



RILA GEOPARK

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Beli Iskar glacier at its terminal moraine during the Würm Ice Age 20 000 years ago

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Concept. Geoparks are areas with significant examples of geological heritage where knowledge about the Earth is promoted through geotourism - an economically successful and rapidly developing new tourism business sector. These are nationally protected areas with geological sites of particular importance, rarity or beauty, which are part of an integrated concept of protection, education and sustainable development.

The label "UNESCO Global Geopark", which every national geopark strives for, brings popularity and pride, but it is also a great responsibility. Interpretation of geological processes and phenomena in a language accessible to the general public is a major tool for promoting geological heritage. Geo-education is considered in the local context, so that visitors learn about it in its interrelation with the local cultural and spiritual heritage, emphasizing the national and international significance of geological phenomena.

The petrographic and geomorphological diversity of the highest mountain on the Balkan Peninsula and the second highest in Eastern Europe – Rila, are complementary attributes and important prerequisites for the development of a geopark and its nomination as a UNESCO Geopark. The main goal is to present Rila to ordinary people (not skiers, mountaineers, geologists or biologists) as a place where one can have a good time and at the same time learn something about the geological past of this incredible mountain and the mechanism of formation of its alpine relief.

The main priority of the Rila Geopark is to create appropriate conditions for geotourism by providing the necessary information for an ordinary tourist to safely pass with his family through the glacial valleys, cirques, lakes and moraines. Geotourism is among the main tools for popularizing geological heritage among the widest possible circle of people and its preservation for future generations. It requires not only serious analyses, but also the development of attractive visitor facilities such as advertising information, guides, mobile applications and interpretative facilities (Fig. 1), which enable tourists to gain knowledge and understanding of geological processes and phenomena beyond the usual passive inspiration from natural landscapes.

Glacial activity is at the heart of the concept for the development of Rila Geopark. The main theme of the geopark requires a scientific analysis of the glacial processes and phenomena that led to the formation of the Alpine landscapes and their interpretation in a language accessible to the general public. More than a century ago, the renowned Serbian geomorphologist [Јован Цвијић \(1897\)](#) first identified traces of glacial activity on the Balkan Peninsula. Later, the glacial forms were described in detail by [Иванов \(1954\)](#) and [Гловня \(1958, 1962, 1963, 1968, 1969, 1972\)](#). Analyzing the remarkable geomorphological, mineral and petrographic diversity of Rila, [Синьовски \(2014\)](#), [Sinnyovsky \(2014, 2015\)](#) together with the initiators from Samokov established the high geotourism potential of Rila and proposed the idea of developing an attractive national geopark, which became a subject of two doctoral theses ([Атанасова, 2019](#); [Цветкова, 2019](#)) and was adopted by the Samokov community as an opportunity for the development of year-round tourism (Fig. 2a).

Glaciers arise at an altitude above the so-called "snow line", where in summer the snow does not melt, but turns into firn – a granular semi-glacial mass gradually turning into ice. During the last Würm ice age, which lasted between 115,000 and 11,700 years ago, the snow line in Rila was below 2,200 m, which led to the formation of cirques and mountain glaciers. The remarkable glacial formations – carlings, cirques, arêtes, cirque lakes (tarns), trough valleys, hanging valleys, moraines, drumlins, sheep humps (roche moutonnée), etc., caused dramatic changes in the higher parts of the mountain.

After the last Ice Age, the altitude of the snow line rose above 3000 m and the glaciers melted, but left behind a well-defined glacial relief, which provides unlimited opportunities for interpreting glacial processes and presenting them in an attractive and accessible language for the general public. The establishment of the Rila Geopark will increase public awareness of the geological history of this exceptional mountain and will create conditions for sustainable geotourism and application to the UNESCO Global Geoparks Network. The most common glacial landforms in Rila are cirques, glaciers and sharp pyramidal peaks - "horns" with a typical representative being the Matterhorn in the Alps, with steep cirque slopes.

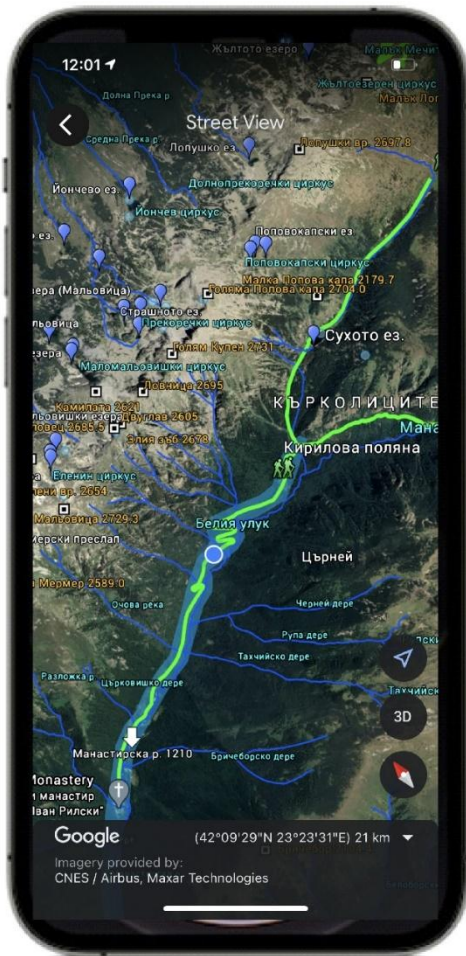


Figure 1. Mobile application on Google Earth, designed for terrain navigation in the Rila Geopark including peaks, rivers, lakes, waterfalls, passes, cirques, frontal moraines, geotopes,

The highest peak in Rila - Musala (2925 m) (Fig. 2b) is a horn, surrounded by three cirques - "Trionite", "Ice Lake" and "Aleko", and the trough valley of the Beli Iskar River. As the highest peak in the Balkans, it is primarily a geographical object. Alpine geotopes are the numerous cirque lakes (tarns), sometimes grouped in paternoster cirques such as the Seven Rila Lakes (Fig. 2c) and the Seven Musala Lakes (Fig. 2d). At an altitude of over 2200 m there are many peaks of the "horn" type, such as Malyovitsa Peak (Fig. 2e) and aretes (arêtes) – sharp inter-cirque ridges such as the "Trionite" between Musala and Malka Musala (Fig. 2f).

