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IDENTIFICATION AND ASSESSMENT OF CRETAN GEOTOPES

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Abstract

This study presents the first complete list of the most important geological features and landforms of Crete. Identification of geotopes and collection of data were based on earlier publications and similar efforts, search in existing scientific literature and field observations. A database was formed containing the overall documentation of each geotope, on which evaluation was afterwards implemented. Worldwide tested methodologies were used for the recognition of the importance and value for each geotope, as well as, the identification of possible threats and future perspectives for local economic and scientific development. About 132 geotopes were recognized for their national or regional importance, their representativeness for the interpretation of Cretan geology and impact on natural ecosystems and local culture. The majority of these geotopes are of high scientific and aesthetic value serving in our days tourist and scientific/educational purposes. Generally no serious threats or dangers have been recognized, except of few caves where the impact of massive tourism is serious. These results set a minimum base for the conservation and enhancement of Cretan earth heritage, that should be followed by nationally based actions for further recognition and legal protection of our geodiversity.

Key words: *Geotopes, geodiversity, earth heritage, geoconservation, Crete.*

Περίληψη

Η εργασία αυτή αποτελεί μια πλήρη καταγραφή των πιο σημαντικών γεωτόπων της Κρήτης που βασίστηκε στην αποδελτίωση της υπάρχουσας βιβλιογραφίας και προηγούμενων προσπαθειών και στη συλλογή στοιχείων υπαίθρου. Ακολούθως δημιουργήθηκε μια βάση δεδομένων με την τεκμηρίωση των γεωτόπων στην οποία και στηρίχθηκε η προσπάθεια αξιολόγησής τους. Κατά το στάδιο αυτό χρησιμοποιήθηκαν διεθνώς αποδεκτές μεθοδολογίες ώστε για κάθε γεώτοπο να καθοριστεί η σπουδαιότητα, η αξία, οι ενδεχόμενες απειλές και η μελλοντική συνεισφορά τους στην ανάπτυξη της επιστήμης και των τοπικών κοινωνιών. Έτσι αναγνωρίστηκαν περίπου 132 γεώτοποι εθνικής ή περιφερειακής σπουδαιότητας, που είτε αντιπροσωπεύουν χαρακτηριστικές θέσεις για τη γεωλογία της Κρήτης, είτε έχουν μεγάλη αξία για οικοσυστήματα ή τον πολιτισμό. Η αξία των περισσότερων από αυτούς είναι κυρίως επιστημονική/εκπαιδευτική ή αισθητική, ενώ δεν αναγνωρίστηκαν σημαντικές απειλές για την

πλειονότητα τους, εκτός από την επίδραση του τουρισμού σε μερικούς σπήλαια. Τα αποτελέσματα της προσπάθειας αυτής σε συνδυασμό με μια αλλαγή στάσης σε εθνικό επίπεδο μπορεί να αποτελέσουν την απαρχή για τη διατήρηση και την ανάδειξη της γεωλογικής κληρονομιάς της Κρήτης.
Λέξεις κλειδιά: *Γεώτοποι, γεωποικιλότητα, γεωλογική κληρονομιά, γεωδιατήρηση, Κρήτη.*

1. Introduction

The geological environments are commonly regarded by geologists as sites with only scientific or economic importance. However, their involvement in the environment of the Earth is as vital as other important resources, like water or oxygen. Not only plants and animals are directly dependent on the geological foundation, but also humans are affected by the surrounding geological environment (Fassoulas 2001). Landscape, rocks and soils not only provide elements and raw materials for our economy, but also affect significantly human temper and culture.

Ancient Greek civilizations are some of the most outstanding examples of how natural and geological phenomena have been part of human history and culture. Greek mythology offers some relevant examples presented earlier by Mariolakos (2001). The great cataclysm in the Bible is another international example of a past geological process that had an enormous effect on the human history (Ryan and Pitman, 2000). It is thus apparent that the geological environment of an area is part of its heritage; it's the so-called geological or earth heritage (Gray 2004).

The pure geological context of the earth heritage of an area is usually referred as geodiversity. The term geodiversity was recently induced in the international literature in an effort to describe, in the same way that biodiversity does, the wide natural range (diversity) of geologic (rocks minerals, fossils), geomorphologic (landform processes) and soil features, including their assemblages, relationships, properties, interrelations and systems (Gray 2004). Although abiotic environment is one of the main parameters of nature, the degree of its conservation globally is much lower compared to biodiversity. Many international nature conservation organisations used the term "nature conservation" to refer mainly to the "wild life" conservation, focusing most of their attention on the latter (Milton 2002). However, geological and geomorphologic conservation efforts in Europe, Australia and other places worldwide started about a century ago focusing either on landforms and geological formations or on structures that occur in certain geological sites (Gray 2004). This has led to the recognition of the geosites or geotopes (the term that comes from the ancient Greek words *γαία=geo* and *τόπος=tope=site*, which we shall use in concordance with the ecotopes) that constitute the geodiversity of an area.

Therefore, it is crucial for a territory to identify its geological heritage and recognize its indubitable value. This article deals with the wealthy geodiversity of Crete island in the south Aegean (Fig. 1). It presents the identification and assessment of the most important geotopes of the island, as well as some thoughts for their conservation and enhancement.

2. Conserving and Assessing geodiversity

2.1. Assessing geodiversity's value

The question that arose decades ago, why we should conserve biodiversity and nature in general, is the starting point to discuss the possible or real value of geodiversity. Furthermore, nowadays it is clearly demonstrated (Ellis *et al.* 1996) that: natural landforms create the environments within which the diverse flora and fauna live; rocks provide the soil and influence the drainage conditions of biological habitats; biological and geological forms and functions are inextricably linked to create a series of natural ecosystems of immense richness and diversity.

