

Review paper
UDK 549.742.111+552.543]:553.548(497.6)
<http://dx.doi.org/10.7251/afts.2022.1427.001F>
COBISS.RS-ID 137251841

GEOLOGICAL AND ECONOMIC CHARACTERISTICS OF DOLOMITE DEPOSIT NIKOLIN POTOK NEAR BUGOJNO

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SUMMARY

This paper presents the results of detailed geological investigations of the Middle Triassic dolomite deposit of Nikolin Potok, which is located west of Bugojno. Based on the established borders of surface distribution and research results, geological reserves of about 4.6 million m³ have been determined in the wider area of the deposit. The dolomite reserves that have been established so far in this area are at a low level of geological exploration. For this reason, the level of research should be significantly increased, because the calculated and confirmed reserves are very modest compared to the potential possibilities.

The paper contains a description of the geological characteristics of the area and the qualitative-quantitative characteristics of dolomite.

The results of the conducted research point that the general geological and technical-exploitation factors are favorable and indicate profitable exploitation of the deposit in the coming period as well. Taking into account the significant raw material potential, and the possibility of expanding the existing raw material base, this area has a special significance for the perspective development of dolomite exploitation and its use in the production of technical-building stone.

Key words: *dolomite, Nikolin Potok, reserves, technical-building stone*

INTRODUCTION

The deposit of technical-building stone Nikolin Potok is located on the edge of the Bugojno basin, 4 km west of Bugojno next to the road to Kupres, on the left bank of the Poričnica River. The area where the quarry is located belongs to a hilly and mountainous region that is not favorable for the development of agricultural production.

Surface of the research area is 8.74 ha, while the total area of the exploitation field is 7.96 ha, Figures 1, 2 and 4. The deposit is located on the sloping part of the karst-erosive terrain, with quite steep slopes, which significantly facilitates the conditions for dolomite exploitation. The basic exploitation level is currently located at a height of 850 m, and exploitation takes place in four hypsometric levels up to a maximum elevation of 915 m.

At the Nikolin Potok deposit, dolomite reserves were researched in detail, verified, and checked in the process of exploitation and technological processing [1,2]. Only a part of the dolomite massif was

covered by the research works, and there is a possibility of increasing the reserves by expanding the contours of the deposit in the northwest direction. It should be taken into consideration that only the locality Nikolin Potok has been investigated in detail, so it is justified to forecast significantly larger reserves of dolomite in a wider area [1].

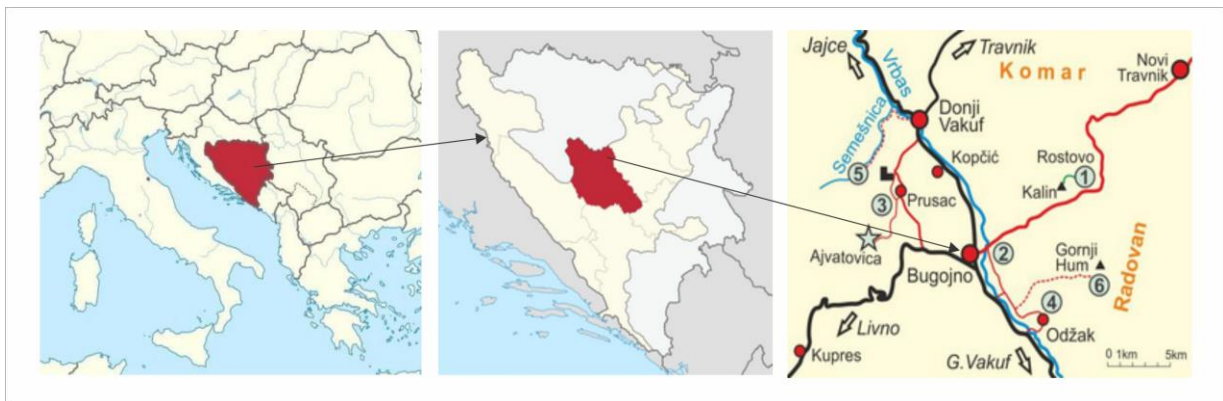


Figure 1. Geographic position of the wider research area

Detailed geological researches of the dolomite deposit were carried out in 1986, while exploitation geological researches were carried out in 2012 and 2020 [1,2].

