

POTENTIAL VALUES OF URBAN GEOTOURISM DEVELOPMENT IN A SMALL POLISH TOWN (PRUSZKÓW, CENTRAL MAZOVIA, POLAND)

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ABSTRACT: The paper presents abiotic resources which are located in a small town in central Poland. They remain unknown to authorities and inhabitants. For the first time they are illustrated in a scientific paper. The objects of local geological heritage point to geodiversity of this district town in the south-western Mazovia. When the geodiversity is interpreted in a simple, an understandable way, it may become attractive for tourists. We show how abiotic resources located within an urban area can be used to support urban geotourism development. The scientific, educational and aesthetic values of these resources may create the town image in accordance with the principles of environmental protection.

KEY WORDS: abiotic resources, geodiversity, urban geotourism, south-western Mazovia, central Poland

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Introduction

Pruszków is a district town in the south-western Mazovia (central Poland; Fig. 1), and currently is used as a sleeping quarter of Warsaw – the capital of Poland. Today, it is a very quiet town without heavy industry. It hosts some objects of historical and cultural heritage of the region: the Museum of Ancient Mazovian Metallurgy and Dulag 121 [abbreviation of the German Durchgangslager 121) – a transit camp] Museum. The quarter of old Majewski Pencil Factory is waiting for revitalization. Plants of the Association of Polish Mechanics from America (in which machine tools were designed and

produced) are currently being demolished but they are at least worthy to be commemorated.

The area of Pruszków is quite rich in elements of natural heritage, called natural resources. Due to the location in the urban area and insufficient knowledge of the municipal authorities and inhabitants, they remain unnoticed. They deserve attention, because of their cognitive, educational and often aesthetic values. They may become touristic values (Lijewski et al. 2000) if they arouse curiosity and are interesting for them. In order to distinguish these abiotic resources of natural environment, which are valuable and attractive for tourists, it is proposed to call them geotourist values. As a formality, it should be noted

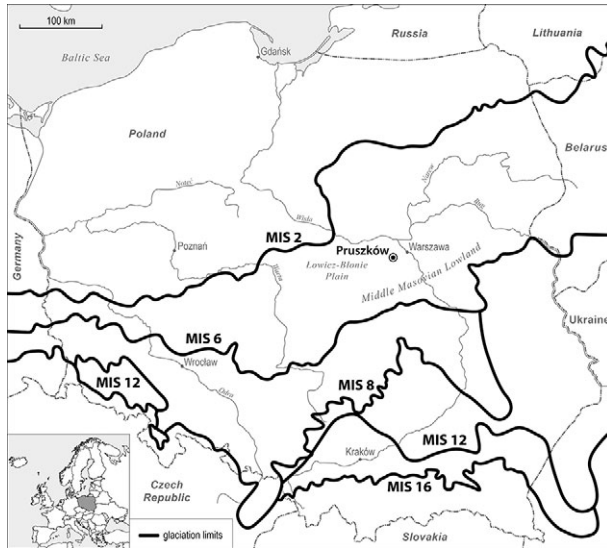


Fig. 1. Location of Pruszków in relation to the extents of Pleistocene glaciations in Poland. Ice limit acc. to Marks et al. (2016).

Dates acc. to INQUA, Bern (2011), Lisiecki and Raymo (2005): MIS 2 – Last Glacial Maximum, 29–14 ka BP, MIS 6 – 191–130 ka BP, MIS 8 – 300–243 ka BP, MIS 12 – 478–424 ka BP, MIS 16 – 676–621 ka BP.

that the abiotic natural resources – georesources – include, among others, bedrock (including outcrops and petrographic types of rocks), soil, relief, surface and underground water, weather, and local climate (e.g. Kożuchowski 2005; Migoń 2012; Dowling 2013; Palacio-Prieto 2015).

Georesources occur not only in non-urban areas. Valuable examples of geological heritage (=geosites) may also occur within towns (Rubinowski and Wójcik 1978, Migoń 2012, Del Monte et al. 2013, Dowling 2013, Reynard et al. 2015, Lollino et al. 2015, Pica et al. 2015). Palacio-Prieto (2015) defines urban geosites as the places representing geological or geomorphological values, formed as a result of geological processes or produced by man but showing a close relationship with geology. According to him, these can be, among others, buildings built of natural rocks. Migoń (2012) and Reynard (2008) indicate that erratics, integrated into developed urban space, can be such objects, as well.

Geovalues are of geotourism interest (among others Hose 1995, Migoń 2012, Newsome and Dowling 2006, 2010, Słomka and Kicińska-Świdorska 2004), including urban geotourism (among others Del Lama et al. 2015, Del Monte et al. 2013, Lollino et al. 2015, Pica et al. 2015, 2016, Rodrigues et al. 2011). Geotourism is a new term

for the tourism industry, which appeared about 15 years ago, and combines sightseeing and qualified tourism. Geotourism is a branch of cognitive tourism based on the exploration of geological objects and processes, which provides aesthetic experiences. Geotourism is also an economic activity. It offers geoproducts (e.g. Reynard et al. 2015), services and infrastructure, whose aim is to promote earth sciences, and in this way it brings real financial benefits to people involved in implementing it.

The purpose of this paper is to promote geomorphological and geological heritage of Pruszków, based on which geotourism has a chance to develop in this small Polish town. The particular examples of geotourism development are also presented. The authors hope that the article will contribute to the popularization of knowledge of inanimate nature occurring in the urban area. When the inhabitants will acquire knowledge of geotourist objects in their town, tourism servicing can result in a real economic development of the town (Gordon 2012).

Georesources of Pruszków and its surroundings

There are several objects of abiotic heritage in Pruszków and its surroundings: old glacial relief, Pliocene clays, till, erratics and stones, bog iron and water. They occur in different combination (Table 1). Their location is shown in the Fig. 2.

Pruszków District is located in the Łowicz-Błonie Plain belonging to the Middle Mazovian Lowland (Kondracki 2013) in central Poland (Fig. 1). Almost flat (90–100 m a.s.l.) plain is built of ground moraine, which was left by the Scandinavian ice sheet during the Warthian stadial of Odranian glaciation (MIS 6; Fig. 1), i.e. about 185–130 000 years ago (Mojski 2005). Ground moraine is composed of till. This material was eroded in an alimentation area (e.g. in Scandinavia) and transported by the ice sheet. When the ice sheet melted, till was deposited in the place where it occurs at present (e.g. in the Łowicz-Błonie Plain). Till is characterized by low permeability, a feature especially valuable in agriculture. Pedogenesis has transformed till into fertile soil. It has been using for growing vegetables between Pruszków and Grodzisk Mazowiecki.