The majestic body of Rila is furrowed by deep U-shaped valleys typical of mountain glaciers, among which is the deepest glacier valley on the Balkan Peninsula, the Beli Iskar Valley (Fig. 2g), whose displacement with Musala Peak is 1250 m. It is also the longest glacial valley in the Balkans with a distance of 23 km between the feeding Kanarski Cirque and the frontal moraine at the village of Beli Iskar (Fig. 2h).

Other notable trough valleys are those of the Malyovitsa Glacier (Fig. 3a), Monastery Glacier, Maritsa Glacier, Yakoruda Glacier, etc. Remarkable glacial forms are also the so-called "hanging valleys", which are tributaries of the main glacier valleys and after the glaciers melt remain "hanging" hundreds of meters above their bottom. The highest hanging valley in Rila is the right tributary of the Monastery Glacier in the "Karkolitsite" area between Suhoto Lake and Kirilova Polyana (Fig. 3b), which is 400 m above the main glacial valley of the Monastery River, formed by the Monastery Glacier during the Würm Ice Age. The process by which glaciers effectively erode bedrock involves plucking entire blocks of them, called "joint blocks," and quarrying them into the rock massif.

The way in which this destruction occurs is described by Matthes (1930, p. 90): "Any joint block in the bed of a glacier, such as that marked A (Fig. 3c), which is for any reason unsupported or weakly supported on its downstream side, is particularly susceptible of being dislodged, for the force of the glacier is exerted upon it at a small angle forward from the vertical, as indicated by the arrow. The block A and its side companions having been removed, the block B and those flanking it will next be unsupported and ready for removal, and so the process will continue farther and farther up the valley." As a result of temperature changes, the blocks move apart, break off, and fall gravitationally down the slope, forming scree slopes (Fig. 3d).

Cirques are the most common glacial landform. Their formation begins with the year-round preservation of snow patches and the transformation of snow into firn, and firn into ice. Under the ice mass, frost weathering of the bedrock takes place by filling the cracks with water, which, when frozen, expands and gradually destroys the bedrock. This process of destruction, aided by the gravitational pressure of the expanding ice mass, is called glacial exaration. It leads to the formation of chair-like depressions - cirques, surrounded by three steep walls and a frontal open part through which the ice flows down the slope.

Cirque glaciers feed mountain glaciers, which in turn form U-shaped glacial valleys, called trough valleys. Heavy ice masses flow slowly, scraping away bedrock and leaving a ground rock mass at the base (bottom moraine) or to the side of the ice river (lateral moraines).

Figure 2



Figure 2: *a*, The initiators of the idea of developing a Rila Geopark on Musala Peak in August 2013 (from left to right): Georgi Gurkovski, Diana Kanazireva and Dimitar Sinyovski; *b*, Musala Peak (2925 m), the highest peak in the Balkans built of granites of Lutetian age (35-40 Ma); *c*, Paternoster cirque "Seven Rila Lakes" incised into Precambrian metamorphites and Lutetian granites (Musala Body of the Rila-West Rhodope batholith); *d*, Paternoster cirque "Seven Musala Lakes" incised into Lutetian granites (Musala Body of the Rila-West Rhodope batholith); *e*, Malyovitsa horns; *f*, "Trionite" arete between Musala and Malka Musala; *g*, U-shaped valley of the Beli Iskar glacier at Beli Iskar dam; *h*, End moraine of the Beli Iskar glacier south of the village of Beli Iskar.

The material in the front marks the end of the glacier. It is called the frontal moraine. After the climate warmed at the end of the Ice ages, the glaciers left deep traces in the mountain ranges, which are evidence of their glacial past. Rila is a typical example of a glacial mountain and a wonderful test site for demonstrating glacial processes and phenomena. There are hundreds of cirques in Rila, but the best expressed and preserved are those with northeastern exposure, where solar heat was scarcest. A classic example of a well-formed cirque is the Ice Lake under Musala Peak. During the ice age, the back wall was subject to disintegration according to the scheme of Matthes (1930) (Fig. 3c). The angular rock blocks that separated from it fell onto the surface of the cirque glacier and some of them were transported to the valley, but most of them sank into the ice (Fig. 3e). As a result of the gravitational pressure exerted by the ice on the bottom of the cirque, the cirque bowl was formed. After its melting, angular pieces remained under the back wall in the form of a supraglacial moraine (Fig. 3f). The concave part was preserved as a tarn (Ice Lake) and in the front part the frontal moraine remained.

The largest cirque in Rila – the Maritsa Cirque, went through a dramatic Quaternary history. Above it was the highest peak of Rila before the Quaternary glaciations – Paleo-Musala, whose height was about 3030 m (Fig. 4a). It was of "chal" type - a local name for a rounded peak covered with soil. The uplift of Rila began in the Miocene epoch, when the leveled Miocene surface from 200-300 m above sea level rose above 2400 m.

During the Ris Ice Age 200-250 thousand years ago, the formation of a small cirque began on the NE slope of Paleo-Musala, feeding a shallow glacial valley. During the Würm Ice Age, this cirque was abundantly fed with ice and became the largest Rila cirque complex built up of several cirques: "Maritsa", "Preslap", "Malak Bliznak" and "Trionite", feeding the Maritsa Glacier. According to the GIS reconstruction of the Maritsa Cirque before the Quaternary glaciations (Fig. 4a), about 1.4 billion cubic meters of destroyed rock material was removed from the Marishka Cirque complex (Fig. 4b), proving the enormous destructive power of the glaciers (Sinnyovsky et al., 2020). Large-scale glacial formations such as horns, cirques and glacial valleys are complemented by smaller glacial forms typical of Alpine landscapes: sheep's humps (roche moutonnée) - bedrock scraped by the glacier (Fig. 4c), huge "eratic" blocks dragged by glaciers tens of kilometers from the place of detachment from the bedrock (Fig. 4d) and various types of moraines.

