interesting, sand-pink tint was mined. It was mainly used for lining and flooring. Traces of extraction techniques that were used in the past can be seen on the faces of the quarry.



fot. J. Jędruchowski

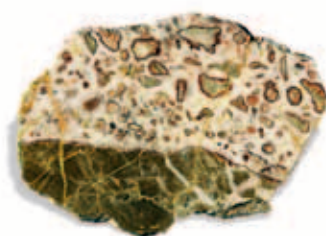
# GÓRA ZELEJOWA - reserve

The quarries on Zelejowa mountain are one of the most interesting historical mining sites. This site was famous for the "róžanka zelejowska" - calcite deposits that take on unique patterns. The white and pink calcite, coloured with cherry-red haematite and decorated with green and blue touches from copper ore, created a colour pattern unlike any other. The name "róžanka zelejowska" stems from the unique structure of the rock, where slivers of white calcite are surrounded with cherry-red haematite, creating a characteristic rose pattern. Moreover, the róžanka could be polished neatly, which made the local rock a worthy competitor to Italian marble.

The first mention of the extraction of this mineral comes from the 15th century, when the Polish historian Jan Długosz wrote: "Chęciny, a hill with a castle adjoining a town that goes by the same name, in and around it many marble mines". The oldest known products made from róžanka zelejowska can be found in the Wawel cathedral in Cracow. They can also be seen in many baroque temples not only in royal Cracow, but also in Kielce, e.g. in the details of the main altar of the monastery on Karczówka. In the local vocabulary, many limestones mined here are called "marble". This is an incorrect use of the word, as – contrary to marble – the Świętokrzyskie limestone is not metamorphic rock. What makes the "róžanka zelejowska" similar to marble is its crystal structure. However, it were not metamorphic processes that formed this crystal structure but



fol. P. Piersciński



Kalcyt typu róžanka, fot. J. Jędrychowski

hot mineral (hydrothermal) waters which flowed under pressure in the limestone cracks during the Variscan orogeny in the late Carboniferous period (299-325 Ma). The slotted post-mining excavations that were formed after extraction of the calcite cut through the limestone heights from north to south reaching ca. 20 metres of width in some places. At certain points a red or brick-coloured decomposed karst rock can be observed on the faces of the cavities. Karst waters have dissolved the limestone and removed the calcium carbonate. They left loam and rusty compounds of iron oxides, which often accumulate in karst voids.

Traces of old mining works can be observed on the faces of the excavations. Here you can see hollows cut in stone where wedges were thrust to separate blocks of "róžanka" from solid rock. At first dry wooden wedges were used for this purpose. After thrusting the wedge into the hollow, water was poured over the wedge and caused it to swell and break the stone. The last stone blocks extracted at this site were used for the siding of the columns of the museum of the Świętokrzyskie Branch of the Polish Geological Institute located at 21 Zgoda street in Kielce. The quarry ceased operation in 1954.



fol. P. Piersciński





## GÓRA ZAMKOWA - reserve

The quarry is located in the western part of Góra Zamkowa, which overlooks Chęciny. Mining works that took place in the 1940-ties have exposed almost vertical rock layers. These are narrow-banked limestones that formed in the middle and late Devonian period (375-390 Ma). The sediment from which the limestone was formed had accumulated on the bottom of the shelf of a warm, shallow sea. Rich organic life had developed there. It was, however, a somewhat deeper area than the ones exposed at Kadzielnia or Wietrznia. Remains of old organisms can be seen on the isolated limestone surface in the northern part of the quarry. Some of the rock banks are full of Brachiopoda, remains of Anthozoa and sponges. Fragments of Gastropoda, fossil Coelenterata - Stromatoporoidea and Amphipora and Crinoidea that come in various sizes can also be observed. In the middle section of the exposure, among limestones, one can see layers with hard quartzitic rock.

