

**Универзитет „Гоце Делчев“ - Штип, Македонија  
Факултет за природни и технички науки**

**University „Goce Delcev“, Stip, Macedonia  
Faculty of Natural and Technical Sciences**

UDC: 622:55:574:658

ISSN: 185-6966

# **Природни ресурси и технологии Natural resources and technology**

Број 9  
No 9

Година IX  
Volume IX

Ноември 2015  
November 2105

**УНИВЕРЗИТЕТ „ГОЦЕ ДЕЛЧЕВ” – ШТИП  
ФАКУЛТЕТ ЗА ПРИРОДНИ И ТЕХНИЧКИ НАУКИ**

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UDC 5 3 6

ISSN 8 6



**Природни ресурси и технологии  
Natural resources and technology**

**ноември 2015  
november 2015**

**ГОДИНА 9  
БРОЈ 9**

**VOLUME IX  
NO 9**

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**UNIVERSITY “GOCE DELCEV” – STIP  
FACULTY OF NATURAL AND TECHNICAL SCIENCES**

**ПРИРОДНИ РЕСУРСИ И ТЕХНОЛОГИИ**  
**NATURAL RESOURCES AND TECHNOLOGY**

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## Project Proposal:

# Geological Heritage of the Republic of Macedonia as a Challenge for the Development of Geoparks Blazo Boev



## Introduction

Owing to the favorable geographic location, complexity of the geological composition, versatile and specific natural characteristics, agrarian, demographic, ethnic and other characteristics Macedonia has always been an interesting area for description and study.

Natural and scientific studies of Macedonia carried out in the XIX century are different regarding the subject, content and methodology.

The most common literary form used was description or descriptive analysis of the issues. Travel writings over the past, although small in number are of importance.

If we leave out fragmentary description on the natural-geographic characteristics in travel and other reports, it can be said that individual studies did not exist in the XIX century. A longer work published at the time was “Geographie physique de la Macedoine” published by Carlovitz (Paris, 1881).

The period from the beginning of the XX century to the Balkan Wars (1912) marked the beginning of the study of the entire character of the area of Macedonia. The most important study as a regional-geographic nature that will be used by many generations of research workers during the whole period of the XX century is the long Monograph of Cvijic entitled The Element of Geography and Geology for Macedonia and Old Serbia (Belgrade, 1906 - 1911).

For the period to the Balkan wars, the works of Oestrich “Beitrag zur Geomorphologie Makedonien” (Wien, 1902), Uvanovja “Geografihja na Makedonija, fiziceska geografija (Sofija, 1911), and Kencov Orografija na Makedonija (Plovdiv, 1911) are worth of mentioning. In the conclusion for the period it can be inferred that the intensity of studies in Macedonia increased, although owing to the uncertain political and military events, investigations were limited. After the Balkan Wars, particularly after World War I, investigations in Macedonia increased. After 1920 natural-scientific investigations, in addition to intensity, saw serious methodological approach. Important contribution in that regard until World War II were the works of Boncev 1920, Kossmat 1924, Lukovic 1931, Jovanovic 1927, 1928, 1931, Radovanovic 1928, 1931, 1932, Vujevic 1929, Kirov 1935, Kuhlbordt 1020, Karaman 1931, 1097, Kosanin 1011, 1021, 1024, Stankovic 1027, Todorovic 1931 et al.

The second half of the XX century (1950 - 2000) is a period when investigations in Macedonia saw its maximum intensity. Besides, it can be said that some studies published in the first half of the XX century (on the Skopje Valley, Porece, the denudation forms in Mt Selecka, the glaciating of Jakupica etc.) have remained unsurpassed to the present time. Most probably geological investigations made the greatest progress due to the practical applicability of

the results. Researchers who in this domain have achieved the best results are Izmajlov, Arsovski, Stojanov, Garevski and Dumurdzanov.

The understanding of soil characteristics of the territory of Macedonia has achieved a high level thanks first of all to the enormous contribution of academician Filipovski. Over the last decades of the XX century intense ecological investigations led by Prof. Grupce, geomorphologic by Manakovic, Andonovski and hydrogeological by Gasevski, Guzelkovski, Kotevski et al.

