ISKAR CANYON GEOPARK

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Concept

The first Bulgarian geopark, Iskar Defile, was created under the project for developing of the Register and Cadastre of Geological Phenomena in Bulgaria, funded by the Ministry of Environment and Water in 1999. The picturesque landscapes and the exceptional diversity of igneous, sedimentary and metamorphic rocks ranging from Precambrian to Quaternary, are the basis of the geopark concept presented at the 3rd meeting of the European Geoparks Network in Eggenburg, Austria (Jelev et al., 2002). Despite its high scientific and aesthetic value, the Iskar Gorge geopark remained in a working version due to the lack of funding and misunderstanding between the interested parties.

This remarkable canyon, crossing the Stara Planina between the Sofia Plain and the Fore-Balkans, is located on the territory of three municipalities - Novi Iskar, Svoge and Mezdra. The initial idea for creating the geopark was in line with European and global trends at the beginning of the century, based on 22 geotopes included in the national Register and Cadastre and 16 geotopes of scientific value, representing natural outcrops of stratigraphic boundaries and units, igneous and metamorphic rocks, fossil deposits, etc.

The main theme of the geopark is the impressive gorge formed by the Iskar River after the drainage of Sofia Lake in the Lower Danube Basin, which existed about 4.5 million years ago on the territory of today's Danube Plain. It offers a number of picturesque landscapes such as Lakatnik Rocks, Ritlite, the incredible Cherepish Rocks with the Cherepish monastery preserving the bones of Tsar Ivan Shishman's soldiers who died in the last battle with the Turks in 1396.

Now the Iskar River receives its waters from the Rila Mountain, the highest mountain in the Balkans, passes through the Sofia Plain between Pancharevo and Novi Iskar, crosses the Balkan Mountain through the picturesque Iskar Gorge, passes through the Moesian Platform and flows into the Danube.

In the Early Miocene, 15-20 million years ago, the Sofia Plain was a hilly plain with small rivers flowing north. In the Middle Miocene, 14-15 million years ago, tectonic activity occurred and the Early Miocene peneplain was intersected by numerous faults that formed grabens and horsts. To the south, a new mountain, Rila, began to rise, and in the Sofia Plain, the Sofia Graben was formed, the initial subsidence of which was compensated for by the accumulation of river sediments. The graben formed during the Pontic Age (5-7 million years ago) interrupted the river flow through the Miocene hilly plain and initiated the formation of Sofia Lake. It existed during the Late Miocene and Early Pliocene between 7 and 4.5 million years ago. During this time, over 700 m thick sediments were deposited on its bottom, with several layers containing marine mollusks. These fossils are an evidence for its connection with the saline waters of the Pannonian Sea which was part of the large Para Tethys basin that existed until the Late Pliocene.

The outflow of Lake Sofia to the north is the main reason for the formation of the picturesque Iskar Gorge. In addition to the remarkable natural beauties, the entire Phanerozoic history of the Earth is preserved within 100 km of the capital. The diabase-phyllitoid complex is made up of low-metamorphic rocks formed 500-600 million years ago. The Early Paleozoic rocks in the vicinity of Svoge, formed on the periphery of the huge Paleozoic continent Gondwana near the then South Pole, contain graptolites (Fig. 1a) and trilobites, which disappeared already during the Paleozoic era. The Ordovician-Silurian and Silurian-Devonian boundaries have been established in these rocks (Sachanski, 1993) as well as the boundaries between the series of the Silurian and Devonian systems. Among the carbonaceous sandstones around Svoge, formed during the Carboniferous period, stems of lepidophytes (Fig. 1b), sphenophytes and ferns (Тенчов, Желев, 2009), which also disappeared at the end of the Paleozoic era, are preserved. In the vicinity of the town of Novi Iskar, volcanic rocks and fluvial conglomerates from the Permian period are preserved, underlying the Kurilo threshold, through which Sofia Lake drains. The red-colored sandstones in the vicinity of the villages of Tserovo and Gara Bov, in which “Juglata” Rock is located, are part of the famous continental Buntsandstein facies, formed 250 million years ago.

***Figure 1.** Notable fossil-bearing levels, geological cycles and events: **a,** Oktavites spiralis – Silurian graptolite from the area of the village of Tseretsel, Svoge region, illustrated in the magazine National Geographic (2000, volume 6, no. 2); **b,** Stems of calamites and lelidophytes in the Stefan sandstones near the town of Svoge; **c,** The iridium layer at the Cretaceous/Tertiary boundary near the village of Moravitsa, Mezdra area; **d,** Paleocene limestones with Milankovitch climatic cycles along the Kamenitsa River, SE of the town of Mezdra; **e,** The building of the central mineral bath in Sofia; **f,** The monument to the Vazov's hero Grandpa Yotso near Ochin Dol village.*

The Lakatnik Rocks represent the alpine type of Triassic, whose limestones and dolomites make up a large part of the Alps. The famous "Ammonitico rosso" and "Black Jurassic" facies are also present in an almost complete section of the Jurassic system. Cretaceous is represented by the remarkable Cherepish rocks and the famous Urgonian facies, in which "Ritlite" upright beds were formed. In the Kamenitsa River valley near the town of Mezdra, the iridium layer of the Cretaceous-Tertiary boundary was established (Синьовски, 1998) (Fig. 1c), formed during the collision of the Earth with the Chicxulub meteorite, known as the "meteorite that killed the dinosaurs". The steep northern slope of the river is made of cyclic limestones with flint (Fig. 1d), in which the Milankovitch cycles reflecting climate changes during the Paleocene are recorded.

Geothermal activity, as an important feature of the Bulgarian geological heritage, is also an important part of the geopark concept, providing a link between geology and human culture, between antiquity and modern times. Simultaneously with the Sofia graben, during the intensive faulting during the Pliocene, numerous mineral springs also appeared. Sofia inherits an ancient settlement, created around the mineral sources during the Bronze Age, which were the focus of the ancient and medieval settlements of Serdica and Sredets, preceding the modern capital city around which there are over 70 mineral springs (Fig. 1e). During the Roman age, they attracted many rulers, such as the Roman emperors Trayan and Constantine the Great, but also ordinary citizens and military veterans of the Roman legions.

All this variety of geological landscapes, rocks, minerals, fossils and interesting geological events have occurred over the last 600 million years and are recorded in the rocks between Sofia and Mezdra. Together with the cultural and historical heritage of the gorge (Fig. 1f), these geological phenomena are waiting to be explored, interpreted and presented to the world in the form of a geological park, as was the original idea of the Iskar Defile Geopark in the Register and Cadastre of the Bulgarian Geological Phenomena.

