

V SESSIONE
V SESSION

ASPETTI LEGISLATIVI E POLITICI
POLICY AND LEGAL ASPECTS

Chairman: V. PIZZONIA

Nature does not select, we do! Some thoughts on geoconservation and selection

La natura non seleziona, noi sì! *Alcune idee sulla geoconservazione e sulla selezione*

GONGGRIJP G.P. (*)

ABSTRACT - The rapid deterioration of nature at the end of the last century led to the development of nature conservation movements. At first, earth scientists followed these new ideals from some distance. Their involvement increased, as geological sites became more and more subject to human impact. Although the influence of geoconservation in society is still modest, it is continuously growing.

In order to guarantee geoconservation for the future, it is necessary to make the geoconservation aims clear towards earth scientists for scientific and educational support, towards policy makers and politicians to develop and to support geoconservation policy and implementation and last but not at least towards the public for continuation on the long term. Therefore a legal basis, scientific research, education, sound classification and evaluation systems based on generally accepted principles and relevant preservation and management are necessary.

Recently a classification and selection system for geotopes, based on the geogenesis, has been worked out in the frame of the Nature Policy Plan. The representativeness of the sites for the geological history forms the basis for the selection. Rareness, 'form' representativeness and naturalness are the other criteria.

KEY WORDS: Geoconservation, classification, selection

RIASSUNTO - Il rapido deterioramento dell'ambiente alla fine del secolo scorso ha portato allo sviluppo di movimenti per la conservazione della natura. All'inizio, i cultori di scienze della terra seguivano questi nuovi ideali con un certo distacco. Il loro coinvolgimento è aumentato, man mano che i siti geologici sono divenuti sempre più soggetti all'attacco dell'uomo. Sebbene l'influenza della geoconservazione sulla società sia ancora modesta, essa sta continuamente crescendo.

Al fine di garantire nel futuro la geoconservazione, è necessario rendere chiari gli scopi della geoconservazione nei

confronti degli scienziati per il sostegno scientifico e per l'istruzione, nei confronti degli opinionisti e dei politici per sviluppare e sostenere la politica e l'implementazione della geoconservazione e, ultimo, ma non meno importante, verso il pubblico per un impegno a lungo termine. Perciò sono necessarie una base legale, la ricerca scientifica, l'istruzione, validi sistemi di classificazione e valutazione basati su principi comunemente accettati e ovviamente la conservazione stessa e una adeguata gestione.

Recentemente è stato elaborato, nell'ambito del Piano della Politica per la Natura, un sistema di classificazione e selezione dei geotopi basato sulla geogenesi. La rappresentatività dei siti per la storia geologica costituisce la base della selezione. Rarità, «aspetto», rappresentatività e naturalità sono gli altri criteri.

PAROLE CHIAVE: Geoconservazione, classificazione, selezione

1. - INTRODUCTION

The natural environment has always been and still is subject to continuous change. This is due to various natural processes steering the environmental system, like climate, geological processes and biological influences (WESTBROEK, 1991). All of these processes effect the landscape and change it continuously. Except for disasterous processes, like volcanism, earthquakes, mass movements, floods, etc. most changes are slowly, refering to human time table. But anyhow the death of species and geological features and the birth of new ones is a natural process, related to the environmental development in space and time.

(*) Institute for Forestry and Nature Research - P.O.Box 23 - NL-6700 AA Wageningen - The Netherlands



Fig. 1. – Deterioration of the geological landscape by sand and gravel winning. The dilemma in geoconservation: affected geomorphology but visible geology.

– *Deterioramento del paesaggio geologico causato dall'estrazione di sabbia e ghiaia. Il dilemma nella geoconservazione: geomorfologia intaccata ma geologia visibile.*

However the arrival of humankind introduced a new factor in the environmental system. In the beginning the effects of its presence were very little. Since humankind ceased hunting and gathering, and settled to practice agriculture, the natural environment changed by its activities and became more and more cultivated. The behaviour of humankind, being one's own master according to the Biblical-word in Genesis 1:28 "fill the earth and subdue it" has led to great losses in the natural environment. The deserts in the Near East testify of the enormous impact of overuse in ancient times. In most of the world the natural vegetation became almost completely replaced by a cultural determined one. Furthermore mineral resources were exploited, roads, city's, etc. were build and agricultural land was drained and leveled.

In the last century this ongoing process of "artificialization" of the landscape increased, as a result of the rapidly growing population caused by improved hygiene and medical care. The development of a society based on manual, wind and water power into a technical dominated one, accelerated the pressure on the natural environment enormously (GONGGRIJP & BOEKSCHOTEN, 1981; BLACK & GONGGRIJP, 1990). In a relatively short time plant and animal species were diminished or even disappeared completely.

The geological landscapes, in early days rather untouched, changed into intensively cultivated areas. The disappearance of geological sites, active or fossil, was no longer just a natural process but became highly stimulated by human impact (fig. 1).

2. – NATURE CONSERVATION

During the last century the knowledge about nature in general has been increased substantially and therefore the consequences of human activities on nature became more clear. At the end of the nineteenth century in many countries this process of deterioration of nature and landscape resulted in the foundation of nature organisations, opposing this decay. Generally the motives used to support the preservation of the natural heritage were ethical, aesthetic, educational and scientific. Gradually the opposition against the decay of the natural landscape became more common. And nowadays nature conservation and environmental protection are international items that can not be neglected any more by governments and supranational organisations. This nature conservation attitude led to the preservation of a growing number of sites, in most cases focused on the protection of endangered species and habitats and striking parts of the landscapes.

In the sixties and seventies the development of ecology as a science, gradually changed the concept of nature protection. Interrelations between abiotic and biotic systems and processes were more and more recognized and became integrated in the preservation system. Because of the pollution of air, water and soil, not only the internal management of protected sites was important but also the external management. Therefore in the seventies and eighties nature conservation changed towards the protection of more extended, ecologically based units and the environment. A new "environmental nature conservation" approach became the answer to the old limited view on nature conservation. The term "sustainable development", first used by the Commission Brundtland for a vision on long term economical development in relation to the environment, was quickly adopted by ecologists.

In The Netherlands the Ecological Network, laid down in the Nature Policy Plan (MINISTERIE VAN LANDBOUW, NATUURBEHEER EN VISSERIJ, 1990) formed the basis for a future integrated nature protection policy. It was the Dutch response to the concept of sustainable nature development. This network is based on a system of extended, more or less natural areas, like: national parks, nature reserves and monuments, connected by more cultivated areas that have to be re-naturalized by nature development (GONGGRIJP, 1992). However that is just a part, although a big part, of the nature conservation story. There is more to it! What to do with all the so-called white areas: the cultivated landscapes with almost no natural vegetation

left and where the (rather) natural landforms are the only actual and surprising elements? Should these areas be outlawed? A healthy and pleasant environment, in which people can feel at home, is more than just an Ecological Network, completed with clean air, water and soil. In this respect the earth-scientific aspects play a significant role, because natural relief forms a basis for the generally appreciated landscape variety. Therefore a special protection policy for the 'white areas' outside the Ecological Network was formulated and called "Specific Landscape and Scenic Values". They include cultural historical, earth-scientific and scenic values.

3. – THE ROLE OF GEOCONSERVATION

What about geoconservation in relation to the growth of the nature conservation concept? In most European countries geoconservation followed the "biological" development at a long distance, due to several causes. The main reasons were the lack of interest from the classical nature conservationists, mostly biologists, the indifference of the earth scientists themselves and the power of the biologically dominated nature conservation organisations (BLACK & GONGGRIJP, 1990). In cases of overlapping values, the protection of earth-scientifically important sites was no problem. However sound, but highly polluted, unique landforms were difficult to protect. This was also the case with more specialized sites like geological exposures or erratics. Divergent management measures, especially in pits and quarries, very often sabotage the earth-scientific value of the sites (fig. 2). This frustrating situation led to the development of separate geological conservation movements on national level and more recently even on an international scale (ProGEO, 1988 and Malvern Task Force, 1992).

Since the beginning of the seventies in The Netherlands geotope inventory data became available. They were collected by the interinstitutional working group Gea. The publicity focused on the conservation and management of these sites more and more drew the attention of nature conservationists and policy makers (GONGGRIJP & BOEKSCHOTEN, 1981). In 1990, after twenty years of slowly increasing interest, a real break-through was obtained with the publication of the national Nature Policy Plan (GONGGRIJP, 1992). This document incorporated the results of the background report "Nederland in Vorm" (The Netherlands in Shape) dealing with geoconservation in



Fig. 2. – A fossil cliff in boulder clay. The particularly developed boulder clay, once exposed, is no longer accessible, because of the interesting vegetation.