The glacial formations in Rila have been preserved almost in their original form after the melting of the glaciers "only" 11,000 years ago. However, in the higher parts of the mountain, geocryogenic processes continue to shape the relief complementing the general concept of the Rila Geopark (Sinnyovsky et al., 2017). They are a consequence of frost weathering (24-hour freezing/thawing), which drastically changes the earth's surface in the higher parts of the mountain. It provokes the displacement of a huge amount of soil masses and rock blocks, and forms attractive relief forms, the explanation of which can be presented to tourists in a popular science style.

Postglacial (geocryogenic, periglacial) morphostructural forms of the relief are gradually superimposed on the fossil glacial relief of the mountain, modeling it by destruction the bedrock and forming cryonival cirques, screes and cones. Each of these forms can be presented to visitors in an attractive way through information boards with schematic interpretations, graphs and photographs in accessible popular language. An important stage in the interpretation of the processes for the purposes of geotourism is their distinction

from fossil glacial forms and demonstrating the results of their influence on the Würm glacial relief. The places where modern geocryogenic processes and phenomena operate are at an altitude of over 2200 m.

Figure 3

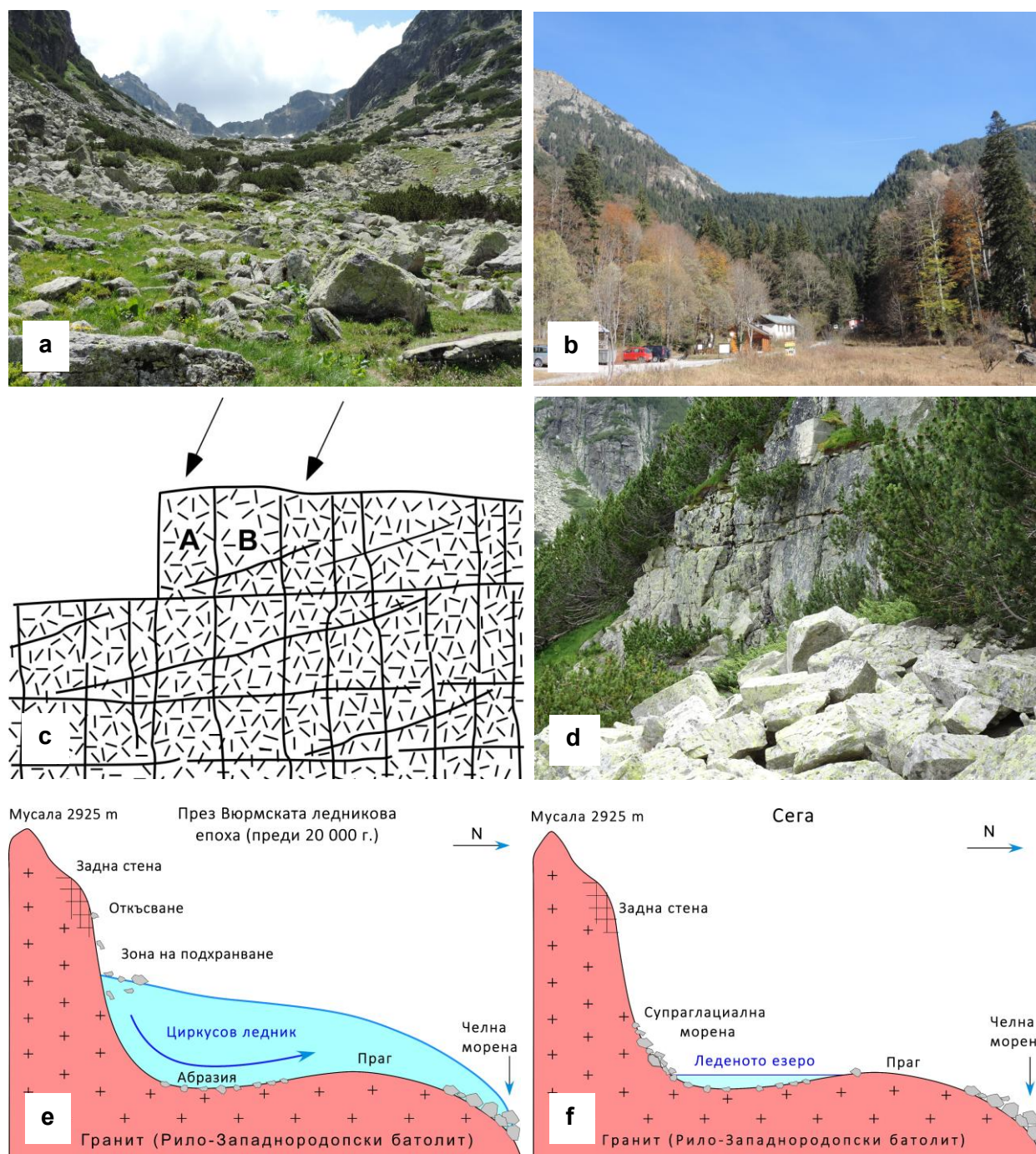


Figure 3: **a**, The typical U-shaped valley of the Malyovitsa Glacier with numerous erratic boulders on the bottom; **b**, The highest hanging valley in Rila, located 400 m above the bottom of the Monastery trough valley; **c**, Scheme of glacial indentation in a cracked rock massif by “plucking” of “connected blocks” (according to Matthes, 1930); **d**, Supraglacial moraine (scree slope) formed according to the scheme of Matthes (1930) as a result of frost weathering of granodiorites of the first phase of Rila-West Rhodope batholith in the Granchar Cirque; **e**, The cirque glacier of the Ice Lake during the Würm Ice Age; **f**, Modern view of the Ice Lake cirque.

They are expressed in frost weathering of soils and rocks and are denoted by the terms cryoclasticism, geocryogenic denudation, gelifluction, gelifraction and cryosolifluction. To denote all aspects of frost weathering from residual snow patches in summer, Matthes (1900) introduced the unifying term “nivation”.

Figure 4

Figure 4. *a*, Reconstruction of the Maritsa Cirque area before the Quaternary glaciations, where the highest peak in Rila - Paleo-Musala (~3030 m) was; *b*, Maritsa Cirque complex after the last ice age; *c*, “Roche moutonnée” in serpentinized

ultrabasites near Trilistnika Lake, Seven Rila Lakes; d, Erratic block near Ribno Lake, Seven Rila Lakes; e, Nivation process around a snow patch in the Zavrachitsa Pass; f, Cryonival cirque on the northern slope of the Maritsa Cirque complex between Preslap Cirque (left) and Trionite Cirque (top right); g, Scree slope (supraglacial moraine) on the southern slope of Granchar Cirque; h, On the back wall of the "Okoto" tarn, the Seven Rila Lakes, with scree particles scattered on the snow, "temperature weathering continues even before our eyes."