This idea was revived in 2018 by the three Iskar municipalities - Mezdra, Svoge and Novi Iskar as an initiative to create a geopark under the name "Iskar Gorge". The new initiative was supported by the Ministry of Environment and Waters and the National Commission for UNESCO. Despite the lost time, this area has enormous geotourism potential with its remarkable geomorphological forms and sites of scientific, cultural, socio-economic and landscape interest (Синьовски и др., 2019). With a responsible policy and a proper management approach, this potential could be developed into a modern and attractive geological park with well-developed and marked geotrails, museums and educational centers that would integrate tourism activities into a common concept for the preservation and promotion of the natural and cultural heritage of the region in the name of improving the socio-economic situation of the local population.

Key Geotopes

Kurilo threshold

The first Bulgarian geopark "Iskar Defile" was developed according to a concept based on the remarkable geodiversity of the Iskar Gorge - picturesque landscapes and impressive outcrops of igneous, sedimentary and metamorphic rocks with ages from Precambrian to Quaternary (Jelev et al., 2002). Despite its scientific and scenic value, the Iskar Defile Geopark remained in a working version due to lack of funding and disagreements between stakeholders. The renewal of efforts to create a geopark in 2018 provoked new studies of geotopes with scientific value. Of particular importance among them is the Kurilo Threshold with its direct role in the formation of the Iskar Gorge.

In the Early Miocene, 15-20 million years ago, the Sofia Plain was a hilly plain with small north-flowing rivers, inhabited by tropical flora and fauna (Fig. 2a). In the middle of the Miocene, regional tectonic activity was manifested and the Early Miocene peneplain was crossed by faults. To the south, a new mountain began to rise - Rila, and in the Sofia Plain, a large graben began to form.

According to Канев (1988), the Sofia Graben, which originated during the Pontian Age (7 million years ago), interrupted the river flow through the Miocene plain and led to the formation of Sofia Lake, which existed during the Pontian and Dacian Ages between 7 and 4.5 million years ago. Initially, as a result of river activity, sandy-gravel deposits were deposited, united in a terrigenous formation, after which typical lacustrine sedimentation was established and over 700 m of sediments accumulated, belonging to the Gnilyane, Novi-Iskar and Lozenets Formations (Каменов, Коюмджиева, 1983).

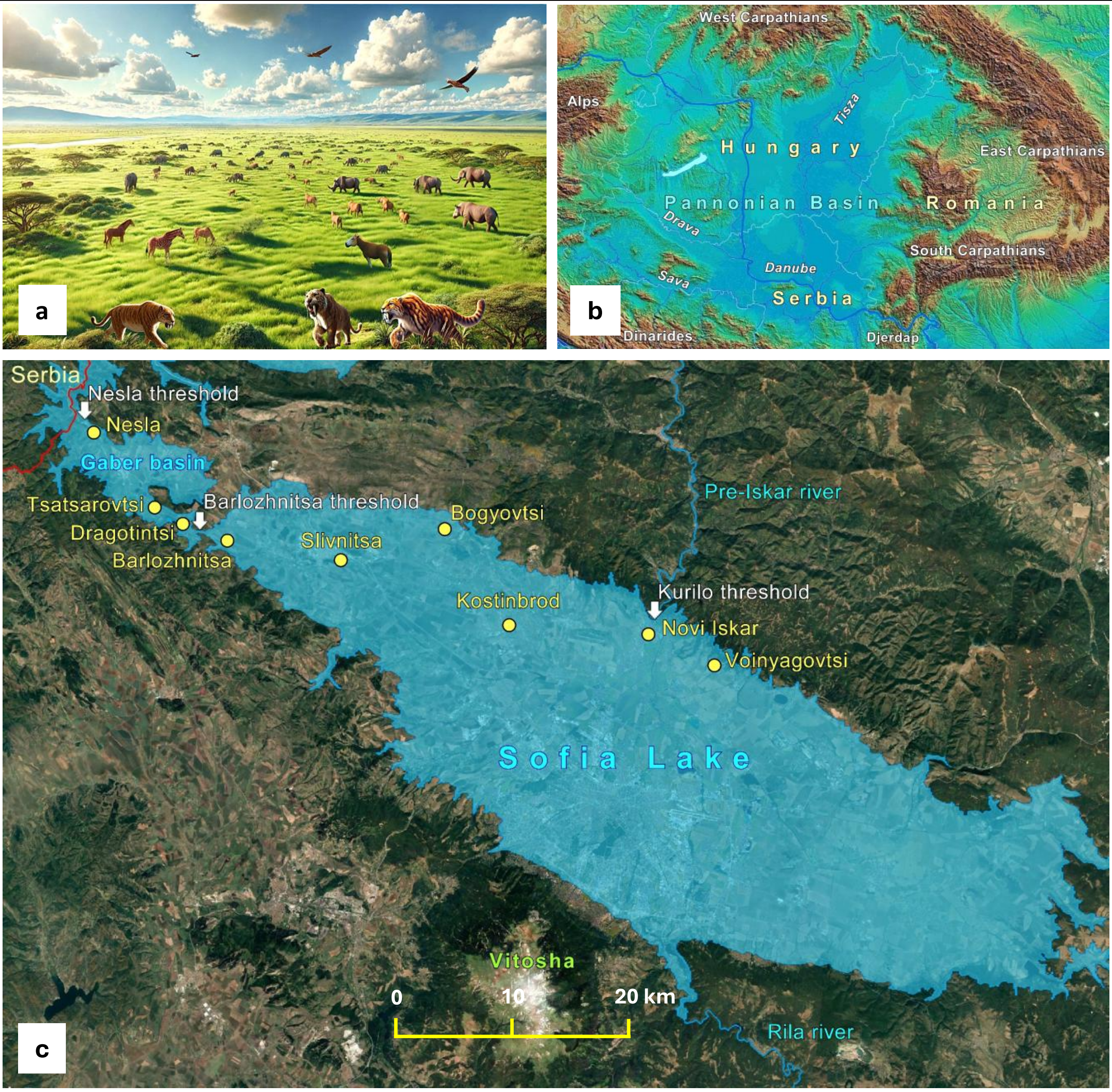

Figure 2. *Neogene history of the Sofia Plain:* ***a,*** *Late Miocene mammal association illustrating tropical landscape of Sofia Plain before the formation of the Sofia Graben;* ***b,*** *Pannonian Sea, which existed until 1 million years ago;* ***c,*** *Sofia Lake, which existed for 2.5 million years during the Pontian and Dacian ages in the present-day Sofia Plain.*

Initially, Sofia Lake began to drain westward towards the Pannonian Basin (Fig. 2b) through a narrow channel in the Upper Jurassic limestones of the Slivnica Formation (Barlozhnitsa threshold - Kanev, 1988). The reconstruction of the shoreline of Sofia Lake along a contour of 690 m (Fig. 2c) - the modern elevation of the threshold of Barlozhnitsa (Fig. 3a), shows that this was the only possible corridor for a sea connection through the small Gaber Basin, the Nesle Gorge and the Nišava-Moravian Basin connected to the Pannonian Sea, which existed up to 1 million years ago on the territory of Hungary and parts of Serbia, Bosnia and Herzegovina, Romania, Austria, Slovenia and Slovakia.

