Inventory of Geoheritage Sites – the Base of Geotourism Development in Montenegro

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Abstract

The main principles and methodology of establishing the inventory of geoheritage sites are analyzed. Special attention is given to theoretical and practical problems related to application of the established principles. Geoheritage sites in Montenegro, classified according to international standards (ProGeo) were presented, including their valorization based on the aspects of tourism valorization. Possibilities and limitations of geotourism development in Montenegro were emphasized, too.

Key words: geodiversity, geoheritage, tourism, geotourism, Montenegro

Principles and methodology of establishing the inventory of geoheritage sites

Geotectonic base and exogenous processes brought to distinctive complex of natural, abiotic elements within the particular area. These elements construct the overall diversity known as geodiversity. Geodiversity objects should be recognized and study during the special scientific studies among different geodisciplines. Extensive studies enlarge our knowledge related to geodiversity of distinct area. However, more apparent insight into the geodiversity wealth requires the distinguishing of representative objects, i.e. geoheritage sites as representatives of geodiversity (Djurović P., Mijović D, 2006). These include geological, geomorphological, hydrological-hydrogeological, pedological and distinct, geo-archeological values emphasized with their notable scientific and cultural significance, making a part of distinct European and world heritage. From that reason they require to be concerned of all relevant social factors in their protection as well as in their presentation to domestic and foreign scientific and professional publicity (Pantić N., Belij S., Mijović D., 1998).

Geoheritage sites differ a lot concerning their forms and essential values. These differences

could cause some problems during their inventory, protection as well as during their presentation. Concerning their forms should be distinguished dotted, aerial and linear forms, whereas concerning size exist sites in meter scale, decameter and kilometer scale. Dotted geoheritage sites of meter and decameter size might be incorporated into linear or aerial objects of kilometer size. This actually means that geoheritage sites could be simple or complex. For example, the canyon of the Tara River was determined as linear geoheritage object in kilometer scale. It represents complex site, as embraces several pointless sites in decameter scale e.g. springs Ljutica, Bijelo vrelo, Bajlovića sige, Djavolje lazi etc. (Djurović P., Djurović M., 2010).

Distinguishing of geoheritage sites among the geodiversity objects is possible concerning few criteria: scientific values, rarity, original, representative, aesthetic etc. The group of representative objects – geoheritage sites determined within the geodiversity objects, need to be categorized, i.e. its importance related to similar objects need to be evaluated. Categorization is usually among the sites of local, national, regional, European and world importance (Dangić A., 1998). Their identification and classification should be followed with their protection and conservation. Different protection measures based on different law acts de-

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pending from the worthy of the sites, their temporary and potential endanger, will be applied. At some geoheritage sites, applied conservation should prevent further deterioration. Conservation includes physical protection of sites from the influence of natural processes and anthropogenic impacts. Simultaneously with conservation and protection should be done valorization and presentation of geoheritage sites. Presentation of geoheritage sites should be directly at their site or indirectly. Former includes either the exposition of panels, which will present the main site values, or organization of leader services. The latter includes presentation in various publications, scientific (magazines, monographs etc.), professional (books, reference books etc.) and popular (itinerary, guide books etc.) as well as in medias like television or newspaper reports and so on. Valorization of geoheritage sites is based on different criteria depending from the object themselves. Valorization is often in discordance with the protection, as could decrease its importance, or destroy it.

Touristic valorization of geoheritage sites

From the above-mentioned modes of inventory of geoheritage sites creation is obvious that it represents a long and complex process, both scientific and professional, as well as legislative.With this process, or near its end, could be created valorization of geoheritage sites in the sense of its value for tourism. Principles of tourist valorization are different from principles of distinguishing geodiversity objects and valorization of geoheritage sites. These differences are the consequence of different criteria for the geoheritage sites valorization. A scientific criterion, which is the main decisive factor in selection of geoheritage sites, is not the main in tourist valorization, where the advantage belongs to aesthetic values and rarity. Communication and economic defray are two approaches which highly govern tourism valorization of geoheritage sites. The highest attraction deserves complex sites of aerial or linear distribution, kilometer in scale (Figure1 and 2).

