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KARST AND GEOTOPS OF KARST ORIGIN IN ALBANIA

A. SERJANI[1], H. HALLACI[1], A. NEZIRAJ[1] & A. HALLACI[2]

ABSTRACT

Albania is one of the most karst-developed countries in Europe. Karst phenomena are related to soluted carbonate formations which cover of about 7300 km^2 of Albanian territory and with sulfate evaporates rocks, which outcrop of about 500 km^2. Typically alpine relief of average altitude 708 m above the sea level and high horizontal splitting are favorable for karst development. Karst and geological sites of karst origin are widespread mainly in Albanian Alps and in Ionian zone. In Albanides there are determined surfaces and underground karst forms which belong to the Neo-Pliocene-Quaternary age and deep karst forms belonging to the paleokarst in old formations. The most widespread karst forms in carbonate rocks there are valleys, caves, cones etc., while into salt rocks there are formed many karstic lakes and depressions. Up to now there are determined about 80 karstic caves, nice karst fields, valleys, plains, which represent geological sites of karst origin.

KEY WORDS: Albania, carbonate formations, evaporate rocks, karst phenomena, geological sites.

INTRODUCTION

Due to widespreading of carbonate and evaporate rocks in Albania a lot of karst landscapes there formed as well. In many cases these landscapes are of nice aesthetic view. They are of geoscientific importance representing geological sites of karst origin. Karst phenomena in Albania are treated during geological mapping of different regions and in Physical Geography of Albania (1991,1992). For the first time, Kristo (1973) and Dhame presented karst in his thesis (1988). Separate presentations are done last years on international symposiums and meetings (Serjani, et al., 2000), Hallaηi, et al., 2000). Geological sites of karst origin are described and classified in framework of studies and papers on Geological Heritage (Serjani et al., 1997, 1998, Serjani and Neziraj, 2000).

There are of about 25 known surfaces of intensively karst development in Albania. In most cases these surfaces represent interesting and beautiful natural geological-geomorphologic phenomena of scientific, didactic-educational and geotourist values. Amongst the above mentioned karst regions we can name: Kurveleshi Highland, which is considered as "natural museum of karst phenomena", Hajupi mountain, Pilur-Vali Vunoit, Tomorr-Kulmaka regions in Ionian zone, Sazan-Karaborun carbonate platform, Mali me Gropa ("Mountain with Holes"), Mali i Thate ("Dry Mountain"), Prespa, Klenja, Studa, Qarrishta, Biza, Munella, Arni karstic fields in Mirdita zone and Ivanai, Villa, Paruni, Veleηik, Rragami karstic fields in Albanian Alps zone. Karst forms represent nice and important geological sites of the same origin. That is why they must be known, evidenced, studied, managed and protected by Albanian State for coming generations. Some of karst fields situated at mountainous highlands are of complex erosional-karst geotourist values and need exploration fieldwork and detailed researches. The same we can say for many deep karst caves, which are not explored yet.

KARST ROCKS IN ALBANIA

Karst phenomena are widespread mainly in carbonate and evaporate rocks. Total surface covered by carbonate formations in Albania is of about 7300 km^2. Carbonate rocks are widespread in Northern Albania, where they construct Albanian Alps or Northern Mountainous Geographical Unit, in Southern Albania or Southern Mountainous Unit belonging to the Ionian tectonic zone and in Sazan-Karaborun Cretaceous carbonate platform (Fig.1). Karst is developed mainly in limestone rocks, and in few cases in dolomites. Jurassic and Cretaceous thick sections of limestone are evident in Malesia e Madhe subzone of Albanian Alps. They form a large karst region prolonged from Kopliku southwest up to the most northern mountain picks to the confine. In northern part from Boga up to the border (Seferηe), there is spread karst in more than 2000 m above the sea

1. Institute of Geological Research, Blloku "Vasil Shanto", P.O.Box 1427, Tirana, Albania
2. ITNPM, Blloku "Vasil Shanto"., Tirana, Albania

levels into the limestone of Upper Cretaceous, while to the southwestern part from Kopliku up to the Cemi river valley, karst it is widespread intensively in lower levels into the carbonate rocks of Jurassic age.

In eastern Albanian Alps (Valbona subzone) karst is linked with sections of Triassic limestone, some times dolomitized. Here, is placed one of the most interesting and important karstic region between Jezerca mountain (2693 m), Iron Pick (1560 m), "Black Pick" (2359 m), Big Pick (2011 m), and Radohima Pick (2559). Karst is developed at levels 1800-2500 m, while all over slopes of Valbona, Curraj, Shala and Perroi Thate rivers there are formed a lot of karst and erosion forms as well.

