GEOLOGICAL HERITAGE VALUES IN THE IRON GATES NATURAL PARK, ROMANIA

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ABSTRACT

The South Carpathian Mountains are crossed by the Danube between Bazias and Schela Cladovei, and along this transect, an important series of outcrops, geosites and Sites of Special Scientific Interest (SSSI) are recorded and discussed in this paper, presented here as a preliminary report. An important SSSI along the Danube Gorges is the paleontological reserve from Saraorschi Creek, with a diverse and well preserved Middle Jurassic cephalopod fauna. Important geosites along the Danube Gorges are recorded at Cozla (Early Jurassic plants), Munteana-Dumbravita (Lower and Middle Jurassic invertebrate faunas and sedimentary structures, spectacular structural features, including the famous "suspended fold" at Dumbravita), Trescovat (a Permian volcanic neck), Staristea (Permian porphyry), Romanian Greben (various types of folds and faults, formerly described as the geological "gothic" style, even more spectacular along the Serbian Greben shore), Zeliste and Veligan Peaks (Lower Jurassic fanglomerates, with unique sedimentary and geomorphological features), Tri Cule (geomorphological features, Lower Jurassic fanglomerates generating a spectacular cuesta), Selski Creek (Permian red-beds and a post-Liassic dyke), Dubova (geomorphological features in Cretaceous limestone), Cazanele Mici and Cazanele Mari Gorges (geomorphological sites) and the Ponicova Cave (speleological site). Excepting the SSSI and the geosites, a long series of important outcrops occurs, both along the Danube's shore and within the Almaj Mountains, and these outcrops show interesting geological features, discussed in this paper.
The Danube Gorges is not the only area with important geological heritage values, such values occurring within the Almaj Mountains as well, in the central or eastern areas of the natural park. An important preserved site is Bahna SSSI, in the eastern part of the park, with a very rich and well preserved Miocene invertebrate and rare vertebrate fauna. Significant geosites are here recorded at Baia Noua, Eibenthal, Cucuiova and Povalina (Late Carboniferous and Permian fossil plants), Bigar, Stanca, Pietrele Albe, Buschmann (Early Jurassic fossil plants), together with interesting outcrops along various valleys in Almaj Mountains.
The geological heritage of the Iron Gates Natural Park represents one of the most significant heritages of this kind in Romania. Such values deserve a better and a more responsible protection, especially when enforcing the new Romanian Law of Environment. Fortunately, as the natural park is now reorganized, illegal collecting of fossils and the general loot of the geological heritage values will receive a better, stronger institutional response.

Keywords: Geosites, geological heritage values, Sites of Special Scientific Interest (SSSI), Iron Gates Natural Park, South Carpathians, Romania.

INTRODUCTION

The Iron Gates Natural Park is an important area for geoconservation in Romania, as its geological heritage is among the richest in the South Carpathians. The series of structural units, typical for the South Carpathians, crossed by the Danube, shows unique features from paleontological, structural and morphological points of view,

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making the Park one of the most interesting areas in Geosciences, for research and education.

The Geology of the Iron Gates Natural Park is complicated and it is still a matter of debates from many points of view, such as structural, tectonic, sedimentological and paleontological perspectives. This paper is not intended to contribute new geological data, but to emphasize the outstanding geological heritage and potential of the park. The geology of the park represents the backbone for all the other natural aspects representing the natural heritage in the area, as the geology is one of the most important biotope aspects of the entire system, a true frame in which all the other elements are included and related with.

The history of the geological research in the region is long and it begins with the first papers of Austrian, Romanian and Hungarian geologists of the XIX-th Century. Among the most important contributions to the Geology of the South Carpathians must be cited those of Murgoci (1905), Streckeisen (1934), and Codarcea (1940). For the area including the Iron Gates Natural Park, that of Raileanu (1953) is the most important, a synthesis still valid today, 50 years after its publication. Later, contributions of Pop (1988, 1996), and Stanoiu and Stan (1986), Berza et al. (1983), Berza and Draganescu (1988), for tectonics and sedimentology, and of Bercia and Bercia (1975), Maruntiu and Seghedi (1983), for the metamorphic basement, detailed the knowledge in the area of the natural park. In Paleontology, important contributions are those of Kudernatsch (1852), Semaka (1963, 1970), Antonescu and Avram (1980). A series of field guidebooks were edited by Codarcea et al. (1961), Nastaseanu et al. (1981), Berza et al. (1984) and Pop et al. (1997), the last title detailing the geology of the Danube Gorges.