On this deposit, the exploitation of technical-building stone began in 1986. The interruption of production was recorded in the period from 1992 to 1995.

So far, tests of the possibility of using these dolomite have been carried out only for the production of technical-building stone, but the possibilities of application are considerably wider. For this reason, it is necessary to carry out additional laboratory and industrial tests.

GEOLOGICAL CHARACTERISTICS OF THE DOLOMITE DEPOSIT NIKOLIN POTOK

The wider research area belongs to the border area between the central and inner Dinarides. Formations of Triassic to Quaternary age take part in the geological structure [1]. Middle Triassic carbonates form the largest part of the peripheral belt of the northwestern Bugojan freshwater Neogene basin. The Anisian sediments are developed in dolomite facies, which are light brown and ash grey in color, followed by dolomitic limestone, limestone and dolomitic-limestone breccia. The Middle Triassic sediments lie concordantly over the Lower Triassic sediments. Middle to Upper Miocene sediments are placed discordantly over Middle Triassic sediments.

Geological structure of the deposit is relatively simple, because only Middle Triassic dolomite is found in the area of the quarry and its immediate vicinity [1,4,5]. The size of the deposit is 300x500 m [1].

Within deposit, humus cover and dolomite of the Anisian stage, which stratigraphically form the lower part of the Middle Triassic, were found here (Figures 2, 3 and 4). The quarry is cut into the steep slope of the hill that rises above the left bank of the stream called Nikolin Potok, which forms the southwestern border of the deposit. Dolomite of Anisian stage represents an integral part of the structural-facies unit Gorica-Ljuša-Bugojno [5]. These rocks lie concordantly over Lower Triassic sediments in a large area along the western and southwestern rim of the Bugojan Neogene Basin.

The roof part of the dolomite deposit consists of a humus cover, contaminated with dolomite, under which there is a part of the deposit made of dolomite grit. In the lower parts, there is homogeneous massive dolomite, Figures 2 and 3.



Figure 2. Panoramic view of the dolomite deposit Nikolin Potok (Forčaković Dž. 2022)


| AGE | SIMBOL | THICKNESS (m) | LITHOLOGICAL COMPOSITION |
|-----------------|--|---------------|---|
| Middle Triassic |  | 0,5 | Clay, humused, with fragments of dolomite |
| | | 20 | Dolomite, light, grey, cracked and gritty |
| | | 130 | Dolomite, light grey, solid and massive |

Figure 3. Synthesized geological column of dolomite deposit Nikolin Potok (Forčaković Dž. 2022)

GENERAL DOLOMITE CHARACTERISTICS

Dolomite of this deposit belongs to marine sedimentary deposits or deposits resulting from dolomitization of limestone [6,7,8,9].

In the researched area, dolomite is massive, mostly without visible layering [2]. Near the surface, dolomite is heavily cracked, disintegrated and turned into dolomite grit. The thickness of the dolomite in the open profile of the deposit is about 150 m. It is believed that it was formed by the replacement of limestone deposits during diagenetic processes. Dolomite is light grey in color, solid and compact in structure, interspersed with numerous thin white laminae crossing each other. The texture of dolomite is fine-grained crystalline, partially also medium-grained crystalline, and the structure is massive [3].

The rock material is decomposed on the surface and turned into dolomite grit, within which there are occasionally smaller blocks as embedded bodies of more physically resistant rocks. Presence of dolomite was determined by investigative works in a wider research area. The amount of calculated reserves of quality dolomite is about $4.6 \times 10^6 \text{ m}^3$.

Occurrences of potential C₂ category reserves have been identified in a wider scope of the research area. No geological research or laboratory tests were performed on them [1,2].