Geoheritage sites in Montenegro

Geotectonic setting and physical-geographical conditions resulted in formation of numerous and diverse, natural geo-complexes in Montenegro. Accompanied with biotic elements they represent a true complex of natural diversity in this area (Radojičić B., 1996).

Several macro geotectonic units have been divided in Montenegro: Dinarides, Prokletije and coast-



Figure 1. Geoheritage of Montenegro: a) Canyon of the Mrtvica River (Southwest from Kolašin), b) Waterfall of the Perućica River, c) Cliff near Petrovac (on the Adriatic Coast), d) Riverbed of Cijevna (near Podgorica)

al Adriatic region (Ivanović S., 1991). Each of these geotectonic units past through different evolution phases, thus their petrological and structural elements witness of thundering evolution in this part of the Europe. Different physical-geographical factors, both in modern times and in ancient geomorphological past, imprinted the existing geological basement creating a treasure of different forms, occurrences and processes (Figure 1 and 2). The highest influence on nature in Montenegro had two noteworthy changes. They correspond to alternation of glacial and interglacial periods that took part approximately in last 2 million years. These alternations either caused motions, or stopped the numerous physical-geographical processes. They had the direct influence on highland-mountainous region whereas the complete Montenegro area affected indirectly. Another significant change is related for the rise of Adriatic Sea level as the consequence of global sea level increase. This happened about 12 -14,000 years ago and resulted in drown-



Figure 2. Geoheritage of Montenegro: a) Lipska Pećina (cave near Cetinje), b) Buljarica (bay near Petrovac on the Adriatic Coast), c) Pešića jezero (lake on the Mount Bjelasica), d) Beška (island in the Skadar Lake)

ing of previous relief and translation of landforms into submerge forms (submarine springs, drowned springs, drowned karst valleys called vrtače, karst fields etc.).

Inventory of geoheritage sites

Geoheritage sites are classified into 9 main groups:

- historical-geological and stratigraphically sites heritage,
- structural sites,
- petrological sites,
- geomorphological sites,
- neo-tectonic activities sites,
- speleological sites,
- hydrological-hydrogeological sites,
- pedological sites and
- archeological geoheritage sites (Wimbledon W.A.P. 1996,1999).

State and perspectives of tourist valorization of geoheritage sites in Montenegro

The official inventory of geoheritage sites in Montenegro does not exist. A group of authors made some preliminary list. It embraces small number of sites related to their real number in Montenegro (Djurović P., Djurović M., 2010). According to this preliminary list the existence of diverse geoheritage sites in Montenegro, whose values often exceed local importance, is designated. Numerous sites occur as significant natural curiosities beside their pronounced scientific values representing very good potentials for tourism development. The most valuable are sites of geomorphological, hydrological, and partly sites of speleological geoheritage (Lješević M. 1980). Deep karst is prevailing in Montenegro, thus pits are the most abundant. Although caves are not so numerous, some of them have notable aesthetic values. Historical-geological geoheritage sites represent lesser objects of tourist valorization. However, some of them accompanied with the proper informative puncts might evaluate into touristic destinations especially those able to offer and present the evolution of the Earth on suitable way for visitors. The example is the spring Smrdan in Crmnica that spurts sporadically methane bubbles etc.

Geoheritage sites in Montenegro are partly included as natural rarities into touristic offer. In the frame of touristic presentation, the Ministry of tourism placed along the important roads

cursors that point onto distinct objects of natural or cultural-historical significance. Geoheritage sites are included in these signed objects. However, touristic valorization was not carried out planned and systematically, just for the particular sites. Well-defined criterion for selection of pointed sites was lacking too. Some sites without wellarranged paths, although dangerous for potential visitors, were also assigned (the well Ljutica in the Tara river canyon). This concerns especially speleological objects, which were not arrange yet, as well as objects accessible through rough and risky paths. Mentioned cursors embraced a negligible number of sites, whereas the majority of them remained without any adequate sign or instruction for potential visitors.

