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THE SIGNIFICANCE OF THE AEGEAN REGION FOR EARTH-SCIENCE CONSERVATION IN EUROPE WITH EMPHASIS ON THE GEOLOGICAL HERITAGE OF MILOS

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ABSTRACT

Earth-Science Conservation is an absolute necessity for science and education. Two Greek sites are listed in a first provisional UNESCO-list of geological World Heritage Sites:

Lesbos Island Petrified Forest and Pikermi.

But for concepts of Earth-Science Conservation in Europe Milos and Thera must also play an important part. Both islands document the island arc volcanism in a unique way, especially in connection with their history.

This paper should serve to introduce and to promote Earth-Science Conservation in Greece using the island of Milos as an example. Therefore, a system of geotopes developed in Germany for the use in Germany is applied to the geotopes of Milos.

87 sites of Milos are listed as geotopes which can be subdivided into 133 types. The type density for the whole island is 0.9 types per square kilometres, a value which is nearly tenfold higher than the value of the German hill countries.

86 of 87 sites can be combined in seven potential conservation areas, which have together 71.2 square kilometres, 47.4 per cent of the island's area. The protection of these seven areas is also important for nature conservation and for the promotion of tourism. The seven areas are nearly free of mining activity.

The creation of a geological nature park on Milos and Thera may be an important step in the conservation of the European geological heritage.

The European Working Group on Earth-Science Conservation is looking for co-workers in Greece. The office is at the Rijksinstituut voor Natuurbeheer, Postbus 46, 3956 ZR Leersum, The Netherlands.

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INTRODUCTION

The island of Milos is well known for its deposits of industrial minerals and its resources of geothermal energy. The island was mapped by FYTIKAS (1977) in connection with the geothermal research. A summary on the last geothermal projects was given by GARNISH et al. (1989). A description on the history of the exploitation of the resources of Milos by the author is in print; a brief overview on bentonite was given by LÜTTIG & WIEDENBEIN (1990).

Milos documents island arc volcanism par excellence. Soon SONDER (1925) characterized Milos as that island, which holds the key for understanding the South Aegean volcanism, much more so than Thera famous for its eruptions and classical forms. MACK (1977) compared the island of Milos with a geological museum.

But neither Milos nor Thera are listed on the first UNESCO World Heritage List for geological sites given by COWIE (1990).

In June 1990 the First International Symposium on the Conservation of our Geological Heritage took place at Digne-les-Bains, France. The symposium was directed by the European Working Group on Earth-Science Conservation which has its office at the Institute for Forestry and Nature Research in Leersum, The Netherlands.

At this symposium more than 100 participants from more than 30 states all over the world discussed aims and methods of Earth-Science Conservation. Greece was invited but absent, the author reported on Earth-Science Conservation in Germany (WIEDENBEIN 1991 b). The proceedings of the symposium will be published in the near future. A brief report on the symposium was also given by the author (WIEDENBEIN 1991 c).

This paper should serve to introduce and to promote Earth-Science Conservation in Greece using the island of Milos as an example.

GEOTOPES AND THE PROTECTION OF GEOTOPES

Geotopes are places worthy of protection for their geogenic fittings. The protection and conservation of geotopes are an integral part of nature conservation. Earth-Science Conservation is an absolute necessity for science and education, see ANDERSON et al. (1990) and BLACK & GONGGRIJP (1990).

In the following a system of geotopes developed in Germany for use in Germany should be applied to the island of Milos.

The introduced system of geotopes grades and indicates the sites aaccording to their composition and origin. The advantage of this system is to have the possibility to accumulate features in different levels (see table 1). Only the accumulation of features brings an approach to the facts. Please note that type-groups are separated by an oblique line (/) and suffix-groups are separated by a point from the type-groups. Suffix-groups indicate the grade of naturalness, the kind of utilization, the regional importance and the grade of protection and endangerment. The creation of more and other groups adapted to specific conditions and questions is possible and easy to practise.

Table 1: System of Geotopes. A German Approach.

G GEOTOPE S. STR.

GS -- Stratigraphical site
extraordinary sequences, type profiles etc.
GF -- Fossils (paleontological subjects)
extraordinary fossils and fossil associations
GM -- Minerals (mineralogical subjects)
extraordinary minerals, crystals and associations
GR -- Rocks (petrographical subjects)
extraordinary rocks and structures, contact areas, etc.
GT -- Tectonical site
extraordinary faults, folds, trenches, etc.
GV -- Volcanic site
extraordinary craters, dikes, fumaroles, etc.
GI -- Impact site
generally large meteorites, shatter cones etc.
GP -- Pedological site
extraordinary soil profiles and soil structures
GH -- Hydrogeological site
extraordinary springs, lakes, bogs, etc.