Another one interesting geological-structural unit in Northern Albania constructed mainly by Cretaceous-Paleocene marl limestone of Triassic-Lower Jurassic age in its core, it is Cukali anticline. Here, around the Cukali mountain pick (1723 m) and all over the slopes of Kiri and Shala rivers there are formed a lot of karstic fields, valleys, ridges, caves.

Separate large carbonate structures with a lot of surface and underground karst forms are on both eastern and western flanks of Albanian Ophiolites, belonging to Mirdita tectonic zone. Amongst the largest Cretaceous carbonate formations there are Pashtrik-Manze anticline in Kukesi region, Munella Cretaceous carbonate Mountain (1991 m) placed on the volcanic rocks of Mirdita Ophiolites and long Cretaceous carbonate ridge from Zebe Pick (1987m) north to Red Stone Pick (1511 m) up to Deja Mountain (2246 m) south. This wide carbonate ridge is placed between volcanic rocks of Mirdita in the west and Lura ultrabasic massif in the east. Further to the south, there are placed some other carbonate massifs such as: Mali me Gropa ("Montain of holes") to the east of Tirana, which represents one of the best intensively karst phenomena in regional scale, Berzeshte-Polis anticline of Cretaceous-Paleocene limestone, Voskopoja, Vithkuqi and Radanji (Leskovik) anticlines constructed by Cretaceous and Paleogen limestone as well. Some carbonate fields belonging mainly to Upper Triassic-Lower Jurassic age are placed in Korabi tectonic zone such as: Koritnik-Gjallica mountain in Kukesi region, Ostren-Stebleva-Qarrishta karst region, Dry Mountain (east of Ohrid lake), Prespa karst region etc.

As two thin long bands from north (Shkodra-Lezha region) towards the southeast direction are placed Cretaceous carbonate rocks of Kruja-Dajti ridge (Kruja tectonic zone) and Krasta subzone. Limestones of Kruja zone are platformic, neritic ones with a lot of macrofossils often dolomitized, while limestones of Cukali zone are pelagic ones.

In Ionian zone, there are widespread carbonate formations outcropped mainly in anticline belts, but karst phenomena is widespread mainly in Cretaceous and Paleocene limestones and in massive limestones of Lower–Middle Liassic. The largest karst surfaces in Ionian zone there are: Kurveleshi Plateau, Mali i Gjere ("Wide Mountain"), Bureto–Lunxheri-Shendelli, Nemerŋke-Dhembel, Trebeshina-Fterra-Vermik and Hika carbonate mountain chains. Separate karst regions are those formed on the surface of Dhrovjani, Grazhdani, Janicat and Shtutgara carbonate anticlines and Saranda-Butrinti-Bogazi-Konispoli carbonate structures.

Sazan-Karaburun zone is constructed by Cretaceous neritic limestones.

Evaporate rocks outcrop in Pre-Adriatic Depression, in Ionian and Korabi zones. Dumrea salt diaper, the largest diaper in Albania it has surface of about 300 Km^2. On it's surface there are formed many karst lakes and depressions. In Ionian tectonic zone evaporates outcrop in form of diapers in Kardhiq, Delvina, Vermik, and Hiflik. Two large white salt domes are formed in Peshkopi region (Korabi zone): "White Mountain" and Banjat-Peshkopi salt domes. Small outcrops of evaporates there are in Dibra region (Macedonia) as well.

LOCATION AND FORMS OF KARST

The karst phenomena in Albania it is new karst of Post-Pliocene-Quaternary age and deep karst. This last type belongs to paleokarst of old formations. Karst in Albania represents typically Mediterranean karst. Amongst the most intensive orogenic stages of paleokarst in Albania there are noted the following:

- Paleocene-Eocene stage, expressed in Ionian, Sazani, Kruja, Mirdita, Korabi, Gashi zones.
- Oligocene stage, expressed more clearly in Kruja, Krasta-Cukali, Mirdita, Albanian Alps zones.
- Jurassic-Cretaceous boundary orogenic stage expressed in Mirdita, Korabi, and Gashi zones.

In most cases paleokarst traces are intercalated gradually with Pliocene-Quaternary neo-karst phenomena. In Fig.2 it is presented the scheme of karst location in Albania.