Hydrological geoheritage sites should be noted and underlined as examples of positive and good touristic valorization, e.g. karst spring Ravnjak (between Mojkovac and Žabljak), springs of Alipaša (Gusinje), Glava Zete (near Danilovgrad) etc. These places mark significant number of visitors, but the proper information about the value of these sites worthy to visit is still missing. Springs in Boka Kotorska are without touristic offer although they display extraordinary and rare properties, thus remain unknown to numerous tourists that only pass by. The spring Ljuta, for example, has maximal discharge over 180 m3/s with a channel depth over 100 m. Cave channels, which brought water for the spring Gurdić and Sopot, penetrate deep beneath the sea surface.

Aerial distribution of the geoheritage sites is extremely good. They are uniformly distributed in the coastal area as well as in medium, central and mountainous region. Numerous sites are close to main roads and big cities, as well as close to tourist destinations, enabling their easier valorization. Touristic arrangement in the adjacent vicinity of some sites remained unsolved, as completely absent or inadequately and insufficiently obtained. It should be noted that the people dealing with tourism are not either well or enough informed about geoheritage sites and their touristic values. That is the main reason for the absence of any idea concerning their presentation and their assessment into touristic offer living numerous interesting sites out of tourist offering.

The existing touristic maps of Montenegro contain small number of data related to geoheritage sites, commonly only its location without any additional notes concerning its value. Tourist guidebooks are better supply with information but still are far from correct presentation of all geoheritage sites and their values. Geoheritage sites are best explained and presented in scientific monographs with touristic content, but as natural rarities of particular places instead as geoheritage sites (Nikolić S., 2000). Another problem arose from their application within scientific population, not among tourists.

Creation of tourist map with positions of the most important geoheritage sites would pay attention of tourists and force their visiting. This map should contain beside the exact position of the site, its value and importance, what will allow tourists to choose objects of interests concerning their own affinities.

The arrangement of the adjacent vicinity of geoheritage sites should be (cursors, approaches, paths, protective fences etc.), under municipal tourist organizations and responsible Ministry, as well as the methods of their proper touristic valorization (tickets etc.).

Conclusion

Small number of geoheritage sites in Montenegro was touristic valorized up to now. Taking into consideration that the present touristic offer, mostly related for coastal tourism has reached its real maximum, and that the mountainous tourism is highly dependable from the surrounding competition, the main goal in the future is geotourism development, i.e. valorization of the most important geoheritage sites. These require establishing a conscience about the geoheritage, its value and importance, starting from the municipal tourist organizations and direct realisators of touristic offerings (touristic agencies, tourismologists, touristic guides etc.). Pronounce education of touristic workers is necessary for realization of suggested task. On the other side, skills for arrangement of selected geoheritage objects must be directed. All of these demand significant activities related for touristic marketing mostly concerned to creation of General Geotouristic map of Montenegro, as well as geotouristic maps for particular areas of touristic interest in Montenegro, respectively.

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Appendix - Inventory list of geoheritage sites in Montenegro

Nº	Name	Location
1	Devonian sediments in the upper river Grnčarevska	Northwest of Bijelo Polje (paleontological records).
2	Devonian-carbon sediments in the upper course of the Ibar	Upstream of Rožaje (paleontological records) (findings Conodonts genera and species, foraminifera, flora, stromatoporida et al.
3	Carboniferous sediments Turjak	Rožaje
4	Permian sediments in the valley Ćehotina	Near the village Skenderovine, downstream from Pljevlja (paleontological records)
5	Lower Jurassic sediments (Lias inner areas)	Environment Vilusi
6	Lower Jurassic sediments, (complete Lias)	Canyon Mrtvica
7	Middle Triassic sediments	Gornje polje Nikšić
8	Lower Cretaceous sediments	The Budoš near Petrović
9	Upper Cretaceous sediments	Jelina pećina south of Nikšić
10	Neogene sediments	Brezna
11	Middle Miocene sediments	Mendara, NW of Ulcinj, (paleontological records benthic foraminifera form)
12	Orijensko-bjelogorski synclinorium	Mt. Orijen
13	Old Montenegrin anticlinorium	Podgorica - Nikšić
14	Anticline Velji Garač	Danilovgrad
15	Anticline Platija	Podgorica - Kolašin
16	Anticline Sadjevice	South of Danilovgrad
17	Anticline Možure i Brivske gore	Ulcinj
18	Lješanska fault	Near Podgorica
19	Raslovački fault	Between Lutovo and Bioče
20	Fault Brezovih Rupa	Bioče
21	Sušički fault	West of Danilovgrad
22	Kraljušt Martinića	Danilovgrad

