Silicites of the Blovice Complex (Western Bohemia) – their Probable Genesis, Position and Utilization

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Abstract

This article deals with silicites (lydites) and their characteristics in the environs of Western Bohemian villages of Skašov, Týniště and Kbelnice (former Plzeň – jih county). These rocks form long and narrow lenticular bodies in adjacent rocks of the so called Blovice complex (the southern part of Bohemicum, the Teplá – Barrandian part). However, the origin of silicites has not been fully clarified so far. Authors of many studies differ in their opinion – whether these rocks originated either in shallow waters or deep (oceanic) ones, which processes made for this kind of silicites, whether microorganisms were involved, et cetera. In the past, these rocks were quarried because of their excellent properties – hardness, strength as well as a minimum inhibition and utilized for soling forest ways as well as roads and for various constructions including basements, walls and even whole houses – residential and farming ones. In the area, there are many evidences of quarrying lydites in the form of various pits and abandoned quarries with remnants of technology (ramps, service buildings, etc.). The article is supplemented (by / with) original photos as well as simplified maps within the frame of this text.

Keywords: *Silicite (lydite), Blovice complex, accretionary wedge, rock genesis, quarrying the stone, utilization*

1. Introduction

Silicites (lydites) form a part of the so called Bílovice complex which represents the south – western part of Bohemicum, concretely the Teplá – Barrandian zone. Silicites represent a very important occurrence of the Late Neoproterozoic in this region; it is obvious that recurrent processes of magmatism, erosion, sedimentation, accretion, and tectonics used to take part there. These processes were active until the Middle or even Upper Cambrian (see below).

Nevertheless, the boundary of the Upper Proterozoic and Cambrian towards NE is mainly tectonic one [6] and new views of the regional paleogeography (i.e., accretion wedge at the Gondwana northern margin) are based on recent and more precious methods of absolute dating.

The origin of silicate bodies – however – remains the subject of theories. Some authors prefer the origin in shallow waters (the so-called photic zone), others suppose deep ones near subaquatic sources of magmas. A possible role of microorganisms is widely debated as well.

In the past, silicites were intensively quarried with one important advantage – rocks were accessible in local quarries as the most suitable material for constructional purposes (beddings, walls and even whole buildings. The main advantage of the rock was an easy cleavability and possibility to put fitting pieces together.

Nowadays, silicites form prominent rocky walls and knobs which give the landscape its character. Signs of former quarrying can be seen almost everywhere.

The article describes these remnants of quarrying locations in the area covering roughly 10 km2, situated in the Blovice complex central part lying SE from the town of Přeštice.

Besides maps and original photos, the article includes citations from old municipal chronicles which mention (though sporadically) quarrying the stone and utilizing it.

Actual remnants of silicate quarries in the area are maybe the last reminders of once intensive human activities here.

2. The geological past

The absolute dating of the Blovice complex is not very exact even if recent studies based on fragmental zircons from (meta)greywackes shifted or knowledge regarding the development and age of rocks in question.

The authors of study [4] regard the Blovice complex a metamorphosed accretion wedge situated at the northern margin of Gondwana. This wedge was formed during the Cadomian orogenesis; the maximum of zircon samples corresponds with the Late Cryogenian and Early Ediacaran. In the Bohemian Massif, the Cadomian era was not limited only to the Neoproterozoic – cyclic periods of magmatic events, erosion, sedimentation accretion and tectonic phenomena was probably prolonged to the Upper Cambrian (499 Ma) since zircons of this age are dominant in some samples. Moreover, it is highly probable that most materials underwent accretion about 527 Ma with following phases of plutonism. According to the authors of study mentioned above, Cambrian samples give the evidence existing forearc basins which covered the accretion wedge. These processes were controlled through the oceanic subduction which occurred in the terminal phase, followed by opening the Rheic ocean (490–480 Ma) and di-

Fig. 1. A rare silicite rock with rough laminar texture
Rys. 1. Rzadka skała krzemianowa o szorstkiej warstwowej teksturze

Fig. 2. crackled silicate with secondary quartz (left) and rare flow folds in the same type of stone (right)
Rys. 2. Krzemian spękany z wtórnym kwarcem (po lewej) i rzadkimi fałdami płynięcia w tym samym typie kamienia (po prawej)

vergent tectonic processes. The terranes of Cadominan age then become parts of the Cadomian orogeny.

3. The question of genesis

The issue of silicites and their origin is still the matter of debates. Generally, these rocks are considered silicified, fine grained oceanic sediments which occurred near hydrothermal vents, probably in the presence of microorganisms. Some other authors prefer the origin of silicites in shallow waters (photic zone) due to their palaeontological content and locally depicted "stromatolitic" structures [11, 13, 14]. Nevertheless, it is necessary to regard the area where silicites originated – the Ediacaran period should provide some samples of its typical biota. Unfortunately, there is no reliable evidence of it in the Bohemian Massif [12].