Two genetic types of neokarst there are determined in the carbonate formations:

- Karst forms on slopes of river valleys according to the drainage movement of underground waters and depending on vertically changes of the level (basis) of underground waters.
- Karst forms on slopes of mountains, where drainage of the underground waters depends by relations between karst soluble formations and solid, nonpermeable formations, above the level of existing base of weathering.

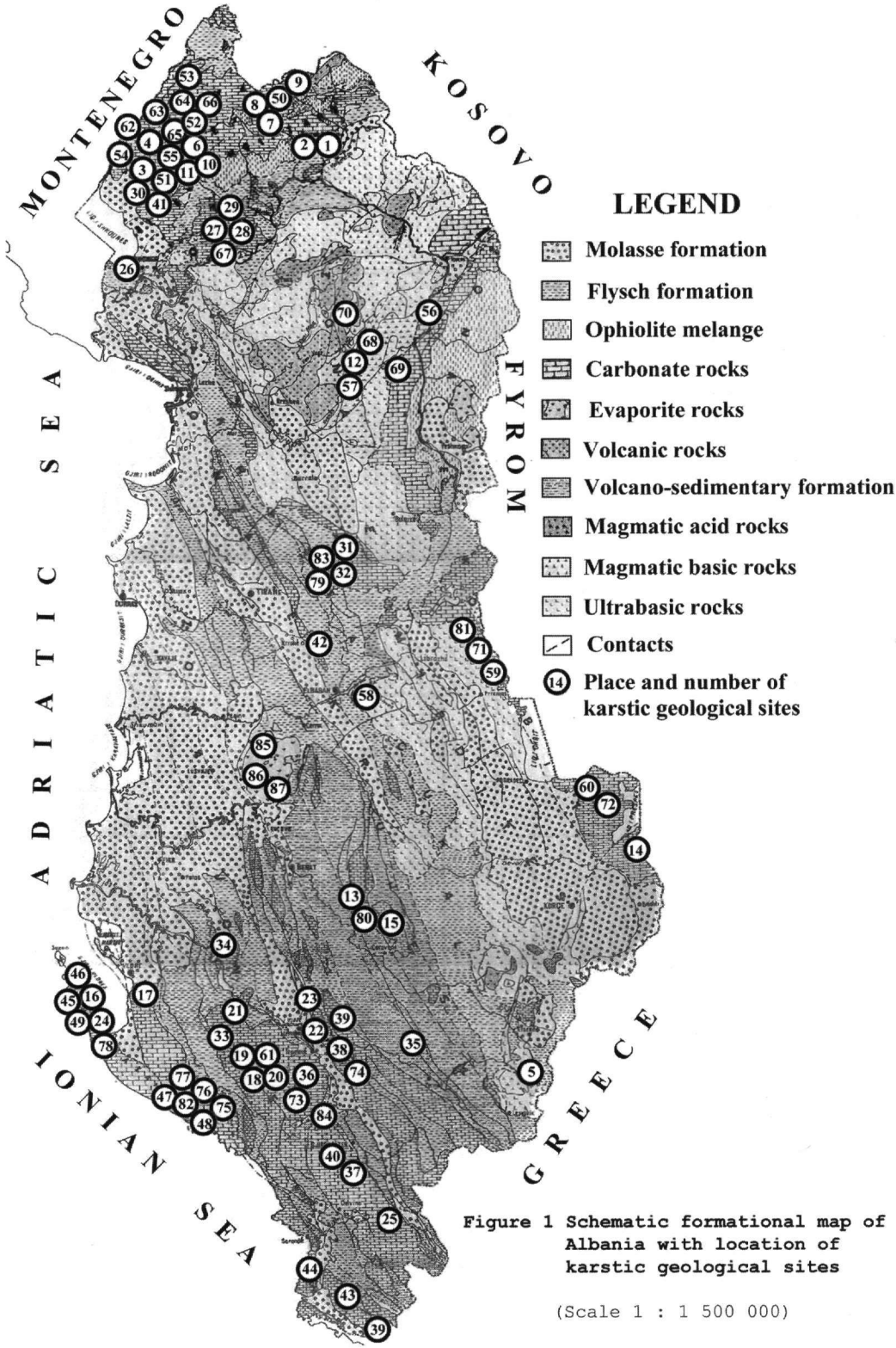

Figure 1 Schematic formational map of Albania with location of karstic geological sites

(Scale 1 : 1 500 000)