Table 1. Objects of abiotic heritage in Pruszków, present in different combination

Symbol	Explanation
A	Pedogenesis has transformed till into sapric gleysol used in agriculture
B	Historical palace of Count and Countess Antoni and Jadwiga Potulicki, last owners of Pruszków
C	Palace of Helenówek and former fish ponds
D	Old tenements built of brick in the so-called „Quarter of Millionaires”
E	„Count’s clay pit ponds” in the city district Ostoja
F	Fishponds in the Count Potulicki’s Park are former “Count’s clay pit ponds”
G	Small ponds in Żwirowisko Park are the former “Count’s clay pit ponds”
H	Museum of Ancient Mazovian Metallurgy
I	Local bathing pool in the Mazovia Park of Culture and Recreation is the former “Count’s clay pit ponds”
J	Komorów Reservoir was formed by damming the Utrata River
K	Historic hydro-technical systems located along the Utrata River valley evidence the old fishponds belonging to Potulicki
L	Water intake from the Oligocene aquifer from a depth of 244 m at Jasna St
M	Water intake from the Oligocene aquifer from a depth of 245 m at Lipowa St
N	Water intake from the Oligocene aquifer from a depth of 244 m at Żbikowska St
O	Water intake from the Quaternary aquifer from a depth of 29,5 m at Prusa St
P	Gabions in Żwirowisko Park (former “Count’s clay pit ponds”) have aesthetic, decorative and stabilizing function
R	Gabions create also a unique fence of the private property in Podhalańska Street No. 10.
S	The outer walls of the building of District Authority Office are covered with the Novabrik elevation brick made of the mixture of broken granite, marble and mica
T	Most of the matzhevas in the Jewish cemetery are made of the so-called Kunów sandstone (Lower Jurassic)

Agricultural lands within the limits of Pruszków are located in the northern part of the town (A in Fig. 2). They belonged to the historical Production Complex of Horticulture, which was established by Piotr Ferdynand Hoser around 1898 (District Register of Monuments, 2009). Vast open areas of the Łowicz-Błonie Plain, developed as meadows and cultivated fields, are the foreground for the palace and park complexes, and highlight their architectural and composition values (Lewin

and Korzeń 2008). The historical palace of Count and Countess Antoni and Jadwiga Potulicki is located in the very heart of Pruszków (B in Fig. 2). In the nearby villages of Helenówek (C in Fig. 2) and Pęcice there are two other mansions: Representative Centre of the Ministry of National Defence and private old Polish Manor, respectively.

Relief and deposits

Activity of the last ice sheet in the region resulted, among other, in the intensive glaciotectionic push and squeeze processes, which moved the underlying Pliocene clays from their original position (Kowalczyk and Nowicki 2007). The clays, commonly called loam, occur on the ground surface or at shallow depth in many places in Pruszków and the surroundings. Good quality of these clays, used as building raw material for the construction of industrial and residential buildings, was recognized by Jonas Abramson, Szulim Ditman and Count Antoni Potulicki who established the company and managed a quite prosperous brickyard in the years 1878–1938 (Kaleta 2010). Today, we find in the town some remains of the construction boom of the late 19th and early 20th centuries. These are old tenements

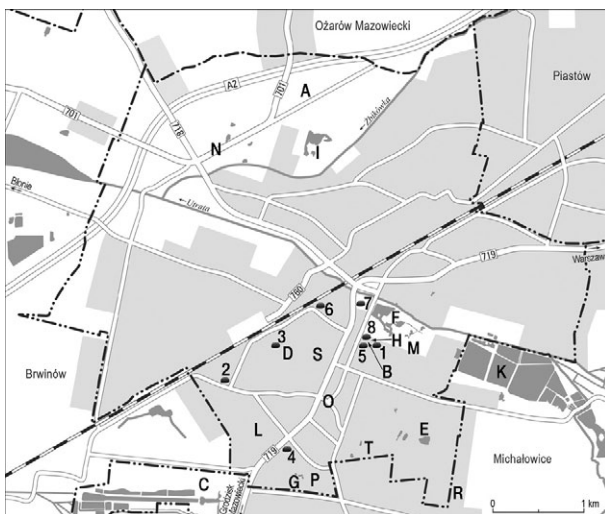


Fig. 2. Objects of abiotic heritage in Pruszków. A–T – for explanation see Table 1, 1–8 – erratics, for explanation see Table 2.

built of brick along Steel Street or Pencil Street in the so-called „Quarter of Millionaires” (D in Fig. 2) (Krzyczkowski 2009), and several street names such as Brick Street, Brickyard Street, Ceramic Street, Gravel Street. Traces of old exploitation pits are visible as the depressions (commonly known as „Count’s clay pit ponds”) occurring in Ostoja (E in Fig. 2) – a quarter of Pruszków (Kaleta 2010), and ponds in the Potulicki Park (F in Fig. 2) in the town centre (Bielawski 2009). Small ponds in the so-called “Pits”, which occur between the church dedicated to Our Lady of Perpetual Help and the Municipal Kindergarten No. 13 in the southern part of the city (G in Fig. 2), are also evidence of clay exploitation in this part of Pruszków.