The geocryogenic forms obtained as a result of nivation are the result of periglacial weathering associated with the repeated diurnal and seasonal processes of freezing/thawing in the high mountain belt above 2200 m above sea level. The erosional effect of nivation is expressed in the carving of elongated negative forms by the constant wetting of the rock substrate under the melting seasonal snow patches (Fig. 4e), which facilitates the gelifractation of the bedrock. As a result of abrasion, the nivation depressions expand and deepen into the slope, gradually acquiring a circular shape and turning into nivation (cryonival) cirques.

The most common geocryogenic forms in Rila are cryonival cirques (Fig. 4f) and scree slopes (talus slopes, scree slopes/fields). This weathering pattern is observed on the slopes of all cirques and glacial valleys in Rila. The main role in loosening the connections between the blocks is played by the repeated daily and seasonal freezing/thawing of water, which fills and widens the cracks. This process is especially active in spring, when it is a daily phenomenon. The highest part of the wall from which the blocks break off is determined by the power of the glacier and the structure of the bedrock. In cirques, this is the back wall (headwall), which is extremely steep. Further down the slope, scree (talus) slopes, also known as supraglacial moraines, are formed, with gravitational sorting of the pieces (Fig. 4g). Due to their large mass, the largest blocks reach the farthest down the slope, while the smaller ones are "caught" on the slope between other pieces of the scree.

Along with the large, angular blocks, frost weathering also supplies fine material that fills the inter-clump spaces. According to Канев (1988), *"temperature weathering continues even before our eyes"*: after the snow melts, fine scree particles descend on the slopes of the cirques, which remain invisible among the large clumps, but are noticeable against the white background of the snowdrifts (Fig. 4h).

Geocryogenic forms include avalanche chutes (Fig. 5a) and scree cones (Fig. 5b) at their base. In contrast to the negligible speed of movement of the particles in scree slopes, in avalanche chutes this happens instantly and catastrophically. The transport of rock masses in this way leads to the accumulation of scree cones (stone horseshoes), which over time can reach enormous sizes.

Against the background of the diverse supraglacial forms created by geocryogenic denudation over the last 11,700 years - cryonival cirques, scree slopes and avalanche cones at the base of avalanche chutes, it is difficult to set the boundary between glacial and postglacial activity.

The formation of scree slopes began during the Ice Age, when in the rear parts of the cirque glaciers, angular blocks, torn off from the bedrock in which the cirque bowl was carved, accumulated. The rock blocks from the side walls also fell onto the surface of the cirque glacier. After its melting, they mixed with the materials at the bottom of the cirque, especially at the base of the headwall, and subsequent geocryogenic processes added new rock blocks on top of them. For this reason, periglacial landscapes provide a wide field for interpretation of the results of typical glacial activity during the Würm Ice Age and the frost weathering that formed the high-mountainous relief.

The emphasis on well-developed periglacial processes and frost weathering phenomena in the most visited higher parts of Rila is a reliable approach for developing thematic geotrails in the context of the main theme of the geopark – glacial activity and the modeling of the high mountain relief from glacial and post-glacial processes and phenomena.

Demonstrating the connection between geological and geomorphological themes on the one hand and historical and spiritual heritage on the other, is the only correct approach for identifying the remarkable cultural and natural heritage of Rila and its promotion on a global scale.