Evidence for the connection with the Pannonian Basin are the beds with mussels (*Dreissena*) and snails (*Viviparus*) in the Novi-Iskar and Lozenets Formations (Fig. 3b), characteristic of the Pannonian Sea, which is part of the large Paratethys basin (Каменов, Коюмджиева, 1983). Regardless of this connection, Sofia Lake drained to the north through the Kurilo threshold. According to Канев (1988), the upper course of the modern Iskar River coincided with a small Rila river that fed Lake Sofia from the south. The formation of the gorge began with the overflow of Sofia Lake through the Kurilo threshold. There are at least three theories for the formation of the gorge, given the way the mountain was broken: (1) erosion-overflow, (2) erosional and (3) antecedent.

Figure 3. *Neogene history of the Sofia Plain:* ***a,*** *The Barlozhnitsa threshold through which Sofia Lake connected to the Pannonian basin;* ***b,*** *The "Viviparous" benchmark from the quarry near the village of Bogyovtsi with nuts of Viviparus bulgaricus* Brusina*;* ***c,*** *The Djerdap threshold between Serbia and Romania - the channel through which the Danube now crosses the Carpathian-Balkan chain;* ***d,*** *The beginning of the Iskar Gorge - the Kurilo threshold through which Sofia Lake flowed north to the Lower Danube basin and formed the Iskar Gorge.* ***d,*** *Vertebrae of Silurus serdicensis (Sofia catfish) from the Novi Iskar Formation near the village of Voynyagovtsi, donated by Prof. Ilia Patronev to the Museum of Geology and Paleontology at the University of Mining and Geology "St. Ivan Rilski".*

(1) The erosion-overflow theory is based on the assumption that the lake overflowed to the north and formed a channel through the Kurilo Ridge. This could only have happened with a large inflow of water from the Rila Uplands. Initially, the water flowed only during intense rainfall and high lake levels. These temporary

flows began to form the channel, which gradually turned into a gorge. Through the Danube Plain, the river flows along the bed of the Pre-Iskar to the Lower Danube Basin, which existed on the territory of Dacia. It was part of the Paratethys, fragmented during the Pliocene into separate small basins.

(2) According to the erosion theory, the Kurilo threshold was breached by two rivers flowing in opposite directions. The southern "lake river" flowed from the ridge southward to the lake, and the northern "mountain river" (Pre-Iskar) flowed northward to the Lower Danube basin in the Danube Plain. There was a saddle between the upper reaches of the rivers, but the erosion base of the northern river was apparently lower than that of the southern one, so it cut faster and formed a deeper channel against the bed of the lake river, which "attacked" the threshold from the north and "stole" part of the water of the lake river. This process, called "piracy", developed under the influence of the lower erosion base of the Pre-Iskar, whose valley "eats" the threshold from the north and the lake began to flow along it, forming a gorge.

(3) The antecedent origin suggests that the Iskar River existed before the mountain was raised and was imposed on the newly rising mountain range. However, the formation of the lake implies the existence of a fence mountain from the north. Otherwise, it could not have existed for 2.5 million years, as evidenced by the lacustrine deposits of the Novi-Iskar and Lozenets Formations.

From what has been said so far, the question arises as to why the lake has not drained through the Barlozhnitsa threshold. According to Канев (1988), the erosional base of the Djerdap threshold in Serbia (Fig. 3c) is at a higher altitude, and the Pannonian Basin has a higher lake base than the Lower Danube basin. Thus, the Stara Planina rivers flowing into the Lower Danube basin cut faster than the rivers of the Pannonian Basin, and Pre-Iskar reached the Kurilo threshold earlier. This is also due to the buffering role of the Gaber Basin, whose connection with the Nishava-Moravian basin, unlike that with Sofia Lake, is through the well-formed Nesla Gorge. Due to these circumstances, the Barlozhnitsa threshold, built of limestone, between Sofia Lake and Gaber basin, does not cut through quickly enough, and Sofia Lake drains through the Kurilo threshold (Fig. 3d).

There is no doubt that the marine mollusks in the sediments of the Novi-Iskar Formation, deposited at the bottom of Sofia Lake, prove a two-way exchange of water through the Burlozhnitsa threshold. The intrusion of seawater into the lake was possible only if it had drained from somewhere. The only place with an altitude close to that of the Burlozhnitsa threshold is the Kurilo threshold, from where the lake could have drained to the north. Another prerequisite for its outflow into the Lower Danube basin is that the level of the latter was lower than that of the Pannonian Sea. This is not unusual for continental-type basins. A modern example is the Caspian Sea, whose level is 28 m lower than that of the Black Sea. A two-way circulation such as that between the Black and Marmara Seas through the Bosphorus is unlikely due to the shallow depth of the Burlozhnitsa threshold. According to the available data, the drainage of Sofia Lake through the Kurilo threshold led to the gradual deepening of the Pre-Iskar River into the rising Stara Planina Mountain. During the Late Miocene, the Kurilo threshold was at least 100 m higher, as evidenced by the old river terraces on both slopes, the highest of which is 120 m above the modern river level.

The Nesla Gorge played an important role in the exchange of fresh and salt water between Sofia Lake and the Pannonian Sea. During the Late Miocene and Early Pliocene, the Slivnitsa limestones formed several thresholds between the individual basins of the cascade lake system under the general name Nishava-Moravian basin, through which the connection between the Sofia and the Pannonian basins was established. The small Gaber basin, between the Barlozhnitsa and Nesla thresholds (Fig. 2c), served as an overflow. The freshwater nature of Sofia Lake is proven by the fossil remains of mussels, snails and fishes (Fig. 3f). However, the presence of brackish mussels of the genus *Paradacna* (Kamenov, Koyumdzhieva, 1983) proves a two-way movement of water through the Barlozhnitsa threshold. The intrusion of seawater into the lake was possible only if it drained from somewhere. The only place with an altitude close to that of the Barlozhnitsa threshold is the Kurilo threshold, from where the lake could have drained to the north. Another prerequisite for its outflow into the Lower Danube basin is that the level of the latter was lower than that of the Pannonian Sea. This is not unusual for continental-type basins, for example the Caspian Sea level is 28 m lower than that of the Black Sea.

The outflow probably occurred at intervals following fluctuations in the Pannonian Sea due to Milankovitch climate cycles. This was a slow and uneven process that lasted at least 2 million years. The low sea level during the ice ages caused the outflow of fresh lake water to the Pannonian Sea. Accordingly, the high sea level during the interglacial ages led to the influx of saltwater into the lake and its overflow through the Kurilo threshold along the Pre-Iskar River valley. During the Early Pliocene, the level of the threshold was already low enough to ensure a constant outflow of Sofia Lake, supporting the erosion of the river in the nascent gorge through the rising Balkan Mountain. The lake gradually silted up and at the end of the Pliocene about 4.5 million years ago the level of the Kurilo threshold reached its bottom and it dried up. Then the small Rila River, which fed the lake from the south, joined with the Pre-Iskar River and formed the modern Iskar River - from Rila through the Sofia Plain, the Balkan Mountain and the Danube Plain to the Danube River.