Bog iron ore was another raw material exploited near Pruszków and Brwinów (Fig. 3A). This is a sedimentary rock with low content of iron, which occurs in mires and other wetlands (Mazurek 2011, Ratajczak and Rzepa 2011). Formation of bog iron ore is shown schematically in Fig. 3B. In the period from 2nd century BC to 4th century AD these natural resources became the

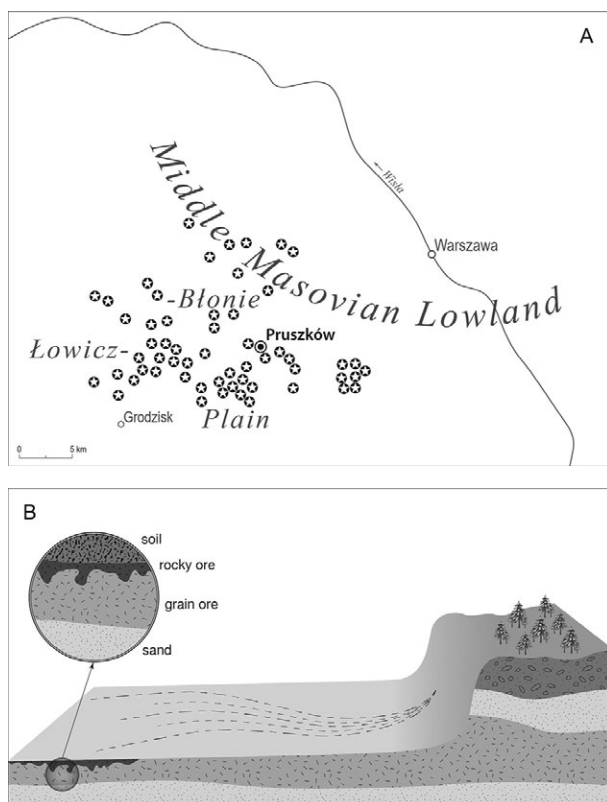


Fig. 3. A: Ancient Mazovian metallurgy in the vicinity of Pruszków – archaeological sites are marked.

B: Formation of bog iron ore.

Source: Rutkowski (2001), modified.

basis for the development of a large centre of production and processing of iron (Tomczak 2007, Woyda 2002, 2006). The results of archaeological excavations are exhibited in the recently renovated Museum of Ancient Mazovian Metallurgy (H in Fig. 2).

Water

Water is a natural resource, which is underestimated by the inhabitants of the Mazovia region. In the Łowicz-Błonie Plain water occurs mainly in numerous rivers and streams. This area is drained by the Utrata River (Figs 2, 4) and its tributaries (Zbikówka, Regułka, Raszynka, Zimna Woda). These rivers, shifting their courses from one bank to the other, have formed classic meanders and water-logged areas. Some meanders have been turned into oxbow lakes. All these forms are effects of lateral erosion of the rivers. Fluvial relief, being a natural composition element of parks, constitutes great tourism potential of this region.

In the immediate vicinity of Pruszków there are no lakes but a local bathing pool (I in Fig. 2) was opened in the northern part of the town, in the Mazovia Park of Culture and Recreation in 2014. Its popular name – „clay pit ponds” – indicates that the Pliocene clays have been formerly exploited there. After recent modernization the Park is an ideal resting place for the inhabitants of Pruszków and the surrounding area.

Another water body – Komorów Reservoir (Fig. 5; J in Table 1) – adjacent to Pruszków from SE, is already located in Commune Michałowice



Fig. 4. Utrata River drains the described area; in the photo: the river after leaving Komorów Reservoir.

Photo by M. Górską-Zabielska (2017).



Fig. 5. Komorów Reservoir – local favourite place of walks and angling. Photo by M. Górską-Zabielska (2011).

(Fig. 2). This reservoir was formed by damming the Utrata River between the villages of Komorów-Wieś and Pęcice. Today it is the storage reservoir of this river. The natural water resources in Pruszków and immediate surroundings, transformed by man, are an undoubted geotourist value, appreciated by the inhabitants of Pruszków and the surrounding area who go there for walks. The Komorów reservoir is also appreciated by anglers.

Water occurs in historic hydro-technical systems located along the Utrata River valley, i.e. in the old fishponds belonging to Potulicki (F and K in Fig. 2), in the ponds belonging to the Pęcice estate and to Tworkowski (Jakubowski 2009, Lewin and Korzeń 2008, Skwara 2002), and in the „Count’s clay pit ponds” mentioned above. The ponds in the Potulicki Park (F in Fig. 2) are the most impressive of them. The landscape value of these ponds was appreciated in 1963 when they entered, together with the palace, into the Register of Monuments. All these objects were created due to favourable natural relief and the adaptation of the Utrata River oxbows and old exploitation pits of the brickyard (Bielawski 2009).

Resources of confined groundwater are exploited for the need of the Pruszków inhabitants in four water intakes. Groundwater from the Oligocene aquifer is drawn from a depth of 244 m (L in Fig. 2), 245 m (M in Fig. 2), and 238 m (N in Fig. 2) below ground surface in Jasna Street, Lipowa Street and Żbikowska Street, respectively. Groundwater from the Quaternary aquifer is drawn from a depth of 29.5 m (O in Fig. 2) below ground surface in Prusa Street (Kowalczyk and Nowicki 2007).

Erratics

In the natural environment of the town there are, besides those mentioned above, several objects that unquestionably form its geotourist resource. These are objects of inanimate nature – glacial erratics, which here and there emerge from the square greenery, lie on the sides of the avenues, and are the obelisks in city parks. Unfortunately, they have not attracted much attention of the authorities and inhabitants of Pruszków so far. Very few people see erratics at all, and even fewer are conscious of their scientific, educational, conservation, and finally geotourist importance. When the authorities made an effort and show the beauty of these boulders, put them under protection, set an information board, perhaps if they marked out a geotourist path based on them, it would appear that erratics can attract the attention of inhabitants and tourists. And then their rank will change from the resource into the tourist value.

Erratics are traces of the last ice sheet that covered the Mazovia region. These rock fragments were eroded by the ice sheet in Scandinavia, incorporated by the ice mass (Górską 2006, Górską-Zabielska 2008, 2010, 2016) and transported to central Poland during the advance between 215–210 ka BP and 130–125 ka BP (= MIS 6; Marks et al. 2016; Mojski, 2005). When the ice sheet melted, the erratics were left in surface deposits, e.g. near Pruszków. The authors know of at least eight large erratics located within the limits of Pruszków (Table 2). Some of them are characterized below.

The largest erratic is granite, which is located in the centre of town, near the John Paul II Square (Fig. 6; Number 1 in Fig. 2 and in Table 2).