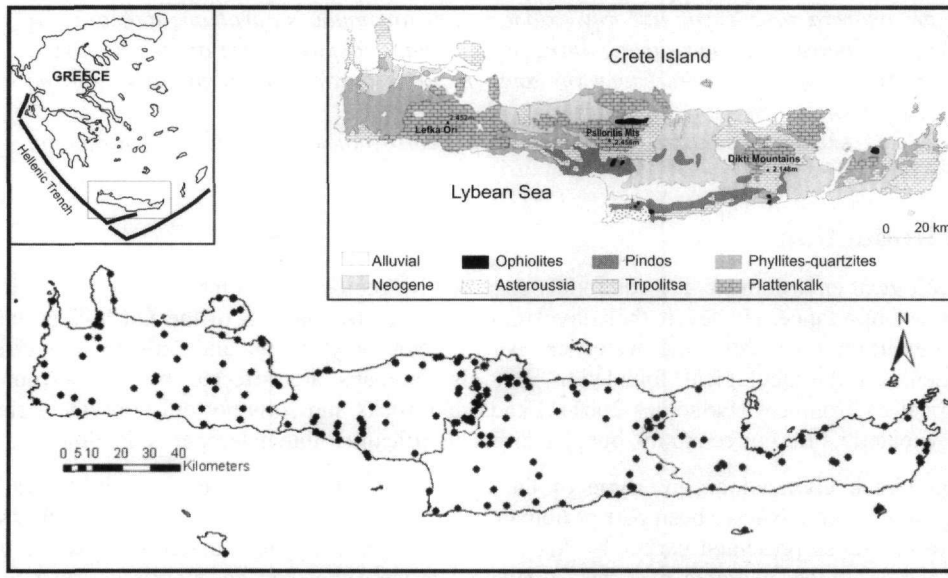


Figure 1 - Distribution of considered geotopes in the four Cretan prefectures. In the embedded figures a general geological map of cretan nappes based on Creutzburg *et al.* (1977) and the location of study area

Hence, the determination of geodiversity's value in a territory assigns its degree and importance as an economic resource. Although the value of nature or the rationale of nature conservation was studied by many organizations and scientists (see Nature Conservancy Council 1984 and Constanza *et al.* 1997), the way to value geodiversity has recently been outlined (Ellis *et al.* 1996). Several approaches have been presented in the literature, however, the most comprehensive and expanded one (Gray 2004) classifies the value of each geotope into six groups: intrinsic or existent; cultural; aesthetic; economic; functional; and research or educational one. This value can further demonstrate the international significance, the exceptional nature, the representativeness of features and the contribution to environmental forecasting for each geotope.

In Greece, only a few studies focused on the assessment of geological heritage have been implemented till now and these are related with the management of the two European and UNESCO Global Geoparks of Greece (Fassoulas and Skoula 2006, Zouros 2005).

2.2. Conservation practices

Many examples can be presented for a successful recognition and conservation of the geological heritage around the world. The English Nature, the Countryside Council of Wales and the Scottish Natural Heritage have contacted since 1990 a project for the inventory and assessment of British geological heritage (Ellis *et al.* 1996). In England it resulted into the designation of about 500 areas as Sites of Special Scientific Interest (SSSI) and much more as Regionally Important Geological/Geomorphological Sites (RIGS), managed and conserved under the special Geodiversity Action Plans (English Nature *et al.* 2003).

International organisations such as the International Union for the Conservation of Nature (IUCN), UNESCO and the International Union of Geo-Sciences (IUGS) have established certain projects to include geodiversity to their nature conservation policies. More specifically, UNESCO presented an initiative called *Geoparks* to enhance the value of nationally important geological sites, while IUGS together with UNESCO established in 1995, the project *Geosites* to compile a global list of the world's most important geological sites. The latter has recently resulted in a list of the most important geological sites of south-eastern Europe (Theodosiou-Drandaki *et al.* 2004).

A new initiative, the *European Geoparks Network*, was created in 2000 through the LEADER program by four European territories (Spain, France, Germany and Greece) and was immediately put under the auspices of UNESCO and later was accepted by the organisation as a model for the other continents. The initiative aims to manage both abiotic and living nature, including cultural heritage, in certain European territories in order to achieve high standards of conservation, promotion and finally true economic development (Zouros and Martini 2003). Two territories from Greece, Lesvos Petrified Forest and Psiloritis Natural Park in Crete are currently members of this network.

Despite all this progress on the conservation of geological heritage worldwide, in Greece the existing legislation for the conservation of Nature actually do not permit any recognition and further conservation of geotopes (Fassoulas 2004). The only geological monument protected by law is the Lesvos Petrified Forest, whereas other monuments such as Olympus Mt or Samaria Gorge are protected as National Parks because of their ecologic value (Zouros and Fassoulas 2006). Meteora in Thessaly, on the other hand, are included in UNESCO's World Heritage List but only as a cultural monument due to the monasteries. Furthermore, funding of geo-conservation under National or European funds is impossible, because only the living and human environment is regarded as Nature!

However, several studies have been published to catalogue and promote geological heritage of Greece. The most comprehensive are the Atlas of Geological Monuments of Aegean (Mountrakis *et al.* 2002) and the Natural Monuments of Greece (Bornovas, 1999), whereas several others are focused on smaller regions or territories (Ewing-Rassios 2004, Fassoulas 2000, Zouros 2000)

3. Materials and Methods

3.1. Identification and monitoring of Cretan geotopes

A first attempt to identify and map Cretan geotopes was undertaken by the Natural History Museum of Crete in 2000 (Fassoulas 2000). During that study more than 48 geotopes were recognised and described, whereas some of those were later listed in the Atlas of Geological Monuments of Aegean (Mountrakis *et al.* 2002), while, the most important of those were also included in the IUGS "*Geosites project*" inventory (Theodosiou-Drandaki *et al.* 2004). Using that study as a starting point we have re-explored the island of Crete to identify and map new geotopes, re-filtered the existing literature for geological formations and palaeontological sites, and discussed further with local authorities and inhabitants. Useful tools in this effort were the published field guides (Kuss 1980, Meulekamp *et al.* 1979, Papanikolaou 1988), the reports and lists of karstic features (Faure, 1996, Platakis, 1975) and other synthetic publications (Bornovas 1999). Furthermore, for central Crete the database of Psiloritis European Geopark was also used (Fassoulas and Skoula 2006).

For each site we collected geographical information, data about the nature and character of the site, geological and literature descriptions, environmental issues, human activities in the broader areas (which refer to traffic for the case of neighbouring with highways or heavy traffic roads; tourism for all touristic activities; watering for water supply and irrigation purposes; agriculture for pasturing or cultivations; mining for occurrence of active quarries etc.; or sports for hiking, and other extreme sport activities) and any other related information. Data were documented and stored in a database and were later categorized into several main categories according to their nature and character; i.e. Landforms, Lithologies, Faults, Folds, Caves and Karst, Fossil sites, Hydrology and Mining features (Figs 2a-d).

