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THE FATE OF SHOKHA QUARTZITE AS A BUILDING AND DECORATIVE STONE

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The background of crimson quartzite, a unique stone with properties second to none, is discussed. The wide use of the stone in the past has made it famous, but the area where it was and is quarried has not become a monument. The authors wish to attract the attention of the reader to this area and to establish a mining and industrial park nearby.

The Shoksha quartzitic sandstone deposit is part of the geological and mining heritage. Its outcrop lies 65 km from Petrozavodsk, on the shore of Shoksha Bay of Lake Onega (fig. 1). The bay is deep enough for cargo ships which transport the stone.

Shoksha quartzite has a rare crimson colour, a fine-grained structure and a high wear resistance. The stone can be polished. The Chesmen Column in the Catherine Park of Tsarskoe Selo, the frieze of Mikhailovsky (Engineer) Castle, the mosaic floor of The Kazan Cathedral, the reception rooms of The Winter Palace, some of the fragments of The Isaac Cathedral's iconostasis, the base of the monument to Nicholas I in Sankt-Petersburg and the Napoleon Bonaparte sarcophagus in Les Invalides in Paris are all the immortal witnesses of the grandeur of the crimson quartzitic sandstone. The stone is now used for the production of paving slabs, decorative facing and ritual articles, staircases, tabletops and windowsills, ball mill lining and in landscaping.

Quartzite in general is an extremely brittle stone. Its brittleness is responsible for the high fracturing of the rock sequences where the stone is common because of tectonic processes in the earth crust. Therefore, the quantity of large stone blocks



Fig. 1. Location of the Shoksha quartzite deposit (on the background of Google Map)

Рис. 1. Położenie złoża kwarcytu Shoksha (na podkładzie Google Map)

produced is too small to sustain the high economic production rate of a stone-quarrying company. People involved in stone processing business are reluctant to deal with quartzite because it is hard to process and its sawing, grinding and polishing are expensive. Therefore, to be used as a facing stone, quartzite is expected to have some extraordinary parameters.

A great interest in the Shoksha quartzitic sandstone persists for over 200 years. Its high decorative properties, unique colour and homogeneity have made the stone a symbol of wealth, power and glory. It is known as tsar's/noble stone, and the rock itself is now on top of stone art. Therefore, the deposit is now regarded as both a geological monument and a mining and industrial heritage site.

1. Geological reference

In accordance with the official version of Karelia's Regional Stratigraphic Scale, used for constructing Russia's General Precambrian Scale, the Shoksha quartzite belongs to the Vepsian horizon, which is the uppermost Paleoproterozoic superhorizon (Vepsian, 1800–1650 Ma). It consists of red continental alluvial-lacustrine-delta mature monomictic quartz deposits formed in a hot, arid climate (Paleoproterozoic..., 1991) Thus, Shoksha quartzitic sandstone is well-graded, closely packed metamorphosed sediment of marine coastal origin. Rock exposures contain geological signs and markers of its environment and mode of formation such as parallel and cross-diagonal bedding, ripple marks from the shallow-water zones, mud cracks, traces of raindrops, hieroglyphs, sedimentation and gleying. As the stone has a rare and deep purple colour (fig. 2), it was called porphyry (the Greek word "*porphyros*" means "purple", "blood-red"). This colour is due to the presence of thin iron oxide (Fe_2O_3) lamellae. It should be noted that the stone is arbitrarily



Fig. 2. Polished Shoksha crimson quartzite (Photo: N. Shekova)

Ryc. 2. Polerowany fragment czerwonego kwarcytu Shoksha (fot. N. Shekova)

called “porphyry” because it is similar in colour and pattern to porphyry, which is of magmatic origin.

The physico-mechanical properties of the stone are typical of quartzite: true density is 2.67 g/cm³, average density is 2.63 g/cm³, porosity is 0.015 %, water absorption is no more than 0.1 %, compressive strength is 200–250 Mpa and frost resistance (cycles) is 300 (after tests made in the Test Center of the Institute of Geology Karelian Research Centre RAS). Therefore, the stone is weather-resistant and its radionuclide content is 63 BC/kg.

Its mineral composition shows that Shoksha quartzite is practically pure quartz (up to 98%).