– *Una scogliera fossile in argilla.*

Le argille particolarmente sviluppate, una volta esposte, non sono più accessibili, a causa dello sviluppo della vegetazione.

The Netherlands (GONGGRIJP, 1989). In fact, with the publication of this plan the government recognized for the first time the importance of geoconservation. The path for a successful geoconservation policy and practice had been paved.

4. – SOME THOUGHTS ON GEOCONSERVATION

The development of the Nature Policy Plan created new needs for a revision of the nature conservation concept in general and for geoconservation in particular. Questions like: why?, what?, for whom? and how?, playing an essential role in nature conservation strategies, were put forward again.

4.1. – WHY?

Nature conservation has been based on ethic, aesthetic, scientific and educational motives. Nature itself does not evaluate; in nature there is no good or bad, beautiful or ugly. In fact nature and environmental conservation are pure human activities, like collecting art. The world will turn with or without orchids, pandas, birds of prey, eskers, castles, Rembrandts or even human beings. There is no natural law that prohibits or prevents the extinction of these phenomena. In principle extinction means room for something else. However the point is, do we, human beings, want the world to turn without these phenomena as a result of



Fig. 3. – A protected, scientifically important type locality, studied for the third time in thirty years, because of the development of new dating technics.

– Un'importante, da un punto di vista scientifico, località tipo protetta, studiata per la terza volta in trent'anni per lo sviluppo di nuove tecniche di datazione.

our activities and knowing that at the end destruction of the natural environment can lead to our destruction as a species?

Recently nature conservation has been defined in terms of functions that nature fulfils for humanity (VAN DER MAAREL & DAUVELLIER, 1978; DE GROOT, 1992). They have been specified as regulation, carrying, production and information functions. In this context it is absolutely legal for everybody to plead for the preservation of everything, even geological sites, one wants to preserve. We just have to convince the others! And that can only be achieved by putting forward generally excepted arguments. These can be scientific, educational, scenic or even religious ones. Of course geoconservation or geotope conservation has to be defined to make it clear to outsiders what has to be conserved. Although the geological setting influences life on earth and is for that reason an important ecological factor, it also has its own information function for earth scientists and the general public the geological processes and features have much more significance than just the ecological relations.

These geological phenomena represent aspects of the geological history and they fulfil their own scientific and educational information function, separated from the ecological, cultural and scenic values.

Therefore the promotion of the preservation of the typical geological heritage is the concern and first responsibility of the earth-scientific world.

4.2. – WHAT?

According to STUERM (1992) geotopes are distinct parts of the geosphere of outstanding geological and geomorphological interest. In our opinion this abridged definition should at least include pedological sites too. In fact the geotope concept should cover all geological (s.l.) features.

The early selected geotopes were mostly single sites, like spectacular landforms, big erratics and particular outcrops. The selection and preservation was very often based on personal interest and persistence. Nowadays there is a more general interest and there is room for a broader view on geoconservation. In the background report “Nederland in Vorm” (The Netherlands in Shape) (GONGGRIJP, 1989) it has been stated that geotopes should represent the geological history. This means that not only the exceptional, rare sites should be preserved, but also the representative, more common features.

4.3. – FOR WHOM?

In the first place earth scientists have a permanent interest in sites, which are or may be important in explaining the geological history, like type localities (fig. 3). Students have to be educated and therefore all kinds of examples of geological (s.l.) phenomena need to be preserved. But there is more attention for geoconservation. The public, interested in nature, needs a set of simple sites explaining the geological landscape. And last but not least the general public, enjoying nature and landscape, has a right to be confronted with a sound geomorphology not effected by large scale levelling or hugh rubbish mounds.

4.4. – HOW?

How to select these geotopes? In the past there was hardly any balanced selection system. Sites were selected and protected because they were unique, threatened or spectacular. Later on classifications and criteria were developed. Mostly those classifications were and still are based on a single disciplinary approach, comparable with the species protection in “biological conservation”.

In our opinion the classification and evaluation systems have to be revised and to be based on the geological history and the representativeness for this history. The protection measures and protection urgency are a different story and have to be determined by factors like threat, vulnerability and rarity.

5. – PRACTICE OF CLASSIFICATION

The first phase of the geoconservation Project 32, carried out in the frame of the Nature Policy Plan, deals with the classification and evaluation of geotopes. In GONGGRIJP (1996a; 1996b) the approach has been worked out in detail. As stated before a classification system has to be based on the geological history, including endogenic and exogenic features, geomorphology and pedology. And because countries are no geological islands the classification should have an international basis!

Politically it was decided that this classification system had to support geoconservation on a landscape basis. This of course had consequences for elaboration of the classification.

As a basis for the classification the geomorphological regions of Europe distinguished by EMBLETON (1984) could be used. They are based on geo(morpho)logical megastructures (called morpho-provinces) and large scale geological processes (called morphoregions). The next step in the hierarchic division was the selection of national set of (twenty) geomorphologically and chronologically determined landscape units (called morphocomplexes). These morphocomplexes form the starting point for the classification and evaluation system. The morphocomplexes include systems of morphopatterns built up by the individual morpho-elements, the smallest units in the system.

As the system is mainly built upon geomorphology, the input of geological and pedological sites may cause difficulties. As far as geological features have a morphological expression there is no real problem; they are included in the system. The geological outcrops, erratics and the pedological sites need a different approach. These aspects are not worked out in this phase of the project. Probably they can easily be added to the system on the morpho-element level.

6. – SELECTION, THE CHOICE OF CRITERIA

A classification is needed to bring order in the geological system. The evaluation is necessary to make a selection for the interested "public". The first concern is the selection of sites for (earth) science and (earth-science) education. That does not mean, we have no responsibility for the whole of the natural system. But if we are not able to make it clear which sites we want to preserve as earth scientists, we lose the game. For example we want to protect type loca-



Fig. 4. – A periglacial dune, typical for the Pleistocene geological landscape. In the so-called 'white areas'. A lot of those small dune mounds have been levelled for local sand winning and agricultural reasons. This process changes the landscape radically.

– Una duna periglaciale, tipica per il paesaggio geologico pleistocenico, nella così definita area-bianca. Un insieme di queste piccole dune è stato livellato o per commercio locale o per usi agricoli. Questo processo cambia radicalmente il paesaggio.

lities: geological, geomorphological or pedological ones. Our earth-scientific systems are built on those and they are of no interest for ecologists, etc. The chosen criteria should enable the selection of these typical geological (s.l.) sites.

ERIKSTAD (1991) made an inventory of all criteria applied for geotope selection and distinguished primary (rarity, representativeness, diversity, coherence and soundness) several secondary criteria. GONGGRIJP (1996a; 1996b) discussed the criteria and arranged them into various categories depending on the purpose of the selection. Criteria to select sites of scientific importance differ from those for education or a strategy for protection.

The geogenesis is the basis for the classification and the selection system. Therefore the first and most important criterion is **"geogenetic" representativeness**, followed in order of importance by **rareness**, **"form" representativeness** and **naturalness**.

In practice this means that we want to select those sites which are **typical for the geological history**. For example almost half the country is covered by periglacial dunes from the Weichselian, varying in age and form. Most of these low (0,5 m - 2 m high) dunes are common features in the Pleistocene part of the country (fig. 4). They form the geological basis of the landscape and because of that, they determine the image of that landscape. It will be evident that the best examples of this particular geogenesis should be selected.

Rare phenomena can be rare because of rare geological processes or because of human destruction. In

both cases these phenomena deserve to be selected. Especially for educational purposes the selection of instructive examples is needed. **Form representativeness** is used to distinguish these sites. This may be a typical parabolic dune or a typical sequence, like an outcrop, showing Weichselian cover sands on Saalian boulder clay, common in the northern part of the country.

The criterion **naturalness** is being used to separate the sound examples from the affected and therefore less valuable ones. If a landform is effected by a pit or quarry, it is the importance of the geological sequence that determines the value of the site.

In principle these criteria are applied on the morphocomplex level for the national scale. The reason is that those complexes are more or less geogenetically homogeneous areas. The following example will illustrate the reason for this choice. In the Netherlands periglacial pingo remnants are very common in the northern part of the country, especially in the Saalian boulder clay area. In the central part just two pingo remnants occur. Because of the representative situation in the northern part, the selection would be *concentrated* on that area. On the other hand those two pingo remnants in the central part represent a special geological situation. By selecting within the morphocomplexes these two pingo remnants become selected on a national scale not for their representativeness but because of their rareness within this morphocomplex. In our opinion this concept provides a more balanced selection of sites.