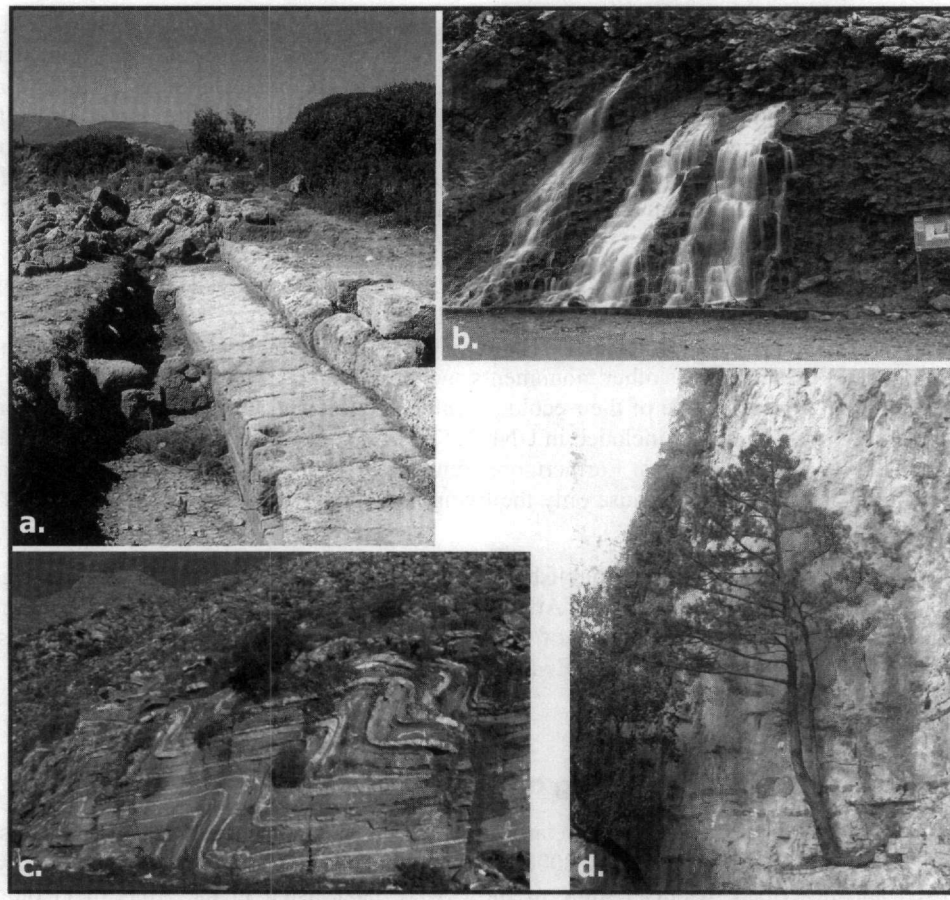


Figure 2 - a. Ancient Falasarna harbour at the western coast risen about 6 meters over present sea level; b. Part of the Talea Ori stratigraphic section in Rethymno with a seasonal karstic spring in stormatolitic dolomite of Plattenkalk nappe and an information panel of Psiloritis Geopark; c. Vossakos fold succession in plattenkalk in Vossakos area, Rethymno; d. Imbros gorge in Hania with rich flora

This inventory finally resulted into the identification of about 195 geotopes all over Crete and the surrounding small islands (Fig. 1). These do not include all the known gorges or karstic structures of the island, which are abundant (Fassoulas *et al.* 2004, Platakis 1975).

Hence, only the most scientifically important and beautiful gorges, karstic depressions and caves are included in the list. It is worth mentioning that in Crete more than 6,000 caves and other karstic depressions have been recognised till now (Paragamian, unpublished data) and sufficient data for their condition and importance exist for nearly 800 of them. Earlier studies (Faure 1996, Platakis 1975, Schmalfuss *et al.* 2004, Sket *et al.* 2004) were used to filter this huge information and additional data collected. Finally, about 32 caves have been used for this study.

After a first evaluation only the most important geotopes are discussed here, comprising those of Regional and National value only. The list comprises about 132 geotopes, 39 of them located in Hania prefecture, 39 in Rethymno, 30 in Irakleio and 24 in Lasithi prefecture (Appendix I).

3.2. Assessment procedure

At a first level of assessment we classified the Cretan geotopes according to their overall importance in Local, Regional and National (Appendix I). Our evaluation of Cretan geotopes was

based on the criteria presented in earlier studies after their adaptation to the Cretan situation (Ellis *et al.* 1996, Zouros 2005).

Thus, the main criteria used were their importance for the national or even international earth scientists, their representativeness for the interpretation of Cretan geology, their exceptional nature, their impact to the local and larger community, their significance for existing educational activities and any other existing designations. For the identification of the importance primarily of the national and secondary for the regional geotopes, additional criteria, such as the minimum duplication of interest between geotopes and the possibility for conservation, were considered as well.

The different kinds of value of each geotope (Gray 2004) were then determined based on its contribution to the local development and scientific process, the activities that are related with it, the potential future activities, its interaction with the broader natural environment and its influence to the local history and culture. The value was assigned as Aesthetic (mainly for tourist purposes), Scientific (for the scientific and educational activities), Economic (for contributing to the local economy), Natural (for its role to the establishment of special environments) and Cultural (for their relation to history and culture).

