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From Industrial Resource to Scientific Heritage: A Holistic Approach for the Czarnogłowy (Zarnglaff) Quarry and Its Role in the Geological and Paleontological Landscape of Northern Poland

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Abstract:

Purpose: *This article presents the geology, research history, and current state of the Czarnogłowy quarry—one of the most significant Mesozoic sites in Western Pomerania, Poland.*
Design/Methodology/Approach: *As a rare in situ exposure of pre-Quaternary rocks in the region, the quarry represents a valuable geological resource. Over a 60-year period, the site was extensively exploited for limestone, culminating in the establishment of Pommersche Kalksteinwerke Zarnglaff, once one of the largest limestone production plants in Pomerania. Following its post-war industrial decline, the quarry transitioned from an economic resource to a scientific and educational one. Generations of German and later Polish geologists and paleontologists have studied the site, documenting a wealth of fossil material, including ammonites, echinoids, brachiopods, and vertebrate remains—particularly marine reptiles such as Machimosaurus and Steneosaurus.*
Findings: *Today, the flooded quarry forms a lake, repurposed as a local recreational area, illustrating the transformation of natural resource sites over time.*
Practical Implications: *The article highlights the need to preserve and protect historically significant geological sites like the Czarnogłowy quarry, which remain valuable for educational purposes and limited paleontological research, despite being no longer actively mined.*
Originality/Value: *This paper provides a uniquely comprehensive synthesis of geological, paleontological, and historical data on the Czarnogłowy site, integrating archival sources, fossil collections, and field observations that are rarely combined in existing literature.*

Keywords: *Geological resources, abandoned quarry, paleontological heritage, West Pomeranian Region.*

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1. Introduction

The old, flooded quarry in the village of Czarnogłowy is located 72 kilometers north of Szczecin, in Przybiernów municipality (Goleniów County). It is a unique place not only in the West Pomeranian Voivodeship but also northern Poland. The waters and bottom of Lake Czarnogłowy conceal over 60 years of limestone exploitation.

This article results from an interest in the quarry's geology, history, and current state now transformed into Lake Czarnogłowy. The summary of this knowledge is the result of years of library and museum research, Internet searches, and direct conversations with former quarry workers and their families. For those who have ever visited this place, the article may provide new insights into this history, as well as the current condition of the geological exposures.

Limestone deposits in the regions of Zarnglaff (now Czarnogłowy), Böck (Buk), and Schwanteshagen (Świętoszewo) were known as early as the 18th century (Ramlow, 1967). The author of the first comprehensive monograph on Jurassic deposits in Pomerania was Martin Schmidt (Schmidt, 1905), presented a detailed analysis of Upper Jurassic formations, described stratigraphic and paleontologic findings, which included 415 taxa of almost all animal phyla.

The stratigraphic profile was fragmentary and, for obvious reasons, did not include layers that were later exposed as the quarrying area expanded. Based on the ammonites *Pictonia cymodoce* and *Olcostephanus berryeri*, Schmidt dated the rocks in Czarnogłowy to the Middle Kimmeridgian. The second broad description of the Jurassic rocks in Zarnglaff was provided by Deecke (1907), who presented a 25-meter stratigraphic profile, which included oolitic limestones, sandstones, and fossil-rich limestone layers.

Deecke provided a sketch of the area along with a description of the fossil assemblage, which included *Exogyra virgula, Terebratula subsella, Rhynchonella pinguis*, as well as numerous crocodilomorph teeth from the genera *Machimosaurus* and *Steneosaurus*. According to initial reports, the strata dipped 15 degrees from the northeast to the southwest. The thickness of the Jurassic sequence ranged from 10 to 80 meters, with an overburden thickness of 2 to 15 meters (Deecke, 1907).

The first comprehensive study on ammonites from Zarnglaff was published by Dohm in 1925. With access to a more extensive ammonite fauna, Dohm (1925) was able to establish a more precise stratigraphic subdivision and identified not only the Kimmeridgian but also the Upper Oxfordian.

An even more complete stratigraphic profile was later presented by Richter (1931), who identified eight ammonite zones ranging from the Upper Oxfordian to the Upper Kimmeridgian. However, Richter's scheme does not align with the earlier stratigraphic frameworks proposed by Schmidt or Dohm.