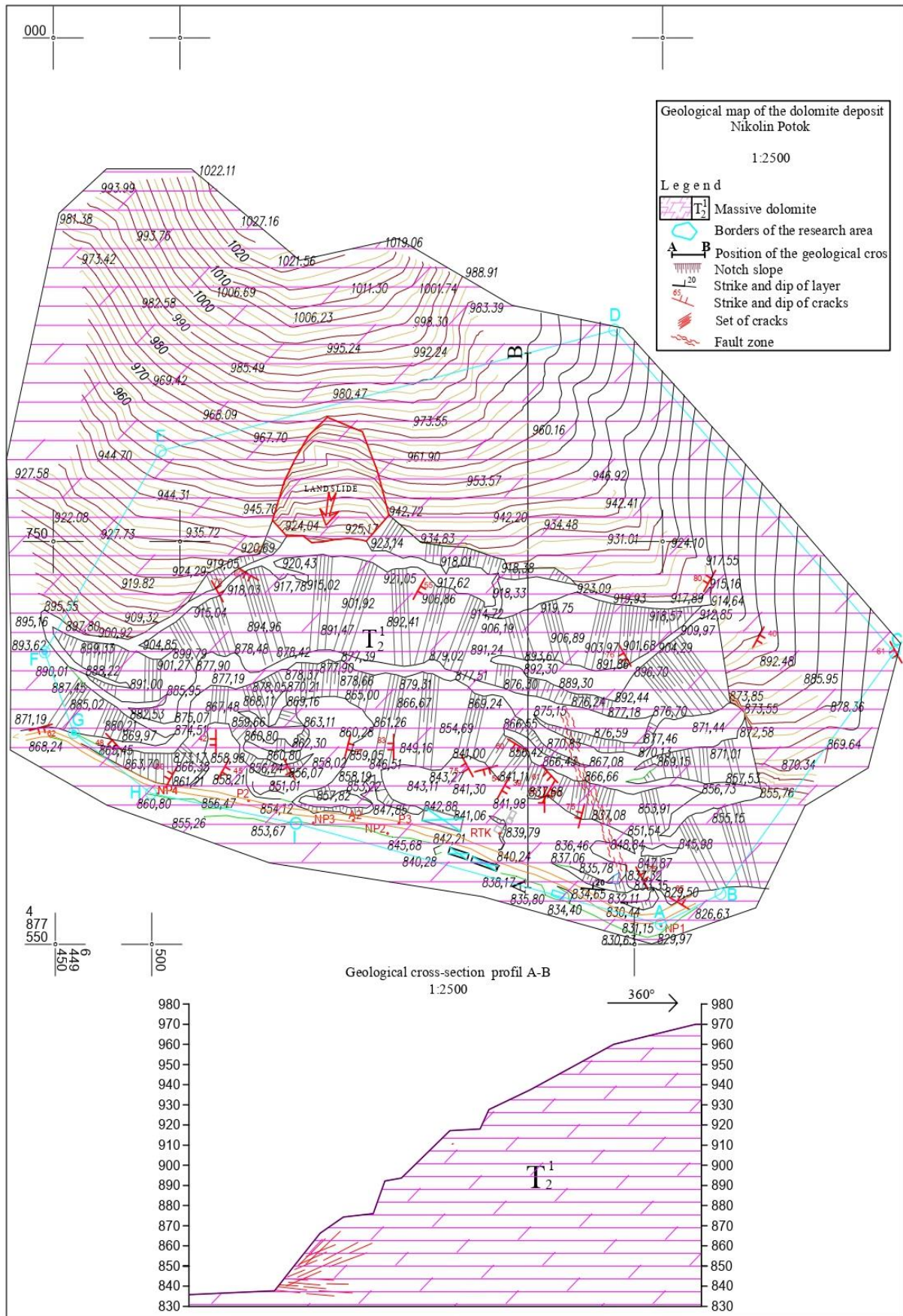


Figure 4. Geological map of the dolomite deposit Nikolin Potok (Forčaković Dž. 2022)

RESEARCH METHODOLOGY

In order to define the Nikolin Potok dolomite deposit, and with the aim of expanding the reserves and testing the quality, field research and laboratory tests were carried out [10,11,12].

Field research included:

- detailed geological mapping of the wider area
- exploration and exploitation floors
- investigative open pits
- mapping of investigative works with testing of characteristic intervals
- taking samples for laboratory tests: mineralogical-petrographic, chemical and physical-mechanical tests.