On the other hand, it is necessary to allow for a tight relationship between submarine magmas (spilites) and their basaltic character [8]. This solution is, for instance, preferred by Dubanská et al. [3].

Cílek et al. [1] assume silicates used to originate near hot submarine resources where magma was in contact with seawater. During this process, alkali were released and dissolved silicium in adjacent rocks. Microorganisms were probably involved too. Under these conditions, materials coagulated into silicate bodieies. Cílek also explains why silicites of a later datation do not occur. Sea sponges and radiolarites build their skeletons of silicium dioxide – therefore this material was not later available.

Dick et al. [2] also suppose that hydrothermal vents near active ridges inside sea basins [5] had a potential to host microbial life – together with abiotic processes, this circumstance could make for the origin of silicites.

4. The stone and its properties

Silicites of the Blovice complex are grey or black-grey (because of graphite content), mostly massive but sometimes with laminar textures (Fig. 1).

Due to their hardness and resistance, these rocks underwent a fragile deformation only [7]; during two orogenic cycles (Cadomian and Alpine) they were fractured, which resulted in many chaotic crackles and crevices from microscopic ones to several decimeters, always filled with white quartz.

However, the question of fragile deformation is not so clear; plastic ones had taken place as well – it is obvious in Fig. 2 (right). The sample was found in the chaotic terrain westwards of Týniště. Subtle flow folds have amplitudes from 5 to 10 milimeters.

Planes of separation are often covered with limonite. Mrázek and Pouba [9, 10] emphasize a higher content of Fe, V and U. Sources [11, 13, 14] then mention microfossils as written above.

In the slightly indented terrain of the Plzeň upland, silicites represent distinct landscape dominants – from particular rocks to long rock walls which copy particular silicate bodies. Most of these bodies SW – NE oriented and walls are often higher than 20 meters.

As the locally available material, silicites became very popular among local people. The hardness and durability

Fig. 3. The wall of residential house, where silicate piecesare combined with adobes. Especially northern walls below slopes had to be reinforced because of abrupt strong floods
Rys. 3. Ściana domu mieszkalnego, gdzie kawałki krzemianu są połączone z cegłą. Zwłaszcza północne ściany poniżej stoków musiały zostać wzmocnione z powodu nagłych, silnych powodzi

Fig. 4. The piece of touchstone with lines of gold. The stone in the form of finely brushed enables to distinguish gold from common metals and even roughly assess its purity
Rys. 4. Kamień probierczy z liniami złota. Kamień w formie drobno szczotkowanej pozwala odróżnić złoto od metali nieszlachetnych, a nawet z grubsza ocenić jego czystość

(together with an easy workability) predestined silicites for constructional works – roads, basements, and even houses both farming and residential ones. The stone was often combined with other materials, i.e., bricks, adobes, etc. (Fig. 3).

It is also useful to mention another silicate utilization – it is important for jewelers and goldsmiths as the touchstone (Fig. 4).

5. Selected locations – a brief description

SKAŠOV – the quarry is located about 600 m to NNW from the northern part of village. The chaotic rocky terrain in the middle of an old spruce forest represents a remnant of silicate quarry. There is a dominant rocky tor, simply called "Rock" (Fig. 5).

Direct witnesses of quarry activities do not live; however, it is obvious that working there had to be long and intensive, providing lots of stone. From the surrounding debris, suitable pieces were taken out or boulders were cleaved, and particular pieces were trued in order to obtain the best result.

Nowadays, there is a remnant of reinforced concrete pillar, originally carrying a stone crusher. Many local people believe that the crusher was installed during World War II or shortly later. This conjecture may be supported by the current condition of pillar: its concrete is strongly deteriorated – it is obvious that builders used a minimum of concrete filled with dine silicate gravel pieces. The structure is reinforced with thin and corroded iron wires; surface effects of suffusion are well visible (honeycombs, deep dents) which corresponds with a war scarcity of any quality concrete (Fig. 6).

The Municipal chronicle of Skašov provides another important guideline – besides traditional social reports, the early 1936 report writes [16]:

"The state road between Towns of Přeštice and Nepomuk was reinforced with gravel and rolled. Many Skašov inhabitants were involved in crushing the stone in the Kaiser´s quarry and others transported it".

Had the owner possessed any industrial crusher, he would not have needed and paid so much manual work.

TÝNIŠTĚ – the silicite quarry near Týniště is now hidden in the spruce forest; the area was certainly utilized for a long time. Towards Skašov there are numerous pits of different depth and diameter or trenches (Fig. 7). People obviously used to pick suitable pieces of stone from debris below rocks here (the so-called wild digging). Today, the debris is buried below the forestland.