According to the information board, the largest granite in Pruszków was excavated during the construction works in Pruszków in 1995. The occurrence of this erratic in surface deposits indicates that it has been brought to this region by the Scandinavian ice sheet during the younger part of Odranian Glaciations (=Warthian stadial, MIS 6; Marks et al. 2016). It was eroded from the bedrock in the south-eastern Sweden (Småland region), as is indicated by its mineral composition. The boulder is mainly composed of grey-reddish, brick-red or brownish-reddish feldspar crystals 1–10 mm long, which are accompanied by white

Table 2. List of the eight largest erratics in Pruszków

Petrographic type, origin, age, Fig. no.	Length [m]	Width [m]	Height [m]	Circumference [m]	Volume [m ³]	Weight [t]	Location in the town
Småland granite from the south-eastern Sweden; 1.75–1.5 billion years; Fig. 6	3.1	2.3	1.3	8.0	4.64	12.8	1. Museum of Ancient Mazovian Metallurgy 52°09'51.8"N 20°48'32.3"E
Granite-gneiss from the Baltic Shield; 1.96–1.75 billion years	1.85	1.95	0.95	6	1.79	4.93	2. Secondary and Sport School Complex in Pruszków, 2, Gomuliński St 52°09'39.5"N 20°47'04.6"E
Gaize from the bedrock of Gdańsk Bay or Lower Vistula valley; 145–66 million years; Fig. 8	2.05	1.7	1.15	6.0	2.1	4.19	3. In front of the building of Social Insurance Institution, Steel Street 52°09'51.3"N 20°47'38.0"E
Småland granite from the south-eastern Sweden; 1.75–1.5 billion years	2.15	1.3	1.0	5.6	1.46	4.0	4. Southern part of the town 52°09'14.5"N 20°47'37.6"E
Scandinavian sandstone; probably Cambrian (541–485 million years)	2.65	0.55	1.85	5.85	1.4	3.9	5. Small hill in the John Paul II Square 52°09'52.1"N 20°48'30.0"E
Småland granite from the south-eastern Sweden; 1.75–1.5 billion years; Fig. 9	1.2	0.8	1.08	3.45	0.54	1.49	6. Bersohn's Square 52°10'06.1"N 20°48'02.1"E
Gneiss from the Baltic Shield; 1.96–1.75 billion years	1	0.65	1.1	3.15	0.37	1.03	7. Next to the crossroads of Polish Army and Mira Zimińska-Sygietyńska Streets 52°10'06.1"N 20°48'24.8"E
Rapakivi granite from the Åland Islands; 1.7–1.54 billion years; Fig. 10	1.25	0.7	0.8	3.4	0.37	1.01	8. John Paul II Square, in front of the building of Register Office 52°09'53.9"N 20°48'28.1"E

Explanations: boulder volume was calculated using the following formula: $0.523 \times \text{length} \times \text{width} \times \text{height}$ (Schulz 1999); boulder weight was estimated on the assumption that $1\text{m}^3 = 2.75 \text{ t}$.

or light yellow plagioclase crystals 1–3 mm long, and single crystals of blue quartz (typical of Småland) with a diameter of not more than a few mm (Czubla et al. 2006). The size of the boulder (volume – 4.6 m³, estimated weight – 12.8 t) can also indirectly indicate that it has been transported by ice sheet from the south-eastern Sweden, where the source region delivered only big fragments of rocks. This granite is a monument of inanimate nature, protected by law in accordance with the Nature Conservation Act from 2004, the only one of its kind in the Pruszków District.

The second largest erratic in the town is granite-gneiss exposed in the square in front of the Secondary and Sport School Complex in Pruszków, Gomuliński Street No. 2 (No. 2 in Fig. 2 and in Table 2). It is accompanied by three smaller erratics. All the boulders were dug up in a gravel-pit located about 10 km from Pruszków. The corners and edges of the largest erratic (of almost 5 tons in weight) are rounded. This feature indicates glacial transport, with a significant participation of water carrying, among others, gravel and sand grains. They acted as an abrasive



Fig. 6. Småland granite is the largest erratic in Pruszków; this is the only one monument of inanimate nature in Pruszków; No. 1 in Table 2. Photo by M. Górska-Zabielska (2011).

material, which at first rounded off the edges of the boulder. Such a process could have taken place in the en/sub/glacial tunnels carrying water from melting ice sheet. The sides of the boulder are smooth. This is the result of aeolian process called abrasion, i.e. wearing down the protruding elements of the boulder by wind-sand-snow streams. This process took place in dry and cold environment in the foreland of retreating ice sheet. Memorial plaque fixed on the boulder is dedicated to *Julian Gomuliński (1894–1961), long standing director of vocational schools, teacher of many generations of specialists for the machine tool industry and the great friend of youth.*

Adjacent, smaller erratic boulder shows a perfect example of crescentic fractures which are, most likely, made by the removal of piece/s of rock between the ice body and the substratum (Figs 7a, 7b).

The third largest erratic (Fig. 8; No. 3 in Fig. 2 and in Table 2) occurs in the square in front of the building of Social Insurance Institution, Steel Street No. 25. It is most probably gaize – light and porous sedimentary rock, with carbonate cement and preserved few internal moulds. Such a large erratics of sedimentary rocks are very rare in the deposition area of the Warthian ice sheet. Therefore, the described erratic is a unique object on the geotourist map of Pruszków. The erratic probably came from the gaize beds, which were exposed in the Lower Vistula valley and in the bottom of Gdańsk Bay (Górska-Zabielska 2008). The dimensions given in Table 2 relate to the aboveground part of the boulder.