***Figure 4**. Lakatnik Rocks: **a,** Triassic limestones and dolostones on the left bank of the Iskar River near Gara Lakatnik village; **b,** Karst Spring "Zhitolyub" in the Triassic limestones near Gara Lakatnik village; **c,** Rock wall in the limestones of the Babino Formation; **d,** Milankovitch climatic cycles in the Opletnya Member of the Mogila Formation with yellow dolomite layers in the upper part.*

Lakatnik Rocks

The Lakatnik Rocks are a geotope with high aesthetic, scientific and educational value. They are among the most attractive and popular natural landmarks in Bulgaria. The beauty of the Iskar Gorge and their proximity to Sofia, as well as the well-marked tourist trails with a starting point at Lakatnik railway station, make this geotope a lively tourist site at any time of the year. The high aesthetic value of the Lakatnik Rocks is due to the impressive rock crown, rock pinnacles and towers, caves and karst springs, a product of the multi-stage deep erosion of the Iskar River, carried out among the Triassic rocks over several million years (Fig. 4a). At the base, the red sandstones of the Petrohan terrigenous group, known as "Buntsandstein" (German Triassic), are revealed, and the rest of the section is represented by limestones and dolomites of the so-called Alpine Triassic, united in the Iskar Carbonate Group.

The formation of the rock phenomena is directly related to the drainage of Sofia Lake 5-6 million years ago and the formation of the Iskar Gorge. The continuous deepening of the Iskar riverbed among the Triassic limestones and dolomites has contributed to the development of a multi-level karst system, the lowest level of which today is the Iskar Riverbed. Part of it is the Temnata Dupka cave located on the left bank of the river 27 m above the road to Sofia. Below it is the karst spring "Zhitolyub" (Fig. 4b), from which the cave waters flow. As a result of the intensive karstification, numerous picturesque rock pinnacles and pillars have developed among the Triassic limestones and dolostones, crowning the vertical slopes along the left bank of the Iskar River. Here the maximum height of the rock wall is 300 m, but in the area of the Sfrazhen hamlet and the Rusinovdel locality to the northeast it reaches 600 m. The rock wall in the upper part of the Babino Formation is a traditional mountaineering site (Fig. 4c). In addition to the impressive relief forms, the Lakatnik Rocks have high scientific and educational value due to the excellently exposed section of the Triassic system. In the limestones of the Mogila Formation next to the artificial lake at the inn, Milankovitch climatic cycles are preserved, the upper parts of which are marked by yellow-colored dolomite layers (Fig. 4d). The excellently exposed Triassic section contains fossil-bearing levels with fossils of brachiopods, mussels and cephalopods, which were first documented by the Viennese professor Franz Toula during the 19th century.

Skaklya Rock Ridge

In the 1970s, a trail connecting the villages of Zasele and Gara Bov emerged. At the initiative of the Svoge municipality in 2007, the most attractive part of the trail was developed as a tourist "Vazov's Eco-Trail". The approach from the village of Zasele is from the road to Zimevitsa villga, 8 km after the fork in the village of Tserovo, where it is marked by a signpost. The other approach from Gara Bov village, also marked by a signpost on the Sofia-Mezdra road (Fig. 5a), is located 1.4 km along the road through the western hamlet of Gara Bov village in the Skaklya River valley.

According to some sources, the folk poet Vazov wrote some of his most beautiful works on the rock crown "Skaklya", including the inspiring story "Grandpa Yotso is Watching". The well-maintained "Vazov's Ecotrail" is well marked and provided with steps, railings and other amenities for the continuous flow of visitors when climbing the steepest part of the trail (Fig. 5b). The rock crown "Skaklya" near the village of Zasele вхино less impressiveis part of the natural wealth of the region and is not inferior to the Lakatnik Rocks in its aesthetic impact and beauty.

The rock cliff is formed in the Middle Triassic limestones of the Zgorigrad Member of the Babino Formation (Anisian). The Babino Formation consists of two clearly distinguishable relief units (Fig. 5c). The lower one is composed of about 100 m thin-bedded granular limestones with wavy layered surfaces, forming the sloping part of the section. The upper part, distinguished as the Zgorigrad Member, forms the vertical wall of the rock ridge and the Skaklya waterfall. The limestones are uniform, dark gray, mostly micrograinular with uneven layered surfaces and few flint concretions. The base of the rock ridge is at an altitude of 750 m, and its upper edge near the village of Zasele is 900 m above sea level. The steepest part of the vertical slope, located immediately east of the village of Zasele, is a dizzying karst abyss into which the waters of the "Skaklya" waterfall descend (Fig. 5d). It has a total height of 120 m, which makes it one of the highest waterfalls in Bulgaria. It consists of three cascaded jumps, the highest of which is 85 m, and the total height of the other two jumps is 35 m. In summer, the river dries up to its upper reaches, which is why the waterfall is intermittently flowing. The highest intermittently flowing waterfall in Bulgaria and the Balkans (141 m) near the city of Vratsa also bears the same name.