Laboratory tests were performed in accredited laboratories for the following analyzes that give the characteristics of dolomite:

- Partial chemical tests included analysis of the following elements: SiO₂, CaO, MgO, CaCO₃, MgCO₃, S and loss on ignition (LOI). These tests were performed on 6 samples.
- Complete chemical tests included analysis of the following elements: SiO₂, CaO, MgO, CaCO₃, MgCO₃, S, P₂O₅, SO₃, K₂O+Na₂O and LOI. These tests were performed on 3 samples.
- Mineralogical and petrographic tests were performed on 5 samples.
- Partial physical-mechanical tests were performed on 25 samples.
- Complete physical and mechanical tests were performed on 3 samples.

The conducted researches and tests had aim to prove the suitability of dolomite for use as a technical-building stone.

RESEARCH RESULTS

Data on the quality of dolomite deposit represent the average of many years of laboratory and technological tests, tables 1,2,3. They indicate that mass exploitation of dolomite is possible in the studied deposit, which meets the quality criteria for the production of technical-building stone [10,11,12]. The chemical composition of dolomite was determined by tests conducted in several relevant institutions [10,11,12].

Table 1. Average chemical composition of the dolomite in the area of Nikolin Potok

| Loss on ignition (%) | SiO ₂ (%) | CaO (%) | MgO (%) | CaCO ₃ (%) | MgCO ₃ (%) | S (%) | P ₂ O ₅ (%) | SO ₃ | K ₂ O +Na ₂ O |
|----------------------|----------------------|---------|---------|-----------------------|-----------------------|-------|-----------------------------------|-----------------|-------------------------------------|
| 43,10 | 0,08 | 28,40 | 17,32 | 54,10 | 36,20 | 0,11 | 0,016 | 0,01 | 0,006 |

Table 2. Average physical and mechanical characteristics of stone in the Nikolin Potok area

| Wear resistance (cm ³ /50cm ²) | Abrasion resistance LA (%) | Porosity and density (%) | Compressive strength (MPa) | | | Water absorption coefficient (%) | Freezing resistance | Bulk density (KN/m ³) |
|---|----------------------------|--------------------------|----------------------------|----------------------------|----------------|----------------------------------|---------------------|-----------------------------------|
| | | | In a dry state | In a water-saturated state | After freezing | | | |
| 14,1 | 22,0 | 2,0 | 100 | 98 | 92 | 0,68 | Stable | 27,1 |

Table 3. Average physical-mechanical properties of the fractionated crushed dolomite aggregates Nikolin Potok

| Standard | Type of test | Research results | | | |
|---------------------|---|------------------|------|------|---------|
| | | 0-4 | 4-8 | 8-16 | 16-31,5 |
| BAS EN 1097-3: 2007 | Bulk density (kg/m ³) | 1740 | 1510 | 1553 | 1490 |
| BAS ISO 7033: 2002 | Grain density (kg/m ³) | 2690 | | | |
| BAS ISO 7033: 2002 | Water absorption (%) | 0,5 | 0,61 | 0,42 | 0,32 |
| BAS EN 1367-2: 2011 | Determination of resistance to freezing and thawing, Mg (%) | 0,5 | | | |
| BAS EN 1097-2: 2011 | Determination of crushing resistance LA (%) | 28,2 | | | |
| BAS EN 933-4: 2011 | Grain shape-index shape (%)* | - | 8 | 12 | 9 |
| BAS EN 933-1: 2012 | Content of fine particles (%) | 11,9 | 1,1 | 0,8 | 0,6 |
| BAS EN 933-1: 2012 | Granulometric composition of aggregates* | | | | |

* Methods accredited by BATA according to the system BAS EN ISO/IEC 17025: 2018.

In the structure of the total reserves of the dolomite deposit, balance reserves participate with 57.4%, and potential reserves with 42.6% [1]. The large share of potential reserves in total reserves shows that dolomite reserves have a very low degree of exploration. Dolomite reserves are also characterized by an uneven degree of exploration. At the achieved level of research, based on established borders of the surface distribution and the results of research in the Nikolin Potok area, around 4.6 million m³ of dolomite reserves have been proven and assumed [1].

The determined amounts of reserves are significant and can serve as a reliable basis for further mining development as well as long-term exploitation.

