
MACIEJ J. KOTARBA & JOANNA GAWĘDA-SKROK
Faculty of Geology, Geophysics and Environmental Protection
AGH University of Science and Technology
Al. Mickiewicza 30, 30-059 Krakow
POLAND
kotarba@agh.edu.pl  http://www.agh.edu.pl

Abstract: - The discovery of large Pleistocene mammals at the Starunia earth wax mine (the Ukrainian Carpathians) was a spectacular scientific event on a world scale. The initial discovery was made in 1907 when relics of partly preserved mammoth and woolly rhinoceros were excavated. Later, in 1929, a unique, nearly completely preserved woolly rhinoceros carcass embedded in Pleistocene sediments was found. A specific combination of brine, oil and clays into which the animal had sunk, is responsible for almost perfect preservation of this animal. The specimens found in 1907 are exhibited at the Natural History Museum in Lviv, Ukraine, whereas the unique specimen excavated in 1929 is displayed at the Natural History Museum in Kraków, Poland. The three sites: Starunia, a small Ukrainian village in which the geopark with the museum and the tourist centre are planned to be developed, two historical towns: Lviv and Kraków, closely connected with the discoveries of extinct large mammals, will be the key sites at the planned Ukrainian-Polish cross-border geotourist trail “Traces of large extinct mammals, earth wax, oil and salt: from Starunia to Kraków”. The trail will also include the sites where occurrences of earth wax (ozokerite), salt, brine and oil are known, i.e., the substances which preserved the animal carcasses. These are: the most famous Ukrainian resort – Truskavets, one of the oldest oilfields in the world – Bóbrka (Poland), with the Ignacy Łukasiewicz Memorial Open-Space Museum of Oil and Gas Industry; and the historical rock-salt mine in Wieliczka (Poland). The idea of Ukrainian-Polish trans-border tourist trail is strongly supported by geological, natural and cultural values of the Polish and the Ukrainian Carpathians.

Key-Words: - Starunia palaeontological site, woolly rhinoceros, Ukrainian-Polish trans-border geotourist trail

1 Introduction

The discovery of large Pleistocene mammals dated at 37,700 years BC [1] at the Starunia ozokerite (earth wax) mine (Fig. 1B) (about 130 kilometres southeast of Lviv, Ukraine) was a spectacular scientific event on a world scale [2]. The initial discovery was made in 1907 when relics of a partly preserved mammoth and rhinoceros were excavated within the Pleistocene clays on the depths 12.5 and 17.6 metres, respectively [2]. Later, in 1929, the Polish Academy of Arts and Sciences organized a scientific expedition to the site and discovered a nearly complete preserved woolly rhinoceros carcass at a depth of 12.5 metres (Fig. 1). A unique combination of brine, oil and clays into which the animal had sunk, is responsible for almost perfect preservation of this specimen. Since this discovery the remnants of two more rhinoceroses have been found at this site. These specimens are now displayed at museums in Poland and Ukraine: those found in 1907 are exhibited at the Natural History Museum of the National Academy of Sciences of Ukraine (the former Dzieduszycki’s Family Museum) in Lviv, Ukraine and specimens excavated in 1929 are displayed at the Natural History Museum and in the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences, both in Kraków, Poland (Fig. 1A). The three sites: Starunia – small village in the Ukrainian Carpathians and two historical cities – Kraków and Lviv (Fig. 1B), closely connected with the unique palaeontological finding will be the key points at the planned Ukrainian-Polish trans-border geotourist trail “Traces of large extinct mammals, earth wax, oil and salt: from Starunia to Kraków” [3, 4, 5]. In Starunia the geopark, the museum and the tourist centre are planned, belonging to the UNESCO network. Moreover, the trail will include other sites related to the occurrence of the earth wax (ozokerite), salt, brine and oil, hence, the factors which contributed to the preservation of the bodies of large extinct mammals. In the Carpathian region
there are historical rock-salt mining sites: Wieliczka and Bochnia mines in the Polish part \[6\], and Kalush and Stebnik mines (Fig. 1B) in the Ukrainian part \[7\]. There are also springs of brines and saline mineral waters utilized in many health resorts. Authors of numerous papers present the most famous Ukrainian resort - Truskavets (formerly Truskawiec) \[8\] as well as the Polish resort - Iwonicz-Zdrój \[9\].