The fossils collected and described by the aforementioned researchers are still exhibited today in the small University Geological Museum in Greifswald. In addition to numerous invertebrate fossils, the museum also houses a substantial collection of vertebrate remains, including specimens of marine reptiles previously found at the site.

After WWII, Polish researchers began studies, focused primarily on paleontologic and stratigraphic aspects of the rocks exposed by excavations in Czarnogłowy. The rich Jurassic fauna available in the Czarnogłowy quarry was mainly studied by researchers from the Department of Geology at Nicolaus Copernicus University in Toruń and the Polish Geological Institute.

Kongiel (1957) determined the age of rocks exposed in the quarry to be Oxfordian to Bononian (Tithonian). He described 14 echinoid species, including two new ones, and proposed lowering the Oxfordian–Kimmeridgian boundary. A new stratigraphic scheme based on microfauna studies and referencing earlier macrofaunal profiles was developed by Bielecka and Dąbrowska (1958).

The stratigraphy of the Upper Jurassic deposits from Czarnogłowy, based on ammonites, was later studied by Wilczyński (1962), who established the most detailed lithological profile and compiled the stratigraphy of sediments observed in the quarry as reported by various authors. The researcher provided an exceptionally detailed characterization of eight profiles in both Czarnogłowy and Świętoszewo, based on lithology and faunal assemblages. In the paleontological section, he presented precise identifications of 18 ammonite species.

According to Wilczyński, the quarry walls in Czarnogłowy are composed of rock layers striking WNW–ESE, dipping towards SSW, with dip values ranging from 4° to 12°. The rocks exhibit significant lithological variability, consisting mainly of marls (oolitic, clayey, sandy, sandy-glauconitic, and dolomitic), oolitic limestones, clayey limestones, and shell conglomerates.

The thickness of individual layers varies from a few centimeters to approximately 3 meters, intersected by numerous faults. In later years, a comprehensive description of gastropods and bivalves from both Czarnogłowy was provided by Dmoch (1970). In the monumental, multi-volume work *Geology of Poland*, all taxa previously described from the studied sites were listed in the volume *Catalogue of Fossils* by Bielecka *et al.* (1970).

The brachiopod fossils from Czarnogłowy were also studied by Dzik (Dzik, 1979), who noted in his article that "the quarry has not been exploited since 1962, and no good exposure of the terebratulid-bearing layer exists." He identified *Epithyris subsella* and *Zeilleria humeralis* as the main species. Later, he also described oysters attached to algae remains, mainly *Goniolina* (Dzik, 1992).

After the quarry was flooded by groundwater (1967-1968), the acquisition of new material from the site became almost impossible. As a result, all subsequent publications have either relied on historical material housed in collections at the University of Greifswald (Kutscher, 1992) or specimens currently stored in Polish scientific institutions.

Radwańska (1999) provided a detailed account of echinoids from Czarnogłowy, based primarily on Kongiel's collection. In the early 2000s, Cedro reported about 0.6 m of rock exposure on the northern shore of Lake Czarnogłowy during low water levels (Cedro, 2005). Several new articles, conference materials, and a thesis were published, describing vertebrates from Czarnogłowy, these paleontological materials originated from old German finds housed in the Geological Museum in Greifswald.

Among the material from Czarnogłowy, the reports documented 172 reptile teeth, 36 reptilian bone fragments, 446 fish teeth, and 24 skeletal fragments (Hoffmann and Bickelmann, 2008; Hoffmann and Kriwet, 2008). In most articles and books describing Late Jurassic crocodylomorphs and Cimmerian marine reptiles found in Europe, the importance of the site at Czarnogłowy is emphasized (Young *et al.,* 2014; Weryński *et al.,* 2024).

2. The History of the „Pommersche Kalksteinwerke Zarnglaff"

The company Pommersche Kalksteinwerke GmbH, which operated limestone extraction in Zarnglaff, was founded in 1901. The following year, construction of the first ring kiln began. The plant was gradually expanded, with the installation of grinding and hydration equipment, but the company struggled with issues stemming from strong competition and insufficient working capital.