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Nº	Name	Location
23	Kraljušt Meduna	Podgorica
24	Quartz diorite of the Paleozoic	Intrusives in the form of bodies or wires in the valley of NW Lješnica Bijelo Polje
25	Kornit Paleozoic	NW of Bijelo Polje
26	Paleozoic quartz keratophyre	(Revised and metamorphed volcanics) in the valley Ljuboviđa NW of Bijelo Polje
27	Middle Triassic igneous rocks (tuffs, tifiti, volcanic breccia)	Bijela Crkva northeast of Rožaje
28	Middle Triassic rhyolite	Kozička River valley, between the villages Kozice and Vrulja (NW of Kovren)
29	Triassic tuffs	Near Kovren
30	Spiliti jure	In the valley of the Bistrica River, near the village of Bistrica
31	Middle Triassic andesite	On the Mt. Ljubišnja, Šuplja stijena
32	Middle Triassic dacite	On the Mt. Ljubišnja, the source of rivers River
33	Secondary metric hydrothermally altered andesite and dacite (lead and zinc)	Šiplja stijena
34	Volcano-sedimentary series of ladinic (bentonites)	SW of Virpazar (Bijelo Polje)
35	Verfen dolomite and shale (barite, hydrothermal origin)	Between Sutomore and Mišići (Spič)
36	Dolomite and clastic sediments mercury	Sozina
37	Sedimentary origin limonite (iron)	Between Petrovac and Virpazar
38	Hydrothermally altered andesite and dacite Anisian (iron in the form of hematite)	Krnja Jela
39	Cenomanian limestones (bituminous shale)	Locale Hum and Božaj

Nº	Name	Location
40	Upper Cretaceous limestone (asphalt)	West of Ulcinj
41	Miocene sediments (asphalt)	South of Ulcinj
42	Verfens slate (occasional outbreaks of blisters natural gas and oil droplets)	Smrdan, Crmnica
43	Series of Middle Triassic limestones and conglomerates (oil and gas)	Buljarica
44	Volcano-sedimentary series (manganese)	Near Mažići Budva
45	Red bauxite Middle and Upper Triassic (Triassic horizon)	Oldest bauxite Montenegro, Niksicka župa
46	Red bauxite between Liassic and Upper Tithonian (Jurassic horizon)	Nikšićka župa
47	Graffiti, hydrothermal origin	Mt. Prekornica
48	Travertine	Tomaševo, Bijelo Polje
49	Travertine	Pljevlja
50	Travertine	Pjevalja
51	Travertine, Podmalinsko	Boan
52	Lakes sediments	Plavnca, Skadar Lake
53	Lakes sediments	Šasko jezero Lake
54	Lakes, Pleistocene sediments	Nikšićko polje
55	Rumija-Lovćen block uplift	Mt. Rumija & Mt. Lovćen
56	Orijen block uplift	Mt. Orijen
57	Njeguši block uplift	Mt. Lovćen
58	Maganik block uplift	Mt. Maganik
59	Skadar- Zeta blok lowering block	Skadar Lake
60	Petrovac - Budva lowering block	Budva
61	Talus cones	Mt. Komovi
62	Karst windows	Canyon Piva
63	Karst windows	Karanfili – Mt.Prokletije
64	Canyon Cijevna	Near Podgorica
65	Canyon Kazani	Ćehotina
66	Canyon Piva	
67	Canyon Sušica	
68	Canyon Komarnica	
69	Canyon Tara	
70	Canyon Draga	
71	Canyon Lim	
72	Canyon Đalovića klisura	
73	Canyon Pridvarica	
74	Canyon Bukovica	
75	Canyon Mrtvica	
76	Canyon Morača	
77	Canyon Trebješnica	
78	Canyon Kruševica stream	
79	Canyon Mala Rijeka	

