The “Selinitza-Drakos” coastal karstic system in the Messinian Mani Peninsula (southwestern Greece) in relation to the terrestrial geoenvironment

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Abstract. The studied coastal karstic system comprises “Selinitza” Cave and “Drakos” Underground River. It is located in southwestern Greece across the western coastline of the Messinian Mani Peninsula. It is developed into limestones of Upper Senonian to Upper Eocene age belonging to the Mani geotectonic unit. “Selinitza” is mainly developed above the sea level, whereas “Drakos” is under water down to -48 m. These two caves are now connected through a 28-m long narrow passage at depth of -28 m, thus creating a united karstic system. Both caves were initially separate and terrestrial. Today, the majority of cave passages of “Selinitza” are terrestrial. In “Selinitza-Drakos” karstic system, sequential karstification base levels have been identified. These levels determined the karstic system development. “Selinitza” passages are phreatic and vadose, whereas “Drakos” passages are only phreatic, acting as lifting tubes. The passage network of both caves presents dendritic pattern and comprises the hydrological equivalent of the surface drainage network. To the east of the karstic system, karst margin plains are present comprising karstified tectonic terraces, whereas above the “Selinitza-Drakos” system manmade terraces exist for agricultural purposes.

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Key words: “Selinitza” cave, “Drakos” Underground River, terrestrial, hydrological equivalent network, speleomorphology.

INTRODUCTION

The studied “Selinitza-Drakos” coastal karstic system is located in southwestern Greece, at the western coast of the Messinian Mani Peninsula, 46 km southeast of Kalamata city, in western Mani municipality. It comprises the cave of “Selinitza” and the underground river of “Drakos” (Papadopoulou-Vrynioti, 1999, 2002). Both karstic forms are located at the coastline: “Selinitza” – at 1 km south of Agios Dimitrios village, and “Drakos” – at 500 m south of “Selinitza”. The entrance of “Selinitza” is located at 10 m above the sea level and “Drakos” is accessible only underwater.

This study aims at clarifying the relation between “Selinitza-Drakos” underground coastal karstic system and the terrestrial geoenvironment.

GEOLOGY

This karstic system is developed into typical white-grey to white, medium-bedded platy semi-crystalline limestones of Upper Senonian to Upper Eocene age, 300–500 m thick, belonging to the Mani (Plattenkalk) geotectonic unit (Fig. 1). In wider area, slightly metamorphic flysch of Upper Eocene – Oligocene age and silicate schists of Lower – Middle Jurassic age occur stratigraphically above the Upper Senonian – Upper Eocene limestones. Pantokrator limestones of Middle Triassic – Lower Jurassic age crop out at the lower stratigraphic level of Mani Unit (Papanikolaou et al., 1990). Post-Alpine Late Cenozoic clastic deposits, Pliocene marine marls and Pleistocene clays are observed in unconformity along the coastal zone (Kelletat

and Gassert, 1975). Late Pleistocene and Holocene fans cover the plain areas.

The tectonics of the studied area is represented by faults of NNW–SSE orientation and minor E–W orientation, mainly formed during the Miocene (Mariolakos et al., 1985) which affected the whole Mani Peninsula. Since the Middle Pleistocene, the stresses in the area are being reversed to extensional with WNW–ESE direction.

GEOMORPHOLOGY

Karst margin plains were recognized during the field-work in the wider area of the caves. They are located between 160–200 m and 200–240 m (Fig. 2), developed on the Upper Senonian – Upper Eocene limestones. Post-Miocene karst margin plains were developed south of the studied area (Stocker, 1976). Karst margin plains consti-

Fig. 1. Geological map of the studied area (IGME, 1983) modified

tute karstified tectonic terraces therefore they reflect the uplift of the area.

Manmade anthropogenic terraces were recognized above the caves. They are constructed at altitudes of 200–220 m and comprise also artificial agricultural fields for the olive tree cultivation.