In the financial crisis, the company was aided by the secret trade advisor Friedrich Lenz (Eisenbahn-Lenz), who leased the plant for five years and provided the necessary funds for further development. In 1907, a two-chamber shaft kiln was built, and in 1910, a second ring kiln was installed. After the end of World War I, plant development accelerated. Machines were modernized, and in 1919, a steam-powered electric plant was installed.

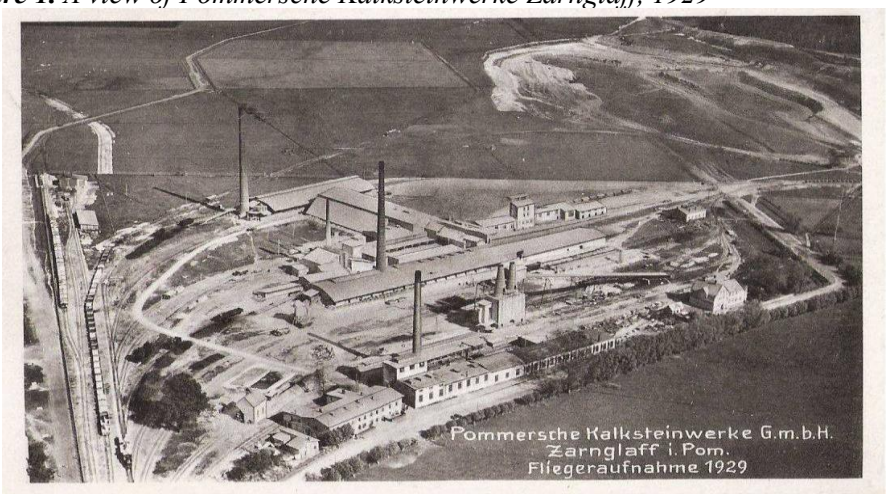
In 1921, a 85-ton electric excavator was launched in Zarnglaff, which was the first excavator in Europe to move on conveyor belts without the need for rails. The machine was so innovative that it attracted the interest of foreign specialists, and delegations from Sweden, Finland, Norway, and Spain visited Zarnglaff to learn

about its design (Ramlow, 1967). Thanks to these investments, by the 1930s, Pommersche Kalksteinwerke Zarnglaff was considered one of the most important lime production site in Germany (Flemming, 1931), and produced building lime, lime for the production of calcium-silicate bricks, and calcium fertilizers.

Over 80% of production was delivered as fertilizers to the agricultural sector. The plant included a chemical laboratory, where the quality of raw materials and final products was monitored. In 1936, a Leopold-type rotary kiln was launched, which produced 10,000 tons of quicklime per month. This was the first plant in Germany to successfully carry out the economical production of lime in a rotary kiln. Since 1911, the plant had a railway connection to the station in Rackitt (now Rokita) and, since 1903, to the narrow-gauge railway Gülzow–Stepenitz (Golczewo-Stepnica).

The entire railway infrastructure consisted of about 12 km of tracks in a three-rail system (for both standard and meter-gauge tracks). Additionally, around 20 km of 60 cm gauge tracks were purchased to service the quarry and plant. To transport raw materials, 15 locomotives and 780 self-unloading wagons were used. Continuous water pumping was necessary due to the high influx of water. Every hour, 500 m³ of water had to be removed, which resulted in an annual consumption of 550,000 kW of electricity (Ramlow, 1967).

Figure 1. *A view of Pommersche Kalksteinwerke Zarnglaff, 1929*



By the late 1920s, the company owned an area of 900 ha around Zarnglaff, of which 350 ha were used for agricultural purposes (Figure 1). In addition to production buildings, the village had 43 residential houses for workers and administrative employees, along with farm buildings, that provided accommodation for 108 families. For about 350 new workers, two brick canteens and two wooden barracks with showers and baths were prepared (Flemming, 1931; Richter, 1931).

To ensure entertainment and social integration for the quarry workers, a Workers' House (Belegschaftshaus) with an area of 360 m² for 450 people was built between 1934 and 1935, and housed a meeting room, library with about 1,500 books, caretaker's apartment, and bathhouse for workers and their families. After the outbreak of World War II, the plant continued to operate, and construction of a new cement plant with a daily capacity of 400 tons was advanced enough that production was planned to start in July 1945. In the early 1940s, this plant employed 630 workers, and in 1941, extraction exceeded 600,000 tons. By the end of the war, Quarry I (Zarnglaff) covered 45 ha, and Quarry II (Schwanteshagen) covered 15 ha (Ramlow, 1967).