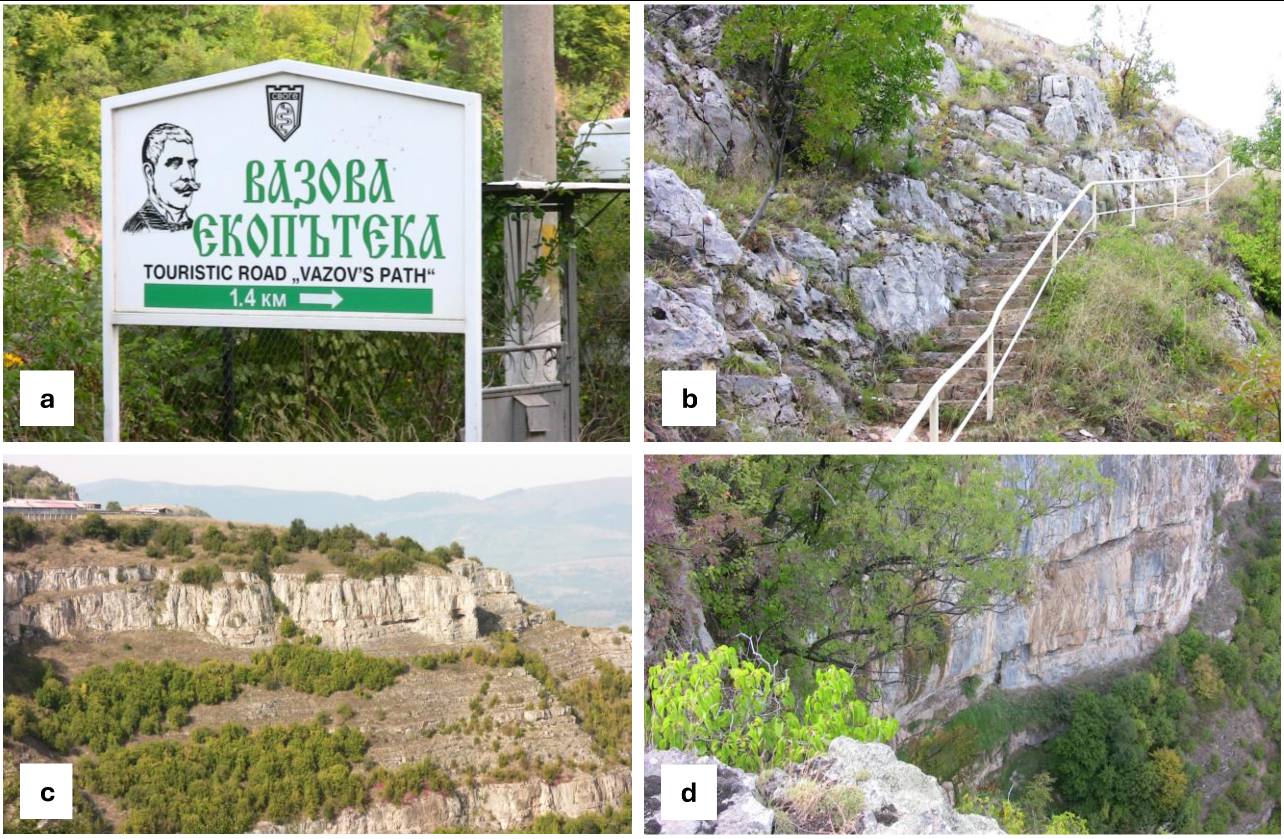

***Figure 5**. The Skaklya rock ridge: **a,** The Vazov's eco-trail; **b,** Facilities for crossing the ecotrail; **c,** Rocky slope of the Babino Formation below the village of Zasele; **d,** The dizzying karst abyss of the Skaklya waterfall.*

"Juglata"

"Juglata" ("The Camel") is a geotope of high aesthetic value. It is a rock pinnacle built of Lower Triassic red-colored quartz sandstones, formed about 250 million years ago. It is located at an altitude of 470 m above sea level on the floodplain terrace of the Iskar River, on which the village of Tserovo is located. It was declared a natural landmark in 1964 and is a rock mushroom (Fig. 6a) with a height of 15 m, formed by the erosional action of the waters of the Iskar River. It is formed among the Lower Triassic sandstones of the Petrohan terrigenous group, represented by clastic continental, red and motley sandstones, characteristic of the so-called Buntsandstein facies type (Fig. 6b). The total thickness of these rocks in the area is 110 m and in places they form impressive vertical slopes, such as the "Red Wall" near the village of Tserovo, used as a background in a series of westerns by the former East German film studio DEFA (Fig. 6c).

"Juglata" is located on the second flood terrace on the western bank of the Iskar River. It is located at the northern end of an elevated rock platform within the village of Tserovo, right next to the Sofia-Mezdra railway line. The turbulent waters of the Iskar River played a leading role in its formation, which has shaped the rock for tens of thousands of years. The uneven outlines of the rock mushroom are due to the lithological properties of the rocks, built of layers with different erosion resistance. Marls and carbonate-enriched paleosols, in which horizontal niches are formed, are particularly susceptible to weathering. In general, the rock pinnacle is built mainly of sandstones, thanks to which it has withstood the destructive force of river waters. Comparing its current condition with that of the photograph from 1896 (Fig. 6d), it is clear that no particular changes have occurred over the past 120 years.

At the end of the 19th century, interesting events took place around "Juglata" in connection with the construction of the railway line through the Iskar Gorge, which played a decisive role in its preservation. In 1986, the route, the construction of which was entrusted to Italian contractors, reached the village of Tserovo. According to the preliminary design, it passed through the rock mushroom, which was why it was subject to explosion. Fortunately, the local population understood in time and managed to change the design in order to preserve the natural landmark for future generations. Today, it is present in the coat of arms of the village of Tserovo and is an integral part of the history of the village and the municipality of Svoge.