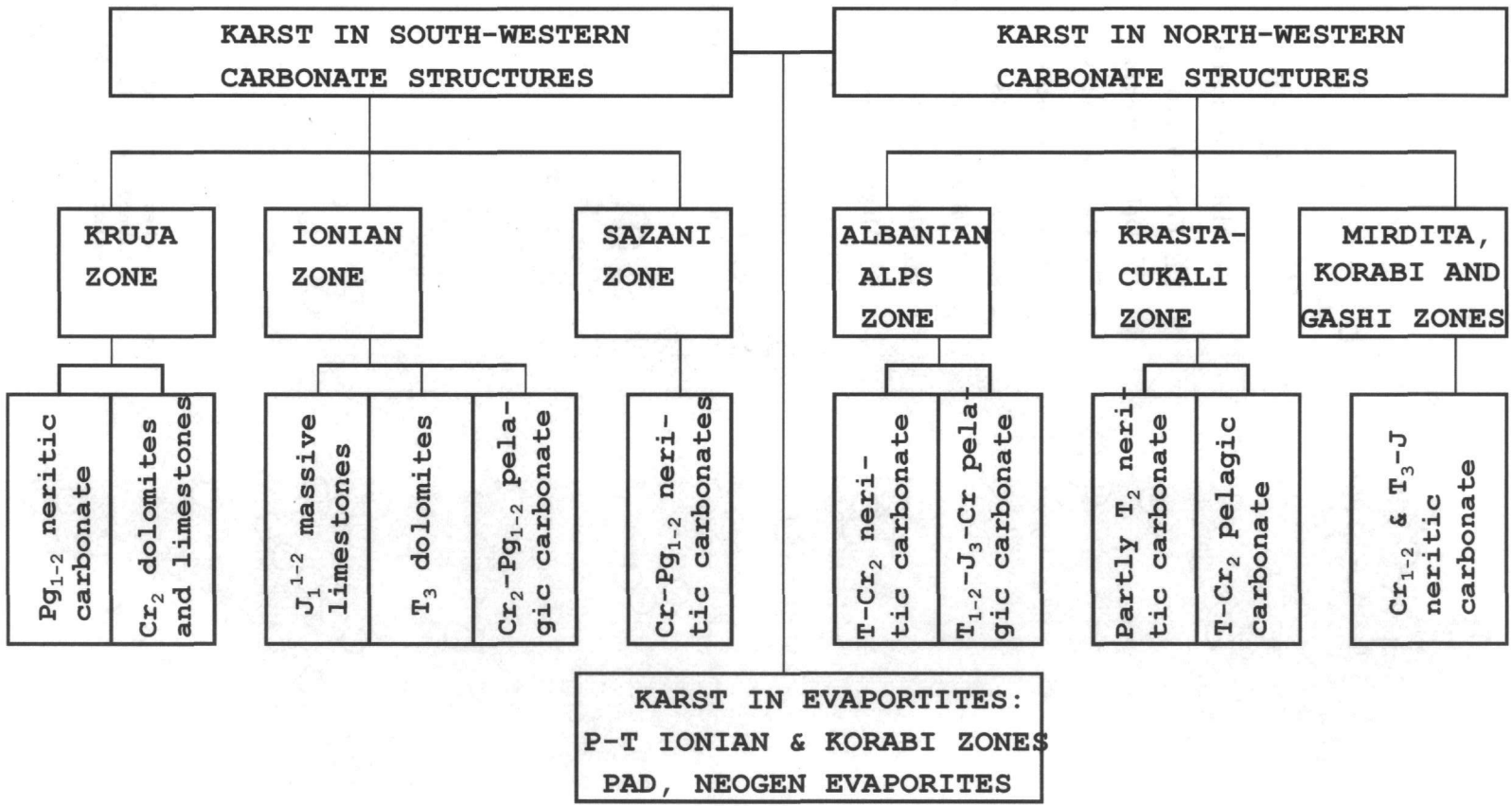

Figure. 2 - Scheme of the karst location in Albania

Karst is developed mainly in the following three levels:

- Lower level, (300-1000 m), characterized by the plane relief and spreading of caves and karstic valleys.
- Middle level, (1200-1600 m), characterized by the accidental relief with spreading of karstic fields, plateaus, funnels, karstic caves etc.
- High level, (1600-2500 m), developed mainly in Albanian Alps and in Korabi highland with intensively accidental relief. In middle and high levels karst phenomena there are intercalated with the glacial traces, while in all levels karst processes there are intercalated with erosion ones.