The Iron Gates Natural Park includes all tectonic units of the South Carpathians, from west towards east: Supragetic Nappe, Sasca-Gornjak Nappe, Getic Nappe, Severin Nappe, and Danubian Units. The Supragetic, Getic and Danubian Units include both basement and sedimentary terranes, while the Sasca-Gornjak and Severin Nappes lack basement elements. Within the natural park, two important basins are recorded: Resita Basin (sedimentary cover of the Getic Nappe in the area) and Sirinia Basin (sedimentary cover of the Danubian Units in the area). These basins record an Upper Paleozoic sequence (Upper Carboniferous – Permian), a Mesozoic sequence (Lower Jurassic – Middle Cretaceous) and a Tertiary post-tectonic cover (Miocene-Pliocene and Quaternary). The southernmost parts of the Danubian Presacina and Cerna-Jiu Basins are recorded north of Orsova, in the NE area of the park. Sediments belonging to the Severin Nappe (such as the Sinaia beds), and to the Sasca-Gornjak Nappe (Triassic carbonate sediments), are also well documented in the park.

The geological heritage in the Iron Gates Natural Park can be assigned to the following categories: 1. Sites of Special Scientific Interest (SSSIs); 2. geosites; and 3. important sites. SSSIs are strictly preserved paleontological areas of the park. Geosites are defined in this paper as outcrops, road cuts, quarries or coal mine sterile dumps, important for their fossil, mineral or structural content, or as geomorphological elements, and they are not administered as SSSIs, although some of them deserve such a status. Important sites are local quarries, roads or natural outcrops showing an interesting structural, tectonic, lithological or paleontological feature, making them useful for education, field trip stops, photographs or landscape views.

SITES OF SPECIAL SCIENTIFIC INTEREST (SSSIS)

Saraorschi Creek SSSI (Text-fig. 1, point no. 1) is also known as Svinita paleontological site, as its occurrence is close to Svinita village. This site is preserved for its highly valuable paleontological content, and it is one of the most important paleontological reserves in the South Carpathians. From a lithological point of view, the site is represented by a sequence of Middle and Upper Jurassic red, nodular limestone, very rich in ammonoids and brachiopods. The Aalenian limestone is less fossiliferous, the Bajocian sequence has brachiopods and ammonoids, the Bathonian – Lower Callovian, in Klaus facies, is rich in ammonoids and contains even a very dense ammonitid lumachelle, 1-1.5m thick (with *Oxycerites aspidoides*, *Macrocephalites macrocephalus*, *Holcophylloceras mediterraneum*, *Lytoceras adeloides*, etc). The Middle Callovian-Oxfordian has also cephalopods, while the Tithonian is again rich in ammonoids, the site having more than 60 taxa of cephalopods (Bleahu et al., 1976). This site was first studied by Kudernatsch (1852), making it widely known in the paleozoological scientific community, the fossil material collected after 1852 being curated in Romania and abroad as well. Unfortunately, the site was systematically sacked for many, long years, but in spite of all collecting activities, legal or illegal, the site is still rich and well preserved.

Bahna SSSI (Text-fig. 1, point no. 2) occurs close to Bahna village, although the preserved sites of Bahna SSSI are scattered between Ilovita and Bahna villages. This SSSI preserves Miocene (Badenian) fauna, with bivalves, gastropods and vertebrates, about 400 taxa totally (Bleahu et al., 1976). The facies is represented by reef limestones, sandstones, sands and clays, the limestone sequences being the richest in fossils. The Miocene Bahna basin had a short evolution as a marine channel connecting the Pannonian and Dacian Basins. Ostreid assemblages are the most impressive, accumulated in thick, large beds, very dense in fossils. Marinescu (1965) studied in detail the paleofauna of the Bahna Basin. Bahna is an important SSSI for several reasons: the fossil fauna is highly diverse and well preserved, the paleoecological information is well preserved too, and the quality of the outcrops is still good, in spite of successive looting and recent plant growth.

Both Saraorschi and Bahna SSSIs deserve a very attentive and careful protection. First of all, this protection should be undertaken by continuous monitoring of the sites. Local people were informed repeatedly with regard to the importance of these sites, and they are aware of the sites value, but geological education is still very necessary for the locals, as they should be the first keepers of the sites. Park rangers represent today another warranty for the preservation of these unique SSSIs.