The whole Góra Zamkowa was once a site of lead ore mining and prospecting - many traces of old mining works can be found here. The galena (lead sulphide) that was mined here contained traces of silver. The rock layers on the ridges of Góra Zamkowa and Góra Zelejowa are steeply sloping. In the past they

had laid horizontally, as had the sediment in the Devonian sea. During the Variscan orogeny in the late Carboniferous and the Permian periods (251-325 Ma) the Świętokrzyskie region was folded. A fold was formed between the two aforementioned heights where the rock layers were strongly uplifted. The long-lasting erosion had first levelled the terrain by cutting through the Devonian rock which served as a hard shell. It then formed the vast, flat Chęciny Valley. On the edges of an old hill, the ridges made of steeply sloping Devonian rock remained and resemble fragments of a hard shell.



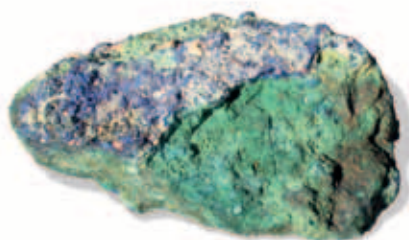
# GÓRA MIEDZIANKA - reserve



fol. P. Piersiński

Miedzianka is an old Polish name for copper ore. The "Góra Miedzianka" reserve is located within the limits of the Chęciny-Kielce Landscape Park. It can be reached by taking the road that leads westward out of Chęciny, in the direction of Polichno and Miedzianka. The village and the hill lie in the western part of the Chęciny range.

The hill is formed out of limestone dating back to the middle-late Devonian period (380-390 Ma). There is an abundance of Anthozoa and Stromatoporoidea remains to be seen there. When looking from the north, one can see that Miedzianka resembles Giewont (a mountain in the Polish Tatras) in shape. For this reason it is sometimes facetiously called „Giewont Świętokrzyski”. In the past it was also known as Wielka Sowa and Góra Miedzińska. It is not known when the local deposits were first mined. In the inspection report of the Chęciny county that was done in 1569 there is a paragraph that reads: "The fourth mountain lies behind the civic village of Polichno, it is called Miedzianka and the city foundries are located there. The copper ore from



Malachit i azuryt  
fol. J. Jędrychowski

this hill is very good. It's azure is precious and the green marvellous. Much treasure came from this mountain in times past and today there is still a lot, but it must be worked, only a huge expense would have to be made".

There is also a record of how Stanisław Łaszczyński found a treasure of Roman coins in 1902. The coins were found during the exploitation of an old heap at the southern slope of Miedzianka, where traces of past mining activity have been exposed.



Różne generacje kalcytu  
fot. J. Jędruchowski

So, as we can see, Miedzianka played an important role in ore mining and can now aspire for the title of the Historical Center of Ore Mining for the whole Świętokrzyskie region. The reserve also includes sites where, in the past, limestone was mined for its unique colours. Light blue limestone layered with several generations of red-brown calcite veins, embellished with green and blue sputters of malachite and azurite was an attractive material for producing stone haberdashery items. Other minerals that can be found here include chrysocolla, chalcocite, chalcopyrite, copper, galena and traces of silver, coellite, pyrite, baryte and haematite. Prospecting and mining works led to the creation of a large underground network of excavation inside the hill. It is made up of rock voids that were formed due to the extraction of mineralized calcite veins, the mining of deposits accumulated in karst formations, as well as shafts and adits bored out in the calcareous rock. The total length of these underground excavations is ca. 4 kilometres.

One of the last people who believed in the boundless treasures hidden inside Miedzianka were two brothers – Stanisław and Bolesław Łaszczyński. In the beginning of the 20th century they undertook an attempt to exploit copper ore. Alas, they only proved the sad truth that through the centuries of mining, the ore deposit on Miedzianka had been nearly exhausted. The Museum Chamber of Ore Mining located in a former school building in Miedzianka collects and exhibits items related to old mining work. The minerals and tools gathered here are a testament to the region's rich history and its importance.

While wandering through the Chęciny-Kielce Landscape Park we traverse areas of intensive rock penetration in search of lead, copper, baryte and coloured limestone. There are many old mining shafts here that are often hidden from the human eye by vegetation. This is why it is crucial to take safety precautions and only move along marked trails.