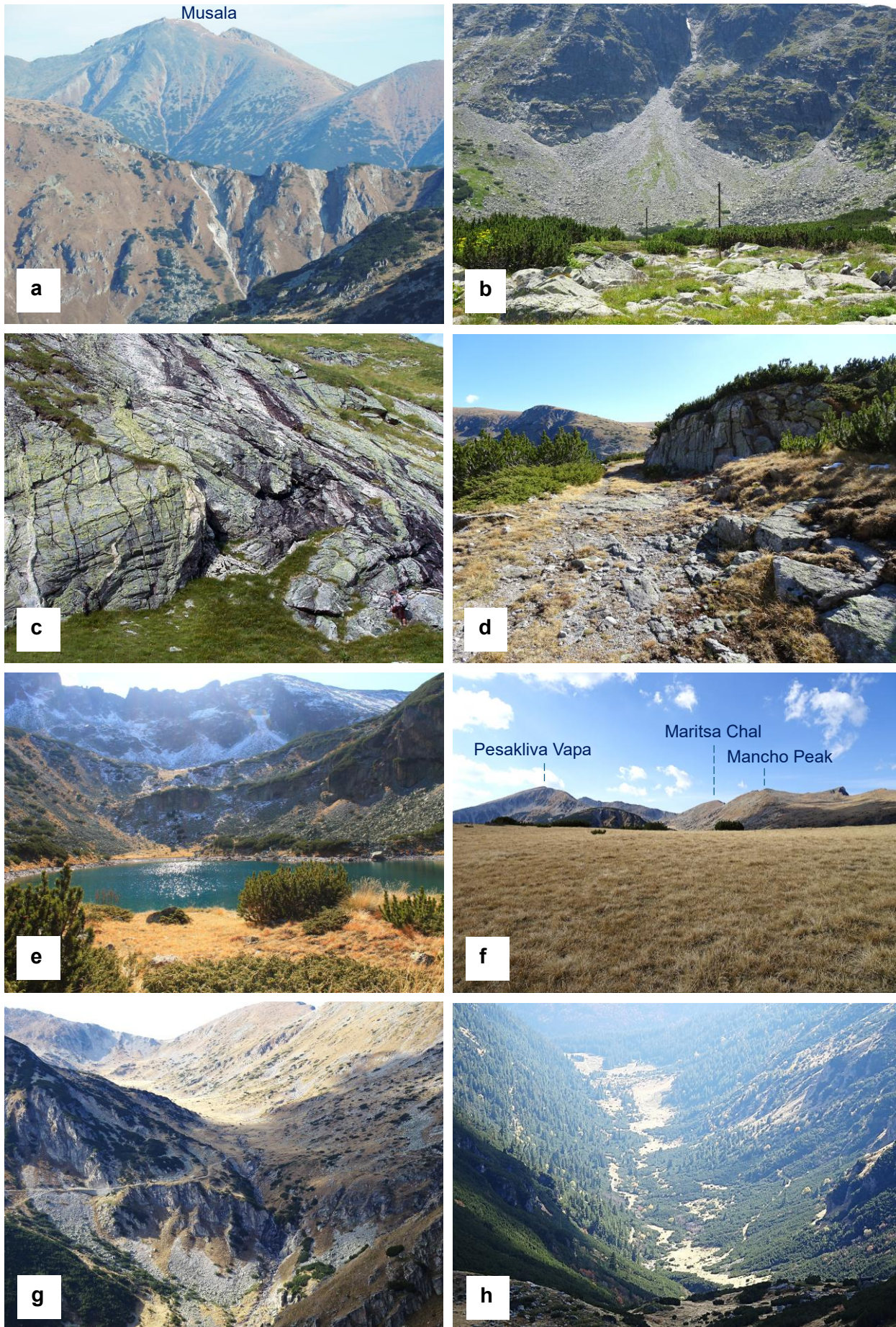
Figure 5

Figure 5. *a*, Avalanche chutes on the northern slope of the Marinkovitsa Cirque above Tiha Rila against the backdrop of Musala Peak; *b*, Deep avalanche chutes and screes on the southern slope of the Karakashev Cirque; *c*, Emerald-bearing Chepelare variegated metamorphites from the Rupchos metamorphic complex in the Urdini Lakes geotope; *d*, Kaiser's Road through the Zavrachitsa Cirque; *e*, Maritsa Cirque and the Upper Marichino Lake; *f*, Early Miocene Kapatnik Peneplain elevated to 2400 m above sea level in the Zavrachitsa Pass; *g*, Kaiser's Road through the picturesque Ropalitsa Cirque complex; *h* - U-shaped Ropalitsa Glacial Valley.

Petrographic diversity. Against the backdrop of the impressive Alpine landscapes and remarkable geomorphological diversity, the petrographic diversity of the mountain seems relatively poor. However, Rila is composed of geologically young Upper Cretaceous and Paleogene granitoids and variegated more than 600 million years old old Neoproterozoic metamorphic rocks demonstrating a significant petrographic diversity, which is the subject of long-term petrographic studies dating back to the mid-19th century.

The main part of the mountain is made up of granitoids, forming the Rila-West Rhodope batholith, the largest batholith on the Balkan Peninsula. It is characterized as a complex magmatic massif with four phases of magmatic activity (Вылков et al., 1989). The first phase includes Upper Cretaceous about 80 million years old granodiorites with a quartz-diorite composition, forming several separate bodies. During the second phase, which took place in the Lutetian Age of the Eocene Epoch about 35-40 million years ago, medium- and coarse-grained biotite granites were intruded, which formed the main part of the batholith and formed four bodies located around the intrusions of the first phase. The third phase includes fine-grained granites to plagiogranites, forming several small bodies. Their contacts with the host metamorphites and granitoids of the earlier phases are intrusive. The fourth phase is represented by aplitoid and pegmatoid granites, forming small rod-shaped bodies or veins. The overview of the geoconservation significance of igneous rocks in Rila (Синьовски, 2020) outlines unlimited possibility for interpreting igneous processes such as crystallization of magma or demonstration of basic geological principles, e.g. the principle of crosscutting relationships.

The metamorphic rocks exposed in the mountain also have great interpretive potential for geotourism purposes (Синьовски, 2021). They are considered in two ways: as lithotectonic units and as lithodemic units according to the method for characterizing metamorphic rocks recommended for the geological mapping of Bulgaria at a scale of 1:50,000 (Hrishev, 2005). The diversity of metamorphic rocks in Rila is truly remarkable, and today's knowledge of them is due to the long-term research of many authors, the greatest contribution of which is made by Dimitar Kozhoukharov (Кожухаров, 1968,1984; Kozhoukharov, 1978, etc.). The oldest Maleshevtzi and Troskovo metamorphic complexes are made up of amphibolites, serpentinites, gneiss-granites, metadiorites and metagabbro. The younger metamorphic complexes Rupchos and Predela (Зарорчев, 1976) are composed of all metamorphic varieties described in the petrographic literature: biotite and two-mica gneisses, muscovite-albite gneisses, migmatite gneisses, gneiss schists, disten-sillimanite and kyanite schists, amphibolites, biotite and two-mica leptinites, serpentinites, serpentinitized ultrabasites, metagabbro, eclogites, marbles, etc. In the rocks of the Chepelare variegated metamorphites of the Rupchos metamorphic complex, some of the famous Rila tarns are developed - the Seven Rila Lakes, the most visited place in the Rila Mountain. In the tarns of the Urdini Lakes, which are carved into the same unit, there are pegmatite veins with emeralds (a precious variety of beryl) (Fig. 5c), intersecting intensely folded carbonate-silicate schists with skarn mineralization of metasomatic minerals from the garnet group (grossular, andradite), vesuvian, scapolite and epidote (Петрусенко et al., 1965). One of the most valuable and rare minerals in the world – chrysoberyl (alexandrite), which is rarer than diamond, has also been found here. The remarkable geomorphological and petrographic diversity is complemented by the exceptional cultural and spiritual heritage of Rila. At the foot of the mountain is the medieval Rila Monastery founded in the 10th century, which is a World Cultural Heritage site. Its walls are embedded with river stones from the entire petrographic diversity of Western Rila, which makes it a geological museum. Several geotrails of historical value for Bulgarian geology and culture are in the process of being developed. The longest (69 km) is the so-

called “Kaiser’s Road” (Fig. 5d), along which the German Kaiser Wilhelm II and Tsar Ferdinand passed on October 13, 1917, to visit the newly liberated Bulgarian territories south of Rila.

Geotrails

The Kaiser’Road starts from Borovets, the largest winter resort in the Balkans, and passes through Sitnyakovo, the Saragyol Cirque, the hanging valley of the Deno Cirque and the Maritsa River valley, carved out during the Würm Ice Age by one of the largest glaciers in Rila starting from the deepest cirques in Rila - the Maritsa Cirque (Fig. 5e).