The Carpathians constitute one of the oldest petroleum-producing regions in the world. The exploitation of oil has started in 1854 and that of natural gas in 1920 \[10\]. There are papers dealing with one of the oldest oilfields exploited in Poland – the famous Bóbka (Fig. 1B), with the Ignacy Łukasiewicz Memorial Open-Space Museum of Oil and Gas Industry \[9\], and in Ukraine – Boryslav (Fig. 1B) \[8\].

Fig. 1. (A) The woolly rhinoceros after conservation at the Natural History Museum in Krakow. Photo by P. Witosławski, and (B) location map of sites at the Ukrainian-Polish trans-border geotourist route “Traces of large extinct mammals, earth wax, oil and salt: from Starunia to Kraków” and the major tectonic units of the Polish and Ukrainian Carpathians.
2 Starunia
A small village of Starunia is located in the picturesque area of the Fore-Carpathian region (Fig. 1B), from where the 2,000-metre-high snowy peaks of the Gorgany Mts can be seen. Moreover, the Starunia area has the following spectacular features: palaeontological site, abandoned ozokerite mine, mud volcanoes and oil and gas surface seeps and archaeological sites.

3 Truskavets
Truskavets is one of the great Ukrainian health resorts, famous for its brine and sulphate-alkaline mineral springs. In the period between the World War I and II, Truskavets was one of the most popular spas in Poland. The spa itself was opened in 1836. Mineral water from the "Józia" spring (bicarbonate-alkaline) was bottled and sold as table water. Truskavets is also famous for the “Naftusia” – mineral water spring renowned for its healing values [8].

4 Lviv
The city is regarded as one of the main cultural centres of today's Ukraine and historically has also been a major Polish and Jewish cultural centre. Lviv is a home to many world-class cultural institutions, The historic city centre is on the UNESCO World Heritage List. In the Natural History Museum (Fig. 2) of the National Academy of Sciences of Ukraine in Lviv there is a collection with a famous Pleistocene mammoth and a woolly rhinoceros, the so-called “first rhinoceros” from Starunia. The State Museum of Natural History is one of the oldest and the richest scientific collections in Europe [4]. It was founded in 1854 by count Włodzimierz Dzieduszycki (1825-1899), famous Polish zoologist, ethnographer and archaeologist. Moreover, in Lviv, at the Mickiewicz Square, close to the exit of the Kopernik Street (both historical names have survived) there is the pharmacy “Under the Golden Star”, established in 1828 by Peter Piotr Mikolasch. Here, in 1853, the pharmacist Ignacy Łukasiewicz and his collaborator Jan Zeh for the first time distilled the kerosene (lamp oil) from the Carpathian oil.