80Canyon Žijeb81Canyon Radman river82Canyon Ibar83Canyon Škurda84Canyon Cijevna - upper85Canyon Brcka86Canyon Rikavac87Canyon Vruća rijeka88Canyon Grija90Riverbed Cijevne (bottom)91Epigenić Ćehotina river	
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91 Epigenic Ćehotina river Plievalia	
92 Epigenic Skakavac river Vusanje - Gusinje	
93 Piracy river Ljubovidja and Kovren Ćehotina	
94 Piracy Medjurečka rijeka Ulcinj river	
95 Meanders Ćehotina Pljevlja	
96 Meanders Crnojevića River Skadar Lake	
97 Bay Valdanos Ulcinj	
98 Bay Pećin Čanj	
99 Bay Jaz Budva	
100 Dolina Djurovo oko Karuč – Skadar Lake	
101 Dolina Kaludjerovo oko Karuč – Skadar Lake	
102 Ada Bojana Island Ulcinj	
103 Basin Zoganjsko jezero Ulcinj	
104 Cliff - Dubovica Buljarica	
105 Cliff Crvena srtijana Petrovac	
106 Cliff Mogren Budva	
107 Marine sand and gravel Ulcinj	
108 Marine sand and gravel Buljarica	
109 Island Lastavica Boka Kotorska	
110 Island Sveti Nikola Budva	
111 Island G.& D. Katić Petrovac	
112 Island Žabljak Skadar Lake	
113 Peninsula Prevlaka Tivat, Boka Kotorska	
114 Island Beška Skadar Lake	
115 Island Vranjina Skadar Lake	
116 Marine monadnock Kam Sutomore	
117 Limestone hum Spuška Spuž glavica	
118 Space development of micro Bolj – Mt. Durmitor karst forms	
119 Space development of micro Mt. Maganik karst forms	
120 Cockpit karst Mt. Bjelič	
121 Cockpit karst Mt. Sinjavina	
122 Cockpit karst Mt. Pivska planina	
123 Karst table; Bolj Mt. Durmitor	
124 Grahovsko polje	
125 Cetinjsko polje	

Nº	Name	Location
126	Njeguško polje	
127	Nikšićko polje	
128	Polje Brezna	
129	Nivacione doline	Šljeme – Mt. Durmitor
130	Cirque-karsta doline	Jezerina, Mt. Lovćen
131	Natural Bridge	Štuoc – Mt. Durmitor
132	Natural Bridge	Komarnica
133	Uvala Ugnji	Cetinje
134	Uvala Donje i Gornje Ledenice	Risan
135	Cirque Valoviti do	Mt. Durmitor
136	Cirque Krstac	Mt. Stožac
137	Cirque Bljuštur	Mt. Bioč
138	Oštrikovački cirque	Mt. Volujak
139	Cirque Ordeni doli	Mt. Volujak
140	Cirque basena Trnovačko	Mt. Maglić
	jezero	
141	Cirque Carev do	Mt. Maglić
142	Suha valov	Mt. Volujak
143	Cirque Medjukomlje	Mt. Komovi
144	Cirque Mojan	Mt. Prokletije
145	Cirque Surdup	Mt. Zijovo
146	Valov Gorni i Donji do	Mt. Bloc
147	Valov Grbaja	Gusinje
148	Valov Ropojan	Gusinje
149	Moraine in the Velikoj Kalica	Mt. Durmitor
150	Moraine Govedji breg	Drogolisko gezero Lake
151	Moraine Macja stopa	Mt. Durmitor
152	Nunatak Stolaa	Mt. Voluiek
15/	Nunatak Visaki kam	Mt. Volujak
155		Mt. Komovi
156	Carine, perigiaciai rener	Mt. Durmitor
157	Cave Mali Lompi do	Mt. Durmitor
158	Cave Ilviti do	Mt. Durmitor
159	Cave Prihatov do	Mt. Mananik
160	Cave Stožac	Mt. Kana Moračka
161	Cave Maistori	Mt. Lovćen
162	Cave Duhoki do	Nienuši
163	Pestingradska jama Cave	Kotor
164	Pećina u Diavoliim firovima	Bistrica - Bielo Polie
	Cave	
165	Lipska pećina Cave	Dobrsko selo – Cetinje
166	Začirska pećina Cave	Začir, Cetinje
167	Pećina Grbočica Cave	Virpazar
168	Cetinjska pećina Cave	Cetinje
169	Džupanska pećina Cave	Lubnica, Berane
170	Ledena pećina Cave	Mt. Durmitor
171	Waterfall in the river Perućici	Danilovgrad