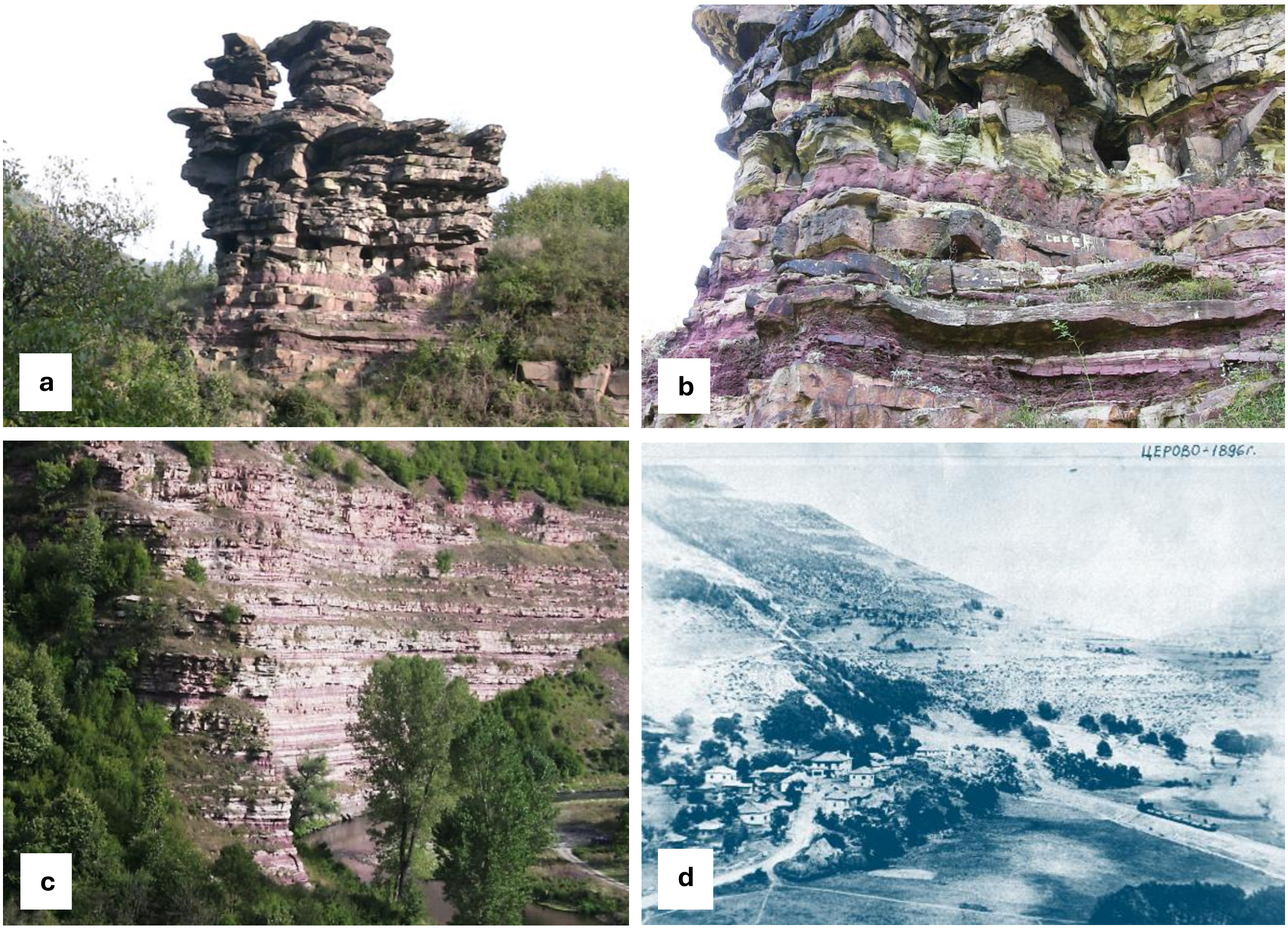

Figure 6. *Juglata:* ***a,*** *General view of the 15 m high rock mushroom;* ***b,*** *The colorful sandstone layers of the Buntsandstein facies at the base of Juglata;* ***c,*** *The Red Wall on the right bank of the Iskar River;* ***d,*** *The construction of the railway line along Juglata in 1896.*

“Ritlite”

Geotope "Ritlite" is a site of aesthetic, scientific, ethnographic and historical value. This is the first protected geological phenomenon in Bulgaria, declared a natural and historical site entered under No. 2 in the old Register of Natural Landmarks in 1938. It is located at an altitude of 250 m above sea level on the left bank of the Iskar River near the village of Lyutibrod (Fig. 7a).

The rock walls, called “Litri” or “Ritli” (racks -side covers of a horse-drawn cart) are vertical limestone and sandstone layers with a height of over 30 m (Fig. 7b), located in the uppermost part of the Lyutibrod Formation. They were formed 110-120 million years ago in a shallow marine reef that existed during the Barremian and Aptian ages of the Early Cretaceous. Franz Toula (Toula, 1878) called them “Orbitolinen Kreide” due to the abundant content of large foraminifera of the genus *Orbitolina* (Fig. 7c). One of the unique watercolors of Felix Kanitz (1873) stored in the Archive Institute of the Bulgarian Academy of Sciences is dedicated to them (Fig. 7d).

The Lutibrod Formation is made up of extremely diverse sedimentary rocks – sandy limestones, marls, calcareous sandstones, siltstones and mixed rocks, rich in fossils – colonial and solitary corals, orbitolins, mussels, snails, ammonites, belemnites, brachiopods, sea urchins, bryozoans and hematitized remains of Cretaceous trees. It contains two limestone units resembling the limestones of the famous Urgonian facies in France, which Bonchev (1932) called the “Lower” and “Upper” Urgonian limestones. Therefore, the entire variegated sequence is referred to the so-called “Vratsa Urgonian Group”. In fact, the typical Urgonian rocks here are the Cherepish limestones containing abundant *Requienia* shells, which were logically confused with the "Urgonian" limestones of this group at the Vratsata Pass (Nikolov et al., 1972).

***Figure 7.** "Ritlite": **a,b,** "Ritlite" are vertical layers of the Lyutibrod Formation on the right bank of the Iskar River near the village of Lyutibrod; **c,** Benthic foraminifera called Orbitolina have a rock forming role in the Lyutibrod Formation; **d,** Watercolor by Felix Kanitz from 1873; **e,** The Kostalevo thrust, along which the vertical layers of the Lyutibrod Formation reach the Cherepish limestones*

"Ritlite" are formed as a result of the uneven weathering of rock types of different resistance. The strong limestone and sandstone layers are more resistant to erosion and form protruding beams (beam relief) against the background of the less resistant marl layers between them. A decisive role in their formation is played by the vertical orientation of the layers in the northern limb of the Zgorigrad anticline, cut diagonally by the Kostalevo fault, along which they reach the Cherepish limestones (Fig. 7e). If they were inclined, the layers would have disintegrated along the transverse cracks as soon as they were exhumed on the earth's surface.

In addition to the geomorphological forms, there are also interesting sites with archaeological and spiritual value here. Between the racks there was a Roman fortress - "Koritengrad", and next to the last rack there are remains of an early Christian Basilica from the 3rd century and a medieval church from the 14th century. SW of Ritlite is the entrance to Rashov dol, the battlefield of 12 Botev's chetniks, which is visited by hundreds of pilgrims on June 2. At this place, the Vazov's heroine Baba Iliytsa crossed the murky waters of the Iskar River in a boat to bring bread to one of the Botev's chetniks.

"Ritlite" are the starting point of the "Roman Road" geotrail, dedicated to the famous Urgonian facies, which passes through the village of Lyutibrod and along the old Roman road through "Cut Stone" ends at the "St. Atanas" fort, where a wonderful view of the Cherepish Rocks opens.

Cherepish Rocks

The Cherepish Rocks are a geotope of high aesthetic, cultural and spiritual value. They are made of pure organogenic limestones forming a wonderful rock ensemble, an integral part of which is the medieval Cherepish Monastery.

The limestones of the Cherepish Formation were formed during the Late Jurassic and Early Cretaceous (130-150 million years ago) in a shallow-marine environment on the northern periphery of the Tethys Ocean.

The formation is made of organogenic, hemogenic and clastic limestones, interpreted as a carbonate reef. On a fresh surface they are light beige, and on a weathered surface – white, strongly karstified (Fig. 8a), with remains of mussels, corals and bryozoans. Because of the abundance of shells of the Cretaceous mussel *Requienia*, formerly known as *Caprotina*, one of the first explorers of our lands, Professor Franz Toula of the Vienna Technical University (Toula, 1878), called them "Caprotinen Kalk". They are strictly similar to the Urgonian limestones of southern France. The classical French "Urgon" is made up of strong reef limestones with remains of Requienia (Fig. 8b). The similarity of the Cherepish limestones with the Urgonian limestones shows that the Barmian-Aptian reef between the Pyrenees and Himalayas, inherited older reef structures similar to this near Cherepish.

Figure 8. *Cherepish Rocks:* ***a,*** *Microkarrens in the limestones of the Cherepish Formation;* ***b,*** *Requienia mold in an original Urgonian limestone from the "Bouges" Geopark in the Savoy Alps, SE France;* ***c,*** *The narrowest and deepest gorge in the Iskar Canyon – the entrance of the canyon from the north;* ***d,*** *Watercolor of the Cherepish Rocks by Felix Kanitz, 1873;* ***e,*** *Cherepish Monastery "St. Assumption of the Holy Virgin Mary";* ***f,*** *The ossuary with the skulls of the Shishman's warriors;* ***g,*** *The* bey's house; ***h,*** *The Vazov's room;* ***h,*** *The Alley of Aleko along the Iskar River.*

The Cherepish limestones form the "Vezhdata" rock ridge, in which the waters of the Iskar River have carved the narrowest and deepest gorge in the entire Iskar Gorge (Fig. 8c), immortalized by the Hungarian artist Felix Kanitz back in 1873 (Fig. 8d). The length of the "Vezhdata" is 2 km, and the difference in elevation between the riverbed and the highest elevation on the western slope is almost 900 m.