## GÓRA RZEPKA reserve



fot. A. Drzewiecka

At ca. 800 metres from Góra Zamkowa there is another rock reserve - "Góra Rzepka". The reserve includes two hills - Rzepka and Belina, together with the "Korzecko" quarry, where the southern ridge of these hills was exposed through mining. The face of the excavation that remained after mining had ceased makes for a very interesting educational site where you can observe the internal geological structure of the hills of the Chęciny region. Middle Devonian thick-banked dolomites with limestone lying in the upper floors have been exposed here. In some parts, the rock layers are unsettled by faults. On the northern face there is an area riddled with cracks filled with white and red calcite veins with a varied structure which are of the "rózanka zelejowska" type. In the years between the two world wars and after WWII up until 1963 this valuable mineral was used in the production of terazzo.

The ridges of Rzepka and Belina are an area where tangible traces of the mining activity that took place here in the 14th to 19th centuries still remain. As is the case with most local hills, at first this was mainly a site where galena was mined. There are plans to open an outdoor exposition of the most interesting rocks found in the Chęciny-Kielce Landscape Park.



fot. J. Jędruchowski



## JASKINIA PIEKŁO (HELL CAVE) - reserve

The best way to reach the cave is to take the Piekoszów-Rykoszyn road. Midway through Rykoszyn, we turn south-eastwards for Gałęzice and after passing the eastern limits of the village, just behind the last buildings and before the forest, we arrive at the cave. It is located at the sharply sloping western ridge of Góra Żakowa, in Devonian limestone. The Piekło cave, also known as Piekło pod Skibami or Piekło Gałęzickie, is one of the most interesting karst caves in the Chęciny region. Its total length is 57 metres. On the left side of the entrance there is a small corridor that ends with a window and at the end of the cave there are two chimneys that are also connected to the surface. At about 10 metres from the entrance, on the cave floor, there is a 1.5 m recess which is a remains of an old mining shaft. It is a reminder of the mining activities that had taken place in the region of Chęciny in the 15th to 18th century.

There are plans to open the whole depth of the shaft, along with proper lighting and reinforcement. Only in the final section have trace fragments of calcite formations survived to this day. The cave floor near the entrance is covered with silt and clay dug out during mining works. Many species of bats, snails, as well as spiders, crickets and flies inhabit the cave. The Piekło cave lies within the limits of the village of Skiby and is protected by law.



fol. A. Drzewiecka



fol. A. Drzewiecka

## STOKÓWKA QUARRY

The quarry is located in the Zelejowskie range, west of the Piekło cave and south of the village of Gałęzice. It is one of the most discernible exposures in the Chęciny region. A calcite vein of the "rózanka zelejowska" type had cut through Stokówka mountain exactly in the middle. It was formed as a result of crystallization from hot mineral waters that flowed through the rock cavities during the Variscan orogeny in the late Carboniferous period (299-325 Ma). The mining of the colourful calcite has led to the creation of a picturesque gap whose height reaches 15 metres in certain places. Karst phenomena, small chimneys and rock voids filled with residual clay can be observed on the faces of the excavation.

The whole hill is overgrown with xerothermic vegetation which can thrive on the calcareous substratum and very poor soil. For years, Stokówka has also been a site for practising climbing.

We have thus reached the final destination on our archeogeological trail. A trail that connects the most interesting sites and towns that are of high importance to the geology of the Świętokrzyskie region. The idea of this project is not only to promote the presented sites but also to draw attention to the necessity of protecting them.

There are places outside the archeogeological trail that are no less attractive to geotourists visiting our region. Due to their high educational and scenic value they should not be missed.