The classification and evaluation system can be related to the geomorphological GIS database GEOMORF (MAAS *et alii*, 1994). This allows a computerized selection of geotopes on the basis of geogenetic representativeness and rareness. Tests on a morpho-element level within a morpho-complex have been successful. Further selections on basis of form representativity and naturalness have to be executed "by hand", because until now there is a lack of systematically collected data. The next phase of the project, a nation wide selection of sites will be executed by a sister institute, the Staring Centre. This part of the project will be finished in the beginning of 1997.

7. – EPILOGUE

A classification and selection system for geological (s.l.) sites is an artificial method to establish a list of geotopes and there is no other solid way. As every conservation goal has its own method, it is important to

realize what the goals actually are. Selecting geological sites, which are interesting for ecology or cultural history is quite different from selecting sites for geological research or education. Criteria to be used for selection should fit into the social-cultural system. Of course scientifically founded arguments are essential for the scientific and educational justification of the selection. But in conservation practice sometimes other arguments, even emotional ones, can be used. That is no problem as long as it is (generally) excepted. What we have to keep in mind is that **nature does not select, we do!**

BIBLIOGRAPHY

- BLACK G.P. & GONGGRIJP G.P. (1990) - *Space and time: a new approach*. *Naturopa*, 65: 10-13, 2 figg.
- DE GROOT R.S. (1992) - *Functions of nature*. pp. 315, 38 figg., 24 tabb., Wolters-Noordhoff, Groningen.
- EMBLETON C. (1984) - *Geomorphology of Europe*. pp. 465, 282 figg., Macmillan publishers, London.
- ERIKSTAD L. (1991) - *stfold kvartærgeologiske verneverdige områder*. pp. 61, 39 figg., 3 tabb., Utredning 26, NINA, Oslo.
- GONGGRIJP G.P. (1989) - *Nederland in Vorm*. pp. 139, 85 figg., 3 tabb., SDU, 's-Gravenhage.
- GONGGRIJP G.P. (1992) - *Nature Policy Plan, New Developments In The Netherlands*. Utredning 41: 5-16, 7 Figg., NINA, Oslo.
- GONGGRIJP G.P. (1996a) - *Indelings- en waarderingsmethode voor aardkundige waarden*. rapport 218, pp. 95, 6 figg., 4 tabb., IBN, Wageningen.
- GONGGRIJP G.P. (1996b) - *A classification and evaluation system for geotopes*. 3 figg., in Print.
- GONGGRIJP G.P. & BOEKSCHOTEN G.J. (1981) - *Earth-science conservation, no science without conservation*. *Geol. & Mijnb.*, 60: 433-445, 9 figg.
- MAAS G.P., DE WAAL R.W. & WOLFERT H.P. (1994) - *Landschapsecologische kartering van Nederland: Geomorfologie*. LKN-Rapport 5. pp. 70, 19 figg., 8 tabb., SC-DLO. Rapport 335, Wageningen.
- MINISTERIE VAN LANDBOUW, NATUURBEHEER EN VISSERIJ (1990) - *Natuurbeleidsplan*. pp. 272, 35 figg., 5 tabb., SDU. 's- Gravenhage.
- STUERM B. (1992) - *The geotope concept: Geological nature conservation by town and country planning*. Geological and Landscape Conservation, 27-31, 1 fig., Geological Society, London.
- VAN DER MAAREL E. & P.L. DAUVELLIER. 1978. *Naar een globaal ecologische model voor de ruimtelijke ontwikkeling van Nederland*. Studierapport 9. Deel 1 pp. 314, Deel 2 pp. 166, 76 figg., RPD, Min. van VRO, Den Haag.
- WESTBROEK P. (1991) - *Life as a geological factor*. pp. 240, 36 figg., W.W. Norton. New York.

Calabria and Sicily: three laws devoted to the protection of the cultural and natural goods but the same dramatic damage and destruction of the fossil bearing deposits

Calabria e Sicilia: tre leggi destinate alla protezione dei beni culturali e ambientali ma lo stesso drammatico abbandono dei depositi fossiliferi

BONFIGLIO L. (*)

ABSTRACT - In Calabria and Sicily the fossils are protected by the state law n. 1089, decreed in 1939. In Sicily two advanced regional laws are designed to protect the cultural and natural goods (n. 80, August 1, 1977) and the natural environment (n. 98, May 6, 1981). Excluding a few sites really protected and some localities where palaeontologists in co-operation with the Archeological Superintendencies occasionally preserve vertebrate fossil remains which crop out during public works, most of the fossil-bearing deposits have been destroyed by buildings, quarry excavations, public works as well as by the not controlled collecting activity of some amateurs. This paper suggests that the present legislation regarding the excavation and protection of palaeontological deposits is to be modified.

KEY WORD: Palaeontologic deposits, Calabria, Sicily.

RIASSUNTO - In Calabria e in Sicilia i fossili sono protetti dalla legge n. 1089, (giugno 1939). In Sicilia due leggi regionali molto avanzate sono destinate alla protezione dei beni culturali e ambientali (n. 80, agosto, 1977) e degli ambienti naturali (n. 98, maggio, 1981). Ad eccezione di alcuni siti realmente protetti e di alcune aree dove fossili di vertebrati casualmente affioranti sono stati recuperati dai paleontologi in collaborazione con le Soprintendenze, la maggior parte dei depositi fossiliferi sono stati distrutti durante lavori pubblici, coltivazioni di cave e dalla raccolta incontrollata dei collezionisti. Le condizioni di abbandono del ricco patrimonio paleontologico della Sicilia e della Calabria richiedono una sostanziale modifica della normativa riguardante le attività di scavo e la protezione dei depositi fossiliferi esistenti.

PAROLE CHIAVE - Depositi paleontologici, Calabria, Sicilia.

1. - INTRODUCTION

In Calabria and Sicily the fossils are protected by the state law 1089, decreed in 1939.

In Sicily two advanced laws are designed to protect the cultural and natural heritage (n. 80, August 1, 1977) and the natural environment (n. 98, May 6, 1981). Fossils are considered as historical goods by state law 1089, which does not take in consideration the sedimentary context where fossils are found, *i. e.*, stratigraphic and taphonomic characters of deposits containing the fossil remains. The protection of the fossils is assigned to the Archeological Superintendencies, which lack specialists in Palaeontology. The Italian Palaeontological Society organized several meetings having the aim to discuss about the protection of the paleontological heritage. All the attending members agree upon the need of modifying the extant law taking into account the wealth of the Italian palaeontological heritage and the different value of fossils which is related to their rarity, paleoecological meaning and taxonomic position (SORBINI, 1990; MIGLIORINI, 1990; MUSCIO, 1990; SEVERINI, 1990; PINNA, 1994; BARATTOLO, 1994; PUGLIESE, 1994; BONFIGLIO, in print). Almost all experts have pointed out that the Archeological Superintendencies lack the necessary competences to evaluate the stratigraphic, taphonomic and paleobiological meaning of fossils.

(*) Istituto di Scienze della Terra Università degli Studi di Messina - Via Sperone, 31 - casella postale 54 - 98166 S. Agata di Messina

The huge heritage of fossil invertebrates of Sicily and Calabria provides fundamental evidence of an extreme rate of tectonic uplift of the Plio-Pleistocene coastlines in these regions. The very rich assemblages of invertebrates have yet to be fully investigated.

The very important Pleistocene vertebrate-bearing deposits of Sicily, which contain numerous endemic taxa, illustrate the paleogeographic evolution of the island.

Excluding a few sites really protected and some localities were palaeontologists in co-operation with the Archeological Superintendencies occasionally preserve fossil remains which crop out during public works, most of the fossil-bearing deposits have been destroyed by buildings, quarry excavations, public works as well as by the un controlled collecting activity of some amateurs. Some cases from Southern Calabria and Sicily serve as examples to show the present dramatic damage of the fossil bearing deposits (fig. 1).

2. - PLEISTOCENE VERTEBRATE BEARING DEPOSITS OF SICILY

In Sicily 79 sites are declared by law as natural reserves; the most of them take in consideration both fauna and flora, but they generally exclude fossil-bearing deposits.