In the narrow gorge on the right bank of the Iskar River is the Cherepish Monastery "Assumption of the Holy Virgin Mary", founded in the 14th century (Fig. 8e). It consists of a church and several buildings. High in the rocks is the bey's house, built by Rushid Bey, the governor of Vratsa, whose daughter recovered from an incurable disease here by praying in a Christian way. According to legend, the last battle of Tsar Ivan Shishman with the Ottoman invaders took place in the area, and the skulls of the killed Bulgarian warriors are kept in the monastery's ossuary, hence its name (фиг. 8f). High in the rocks is the Bey's house, built by Rushid Bey, governor of Vratsa, as a sign of gratitude that his daughter had recovered from an incurable disease here, praying in a Christian way (Fig. 8g).

The cave openings above the Cherepish station are known as "Shishman's Holes", and the vertical cliff at the exit of the gorge is called "Shishman's Rock". Devastated many times during the Austro-Turkish wars, the monastery was restored at the end of the 16th century by Pimen Zografski. Many ancient manuscripts are kept here, the most famous of which is the Cherepish Four Gospels from the 15th century with gilded binding, made in 1612 by Chiprovtsi goldsmiths. In 1798, Bishop Sophronii Vrachanski stayed here. Before the Liberation, the abbot of the monastery, Hieromonk Epiphanius from the village of Lyutibrod, founded a secret revolutionary committee. In 1899, Ivan Vazov wrote in the monastery, praising it in two unforgettable stories, “The Claw Beats” and “A Bulgarian Woman.” Today, Vazov’s Room is open to visitors (Fig. 8h), and along the river is “Alekov’s Alley” (Fig. 8i) named after the writer Aleko Konstantinov who praised the monastery’s beauty at the end of the 19th century.

Cretaceous/Tertiary Boundary

65 million years ago, at the end of the Cretaceous period, a giant meteorite approached the Earth at 40,000 miles per hour, passed through the atmosphere, and, heated to melting, hit the planet, causing the greatest catastrophe in its history (Fig. 9a). It landed in the Gulf of Mexico region (Fig. 9b), disappeared in seconds into the Earth's crust, and immediately after the impact, a cloud of hot dust, ash, and steam erupted from the crater, rising to the stratosphere. A rain of molten rock (tektites) poured from the sky.

A powerful shock wave and a huge tsunami swept over a nearby continent, and the cloud covered the entire planet and blocked sunlight for years. As a result, many photosynthetic organisms disappeared from the face of the earth, such as the unicellular algae (coccolithophores) that dominated the Cretaceous oceans, whose mass extinction caused the extinction of groups of organisms throughout the food chain.

In the late 1970s, the American geophysicist Glenn Penfield discovered a large ancient crater with a diameter of 180 km in the Gulf of Mexico near the Yucatan Peninsula. According to astrophysicists, the diameter of an asteroid that caused such a crater would be at least 10 km, i.e. higher than the Himalayas. Nobel laureate Luis Alvarez suggests that this is the crater of a meteorite that hit the Earth at the end of the Cretaceous. Alvarez et al. (1980) discovered in Italy a thin layer at the Cretaceous-Tertiary boundary with a high content of iridium - very rare in the Earth's crust, but not in meteorites. Thus, science unravels the cause of the mass extinction at the end of the Cretaceous, when entire groups of organisms disappeared forever from the face of the earth - dinosaurs, pterosaurs, marine reptiles, ammonites, belemnites and many unicellular organisms, and the meteorite was named after the small Mexican town of Chicxulub on the Yucatan Peninsula, where it landed 65 million years ago.

The global fallout after the impact formed a thin, iridium-rich layer with a global distribution on the ocean floor, which is a unique geological phenomenon proving the great cosmic catastrophe at the end of the Cretaceous. In the Mezdra region, the iridium layer was established by the abrupt change of unicellular algae at the Cretaceous-Tertiary boundary in the limestones of the Mezdra Formation along Kamenitsa River, south of the village of Moravitsa (Fig. 9c). It is well expressed as a negative form in the relief (Fig. 1c). Its thickness is 1-2 cm, and the iridium content is between 7 and 11 ppb (Fig. 9d). The location of the geotope is 1.5 km SE of the village of Moravitsa and 4 km SW of the town of Mezdra (Fig. 9e).