M MORPHOLOGICAL GEOTOPES

ME -- Erosional form
extraordinary gorges, arches, cliffs, etc.
MA -- Aggradational form
extraordinary dunes, walls, bars, etc.
MK -- Karst form
extraordinary caves, sinks, hums, etc.
MB -- Boulder (especially erratic blocks)

If possible to combine with: 4 -- postglacial form
3 -- glacial or periglacial form
2 -- interglacial form
1 -- preglacial form

T TECHNICAL GEOTOPES

TU -- Using marks (e. g. cartwheel marks)
TM -- Mining subjects
TQ -- Quarrying subjects
TE -- Engineering subjects

E ECOLOGICAL GEOTOPES

EP -- Primary habitat
ES -- Secondary habitat

Suffix-group 1: Naturalness

n -- natural site
a -- artificial site
man-made site with no historical-cultural dimension
d -- developed site: An old natural or man-made site, which was developed by man for his purposes. A developed site always has a

Suffix-Group 2: Utilization

t -- site useable for tourism and leisure activities
c -- a natural site useable as a historical-cultural site for education, research and leisure activities

Suffix-Group 3: Regional significance

I -- site of regional importance
II -- site of national importance
III -- site of European importance

Suffix-Group 4: Protection and endangerment

** -- especially protected site (e. g. as a geological monument)
* -- protected site (e. g. as a part of a nature park)
! -- threatened site (e. g. by visitors)
!! -- strongly threatened site (e. g. by re-filling)
+ -- lost site

GEOTOPES OF MILOS

The geotopes of Milos were registered by the author between 1983 and 1986 in connection with the fieldwork for his thesis (WIEDENBEIN 1988). All types of geotopes given in the above system, except for type GI (Impact Sites), are represented at Milos. A total of 133 type counts in 87 sites were listed (see tables 2 and 3). With Milos covering an area of 150.6 square kilometres this correspondends to a site density of 0.6 sites per sqkm or 0.9 type counts per sqkm. These values are nearly tenfold higher than the values of the German hill countries.

Table 2: Important Geotopes of Milos.
Listing of geotopes, their codes, names and coordinates.

No	code	site name *)	coordinates **)
01	TE.IIdt	-- Zephyria	x 02.72 y -05.68
02	ES.Id	AL Alyki	x 00.60 y -05.60
03	MK2/GH/EP.Inc	AL Loutra Alykis	x 00.54 y -05.25
04	GV/GH.Int!	AL Kanava	x 00.10 y -04.84
05	GR.Ia	AL Ag. Panteleimon	x 00.10 y -04.18
06	GV.In!!	NW Adamas NE	x -01.76 y -02.28
07	TE/GH.Id	NW Loutra Makrinou	x -01.95 y -02.13
08	TE/GH.Id	NW Loutra Lakkou	x -02.15 y -02.95
09	GS/GF.In	NW Adamas SW	x -02.40 y -02.85
10	GR.In	NW Tourla	x -02.68 y -02.63
11	TE.Id	NW Ag. Stulianis	x -02.92 y -02.34
12	TQ/GR/TE/EP.IIIdt!	NW Sta Nychia	x -02.90 y -02.90
13	GV/EP.IInt!	NW Bombarda NE	x -02.72 y -03.30
14	GR/TQ.Idc!	NW Bombarda SW	x -02.94 y -03.40
15	GV/GH.In	NW Skinopi	x -03.85 y -02.40
16	TE.IIdt!	NW Klima SE	x -04.14 y -01.98

