



НАУЧНО-ТЕХНИЧЕСКИ СЪЮЗ ПО МИННО ДЕЛО, ГЕОЛОГИЯ И МЕТАЛУРГИЯ
SCIENTIFIC AND TECHNICAL UNION OF MINING, GEOLOGY AND METALLURGY
НАУЧНО-ТЕХНИЧЕСКИЙ СОЮЗ ПО ГОРНОМУ ДЕЛУ, ГЕОЛОГИИ И МЕТАЛЛУРГИИ

PROCEEDINGS

OF THE XITH NATIONAL CONFERENCE
WITH INTERNATIONAL PARTICIPATION
OF THE OPEN AND UNDERWATER
MINING OF MINERALS



елаците мед АД  ellatzite med АД



УПРАВЛЕНИЕ И ОБОГАТИТЕЛНА ФАБРИКА - с. Мирково 2086
Тел.: (02) 923 77 12, Факс: (02) 923 78 67
РУДНИК - гр. Етрополе 2180
Тел.: (02) 923 76 72, Факс: (02) 923 76 78

HEAD OFFICE AND FLOTATION PLANT - 2086 Mirkovo, Bulgaria
Tel.: (+359 2) 923 77 12, Fax: (+359 2) 923 78 64
MINE - 2180 Etropole, Bulgaria
Tel.: (+359 2) 923 76 72, Fax: (+359 2) 923 76 78

PROCEEDINGS OF THE XITH NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION OF THE OPEN AND UNDERWATER MINING OF MINERALS

June 19-23, 2011
International House of Scientists "Fr. J. Curie"
Varna, Bulgaria



QUALITATIVE-QUANTITATIVE CHARACTERISTICS OF THE MARBLES FROM BELOVODICA AREA (MK) AND OPPORTUNITIES FOR THEIR EXPLOITATION

Prof. d-r Orce Spasovski, Dr.Sci., University "Goce Delcev", FNTS,
Institute of Geology, Stip, R.Macedonia, E- mail:orce.spasovskiugd.edu.mk
Prof. d-r Risto Dambov, Dr.Sci., University "Goce Delcev", FNTS, Institute of Mining, Stip,
R.Macedonia, e-majl; risto.dambov@ugd.edu.mk , dambov2004@yahoo.com

ABSTRACT

The use of marbles as a building - architectural stone for their aesthetic - technical characteristics has a long tradition in Macedonia from ancient times until today.

Dolomitic white marbles are most prevalent in understudied area and clearly different from the gray-white and gray dolomitic marbles.

The samples were determined as a fine-grained dolomitic marble, which are quite cleaned like mineralogical and chemical composition.

According petrological, mineralogical and microscopic tests and chemical analysis of these dolomitic marbles, can find wide application in construction and in civil engineering, the concrete mixtures, and other hydro-technical works. It can also be used as architectural stone allows removal of larger blocks.

Based on calculations performed on mining stocks can be concluded that the investigated area is promising in terms of exploitation of white dolomitic marble.

The fact that within the field are calculated geological ore reserves more than of 50 millions m³ is a sufficient indicator of perspectives in this area. In this case we can make location for future fields for mining exploitation.

Key words: *dolomitic marble, architectural-building stone, ore reserves, structure, rock quality, exploitation*

1.0. Introduction

The use of marbles as construction-architectural stone has had a long tradition, from early times to the present day, owing to its aesthetic and technical characteristics.

The white marbles are also used in the making of art statues, colonnades, caryatids etc. This is can be seen in many Roman archaeological sites such as Stobi, Heraclea and others.

The search for white marbles in a number of sites were the subject matter of investigations. The best known in the country are those of Sivec, Bela Pola, Pletvar, Kitka, Zrve and others. The highest interest has been in the white marble in the Pletvar-Sivec-Pela Pola zone. Besides its whiteness, the marble has been in use for such a long time due to the fine-grained structure, which helped sculptors make their master pieces.

In Macedonia marble has been used as building material continuously, but with variable intensity.

The first large undertakings and organised economic interest in excavation and processing started after 1956.