The great deal of understanding indicates that the territory of the Republic of Macedonia abounds in specific and rare occurrences of geological heritage. All these make possible their identification, classification and suggest measures for their protection.

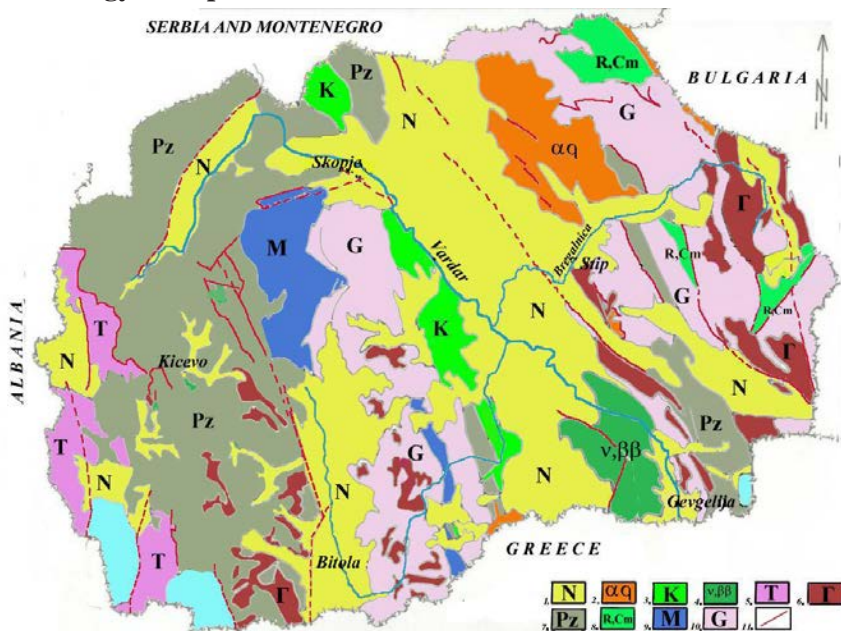


*Fig. 1.* The Map of Macedonia of 1689

Modern world is facing one of the most difficult tasks in its evolution - to overcome the crisis caused by the degradation of the global natural environment. To secure long term survival, protection of nature is a priority of exceptional importance.

Through diversity (the versatility of non-living nature), as component part of the system of natural values, one can come to complete understanding of the genesis of the natural systems which is an essential precondition for more successful harmony in the man - nature relationship.

### Geology of Republic of Macedonia



**Fig. 2.** Simplified geologic map of the Republic of Macedonia.

1. Neogene; 2. Volcanics; 3. Cretaceous; 4. Gabbros and diabbases; 5. Triassic; 6. Granites; 7. Paleozoic; 8. Marbles; 9. Riphean-Cambrian; 10. Gneisses; 11. Faults

The following geotectonic units have been distinguished in the regional geologic pattern of the territory of the Republic of Macedonia: the Western-Macedonian zone, the Pelagonian metamorphic complex, the Vardar zone and the Serbo-Macedonia massif. The Serbo-Macedonian massif (SMM) occupies the eastern parts of the country. In the north it extends further on to Serbia and in the south to Greece. It is composed of Precambrian and Paleozoic metamorphic rocks and divided into upper and lower metamorphic complexes.

The lower metamorphic complex is composed of gneisses, schists and small amphibolite, quartzite and marble bodies. The upper complex is present as volcanogene-sedimentary formations metamorphosed in a series of greenschists. Chlorite schists, amphibole-biotite schists, chlorite-sericite and quartzite schists prevail.

The Vardar zone is a separate unit formed between the Serbo-Macedonian massif in the east and the Pelagonian massif and the Western Macedonian zone in the west. It is a continental rift of which, in the territory of the country, fragments of Precambrian earth's crust have been included, then Paleozoic volcanogene sedimentary complex as well as acid Mesozoic magmatism. Remains of ocean crust are present as larger gabbro diabase ophiolite complexes.