3. The Post-War History of the Quarry

There is little information about the post-war operations of the Czarnogłowy plant. General data indicates that the quarry was reopened in 1947. Archival accounts indicate that, in the post-war period, the Czarnogłowy quarry operated as a forced labor camp within the People's Republic of Poland. Individuals labeled as "enemies of the people," including private merchants and landowners, were detained there, and access to the site required authorization from state security services.

Despite limited access to the excavation site, some researchers were able to conduct fieldwork; in his 1962 study, Wilczyński reported that the Czarnogłowy quarry covered approximately 0.5 km², while the Świętoszewo quarry spanned 2 hectares. In the exposure, the vertical walls in the eastern, southern, and southwestern parts of the quarry reached up to 25 meters.

At that time, there were several different operational levels in the Czarnogłowy quarry, with the northern part being exploited (height 4-6 m), while the eastern, oldest part was covered with dense vegetation.

Mining operations for limestone extraction were suspended in the mid-1960s; following the shutdown of the drainage pumps, the water level in the mine gradually rose to its present level. In the late 1960s and 1970s, fossil collecting in Poland was mainly carried out by private collectors.

Following the quarry’s closure and public access to the site, many specimens entered private collections. These are now scattered across museums in Poland (Museum of the Earth and Institute of Paleobiology, Polish Academy of Sciences in Warsaw), Germany (for example, in the collections of the Museum für Naturkunde in Berlin), and throughout Europe.

Although only a small portion of the stratigraphic section is currently accessible and most of the spoil heaps are now overgrown with forest, it is still possible to collect paleontologically significant specimens at the site.

4. Present State

The Czarnogłowy quarry is currently completely flooded with groundwater, forming a large lake. A small sandy beach on the western shore attracts many tourists on warm days. The area features a parking lot, renovated shelters, benches, a fire pit, and a short educational trail with informational boards about the local environment. The lake is popular with both anglers and recreational divers. However, visibility is often poor due to suspended particles, with the best diving conditions typically occurring from mid-September. Notable underwater features include vertical rock walls, remnants of a pumping station in the south, and a submerged forest in the eastern part of the lake. The old buildings of Pommersche Kalksteinwerke are now in ruins. On part of the former cement plant's land, there is a grain warehouse owned by an international corporation involved in grain trading and storage.

Since 2013, the southern and eastern shores of the lake have been protected as part of the 49.11-hectare Wołczenica River Gorge Nature Reserve. The goal of nature conservation within the reserve is to preserve the post-glacial landscape with the Wołczenica River gorge, along with its diverse flora and plant cover growing on its steep and rocky shores.

The area around the lake is also a site for occasional field trips for geology students and fossil hunters. It is important to note that due to the legal protection of this area, there is an absolute ban on fossil hunting and collecting in the Wołczenica River Gorge. Fossil hunting is only permitted on the northern and western shore of the lake.

5. Summary

The Czarnogłowy quarry is a unique place not only in terms of geology but also historically. Aside from individual historical exposures this is the only place in Western Pomerania where rocks older than the Quaternary could be studied *in situ*. Over several decades of exploitation – first under the Pommersche Kalksteinwerke GmbH and later, in the post-war period, by the Polish lime plant – this location has provided many unique Upper Jurassic fossils.

These fossils have been, and continue to be, the subject of numerous scientific studies by both German and Polish researchers. The closure of the quarries in Czarnogłowy, represents a significant loss for geology and paleontology. Reopening the now-flooded excavation sites is, of course, no longer feasible, and thus the opportunity to describe new taxa from these localities is very limited.

References:

Bielecka, W., Dąbrowska, Z. 1958. Uwagi o stratygrafii malmu Pomorza Zachodniego okolic Kamienia Pomorskiego. Biul. Inst. Geol., 142, 5-72 [in Polish].