The greater use of marbles called for intense geological investigations, starting with opening new quarries and construction of new facilities for processing. Thus, in 1956 production of marble blocks amounted to 8.000m³ and processing of 6.000m³ slabs.

In 1983 new mines emerged whose block output reached 22.000m³ along with new facilities in Prilep, Gostivar, Cer and Kumanovo were built. The entire annual nominal capacity of slab processing amounted to 500.000 m².

However, this trend of increase was folloed by a period of stagnation in 1990 and in 1997 production reduced to 10 to 12.000m³ of blocks and processing of 80.000m² slabs annually. At the same time the period



was also characterised by the establishing small processing plants almost in every towns. Products were used mostly in erecting monuments.

2.0. Geological characteristics of the immediate vicinity

The Belovodica marbles are part of the marble mass in the south part of the Pelagon. The mass is located in the marginal part of the Pelagonian metamorphic complex in the west and the Vardar zone in the east. It is a fairly narrow zone with two marble types: calcite in the eastern marginal part with the Vardar zone and dolomite in the western in immediate contact with the gneiss series of the Pelagonian metamorphic complex.

The basic structural characteristics of the metamorphic phase in the Pelagon are the result of syngenetic processes of high regional metamorphism and folding with plastic flow mechanism with contemporaneous intrusion of granodiorites of the first phase when large fold structures were formed. It is worth mentioning that an important role played the second granitoid phase which manifested as major magmatic activity whose products, in addition to the metasomatic changes and homogenisation of the metamorphic rocks, in some parts of the Pelagon caused refolding and developed new large foldings when destruction of earlier fold structures took place.

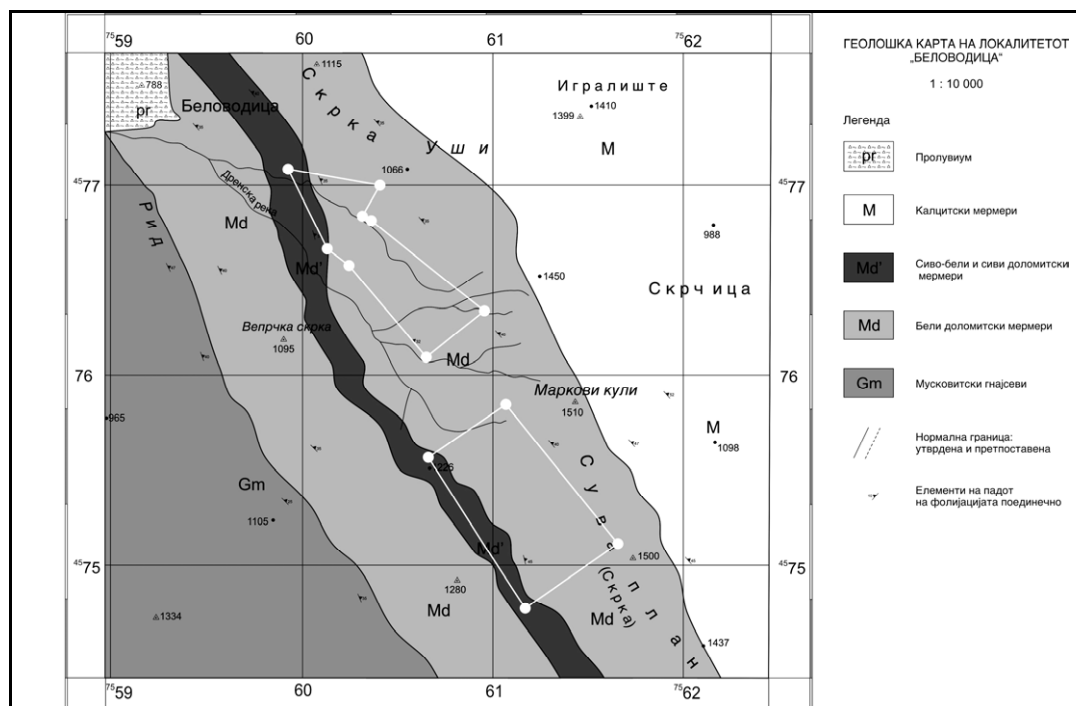


Figure 1. Geological map of "Belovodica" area

The whole Belovodica site is situated in the eastern wing of the larger Dren anticline shape which is a dome like elongated structure of N - S strike. The composition of the Dren anticline consists of the rocks of both mixed and marble series. Of importance for the marble mass in Belovodica is that, in its lower part, homogenisation, whitening and dolomitisation of marbles took place.