The Pelagonian massif is of Precambrian age with rock complexes that differ from other tectonic units. It is composed of high metamorphic crystal rocks, gneisses, micaschists, marbles etc. as well as regional metamorphic complexes with large masses of palingenetic granites whose age has been determined as 800 to 1000 Ma.

The Western Macedonian zone is present as several formations. The oldest is volcanogene-sedimentary spilite-keratophyre formation of early Paleozoic age. The upper phyllite-marly series is of Paleozoic age (Ordovician, Silurian, Devonian) which includes quartz porphyry. As a result of complex geological compositions Republic of Macedonia is enriched with many scenic geologic features and a strong geologic heritage.

### **Relief forms**

Numerous relief forms have been registered in the territory of the Republic of Macedonia. They differ in the manner of occurrence (genetically), the time of occurrence (morphographically) etc. Of these, some fifty localities or individual forms deserve special attention, some being natural rarities that surpass not only our or the boundaries of the Balkan Peninsula but European boundaries, as well.

The primary relief is present as thirty structural blocks (horsts) and a smaller number of grabens (depressions). Of the high mountains (those higher than 2000 m above sea level) five are higher than 2.500 m, which is one third of such mountains in the Balkan Peninsula.

Structural relief in the southwestern part of the Republic of Macedonia with explanation of the dynamics of recent uplifts.

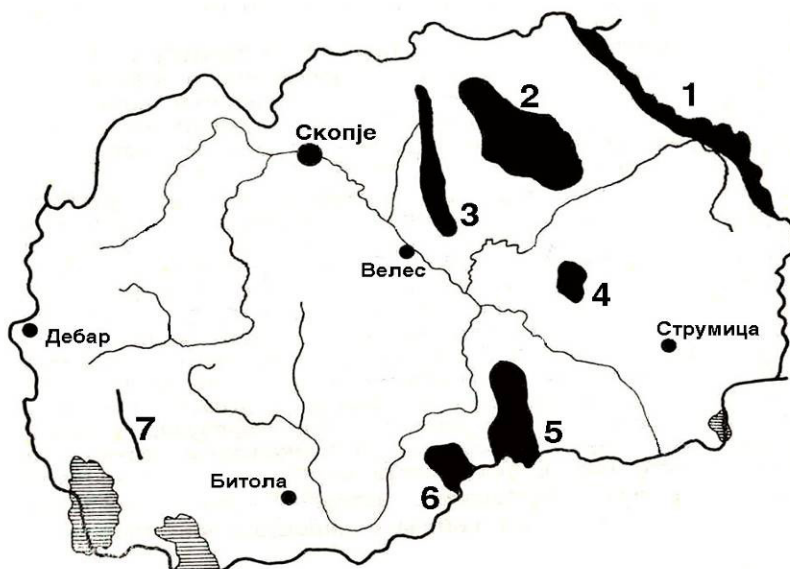


*Fig. 3.* Landscape characteristics of Mt Pelister (2.601 m).



*Fig. 4.* Landscape characteristics of Mt Jablanica (2.256 m).

The relief of the Republic of Macedonia is present as pre-graben valleys which are exclusive occurrences in the Balkan Peninsula, then fossil abrasive terraces and Paleovolcanic relief forms found as heaps, calderas and other kind of extrusions.



*Fig. 5.* Areas of dormant volcanoes in the Republic of Macedonia.

Osogovo - Males volcanic area, 2. Kratovo - Zletovo, 3. Kumanovo - Sv. Nikole, 4. Sopur - Damjan, 5. Kozuf - Vitacevo, 6. Mariovo - Kajmakcalan, 7. Ohrid - Kosel areas.



*Fig. 6.* The Pilav Tepe volcanic cone near Radovis.



*Fig. 7.* Paleovolcanic relief (basalt slabs) near Nagoricani, Kumanovo.



*Fig. 8.* Volcanic bombs in the Kratovo - Zletovo volcanic area.



*Fig. 9.* The Duvalo post volcanic occurrence near Ohrid.



*Fig. 10.* Fossil delta in the Debar Valley and that in the Vardar in the Skopje Valley.