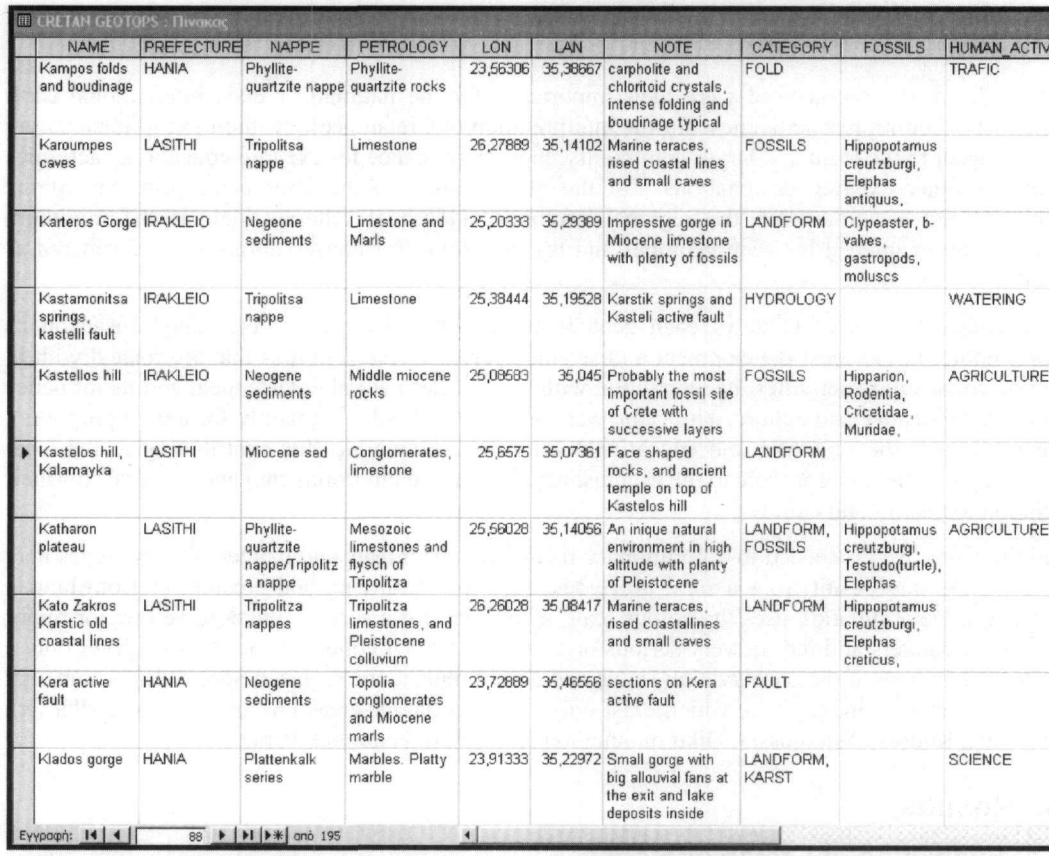
Additionally, we proceeded in a preliminary recognition of threats and dangers that geotopes may face. These may result from natural processes, such as weathering and erosion, or from human activities. Determination uses the colour scale with green for a secure situation, yellow for minor threats or dangers and red for very serious or direct threats. Of course this evaluation gives only a general overview of the conservation status and do not replace the required Special Environmental studies or management plans, which exist only for some larger areas (Agios Dikaios, Lefka Ori, Psiloritis, Kedros, Asteroussia, Dikti mountains) and Samaria National Park.

4. Results

4.1. Evaluation of Cretan geotopes

The above presented study resulted into the first complete database of Cretan geotopes hosted in the Natural History Museum of Crete Collections and Databases (Fig. 3). A first attempt for a rough assessment of the protection status of each geotope was also undertaken based in the collection of all the existing data and references. This assessment needs further improvement and re-examination under a wider reference level, combining all potential changes in conservation status and human activities in the surrounding areas, the planning policies of local and regional authorities, as well as the local development priorities. Such studies however, require time, political support and funding, issues that were out of the purposes and limitations of this study.

Nevertheless, it was revealed that from the approximately 195 Cretan geotopes and the abundant karstic features, 48 are at least of National importance (not excluding the case that some might be of international importance as well), 84 are of Regional importance and the rest of Local importance. Among the geotopes of National importance lie the well known Samaria Gorge and Vai palm valley, the three archaeological caves of Idaion and Diktaion Andro and Kamares, the Gourgouthakas, the deepest cave in Greece and among the list of the 30 deepest caves in the world, the Lassithi plateau, the exposure of Cretan detachment fault in Agios Fanourios, the Ierapetra active fault, the Agios Pavlos folds, the Asteroussia rocks, the Ravdoucha beds as the base of Tripolitsa nappe, the Talea Ori stratigraphic section (Fig. 2b) for the preservation of the whole Plattenkalk sequence, the well-preserved in metamorphic rocks Fodele fossils, the Makrilia paleoflora, the uplifted ancient harbour in Falassarna (Fig. 2a) and many others.



CRETAN GEOTOPS : Πίνακας

NAME	PREFECTURE	NAPPE	PETROLOGY	LON	LAN	NOTE	CATEGORY	FOSSILS	HUMAN_ACTIVT
Kampos folds and boudinage	HANIA	Phyllite-quartzite nappe	Phyllite-quartzite rocks	23,56306	35,38667	carpholite and chloritoid crystals, intense folding and boudinage typical	FOLD		TRAFIC
Karoumpes caves	LASITHI	Tripolitsa nappe	Limestone	26,27889	35,14102	Marine teraces, rised coastal lines and small caves	FOSSILS	Hippopotamus creutzburgi, Elephas antiquus,	
Karteros Gorge	IRAKLEIO	Negeone sediments	Limestone and Marls	25,20333	35,29389	Impressive gorge in Miocene limestone with plenty of fossils	LANDFORM	Clypeaster, b-valves, gastropods, moluscs	
Kastamonitsa springs, kastelli fault	IRAKLEIO	Tripolitsa nappe	Limestone	25,38444	35,19528	Karstik springs and Kasteli active fault	HYDROLOGY		WATERING
Kastellos hill	IRAKLEIO	Neogene sediments	Middle miocene rocks	25,08583	35,045	Probably the most important fossil site of Crete with successive layers	FOSSILS	Hipparion, Rodentia, Cricetidae, Muridae,	AGRICULTURE
Kastelos hill, Kalamayka	LASITHI	Miocene sed	Conglomerates, limestone	25,6575	35,07361	Face shaped rocks, and ancient temple on top of Kastelos hill	LANDFORM		
Katharon plateau	LASITHI	Phyllite-quartzite nappe/Tripolitza nappe	Mesozoic limestones and flysch of Tripolitza	25,56028	35,14056	An inique natural environment in high altitude with planty of Pleistocene	LANDFORM, FOSSILS	Hippopotamus creutzburgi, Testudo(turtle), Elephas	AGRICULTURE
Kato Zakros Karstic old coastal lines	LASITHI	Tripolitza nappes	Tripolitza limestones, and Pleistocene colluvium	26,26028	35,08417	Marine teraces, rised coastallines and small caves	LANDFORM	Hippopotamus creutzburgi, Elephas creticus,	
Kera active fault	HANIA	Neogene sediments	Topolia conglomerates and Miocene marls	23,72889	35,46556	sections on Kera active fault	FAULT		
Klados gorge	HANIA	Plattenkalk series	Marbles. Platty marble	23,91333	35,22972	Small gorge with big allouvial fans at the exit and lake deposits inside	LANDFORM, KARST		SCIENCE

Εγγραφή: 88 από 195

Figure 3 - An example of the complete database created under this study for the documentation and evaluation of Cretan geotopes

Of Regional importance (Figs 4a-d) are the Ravdoucha mines, the Agia lake, Omalos and Katharo plateaus, Preveli and Klados gorges, Voulismeno Aloni doline, Sfentoni and Simonelli caves, Kalamayka's meteora (Fig. 4c), Lastros active fault, Kalavros beds, Psiloritis metaflysch, Pantanasa section etc.