The approach to the highest pass – the Zavrachitsa Pass, branches along the valley of the Prava Maritsa River, flowing from the Zavrachitsa Cirque. Although with a small elevation of about 100 m, it hangs above the Maritsa River valley. South of the Zavrachitsa Cirque, the road crosses the Rila Ridge through the Zavrachitsa Pass, where it passes through the Early Miocene Kapatnik Denudation Surface, the oldest elevated peneplain in Rila at an altitude of 2400 m with the peak Yanchov Chal (2480.6 m) – a typical representative of the so-called “chals” (Fig. 5f) – a local name for the regolith-covered rounded peaks in Rila. To the south, the road passes through the picturesque Ropalitsa Cirque Complex (Fig. 5g) with the straight U-shaped valley of the Ropalitsa Glacier (Fig. 5h).

Then the road passes through two small cirques - Pesykliva Vapa and Ovcharets on the western slope of the glacial valley. Below the highest mountain pass Dzhanka, the road enters the Granchar Cirque with the Granchar Lakes (Fig. 6a). It hangs over the U-shaped glacial valley of the Grancharitsa River and the waters flowing from it form the Granchar Waterfall. After 5-6 km, the road passes through the valley of the Golema Banenska River in the Nehtenitsa area (Fig. 6b), where the frontal moraine of the Yakoruda Glacier is fed by the Yakoruda cirque complex - the cirques of Ribnoto, Martvoto (Fig. 6c) and Sinyoto Ezero. Further on, it crosses the Malka Banenska Valley and after three small glacial valleys descends into the valley of the Votrachka River near the village of Belitsa.

Glacial and post-glacial processes can be demonstrated in the numerous cirques along the entire length of the Kaiser’s Road. The main theme of the geotrail is the geotopes formed during the Würm Ice Age. Their interpretation for geotourism purposes requires differentiating fossil glacial forms from modern geocryogenic phenomena and demonstrating the results of the Würm glaciation.

In addition to the cirques, glacial valleys and moraines, relief forms related to modern frost weathering in the active periglacial zone of Rila can also be demonstrated. They significantly changed the high-mountain landscape after the end of the last ice age and are a good example of modern geological processes that continue to shape the alpine relief of the mountain.

On the other hand, the 100-year-old road is a convenient walking and cycling route, which is also the link between geology, history and tourism. The Kaiser's Road was intended for two-wheeled vehicles. Its main purpose was to provide access to the Bulgarian territories south of the Rila ridge, annexed during the Balkan War. On October 13, 1917, Tsar Ferdinand took his high-ranking guest Kaiser Wilhelm II across the Rila ridge to show him the newly liberated Bulgarian lands.

At the sight of Pirin from the Nekhtenitsa area under the Yakoruda Cirque, the German emperor exclaimed: “Oh, a wonderful, incomparable picture! Who in Europe would have thought that the Balkan Peninsula hides such magnificent scenarios and mountain landscapes in its bowels” (Делирадев, 1932).

The “Ferdinand’s Road” geotrail is the route designed to connect the village of Govedartsitsi with the Rila Monastery. It is the second road in Rila after the Kaiser’s Road, built by Tsar Ferdinand during the First World War. The road passes through the ridge of the so-called “Pashanitsa” – the Malyovitsa part of Rila through the peaks of Golyam Mechit (2567 m) and Malak Mechit (2535 m) and reaches the foot of Malak Lopushki peak (2537 m), where it remains unfinished before Kobilino Branishte. Part of this road is well preserved, including the highest parts of the route through the mentioned peaks (Fig. 6d). Until the Balkan War, the region was a deserted highland landscape, close to the southern state border.

Figure 6

Musala



Figure 6. *a*, The Potters' Circus looming over the glacial valley carved by the Potters' Glacier; *b*, The Kaiser's Road through Nekhtenitsa; *c*, The Dead Lake in the Yakoruda Circus Complex; *d*, The route of the Ferdinand's Road past Golyam Mechit Peak (2567.4); *e*, A memorial plaque marks the passage of Tsar Ferdinand's retinue through Lopushnitsa on June 2, 1899; *f*, The Rila Monastery, a World Heritage Site, founded in the 10th century by St. Ivan Rilski; *g*, The walls of the Rila Monastery, built of Rila rocks and minerals, are an example of the material and spiritual unity of the living and inorganic world, of man and the planet; *h*, The frontal moraine of the Monastery Glacier.

The only outside guests on the mountain were visitors to the Rila Monastery, who reached it from Dupnitsa and Rila towns, while Gorna Dzhumaya (Blagoevgrad) was still on the territory of Turkey. In Gorna Dzhumaya, a new road to Rila was built along the Bistritsa River, and construction of a purely alpine road began from the north, which would facilitate access from Sofia to the Rila Monastery. It starts from the village of Govedartsa and continues south along the ridge between the Dzhupanitsa and Yurochka rivers. The road emerges on the ridge 500 m west of Budachki Kamak peak and continues through the peaks of Golyam and Malak Mechit.

At the same time, the road is intended to provide a unique experience of contact with the Alpine part of the mountain, where the ruler of the Third Bulgarian State passed with his retinue as early as the end of the 19th century (Fig. 6e). Its construction is taking place simultaneously with the Kaiser Road, which, however, has priority due to the expected visit of the German emperor. After the end of World War I in 1918 and the national catastrophe that occurred with the capitulation of the Triple Alliance, the road remained unfinished. Its built part is well preserved and provides good opportunities for geotourism with outcrops of metamorphic and igneous rocks.

The "Fish Lakes" geotrail is of cultural, historical and spiritual value. It starts from the Rila Monastery (Fig. 6f) and passes through the end moraine of the Monastery Glacier, the cave of St. Ivan Rilski, "Beliya Uluk" geotope, Kirilova Polyana with the hanging glacial valley and the "Tsarney" quarry, Tiha Rila hut, the Fish Lakes cirque with the Fish Lakes hut, Rilets peak (2712) and ends at the Pearl Lakes in the Dzhendem cirque.