TE.IIdt!	NW	Klima NW	x -04.25	y -01.80
TE.IIIdt!!	NW	Trypiti	x -03.84	y -01.52
GV.IInct	NW	Small Prof. Ilias	x -04.32	y -01.36
GV.IInct	NW	Plaka-Kastro	x -04.04	y -00.60
GR.In	NW	Areti S	x -04.78	y -00.98
TE.Id	NW	Areti N	x -04.84	y -00.84
TE.Id	NW	Fourkouvouni S	x -05.02	y -00.27
TM.Id	NW	Fourkouvouni N	x -05.08	y -00.04
ME4.Inc	NW	Arkoudes	x -05.58	y 00.32
MA4/EP.Int!	NW	Plathiena	x -04.95	y 00.40
GV.In	NW	Trachilas	x -04.18	y 00.40
GV.In	NM	Fyropotamos	x -03.68	y 00.80
TE.Id!	NM	Mandrakia	x -02.02	y -00.20
ME4.IInt!!	NM	Sarakiniko	x -00.85	y -00.88
GF/GS/ME4/EP.IIIn!!	NM	Kaminia	x -00.03	y -01.05
GT.IIa!	NM	Ag. Eirini	x 01.27	y -01.24
GP.In!	NM	Ag. Konstantinos	x 01.93	y -00.05
GV.IInt	NM	Glaronisia	x 01.92	y 00.82
TE/ME4.IIIdt!	NM	Papafrangas	x 03.02	y 00.22
TE.Idt	NM	Ag.Ioannis	x 04.04	y 00.54
GR.In	EM	Cape Kastana N	x 06.26	y -01.84
GR.In	EM	Cape Kastana S	x 06.24	y -01.95
TE.Id	EM	Kato Komia	x 05.90	y -03.10
GR.In	EM	Ag. Barabara	x 06.18	y -03.02
GR/ME2.IId!!	EM	Agkali	x 06.44	y -03.50
TQ/GR/ME4/EP.IIIdt	EM	Oemenagaki	x 06.46	y -04.40
TM.Idc	EM	Rhema	x 06.60	y -05.63
TM.IIIdt	EM	Thiorychia N	x 06.75	y -06.24
GM/TM.Id	EM	Thiorychia S	x 06.86	y -06.36
GV.IIInt!	EM	Ag. Theodori	x 05.40	y -05.80
GR.Inc	SM	Cape Spathi	x 05.27	y -08.86
GV/GH.Int!	SM	Paliochori	x 04.04	y -08.60
MA4/ME4/EP.Inc	SM	Ag. Kyriaki E	x 02.54	y -08.80
GV.IInt	SM	Ag. Kyriaki W	x 02.10	y -08.45
MA3/ME4.In	SM	Kalamos E	x 02.27	y -09.40
GV.Int	SM	Kalamos W	x 02.08	y -09.45
GS/GP.IIn	EC	Tsigrado	x -00.10	y -09.75
GP.In	EC	Firoplaka	x -00.16	y -09.56
GV/GR.IIn	EC	Lagoudina	x -00.48	y -09.28
GS.IIn	EC	Boudari	x -01.68	y -09.20
GP.Inc	EC	Ag. Sosti	x -01.74	y -09.04
TE/GV/ES.IIdt	EC	Loutra Provata	x -01.15	y -07.62
ME4.In	EC	Mavra Gremna	x -00.90	y -06.15
EP/GH.IIn!	EC	Hivatholimni	x -01.75	y -06.90
TE.Id	EC	Provatas	x -02.44	y -08.66
GV/EP.In	EC	Panagias Vounali	x -03.45	y -09.18
GS/GR.In	EC	Glifada	x -05.02	y -10.38
EP.IIIn!	EC	Kalamios-Valley	x -05.50	y -09.30
GR/TM.Id	EC	Orfanou	x -05.10	y -07.32
GH.Idt	EC	Ag. Marina	x -05.95	y -06.82
MA4.In	EC	Rivari	x -05.80	y -05.34
TU.Id	EC	Ag. Stulianos	x -06.74	y -05.30
ME3/EP.In	EC	Profitis Ilias N	x -07.64	y -07.40
GR.In	EC	Chondro Vouno	x -08.50	y -07.75
EP/ME3.IIn	EC	[illegible]	x [illegible]	y -08.60

72	GR.In	EC	Katergo	x -08.50	y -10.80
73	ME4/GS.IInct	WC	Kleftiko	x -12.10	y -11.25
74	EP/GV.IIn	WC	Katsipardos	x -12.00	y -09.45
75	ME4.IInt	WC	Sykia	x -13.20	y -09.24
76	GR.Inc	WC	Skoulas	x -12.18	y -08.26
77	MB.Inc	WC	Spasmata	x -12.10	y -07.30
78	EP.In	WC	Vouno Brionys	x -10.30	y -06.70
79	GF.In	WC	Ag. Athanasios	x -10.55	y -05.64
80	GF.In	WC	Ammoudaraki	x -11.70	y -05.55
81	TM/GH/EP.IId	WC	Triades	x -11.20	y -04.66
82	GM.Ia	WC	Galana	x -11.30	y -04.12
83	ME4/MA4/EP.IInct!!	WC	Agathia	x -11.15	y -02.58
84	GR.In	WC	Kalogries	x -11.10	y -01.66
85	GM/GR/TM/TQ/TE.IIIdt	WC	Vani	x -10.45	y -00.75
86	GV.In	WC	Cape Tourlos	x -10.16	y -00.04
87	EP.IIIn	WC	Kalamarokavos	x -06.55	y -02.80