The majority of these geotopes are in a secure condition as regard to the conservation and protection status. Many of these geotopes are inaccessible, isolated or far away from disturbing human activities. Thirty three of them however face conservation problems or protection threats that might change in worse in future. These are induced due to weathering and erosion processes, quarrying activities, exhaustion of natural resources, massive tourism and the accompanying problems that it causes. Two representative examples can be presented: the case of Agia Lake in Hania that was totally exhausted in 2005 due to overpumping, and the Samaria gorge that accepts about 2000 visitors per day in summer months increasing the possibility for forest fire and accelerating erosion. In some geotopes of local importance serious threats exist related in most cases with land movements at road cuts or coastal areas.

Additionally, caves are the most vulnerable geotopes as they are small areas with unique characteristics (fragile speleothems, unique populations of endemic animal species, bat colonies, archaeological and palaeontological findings) and in most cases suffer from disturbances imposed by uncontrolled human visitations, vandals, etc. Four caves, i.e. Diktaion Andon, Milatos, Agia Paraskevi and Labyrinthos are facing serious problems because of those reasons.

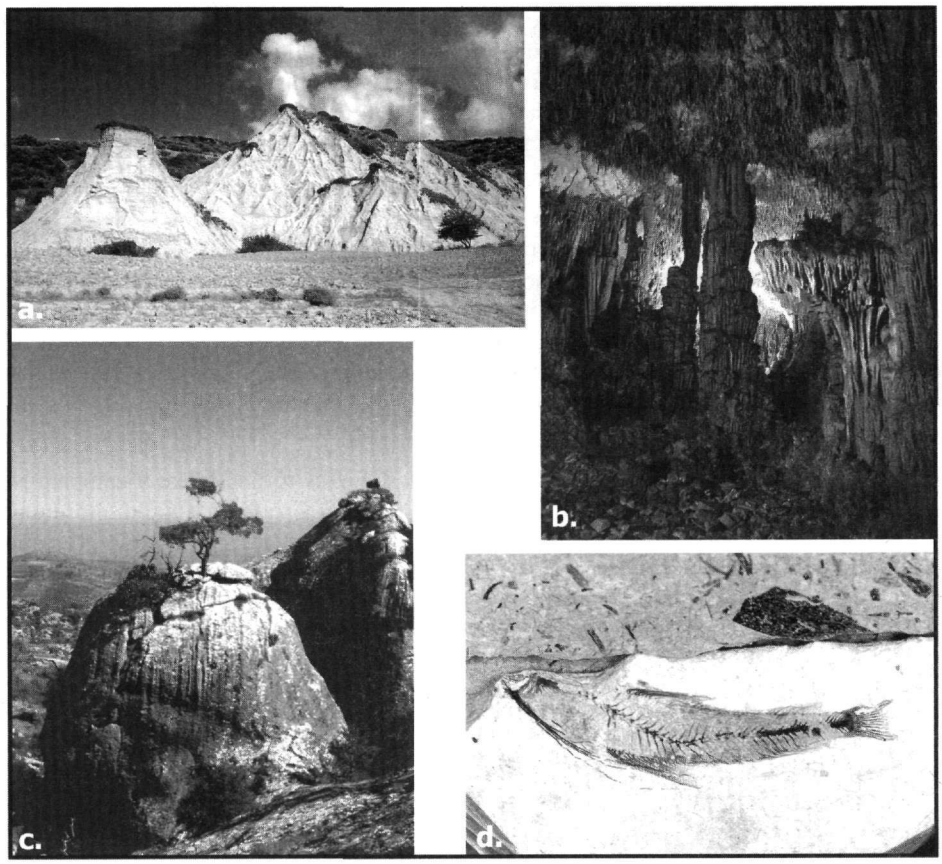


Figure 4. a. Potamida's "nunes" landform in siltstone in Hania prefecture; b. Arkalospilios cave in Rethymno; c. Meteora, made of Miocene breccia at Kalamayka area, Lasithi prefecture; d. Prassas' fossil site in diatomites in Irakleio

Finally, about 38% of the evaluated geotopes appear to have high aesthetic value that would enhance geo-and eco-touristic activities (Figs 2, 4). The same percent of geotopes have a high scientific/educational value and about 5% both scientific and aesthetic value. Several geotopes of high cultural value (as is the case of several caves) have also been recognised and few others are of natural/environmental or economic value.

4.2. Perspective

The Nobel poet laureate S. Heaney has emphasised that "…if chemistry tells us from what our Earth was made of and physics of how it was build, geology definitely tells us how it will be." (Parkes 2004). His words draw clearly a main reason why our earth heritage should be conserved; the ability that only geology among the other disciplines has to predict the evolution of physical processes. Hence, the individual or exceptional geological features should not only be protected for the benefit of natural ecosystems and future generations but also for the further development of science.

There is indeed a fascinating story to tell that is of profound relevance to the world recorded in rocks and landforms, however some chapters are still far from complete. It is thus vital that the important rocks and landforms must be protected in order to be able to provide the necessary scientific resource for future work, including the possibility to utilise new scientific techniques that have not been discovered yet (Ellis *et al.* 1996).

The identification of the existing geotopes in Crete as a whole area is the first step for the recognition of its earth heritage and additionally the determination of its geodiversity. The list of the Cretan geotopes presented in this article is the first complete attempt to recognise the geological heritage of the island. Although legislation and existing public ethics do not permit a legal protection for the geotopes, this effort probably can put the first stone for their conservation.

At a first level, the list presents the most important, from scientific and educational point of view, of the Cretan geotopes setting the base for their potential future protection and conservation. Besides, it offers the possibility to local authorities to identify their local geological heritage and encompass it in their plans, serving also for public awareness and sensitisation through a combination of activities. The examples of how the European Geoparks work for the protection and conservation of geological heritage through educational and geotouristic activities is a secure way to start. Globally gained experience offers tools for site protection, conservation measures and enhancement policies that are always necessary for the economic support of any initiative undertaken.