The present day relief is manifested with numerous genetic types from micrelief to meso- and macrorelief occurrences. Denuded relief is present in the Pelagon (Markovi Kuli, Mt Selecka.). Due to the morphological characteristics of Markovi Kuli, in 2004 the locality was registered in the temporal list of world cultural heritage of UNESCO.

The abrasive relief (besides the fossil, Pliocene) as a recent occurrence is especially expressed along the eastern coast of Lake Ohrid (it has been in the list of world natural heritage) and in the Golem Grad island in Lake Prespa.

The fluvial relief, besides the usual occurrences, is present as 250, in terms of its genesis, various genetic types of waterfalls as well as, several



impressive gorges, some of which are of canyon nature (Matka, Skocivir). The karst relief is present as numerous surface and underground forms. The highest karst field seen in the Balkan Peninsula with leveled bottom 2.050 m above sea level. The well clints in the Matka canyon have been registered as a separate morphologic type in international literature, whereas the karst pots of Jakupica are the southmost occurrence of the kind in Europe. Of the underground karst forms some 200 caves and precipices have been investigated.

The Slatinski Izvor cave is the largest in the world built in Precambrian carbonates. The cave was registered in the temporal list of UNESCO in 2004. The entrance of Pesna (52.5 x 40 m) is one of the largest in Europe and the world.

The glacial relief is especially expressed in the western portions (Mt Sara, Korab and Jablanica). Of special importance among the periglacial are the stone polygons of Jablanica as exceptionally rare occurrence in the wider Mediterranean area, the rocky glacier in Jakupica and the stone rivers of Mt Pelister which are the most representative in the Balkan Peninsula as well as the best expressed grassy terraces in the world those in Mt Galicica.



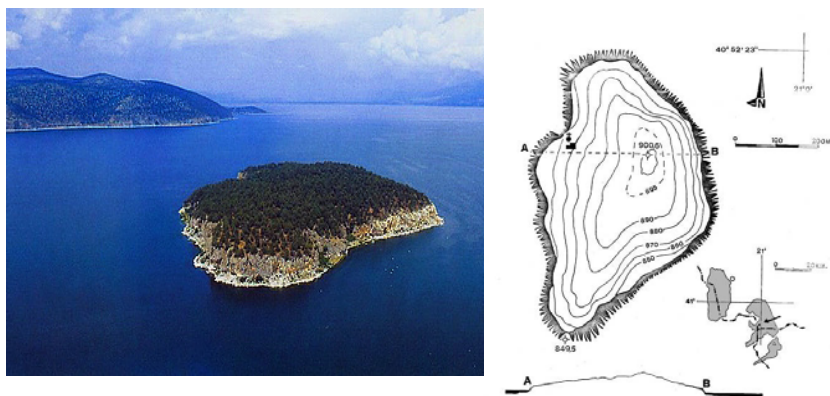
*Fig. 11.* The Markovi Kuli denudation relief



**Fig. 12.** Microrelief forms; footsteps built in the granodiorites south of Zlatovrv summit (1.422m) and stone plates built in sandstones at Ulanci, Krivolak.



**Fig. 13.** Recent cliffs along the eastern coastal line of Lake Ohrid.



*Fig. 14.* The Golem Grad island in Lake Prespa



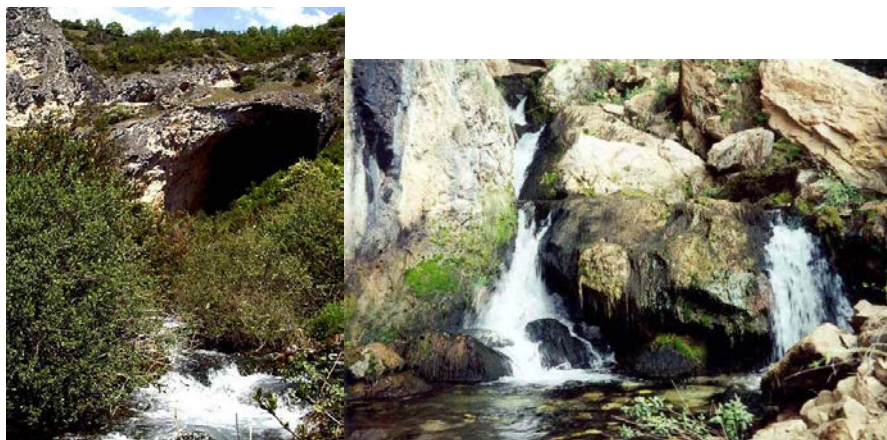
*Fig. 15.* Waterfalls in Mt Belasica, Kolesino (17 m) and Smolarski (45 m)