GEOSITES ALONG THE DANUBE GORGES

Cozla mine has a rich sterile dump along the Danube's shore (Text-fig. 1, point. No. 3), although the main dump is in the Danube itself. At Cozla, within the Sirinia Basin, Lower Jurassic coals are still extracted; in spite of numerous technical and financial difficulties, the Cozla mine is still in function. The underground exploitation horizons are well outcropped and the collecting possibilities are good, although not so seducing like those at Anina, where the mine is ideal for detailed paleobotanical research (north of the park, in Anina Mountains, in Popa, 2000a, b). The Lower Jurassic coal measures are very rich in fossil plants within the Sirinia Basin, former coal mines with rich sterile dumps being located at Ida (close to Cozla), but also

inland, within the Almaj Mountains, such as Camenita (Text-fig. 1, point no. 4), Bigar (point no. 5) and Buschmann (point no. 6). They occur along the Sirinca Valley, at Stanca (Point no. 7) and Pietrele Albe (point no. 8, all north of Cozla).

The paleoflora, mainly Hettangian-Sinemurian in age when generating coal (as there is a rich drifted flora even within the Middle Jurassic marine sequences, with no coal genesis potential), is a typical Mesophytic flora, with very diverse pteridophytes and gymnosperms (Semaka, 1963, 1970, Popa, 1998). The pteridophytes are represented by horse tails (*Schizoneura carcinoides* from Cozla, an effective coal generator during Early Jurassic times), ferns (Dipteridaceae, such as *Dictyophyllum nilssoni*, *Thaumatopteris brauniana*, Osmundaceae, Dicksoniaceae, Matoniaceae, Incertae sedis such as *Cladophlebis* div. sp.). The gymnosperms include seed ferns (*Cycadopteris obtusifolia*, *Sagenopteris* sp., *Pachypteris* sp.), Cycadopsids (cycadaleans, such as *Nilssonia* cf. *orientalis*, or bennettites, like *Otozamites* cf. *molinianus*), Ginkgopsids (*Sphenobaiera* sp., *Ginkgoites* sp.), Incertae sedis (*Czekanowskia rigida*) and conifers (*Pagiophyllum* sp., *Brachyphyllum* sp., *Podozamites distans*). The Lower Jurassic flora of the Danubian Realm is not so well preserved when compared to that of the Getic Nappe, but nevertheless, these fossils represent important geological heritage values. Fossil plant collections from Sirinia Basin are curated in Bucharest (University of Bucharest, Geological Institute of Romania) or Cluj-Napoca (Babes-Bolyai University), but also abroad. These paleobotanical sites deserve a SSSI statute in the park.

At Munteana-Dumbravita occurs one of the most beautiful sedimentary outcrops in the Danube Gorges (Text-fig. 1, point. no. 9). The sequence begins with Lower Permian red breccias, now covered by vegetation, unconformably overlain by Lower Jurassic marine sandstones and limestones, and by Middle and Upper Jurassic nodular limestones, generating a steep hill along the Danube's shore. At Munteana, the famous paleontologist U. Schloembach fell and died in 1870, while collecting fossils.

Lower Jurassic deposits are assigned to the Glavcina (Hettangian-Sinemurian) and Munteana (Plienbachian –Toarcian) Formations, represented by oolithic, ferruginous limestones (Munteana facies, Hettangian-Sinemurian in age), and by marine sandstones (Pliensbachian-Toarcian in age), both with a rich fossil content of belemnites, bivalves, brachiopods and echinoderms. The belemnites generate the so called *belemnite battlefields*, large accumulations of belemnite rostrums arranged more or less parallely by marine paleocurrents. Liassic deposits represented by oolithic, ferruginous limestones, are a rare facies for Lower Jurassic deposits in the South Carpathians. The Lower Jurassic fauna is represented by foraminifers (*Textularia* sp., *Spiroloculina* sp., *Frondicularia* sp.), bivalves (*Plagiostoma gigantea*, *Entolium liasinus*, *Uniocardium numismalis*, *Aequipecten aequivalvis*, *Gryphaea cymbium*, *G. fasciata*), brachiopods (*Spiriferina tumida*, *Terebratulla grestenensis*, *T. punctata*), ammonites (*Acanthopleuroceras rursicosta*, *Amblycoceras planicosta*, *Lyparoceras beckei*) and belemnites (*Megateuthys* sp.). The Middle and Upper Jurassic deposits (Seretina, Zeliste, and Greben Formations) are represented by nodular, red or white limestones with ammonites and belemnites, and these deposits generate south of Munteana a beautiful fold, the so called "suspended fold" from Dumbravita, best seen from the Serbian shore of the Danube. The Oxfordian is represented by ammonites (*Sowerbyceras tortisulcatum*, *Callyphylloceras zignodianum*) and belemnites (*Hibolites hastatus*). The Kimmeridgian has

Aspidoceras acanthicum, *Taramelliceras strombecky*, while the Tithonian is represented by *Lamellaptychus lamellosus*, *Streblites lithographycum*, *Lytoceras montanum*, *Punctataptychus* sp. (Codarcea et al., 1961, Nastaseanu et al., 1981). The Jurassic sequence is conformably overlain by Hauterivian and Valanginian deposits. This geosite deserves an attentive protection and the SSSI statute.