It is probably worthwhile the academic institutions or societies to undertake a campaign for the identification and evaluation of the most important geotopes of Greece that will build the base for a further legal recognition of our geological heritage and subsequent for their protection and conservation that is a necessity in Greece. As a model, the British example for the recognition of Sites of Special Scientific Interest can be used. Although the British case considered both bio- and geo-diversity, the already successful NATURE 2000 network has worked well with bio-diversity all over Europe, covering the case of living environment.

Furthermore, such an effort will strengthen and support the geoconservation initiatives in Greece, in the way that it can change the existing outlook of geodiversity in higher state level and authorities. It is essential to share funds for geodiversity too under the environmental or nature projects, in order to achieve a fundamental conservation and enhancement status for our earth heritage

5. Conclusions

Modern trends for the conservation of environment induce a holistic approach for nature protection based on the continuously manifested confirmation for the vital interactions of abiotic and living environments. Such an approach presumes the protection and conservation of geological foundation in each ecosystem and environment that additionally sets the prerequisite for the identification of geological environment. Complementary, it is broadly recognized that important geological features and landforms should be conserved to serve for future scientific research and utilization of new scientific methodologies, strengthening thus the ability that only geology has among other disciplines, to predict the development of natural processes.

This study focuses primarily on the identification of Cretan geotopes and secondary on the assessment of their value, facing threats and future perspectives, as a base for their recognition and further protection. Worldwide tested methodologies were used for the inventory and recording of the most important geological formations, structures and landforms of the island, as well as for their assessment. Elaboration of data resulted in the recognition of about 132 geotopes of regional and national importance that were further studied for their value and influence to the local environment and society.

The majority of the 48 nationally important geotopes have high scientific value and many of them an outstanding aesthetic appeal; whereas, several have a significant impact to local ecosystems and culture. Most of these geotopes do not face serious threats or danger, quite a few may face some threats in future, while three caves are already under serious threats, as a result of massive tourism and human activities. The rest geotopes are of regional importance for their representativeness for the interpretation of Cretan geology, for their contribution to local scientific, training or cultural

activities or for their impact to natural ecosystems. In this case, the majority of geotopes are of high scientific and aesthetic value, many of them have direct impact to local economy either through mining or touristic activities, while few of them are important for ecosystems and culture of the island. About 25 geotopes of central Crete constitute the Psiloritis Natural Park, the one of the two European and UNESCO Global geoparks of Greece.

This first attempt for a complete identification of Cretan geotopes is a minimum contribution for the recognition and protection of the earth heritage of the island. It serves however, as a useful tool for local authorities and scientific community, for a further development of geoconservation, increase of public awareness and sensitization and enhancement of our geodiversity. Further advance and action is required in national level to achieve higher recognition and better legal protection of our earth heritage.

6. Acknowledgments

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Appendix I. Detailed list and documentation of most important Cretan Geotopes (for discussion see text)

	Name	Prefecture	Lon	Lat	Category	Human Activities	Importance	Value	Conservation
1	**Nopigia aragonite marbles**	Hania	23.72139	35.51000	Lithology		National	S	Yellow
2	**Plakalona detachment**	Hania	23.73639	35.50417	Fault	Traffic	National	S	Green
3	**Ravdoucha beds**	Hania	23.73389	35.54111	Lithology		National	S	Green
4	**Ballos rised bay**	Hania	23.58861	35.58194	Landform	Tourism	National	S, A, N	Yellow
5	**Falassarna area**	Hania	23.56722	35.50917	Landform, Fault	Tourism	National	S, A, C	Green
6	**Triassic evaporites**	Hania	23.56750	35.35222	Lithology	Mining	National	S, E	Yellow
7	**Elaphonisi area**	Hania	23.54167	35.27167	Landform	Tourism	National	A, N	Yellow
8	**Akrotiri section**	Hania	24.16750	35.55444	Lithology		National	S	Green
9	**Kourna lake**	Hania	24.27528	35.33083	Hydrology	Watering, Tourism	National	A, E, N	Green
10	**Samaria Gorge**	Hania	23.96778	35.25528	Landform, Karst	Tourism	National	A, N	Yellow
11	**Gigilos Beds, Omalos**	Hania	23.91944	35.29139	Lithology		National	S, A	Green
12	**Gonies section***	Irakleio	24.92583	35.29528	Lithology, Fault	Science	National	S, A	Green
13	**Almiros Spring***	Irakleio	25.04667	35.33306	Hydrology	Watering	National	A, N, S, E	Yellow
14	**Lavyrinthos cave, Gortys**	Irakleio	24.89400	35.06500	Cave	Tourism	National	S, N, C, E	Red
15	**Asterousia Mts**	Irakleio	24.92944	34.95028	Lithology		National	S, A	Green
16	**Matala caves**	Irakleio	24.75000	34.99500	Landform		National	A, C	Green
17	**Fodele HP Fossils***	Irakleio	24.91889	35.38333	Fossils	Traffic	National	S	Green
18	**Kastellos hill**	Irakleio	25.08583	35.04500	Fossils	Agriculture	National	S	Green
19	**Arvi basalts and radiolarites**	Irakleio	25.37694	35.00722	Lithology		National	S	Green
20	**Lasithi plateau**	Lasithi	25.46306	35.19667	Landform	Agriculture, Tourism	National	A, E	Green
21	**Ha Gorge**	Lasithi	25.83444	35.08528	Karst, Fault	Watering	National	S, A	Green