*) AL = Alyki NW = NW-Milos NM = N-Milos EM = E-Milos
SM = S-Milos EC = E-Chalakas WC = W-Chalakas

**) map: National Library of Greece Listing No 200/16 - 3 - 1982.

Table 3: Important Geotopes of Milos.
System of geotopes, their codes and features.

code *)		no		site name and feature
GS				
-GF/GS/ME4/EP.IIIn!!	II	31	NM	Kaminia (coastal sect., Calabrian)
GS/GP.IIn		53	EC	Tsigrado (coastal sect., Pleistoc.)
GS.IIn		56	EC	Boudari (coastal section, Neogene)
GS/GF.In		09	NW	Adamas SW (coast. sect., Pleistoc.)
GS/GR.In		63	EC	Glifada (coastal sect., Pleistoc.)
GF				
GF/GS/ME4/EP.IIIn!!		31	NM	Kaminia (Calabrian fauna)
-GS/GF.In	I	09	NW	Adamas SW (Calabrian fauna)
GF.In		79	WC	Ag. Athanasios (Calabrian fauna)
GF.In		80	WC	Ammoudaraki (trace foss., Calabr.)
GM				
GM/GR/TM/TQ/TE.IIIdt		85	WC	Vani (Mn-assemblage, ramsdellite)
GM/TM.Id		45	EM	Thiorychia S (vitriol assemblage)
GM.Ia		82	WC	Galana (Pb-Cu-assembl., anglesite)
GR				
-GM/GR/TM/TQ/TE.IIId	II	85	WC	Vani (Mn-mineralization)
GR/ME2.IId!!		41	EM	Agkali (marine terrace, bentonite)
-TQ/GR/ME4/EP.IIIdt	I	42	EM	Demenagaki (obsidian)
-TQ/GR/TE/EP.IIIdt!	I	12	NW	Sta Nychia (obsidian)
-ME4/GS.IInct	I	73	WC	Kleftiko (diatomite)
-GV/GR.IIn	I	55	EC	Lagoudina (silicated crater fill)
GR/TQ.Idc!		14	NW	Bombarda SW (tuff, obsidian)
GR/TM.Id		65	EC	Orfanos (Kastro below Plaka sheet)

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-GS/GR.In                I 63 EC Glifada (diatomite)
GR.Inc                     47 SM Cape Spathi (metamorph. basement)
GR.Inc                     76 WC Skoulas (boulder of obsidian)
GR.In                      10 NW Tourla (obsidian pebbles, alges)
GR.In                      72 EC Katergo (coastal section, tuff)
GR.In                      37 EM Cape Kastana N (rock of agate)
GR.In                      38 EM Cape Kastana S (pipe of jarosite)
GR.In                      40 EM Ag. Barabara (coloured tuff boulder)
GR.In                      84 WC Kalogries (convolut bedding, baryte)
GR.In                      70 EC Chondro Vouno (quartz vein)
GR.In                      21 NW Areti S (Mn-mineralization)
GR.Ia                      05 AL Ag. Panteleimon (welded tuff)

GT
GT.IIa!                    32 NM Ag. Eirini (synsed. tectonics)

GV
GV.IIInt!                  46 EM Ag. Theodori (volcanic crater field)
GV/EP.IInt!                13 NW Bombarda NE (lagoon, fumarole)
GV/GR.IIn                  55 EC Lagoudina (silicated crater fill)
GV.IInct                   20 NW Plaka-Kastro (andesitic dome)
GV.IInct                   19 NW Small Prof. Ilias (andesitic dome)
GV.IInt                    34 NM Glaronisia (islets of volc. columns)
GV.IInt                    50 SM Ag. Kyriaki W (volc. wall, fumarole)
-TE/GV/ES.IIdt           I 58 EC Loutra Provata (Venet. vapour bath)
-EP/GV.IIn               I 74 WC Katsipardos (andesitic dome)
GV/GH.Int!                 04 AL Kanava (beach with hot springs)
GV/GH.Int!                 48 SM Paliochori (beach with hot springs)
GV/EP.In                   62 EC Panagias Vounali (rhyol. rock field)
GV/GH.In                   15 NW Skinopi (rhyolitic dome)
GV.Int                     52 SM Kalamos W (fumarole field)
GV.In                      86 WC Cape Tourlos (cliff, platy rhyolite)
GV.In                      28 NM Fyropotamos (volcanic contact)
GV.In                      27 NW Trachilas (crater wall)
GV.In!!                    06 NW Adamas NE (fumarole, well "Gamma 1")