These processes are related to the granitoid rock intrusion into the Dren anticline. Namely, the lower portions of the marble mass are made up of white sugary to flouery massive dolomite marbles in which, only locally, traces of foliation and micro folding and a small occurrence of calcite veins can be seen.

Going far from the contact with the Dren anticline to the east, dolomite marbles grade into banded and further on into schistose calcite-dolomite marbles.

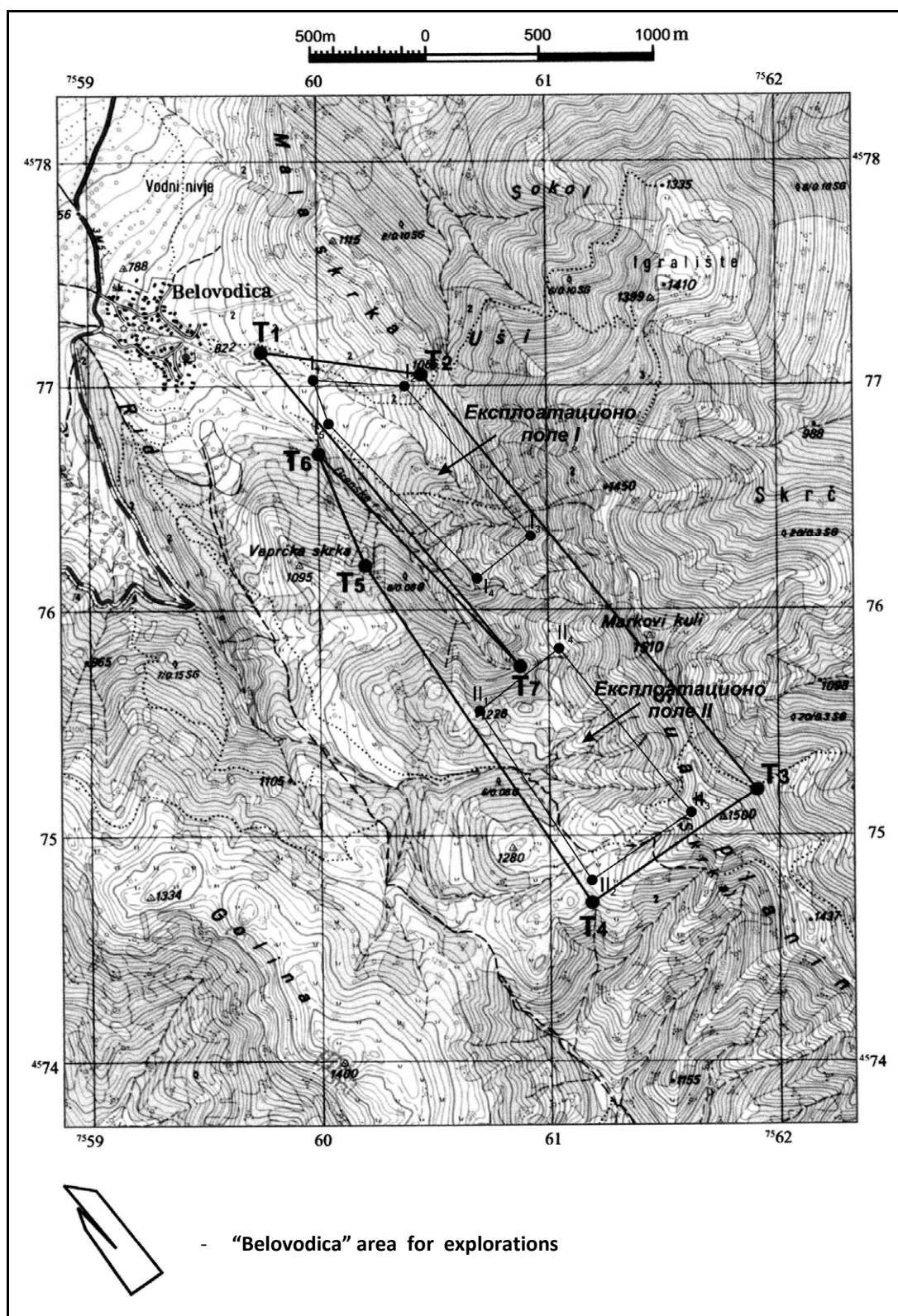


Figure 2. Topographic map form "Belovodica" area and spaces for exploration

For the structural composition of the marble mass an important role played the rupture tectonics which are present as faults, fault and fissure zones. Of course, some of the structures are older, but the main rupture tectonics is of later age and related to the processes of formation of the neotectonic graben in the Pelagonian valley in the Pliocene as well as the processes of younger foldings and faults during the Alpine orogeny.



3.0. Physical - mechanic examinations

At the department of geotechnical engineering at the Faculty of Civil engineering certain examinations for the strength of monolith parts of white dolomite marble from the locality Belovodica – Prilep were made.

A great number of samples to test the pressure strength, strength on one point, volume weight and the absorption of the dampness, as basic classification parameters.

The results from the examination of the point load are presented in encl. 1. According to the examinations the value of the physical-mechanical characteristics is in the following frame:

- Average value $J_s(50)=2,72$ to $3,63$ dependent on the testing
- The volume weight is in a diapason of $=27,87-28,24$ kN/m³
- Absorption of dump is in the frame of $U=0,15-0,16$ %