Another large erratic occurs in the town centre, in the John Paul II Square, on a small artificial elevation (No. 5 in Fig. 2 and in Table 2). It

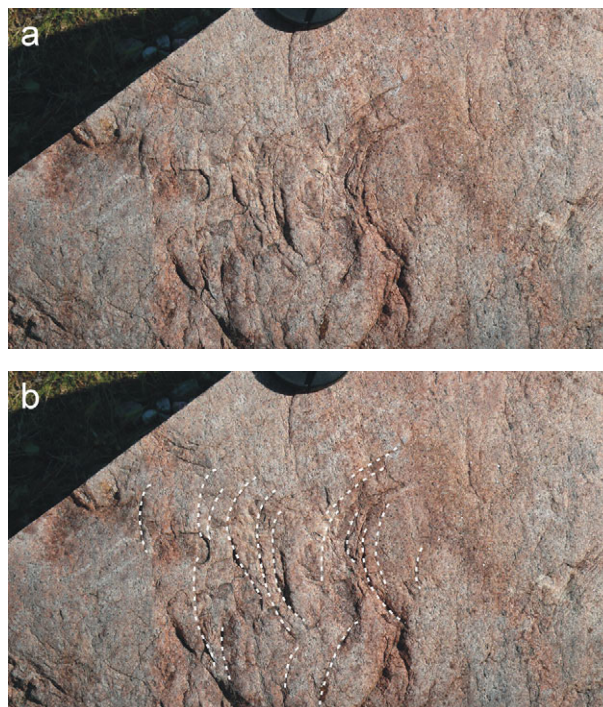


Fig. 7: a – crescentic fractures on the top side of a gneiss (one of three erratic boulders in front of the Sport School Complex); b – marked crescentic fractures.

is a sandstone – sedimentary clastic rock, most probably of Cambrian age. Primary stratification of loose deposit, formed during the deposition of sand grains on the bottom of a water body (sea, lake), is perfectly visible on the side of the boulder. After deposition, the sand was compacted, cemented, and became sandstone. The described boulder, i.e. a fragment of sandstone bedrock, plucked out by the ice sheet, afterwards had to be exposed to atmospheric factors. It was mainly wind erosion, i.e. aeolization, which resulted



Fig. 8. Gaize with carbonate cement and preserved internal moulds is the third largest erratic in Pruszków; No. 3 in Table 2. Photo by M. Górska-Zabielska (2015).



Fig. 9. Sixth largest boulder erratic in Pruszków (at the Bersohn's Square). Parallel-arranged fine crests and troughs (micro-ribs) are the result of the abrasion – destructive aeolian process affecting the boulder in dry and cold periglacial environment in the foreland of the retreating ice sheet.

in distinct smoothing of one side of the boulder. Some anthropogenic destruction in the form of screw holes, which are probably the traces of a memorial plaque, can be seen on the front side of the boulder.

The sixth largest erratic in Pruszków occurs in the Bersohn's Square, near the railway station (No. 6 in Fig. 2 and in Table 2). It is indicator erratic, Småland granite, which has been transported by the ice sheet from the Småland region in the south-eastern Sweden (Górska-Zabielska 2008). One side of the boulder is well smoothed as a result of glacial abrasion. This process could have occurred when the boulder was carried

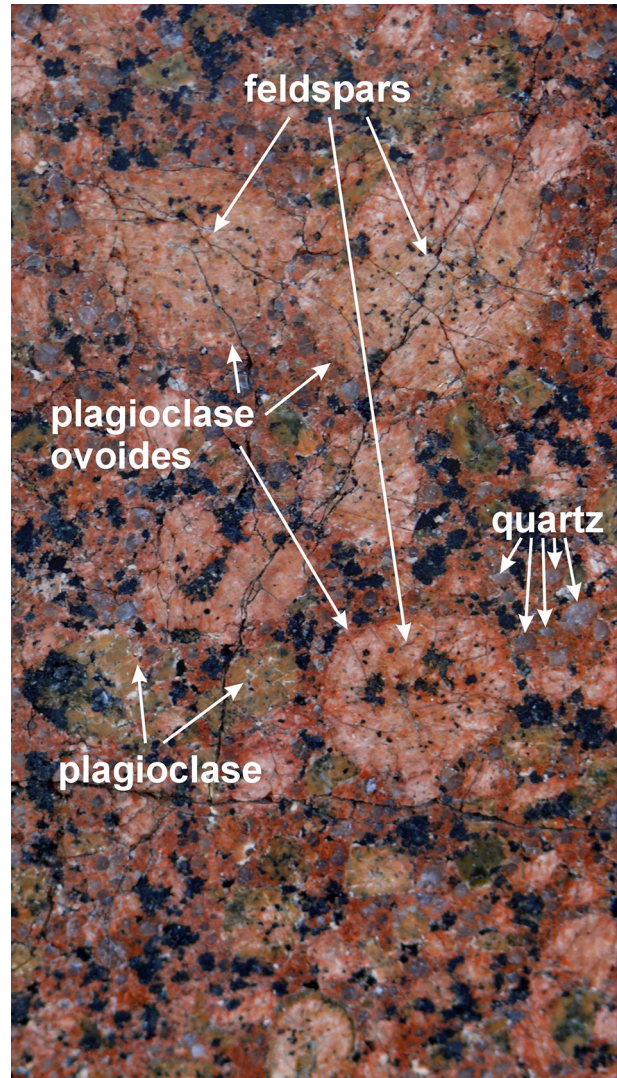


Fig. 10. Rapakivi granite – details of the distinctive structure of this indicator erratic from the Åland Islands; No. 8 in Table 2. Photo by M. Górska-Zabielska (2016).

in the bottom part of the ice sheet and scraped against the substratum, over which the ice sheet moved. It is also possible that the boulder was sunk into the ground, and the ice sheet moved over it and polished it. The smoothed surface of the erratic is called glacial polish. This surface has been used to place a commemorative inscription *In remembrance of heroes who were killed in the struggle for national and social liberation during the Nazi occupation. Society of Pruszków, July 22, 1960.*

Looking more closely at the surface of the boulder from the other, less exposed side, one can see the characteristic parallel-arranged fine crests and troughs (Fig. 9). These are the so-called micro-ribs (a form of microrelief), which are the result of the previously described abrasion

- destructive aeolian process affecting the boulder in dry and cold periglacial environment in the foreland of the retreating ice sheet. The destruction takes place also today, and its traces can best be seen in the upper part of the boulder, in the form of surface peel off, i.e. exfoliation. The main factors of this process are the changes in air temperature, as well as the circulation of water and solutions in cracks and micro-voids between the minerals composing the rock. They lead to the disintegration of the rock. The northern side of the boulder is colonized with lichens. The root system of this epilithic flora penetrates the micro-voids and has an impact on the development of present-day exfoliation of the boulder.