DISCUSSION

Comparing the results of the basic parameters of the Nikolin Potok dolomite deposit, and taking into account the scope of the works, it has been proven that the dolomites have a significant ore bearing capacity, considerable distribution, are exploitable and have great economic importance in terms of continued exploitation (the deposit has proven balance reserves of 2,6 million m³). Potential reserves of around 2.0 million m³ have been proven in the area of the Nikolin Potok deposit. Dolomite occurrences determined by prospecting in the wider area of Nikolina Potok are also significant.

The quality of dolomite in the deposit is quite uniform, both vertically and laterally. In the vertical profile, better-quality masses of dolomite are found in the middle and lower part. There are light gray solid massive dolomites. Slightly lower quality has the light gray disintegrated gritty dolomite found in the upper, near-surface part of the profile.

In the southeastern part of the deposit, a higher content of CaCO₃ and MgCO₃ was recorded compared to the western part, while their values of SiO₂ and S are almost the same. Also, in the southeastern part, the content of CaO is higher compared to the western part of the deposit, while the value of MgO in the western part of the deposit is slightly higher, table 4.

Tabele 4. Comparison of the chemical composition of the southeastern and western parts of the Nikolin Potok dolomite deposit

| Deposit Nikolin Potok | Loss on ignition (%) | SiO ₂ (%) | CaO (%) | MgO (%) | CaCO ₃ (%) | MgCO ₃ (%) | S (%) | P ₂ O ₅ (%) | SO ₃ | K ₂ O +Na ₂ O |
|-----------------------|----------------------|----------------------|---------|---------|-----------------------|-----------------------|-------|-----------------------------------|-----------------|-------------------------------------|
| SE part | 45,11 | 0,09 | 28,31 | 17,32 | 54,10 | 38,10 | 0,12 | 0,016 | 0,01 | 0,006 |
| Western part | 43,90 | 0,08 | 29,30 | 18,22 | 52,32 | 36,31 | 0,11 | 0,015 | 0,01 | 0,005 |

The analysis of the ore-bearing area in the wider space of the Nikolin Potok deposit has proven parts with a distinct potentiality, in which it is possible to secure long-term quantities of mineral raw materials through exploration. Deposit has a raw material potential and perspective that represents the basis for economic exploitation of dolomite and space for expanding the exploitation field. Exploitation is permitted on the deposit according to the spatial plan [13].

So far, research of the dolomite usage has been carried out only for the production of technical-building stone, but its application is also possible in a wider spectrum: in the industry of refractory, brick and cement materials, in ferrous metallurgy as a smelter, in the production of paper, rubber, paint, varnishes as and in the pharmaceutical and ceramic industries. For usage in these industries, it is necessary to carry out additional laboratory and industrial tests.

CONCLUSION

This paper presents the result of research and testing of dolomite in the Nikolin Potok area. Quality of dolomite (mineralogical-petrographic, chemical and physical-mechanical characteristics) was determined by testing samples taken during many years of exploitation and delivery of dolomite as a technical-building stone. Considering fact that the deposit has proven quantities of dolomite for many years of exploitation, it is significant that there are considerable potential reserves of dolomite in the Nikolin Potok deposit itself, as well as in its wider area. In the coming period, these reserves need to be investigated in detail, classified and balanced, which will extend the mine's exploitation life.

Based on performed analysis and evaluation, comparing the conditions on similar deposits, it can be concluded that the general geological and technical-exploitation factors are relatively favorable and indicate a possible profitable exploitation of the deposit. Natural conditions in which the deposit is located enable production to be realized with relatively low costs. The economic assessment indicates the significant geological and economic importance of this deposit, which was demonstrated in the first years of its exploitation. Long-term exploitation makes it possible to satisfy the market of the municipalities of Bugojno, Donji Vakuf, Gornji Vakuf-Uskoplje and Prozor-Rama, as well as for own needs (construction). The multiple importance of production from this quarry is reflected in the provision of cheap and high-quality construction material, as well as employment of the local population, which indicates the economic and social importance of this deposit. If the possibility of using these dolomites in other industrial branches would be proven, the productivity of quarry work would certainly increase.

Considering the fact that exploitation is permitted on the deposit according to the spatial plan, all future research in the coming period should be carried out exclusively according to the programs and projects in accordance with current regulations in the field of geology, mining, spatial planning and environmental protection.

(Received May 2022, accepted June 2022)

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