	Name	Prefecture	Lon	Lat	Category	Human Activities	Importance	Value	Conservation
22	**Hercynian rocks**	Lasithi	25.95000	35.16583	Lithology	Traffic	National	S	Green
23	**Kato Zakros Karstic old coastal lines**	Lasithi	26.26028	35.08417	Landform		National	S, A, C	Green
24	**Diktaion Adron, Psyhro**	Lasithi	25.44500	35.16278	Cave	Tourism	National	A, S, N, E, C	Red
25	**Makrylia flora**	Lasithi	25.71306	35.06889	Fossils		National	S	Green
26	**Chrisi Island**	Lasithi	25.72000	34.87528	Landform	Tourism	National	A, N	Yellow
27	**Vai valey**	Lasithi	26.26389	35.25444	Landform	Tourism	National	A, N	Yellow
28	**Agios Fanourios detachment fault***	Rethymno	24.87417	35.21417	Fault		National	S, A	Green
29	**Idaion Andro**	Rethymno	24.82861	35.20833	Cave	Tourism, Science	National	S, N, C	Yellow
30	**Kamares cave***	Rethymno	24.82754	35.17730	Cave		National	A, S, N, C	Green
31	**Sfentoni Cave, Zoniana***	Rethymno	24.83861	35.29833	Cave	Tourism	National	A, S, N, E, C	Yellow
32	**Agios Pavlos Folds**	Rethymno	24.56222	35.10167	Fold	Tourism	National	A, S	Green
33	**Gerani caves**	Rethymno	24.40694	35.35889	Cave	Tourism, Science	National	A, S, N, C	Yellow
34	**Gerontospilios cave, Melidoni***	Rethymno	24.72944	35.38444	Cave	Tourism	National	A, S, N, C, E	Yellow
35	**Vossakos folds***	Rethymno	24.84611	35.35778	Fold		National	S, A	Green
36	**Talea Ori stratigraphic section***	Rethymno	24.89056	35.39278	Lithology		National	S, A	Green
37	**Spilaio Lera, Stavros**	Hania	24.10289	35.59025	Cave	Tourism	National	S, N, C	Yellow
38	**Spilaio Katholikoy**	Hania	24.14661	35.59025	Cave	Tourism	National	A, S, N, C	Yellow
39	**Tafkoura pothole**	Rethymno	24.85835	35.22222	Cave	Science	National	S, N	Green
40	**Spilaio Ilithiias, Elia**	Irakleio	25.23033	35.3301	Cave	Science	National	A, S, N, C	Green
41	**Agia Paraskevi cave, Skoteino**	Irakleio	25.29749	35.30488	Cave	Tourism	National	A, S, N, E, C	Red
42	**Sykias Spilios, Zakros**	Lasithi	26.27803	35.11966	Cave	Tourism, Science	National	A, S, N, E, C	Yellow
43	**Trapeza cave, Tylisos**	Irakleio	24.00122	35.31013	Cave	Science	National	A, S, N, C	Green
44	**Prinos Cave**	Rethymno	24.64587	35.39129	Cave		National	A, S, N, C	Green
45	**Zoure cave, Azogyre**	Hania	23.70946	35.27168	Cave	Tourism	National	C	Yellow
46	**Skourdoulakia cave, Asfentou**	Hania	24.17692	35.25064	Cave		National	S, C	Green
47	**Mavro Skiadi pothole, Melidoni**	Hania	24.07492	35.33576	Cave	Science	National	S, N	Green
48	**Gourgouthakas potohole**	Hania	24.08436	35.33465	Cave	Science	National	S, N	Green
49	**Kera active fault**	Hania	23.72889	35.46556	Fault		Regional	S	Green

	Name	Prefecture	Lon	Lat	Category	Human Activities	Importance	Value	Conservation
50	**Topolia gorge**	Hania	23.68167	35.41083	Landform	Traffic	Regional	S, A	Green
51	**Ravdoucha Mines**	Hania	23.73083	35.52667	Lithology		Regional	S, C	Green
52	**Kampos folds and boudinage**	Hania	23.56306	35.38667	Fold	Traffic	Regional	S	Yellow
53	**Agioi Theodoroi boudinage museum**	Hania	23.61500	35.29222	Fault, Fold		Regional	S	Green
54	**Voutas detachment**	Hania	23.65583	35.28333	Fault	Traffic	Regional	S	Green
55	**Rodakino gorge**	Hania	24.31417	35.20167	Fault, Landform	Traffic	Regional	S, A	Green
56	**Koundoura Paleorivages**	Hania	23.66735	35.23804	Landform		Regional	S	Green
57	**Agia Spring**	Hania	23.93194	35.47694	Hydrology	Watering	Regional	E, N	Yellow
58	**Therissos Gorge**	Hania	23.99639	35.44278	Landform	Tourism	Regional	A, N	Green
59	**Therissos Blueschists**	Hania	23.97417	35.40278	Lithology		Regional	S	Green
60	**Vrysses paleoflora**	Hania	24.20083	35.36278	Fossils	Mining	Regional	S	Yellow
61	**Imbros Gorge**	Hania	24.16639	35.21500	Karst	Tourism	Regional	A	Green
62	**Askifou Plateau**	Hania	24.18250	35.29222	Landform	Agriculture	Regional	A, E	Green
63	**Aradaina Gorge**	Hania	24.05500	35.20194	Karst	Tourism, Science	Regional	A	Green
64	**Agia Irini Gorge**	Hania	23.83944	35.31167	Landform	Tourism	Regional	A, N	Green
65	**Klados gorge**	Hania	23.91333	35.22972	Landform, Karst	Science	Regional	S, A	Green
66	**Omalos Plateau**	Hania	23.90556	35.33361	Karst	Agriculture, Tourism	Regional	A, N	Green
67	**Leyka Ori Desert and Craters**	Hania	24.09056	35.30944	Karst		Regional	S, A	Green
68	**Zaros spring***	Irakleio	24.91222	35.13917	Hydrology	Watering, Tourism	Regional	A, E	Green
69	**Marathos detachment***	Irakleio	24.98306	35.34528	Fault	Science	Regional	S	Green
70	**Voulismeno Aloni***	Irakleio	25.01778	35.32972	Karst	Science	Regional	S, A	Green
71	**Rouvas forest and Ag. Antonios Gorge***	Irakleio	24.90972	35.16722	Landform	Tourism, Science	Regional	A, N	Green
72	**Aidonochori Karst***	Irakleio	24.89861	35.31333	Karst	Agriculture	Regional	A, S	Green
73	**Sculpures of Nature, Chonos***	Irakleio	24.89222	35.32833	Karst		Regional	A, S	Green
74	**Messara basin, asteroussia klippens**	Irakleio	24.94722	35.00278	Landform	Agriculture, Tourism	Regional	A, S	Green
75	**Fournofaraggo fault**	Irakleio	25.04000	34.99139	Fault		Regional	S, A	Green
76	**Agia Galini Conglomerates**	Irakleio	24.70583	35.11194	Lithology		Regional	S	Green
77	**Giouchtas horst**	Irakleio	25.14444	35.24000	Fault		Regional	S, A, C	Green
78	**Apostoli area**	Irakleio	25.29278	35.21833	Fossils		Regional	S	Green
79	**Arvi gorge**	Irakleio	25.38667	35.09500	Landform		Regional	A, N	Green