2. The history of the Shoksha quartzite investigation and use

We can hardly find out now who was the first to discover the stone. Records tell us that the Shoksha quartzitic sandstone was quarried as early as the 18th century as a refractory material for lining the interior of furnaces for iron production from lake-bog ore. The stone was in great demand for Karelia’s metallurgy.

A well-known Russian traveler, Academician N.Y. Ozeretskovsky, visited Shoksha in 1785. In his travel notes he mentioned the quarrying of pale-green and reddish sandstone in the vicinity of Shoksha. He wrote that the stone “is used in Petrozavodsk in iron smelters or blast furnaces, in which the stone can resist heat much longer than any other brick” (Ozeretskovsky, 1989). The deposit was discovered by Frenchman Louis Antoine Leyson Le Duc (1815–1889), who was involved in search for stone for Napoleon’s tomb in Russia and other countries. A few years after his return from Russia Le Duc wrote a book (Le Duc, 1873), in which he argued that “consultations in the Emperor’s Mining School in Paris” led him to conclude that he

is the true discoverer of Shoksha quartzite (Touret & Bulach, 2016). As a journalist, the Frenchman was far from geology and mineralogy, but he was considered as an expert in Russia and Finland, so he was asked to seek for and deliver the stone.

While in St. Petersburg in 1845, Le Duc applied for help to Italian engineer Jean-Francois Bouyatti, who had lived in Russia for a long time and seems to have sent Le Duc the stone samples sent earlier to Paris. In the early 18th century the Olonets Province, now known as Karelia, already had a well-developed stone industry and shipped high-quality building and facing stone to St. Petersburg, Russia's capital. Shoksha quarries are in the historical Vepsian Volost (administrative unit in Russia), where stone quarrying and stone cutting were a common type of seasonal work done by all able-bodied men. For example, workers from the Vepsian Volost were involved in the construction of the embankments and many monumental buildings in St. Petersburg, Riga and Revel and the stone fortresses in Kronshtadt and other places. It is very unlikely that in the several dynasties of professional stone cutters, who lived nearby, no one was fascinated by a beautiful stone of unusual exposed in the area. Hitherto, only a few experts knew about "red porphyry", but owing to the energy and efforts of Frenchman Leyson Le Duc, the Shoksha quartzitic sandstone deposit soon became known all over the world.

Researchers note that "local proprietors were reluctant to recognize the newcomer. They tried to do their best to reject the project" of the quarry development, proposed by the Leyson Le Duc (Touret & Bulach, 2016). The first-guild merchant M.P. Pimenov, a local proprietor who lived in St. Petersburg since the 1820s, is worth mentioning. He amassed a big fortune quarrying and shipping building stone from the area. The merchants' resistance was probably so strong that Emperor Nicholas I had to support the Frenchman and allowed him to begin quarrying. The Frenchmen launched large-scale quarrying, producing hundreds of blocks of various sizes and "completely destroying the landscape".

The newspaper *Olonetskie Vedomosti* wrote at the time that 28 blocks of the Shoksha quartzite were sent to France as a gift, which was not quite true. Nicholas I "not only allowed to start quarrying, but also did not impose any taxes on the stone quarried". The total sum agreed upon, which included the cost of the quarrying of quartzite monoliths and their delivery to France, was 200 000 francs. Thus, thanks to the general political gesture, made by Nicholas I, the Frenchmen saved 80 000 francs: the market value of the stone blocks produced (2000 francs/m³) and 6 000 francs as the cost of tax exemption (Touret & Bulach, 2016).

To make Napoleon's sarcophagus, 27 to 29 blocks were selected for shipment to Paris. It is well-known that the total volume of the blocks was 38 m³ and that the largest block was 4.6 × 2.9 × 1.06 m in size (Bouyatti saved it for the making of an external sarcophagus). At that time quartzite was used on a small scale, and its application is poorly documented. The striking and outstanding history of the Shoksha quartzite is also remarkable in that the Frenchmen had never dealt with such a hard rock before. Therefore, to speed up the processing of the blocks, they

had to design steam machines with a total capacity of 60 horsepower. It was a real technological revolution (Touret & Bulach, 2016)

As a result of their efforts, Napoleon's tomb in the House of Invalids in Paris was created (fig. 3). The authors (Touret & Bulach, 2016) note that *“Napoleon's tomb and the crypt were designed in 1843 by architect Louis Visconti. The large sarcophagus is in the centre of the crypt; it is observed in two foreshortenings: from above and from below, so that each visitor shows his respect to the Emperor twice. The walls of the crypt and the galleries around it are made of white Carrara marble and carry the high-reliefs and sculptures of the allegories of Napoleon's twelve victories. The mosaic floor displays a variety of bright colours: sunny yellow, green, sky-blue and violet. The architect's idea was to compensate the classical simplicity of the lines and contours by the grandeur of the materials and the harmony of their colour combinations”*. In their paper (Touret & Bullach, 2016) the authors discuss in detail the design and creation of the sarcophagus.