One of the most beautiful erratics in Pruszków is placed (together with two other boulders) next to the building of Register Office in the John Paul II Square (No. 8 in Fig. 2 and in Table 2). It is the smallest of the described here boulders, which only proves that "small is beautiful". The boulder has been cut, and large (5-15 mm in diameter), pink, generally circular crystals of potassium feldspar (Fig. 10) are well visible on the polished surface. These crystals are surrounded by greyish-green rims of plagioclase (sodium-calcium feldspar). Feldspars are accompanied by grey, circular crystals of quartz. Such a structure indicates that the boulder came from the outcrops of rapakivi granite occurring on the Åland Islands in the middle of the Baltic Sea (Górska-Zabielska 2008). The boulder is indicator erratic. The boulder is now placed "upside down" in relation to the position, in which it was left after the ice sheet melted, and in which it was then subjected to the wind abrasion in the ice-sheet foreland. At the bottom part of the boulder (originally the top) one can see the traces of wind abrasion in the form of aeolian micro-ribs.

By contrast, the traces of rounding, which are the results of glacial transport, and erosion activity of meltwater in en/sub/glacial tunnels, are visible in the upper part of the boulder. Meltwater carried sand and gravel grains, which acted as an abrasive material and rounded off the originally sharp edges of the boulder during its movement.

Erratics in the urban space of Pruszków are also present in many other places, like in parks and along green belt area at the roadside, where there have been placed for decorative purpose.

Stones in an open urban space

Stones, other than of Scandinavian provenance, are also present in gabions (Fig. 11) and in the elements decorating the interior of churches. Stones commonly occur as gravestones in the cemeteries located in three city districts Tworki, Gašin and town centre (Gordziałkowski Street), as well as in Lipowa Street (historical Jewish cemetery). However, it should be noted that in recent times some gravestones have been made of artificial stones that are deceptively similar to their natural counterparts.

Gabions (Italian *Gabbione* - cage) are large steel cages filled with coarse gravel (Fig. 11). Besides their aesthetic and decorative functions, they have also practical applications, e.g. they are used to stabilize slopes, for example in the Żwirowisko Park (adjacent to the kindergarten in Antek Street; letter P in Fig. 2 and in Table 2), which was established in the place of the so-called "Pits" (former „Count's clay pit ponds" - old exploitation pits of clays). Gabions create also a unique fence of the private property in Podhalańska Street No. 10 (R in Fig. 2 and in Table 2).

The outer walls of the building of District Authority Office (S in Fig. 2 and in Table 2) are covered with the Novabrik elevation brick. It is made of the mixture of broken granite, marble and mica. Plasticizers, binders and colorants were added to the mixture to improve the visual and technical characteristics of a brick.

Most of the matzevahs in the historical Jewish cemetery (Fig. 12; T in Fig. 2 and in Table 2) in Lipowa Street are made of the so-called Kunów



Fig. 11. Gabions - decorative reinforcement (built of rock fragments) of the slopes of the so-called "pits", i.e. former „Count's clay pit ponds". Photo by M. Górska-Zabielska (2015).



Fig. 12. Matzevahs in the historical Jewish cemetery in Pruszków are made mainly of the so-called Kunów sandstone (Lower Jurassic), exploited in the vicinity of Kunów near Ostrowiec Świętokrzyski. Photo by M. Górską-Zabielska (2016).

sandstone (Lower Jurassic), exploited in the vicinity of Kunów near Ostrowiec Świętokrzyski (Walendowski 2010). This sandstone has been commonly used as the material for architectural details and sculptures. That is why it is found in many cemeteries in the Mazovia region.

It is worth mentioning that the presence of erratics is not limited to Pruszków only. The number of known erratics changes often because more and more new buildings are built around the town and their garage levels reach deep into the subsurface layer of glacial deposits, which contain still undiscovered erratic boulders.

Final remarks

Socio-economic changes taking place in Poland in the last 25 years have a strong influence on Pruszków. The town was always industrial and technical centre (ancient metallurgy, railway workshops, American mechanics), and in 1977 it provided 21,000 jobs for its inhabitants. Today Pruszków is transformed into another dormitory community of Warsaw. The town authorities make a lot of effort to form the place of residence attractive for new residents. They organize both cyclic and occasional artistic and cultural events. The cultural offer is also a statutory activity of two museums. Although their activity cannot be ignored, it is not experienced by the inhabitants, at least due to the research done by the Commune Pruszków authorities in 2007 (Pruszków Stop 2007). Up to 75% of the surveyed residents (group of 450 people aged 25–60 years) are unaware of the tourist attractions of their town.

It seems that today we have on one hand city residents, who complain about a small amount of tourist attractions and on the other – some interesting objects, occurring within the town limits for ages, that are still underestimated. Their educational, scientific, and equally important aesthetic values should be highlighted. This will not involve any big money, because the objects already (still) exist. They should be only put under protection and promoted in order to draw attention of inhabitants and tourists. We are talking about the following objects of abiotic heritage: old glacial relief, Pliocene clays, till, erratics and stones as well as water. Bog iron is the only one georesource, the knowledge of which is popularized in the Museum of Ancient Mazovian Metallurgy. The objects of abiotic heritage occur in Pruszków in different combination; their location is shown in the Fig. 2.

Erratics are especially noteworthy objects of inanimate nature. These undervalued and treated lightly georesources are a valuable evidence of regional geodiversity and the geological past. In this sense, they play a cognitive and educational role. They enhance geotourist value of the natural environment. Some of them are used to commemorate historical events important for a town or country (cultural and aesthetic roles). Such a use of boulders confirms timeless, permanent importance of stone obelisks (e.g. Kopczyński and Skoczylas 2006, Skoczylas and Żyromski 2007). It seems that erratics deserve more attention on the part of conservation institutions and local authorities, which should take care to preserve the natural heritage.

Clever promotion of the objects of abiotic heritage (e.g. through a leaflet, folder, serial or occasional publication, geoquest, educational path, geotourist trail, information board, lecture on a scientific theme for the general public, or a link in the official website of the town) by local tourist society and/or other organizations popularizing the town certainly could stimulate the development of tourism, including sustainable geotourism, in the south-western Mazovia. Some promotion actions have already been undertaken: lectures on geological past of the city (in 2012 and 2017) together with a tour guide along its traces within the city borders (2012). Another lecture will be given to Pruszków inhabitants in September 2017 within the wider project

“European Days of Heritage”. The authors have been writing feuilletons about geological and geomorphological heritage in the city in local monthly since July 2016. Increased interest in the urban tourist offer will be very likely followed by job creation in the services to visitors (in hotels, restaurants, tour agencies) and in the production of consumer goods (for inhabitants and visitors), as well as in the expanded service sector (cf. Dowling 2013).