5 Bóbrka
Bóbrka is a village in the Carpathian region. Here, the Open-Air Museum of Petroleum Industry is presenting the history of oil industry from its beginning to the present days. Some 150 years ago Bóbrka was a small, poor mountain village, but in the second half of the 19th century this small world had dramatically changed, bringing its wealth to the local population [9]. The changes have been caused by development of the “oil mine” in 1854 (Fig. 3). The forested land, useless for agriculture, was full of oil seepages. Thus, Ignacy Łukasiewicz, pharmacist, and two other founders, agreed to run a joint business: to exploit oil and distil it into kerosene (then called “new camphene”), which was applied as a fuel for kerosene lamps. The patent for distillation of petroleum was granted by The Patent Office in Vienna to Ignacy Łukasiewicz and Jan Zeh on December 2nd, 1853. Moreover, Ignacy Łukasiewicz was an inventor and coauthor of the project of a new oil lamp fuelled by kerosene, which generated bright light without fumes. The usage of kerosene lamps during an urgent, surgical operation at the public hospital in Lviv at night of July 3rd, 1853 has been regarded as the beginning of modern Polish and world oil industry [8]. In 1961, at the site of this first “oil mine” the Ignacy Łukasiewicz Memorial Museum of Oil Industry was opened in Bóbrka. The exhibition includes: the Open-Air Museum with a number of valuable
pieces and the outline of museum history and development plans, the outline of geological setting of the Bóbrka Fold, the short geotourist trail named “The Birthplace of the World Petroleum Exploitation” [8], which connects the localities important for the early history of the oil industry (Bóbrka, Chorkówka, Krosno, Rogi, Wietrzno and Równe) as well as the sites known for exploitation of mineral waters (Iwonicz Zdrój and Rymanów Zdrój spas).

Fig. 3. The "Franek” dug-well in the Bóbrka oilfield and Open-Space Museum of Oil and Gas Industry. Photo by A. Radwański

6 Wieliczka and Bochnia salt mines
Historic salt mines in Wieliczka and Bochnia are situated by the old trade road from Kraków to the east (Fig. 1B), in the region well known from salt-making from brines since the Neolith (ca. 3500 BC). In Bochnia the rock salt was discovered in 1248, whereas production of the rock salt in Wieliczka was confirmed in the town charter of 1290. At the end of the 13th century both mines were united forming the Kraków Saltworks. In the 16th century it was the biggest production centre in Poland and one of the biggest in Europe. The rock-salt exploitation ended in Bochnia in 1990 and in Wieliczka in 1996. The Wieliczka Salt Mine is written on the first UNESCO List of the World Cultural and Natural Heritage (1978) and recognised as a National Monument of History (1994). Since 2000 the Bochnia Salt Mine has become the National Monument of History as well. In 1997 the Małopolska voivode issued a decree comprising legal protection of 40 documented sites, important for geology of the Wieliczka deposit, and in 2000 the Natural Reserve “Crystal Caves” in Wieliczka was established. In 2005, twenty seven documented sites were established and provided with legal protection in the Bochnia Salt Mine [7].

7 Kraków
Kraków, the former capital of Poland, was the seat of Polish Kings (Royal Castle at the Wawel Hill). It is a scientific centre, having over 10 universities. The Jagiellonian University, founded in 1364, is one of the oldest in Europe. This old Gothic, Renaissance and Art Nouveau city, with its architectural and cultural monuments, and museums on the UNESCO list of world heritage sites. In the old part of the city one can visit the most spectacular and famous monuments, such as the glamorous Royal Castle (Fig. 4), Church of St Mary, the Cloth Hall, the City Wall remnants and St Florian's Gate with its open-air art gallery. The Natural History Museum of the Polish Academy of Arts and Sciences in Kraków was established in 1865. The museum is an owner of a nearly completely preserved “second woolly rhinoceros” (Fig. 1A) and the other remains of the Pleistocene fauna of Starunia.

8 Other places of geotourist trail
8.1 Kalush and Stebnyk
From the pre-historical up to the medieval time the salt production in the area of western Ukraine was based on evaporation of salt brines [6]. Such mineralized waters, sufficiently concentrated, were used in salt-works. Their occurrences as springs and shallow dug wells in the times of Polish Kingdom were mentioned in numerous old descriptions and notations. After historical data salt springs were noticed in 196 sites located in the foreland of the Polish and Ukrainian Carpathians. In 1773 in the area of western Ukraine 92 active salt-works (called Ruthenian salt-works) were registered, which produced over 40 thousands tonnes of salt per year. Development of industrial underground salt mining in western Ukraine started in the mid-19th century with the discovery of large potash-magnesium salt deposits in Kalush (1854) and Stebnyk (1901) [6].