The Pleistocene vertebrate-bearing deposits of Sicily are known to geologists and paleontologists around the world. The existence of gigantic bones in Sicily is known since FAZELLO times (1558). Healy in

the history of palaeontological excavations the vertebrate bearing deposits of the S. Ciro cave (Palermo) were investigated by SCINÀ (1831). Remains of elephants, hippos, cervids, bison, oxen, bears, wolves, lions, have been collected by numerous scientists, such as FABIANI (1927; 1928a; 1928b; 1932a; 1932b; 1934) and VAUFREY (1929).

Following the paleontological studies and the excavations of the first half of this century, ACCORDI (1957; 1963; 1965) and ACCORDI & COLACICCHI (1962) gave the most significant contributions to the knowledge of stratigraphic conditions of the Pleistocene vertebrate-bearing deposits of Sicily. New finds in recent years deeply modified previous knowledge about the taphonomic conditions of Pleistocene vertebrate-bearing deposits in Sicily, traditionally linked to the cave environment. Recent excavations in North Eastern Sicily and new finds in South Eastern and Western Sicily have shown that Pleistocene vertebrate were distributed in broad, open environments. The fossil vertebrate remains have been found in deposits of lacustrine and coastal plain environments (BONFIGLIO, 1987; 1992a; 1992b; BONFIGLIO & INSACCO, 1992; BONFIGLIO *et alii*, in print; BURGIO & CANI, 1988) as well as in fissure filling deposits (BONFIGLIO *et alii*, 1993, submitted). Recent papers have shown that stratigraphic and taphonomic investigations highly contribute to give to fossils the historical value pointed out by law 1089.

Excavations at Acquedolci (North Eastern Sicily) have shown stratigraphic and taphonomic aspect of a primary lacustrine deposit, containing thousands remains of the endemic hippo *Hippopotamus pentlandi*, associated with scarce remains of elephant, cervid, wolf, bear, tortue (BONFIGLIO, 1992a; 1995). The co-operation of paleontologists with the Archeological Superintendence has really protected the site of Acquedolci. Here the European Community is financing the restoration of the excavation trenches where the fossils are exhibited within the deposits and the realization of an open-air Museum (BONFIGLIO & RICCOBONO, 1990; BACCI, 1989). The case of Acquedolci, represents a rare example of a correct co-operation between Superintendencies and University Earth scientists.

New finds in the carbonatic Ragusa platform (South Eastern Sicily) have shown that in this area numerous fissure-filling deposits are located, which contain abundant vertebrate remains (BONFIGLIO *et alii*, 1993, submitted). The vertebrate remains have been collected during building and public works, by the intervention of private citizens. A program of

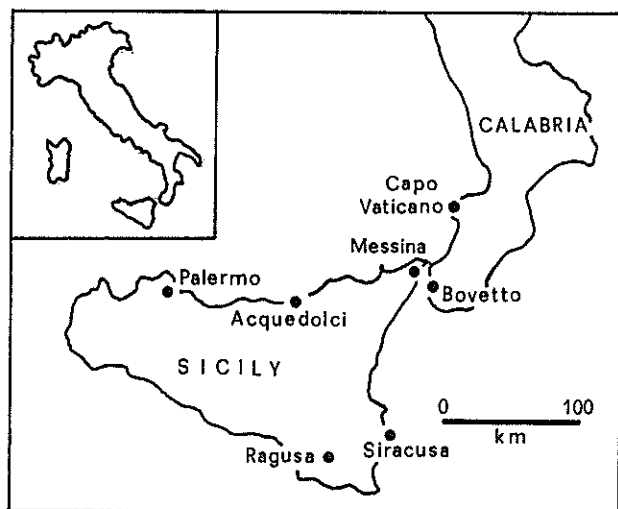


Fig. 1. - Location of the quoted sites in Southern Calabria and Sicily.

- Ubicazione dei siti citati in Calabria Meridionale e in Sicilia.

inspection of works does not exist, to avoid destruction of fossils.

The excavations of the vertebrate bearing deposits at Contrada Fusco (Siracusa) have been directed by the staff of the Superintendence (CHILARDI & GILOTTI, 1996; CHILARDI, 1996). Even if numerous chronological and paleontological evidence have been collected and if some taxa have been studied by paleontologists (CASSOLI & TAGLIACCOZZO, 1996a; 1996b; KOTSAKIS, 1996a; 1996b. RHODES, 1996) a reliable stratigraphic and taphonomic framework lacks, as well as the arrangement of collected data within the palaeogeographic outline of the Hyblean Plateau and the recent literature regarding the Pleistocene continental faunal complexes of Sicily and the Pleistocene geological evolution of the Hyblean Plateau. The complexity of the stratigraphical conditions at Contrada Fusco and the extent of the invested financial resources would have been suggest the co-operation of qualified earth scientists during the investigations.

3. – FOSSIL-BEARING DEPOSITS OF CALABRIA

The huge paleontological heritage of Southern Calabria were described especially by SEGUENZA (1879-80), CORTESE (1895), DE STEFANI (1884) at the end of the last century. The great number of extant rich fossil-bearing deposits needs a choice is be made of the most important sites to be protected before it becomes too late. Two sites are emblematic for the conditions of the most important fossil-bearing deposits.

3.1. – *Bovetto*

The paleontologically significant deposits of Tyrrhenian age at Ravagnese and Bovetto are known to geologists and paleontologists around the world. Early in the history of geological investigation they were described by GIGNOUX (1913) and later by BONFIGLIO (1972) as they exhibit aspects of extreme interest to Quaternary scientists. There is an unmatched wealth of molluscan fossils contained in the deposits. Included among the malacofauna are countless examples of *Strombus bubonius*, the figurehead of a warm fauna that invaded the Mediterranean basin during the last "Riss-Würm" interglacial.

The sediments at the sites attain a great thickness. At Bovetto the *Strombus* bearing sediments are as great as 45 m thick, probably the greatest value of last interglacial sediments known in the Mediterranean basin. Most marine deposits of this age are less than 5 m

thick. The detailed and observable changes in sediment grainsize through the 45 m section allow scientists to interpret the changes in water depth that occurred during the last interglacial. The unlithified nature of the sediments at Ravagnese and Bovetto enable paleontologists to easily extract fossils for study. A majority of the Mediterranean deposits of this age are highly indurated by carbonate "beachrock".

Rare fossil mammals of endemic form have been extracted from the deposits at Bovetto (BONFIGLIO, 1979), which have paleogeographic significance as they represent a phase during the Eutyrrhenian age when southern Calabria was an island severed from the Italian peninsula.

The existence of *Strombus* in two sandy levels (the highest rising to 135 m) represents one of the highest occurrences of this fauna in the Mediterranean basin. The height of these marine deposits provides fundamental evidence of an extreme rate of tectonic uplift of the coastlines in the Strait of Messina, which appears to be continuous in the present. The data that can be obtained from these areas have a great importance in the context of the recent geodynamic evolution of the Calabria/Peloritani Arc. Research in the area will attempt to define the present seismotectonic situation along the Strait of Messina. The palaeontological associations of mollusks in individual strata at Ravagnese and Bovetto have yet to be fully investigated.

The destruction of these deposits will cancel future investigations into the paleoenvironmental significance of the invertebrate assemblages at Ravagnese and Bovetto.

For these reason in 1985 several international scientific Institutions requested that a restriction be placed upon the sites of Ravagnese and Bovetto whereby the deposits will be preserved and permanently protected from further destructive activities.

On 9th august 1988 the Minister for Cultural and Environmental heritage decreed the hill of Bovetto to be protected, having the Ravagnese deposits already been destroyed by the building expansion. At present the hill of Bovetto is not really protected and runs the risk of being destroyed by the illegal building as well as by the collecting activity of numerous amateurs.

3.2. – *Miocene deposits of Capo Vaticano*

The Miocene marine deposits of Capo Vaticano have been described by SEGUENZA (1879-80) and by CORTESE (1895) and later by NICOTERA (1959) and by BARBERA & TAVERNIER (1990).

According to NICOTERA (1959) and BARBERA & TAVERNIER (1990) the Tortonian and Messinian sedimentary sequences at Capo Vaticano include conglomerates, black clays, gray-blue sands, arkosic sands, of open marine and lagoon hypohaline environments. Several species of mollusks, brachiopods, foraminifers, large *Chypaster* specimens are contained in the different stratigraphic units (CHECCHIA RISPOLI, 1925; IMBESI SMEDILE, 1958).