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## ŁAGÓW

This site has been known since the 15th century and has rich lead and iron mining traditions. To see the most interesting geological curiosity of Łagów we head northwards from the market square taking the road for Nowa Słupia and after 500 metres, we turn right into Dule street, which leads us to a rocky canyon by the same name. There is a hypothesis that Dule canyon was formed as a result of the collapse of a large karst cave that water had eroded in ca. 390 million years old middle-Devonian limestone. A testimony to the karst phenomena that are taking place here is the Zbójecka cave, also known as Łagowska which is located on the eastern side, about 20 metres above the bottom of the canyon. The cave has one entrance that has a visible rock hood. The total length of the tunnel that water has eroded is ca. 200 metres.



fol. J. Jędruchowski

Another curiosity is the lesser horseshoe bat that inhabits this cave. This cave is the site where this species was first spotted in the Świętokrzyskie voivodship. Another geological site near Łagów is the very interesting exposure in Plucki - some 1.5 km north of Łagów - where traces of early-Devonian Placodermi (from ca. 400 Ma) can be observed.

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## PIEKŁO (HELL) ROCKS NEAR NIEKŁAŃ - reserve



fol. P. Pierściński

To reach the reserve we take the road from Skarżysko-Kamienna to Stąporków. In the village of Odrowąż, we turn north for Nieklania Wielka where a road, running just behind the last buildings, will take us near the reserve. There we will find rocks made of sandstone that create a picturesque composition with the surrounding forest. The sediment was formed in the coastal area of an early-Jurassic sea 198 Ma. The sea resembled contemporary Baltic sea. What we see are the fragments that remained of what was once a consistent sandstone sheet that lay flatly on the top surface of the local hills. Over time, as a result of erosion, especially the destructive force of wind, interesting shapes resembling smokestacks, mushrooms or church pulpits were formed. The rock belt runs at a distance of ca. 1 km and in some places reaches 8 metres of height.

# GAGATY SOŁTYKOWSKIE reserve



foto: J. Jedrychowski

This place can be reached by driving from Skarżysko-Kamienna in the direction of Końskie. Less than a kilometre before Odrowąż, we turn north and take the gravel road up to a mid-forest clearing where a car park is located. We then walk north along the marked trail.

The excavation located amidst forests was used for extracting early-Jurassic loam from 199 Ma, used in the production of pottery. After closing down, the mine became a true paradise for jet prospectors. The region of Sołtykowo is the only place in Poland with jet deposits. This unique type of coal from which the expression "jet-black" is derived, was sought after because of its use as a material for making elements of jewellery. In Poland, during the November and January uprisings women wore jet jewellery as a sign of mourning after the lost independence. The times when jet was highly popular are gone, but it was during the exploration of this excavation that a different curiosity was found - dinosaur footsteps, traces of nests and egg

fossils. The "Gagaty Sołtykowskie" reserve took under legal protection the excavation where the fossil flood plain ecosystem with its well preserved dinosaur traces is exposed. Amongst these there are traces of herds of herbivorous sauropods. Traces of young carnivorous theropods, that surrounded the herbivorous sauropods when hunting, were also found. This is proof that the dinosaurs cooperated much like contemporary crocodiles do.

Sołtykowo is a unique site, unlike any in Europe. The dinosaur traces were preserved because they were left on a swampy bank of a lazy river and soon after that they were covered with further sediment. The numerous plant fossils found here attest that this was an area of river rushes. However, this was not grass overgrowth (grasses evolved in the middle Paleogenic period - i.e. over 160 million years later). The vegetation included ferns, cycads, horsetails and coniferous plants. Fossilised shells of mussels and snails, as well as insect (cicada) larvae have also been found here.



When describing the age of sediment found in natural or man-made exposures we use conventional naming. To make reading the history of the Earth easier for the reader, we present the following stratigraphic table that will help you place in time the dates of formation of the different rock layers.