It is also important to inform the inhabitants of Pruszków about the scientific value of erratics (and other objects of inanimate nature mentioned in the text) for reconstruction of the geological past of the region. Pruszków, as a “bedroom” of Warsaw, extends continuously the housing offer. Urban infrastructure and multi-family buildings with deep-level garages are being built around the town and the earthworks reach deep into the subsurface layer of glacial deposits, which contain still many undiscovered Scandinavian erratics. Therefore, it would be worthwhile to take care of newly-dug erratics, and to place them in prestigious areas of the town. It would certainly contribute to the increase in the geotourist values of Pruszków.

Appropriately exhibited inanimate objects maintain and strengthen the geographical character of the place – its environment, culture, beauty, heritage and prosperity of its inhabitants (National Geographic 2005; Reynard 2008). Their role in the sustainable socio-economic development of the district and town cannot be overestimated. They contribute to the image creation of the town that adapts the elements of inanimate nature for tourist purposes in accordance with the principles of environmental protection.

Finally, it should be noted that local initiatives, increasing awareness among the inhabitants, and the promotion of all the geotourist values will certainly help to draw attention to the need for stronger protection of inanimate resources of the Earth.

References

- Bielawski P., 2009. *Pruszków. Plan Miasta (City plan)*. Urząd Miasta w Pruszkowie (City Hall in Pruszków) (in Polish).
- Czubla P., Gałązka D., Górka M., 2006. Eratyki przewodnie w glinach morenowych Polski (Fennoscandian indicator erratics in glacial tills of Poland). *Przegląd Geologiczny* 54(4): 245–255 (in Polish).
- Del Lama E.A., de La Corte Bacci D., Martins L., da Gloria Motta Garcia M., Kazumi Dehira L., 2015. Urban Geotourism and the Old Centre of São Paulo City, Brazil. *Geoh Heritage* 7(2): 147–164.
- Del Monte, M., Fredi P., Pica A., Vergari F., 2013. Geosites within Rome City center (Italy): a mixture of cultural and geomorphological heritage. *Geografia Fisica e Dinamica Quaternaria* 36: 241–257.
- Dowling R.K., 2013. Global Geotourism – An Emerging Form of Sustainable Tourism. *Czech Journal of Tourism* 2(2): 59–79.
- Gordon J.E., 2012. Rediscovering a sense of Wonder: Geoh heritage, geotourism and cultural landscape experiences. *Geoh Heritage* 4: 65–77.
- Górka M., 2006. Fennoscandian erratics in glacial deposits of the Polish Lowland – methodical aspects. *Studia Quaternaria* 23: 11–15.
- Górka-Zabielska M., 2008. Obszary macierzyste skandynawskich eratyków przewodnich osadów ostatniego zlodowacenia północno-zachodniej Polski i północno-wschodnich Niemiec (Source regions of the Scandinavian indicator erratics in Vistulian glacial deposits from NW Poland and NE Germany). *Geologos* 14(2): 177–194 (in Polish).
- Górka-Zabielska M., 2010. Analiza petrograficzna osadów glacialnych – zarys problematyki (Petrographic study of glacial sediments – an outline of the problem). *Landform Analysis* 12(2): 49–70 (in Polish).
- Górka-Zabielska M., 2016. *Erratic Disappearances*. Online: science-online.pl/nasze-teksty/nauki-o-ziemi/item/522-erratic-disappearances (accessed 6.02.2017).
- Hose T.A., 1995. Selling the story of Britain’s stone. *Environmental Interpretation* 10(2): 16–17.
- Jakubowski T.H., 2009. *Lata prawie bezgrzeszne (Years almost sinless)*. Wyd. Powiatowa i Miejska Biblioteka Publiczna im. H. Sienkiewicza w Pruszkowie (in Polish).
- Kaleta J., 2010. *Pruszków przemysłowy (Industrial Pruszków)*. Wyd. Powiatowa i Miejska Biblioteka Publiczna im. H. Sienkiewicza w Pruszkowie (in Polish).
- Kondracki J., 2013. *Geografia regionalna Polski (Regional geography of Poland)*. Wydawnictwo Naukowe PWN, Warszawa (in Polish).
- Kopczyński K., Skoczylas J. 2006. *Kamień w religii, kulturze i sztuce (Stone in religion, culture and art)*. Wydawnictwo Naukowe Uniwersytetu im. Adama Mickiewicza (in Polish).
- Kowalczyk A., Nowicki Z., 2007. Warszawa. In: Nowicki Z. (ed.), *Wody podziemne miast wojewódzkich Polski (Groundwater of voivodship cities in Poland)*. Informator Państwowej Służby Hydrogeologicznej, Warszawa, 221–242 (in Polish).
- Koźuchowski K., 2005. *Walory przyrodnicze w turystyce i rekreacji (Natural values in tourism and recreation)*. Wyd. Kurpisz, Poznań (in Polish).
- Krzyżkowski H., 2009. *Dzielnica milionerów (District of millionaires)*. Wyd. Powiatowa i Miejska Biblioteka Publiczna im. H. Sienkiewicza w Pruszkowie (in Polish).
- Lewin M., Korzeń J., 2008. *Park Kulturowy Gminy Michałowice jako narzędzie ochrony walorów i środowiska kulturowego gminy Michałowice (Cultural Park of Commune Michałowice as a tool to protect its natural values and cultural environment)*. Wyd. Gmina Michałowice, pp. 17 (in Polish).