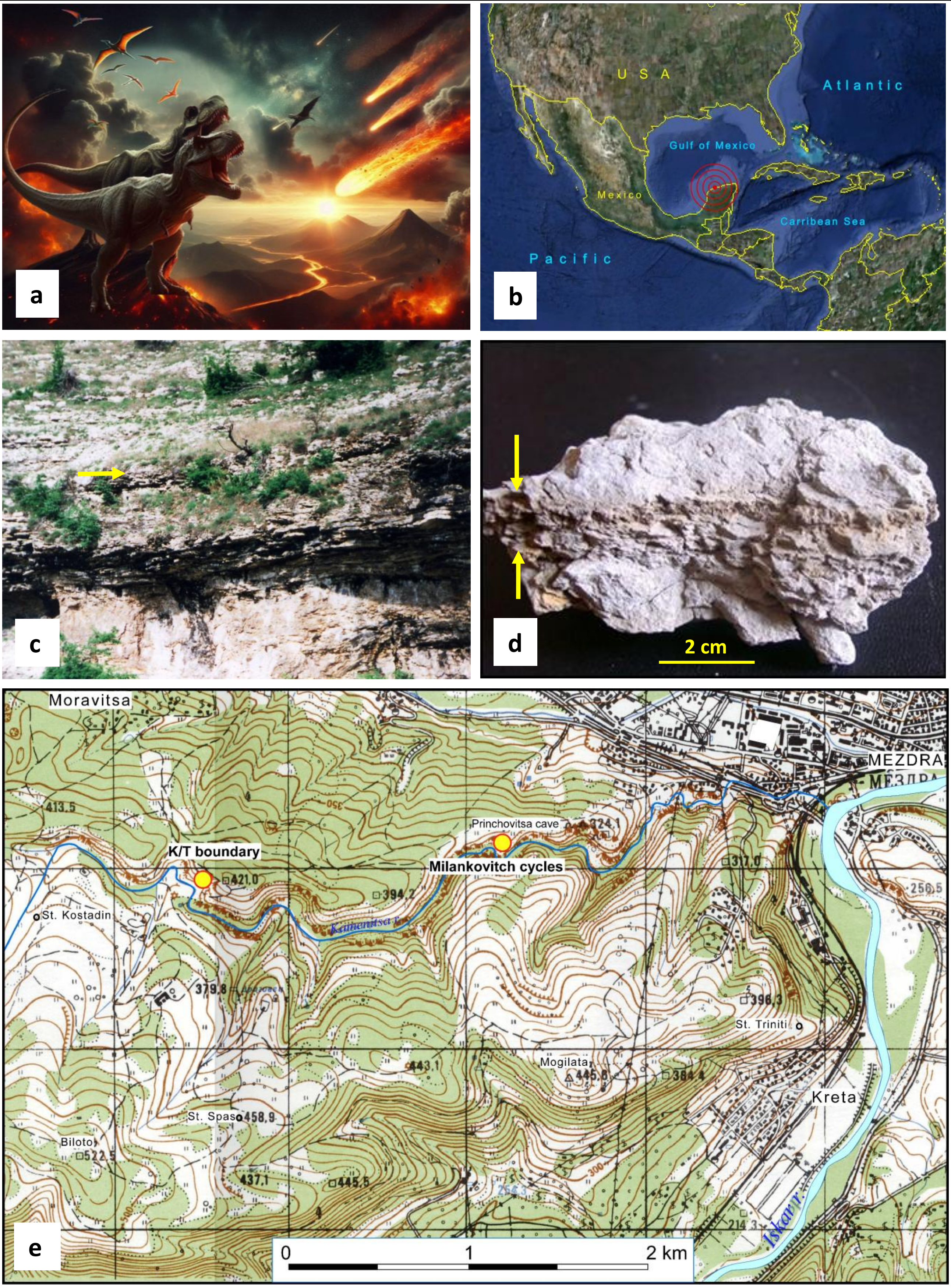

__Figure 9.__ The meteorite that killed the dinosaurs: __a,__ The impact event 65 million years ago; __b,__ The location of the meteorite landing in the Gulf of Mexico; __c,__ The outcrop of the Cretaceous/Tertiary boundary in the Kamenitsa River valley; __d,__ The iridium layer from the Kamenitsa River with an iridium content of 7-11 ppb; __e,__ Location of the geotopes "K/T boundary" and "Milankovitch cycles".

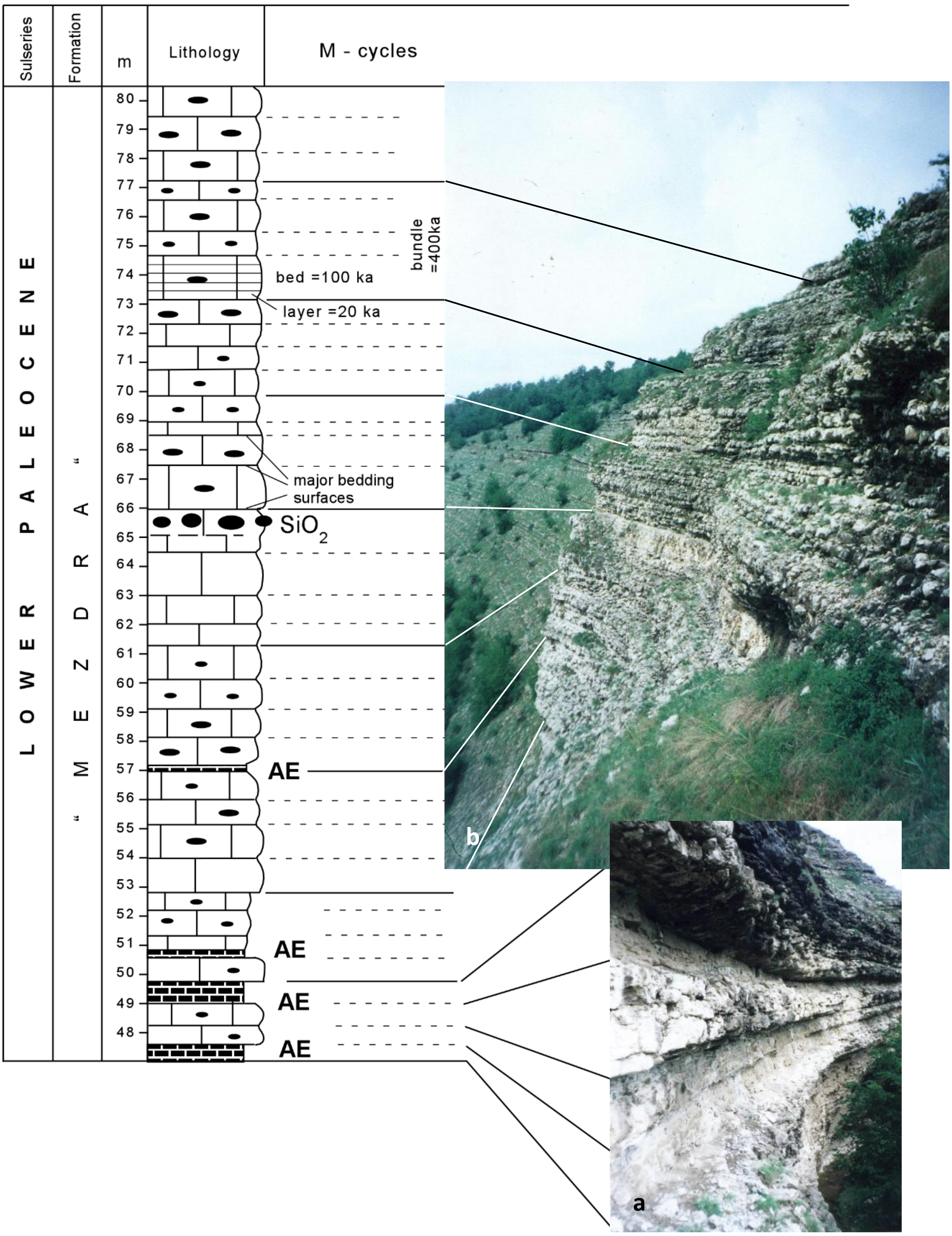

Figure 10. *Climatic cyclicity between 47 and 80 m from the base of the section at Kamentsa River:* ***a****, 400 ka cycle, representing a packet of 4 beds, bounded by major bed surfaces – 100 ka cycles, each containing in average 5 layers, corresponding to 20 ka Milankovitch cycles;* ***b****, General view of the outcrop including several 400 ka cycles, forming step-like relief; AE – anoxic event;* SiO_2 *– cherty concretions.*

Milankovitch climatic cycles

Another feature of the Paleocene limestones in Kamenitsa river valley (Fig. 9e) are the well-defined Milankovitch climatic cycles (M-cycles) established by Синьовски (1998) using the field methodology of Schwarzacher & Fischer (1982).

Well-defined major stratigraphic surfaces are developed between 47 and 78 m from the base of the section along the left slope of the river at intervals of 0.5-1.25 m (~1 m) (Fig. 10a) with an average of 5 layers in each. It is assumed that the intervals between the main stratigraphic surfaces correspond to 100 ka cycles of eccentricity, and the less clearly defined layers in them - to 20 ka precession cycles. In turn, the 100 ka cycles are grouped into 4 corresponding to 410 ka Milankovitch cycles, forming the well-defined stepped relief in Fig. 10b.

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