- The strength of the pressure is $sp=134-171,1$ MPa, but in separate number of samples there are also values of $sp=65,2-65,5$ MPa

In accordance with the performed examinations it can be stated that the dolomite marble has favorable characteristics to be used as an architectonic-building stone.

The present lower values point that the surface areas have weaker parties which should be taken into consideration in the process of exploitation.

It should be also noted that the samples are taken from the surface of the field and usually the more authoritative results are from the deeper zones, where the results are got through research drilling, testing and examination.

4.0. The mining reserves in the location Belovodica

Based on the performed evaluations of the mining reserves it can be noted that the research space is promising in a perspective of exploitation of white dolomite marbles. The very fact that within field I were estimated 9.586.976 m³ geological mining reserves from category B and 16.826.333 m³ from C₁ category and geological mining reserves in the field II 8.688.725 m³ from category B and 21.346.275 m³ from C₁ category or a total of B+C₁ 56.448.309 (m³) (Table 1) is a real indicator for the possibilities of the researched area.

In this opportunity it is necessary to note that the performed evaluations of the geological mining reserves are made without deep research drilling which is necessary for separating reserves from category A and of course confirming the reserves from B and C₁ and also the possibilities of the researched space (Fig 3).

Table 1.

Recapitulation of the mining reserves of dolomite marbles from location Belovodica - Prilep

CATEGORIES OF THE RESERVES	FIELD I	FIELD II	TOTAL (m ³)
"B"	9.586.976	8.688.725	18.275.701
"C ₁ "	16.826.333	21.346.275	38.172.608
TOTAL B+C ₁ (m ³)	26.413.309	30.035.000	56.448.309