	Name	Prefecture	Lon	Lat	Category	Human Activities	Importance	Value	Conservation
80	**Kastamonitsa springs, kastelli fault**	Irakleio	25.38444	35.19528	Hydrology	Watering	Regional	A, E	Green
81	**Aposelemis delta**	Irakleio	25.33139	35.33500	Landform		Regional	N	Green
82	**Kalamayka Meteora**	Lasithi	25.63722	35.06639	Landform		Regional	A, S	Green
83	**Katharon plateau**	Lasithi	25.56028	35.14056	Landform, Fossils	Agriculture	Regional	S, A	Yellow
84	**Lastros Fault**	Lasithi	25.89639	35.15222	Fault		Regional	S	Green
85	**Chonos LASITHIou**	Lasithi	25.42778	35.19167	Karst		Regional	S, A	Green
86	**Milatos cave**	Lasithi	25.57803	35.30824	Cave	Tourism	Regional	A, S, N, E, C	Red
87	**Agios Nikolaos lake**	Lasithi	25.71722	35.19056	Landform	Tourism	Regional	A	Green
88	**Lastros Gypsum**	Lasithi	25.89417	35.16417	Lithology	Mining	Regional	E,S	Yellow
89	**Koufonissi island**	Lasithi	26.14000	34.94222	Landform		Regional	A, S, C	Green
90	**Kalavros beds**	Lasithi	25.96528	35.19194	Lithology		Regional	S	Green
91	**Itanos detachment**	Lasithi	26.26306	35.26750	Fault		Regional	S	Green
92	**Death gorge , Zakros**	Lasithi	26.25611	35.09861	Karst	Tourism	Regional	A, C	Green
93	**Psiloritis Mts - Panorama***	Rethymno	24.89944	35.26750	Landform		Regional	A	Green
94	**Agia Marina metaflysch**	Rethymno	24.88972	35.24528	Lithology		Regional	A,C	Green
95	**Nida plateau***	Rethymno	24.83528	35.20611	Karst, Landform	Agriculture	Regional	A, N	Green
96	**Mithia, Nida***	Rethymno	24.87889	35.22222	Lithology		Regional	S	Green
97	**Petradolakia, Nida***	Rethymno	24.86806	35.21667	Karst	Agriculture	Regional	S, A	Green
98	**Pisloritis summit***	Rethymno	24.77028	35.22611	Landform		Regional	A	Green
99	**Patsos Gorge**	Rethymno	24.57389	35.25500	Landform	Tourism	Regional	A, N	Green
100	**Spili sprigs**	Rethymno	24.53806	35.21972	Hydrology	Watering	Regional	A, E	Green
101	**Spili fault**	Rethymno	24.54556	35.20333	Fault		Regional	S ,A	Green
102	**Sellia, Ravdoucha beds**	Rethymno	24.39306	35.20972	Lithology	Trafic	Regional	S	Green
103	**Vatos scists**	Rethymno	24.54500	35.17472	Lithology		Regional	S	Green
104	**Aktounda ophiolites**	Rethymno	24.54194	35.18861	Lithology		Regional	S	Green
105	**Carpholite schists**	Rethymno	24.53139	35.15472	Lithology		Regional	S	Green
106	**Preveli gorge**	Rethymno	24.47333	35.15306	Landform	Tourism	Regional	A, N	Yellow
107	**Amoudi notches**	Rethymno	24.41917	35.17167	Landform	Tourism	Regional	S, A	Green
108	**Preveli blueschists**	Rethymno	24.46444	35.17500	Lithology		Regional	S	Green
109	**Kourtaliotis gorge**	Rethymno	24.46889	35.20333	Landform	Traffic	Regional	S, A	Green
110	**Barroisitic rocks**	Rethymno	24.61528	35.20778	Lithology		Regional	S	Green

	Name	Prefecture	Lon	Lat	Category	Human Activities	Importance	Value	Conservation
111	**Balli Permian fossils***	Rethymno	24.77167	35.40889	Fossils		Regional	S	Green
112	**Balli submarine springs***	Rethymno	24.78500	35.41056	Hydrology		Regional	S, A	Green
113	**Pantanassa formation**	Rethymno	24.61778	35.26250	Lithology		Regional	S	Green
114	**Metoxi bauxite***	Rethymno	24.9037	35.28614	Lithology	Traffic	Regional	S	Green
115	**Likotinara cave**	Hania	24.25889	35.3927	Fossils		Regional	S	Green
116	**Karoumpes caves**	Lasithi	26.27889	35.14102	Fossils		Regional	S	Green
117	**Kalo Chorafi cave**	Rethymno	24.84439	35.4075	Fossils		Regional	S	Green
118	**Simonelli cave**	Rethymno	24.43263	35.36829	Fossils		Regional	S	Green
119	**Koumpes caves**	Rethymno	24.44183	35.36743	Fossils		Regional	S	Green
120	**Agia Sofia cave**	Hania	23.68158	35.41105	Cave	Tourism	Regional	A, S, C	Yellow
121	**Panagia Arkoudiotisa Cave**	Hania	24.14381	35.58903	Cave	Tourism	Regional	S, N, C	Yellow
122	**Kourna Cave**	Rethymno	24.28599	35.32063	Cave	Tourism	Regional	A, S, N	Yellow
123	**Fantaxospiliara cave**	Rethymno	24.64397	35.39283	Cave	Tourism	Regional	A, S, N, C	Yellow
124	**Hainlospilios cave**	Irakleio	24.926	35.30505	Cave	Science	Regional	A, S, N, C	Yellow
125	**Spilaio Doxas**	Irakleio	24.99893	35.34499	Cave	Tourism	Regional	A, S, N	Yellow
126	**Honos cave, Sarhos**	Irakleio	24.985	35.221	Cave	Science, Tourism	Regional	A, S, N, C	Green
127	**Thergiospilios cave, Kavousi**	Lasithi	25.8346	35.12997	Cave	Tourism	Regional	A, S, N	Yellow
128	**Apoloustres cave, Pafkoi**	Lasithi	25.98945	35.08805	Cave	Tourism	Regional	A, S, N, C	Yellow
129	**Megalo Katofygi cave**	Lasithi	26.03759	35.1006	Cave	Tourism	Regional	A, S, N	Yellow
130	**Prassas fossils site**	Irakleio	25.19209	35.31524	Fossils	Traffic	Regional	S	Yellow
131	**Vigla cave, Vianos**	Irakleio	25.36832	35.01012	Cave	Tourism	Regional	A, N	Green
132	**Mougri cave, Sises**	Rethymno	24.83675	35.39489	Cave	Tourism	Regional	A, S, N, C	Yellow

*Psiloritis Geopark geotopes