GP
-GS/GP.IIn               I 53 EC Tsigrado (fossil soil, gastropods)
GP.Inc                     57 EC Ag. Sosti (Holoc. sect., artefacts)
GP.In                      64 EC Firoplaka (fossil soil, gastropods)
GP.In!                     33 NM Ag. Konstantinos (soil, beach rock)

GH
-TM/GH/EP.IId            I 81 WC Triades (surrounded spring)
-EP/GH.IIn!              I 60 EC Hivatholimni (fresh-water lake)
-MK2/GH/EP.Inc           I 03 AL Loutra Alykis (cave with spring)
-GV/GH.Int!              I 04 AL Kanava (beach with hot springs)
-GV/GH.Int!              I 48 SM Paliochori (beach with hot springs)
GH.Idt                     66 EC Ag. Marina (surrounded spring)
-TE/GH.Id                I 07 NW Loutra Makrinou (tradit. bathroom)
-TE/GH.Id                I 08 NW Loutra Lakkou (tradit. bathroom)
-GV/GH.In                I 15 NW Skinopi (warm spring)

ME
-GF/GS/ME4/EP.IIIn!!   II 31 NM Kaminia (assembl. of abrasion forms)
ME4/MA4/EP.IInct!!         83 WC Agathia (tafonis, used by man)
ME4/GS.IInct               73 WC Kleftiko (pict. cliffs and arches)
ME4.IInt                   75 WC Sykia (marine collapse cave)
ME4.IInt!!                 31 NM Kaminia (assembl. of abrasion forms)
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-TQ/GR/ME4/EP.IIIdt     I 42 EM Demenagaki (tafonis in rhyolite)
-TE/ME4.IIIdt!          I 35 NM Papafrangas (abrasion channel)
-GR/ME2.IId!!           I 41 EM Agkali (marine terrace, artefacts)
-EP/ME3.IIn             I 71 EC Profitis Ilias S (rock wall)
-MA4/ME4/EP.Inc         I 49 SM Ag. Kyriaki E (gully erosion)
ME3/EP.In                 69 EC Profitis Ilias N (smooth slope)
-MA3/ME4.In             I 51 SM Kalamos E (hill top w. Green Lahar)
ME4.Inc                   25 NW Arkoudes (cliff, navigational aid)
ME4.In                    59 EC Mavra Gremna (pict. cliffs, arches)

MA
-ME4/MA4/EP.IInct!!     I 83 WC Agathia (dunes)
MA4/ME4/EP.Inc            49 SM Ag. Kyriaki E (slide masses, ceram.)
MA4/EP.Int!               26 NW Plathiena (dunes)
MA3/ME4.In                51 SM Kalamos E (hill top w. Green Lahar)
MA4.In                    67 EC Rivari (lagoon)

MK
MK2/GH/EP.Inc             03 AL Loutra Alykis (solut. cave, spring)

MB
MB.Inc                    77 WC Spasmata (rock fall)

TU
TU.Id                     68 EC Ag. Stulianos (cattle drinking site)

TM
TM.IIIdt                  44 EM Thiorychia N (sulphur mine W. plant)
-GM/GR/TM/TQ/TE.IIIdt II  85 WC Vani (historical manganese mine)
TM/GH/EP.IId              81 WC Triades (historical ore mine)
-GM/TM.Id               I 45 EM Thiorychia S (historical adit)
-GR/TM.Id               I 65 EC Orfanou (historical kaolin mine)
TM.Idc                    43 EM Rhema (historical millstone indus.)
TM.Id                     24 NW Fourkouvouni N (historical ore mine)

TQ
TQ/GR/ME4/EP.IIIdt        42 EM Demenagaki (prehistor. obsidian)
TQ/GR/TE/EP.IIIdt!        12 NW Sta Nychia (prehistor. obsidian)
-GM/GR/TM/TQ/TE.IIIdt   I 85 WC Vani (historical manganese open pit)
-GR/TQ.Idc!             I 14 NW Bombarda SW (Roman obsidian quarry)