Bielecka, W., Birkenmajer, K., Karczewski, L., Liszkowa, J., Malinowska, L., Nowak, W., Styk, O. 1970. Upper Jurassic fauna. In S. Sokołowski (Ed.), Geology of Poland, Vol. II: Catalogue of Fossils. Part 2: Mesozoic. Warszawa: Wyd. Geol.

Cedro, B. 2005. Rozmieszczenie i stan obecny odsłonięć osadów mezozoicznych na Pomorzu Zachodnim. In: R.K. Borówka and S. Musielak (eds.), Środowisko przyrodnicze wybrzeży Zatoki Pomorskiej i Zalewu Szczecińskiego, 75-90. Uniwersytet Szczeciński, Szczecin [in Polish].

Deecke, W. 1907. Geologie von Pommern. Gebrüder Bornträger, Berlin.

Dmoch, I. 1970. Ślimaki i małże górnojurajskie Czarnogłowów i Świętoszewa oraz warunki paleoekologiczne w jurze górnej na Pomorzu Zachodnim. Studia Societatis Scientiarum Torunensis, Sectio C (Geographia et Geologia), 7(2), 1-113.

Dohm, B. 1925. Ueber den oberen Jura von Zarnglaff in Pommern und seine Ammonitenfauna. Abhandlungen aus dem geologisch-palaeontologischen Institut der Universität Greifswald.

Dzik, J. 1979. Some terebratulid populations from the Lower Kimmeridgian of Poland. Acta Palaeontologica Polonica, 24(4), 565-584.

Dzik, J. 1992. Dzieje życia na Ziemi. Warszawa: Wydawnictwo Naukowe PWN, Warszawa.

Flemming, R. von 1931. Die Pommerschen Kalksteinwerke G.m.b.H. Zarnglaff i. Pom. (163). Deutschlands Landbau. Länderdienst A.G., Berlin-Halensee.

Hoffmann, N., Bickelmann, C. 2008. Upper Jurassic marine reptiles from Northwest Poland. Palherp.

Hoffmann, N., Kriwet, J. 2008. Elasmobranch remains from the Late Jurassic of NW Poland. Ichthyolith Issues, Special Publication, 11, 9-10.

Kongiel, R. 1957. Uwagi o jeżowcach górnojurajskich z Czarnogłowu i Świętoszewa na Pomorzu Zachodnim. Biuletyn Instytutu Geologicznego, 105, 5-74.

Kutscher, M. 1992. Die Echiniden aus dem Malm von Czarnogłowy (ehemals Zarnglaff, Pommern), Polen. Aufschluss, 43, 215-228.

Radwańska, U. 1999. Lower Kimmeridgian echinoids of Poland. Acta Geologica Polonica, 49(4), 287-364.

Ramlow, M. 1967. Camminer Heimatgrüße, Nr. 120 & 122 [in German].

Richter, K. 1931. Geologischer Führer durch die Zarnglaf–Schwanteshagener Malmbrüche. Mitteilungen aus dem Geologisch-paläontologischen Institut der Universität Greifswald, 7, 1-26.

Schmidt, M. 1905. Über Oberen Jura in Pommern. Abhandlungen der Königlich Preußischen Geologischen Landesanstalt und Bergakademie. Neue Folge, 41, 1-222.

Weryński, Ł., Błażejowski, B., Szczygielski, T., Young, M.T. 2024. The first occurrence of machimosaurid crocodylomorphs from the Oxfordian of south-central Poland provides new insights into the distribution of macrophagous teleosauroids. Peer J., 12, e17153. https://doi.org/10.7717/peerj.17153.

Wilczyński, A. 1962. Stratygrafia górnej jury w Czarnogłowach i Świętoszewie. Acta Geologica Polonica, 12(1), 3-112.

Young, M.T., Hua, S., Steel, L., Foffa, D., Brusatte, S.L., Thüring, S., Mateus, O., Ruiz-Omeñaca, J.I., Havlik, P., Lepage, Y., Brandalise de Andrade, M. 2014. Revision of the Late Jurassic teleosaurid genus Machimosaurus (Crocodylomorpha, Thalattosuchia). Royal Society Open Science, 1(2), 140222. https://doi.org/10.1098/rsos.140222.