In the 19th century, Rila attracted a number of European travelers and encyclopedists with its impressive alpine morphology and high-mountain landscapes. Undoubtedly, the first explorers of Rila were attracted by the Rila Monastery, known far beyond the borders of the country. The earliest information about Rila granites was provided by Ami Boué (1840), who described the traditional iron mining in Samokov and defined Rila as part of the "great crystalline island of the Balkans – the Rila-Rhodope massif".

Петрусенко (Кралева, Петрусенко, 2013) noted that the Rila Monastery, whose walls are entirely made of Rila rocks and minerals (Fig. 6g), is a magnificent example of the material and spiritual unity of the living and inorganic world, of man and planet. The petrographic and mineralogical characteristics of the river stones embedded in the Monastery walls demonstrate the remarkable geodiversity of Rila.

An important geotope is the end moraine of the Monastery Glacier, established by Цвијић (1897) east of the Rila Monastery during his first route through Western Rila (Fig. 6h). Then, on the road to Kirilova Polyana, there is a fork to the cave, into which St. Ivan Rilski ascended on August 18, 946 (Figs. 7a,b). Another geotope of historical value is the old marble quarry "Beliya Uluk" in the Chepelare metamorphites between the cave of St. Ivan Rilski and Kirilova Polyana, where stones were extracted for the construction of the Rila Monastery.

Above Kirilova Polyana is the highest hanging valley in Rila, "Karkolitsite", located 400 m above the Manastirska riverbed (Fig. 3b), as well as the "Tsarney" quarry established by Bonchev (1908) 700 m above the riverbed on the southern slope of the valley, where serpentinites called "black marble" were mined for the columns of the monastery church (Fig. 7c).

The road continues to the Tiha Rila site with the hut of the same name, which is the starting point to the Marinkovitsa Cirque, the Smradlivoto (Stinky) and Chernoto (Black) Lake cirques and the Ribnite (Fish) Lakes cirque from where the Monastery River flows under the name Kriva Reka or Kyoravitsa.

Figure 7

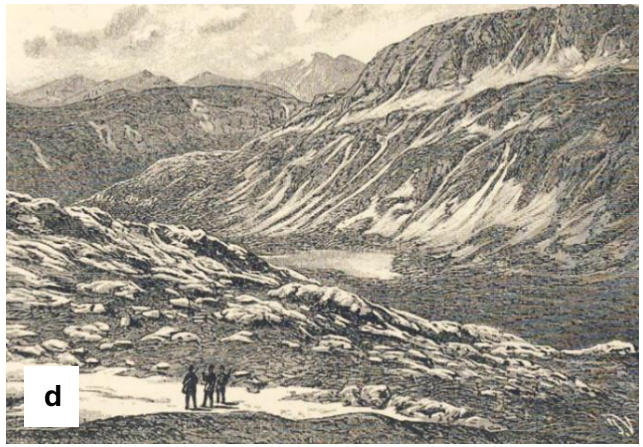


Figure 7. *a*, The approach to the cave of St. Ivan Rilski; *b*, The cave of St. Ivan Rilski in the Chepelare metamorphites; *c*, The serpentinite columns of the monastery church from the "Tsarney" quarry 700 m above Kirilova Polyana on the left slope of the Manastirska River; *d*, Lithograph of the cirque of the Fish Lakes by Toulas (1892); *e*, Rilets Peak; *f*, The Pearl Lakes in the Dzhendemb cirque; *g*, The cirque of the Fish Lakes against the backdrop of Yosifitsa Peak (2696.5 m); *h*, The cirque of the Stinking Lake, the largest glacial lake on the Balkan Peninsula.

In this remarkable cirque, illustrated by Franz Toulas (1890) (Fig. 7d), there is the Ribni Ezera hut, which is a starting point for Rilets Peak (2712 m) (Fig. 7e) and the Sedefeni (Pearl) Ezera in the Dzhendemb Cirque (Fig. 7f). From the peak of Kyoravitsa, a panoramic view opens up to the cirque of the Ribni Ezera (Fig. 7g) and the Smradlivoto Ezera – the largest glacial lake on the Balkan Peninsula (Fig. 7h).

From the peak of Kyoravitsa, a view opens up to the south to the cirques of the Iliyna River and the cirques of Sinyo (Fig. 8a) and Mermersko Lakes (Fig. 8b), located below the ridge, whose name comes from the marbles of the Chepelare metamorphic rocks in which the Mermer Cirque is carved.

Prezrilsko Shosse geotrail is named after the so-called "Prezrilsko Shosse" route, which ran through the "Dolni-kuki" saddle (Делирадев, 1932) of the central Rila ridge or the Main Balkan Watershed, separating the White Sea from the Black Sea watershed. Its purpose was to connect Samokov with Belitsa and Razlog.

Prezrilsko Shosse was officially opened on August 14, 1932 in the Dzhanka area (Fig. 8c), whose name also bears the pass itself, considered the highest mountain pass in Bulgaria (2346 m). The route starts from the frontal moraine of the Beli Iskar glacier 1 km south of the village of Beli Iskar (Fig. 2h) and continues along the road to the Beli Iskar dam. On the left rises Orlovi Sokolets (Fig. 8d), at the foot of which already in the 19th century Hochstetter (1870) described mica gneisses with interlayers of amphibole gneisses, crystalline limestones and serpentinites.

Next is Demirkapiya (Iron Gate) - the narrowest part of the trough valley with the Lyuti Dol waterfall (Fig. 8e) at 8 km and the supraglacial moraines on the right slope. 15 km away is the Beli Iskar dam (Fig. 2g) before which the road climbs along the right slope of the valley to the ridge. This coincides with the main watershed of the Balkan Peninsula between the Black Sea and Mediterranean (Aegean) watersheds. The road passes through the Dzhanka pass - the saddle between the peak of Yurushki Chal (2768 m) and an elevation of 2541 m, then crosses the granodiorites of the first extension and two small bodies of muscovite-biotite plagiogranites of the third extension of the Rila-West Rhodope batholith and descends into the Granchar cirque, where it joins the Kaiser's Road (Fig. 8f). The geodiversity along the Prezrilsko Shosse route is not great, as it is almost entirely in the Lutetian granites of the Musala body from the second phase of the Rila-West Rhodope batholith, (40-35 Ma) (Kamenov et al., 1997), but the longest glacial valley and the ridge between the two main watersheds in the Balkans are worth the climb.