TE
TE/ME4.IIIdt!             35 NM Papafrangas (prehistoric harbour)
TE.IIIdt!!                18 NW Trypiti (Early Christian catacombs)
TE/GV/ES.IIdt             58 EC Loutra Provata (Venet. vapour bath)
TE.IIdt!                  16 NW Klima SE (Early Christian cells)
TE.IIdt!                  17 NW Klima NW (boat caves of fishermen)
TE.IIdt                   01 -- Zephyria (geothermic well "Nilos")
-GM/GR/TM/TQ/TE.IIIdt   I 85 WC Vani (bridge in Roman style)
-TQ/GR/TE/EP.IIIdt!     I 12 NW Sta Nychia (tafoni shelter)
TE/GH.Id                  07 NW Loutra Makrinou (tradit. bathroom)
TE/GH.Id                  08 NW Loutra Lakkou (tradit. bathroom)
TE.Idt                    36 NM Ag.Ioannis (Roman catacomb)
TE.Id                     11 NW Ag. Stulianis (Roman ? catacomb)
TE.Id                     39 EM Kato Komia (cattle caves of farmers)
TE.Id                     61 EC Provatas (cattle caves of farmers)
TE.Id                     23 NW Fourkouvouni S (boat caves fisher.)
TE.Id                     22 NW Areti N (boat caves of fishermen)
TE.Id!                    29 NM Mandrakia (boat caves of fishermen)
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EP				
EP.IIIn		87	WC	Kalamarokavos (rock hab., dark vip.)
EP.IIIn!		64	EC	Kalamios-V. (red vipers, red soils)
-TQ/GR/ME4/EP.IIIdt	II	42	EM	Demenagaki (rock habitat of vipers)
-TQ/GR/TE/EP.IIIdt!	II	12	NW	Sta Nychia (end. gastropods, vipers)
-GF/GS/ME4/EP.IIIn!!	II	31	NM	Kaminia (soil with rare orchids)
-TM/GH/EP.IId	II	81	WC	Triades (habitat of vipers)
EP/GV.IIn		74	WC	Katsipardos (predators)
EP/ME3.IIn		71	EC	Profitis Ilias S (predators)
EP/GH.IIn!		60	EC	Hivatholimni (fresh-water lake)
-ME4/MA4/EP.IInct!!	I	83	WC	Agathia (vegetation of dunes)
-GV/EP.IInt!	I	13	NW	Bombarda NE (lagoon, fumarole)
-MA4/EP.Int!	I	26	NW	Plathiena (vegetation of dunes)
-MA4/ME4/EP.Inc	I	49	SM	Ag. Kyriaki E (ferns)
-MK2/GH/EP.Inc	I	03	AL	Loutra Alykis (bats)
-GV/EP.In	I	62	EC	Panagias Vounali (chasmophytes)
-ME3/EP.In	I	69	EC	Prof. Ilias N (vegetation of scree)
EP.In		78	WC	Vouno Brionys (wet rock wall, ferns)
ES				
-IS 58 TE/GV/ES.IIdt	I	58	EC	Loutra Provata (bats)
ES.Id		02	AL	Alyki (saltworks with salt marsh)

*) Hyphen at the beginning (-) marks repeated listing of sites. Repeated sites are supplemented by their new categories of importance set before the running number.

The regional importance of sites is subdivided into three categories: Regional (I), National = Greek (II) and European (III). Sites of European importance are unique for Europe, while the sites of national importance are only unique for Greece. Within the type-groups of table 3 the sites are listed in order of decreasing value. The standard is given by the number of types per site and by the category of regional importance and the other added suffixes, especially of naturalness and utilization.

As to the protection of sites or plans for protection by the Greek authorities no statements can be given. As a foreigner the author has no insight here. But the extent of endangerment is obvious. On Milos, especially in its western part, the degree of threat is not very high. But this can quickly change due to new developments in mining or tourism. Some sites are already suffering from the growing number of visitors. At some other sites mining, re-filling or waste disposal pose an immediate threat.

GEOTOPE PROTECTION FOR MILOS

Sometime or other, the use of geothermal energy will bring energy and progress to Milos. An industrial park with Milos as its centre is a concrete vision of land-use planners (e. g. KOMNINIDIS 1985). But, first of all mining and tourism are a guarantee for prosperity. Conflicts connected with exploitation are known and foreseeable. But, resource management carried out with the necessary foresight is the most important prerequisite for the development of Milos. The protection and development of natural resources useable for the promotion of tourism can be helpful against the consolidation of economic mono-structures like a succession of mining operations.