The Municipal chronicle mentions reinforcing the state road as well. The chronicler writes [15]: "This year (1936), the Management of state roads has begun repairing the route between Přeštice and Nepomuk. The road metal for rolling the surface between Újezd and Skašov was provided by Mr. V. Kastner owning the rock called "On doomsday hill". That work employed many local people; this had a good impact on improving social circumstances for the period works were going on".

KBELNICE – The quarry near the village of Kbelnice was founded in the 1950´s and then operated by the "Zapadokámen Plzeň" national enterprise. Nowadays, the surrounding area is covered with a young mixed forest, while the

Fig. 5. A typical silicate rock in the Skašov forest
Rys. 5. Typowa skała krzemianowa w lesie Skašov

Fig. 6. The pillar of former stone crusher and its detail
Rys. 6. Fundament dawnej kruszarki kamienia i jego detal

Fig. 7. Remnants of wild digging near Týniště. A typical pit in the forest (left) and debris around one of rocks (right)
Rys. 7. Pozostałości "dzikiego" wydobycie w okolicach Týniště. Typowy dół w lesie (po lewej) i gruz wokół jednej ze skał (po prawej)

central part is utilized as the deposit of biomass. At the entrance to the former quarry, a well-preserved concrete pillar of crusher is visible as well as the operational building (now probably a vacation object). The Municipal chronicle of Letiny (Kbelnice forms one of its parts) does not provide any information regarding the quarry. However, it is known that the quarry was utilized very intensively. Recently, the information plate has been installed, providing brief data of general character, unfortunately without any geological features (Figs. 8,9).

6. Selected properties of silicates and some other building stones

Technical parameters of a quarry stone are very important for its application. While advantages of silicite have been mentioned above, it is useful to allude some other local sources. In this particular case, we can compare silicites with basaltic rocks of the České středohoří mountains. Rocks are utilized as reinforcing materials and for building communications. It is necessary to emphasize that the medieval Borough of Ústí nad Labem was built of local basalts and trachytes, locally with blocks of soft sandstones.

Fig. 10 documents essential differences in the stone quality. Silicites are compact, hard but well workable (left). Basaltic rocks of the České středohoří mountains differ in their quality from place to place. The photo in the middle is a good example of mechanical loosening of the original laccolith due to unloading in the course of vertical deepening, now 90 meters below the surrounding terrain. The sone is nonetheless still suitable for reinforcing roads and railway lines. The right photo explains why the České středohoří protected land area (PLA) is so much affected by both abandoned and active quarries. In the past, pitmen were not constrained to consider environmental rules. In a case of bad stone quality, they simply opened another quarry inside a nearby hill. The Soutěsky quarry represents the typical example of a failed work. The

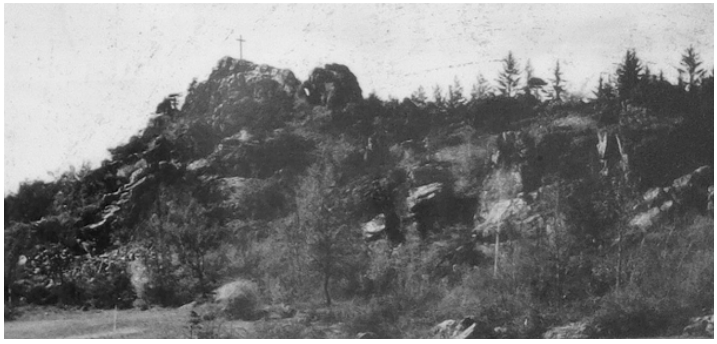

Fig. 8. A rare photo of Kbelnice quarry from the information plate
Rys. 8. Unikalne zdjęcie kamieniołomu Kbelnice (z tabliczki informacyjnej)

Fig. 9. The former quarry and its present day situation
Rys. 9. Dawny kamieniołom i jego obecna sytuacja

Fig. 10. A compact silicite rock (left). Fissured trachytes in the center of Ústí na Labem (middle) and weathered basalts in the Soutěsky quarry near the town of Děčín (right)
Rys. 10. Zwarta skała krzemionkowa (po lewej). Spękane trachyty w centrum Ústí na Labem (w środku) i zwietrzałe bazalty w kamieniołomie Soutěsky w pobliżu miasta Děčín (po prawej)

only one advantage was the layer of column basalt. After 1990, the private owner used to produce decorative garden accessories (cobble stones, pavements, mullions, lamps, stools, etc.). The activity has recently been finished.

Nowadays, several large quarries still work as private facilities (Dobkovičky, Libochovany, Ústí nad Labem, etc.). Here is necessary to express one aggravating thing; until 1990 the rule was valid that quarries are not allowed to change the contour of horizon. Since then, private companies do not observe this rule and exploit their sources "without any mercy".

Finally, the table of selected properties of various rocks is included (more sources).