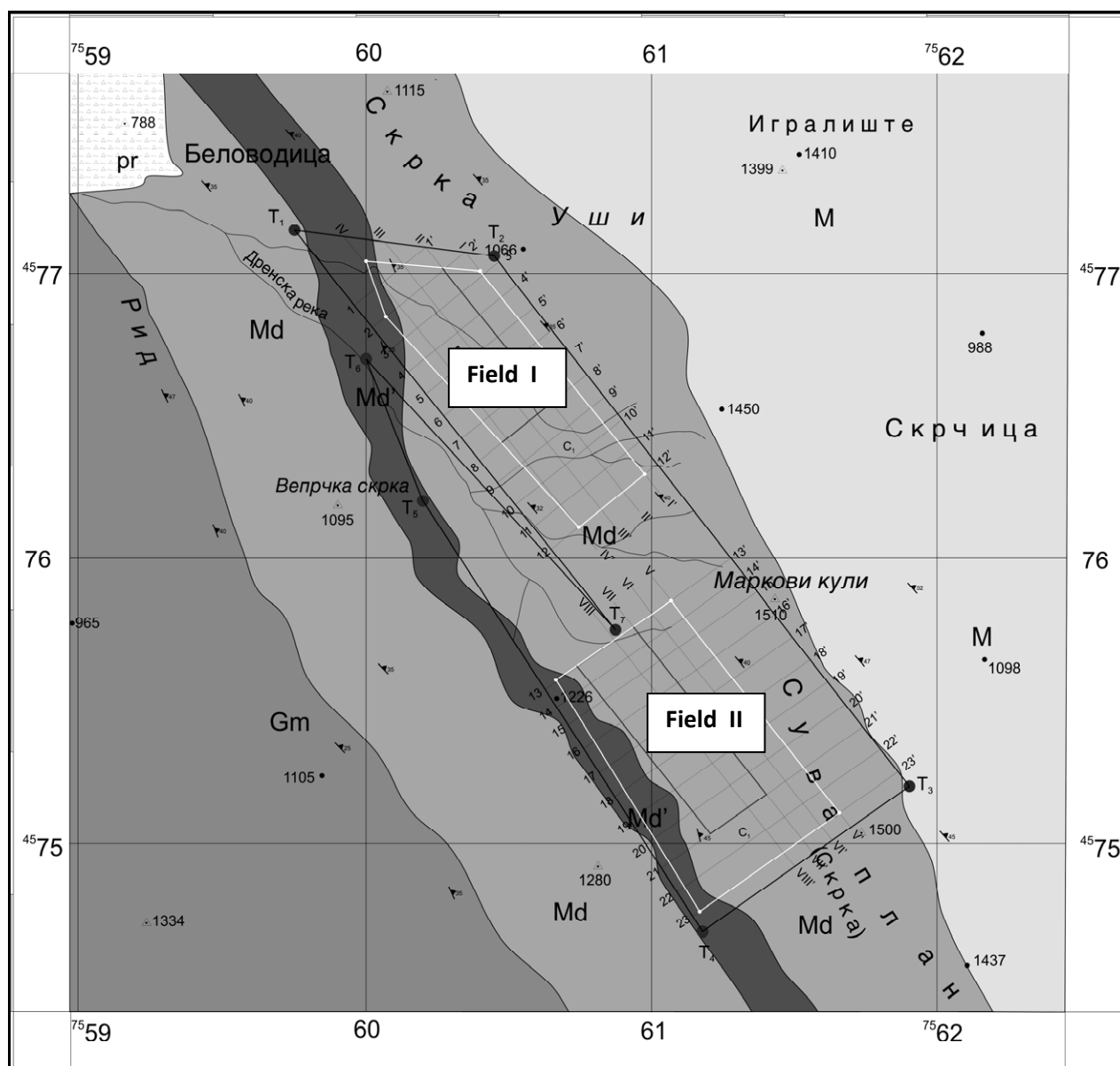


Figure 3. Fields for mining exploitation of Belovodica" area

Conclusion

Based on the presented detailed geological research on the concessive area in the location Belovodica, the following conclusions can be made:

- ❖ With the geological mapping three types of marbles are selected: *stratified to massive dolomite marbles, tectonized dolomite marbles and stratified dolomite marbles.*
- ❖ The separated rocks represent dolomite marbles characterized with white colour and saccharine, sugar like appearance, massive, stratified to bedded - sheet like. With the geological research the massiveness and compactness of the marbles was completely defined.
- ❖ According to the colour, on the geological map mostly predominate the dolomite marbles with clearly apparent white colour and dolomite marbles with greyish-white colour.
- ❖ Dolomite marbles with white colour are mostly found in the research space and can clearly be differentiated from the grayish-white and grey dolomite marbles.
- ❖ From a mineral point, the carbon rocks are mostly dolomite. The samples are determined as finer grained dolomite marble, which are very clear in their mineral and chemical content. The presence of MgO is over 19,52 %, only in the sample marked T- 6. MgO is present with 17,89 %.