In many cases, the geological heritage and its geotopes are

helpful in promoting tourism, however not mass tourism, but the individual tourism of high quality, which is not subject to the seasons. In Germany research institutes for tourism prognosticate an increasing polarisation between longer oversea and shorter inland holidays. The classical holiday countries around the Mediterranean Sea will lose rapidly in significance. The reasons for this are, among other things, increasing pollution and damage to landscape.

The conservation of geotopes must be a part of an integrated resource management. Also, the protection and conservation of geotopes is the fundament for geosciences and education. It is a task for the European Community to discern and to protect the sites of European importance and to provide financial support.

The Aegean region is a classical region of geoscientific research in Europe and in the world. Not only have the volcanism and the resources of geothermal energy and industrial minerals been subjects of research. On Milos recent research also goes into the archaeology of exploitation (RENFREW & WAGSTAFF 1982), especially the prehistoric obsidian deposits (KRONABEL 1989), the volcanic ore mineralization (LIAKOPOULOS 1987) or into its endemic herpetofauna (WIEDENßEIN 1988, 1991 a). Milos, is from a geological point of view, unique in certain respects.

Figure 1 shows the distribution of listed geotopes on the island. It is possible to combine 86 sites in 7 areas with a type density greater/equal than 1.0 types per square kilometre. The share of these 7 areas to the island area is 47.4 per cent (see table 4).

region code	area sqkm	area p. c.	sites number	sites p. c.	site *) density	types number	types p. c.	type *) density
AL	1.0	0.7	4	4.6	4.0	7	5.3	7.0
NW	4.3	2.9	22	25.3	5.1	32	24.1	7.4
NM	5.9	3.9	9	10.3	1.5	13	9.8	2.2
EM	3.4	2.3	10	11.5	2.9	15	11.3	4.4
SM	2.5	1.7	6	6.9	2.4	10	7.5	4.0
EC	29.4	19.5	20	23.0	0.7	30	22.6	1.0
WC	24.7	16.4	15	17.2	0.6	25	18.8	1.0
total	71,2	47.4	86	98.9	1.2	132	99.4	1.9
Milos	150.6	100.0	87	100.0	0.6	133	100.0	0.9

*) number of sites or types per square kilometre

Table 4: Geotopes of Milos. Statistics: Physical conditions.

These seven areas are nearly free of mining activities. Also, these seven areas are most important for nature conservation, especially for the conservation of the endemic species. The proposal given here is to combine these seven areas into a geological nature park.

Another feature of Milos which can be shown in such a park is the mass of historical engineering monuments connected with the extraction and processing of minerals and with the traditional use of hot water and vapour.

Table 5 shows the share of type groups for the geotopes of Milos. The close framework of different geotope types in a small