The Trescovat Peak (Text-fig. 1, point no. 10) is a remarkable Lower Permian porphyry volcanic neck, very well expressed morphologically and well visible from both shores of the Danube. This neck was one of the volcanic sources for many of the terrigenous volcanites in the area of the natural park. The neck is partially surrounded by Lower Jurassic sediments.

Permian quartzite porphyry outcrops very impressively along the Staristea Valley (Text-fig. 1, point no. 11), with prominent peaks and high relief energy.

The Romanian Greben (Text-fig. 1, point no. 12), downstream from the last geosite, between Vodinschi, Saraorschi and Povalina creeks, has exquisite Middle and Upper Jurassic nodular limestones, with beautiful folds cut by various faults, outcropped along the road cuts.

At Zeliste and Veligan Peaks (Text-fig. 1, point no. 13), uphill from the Svinita village, outcropped by the Tiganului Creek, occurs an impressive amphitheater generated by Lower Jurassic continental conglomerates. The conglomerates belong to the Cioaca Borii Formation (Hettangian in age) and they are the first detritic sequence to overlay unconformably the Lower Permian deposits, along a contact that is well expressed morphologically. This amphitheater is one of the most spectacular outcrops along the Danube Gorges, especially when climbed towards the two peaks, on the path to Cucuiova and Povalina. The sedimentology of the continental conglomerates is also very interesting, with very well outcropped cross-bedding at various scales, indicating alluvial and fluviatile (with channel fills) depositional systems during the Hettangian, in Svinita area.

At Tri Cule (Text-fig. 1, point no. 14), downstream from Svinita, the same Cioaca Borii Formation generates a bold cuesta, as a result of the stratigraphic unconformity. Here, the contact is even better expressed by a typical relief. The cuesta is also home for a beautiful pine community.

Close to Selski (Red) Creek (Text-fig. 1, point no. 15), along the Danube's shore, outcrops the unconformable contact between the Danubian basement (gabbros outcropping well at Iuti) and the sedimentary cover (Lower Permian basal breccias and red beds). Also, a basaltic dyke crosses both the basement and the cover. This outcrop is valuable for education and research.

Cazanele Mari (Text-fig. 1, point no. 16) are represented by Upper Jurassic (Tithonian-Neocomian), and Lower Cretaceous (Barremian – Lower Aptian, in Urgonian facies, and Albian-Cenomanian) limestones with a high relief energy. Together with Cazanele Mici (Text-fig. 1, point no. 17), they represent some of the most impressive landscapes in the Danube Gorges, especially when they are seen from the Serbian shore or from boat. At Dubova, at the SE end of the Cazanele Mici gorges, beautiful Urgonian limestone pillars occur (point no. 18).

INLAND GEOSITES

Excepting the former mines extracting Lower Jurassic coals in the Sirinia Basin, several inland geosites are important as they yield a rich Late Paleozoic flora. These geosites are located at Baia Noua (Text-fig. 1, point no. 19), Eibenthal (point no. 20), Cucuiova (point. no. 21) and Povalina (point no. 22). Baia Noua is the only coal mine still open, extracting Upper Carboniferous (Late Westphalian – Stephanian) anthracite. All sterile dumps of these mines yield a rich compressive paleoflora and they certainly deserve a SSSI statute. The Late Paleozoic flora of the Sirinia Basin (Semaka, 1963, Maxim, 1969, Dragastan et al., 1997) is a rich compressive flora, represented by Sphenopsids (*Calamites* div. sp.), Lycopsids (*Lepidodendron* div. sp.), pteridophylls (*Neuropteris* div. sp., *Linopteris* div. sp., *Pecopteris* div. sp.) or Cordaitaleans (*Cordaites* div. sp.). Collections with such material are curated in Bucharest (University of Bucharest) and Cluj-Napoca (Babes-Bolyai University). These geosites certainly deserve the SSSI statute.