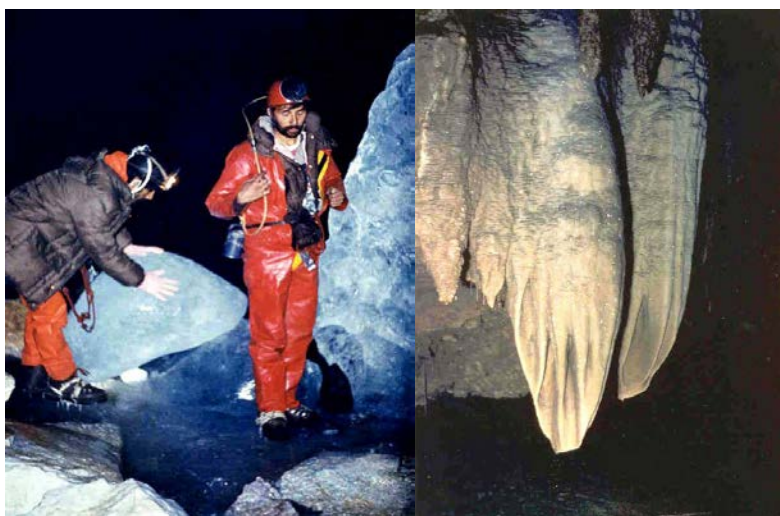
*Fig. 16.* Well-like cliffs along the edge of Matka Canyon and karts pan (2.210 m) in Mt Karadzica.



*Fig. 17.* The Solunsko Pole (7.5 x 3.7 km) in Mt Jakupica



*Fig. 18.* The entrance of the Pesna cave in Porece (52.4 x 40 m)



*Fig. 19.* The bottom of the largest precipice in the Republic of Macedonia (-45 m) with constant ice and marking stalactites in the Ubavica cave in Mt Bukovik.



*Fig. 20.* Grassy terraces in Mt Galicica at 1.900 to 1.950 m



*Fig. 21.* Stone rivers in Mt Pelister

### Soils

The territory of the Republic of Macedonia is a natural museum of almost all kinds of soils that can be seen in Europe. The soil cover, in terms of its space, is an exceptional mosaic and changes in small distances. Over thirty soil types have been registered and even more subtypes and varieties. The most important as geological heritage of Macedonia are the salty (holo morphic) soils of Ovce Pole and some other localities, the peats along Lake Ohrid as well as mountainous peats along Mt Jakupica and around the spring of the River Radika (Lukovo Pole).



*Fig. 22.* Limestone-dolomite dark earth in Galicica

### Hydrographic occurrences

In the territory of over 4.000 springs only 58 yield over 100 l/s. In fifteen of them the yield exceeds 1 m<sup>3</sup>/s. Of interest are the Ostrovo spring at Sveti Naum and Koritiste at the Matka canyon. In terms of mineralization, 170 mineral water springs have been registered, of which with eight the mineralization exceeds 8 g/l. The temperature in 15 springs exceeds 35°C. A dozen sinking rivers have been registered. The most important are the Rivers Krapska, Patiska and Cerska. Some 250 waterfalls (different in their formation), some fifty glacial lakes in Mt Sara, Korab, Jablanica, Stogovo, Pleister and Jakupica and about 200 river islands in the River Vardar have also been found.