The drainage network is of dendritic type north of “Selinitza” and south of “Drakos”. It is represented mainly by small drainage branches of 1st, 2nd and 3rd classes. The biggest streams are “Stepenitsa” Stream north of Agios Dimitrios and “Vathy Lagadi” Stream south of Trachila. According to Strahler’s scale “Stepenitsa” is

Fig. 2. Topographic map of the studied area with the karst margin plains and drainage networks

a 5th class stream (Fig. 2) and “Vathi Lagadi” is a 4th class stream.

Based on the rose diagrams of drainage network branch directions (Fig. 3, Tables 1 and 2) in the studied area, we conclude that the drainage network branches to the north of “Selinita” are developed mainly in NW–SE, NNW–SSE and E–W directions. On the contrary, south of “Drakos” these branches are mainly of NE–SW to E–W directions.

Notable are the Holocene alluvial fans in “Stepenitsa” Stream. These fans have been created due to fault activity of NW – SE direction which was recognized during the fieldwork.

SPELEOMORPHOLOGY

The underground river of “Drakos” has length of about 1232 m and is composed of three levels (Fig. 4). The development of “Drakos” begins some centimeters above the sea level reaching depth of –48 m. The first level appears with limited speleothematic decoration. The beginning of the cave represents a room with dimensions 50 m × 100 m which has two entrances, 10 m and 6 m wide, respectively. At the eastern entrance of “Drakos” Underground River

Table 1

Drainage network directions, north of Selinita in degrees (203 datasets)

300	286	246	220	182	126	317	336
300	322	174	168	290	142	272	36
272	234	180	262	320	220	264	336
270	336	180	257	232	210	270	42
279	340	186	198	217	222	204	40
274	290	216	111	190	232	268	96
280	326	164	80	232	227	343	352
168	322	164	90	252	221	334	281
146	354	234	6	270	154	352	306
140	278	216	60	200	190	310	348
100	172	220	350	228	180	278	344
52	166	216	64	278	164	290	346
100	148	136	17	224	125	326	304
106	153	220	24	190	160	330	30
94	162	115	348	252	224	46	352
58	163	118	338	216	168	75	48
114	110	108	324	216	178	92	354
88	142	156	320	190	224	102	343
138	258	216	342	274	174	170	28
244	258	0

Fig. 3. Rose diagrams of network development directions and cave passage directions

Table 2
Drainage network directions, south of Drakos in degrees
(112 datasets)

277	252	197	200	288	300	176	274
254	272	220	264	334	330	272	216
236	290	220	270	247	272	308	316
246	220	282	310	202	300	264	274
280	186	210	154	237	334	250	146
244	217	184	172	264	316	133	130
250	188	262	246	250	340	166	150
212	230	284	200	258	316	194	202
300	184	250	215	210	286	172	150
220	214	212	180	216	232	240	234
294	226	200	150	180	292	200	210
298	236	204	124	262	316	244	176
252	256	180	192	324	298	205	170
288	330	220	302	238	262	302	276

there is a big stalagmite. Only part of this room is above the sea level. The length is almost 400 m. The first and the second levels are connected through a chimney-shaped fissure, 13 m high, which reaches depth of –18 m. This chimney occurs 100 m away from the “Drakos” entrance.

The length of the second level is about 281 m and it connects with the third level through a chimney-shaped fissure, too. In the second level, the presence of speleothematic material is restricted.

The third level is the deepest part of the underground river where the connection point between “Selinitza” cave and “Drakos” Underground River is located (Koryllos et al., 2004). This point lies at depth of –28 m (Fig. 4) in a room which is actually transverse to the main passageway. There, through a narrow vertical chimney-shaped passage, 28-m long, one passes into the cave of “Selinitza”. The total length of this level is approximately 551 m.

The development altitudes of the above mentioned levels correspond to sequential karstification base levels,

Fig. 4. Simplified exaggerated section of “Drakos” with the three levels after Crossley (1985) modified by Kampolis and schematic view of the composite “Selinitza-Drakos” karstic system

Fig. 5. Mapping of "Selimitsa" cave (Avagianos et al., 1978) modified by Kampolis. Ground plan of "Selimitsa" cave with the main directions of development (continuous line) and the secondary ones (dotted line)

the oldest among them lying at depth of -48 m. This process was probably related to the sea-level changes during the Holocene (Lambeck, 1995).