IMPORTANT SITES

These types of sites are recorded along the Danube Gorges and also inland. They are significant sites as they reflect an interesting geological aspect, becoming very useful from scientific, educational or esthetic points of view.

Between Staristea and Jeliseva Valleys occurs a thick continental Permian sequence, represented by tuffs and red beds. These tuffs, overlying the Staristea porphyry, generated the Tachtalia waterfalls (Text-fig. 1, point. no. 23). Along the Jeliseva Valley, the Permian volcanoclastic sequence is very well outcropped, showing excellent volcano – sedimentary structures (point no. 24). Few kilometers upstream occur the ruins of the Jeliseva “Sovrom Uranium” mine (point no. 25), a former mine exploiting the Lower Permian sequences, for Uranium. Although this is not a typical “geosite”, former mine galleries still give good outcrops in red beds and in volcanoclastic sequences.

On Povalina Valley, Permian tuffs are also very well outcropped (Text-fig. 1, point no. 26). From Povalina, the Serbian Greben is best viewed, with its exquisite folds and faults in Middle and Upper Jurassic nodular limestones.

Sirinia Valley is important for its Middle and Upper Jurassic limestone outcrops with folds and faults (Text-fig. 1, point no. 27). Close to the Bigar village, fossiliferous Middle Jurassic marls outcrop (the so called Bigar beds), a lateral facies of the usual Dogger nodular limestones (point no. 28). Along the Sirinca Valley, beautiful, cross bedded, channel fills outcrop, Lower Jurassic in age (point no. 29).

Between Bostita Mare Valley and Svinita (Iardumovacia) Valley occurs the complete succession of Lower Jurassic to Lower Cretaceous deposits, outcropping along the road (point no. 30). At Svinita outcrops the Barremian fossiliferous marls, with *Phylloceras tethys*, *Silesites seranonis*, *Macroscaphites yvani*, etc (ammonites, point no. 31). Between Iuti and Selski Valleys, few continental Miocene outcrops occur, with well preserved sedimentary structures (point no. 32).

At Iuti (Text-fig. 1, point no. 33), the gabbros quarry is still in good condition, while along the Tisovita Valley (point no. 34), massive serpentinite deposits outcrop (with

dunites and serpentines). At Virciorova, the contact between Severin Nappe and the Danubian Realm can be well observed (Text-fig. 1, point no. 35). This is a historical point, where Alexandru Codarcea understood the position of the Sinaia beds over the Danubian Realm deposits. Between Gura Vaii (Jidostita Valley, point no. 36) and Schela Cladovei, Neogene (Pontian) continental deposits are well preserved along the road. These deposits are opened by the Schela Cladovei quarry.

CONCLUSIONS

The Iron Gates Natural Park represents one of the geologically richest areas in the South Carpathians. Unique preserved sites (Saraorschi and Bahna SSSIs), together with extremely valuable geosites (paleontological, some of them deserving the SSSI statute, mineralogical, structural, stratigraphical), and with important sites (sites interesting for research and education), make the Iron Gates Natural Park one of the most geologically important natural parks in Europe. The geology of the area represents the backbone of the entire ecosystem in the park, and the preservation of its heritage values has to be a priority for all conservation activities in the area.

ACKNOWLEDGEMENTS

This paper is dedicated to Grigore Raileanu, prominent Romanian geoscientist, celebrating 50 years since the publication of his work “Geological researches in the Svinita-Fata Mare region” (1953).

CAPTION OF TEXT-FIGURE 1

Distribution of SSSIs and geosites in the Iron Gates Natural Park. Sites of Special Scientific Interest (SSSIs): 1. Saraorschi SSSI; 2. Bahna SSSI. Geosites: 3. Cozla mine; 4. Camenita pit; 5. Bigar coal mines (2 galleries); 6. Buschmann gallery; 7. Stanca gallery; 8. Pietrele Albe gallery; 9. Munteana-Dumbravita outcrops and “suspended” fold; 10. Trescovat Peak; 11. Staristea Valley; 12. Romanian Greben; 13. Zeliste and Veligan Peaks; 14. Tri Cule cuesta; 15. Selski Creek; 16. Cazanele Mari; 17. Cazanele Mici; 18. Cazanele Mici (Urgonian pillars); 19. Baia Noua; 20. Eibenthal; 21. Cucuiova; 22. Povalina. Important sites: 23. Between Staristea and Jeliseva Valleys; 24. Jeliseva Valley; 25. Jeliseva “Sovrom Uranium” mine; 26. Povalina Valley; 27. Sirinia Valley; 28. Bigar beds; 29. Sirinca Valley; 30. Between Bostita Mare and Svinita (Iardumovacia) Valleys; 31. Svinita; 32. Between Iuti Valley and Selski Creek; 33. Iuti; 34. Tisovita Valley; 35. Virciorova; 36. Between Gura Vaii (Jidostita) and Schela Cladovei.