- ❖ According to the petrologic, mineral – microscopic testing these dolomite marbles can be widely applied in the civil engineering, mostly in low-construction, for concrete mixtures, hydro-technical works, etc. They can also be used as an architectonic stone provided the micro-tectonics allows larger blocks to be detached.
- ❖ In the researched field, three promising parts are selected that will be the research subject in the second phase i.e. a research drilling is planned in the selected parts. These promising parts will be presented afterwards with the supplement on topographic base where the designed research drills will be presented.
- ❖ In accordance with the completed research, the dolomite marble is evaluated with favourable characteristics for its use as architectonic-building stone.
- ❖ Notable lower values point out that areas even have weaker components, which needs to be taken into account before eventual exploitation.
- ❖ It is noted that the samples are taken from the surface of the field, even though the more trustworthy results are usually from deeper zones normally that data is received with research drilling, sampling and examination.
- ❖ The research space has a good perspective merely for exploitation of white dolomite marbles.

References

- Dumurdzanov, N., Hristov, S., Pavlovski, B., Ivanov, V., 1976: Explanation for the page Vitliste - Kajmakalan, BGM SFRY 1 : 100 000, Geological Institute, Skopje.
- Dumurdzanov, N., Hristov, S., 1976, Basic geological map 1 : 100 000 for the page Prilep, Geological Institute, Skopje.
- Dzolev, S., 2007: Supplementary mining project for marble excavation in Belovodica deposit, Prilep.
- Ilic, M., 1995: Istraživanje lezista nemetala – građevinskih materijala. Drugo izmenjeno i dopunjeno izdanje. Rudarsko-geoloski fakultet, Beograd.
- Ilic, M., 2003: Metode istraživanje leziste nemetalnih mineralnih sirovina. Rudarsko-geoloski fakultet, Beograd.
- Jankovic, S., Milovanovic, D., 1957: Oprabuvanje i proracun reserve mineralnih sirovina. Rudarsko-geoloski fakultet, Beograd.
- Jankovic, S., Milovanovic, D., 1985: Ekonomska geologija I osnovi ekonomike mineralnih sirovina. Rudarsko-geoloski fakultet, Beograd.
- Paskaliev, V., 1997: Programa za geolosko-rudarski raboti na beli mermeri lokalitet 'Samarnica – Crvenica' jugoistocno od village Nebregovo – Prolepsko. Rudarski institute AD-Skopje
- Rakicevic, T., Stojanov, R., Arsovski, M., 1965: Explanation for the page Prilep, BGM SFRY 1 : 100 000, Geological Institute, Skopje.
- Rakicevic, T., Stojanov, R., Arsovski, M., 1965: Explanation for the page Vitliste, BGM SFRY 1 : 100 000, Geological Institute, Skopje.
- Staevik, B., 2003: Proektovanje i istraživanje lezista cvrstih mineralnih sirovina. Doe prvi, Graficko proektovanje i geometrizacija. Rudarsko-geoloski fakultet, Beograd.
- Spasovski, O., Dambov, R., 2008: Proekt za detalni geoloski istraživanja na mermer na lokalitetot Belovodica – Prilep. Str.Fond na Larin Mramor Kompani, str.33
- Spasovski, O., Dambov, R., 2008: Proekt za detalni geoloski istraživanja na mermer na lokalitetot Belovodica – Prilep. Str.Fond na Larin Mramor Kompani, str.35
- Vakanjac, B., 1992: Geologija lezista nemetalnih mineralnih sirovina. Rudarsko-geoloski fakultet, Beograd. Katedra ekonomske geologije, Posebna izdanje br.4, Beograd, str 323