8.2 Boryslav region
The Boryslav region is one of the oldest petroleum basins in the world. Oil fields with natural gas were discovered in the second half of the 19th century, near the Boryslav-Tustanovychi-Mraznytsa-Banya
Kotyvska road [8]. Moreover, ozokerite was mined in the vicinity (Fig. 1B). Before the discovery of rich oil fields, Boryslav and Tustanovychi (with nearby Ponerla and Volyanka) were neighboring villages located southwest of Drohobych (Fig. 1B), the beginnings of which date back to the 14th century [8].

8.3 Krosno region and Iwonicz Spa
Krosno - capital of the county (Fig. 1B), formerly, in the years 1975-98, was the capital of the district. The civic rights were granted to the town in the half of the 14th century by the King of Poland Casimir the Great. It was the important trade and industrial centre. The town is an important element of the trail as it hosts both the petroleum industry and other historical monuments, and cultural objects [9]. The petroleum industry objects are related mostly to Ignacy Łukasiewicz, who became the Honorary Citizen of Krosno. There is a monument of Łukasiewicz near the church of Capucin Fathers and one of the streets bears his name. At the Museum of the Fore-Carpathian Region, located in the former bishop’s palace, tourists can see the largest in Europe collection of historical kerosene lamps, better known as “The Museum of Oil Lamps”. Iwonicz is a village and health resort situated in the Polish Carpathians (Fig. 1B). The history of Iwonicz dates back to the 15th century and its development is closely connected with the discovery of mineral waters. There are numerous historical notes on minerals waters from Iwonicz. Their therapeutic values were described as early as in 1578. “Bathing springs” were mentioned in 1633 by Henry Firlej – the bishop of Przemyśl [9]. In 1721 the pioneer of Polish natural sciences, Jesuit monk Gabriel Raczyński described the exploration for, exploitation and even processing of “rock oil” in Iwonicz. The dynamic development of Iwonicz started in 1799 [8]. The Iwonicz health resort flourished in the 19th century. In the town centre tourists can still admire beautiful wooden houses built at that time in the style imported from health resorts in Switzerland. For advertising purposes the name “Zdrój” (spa) was added to the town name. Three mineral water springs were exploited in those days: two of them provided iodine-bromine waters, the third one was ferruginous. Moreover, the local oilfield in Iwonicz, developed in 1890 is still producing. A local peculiarity is the spring named „Belkotka” (“Mumbler”) - the monument of abiotic nature, which releases methane and carbon dioxide [9].

9 Conclusion
The three sites: Starunia, a small Ukrainian village in which the geopark with the museum and the tourist centre are planned to be developed, two historical towns: Lviv and Kraków, closely connected with the discoveries of extinct large mammals, will be the key sites at the planned, Ukrainian-Polish cross-border geotourist trail [11]. In 1907 and 1929 Polish geologists discovered woolly rhinoceroses and mammoth at the ozokerite mine in Starunia. The soft tissue of the animal was preserved due to saturation with brine and oil. A unique, nearly completely preserved “second woolly rhinoceros specimen of Starunia” is recently exhibited at the Museum of Natural History of the Polish Academy of Sciences in Kraków. Previously, in 1907, at the same mine the ”first woolly rhinoceros” and the mammoth remnants were found. These are exhibited at the Natural History Museum of the National Academy of Sciences of Ukraine in Lviv. Both museums in Kraków and in Lviv together with other sites in the
Polish and Ukrainian Carpathians related to the occurrence of ozokerite (earth wax), salt, brine and oil are the backbone of the Ukrainian-Polish cross-border geoturistic route “Traces of large extinct mammals, earth wax, oil and salt: Starunia – Kalush – Boryslav region – Lviv – Bóbrka – Krosno region – Bochnia – Wieliczka – Kraków”. The idea of the trail is supported by geological, natural and cultural values of the Polish and the Ukrainian Carpathians together with inevitable protection of these natural resources in the times of dynamic economic growth of the region.

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