Tectonical-Structural construction in External zones (Sazan-Karaburuni, Ionian, Kruja, Krasta-Cukali and Albanian Alps) has been convenient and influenced for development of karst forms mainly in mountain plains and highlands and next to the ridges, while on mountain slopes, karst is less widespread. In inner Albanides (Mirdita and Korabi tectonic zones) karst phenomena are widespread all over the surface of carbonate formations. The most widespread karst forms on carbonate rocks there are valleys, blind valleys, caves, karst cones, deeps, holes, lapies, poljes etc. On the surface of Dumrea evaporate diaper there are formed tenths nice aesthetic karst lakes, especially in Belshi region, while in Kardhiqi salt diaper (Gjirokastra region) there is Kalcoi deep lake and many karst depressions, holes, cones. On the surface of white salt domes in Peshkopi, it is developed mainly surface karst combined with erosion forms.

Underground karst springs from evaporate rocks and many cold water-springs from carbonate formations testify about widespreading of covered and buried karst. These last kinds of karst phenomena are dangerous especially in Dumrea salt diaper where are many villages.

GEOLOGICAL SITES OF KARST ORIGIN

Intensively, developed karst in Albania has influenced to the formation of beautiful aesthetic landscapes and rare natural phenomena, which represent geological sites. In Belogradchik Meeting of ProGEO (Serjani et al., 1998), were presented 93 geomophological sites of karst origin. Later, in the First Inventory of Geological Sites of Albania (Serjani et al., 1999) were selected 86 karst geotops of local, district, national and international importance.

Karst geotops are of different kinds depending of their form and manner of development of karst processes. There are evidenced the following karst geotops:

Karst caves, formed as result of solution by surface water, especially snow-waters. There are evidenced and presented in Map of Geological Sites of Albania 45 karst caves (Serjani et al., 2000). They are placed mainly in carbonate formations. Many caves are formed in Ionian and Albanian Alps zones, especially in Cukali anticline. The largest and must interesting karst caves are:

- **Jubani cave** in Shkodra district, of about 350 m long with a lot of underground rooms, stalagmites, stalactites, and colloidal forms representing a natural underground museum.
- **Black cave** in Erzeni River, near Tirana,
- **Boga cave** up to 5 km long, near Boga National Forest Park and tourist spot.
- **Duk Gjoni cave** in Karaborun peninsola, 40-45 m deep, 10-20 m wide and 3-4 up to 7-8 m high. Amongst stalactites, stalagmites and wide columns (stalogusts) here are formed boxes in both sides and three small underground lakes.

In Gajtan, Black, Trenit, Benja, Xara, and Konispol caves there are discovered traces of prehistoric stage of life. From Kolonja, "Black Eyes", Shpaniku and some other caves there are flowing underground springs. Up to now there isn't done full evidence of caves all over Albania, while their exploration and documentation is in the first steps.

Karst valleys, fields, slopes, ridges, holes, depressions. There are evidenced 35 such geotops formed mainly on the surface of carbonate rocks. The largest and the most interesting karst fields are the following: Mali me Gropa ("Mountain of Holes") and Biza (to the east of Tirana), Veleŋiku, Kopliku, Vrini, Graca, "Black Field" (1.2 km^2), Studa, Qarrishta, Prespa, Tomor-Kulmaka, Vanova, Vumlo, Rovena karst fields. The most interesting karst holes there are: Markzeza (2.3 km^2), Krekeza, Vrini (4.7 km^2), while amongst the beautiful karst valleys there is noted Hajupi one. On the surface of Mali me Gropa ("Mountain of Holes") there are formed very nice aesthetic landscapes, similar to the bee's net. Holes are of about 50-60 m in diameter and of about 40-50 m up to 100 m in depth. The most intensively karst is developed at level 1330-1400 m. Another one region as "Natural Karst Museum" is Kurveleshi Highland in Ionian zone with a lot of karstic caves, fields, canyons and waterfalls.

Karst lakes and depressions are widespread on the surface of evaporate rocks. On Dumrea Salt Diaper there are formed many karst lakes. Belshi lakes represent beautiful tourist spot. The deep picturesque lake and many depressions are formed in Kardhiqi Diaper.

Karst springs, usually are formed along deep faults in contacts between carbonate rocks and terrigenous flysch and mollase formations. In some cases they are of beautiful view such as: "Blue Eyes" aesthetic spring getting up 45 m. through deep vertical karst cave, Kelcyra, Tepelena, Tragjasi, Bogova and many others cold water springs.

Karst caves formed as result of seawater activity. Seawater karst caves are formed in Ionian rocky seaside. Such caves are formed in Himara and Dhermi (Pirate caves) and in Karaborun peninsula, south of Vlora etc.