A sand quarrying activity is in operation in the Capo Vaticano area since more than 20 years. During quarry exploitations numerous, important fossil remains have been collected by amateurs and by private citizens. From the gray-blue sands abundante remains of reptiles, several carapaces of *Trionix*, theet of fishes, and remains of marine and continental mammals (*Artiodactyla*) and thousands specimens of *Chypaster* come (MONCHARMONT ZEI & MONCHARMONT, 1987; BARBERA & TAVERNIER, 1990). Some of these remains are stored in institutional sites (Palaeontological Museum, University of Napoli). Most of the collected fossil remains are preserved by amateurs with great care but they hide the fossils from palaeontologists. Some amateurs put the fossils on the market also.

The Miocene sedimentary sequences at Capo Vaticano have not been object of detailed descriptions; stratigraphic and taphonomic data lack regarding the continental faunal assemblages which could have a great significance for reconstructing the Miocene paleogeography of the Mediterranean area. The establishment of safeguard criteria may permit the coexistence of a productive industry, like the quarrying, with the preservation of the fossil remains cropping during quarry exploitation.

4. - CONCLUSIONS

The above mentioned examples from Southern Calabria and Sicily show that the present laws do not really protect fossil remains and fossil-bearing deposits. The protection is to be the result of the active participation of both University earth scientists and local communities. Private citizens are to be encouraged to co-operate with the Institutions.

In the near future the present legislation is to be modified, taking into account the following suggestions:

a - A systematic inventory using specific forms and maps is to be prepared. This inventory makes possible to establish different categories of fossil sites to be protected.

b - Motivations or justifications for conserving fossil-bearing deposits are to be prepared by Institutions palaeontologists, which have to be officially concerned with the fossil heritage conservation.

c - Impact studies preliminary to large development works have to take into account the palaeontologic heritage. In order to protect the palaeontologic heritage, in the richest areas buildings, public works and quarrying are to be controlled by palaeontologists in the same manner as archeologists already do for the protection of the archeological goods.

d - The less important vertebrate-bearing deposits cropping during works are to be examined, mapped and the fossil collected by the Institutions palaeontologists, before the works go on. The most important vertebrate-bearing deposits are to be totally and really protected.

e - The excavation and the study of the fossil-bearing deposits are to be carried by the Institutions palaeontologists and earth scientists.

f - Some well known and very important fossiliferous sites are to be really and immediately protected to prevent the destruction of sites by not controlled fossil collecting and by illegal building.

REFERENCES

- ACCORDI B. (1957) - *Nuovi resti di ippopotamo nano nel Pleistocene dei dintorni di Siracusa*. Atti Acc. Gioenia Sc. Nat., 11: 99-109, 1 fig., 1 pl., Catania.
- ACCORDI B. (1963) - *Rapporti tra il "Milazziano" della costa iblea (Sicilia sud-orientale) e la comparsa di Elephas mnaidriensis*. Geologica Romana, 2: 295-304, 6 figs. Roma.
- ACCORDI B. (1965) - *Some data on the Pleistocene stratigraphy and related pigmy mammalian faunas of eastern Sicily*. Quaternaria, 6 (1962): 415-430, 3 figs., 2 pl., Roma.
- ACCORDI B. & COLACICCHI R. (1962) - *Excavations in the pygmy elephants cave of Spinagallo (Siracusa)*. Geologica Romana, 1: 217-230, 5 figs., Roma.
- BACCI G. (1989) - *La grotta di S. Teodoro e le sue emergenze paleontologiche e paleinologiche. Tradizioni e prospettive*. In: Catalogo della mostra "Ippopotami di Sicilia", Messina (1989): 23-21, 4 figs., Messina.
- BARATTOLO F. (1994) - *Intervento su: Località fossilifere: temi e problemi*. Boll. Soc. Paleont. It., 33 (1): 124-125, Modena.

- BARBERA C. & TAVERNIER A. (1990) - *Paleoecologia della successione miocenica di Vibo Valentia*. Proceedings of the fourth Symposium on Ecology and Paleoecology of Benthic Communities, Sorrento 1-5 november 1988. Museo Regionale di Scienze Naturali, Torino: 233-245., 4 figs. Torino.
- BONFIGLIO L. (1972) - *Il Tirreniano di Bovetto e Ravagnese presso Reggio Calabria*. Quaternaria, 16: 137-148, 4 figs., Roma.
- BONFIGLIO L. (1979) - *Resti di cervide (Megacero) dell'Entirreniano di Bovetto (RC)*. Quaternaria, 20 (1978): 87-108, 8 figs., 2 tabs., Roma.
- BONFIGLIO L. (1987) - *Nuovi elementi faunistici e stratigrafici del Pleistocene superiore dei Nebrodi (Sicilia nord-orientale)*. Riv. It. Paleont. Strat., 93 (1): 145-164, 8 figs., 1 tab., Milano.
- BONFIGLIO L. (1992 a) - *Campagna di scavo 1987 nel deposito pleistocenico a Hippopotamus pentlandi di Acquadolci (Sicilia nord-orientale)*. Boll. Soc. Paleont. It., 30 (3): 157-173, 17 figg., Modena.
- BONFIGLIO L. (1992 b) - *Middle and Upper Pleistocene Mammal-bearing deposits in south-eastern Sicily: New stratigraphical records from Coste di Gigia (Syracuse)*. Geobios, M.S. 14: 189-199, 9 figs., Lyon.
- BONFIGLIO L. (1995) - *Taponomy and depositional setting of Pleistocene mammal-bearing deposits from Acquadolci (North-Eastern Sicily)*. Geobios, M.S. 18: 57-68, 13 figs., 1 tab., Lyon.
- BONFIGLIO L. (in print) - *La tutela dei depositi a vertebrati fossili della Sicilia*. Convegno su: La tutela dei Beni Paleontologici: problemi e prospettive. Trieste 12 maggio 1995: 63-70, Trieste.
- BONFIGLIO L., DI STEFANO G., INSACCO G. & MARRA A.C. (1993) - *New Pleistocene fissure-filling deposits from the Hyblean Plateau (south eastern Sicily)*. Riv. It. Paleont. Strat., 98 (4): 523-540, 5 figg., 4 tavv., Milano.
- BONFIGLIO L., DI GERONIMO I. S., Insacco G. & Marra A. C. (in print) - *Large mammal remains from late Middle Pleistocene deposits of Sicily: new stratigraphic evidence from the western edge of the Hyblean Plateau (South-Eastern Sicily)*. Riv. It. Paleont. Strat., 102 (3) (1996), 2 figg., 1 tav., Milano.
- BONFIGLIO L. & INSACCO G. (1992) - *Palaeoenvironmental, paleontologic and stratigraphic significance of Vertebrate remains in Pleistocene limnic and alluvial deposits from South Eastern Sicily*. Palaeogeography, Palaeoclimatology, Palaeoecology: 95: 195-208, 2 figg., 3 tabb., 2 tavv., Amsterdam.
- BONFIGLIO L., INSACCO G., MARRA A.C. & MASINI F. (submitted) - *Large and small mammals, amphibians, reptiles from a new fissure-filling deposit of the Hyblean Plateau (South-Eastern Sicily)*.
- BONFIGLIO L. & RICCOBONO F. (1990) - *Il deposito a Hippopotamus sp. del Pleistocene superiore presso la grotta di S. Teodoro in Acquadolci (Messina, Sicilia), un progetto di museo paleontologico in situ*. Boll. Soc. Paleont. it., 29 (1): 109-115, 8 figg., Modena.
- BURGIO E. & CANI M. (1988) - *Sul ritrovamento di elefanti fossili ad Alcamo (Trapani, Sicilia)*. Naturalista Siciliano, 4, 12 (3-4): 87-97, 5 figs., Palermo.
- CASSOLI P.F. & Tagliacozzo A. (1996 a) - *L'avifauna*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco: 61-67, 2 figs., 3 tabs.. Arnaldo Lombardi, Siracusa.
- CASSOLI P.F. & Tagliacozzo A. (1996 b) - *L'ittiofauna*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco: 54-55, 1 tab. Arnaldo Lombardi, Siracusa.
- CHECCHIA RISPOLI G. (1925) - *Illustrazione dei Clipeastri miocenici della Calabria seguita da uno studio sulla morfologia interna e sulla classificazione dei Clipeastri*. Mem. per servire alla descrizione della carta geol. d'Italia, 9, 3, Roma.
- CHILARDI S. (1996) - *I siti paleontologici del territorio siracusano*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco: 87-91, 1 fig. Arnaldo Lombardi, Siracusa.
- CHILARDI S. & GILOTTI A. (1996) - *Stratigrafia e sedimentologia*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco: 27-34, 4 figs. Arnaldo Lombardi, Siracusa.
- CORTESE E. (1895) - *Descrizione geologica della Calabria*. Mem. descrittive Carta geol. d'Italia, 9, 300 pp., 4 tavv., 1 carta geol., Roma.
- DE STEFANI C. (1884) - *Escursione scientifica nella Calabria (1877-1878): Jeio, Montalto e Capo Vaticano*. Acc. Naz. Lincei, Rend. Cl.Fis., Mat. e Nat., ser. 3, 18, 290 pp., 2 geol. papers, Roma.
- FABIANI R. (1927) - *Resti di Mammiferi del terziario e del Quaternario di Ragusa in Sicilia*. Rend. R. Acc. Naz. Lincei, s.6, 6 (11): 521-524, 1 fig., Roma.
- FABIANI R. (1928 a) - *Cenni sulle raccolte di Mammiferi quaternari del Museo Geologico dell'Università di Palermo e sui risultati di nuovi saggi esplorativi*. Boll. Ass. Miner. Sicil., 4: 25-34, 4 figg., Palermo.
- FABIANI R. (1928 a) - *Aggiunte alla conoscenza dei mammiferi fossili del Ragusano in Sicilia*. Ist. Geol. R. Univ. di Palermo, 8 pagg., 1 fig., Palermo.
- FABIANI R. (1932 a) - *Giacimento a resti di Elefanti scoperto presso Via Libertà a Palermo*. Il Naturalista Siciliano, 28, n.s. 8 : 99, Palermo.
- FABIANI R. (1932 b) - *Risultati di alcuni scavi nella Grotta della "Za' Minica" presso Capaci (Palermo)*. Atti R. Acc. Sc., Lett. e Belle Arti Palermo, 17 (1), 8 pagg., 4 figg., 1 tav., Palermo.
- FABIANI R. (1934) - *Notizie preliminari sui risultati di uno scavo paleontologico nella Grotta della Cammita (Palermo)*. Boll. Sc. Nat. ed Econ. di Palermo, n.s., 16: 3-7, Palermo.
- FAZZELLO T. (1558) - *Storia di Sicilia*. Traduzione in lingua toscana da Remigio Fiorentino. 9 voll., Pedone e Muratori: 1830-1836, Palermo.
- GIGNOUX M. (1913) - *Les formations marines pliocènes et quaternaires de l'Italie du Sud et de la Sicile*. Ann. Univ. Lyon, n.s. 36: VII - XXIV, 693 pp., 42 figg., 20 tavv., Lyon.
- IMBESI SMEDILE M. (1958) - *Clipeastri aquitaniani, elveziani e tortoniani della Calabria*. Paleontographia italica, 43, 47 pp., Pisa (cum bibl.).
- KOTSAKIS T. (1996 a) - *Anfibi e rettili*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco: 56-60 Arnaldo Lombardi, Siracusa.
- KOTSAKIS T. (1996 b) - *I micromammiferi*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco: 68-72. Arnaldo Lombardi, Siracusa.