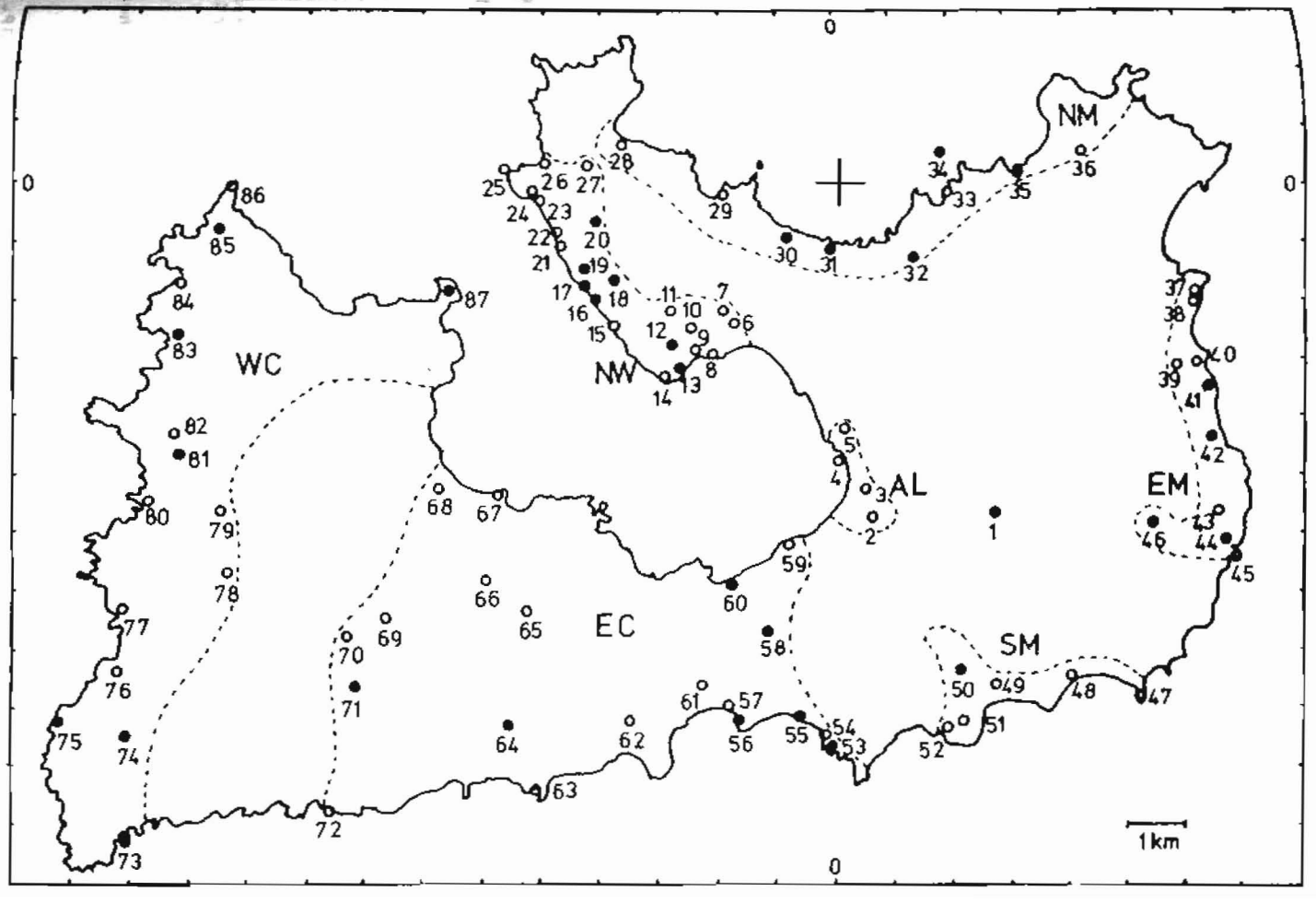

Figure 1: Milos. Distribution of geotopes and of potential areas of geotope conservation. The black points are sites of national or European importance.

sized area also give reasons for the necessity of Earth-Science Conservation at Milos.

Europe needs geologcial nature parks to protect and to conserve its geological heritage. First examples like the Reserve Geologique de Haute Provence in France show the way of realization. The islands of Milos and Thera are most suitable to demonstrate and to document the forms of island arc volcanism in Europe. Because of its historical-cultural dimension they are unique in the world. Milos and Thera also document the cradle of European civilization. There is no other place in Europe which would be better for the creation of such a park.

type group	listing number	listing p. c.	type density	share n	share c + d	share II + III	share t	share ! + !!
G	64	48.1	0.4	33.8	13.5	11.3	12.0	11.3
M	21	15.8	0.1	13.5	8.3	3.8	6.0	5.3
T	29	21.8	0.2	0.0	21.8	8.3	10.5	6.0
E	19	14.3	0.1	10.5	6.0	6.7	4.5	5.2
total	133	100.0	0.9	57.8	49.6	30.1	33.0	27.8

Table 5: Geotopes of Milos. Statistics: Systematical conditions.

GEOTOPE PROTECTION FOR GREECE

John COWIE, Chairman of the International Commission on Stratigraphy, was asked by UNESCO to start a compilation of geological sites for consideration as World Heritage Sites. In 1989 and 1990 first provisional indicative lists were given, which include 90 sites all over the world (COWIE 1990). In these lists two Greek sites were named:

Lesbos Island Petrified Forest (No 1) and Pikermi (No 8).

There can be no doubt about the importance of these two sites. But there are any more sites in Greece of similar importance. They include the landforms of Meteora, Petralona Cave, the ancient mines and quarries of Laurion and Thassos, the ilvaite site of Serifos and the gorge of Samara on Crete.

But, for concepts of Earth-Science Conservation, especially in Europe and Greece, Milos and Thera must play an important part.

The European Working Group on Earth-Science Conservation would welcome co-workers in Greece. The office is at the Rijksinstituut voor Natuurbeheer, Postbus 46, 3956 ZR Leersum, The Netherlands. For more informations you can also contact the author.

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