*Fig. 23.* The Toni Voda active sink in Mt Bistra

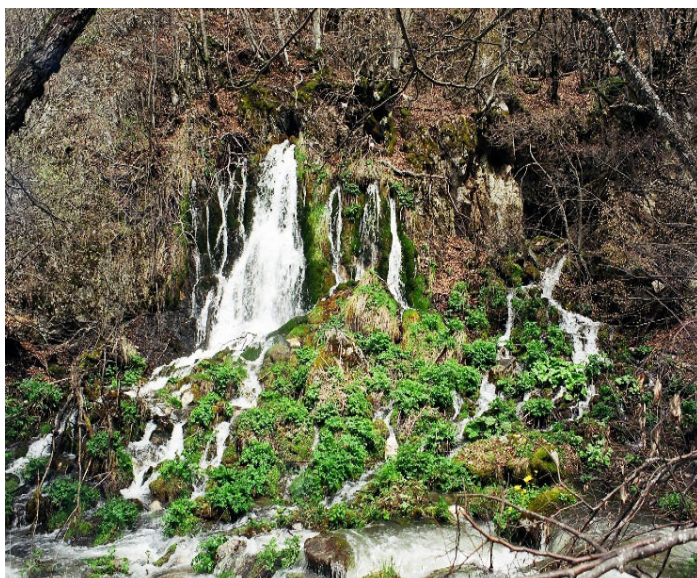


*Fig. 24.* Part of Mt Jablanica with Gorno and Dolno Lake Labunisko





*Fig. 25.* Lake Dojran, the situation in 2004



*Fig. 26.* Source of the river



*Fig. 27.* Rostuse waterfall



*Fig. 28.* Biljana weterfall



*Fig. 29.* Smolare waterfall

***Minerals***

The Complex geological composition of the Republic of Macedonia enables the occurrence of numerous minerals as component part of the geological heritage.