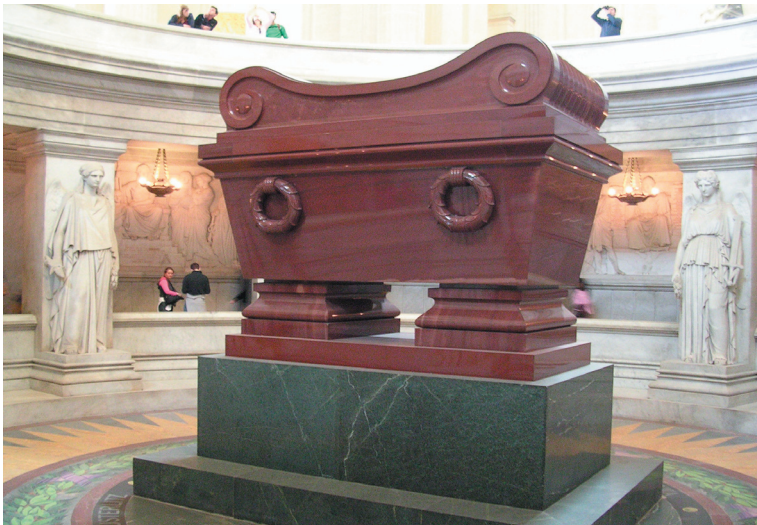


Fig. 3. Napoleon's sarcophagus in Dôme des Invalides, Paris (<https://karelianstone...>, 2017)

Ryc. 3. Sarkofag Napoleona w Kościele Inwalidów, Paryż (<https://karelianstone...>, 2017)

Later stages in the evolution of Shoksha quarry were not so striking and are poorly documented. The stone was used occasionally to produce architectural, sacral and other piece goods. On 25 July, 1859, a monument to Nicholas I was solemnly opened on Isaac Square in St. Petersburg. The equestrian statue of Nicholas I, created by P.K. Klodt, stands on a Shoksha crimson quartzite base (fig. 4) designed by Augustus Montferrand, the famous creator of the Isaac Cathedral. The statue has one distinctive feature: the horse (according to the legend, it is a replica of Amalatbek, the Emperor's favourite stallion) stands on two feet, and the monument is balanced so well that it is stable and does not fall. Therefore, the monument is regarded as an



Fig. 4. Monument to Nicholas I, Isaac Square, St. Petersburg (<https://commons...>, 2017)

Ryc. 4. Pomnik Mikołaja I, Petersburg (<https://commons...>, 2017)

engineering miracle. The bas-reliefs, inserted into the base, concentrate the attention of the viewer on events from the Emperor Nicholas I epoch.

Augustus Montferrand was an expert in facing and decorative stone and used his knowledge and skills. Therefore, the Isaac Cathedral, which he designed, is sometimes called “a stone museum”. To recognize Montferrand’s great contribution, his bust was created using all the types of stone he used for the construction of the cathedral (fig. 5). The red bandoleer on the bust is made of the Shoksha crimson quartzite (Shekov, 2006).

The tradition of using the Shoksha quartzite as “tsar’s stone” was followed in the Soviet period. The quarrying of the deposit resumed in 1922, but quartzite was used as a facing stone less commonly, primarily because of a low block yield when natural fracturing is combined with dislocations caused by blasting. In 1932–1933 and in 1939, the Shoksha quartzite was tested as a refractory and as a material for producing milling bodies (scree) for ball mills. As a matter of fact, until 1992 lining material and milling bodies had been the main products of the quarry.