- MIGLIORINI L., 1990, - Intervento su: *Salvaguardia dell'ambiente e conservazione dei beni paleontologici*. XI Convegno della S.P.I. Umbria 16-18 ottobre 1987: Boll. Soc. Paleont. It., 29(1): 98-99, Modena.
- MONCHARMONT ZEI M. & MONCHARMONT U. (1987) - *Il Metazytherium medium (Desmarest) 1822 (Sirenia, Mammalia) delle arenarie tortoniane (Miocene superiore) di S. Domenica di Ricadi (Catanzaro, Italia)*. Mem. di Scienze geologiche, **34**: 285-341, 3 figg, 2 tabb., 14 tavv., Padova.
- MUSCIO G. (1990) - Intervento su: *Salvaguardia dell'ambiente e conservazione dei beni paleontologici*. XI Convegno della S.P.I. Umbria 16-18 ottobre 1987: Boll. Soc. Paleont. It., 29(1): 106- 108, Modena.
- NICOTERA P. (1959) - *Rilevamento geologico del versante settentrionale del Monte Poro (Calabria)*. Mem. e Note Ist. Geol. Applicata Napoli, **7**: 1-92, 42 ff., 2 geol. papers, Napoli.
- PINNA G. (1994) - Intervento su: *Località fossilifere: temi e problemi*. Boll. Soc. Paleont. It., **33** (1): 122- 124, Modena.
- PUGLIESE N. (1994) - Intervento su: *Località fossilifere: temi e problemi*. Boll. Soc. Paleont. It., **33**(1): 125- 126, Modena.
- RHODES E. J. (1996) - *ESR dating of tooth enamel*. In: Basile B. & Chilardi S. (Eds.) - *Le ossa dei Giganti. Lo scavo paleontologico di Contrada Fusco*: 39-44, 1 fig., 2 tabs. Arnaldo Lombardi, Siracusa
- SCINA' D. (1831) - *Rapporto sulle ossa fossili di Mardolce e degli altri contorni di Palermo*. 64 pp., 2 tav., Reale Tipografia di Guerra , Palermo.
- SEGUENZA G. (1879-1880) - *Le Formazioni terziarie nella provincia di Reggio Calabria*. Atti R. Acc. Lincei, Mem.Cl. Sc. fis. mat. e nat., **6**, s. 3: 1-445, Roma.
- SEVERINI G (1990) - Intervento su: *Salvaguardia dell'ambiente e conservazione dei beni paleontologici*. XI Convegno della S.P.I. Umbria 16-18 ottobre 1987: Boll. Soc. Paleont. It., **29** (1): 100-102, Modena.
- SORBINI L. (1990) - Intervento su: *Salvaguardia dell'ambiente e conservazione dei beni paleontologici*. XI Convegno della S.P.I. Umbria 16-18 ottobre 1987: Boll. Soc. Paleont. It., **29** (1): 95-97, Modena.
- VAUFREY R. (1929) - *Les éléphants nains des îles méditerranéennes et la question des isthmes pléistocènes*. Arch. Inst. Paléont. Hum., **6**:1-220. 45 figg,9 tavv., Paris.

In order to obtain the best conservation is it not sometimes better not to divulge the place of the findings ?

Al fine della migliore conservazione non è, a volte, meglio non divulgare i luoghi dei ritrovamenti ?

DAMIANI A.V. (*)

ABSTRACT - Many geotopes and mainly the small ones, here named geospots, are too often located in scattered places. For them, actually, there are no valid possibilities of protection nor of effective surveillance against the acquisitive greedy collectors, unscrupulous dealers, plunderers, vandals or against the possibility, too, to be materially carried away. Therefore, until people will not be educated to respect their goods and the environment and laws will be promulgated and operative, the best conservation may be obtained by not divulging the places of the findings of the small dimension geo-goods.

KEY WORDS - Geotopes, conservation, environment

RIASSUNTO - Per molti geotopi e, in particolare, per quelli piccoli, qui denominati *geospots*, ubicati sovente in località isolate, non esistono ancora né effettive misure di protezione, né di valida sorveglianza, contro la raccolta dissennata e/o ingorda e contro la loro asportazione anche totale. Pertanto, fino a che la gente non sarà educata al rispetto dell'ambiente e dei geotopi che vi fanno parte, e non sarà emanata, ma, soprattutto, resa operante una valida legislazione, l'A. ritiene che la migliore conservazione sia quella di non divulgare le località di ritrovamento degli oggetti geologici (s.l.) di modeste dimensioni.

PAROLE CHIAVE - Geotopi, conservazione, ambiente

1. - INTRODUCTION

One of the scientific objects of this Symposium is to analyze the problems related to the future and to the conservation of the geological goods. An other proposed theme is "the role of the information and of the diffusion". Reading the programme, the A. remembered what he said some years ago (May 1991), taking part in a debate after a speech at the Italian Council of Researches (=CNR), during a symposium on national geological cartography in which was presented the "*Guida al rilevamento geologico della Carta Geologica d'Italia alla scala 1/50.000*". He called the attention on the opportunity not-to-indicate invertebrates, vertebrates, paleobotanical fossiliferous sites, as well of mineralogical, prehistoric, archaeological and geomorphological interest (pages 145 and 201 of the above mentioned Guide) with special symbols on the official geological maps (=Fogli). As usual, this verbal address did not obtaine any positive result; so, in this symposium, he repeats this call explaining why.

2. - DIVULGING GEOSITES INFORMATIONS, A PROBLEM!

To mark or not to mark the above mentioned specific symbols on a map is a problem for all field geo

(*) Dipartimento Scienze della Terra - Università di Perugia - Piazza Università 1 - 06100 Perugia (Italy)

logists or field operators in other disciplines, had to face quite many times in their geological field activity.