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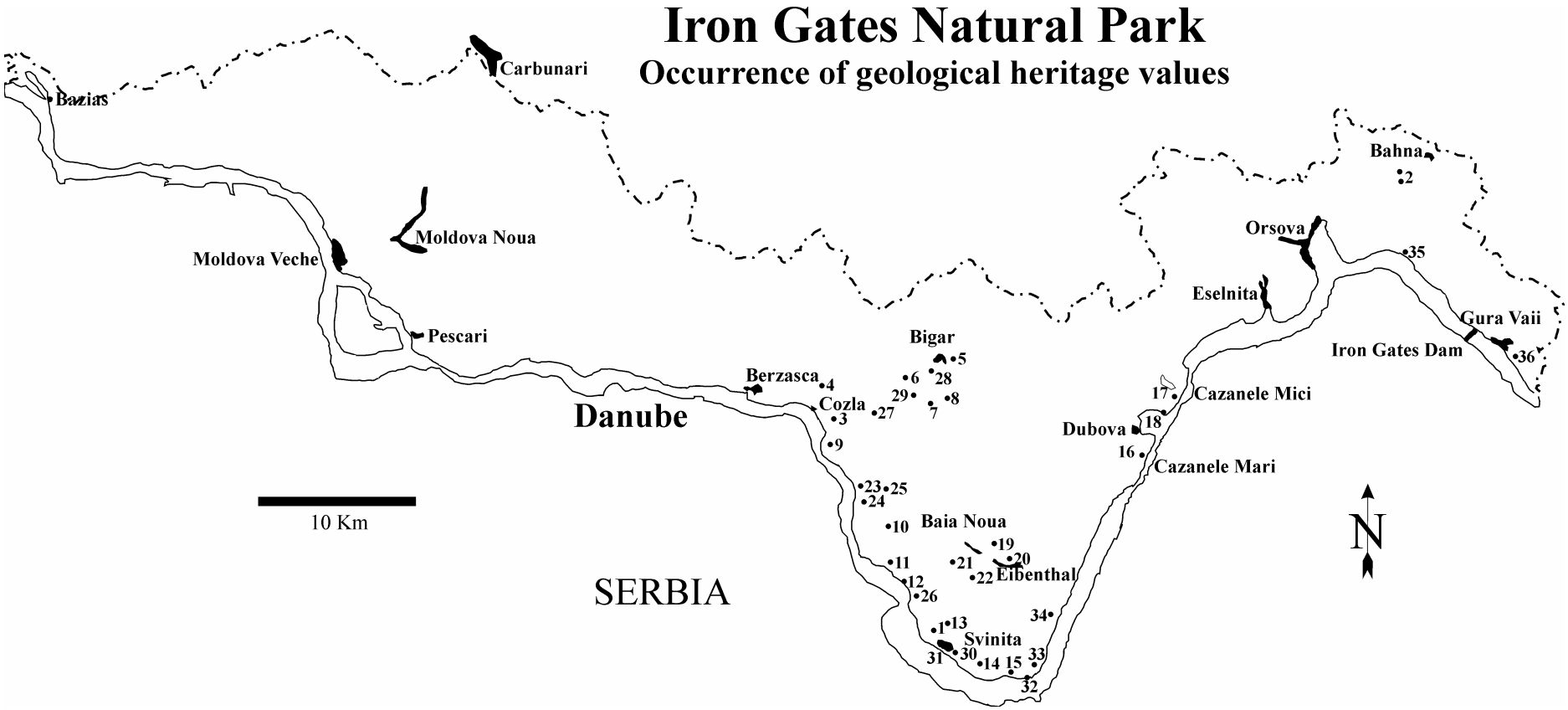
Iron Gates Natural Park
Occurrence of geological heritage values
Carbunari
Bazias
Moldova Noua
Moldova Veche
Pescari
Berzasca
Cozla
Danube
Bigar
Bahna
Orsova
Eselnita
Gura Vaii
Iron Gates Dam
Cazanele Mici
Cazanele Mari
Dubova
Baia Noua
Eibenthal
Svinita
10 Km
SERBIA
N