In Soviet time the deposit was owned by the Kremlin Quarry Administration. Therefore, stone for construction was produced by the permission of Soviet and



Fig. 5. A. Montferrand's bust in Isaac Cathedral in St. Petersburg
(<http://ilovepetersburg...>, 2017)

Ryc. 5. Popiersie Augustusa Montferranda w Soborze Św. Izaaka w Petersburgu
(<http://ilovepetersburg...>, 2017)

Communist Party leaders. In accordance with a Communist party of Soviet Union (CPSU) Central Committee's decree adopted later, crimson quartzite could only be used to meet the needs of the Communist Party and the Government.

The brittleness of the stone has predetermined its destiny. It is easily cut on stone-cutting machine-tools; the economic indices of this process are very high. Quartzite is not widely used as a decorative facing stone in significant structures due to a low production rate (low yield of large blocks is no more than 3%) and processing problems (high hardness).

In 1944 the pylons at Baumaskaya Station of Moscow Underground were decorated with white marble and pieces of the Shoksha quartzite were inserted in accordance with B.M. Iofan's type design to emphasize the grandeur of the statues of the Great Patriotic War heroes (fig. 6 A; <https://ru.wikipedia...>, 2017). In 1954, a monument to Lenin, designed by architect A.I. Gegello, was erected in Kazan. The pedestal is made of the Shoksha quartzite (fig. 6 B). The author of the red flag, made of the Shoksha quartzite (fig. 6 C), and its location remain a mystery. According to one version, this sculpture is located in Yerevan, but all attempts to find it have failed. The authors of the composition, the people who made the monument and its location are unknown.



Fig. 6. Examples of application of Shoksha quartzite: A – Baumanskaya underground station in Moscow (<http://natur-kam.ru...>, 2017), B – a monument to Lenin in Kazan (Photo: V. Shekov), C – a sculpture of a flag (Photo: A.V. Ryleev), D – Memorial Grave of the Unknown Soldier in Moscow (<http://natur-kam.ru...>, 2017)

Ryc. 6. Przykłady zastosowania kwarcytu Shoksha: A – stacja metra Baumanskaja w Moskwie (<http://natur-kam.ru...>, 2017), B – pomnik Lenina w Kazaniu (Photo: V. Shekov), C – rzeźbiona flaga (Photo: A.V. Ryleev), D – Grób Nieznanego Żołnierza w Moskwie (<http://natur-kam.ru...>, 2017)

The distinctive colour of the Shoksha quartzitic sandstone, the high degree of fracturing of blocks, processing problems and, consequently, the high price of such products markedly restricted the use of quartzite as a facing decorative stone. Therefore, stone waste was never thrown away and was used for construction. For example, quartzite chips were used for decorating the façade of N.M. Nelgovsky's former "dokhodny dom" built in 1910–1911 in Chernyshevsky Avenue, 8 in St. Petersburg (Bulach, 2002). In 1967 the memorial architectural ensemble, The Grave of the Unknown Soldier (fig. 6 D), designed by architects D.I. Burdin, V.A. Klimov and Y.R. Rabaev and sculptor N.V. Tomsky, was built in Moscow.

It is hard to find out now where road slabs, made of the Shoksha quartzite, were used. Geographically, its application range is very wide. A well-known Karelian geologist P.A. Borisov wrote that in the 1960s the products of the quarry were consumed by various enterprises and organizations in the Moscow Region, Povolzhye, the Urals, Belorussia and Estonia. Many other architectural monuments and buildings, created using the Shoksha quartzite, will probably be described in the future



Fig. 7. Pavement made of Shoksha quartzite (Photo: K. Shekov)
Ryc. 7. nawierzchnia brukowa wykonana z kwarcytu Shoksha (fot. K. Shekov)

(Borisov, 1963). It should be mentioned that the President's backyard in the Kremlin is paved with the Shoksha quartzite slabs (fig. 7).

The most striking example is 1 May Highway (now 1 May Avenue) in Petrozavodsk. The road, stretching for several kilometers, was paved with the Shoksha quartzite slabs and lasted over 30 years without repair. In the 1980s, the local authorities made the short-sighted decision to dismantle the pavement. Some of the quartzite slabs were sold, others were saved for use in other structures. Nowadays, the Shoksha quartzite slabs can be seen in the village of Nunnanlahti, Finland, in front of the Tulikivi Company Exhibition Centre and in the lake front, streets and squares of Petrozavodsk. Shoksha quartzite fragments also occur in other cities.