The title of this paper is undoubtedly quite provocative and the proposal does not obviously apply to the very large geotopes as National Parks, Regional Parks, Natural Reserves, landscapes, protected Areas, but it may particularly be applied to the tiny sites that I name "geo-spots" (a new key word!). These "geo-spots" even if relatively small, sometimes may be very important for their historical, scientific, cultural information level, very often due to their rarity.

It is obvious that the first step to realize the conservation of a geological good (*latu sensu*) is to prevent its destruction from weathering. However, according to the A., the worse threat comes mainly from illegal, legalized, or legal activities, are carried out with all the official authorizations.

2.1. – ROLE OF MAPS

The symbols of geological goods on geological, touristic and/or naturalistic maps, work as a lighthouse in a stormy night for quite many people, and in the most negative way for acquisitive greedy collectors, unscrupulous dealers, plunderers, vandals !!! The problem is nowadays more emphasized due to the fact that maps are produced more and more at larger scales. Formerly a 3x3 millimeters symbol on a 1/100.000 scale map corresponded to an area of 300 by 300 meters, therefore it was a quite generic indication, but now, on a 1/10.000 scale map, the same symbol corresponds to an area of only 30 by 30 meters, becoming quite a precise localization.

2.2. – ROLE OF GREEDY COLLECTORS

The problem is absolutely not WHY we have to protect the geosites or "geospots", the problem is HOW.

Avid gatherers and vandals may easily completely destroy a "geospot". It is by far more difficult to destroy a geotope, even if this may happen when valleys are completely filled and hill tops cut for extensive agricultural purpose (DAMIANI, 1993a). In any case one thing is to preserve and conserve a landscape, for instance by forbidding new quarries or compelling the

restoration of the environment, as well as to conserve a subsurface mine, mainly if the accesses may be blocked (brickworks, gates). However completely different is to defend goods in geosites or in "geospots", present in small and often secluded sites in random localities. The highest danger is for geo-good which are localized or concentrated in restricted areas as: macrofossils in their paleoenvironmental "niche"; peculiar minerals (for habitus, colour, etc.), "amigdalas" as well as other remains in prehistorical sites not only because they may be easily "uprooted", isolated (for instance from the surrounding rocks), or integrally and wholly removed, but because it has been given to them a commercial value.

Very often these sites are hidden from view, far away from villages and very difficult to be reached even by scientists who study the geo-goods which there occur. Nevertheless these geo-topes are sometimes reached (I do not know how) by gatherers/dealers with trucks. In the Central Apennines for instance, a decametric coral patch reef, indicated in the geological map (F° 152), has been completely taken away. Sometimes these unscrupulous fellows use explosives in order to get a higher quantity of loose material and so destroying the most part of the good. Some other time they use explosives in order to destroy the geo-good and not-to-have other people to trade with it or sharing and enjoying the possession of the same good. This happened, for instance, in Sardinia for the amber-coloured baryte of the Silius old mine. It is utopian to watch constantly over these "geo-spots": it is difficult for volunteers, but almost impossible for official structures.

2.3. – INVENTORIES AND EXIBITIONS

Census and inventories are extremely useful for scientific purposes and for scientific, also because the localizations of the findings allows the study of the phenomenon distribution, but the informations here collected may be and too often are used by unscrupulous fellows to get their business.

Are therefore, from this point of view, useful or dangerous, the mineral and fossil local exhibitions-markets, very often indicating the place of origin of the specimens? Beside all, they foster the competition in the wild searching and in being the possessors of the best geo-good.

2.4. – ROLE OF MASS MEDIA AND GUIDES

Is the immediate mass-media information on new findings (mainly on local TV stations) useful or harmful, before any official or volunteers structures may be alarmed in order to guarantee the protection of these goods? Are the Regional Guides (geological, naturalistic, archeological, etc.), full with detailed informations, useful? Of course it is useful for students, as well for scientists and mainly it would be for local Administrators in order to know what exists in their territory and to plan geoconservation, but they do not read these papers. On the contrary all the details here described may be harmful to the conservation of the geological goods, if we think how they can be misused by eager collectors! It is difficult to evaluate in which grade lists of phenomena, guides, exhibitions and detailed informations, may be harmful and sometimes even more difficult to image how they may be misused. I remember quite many instances, as the case of an aerial photographs show, useful for archeological interpretation, immediately utilized by tomb “hunters”, when the new discoveries could be officially opened, some months later, the tombs were found completely emptied.

2.5. – ROLE OF EDUCATION AND POPULARIZATION

The role of information must be aimed at educating young and old people, from the 1st grade school up to the death, to the respect of goods, even when these may not be an immediate testimony of our cultural heritage. The environment is everything around us: above, below, at our sides. Respect to the environment has not only to be devoted to one of its components: to a flower and to its soil / bedrock; to birds and not to man. A summer course on “education to the environment” in which at the end the pupils knew everything about every single flower, but who cut their names in all desks, tables, beds and let litter everywhere around, must be considered a failure.

The integral scientific popularization has to be spread everywhere: it may avoid damages to the nature and disasters. The lack of knowledge about the past existence of glacial phenomena in our peninsular Italy and about their climatic significance (it is not easy nowadays to imagine here glaciers) led to the frequent anthropic destructions of their testimonies. Corries have been cut by roads and moraines have been excavated as raw material (DAMIANI, 1993b). In the Apuan

Alps, where due to the presence of high quality marble, erratics have been reduced and sold as slabs and glacial corries have been more or less destroyed by marble anthropic industry (VERANI *et alii*, 1996).

3. – CONCLUSIONS

The inclusion of specific geo-goods in an official list of protected objects/areas as units does not mean conservation because there is nobody (or not enough people, in the best cases) entitled to protect them. This means that, in all the forms of listing and of divulging/popularizing we must be prudent and aware of the possible consequences.

I think that there are no possibilities to validly protect “geospots” and/or geotopes if not increasing the cultural background of the people in charge of national and mainly local level government (Comuni, Comunità montane, Enti di bonifica, etc.). Without the help of the local population, educated to respect the surrounding geo-good, it is not possible to achieve any conservation at all.

The proposals of not to indicate “geospots” and vulnerable geotopes on maps, or to indicate them only generically as “locality of geological (etc.) interest”, should be valid not only until new laws will be promoted, but until we will be sure that these laws will be operative and there will be people entitled to apply them, even if, for this realization, geological times may be forecasted.

BIBLIOGRAPHY

- CONSIGLIO NAZIONALE DELLE RICERCHE & SERVIZIO GEOLOGICO NAZIONALE (1991) - *Guida al Rilevamento e all'informatizzazione della Carta Geologica d'Italia alla scala 1/50.000*. 1° Convegno sulla Cartografia Geologica Nazionale: pp. 212–133 Roma.
- DAMIANI A. V. (1993)- *Geologia ed Ambiente. Interventi antropici e riflessi sui futuri rilevamenti geologici. Esempi dal basso bacino del F. Orvia (Toscana meridionale)*. Conv. Int. “Geological research related to the environment” (Min. Ambiente-Serv. Geol. d'It., Roma-Viareggio (1988). Mem. Descr. Carta Geol. d'It., 42 (1992): 207-214, 7 figg. Roma
- DAMIANI A.V. (1993) - *Esempi di gravi manomissioni ambientali nell'Italia Centrale per mancata conoscenza della situazione geologica e “culturale”*. Conv. Int. “Geological research related to the environment” (Min. Ambiente - Serv. Geol. d'It., Roma-Viareggio (1988). Mem. Descr. Carta Geol. d'It., 42 (1992): 215-228, 14 figg. Roma.
- VERANI M. & D' AMATO AVANZI G. (1996) - *Geotipi Apuani e attività estrattiva: possibilità di coesistenza e criteri di salvaguardia*. Communication in this Symposium.

La riqualificazione ambientale del geotopo "Lago Puzzo" nel Comune di Fiano Romano (RM)

Indications for the environmental requalification of the geotope named "Lago Puzzo" - Fiano Romano (Roma)

DI LORETO E. (*), LIPERI L. (*) & PIRO M. (*)

RIASSUNTO - Nella presente memoria viene descritto il geotopo «Lago Puzzo» dalle peculiari caratteristiche geologiche, ubicato nel comune di Fiano Romano (provincia di Roma), nel settore nordoccidentale del distretto vulcanico dei Monti Sabatini in prossimità della valle del Tevere e dei rilievi carbonatici del Monte Soratte.