Balneological aspects. The slogan of the Rila Geopark is "Land of Iron and Water", due to the developed medieval crafts in connection with the extraction of iron from the magnetite deposits in the Rila rivers and the connection of the mountain with the three aggregate states of water: 1) source of many rivers, including the longest river in the Balkans – the Maritsa River with more than 200 glacial lakes (liquid phase), 2) the Quaternary glacial history (solid phase) and 3) numerous thermal springs, including the only geyser in the Balkans (gas phase), which is the hottest geyser in Europe with a steam temperature of 101.3°C – about 20 degrees higher than the Icelandic geysers (Fig. 8g). It serves for heating some public buildings in the town of Sapareva Banya. The mineral water is hyperthermal, slightly mineralized with a very good effect in diseases of the musculoskeletal system, nervous system, skin and gynecological diseases.

Geothermal activity in Rila Mountain is manifested along the number of faults surrounding the mountain. During the Miocene-Pliocene time, active tectonic movements led to an intense uplift of the mountain and its transformation into the highest mountain in the Balkans and the second in Eastern Europe (2925 m) after the Caucasus. There are hundreds of thermal springs around the entire massif of the mountain, which have been used for spa and healing procedures for millennia (Fig. 8h). Here are preserved remains of many Roman baths, which attracted not only Romans, but also Thracians, Byzantines, Slavs and Bulgarians.

Figure 8

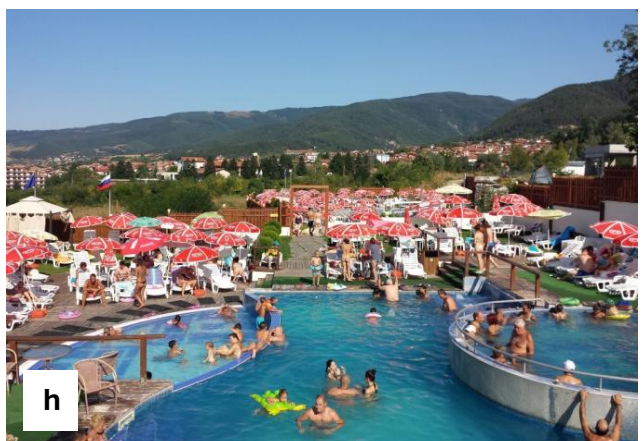
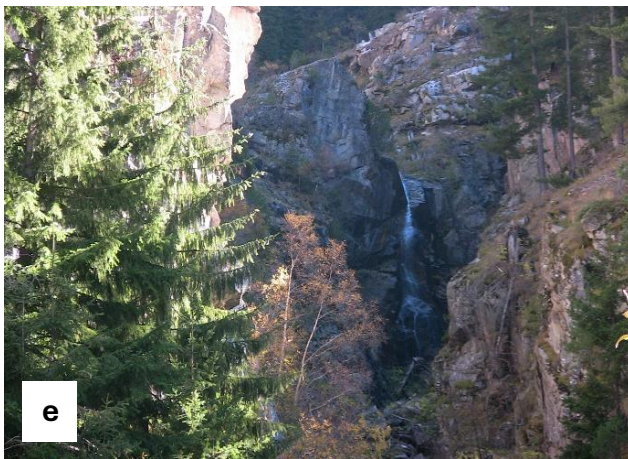
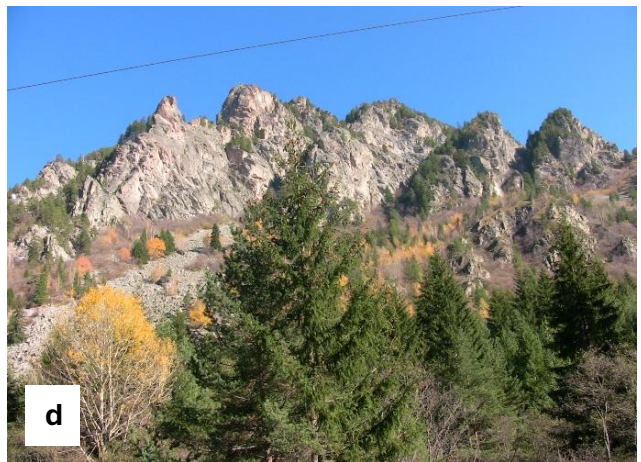
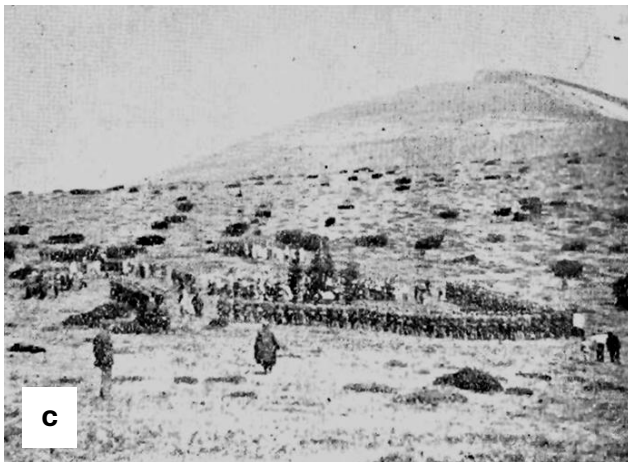


Figure 8: *a*, Blue Lake, view from Mermer Preslap; *b*, Mermer Lake named after the marbles of the Chepelare metamorphic rocks, in which the Mermer Cirque was carved; *c*, The official opening of the Prezrilsko Shosse on August 14, 1932 in the Dzhanka Pass; *d*, The Orlovi Sokolets Elevation on the right slope of the Beli Iskar River Valley; *e*, The Lyuti Dol Waterfall in the Beli Iskar River Valley; *f*, On the northern slope of the Granchar Cirque, the Prezrilsko Shosse joins the Kaiser's Road; *g*, The only geyser on the Balkans in Sapareva Banya; *h*, The mineral waters have been used for balneotherapy for 6,000 years, and today in the surrounding villages of Rila there is a record number of spa centers with hot mineral waters.

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