- Lijewski T., Mikułowski B., Wyrzykowski J., 2000. *Geografia turystyki Polski (Tourism geography of Poland)*. PWE (Polskie Wydawnictwo Ekonomiczne), Warszawa (in Polish).
- Lisiecki L.E., Raymo M.E., 2005. A Pliocene-Pleistocene stack of 57 globally distributed benthic $\delta^{18}O$ records. *Paleoceanography* 20(2) PA1003. doi:10.1029/2004PA001071.
- Lollino G., Giordan D., Marunteanu C., Charstaras B., Yoshinori I., Margottini C. (eds), 2015. *Engineering Geology for Society and Territory – Vol. 8 Preservation of Cultural Heritage*. Springer.
- Marks L., Karabanov A., Nitychoruk J., Bahdasarau M., Krzywicki T., Majecka A., Pochocka-Szwarc K., Rychel J., Woronko B., Zbucki Ł., Hradunova A., Hrychanik M., Mamchuk S., Rylowa T., Nowacki Ł., Pielach M., 2016 (in press). Revised limit of the Saalian ice sheet in central Europe. *Quaternary International*, DOI: 10.1016/j.quaint.2016.07.043.
- Mazurek S., 2011. Zapomniana ruda darniowa (Forgotten bog ore). *Nowy Kamieniarz* 87(2): 70–74 (in Polish).
- Migoń P., 2012. *Geoturystyka (Geotourism)*. Wyd. Naukowe PWN, Warszawa (in Polish).
- Mojski J.E., 2005. *Ziemie polskie w czwartorzędzie. Zarys morfogenezy (Polish lands in the Quaternary. Outline of morphogenesis)*. Wyd. Państwowy Instytut Geologiczny, Warszawa (in Polish).
- National Geographic, 2005. Geotourism Charter. Online: www.nationalgeographic.com/travel/sustainable/pdf/geotourism_charter_template.pdf (accessed 12 November 2015).
- Newsome D., Dowling R., 2006. The scope and nature of geotourism. In: Newsome D., Dowling R. (eds), *Geotourism. Sustainability, impacts and management*. Oxford, UK, Elsevier/Heinemann Publishers, 3–25.
- Newsome D., Dowling R. (eds) 2010. *Geotourism: The Tourism of Geology and Landscape*. Oxford: Goodfellow Publisher.
- Palacio-Prieto J.L., 2015. Geoheritage within Cities: urban geosites in Mexico City. *Geoheritage* 7(4): 365–373.
- Pica A., Vergari F., Fredi P., Del Monte M., 2015. The Aeterna Urbs Geomorphological Heritage (Rome, Italy). *Geoheritage* 8(1): 31–42, DOI 10.1007/s12371-015-0150-3
- Pica A., Grangier L., Reynard E., Kaiser Ch., Del Monte M., 2016. GeoguideRome, urban geotourism offer powered by mobile application technology. EGU General Assembly 2016, 17–22 April, 2016 in Vienna Austria, 941.
- Pruszków Stop 2007. A study commissioned by the Comune Pruszkow by PBS DGA Company o.o. Online: www.pruszkow.pl/poznaj-miasto/przystanek-pruszkow (accessed 10 November 2015).
- Ratajczak T., Rzepa G., 2011. *Polskie rudy darniowe (Polish bog ore)*. Wyd. Akademii Górniczo-Hutniczej, Kraków (in Polish).
- Reynard E., 2008. Scientific research and tourist promotion of geomorphological heritage. *Geografia Fisica e Dinamica Quaternaria* 31: 225–230.
- Reynard E., Kaiser Ch., Martin S., Regolini G., 2015. An Application for Geosciences Communication by Smartphones and Tablets. In: Lollino G. et al. (ed.), *Engineering Geology for Society and Territory – Vol. 8 Preservation of Cultural Heritage*. Springer, 265–272.
- Rodrigues M.L., Machado C.R., Freire E., 2011. Geotourism routes in urban areas: a preliminary approach to the Lisbon geoheritage survey. *Geojournal of Tourism and Geosites* 8(2): 281–294.
- Rubinowski Z., Wójcik Z., 1978. Odslonięcia geologiczne Kielc i okolic oraz problemy ich ochrony i zagospodarowania (Geological outcrops of Kielce and the surrounding area and the problems of their protection and development). *Prace Muzeum Ziemi* 20: 95–121 (in Polish).
- Rutkowski, M., 2001. Żelazne łąki (Iron meadows). *Wiedza i Życie* 5. Online: archiwum.wiz.pl/2001/01050500.asp (accessed 30.10.2015).
- Schulz W., 1999. Sedimentäre Findlinge im norddeutschen Vereisungsgebiet. *Archiv für Geschiebekunde* 2(8): 523–560 (in German).
- Skoczylas J., Żyromski M., 2007. *Symbolika kamienia jako element procesu legitymizacji władzy w cywilizacji europejskiej (The symbolism of the stone as an element of legitimacy in the European civilization)*. Wydawnictwo Naukowe Uniwersytetu im. Adama Mickiewicza, Poznań (in Polish).
- Skwara M., 2002. *Pruszków. Nasze miasto (Pruszków. Our town)*. Wyd. Powiatowa i Miejska Biblioteka Publiczna im. H. Sienkiewicza w Pruszkowie (in Polish).
- Słomka T., Kicińska-Świdarska A., 2004. Geoturystyka – podstawowe pojęcia (Geotourism – basic concepts). *Geoturystyka* 1(1): 5–7 (in Polish).
- Tomczak E., 2007. Starożytne centrum metalurgiczne koło Warszawy. Zagadnienia dyskusyjne (Ancient metallurgical center near Warsaw. Discussion topics). *Archeologia Polski* 52(1–2): 177–186 (in Polish).
- Walendowski H., 2010. Piaskowce kunowskie i dolskie (Sandstones from Kunów and Dolsk, Holy Cross Mountains). *Nowy Kamieniarz* 45, 82 (in Polish).
- Woyda S., 2002. Mazowieckie centrum metalurgiczne z młodszego okresu przedrzymskiego i okresu wpływów rzymskich (Mazovian metallurgical center of the younger pre Roman and Roman periods). In: Orzechowski S. (ed.), *Hutnictwo świętokrzyskie oraz inne centra i ośrodki starożytnej metalurgii żelaza na ziemiach polskich (Metallurgy in the Holy Cross Mountains and other centers of ancient iron metallurgy on the Polish territory)*. Wydawnictwo Świętokrzyskie Stowarzyszenie Dziedzictwa Przemysłowego, Kielce: 151–154 (in Polish).
- Woyda S., 2006. Mazowieckie Centrum Metalurgiczne z czasów Imperium Rzymskiego (Mazovian Center of Metallurgy from Roman Empire Period). In: Horban I., Chmururowa Z., Zegadło, G. (eds), *Przegląd Pruszkowski, Pruszków* 1–2: 5–9 (in Polish).