## Geologic systems, periods and epochs - stratigraphic table

Era	Period	Epoch	Starts	Ends
<b>Cenozoic</b>	Neogene	Holocene	10 Ta	Still lasts
		Pleistocene	1,8 Ma	10 Ta
		Pliocene	5 Ma	1,8 Ma
		Miocene	23 Ma	5 Ma
	Paleogene	Oligocene	34 Ma	23 Ma
		Eocene	56 Ma	34 Ma
		Paleocene	65 Ma	56 Ma
<b>Mesozoic</b>	Cretaceous		145 Ma	65 Ma
	Jurassic		200 Ma	145 Ma
	Triassic		251 Ma	200 Ma
<b>Paleozoic</b>	Permian		299 Ma	251 Ma
	Carboniferous		359 Ma	299 Ma
	Devonian		416 Ma	359 Ma
	Silurian		444 Ma	416 Ma
	Ordovician		488 Ma	444 Ma
	Cambrian		542 Ma	488 Ma
<b>Precambrian</b>			3200 Ma	542 Ma

## Information

### Regionalne Centrum Informacji Turystycznej

Kielce, ul. Sienkiewicza 29, tel. +48 41 348 00 60

### Bałtów

JuraPark Bałtów

tel. +48 41 264 14 21, tel./fax +48 41 264 14 20  
tel. kom. 519 346 140

### Krzemionki

Muzeum i Rezerwat Archeologiczno-Przyrodniczy  
„Krzemionki”

tel./fax +48 41 262 09 78

### Święty Krzyż

Muzeum Przyrodnicze

tel. +48 41 317 70 87

Muzeum Misyjne Misjonarzy Oblatów

tel. +48 41 317 70 21

### Gołoborze

Świętokrzyski Park Narodowy

ul. Suchedniowska 4, 26-010 Bodzentyn  
tel./fax +48 41 311 51 06 lub +48 41 311 50 25

### Nowa Słupia

Muzeum Starożytnego Hutnictwa  
Świętokrzyskiego im. M. Radwana

ul. Świętokrzyska 56, tel. +48 41 317 70 18

Informacja turystyczna

ul. Świętokrzyska 18  
tel. +48 41 317 76 26, +48 41 317 70 13

### Kielce

Muzeum Zbiorów Geologicznych  
Oddział Świętokrzyski Państwowego  
Instytutu Geologicznego

ul. Zgoda 21, tel. +48 41 361 25 37

Geopark Kielce

ul. Strycharska 6, tel. +48 41 367 66 54

### Jaskina Raj

26-060 Chęciny, ul. Dobrzańska  
tel./fax +48 41 346 55 18

### Informacja turystyczna w Sitkówcze Nowiny

Kryta pływalnia „Perła”

tel. +48 41 346 52 60, +48 41 345 96 50 wew. 35

### Góra Zelejowa

Punkt Informacji Turystycznej w Chęcinach

Chęciny, ul. Staszica 3, tel. +48 41 315 18 29  
[www.checiny.pl](http://www.checiny.pl)

### Miedzianka

Muzealna Izba Górnictwa Kruszcowego

tel. +48 41 313 60 76, 501 544 500, 504 154 272

### Gagaty Sołtykowskie

Biblioteka Publiczna Miasta i Gminy Końskie

ul. Partyzantów 1, 26-200 Końskie, tel. +48 41 372 90 88

### Łagów

Punkt Informacji Turystycznej w Łagowie

Łagów, ul. Rynek 62, tel. +48 41 307 40 70  
[www.lagow-gmina.pl](http://www.lagow-gmina.pl)



Regionalna Organizacja Turystyczna  
Województwa Świętokrzyskiego

ul. Ściegiennego 2/32, 25-033 Kielce  
tel. +48 41 361 80 57

[www.rot.swietokrzyskie.travel](http://www.rot.swietokrzyskie.travel)

Wydawca:  
Agencja Reklamy TEST Sp. z o.o.  
25-335 Kielce, ul. Źródłowa 17A

Tekst: Jerzy Jędrychowski

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Archiwum ROT WŚ, Anna Drzewiecka, Jerzy Jędrychowski,  
Krzysztof Pęczalski, Paweł Pierściński.

Projekt i skład:  
Agencja Reklamy TEST Sp. z o.o.  
tel. +48 41 344 49 29, [www.artest.pl](http://www.artest.pl)

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