Gesso e Realgar, Macedonia

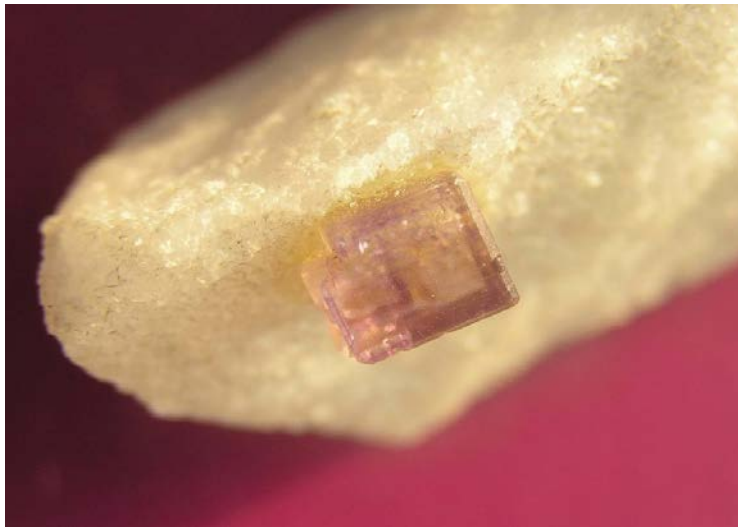


Quarzo e Realgar, Macedonia

*Fig. 30.* Realgar and quartz from Alsar



*Fig. 31.* Almandine from Pelagonian metamorphic complex



*Fig. 32.* Fluorite from white marbles of Sivec



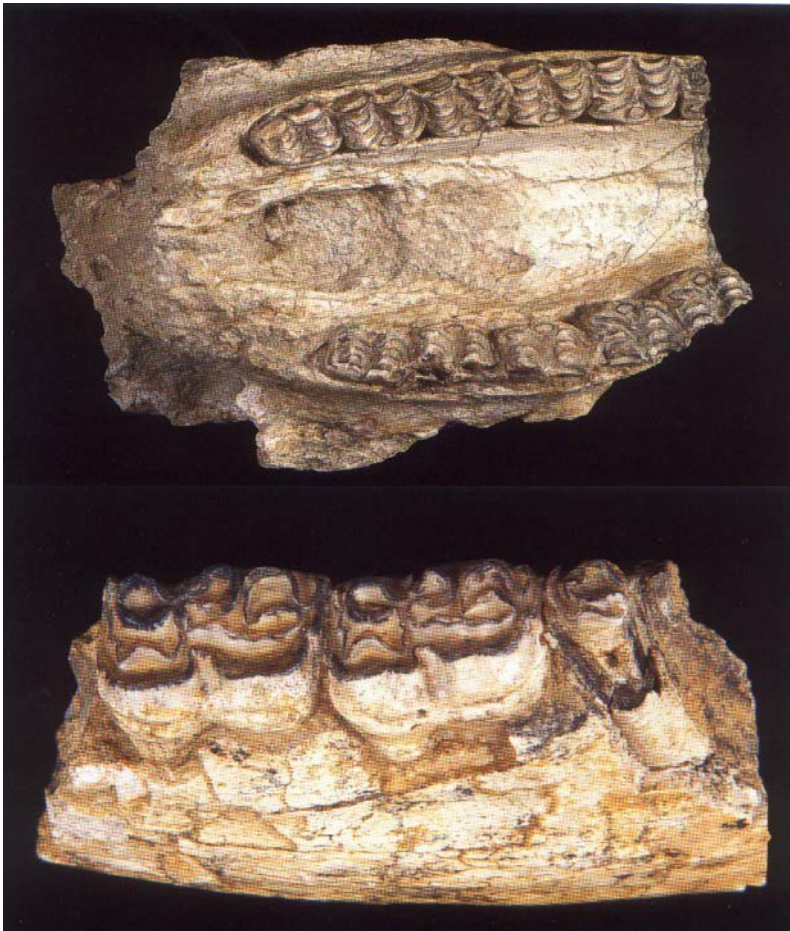
*Fig. 33.* Corundum from white marbles of Sivec



*Fig. 34.* Chlorite from Pelagonian metamorphic complex

**Fossils**

The long geological evolution in the area of the Republic of Macedonia resulted in abundance of fossil remains some of which are exceptionally important as a geological heritage.



*Fig. 35.* Picermian Fauna of Macedonia

**Scenic view**

Present day tectonic movements in the Republic of Macedonia in line with the erosion and denudation processes resulted in the occurrence of exceptionally beautiful landscapes in most of the area of Macedonia.



*Fig. 36.* Panoramic view of Pelister Mountains








*Fig. 37.* Panoramic view of Pelister Mountains



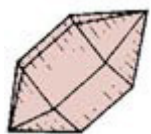




### Geological Heritage of Republic of Macedonia

Heritage geologic features are recognized special places of intertwined geology and landscape. Heritage geologic features may include unique or exemplary outcrops, scenic views, or other geologically significant features that together represent the geologic diversity of the Macedonia. Such features may be classified into different types that may be enjoyed, studied, and appreciated by all. The Department of Nature in the Ministry of Environment and Physical Planning of the Republic of Macedonia, is striving to promote the awareness, appreciation, and conservation of such outstanding geologic features by documenting their presence.

#### Heritage Geology Classification of Sites

				
<b>Erosional Remnants</b>	<b>Fossils</b>	<b>Glacial Features</b>	<b>Landforms</b>	<b>Lithology</b>

The MNHP sites and additional sites under review can be classified into the broad categories shown here. Classification is for convenience and for the MNHP process of preserving outstanding geologic sites. Categories are simply defined and may ultimately include subcategories. Also, some sites can be included in more than one category.

				
<b>Mineral</b>	<b>Scenic Views</b>	<b>Springs</b>	<b>Structure</b>	<b>Waterfalls</b>

#### Heritage Geology Criteria

What makes a place a heritage geology site? The significance of a site is based on values and criteria that define a heritage geology site. As shown in the table below, the criteria used are based on an assessment of a site’s value. For example, if a site has potential value because of the educational merits of the site, then the degree of excellence displayed by the site is used to evaluate its inclusion into the program. In addition, the conservation status and the type of significance is important to consider.

<i>Value</i>	<i>Criteria</i>
Scenic	Degree of excellence and beauty of a scenic natural landscape that clearly displays the result of geologic processes over time.
Educational; scientific	Degree of excellence with which a feature displays aspects of the nature and development of geological, landform, or soil systems in its region; use as a teaching site to show geologic concept; frequency of citation in scientific papers; site of important measurement or discovery.
Recreational	Frequency of recreational usage.
Social/historical	Degree to which a feature has played a role in the life or development of past or present human communities.
“Sense of place”	Degree to which a human community regards a feature as integral to the identity of their place.
Spiritual/ religious	Degree to which a feature figures as sacred or holy in a community’s spiritual life.