The use of Shoksha quartzite for architectural purposes today has decreased. Blasting in the quarry is not conducted because many old blocks and fragments are left. They are detached from the rock using jumbo vehicles and steel ropes (blasting is harmful for this rock because it is brittle). To reveal fracturing in a piece of rock, there is a trick: "*blocks prepared in autumn are exposed to frost in winter and are examined in spring. If no fractures are found, the blocks are polished*" (Bulach, 2002).

The modern quarry area, which bounds on the historical part of the deposit, provides raw material for manufacturing a variety of products on the market to show that this stone has rather good potential to produce both rectilin-ear and complex plastic forms (fig. 8). In the neighbourhood, there is a large quarry which produces crushed stone from light-pink quartzite. In accordance with State Commission on Reserves (SCR) Protocol 8846 of 9 October, 1981, the proven building stone reserves of the Shoksha deposit are over 1.3 million cubic meters.



Fig. 8. Modern Shoksha quartzite products (<https://www.gd-karelia...>, 2017; <https://vk.com...>, 2017)

Ryc. 8. Przykłady współczesnego zastosowania kwarcytu Shoksha
(<https://www.gd-karelia...>, 2017; <https://vk.com...>, 2017)

The Shoksha quartzite is easily recognized by its homogeneity and uncommon colour. In the international standard of colour conformity, RAL (classical palette), the Shoksha crimson quartzite is close in colour to dark-red or purple-violet, “red oxide” or “signal brown”, but is not directly conformable. However, this dimension stone of unique natural colour could give a name for its colour, making it easier for architects and designers to select the right colour. These issues are now dealt with by Global Color Research (UK), a design bureau which publishes applied information on colour systematization.

3. Summary

The Shoksha quartzitic sandstone deposit is a source of unique stone, which has no counterparts in the world. Nowadays, the historical pits of the quarry are surrounded by quartzite scarps facing Lake Onega. In spite of the outstanding history of the quarry and the unique characteristics of the rock, the Shoksha quartzitic sandstone quarry is seldom visited by tourists because it is far from Petrozavodsk, the road leading to the quarry is in poor condition, there are no other tourist attractions nearby and the tourist infrastructure is poorly developed. The establishing of a mining-geological and landscape park in the historically significant “old quarry” is now being discussed. Experts agree in that the Shoksha deposit could be registered as a global cultural heritage monument (Touret, 2016).

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WYKORZYSTANIE KWARCYTU SHOKSHA JAKO KAMIENIA BUDOWLANEGO I DEKORACYJNEGO

*dziedzictwo górnictwa, dziedzictwo przemysłu,
kwarcyt, porfir Shoksha, kamienie dekoracyjne, kamieniołomy skał błocznych,
Republika Karelii, Rosja*

Przedstawiono, sięgającą XVIII stulecia historię wydobycia i wykorzystania unikatowego karmazynowego kwarcytu Shoksha. Skała ta wykazuje wyjątkowo wysokie parametry i tradycyjnie uchodzi za surowiec ekskluzywny, niegdyś nazywana była „szlachetnym kamieniem carów”. Niekiedy, ze względu na charakterystyczną barwę, była ona niepoprawnie określana jako porfir. Odkrywcą złóż był Louis Antoine Leyson Le Duc, który poszukiwał w Rosji kamienia do wykonania grobowca Napoleona.

Skała ta wykorzystywana była przede wszystkim jako surowiec błoczny, z którego wytwarzano elementy nawierzchni drogowych (kostka brukowa, płyty), ale także liczne pomniki i rzeźby. Znajduje się ją w wielu miastach Rosji (m.in. Pietrozawodsk, Petersburg, Moskwa) i Europy (np. Nunnanlah-ti, Paryż). Ponadto kwarcyt ten był wykorzystywany m.in. jako materiał ogniotrwały w hutnictwie żelaza.

Historyczne wyrobiska kwarcytu Shoksha zlokalizowane są nad brzegami jeziora Onega. Obecnie rzadko stanowią one obiekt zainteresowania turystycznego, ale traktowane są jako ważne obiekty geologiczne oraz stanowiska dziedzictwa górniczego i przemysłowego, dyskutowane jest objęcie ich ochroną w ramach parku geologiczno-górniczego i krajobrazowego.