Nº	Name	Location
172	Waterfall Skakavac	Vusanje, Gusinje
173	Waterfall in the Skakavica	Komarnica
174	Estavela Gornjepoljski vir	Nikšić
175	Estavela Gurdić	Kotor
176	Intermittent spring Zaslapnica	Zaslap, Grahovsko polje
177	Spring Glava Bistrice	Bijelo Polje
178	Spring Glava Zete	Danilovgrad
179	Oboštičko vrelo Spring	Danilovgrad
180	Oraška jama Spring	Danilovgrad
181	Vrelo Škurda Spring	Kotor
182	Vrelo Sopot Spring	Risan
183	Vrelo Spila Spring	Risan
184	Vrelo Ljuta Spring	Orahovac, Kotor
185	Vrelo Perućac Spring	Bogetići
186	Vrelo Glava Ćehotine Spring	Pljevlja
187	Alipašini izvori Spring	Gusinje
188	Waterfall Djavolje lazi	Tara River, Bistrica
189	Vrelo Ravnjak Spring	Bistrica
190	Trnovačko jezero Lake	Mt. Maglić
191	Veliko & Malo Stabanjsko jezero Lake	Plužine
192	Crno jezero Lake	Mt. Durmitor
193	Škrčko jezero Lake	Mt. Durmitor
194	Zminje jezero Lake	Mt. Durmitor
195	Pošćensko jezero Lake	Mt. Durmitor
196	Svrablje jezero Lake	Mt. Durmitor
197	Riblje jezero Lake	Mt. Durmitor
198	Poščensko jezero Lake	Komarnica
199	Zminičko jezero Lake	Mt. Sinjevina
200	Biogradsko jezero Lake	Mt. Bjelasica
201	Jezero Ursulovac Lake	Mt. Bjelasica
202	Pešića jezero Lake	Mt. Bjelasica
203	Šiško jezero Lake	Mt. Bjelasica
204	Kapetanovo jezero Lake	Mt. Moračke planine
205	Brnjičko (Manito) jezero Lake	Mt. Moračke planine
206	Visitorsko jezero Lake	Mt.Visitor
207	Rikavičko jezero Lake	Mt. Žiovo
208	Bukumirsko jezero Lake	Mt. Žiovo
209	Terra rosa	Luštica
210	Wetlands	Skadar Lake
211	Wetlands	Žabljak
212	Wetlands	Plavsko jezero
213	Crvena stijena - Paleolithic	Petrovići, Nikšić
214	Bioče Middle Paleolithic	Bioče
215	Cave Vruća Paleolithic and Mesolithic	Canyon Mala rijeka
216	Mališina stijena - Paleolithic	Mataruge, Pljevlja
217	Medena stijena – Paleolithic	Canyon Ćehotina, Pljevlja