### *Significance*

Outstanding significance is displayed by a feature that exemplifies an aspect of geodiversity that is rare, unique, or exceptionally represents an example of its type, or otherwise of special importance. A representative significance is displayed by a feature that may be considered rare or common, but is considered significant as a well-developed or well-exposed example of its type.

### *Conservation*

The condition of the natural values of a feature and the degree to which current land uses and land management practices are likely to protect those natural values given their inherent sensitivity.

### **Conservation Status Categories**

Secure	Values not likely to be degraded under existing landuse conditions.
Potentially threatened	If landuse conditions change, or if vandalism occurs or continues, degradation of values is likely.
Threatened	Values actively being subject to degradation.
Endangered	Values have been subject to degradation.
Destroyed	Features whose values have been lost due to degradation.

### Heritage Geology Definitions

Heritage geology sites represent important elements of the landscape and the underlying geology that defines it. These sites represent unique, exemplary, or illustrative geologic features of Macedonia, and together compose the geologic diversity of the state. The following are definitions for these geologic features.



**Erosional remnant:** A landform or outcrop produced by the erosion process. Examples include outstanding “rock cities” or free-standing rock columns or boulders; bedrock pinnacles, peaks or cliffs; non-glacial potholes; or erosion-shaped oddities of nature that capture people’s imagination.



**Fossil:** Remnants or evidence of past plant or animal life in rock. Can include invertebrate fossils, plant fossils, and trace fossils. Sites are rare or otherwise outstanding examples of fossils in Macedonia.



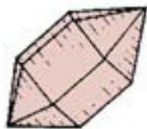
**Glacial feature (includes periglacial features):** Landforms or depositional remnants formed by glaciers, or by near glacial (periglacial) conditions. Can include glacial relicts such as kettle holes, moraines, drumlins, eskers, etc.; and periglacial features such as boulder fields, talus rock piles, and potholes.



**Landforms:** Land patterns and shapes. Include large scale landscape patterns like water gaps, wind gaps, islands, river meanders, etc.



**Lithology:** Rock type. Includes unusual or noteworthy lithologies that crop out.



**Mineral:** Specific mineral deposits or geologic formations. Includes noteworthy minerals or mineral formation examples in an outcrop.



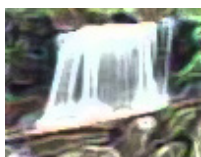
**Scenic view:** A view over a landscape pattern that is visually or aesthetically pleasing, and one that contains an outstanding representation of a particular geologic setting, physiography, or landform of Macedonia.



**Spring:** An emergence of groundwater at the earth's surface. Includes larger or otherwise noteworthy springs in Macedonia.



**Structure:** A geologic fold, fault, or other feature that displays the movement of rock. Includes classic or otherwise notable features of geologic structure in Macedonia.



**Waterfall:** A cascade of water from a higher area usually because of geologic differences.

### **Title of the project:**

Geological Heritage in the Republic of Macedonia as a Challenge for the Development of Geoparks

The major goal of the Project is to initiate establishing a geopark in the Republic of Macedonia. It will create good conditions for the development of geotourism. The idea is strongly supported by the abundant and versatile geological heritage in the country.

### **The Project would consist of two phase:**

- The first phase would include identification of abundant geological heritage and its systematization and classification. The time period envisaged for the phase is three years with the participation of five experts in the field of geoscience. The phase would include extensive field activity and trips to sites in the Republic of Macedonia that might be of interest in terms of the presence of geoheritage. The large field work will make possible the publication of the entire geological heritage in the country with special emphasis on the issues related to the development of geoparks.
- The second phase is envisaged to last for six months. The written publication on the geological heritage of the Republic of Macedonia will

enable to determine the areas that can be defined as geoparks. In addition to the experts who have worked in the first phase, two more experts from the field of spatial planning will join as well as one expert from the field of the cultural and one from the field of natural heritage.