7. Conclusion

The Blovice Neoproterozoic complex of the Teplá – Barandian zone is a part of former accretion wedge nat the northern margin of Gondwana. Cyclic activities were connected with subduction which disappeared at the Cambrian - Ordovician boundary. The convergent character of plate tectonics here was changed into the divergent one.

The Blovice complex contains (meta)greywackes, spilites, basalts, andesites, slates and bodies of silicites – hard and durable rocks. According to some opinions, they were formed near submarine volcanic eruptions or hydrothermal vents via silicification in a presence of microorganisms. The depth of water is still questionable – authors cannot agree whether silicites originated in shallow photic zones or near abyssal sources of heat.

Today, silicites of the Blovice complex are found in the form of long and narrow lenticular bodies inside adjacent rocks.

Owing to their good mechanical properties (hardness, durability and good cleavability), silicites were utilized as building materials for local purposes as well as reinforcing metal, even to the end of 1980´s.

The article describes three abandoned quarrying sites.

Tab. 1. Table of selected properties of various rocks is included (more sources)
Tab. 1. Zestawienie wybranych właściwości skał

ROCK	Classified as	Example	Volume weight ($kg.m^{-3}$) ČSN 721154	Absorbing power ČSN 721155	Pressure resistance (MPa) ČSN 721163
igneous	plutonic (leucocratic)	granite	2500	0,7	90
igneous	plutonic (melanocratic)	diorite, gabbro	2800	0,7	90
igneous	effusive (compact)	andesite	2500	5,5	80
igneous	effusive (porous)	trachyte	2000	3	80
sedimentary	clastic (compact)	sandstone (compact)	2500	5	40
sedimentary	clastic (porous)	sandstone (porous), marl	1800	15	15
sedimentary	chemogenic	silicite	~2500	<1	
metamorphic	carbonate	crystallinelimestone, marble	2600	0,8	40
metamorphic	siliceous	gneiss	2500	1	60

Two of them had rather industrial character, the third one was used for local "wild" digging activities. In 1936, quarrying and manufacturing the stone was organized in the private quarry between Skašov and Týniště in order to repair the local state road.

Nowadays, quarries are abandoned but their remnants and numerous pits prove human activities in this countryside.

8. Acknowledgements
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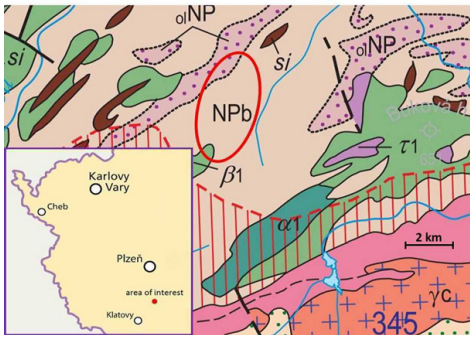
The cutout of the geological map comes from the source [6].



The area of interest and its position in the Western Bohemia combined with detailed geologic map. Particular symbols represent: α1 – andesites, β1 – basalts, γc – granites, tonalites, olNP – olistostroms, NPb – schists, greywackes, si – silicites (small bodies not mapped), τ1 – Neoproterozoic metamorphites, 345 – approximate age of igneous rocks from zircon and monazite. Г ПТ П – contact aureole of pluton.

Krzemiany kompleksu Blovice (Czechy Zachodnie) – ich prawdopodobna geneza, pozycja i wykorzystanie

W artykule omówiono odmianę allotropową krzemu – silicyt (lydit) i jej charakterystykę występujących w okolicach zachodnioczeskich wsi Skašov, Týniště i Kbelnice (dawny powiat pilzneńsko-jih). Skały te tworzą długie i wąskie ciała soczewkowate w sąsiednich skałach tzw. kompleksu Blovice (południowa część Bohemicum, część Teplá – Barrandian). Jednak pochodzenie silicitów nie zostało dotychczas w pełni wyjaśnione. Autorzy wielu opracowań różnią się w swoich opiniach – czy skały te powstały w wodach płytkich czy głębokich (oceanicznych), jakie procesy dokonały się dla tego rodzaju krzemianów, czy w grę wchodziły mikroorganizmy i tak dalej. W przeszłości skały te były wydobywane ze względu na swoje doskonałe właściwości – twardość, wytrzymałość, były wykorzystywane do podbudowy dróg leśnych oraz do różnych konstrukcji w tym piwnic, murów, a nawet całych domów – mieszkalnych i gospodarczych . W okolicy znajduje się wiele śladów wydobywania lyditów w postaci różnych dołów i opuszczonych kamieniołomów z pozostałościami technologii (rampy, budynki usługowe itp.). Artykuł jest uzupełniony oryginalnymi zdjęciami oraz uproszczonymi mapami.

Słowa kluczowe: *odmiany allotropowe krzemionki, Silicit (lydit), złoże Blovice, geneza skały, wydobywanie kamienia, wykorzystanie*