“Selinitza” cave (Fig. 5) has a total length of about 3 km and recovers fabulous speleothematic decoration. Its largest part extends mostly above the sea level and

only a relatively small part of it (approximately 1000 m) appears flooded. Via this part, water is discharged towards the “Drakos” Underground River. “Selinitza” is famous with the largest uniform hall in Greece, with dimensions 250 m × 200 m of the main axes but without speleothematic decoration due to sequential colapses.

Fig. 6. Mapping of “Drakos” Underground River (Koryllos et al. 2004) modified by Kampolis. Ground plan of the underground river of “Drakos” with the main directions of development (continuous line) and the secondary ones (dotted line). Survey: Koryllos et al., 2004

The passages of this coastal karstic system are vadose and phreatic in “Selinitza” and exclusively phreatic in “Drakos”. “Drakos” siphons act as lifting tubes, transferring water from “Selinitza”, from depths of –28 m up to –10 m. The passage network of this karstic system belongs to the dendritic type of underground karst forms (Fig. 4), while this network diverges to the upward direction.

Analysis of “Selinitza” mapping (Fig. 5) in relation to the rose diagrams of its cave passage directions (Fig. 3, Table 3) shows that the larger part of passageway development is of NW orientation, and small sections – of E-W direction. The main axis of the big hall in “Selinitza” is of NW-SE and E-W orientation. The part of “Selinitza” where the connection passage with “Drakos” exists appears to be of NE-SW orientation. Additionally, short passageways are developed along N–S directions. The majority of “Drakos” passages are of N30°E, N32°E orientation and only a small part of them – of N98° orientation (Fig. 6, Table 4).

By comparison of the rose diagrams of the branch development directions of the surface network north of “Selinitza” and south of “Drakos” with the rose diagrams of the cave passage directions in “Selinitza” and “Drakos” (Fig. 4, Tables 1–4), it has been concluded that

Table 3
Selinitza passage directions in degrees (122 datasets)

0	130	135	311	90	6	232	336
100	144	80	296	40	358	98	314
82	118	120	232	98	352	162	300
18	92	90	318	63	350	128	35
72	180	170	290	90	348	90	276
2	120	135	334	5	275	140	248
25	32	75	338	108	270	28	270
64	142	170	306	38	256	80	284
22	266	50	300	90	270	322	317
335	0	160	288	190	4	356	330
0	22	108	250	120	350	152	356
60	348	154	278	70	270	98	19
0	10	122	317	100	255	85	52
129	7	154	330	165	334	352	312
352	0	128	326	112	314	96	220
166	340						

Table 4
Drakos passage directions in degrees (95 datasets)

0	190	285	335	50	340	220	190
50	180	240	335	60	355	190	240
50	210	235	340	60	15	200	250
60	220	265	320	80	325	170	260
20	330	230	315	75	270	270	240
20	275	260	5	60	300	230	190
5	245	270	5	60	330	230	230
355	280	270	250	5	355	60	240
0	220	270	270	10	0	330	30
10	265	280	190	315	0	210	220
30	245	230	240	50	0	220	260
50	200	225	230	335	60	0	

both branches and cave passages follow the same directions. Consequently, the specific dendritic caves are the underground hydrologic equivalent of the surface dendritic networks of the studied area.

CONCLUSIONS

The coastal cave of “Selinitza” and the “Drakos” Underground River were initially terrestrial as it is ascertained by the existence of speleothematic material in both caves. The two caves were primarily separate. They were connected into uniform karstic system in recent geologic times as their connection point is only a narrow chimney-shaped passage, its width corresponding to younger karstification base level.

The levels and the observed widening in the two caves correspond to sequential karstification base levels.

The underground karstic system of “Selinitza-Drakos” represents underground hydrological equivalent of the surface drainage network as both belong to the dendritic type and the development directions of cave passages are the same with the drainage branch directions of the surface network.

Karst margin plains east of this karstic system comprise karstified tectonic terraces and display the tectonic uplift in the area. The sequential scalable and plain surfaces above this karstic system comprise anthropogenic cultivation terraces. Alluvial fans of the “Stepenitsa” Stream are being formed due to regional tectonic activity.

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