In most cases, karst phenomena are combined with erosion and glacial ones. In that manner there are formed complex **erosion-karstic** and **glacio-karstic** geological sites. Such complex geotops are formed in Albanian Alps, in Korabi and Lura highlands, in Kurveleshi Plateau, in Tomorr-Kulmaka chain, where are formed beautiful glacio-karst valleys, lakes, many high severe canyons etc.

Below there is presented the list of karst geotops in Albania.

I.Karst caves.

a. Of local importance

1. "Black cave" (in Albanian Alps)
2. Drela cave
3. Kllogjen cave
4. Debora ("Snow") cave
5. Gurra cave
6. Boga cave
7. Kakveri cave
8. Brovnik cave
9. Shpanik cave
10. Zhyla cave
11. Mbilqethi cave
12. Merkurthi cave (well)
13. Terova cave (Ujanik)
14. Trenit cave (Small Prespa lake)
15. Piro Goshi cave
16. Daci cave
17. Radhima cave
18. Dragani-Progonat cave
19. Gusmari (large deep well) cave
20. Maja Molles (wells) caves
21. Mazhar cave
22. Mezhgoran cave
23. Dragoti cave
24. Duk Gjoni cave
25. Vrima e Ariut ("Bear's Hole") cave
26. Osmani cave Shkoder–Tarabosh
27. Cukali cave
28. Kolika cave
29 Kaurri cave

b. Of national importance

30. Gajtani cave
31. Valiu cave
32. Zall-Dajti caves
33. Velŋa cave
34. Poŋemi cave
35. Benja ("Dove's cave)
36. Kolonja cave

II. Seawater karst caves ***(local importance)***

c. Of international importance

37. Skotini cave
38. Hajupi cave
39. Xoxa cave
40. Qafa e Priftit cave
41. Jubani cave
42. Black cave" (Erzeni-Tirana river)
43. Xara cave
44. Dove's cave (Saranda-Berdenesh) cave
45. Haxhi Alia (Karaborun) cave
46. Gjon Gjileka (Karaborun) cave
47. Pirate's cave Himara
48. Pirates cave Dhermi

III. Karst valleys, fields, holes, slopes, ridges

a. Of local importance

49 Rovena karst slope
50 Ragami karst field
51. Graca and Sopa karst fields
52. "Black Field" karst slope
53. Krekeza karst field
54. Kopliku karst field
55. Paruni karst field
56. Arni karst field
57. Merkurthi karst field
58. Miraka karst field
59. Qarrishta karst field
60. Mali Thate (Dry Mountain) karst field
61. Lekdush-Golem Mountain karst field
62. Zagora karst field
63. Kusha karst field
64. Veleŋik-Bridash karst slope
65. Vrini karst field
66. Mekzeza-Liqethi karst field
67. Vila karst field
68. Bjeshket e Oroshit karst field
69. Krej-Lura karst field
70. Munella karst field
71. Klenja karst field
72. Prespa karst field
73. Maja e Pusit karst field
74. Poliŋan-Zagori karst field
75. Vumlo karst field
76. Shushica karst field

77. Vali Vunoit karst field
78. Rovena karst field

b. Of national importance
79. Biza karst field
80.Tomorr-Kulmaka karst field

c. Of international importance
81. Studa karst field
82. Vanova karst field
b. Of international importance)
87. Belshi karstic lakes

83. Mali me Gropa (Mountain of Holes) karstic field
Karstic lakes

a. Of national importance
84. Kalcoi lake
85.Poroska-Seferan lakes
86. Hana-Merhoja lakes.

CONCLUSIONS

- Albania is one of the most karst-developed countries in Europe.
- Karst is developed mainly in carbonate and evaporates rocks.
- There are formed surface, underground and deep karst phenomena.
- The most widespread karst forms in carbonate rocks there are valleys, caves, cones, deeps, plains, holes, while in salt rocks there are formed many karstic lakes and depressions.
- Some of karst forms represent geological sites. They are nice aesthetic landscapes of geoscientific, education-didactical and geotourist values.
- In The First Inventory of Geological Sites of Albania there are selected 83 geotops of karst origin categorized in local, district, national and international importance.
- The karst activity in Albanian territory is most favorable for the assessment of karst industrial works.
- We recommend to undertake new projects on evidencing and exploration of karst caves, on geological-geomorphologic mapping and exploration of glacio-karst phenomena in Albanian Alps, in Korabi Highland, in Kurveleshi Plateau etc., and studies on underground karstic water basins and their dynamics etc.

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