Si tratta di un piccolo lago di origine carsica (sinkhole) posto in una piccola depressione morfologica subcircolare del diametro di circa 600 metri. Il lago si è formato in varie fasi negli ultimi 140 anni, in seguito ai crolli delle volte di cavità di rocce carbonatiche, al di sotto di modesti spessori di sedimenti poco coerenti. I fenomeni sono stati accompagnati da eruzioni solforose. La formazione delle cavità sotterranee è legata ai processi di dissoluzione chimica, provocati dai fluidi ricchi in CO_2 e H_2S che migrano attraverso le maggiori fratture tettoniche individuate, nell'area dal ramo Nord-Sud della valle del Fosso S. Martino. Gli stessi motivi strutturali sono in relazione alla presenza in zone vicine di altri laghi e depressioni subcircolari, tra i quali il «Lago Vecchio (o Lago Sinibaldi)», il «Lago Nuovo» e «Fontana Ciocci», aventi le stesse origini. Inoltre, l'area è particolarmente interessante per le rilevanti presenze naturalistiche e le testimonianze storico-archeologiche (Lucus-Feroniae), seppure attualmente il lago sia in condizioni di notevole degrado ambientale e sia probabilmente destinato all'interimento a causa di attività antropiche.

Vengono proposti alcuni interventi per ripristinare le condizioni dinamiche esistenti, tesi a limitare il danno ambientale. Si otterrà così il recupero dell'area e nello stesso tempo si potrebbero sviluppare attività di riqualificazione anche ai fini educativi ambientali e ricreativi, quali la creazione di sentieri naturalistici con tabelle descrittive, la realizzazione di un orto botanico e l'organizzazione di programmi di visite guidate ai centri di interesse storico-archeologico presenti nelle aree limitrofe.

PAROLE CHIAVE: Lago Puzzo, depressione subcircolare di origine carsica, geotopo, riqualificazione ambientale

ABSTRACT - In the present paper the geotope "Lago Puzzo" is described. This significant geological site is located in the municipal district of Fiano Romano (Province of Rome), in the North-eastern Sabatini Mountains volcanic district, near the Tiber valley, and Mount Soratte's shear zones.

It is a little lake of karst formation (sinkhole), placed in a small morphological subcircular depression about 600 m large. The lake was formed in several phases during the last 140 years, following the breakdown of carbonate bedrock hollow vaults, below a thin cover of slightly cohesive deposits, in association with sulphureous eruptions. The formation of underground hollows is linked to chemical dissolution processes mainly due to the fluids, rich in CO_2 and H_2S , which migrate through major tectonic fractures. In our case this fractures, can be identified along the N-S branch of the S. Martino stream valley. Under the same geological and structural conditions other lakes and depressions, like "Lago Vecchio (or Lago Sinibaldi)", "Lago Nuovo" and "Fontana Ciocci" were formed in the neighbouring area. Moreover, this area is particularly relevant also for the presence of significant vegetation values and of historical and archeological remains (Lucus Feroniae), even if at the present time the lake shows a great environmental decay and will probably be filled in, due to anthropic activities.

An intervention project is proposed in this paper, in order to restore the previous dynamic conditions and reduce the environmental damage. By so doing, the attained recovery of the whole area may allow the development of activities of environmental education and properly oriented tourism, like the realization of naturalistic paths with notice boards, the creation of a botanical garden, the organization of guided visits to the historical and archeological sites of the area.

KEY WORDS: Lago Puzzo, sinkhole, geotope, environmental requalification

(*) Amministrazione Provinciale di Roma

1. – INTRODUZIONE

L'Amministrazione Provinciale di Roma, su richiesta del Comune di Capena, ha incaricato i propri tecnici di eseguire delle indagini per la elaborazione di un progetto di recupero ambientale e di valorizzazione dell'area del «Lago Puzzo», di proprietà comunale (anche se posta nel territorio di Fiano Romano), soggetta a notevole degrado ambientale. Tale degrado è dovuto principalmente alle attività antropiche e in particolare modo alle lavorazioni agricole intensive, spinte a volte fin sulle sponde dello specchio d'acqua, determinando l'alterazione degli equilibri del sistema idrografico superficiale con fenomeni di accentuata erosione e conseguente parziale interrimento del Lago. Questo è localizzato in una piccola depressione (sinkhole) dovuta a fenomeni di crollo di cavità carsiche presenti nel basamento carbonatico mesozoico sottostante un modesto spessore di sedimenti alluvionali.

Per le sue caratteristiche genetiche il «Lago Puzzo» rappresenta un bene culturale a carattere geologico di elevato valore scientifico poiché, oltre all'indubbio valore paesaggistico, la depressione morfologica rappresenta un tipico esempio di «dolina alluvionale» (SEGRE, 1948; CASTO & ZARLENGA, 1992). (fig. 1).

2. – CARATTERISTICHE GEOLOGICHE

Il Lago Puzzo si trova nel settore Nordorientale dell'area vulcanica dei Monti Sabatini, in prossimità della valle del Tevere, in posizione meridionale rispetto al rilievo carbonatico del Monte Soratte, la cui propaggine più vicina all'area è costituita dal Monte Belvedere.

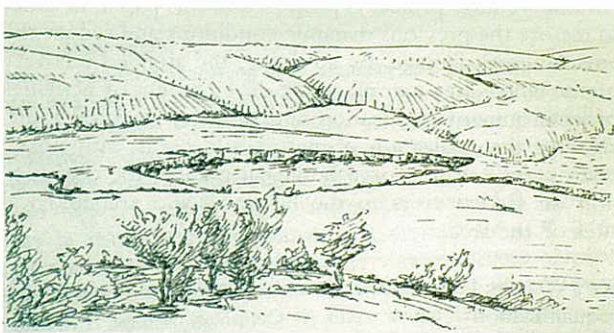


Fig. 1. – Dolina di sprofondamento suballuvionale, il Lago Puzzo nel giugno 1946. (da Segre, 1948).

– Sinkhole, Lake Puzzo - June 1946. (from Segre, 1948).

Dal punto di vista geologico si distinguono in quest'area cinque varietà stratigrafiche, riportate di seguito in ordine di età (fig. 2):

1) «Varietà carbonatiche Meso-Cenozoiche del Monte Soratte e del Monte Belvedere: costituiscono una successione condensata calcareo-siliceo-marnosa «Umbro-sabina» con hiatus a livello del Giurassico superiore e del Cretacico inferiore (PAROTTO & PRATURLON, 1975). In particolare, a sudest di Lago Puzzo, affiorano dei calcari Liassici (nella facies del Calcare Massiccio);

2) «Varietà sedimentarie marine»: affioranti intorno alle strutture carbonatiche, su cui sono trasgressive. Comprendono una serie di sedimenti, di età Plio-Pleistocenica, costituiti da una alternanza di sabbie, argille e ghiaie. Durante questo intervallo di tempo il Monte Soratte e gli altri rilievi minori più meridionali, formavano una serie di isolette e di scogli contro i cui versanti agiva l'azione erosiva del mare dando luogo a una serie di sedimenti clastici con differente granulometria, a seconda della distanza delle aree emerse e delle profondità dell'acqua (BORTOLANI & CARUGNO, 1979);

3) «Varietà vulcaniche»: rappresentate da lave ed estesi depositi di piroclastiti, alternate a epivulcaniti rimaneggiate (DE RITA *et alii*, 1993). Le fasi tensionali che hanno dato origine alle sequenze sedimentarie del ciclo neoautoctono trasgressivo, sono continuate nel quaternario, determinando nella limitrofa area Sabatina l'instaurarsi, circa 600000 anni fa (FORNASERI, 1985), di una rilevante attività vulcanica con imponenti manifestazioni. I prodotti vulcanici sono stati poi incisi dai corsi d'acqua dell'area, lungo i quali è presente una modesta copertura di sedimenti alluvionali recenti;

4) «Varietà sedimentarie di origine lacustre»: intercalate alle vulcaniti, sono presenti depositi sedimentari continentali di origine lacustre (diatomiti);

5) «Travertini»: intercalati ai prodotti piroclastici affiorano anche estese placche di travertino. Queste ultime sono una testimonianza dell'intensa attività idrotermale legata alla presenza di importanti allineamenti tettonici.

3. – QUADRO STRUTTURALE

Nell'area in esame si evidenzia la presenza dell'alto strutturale del Monte Soratte. Si tratta di un Horst dovuto alla culminazione di una struttura composta da almeno due scaglie tettoniche sovrapposte mediante

piani di accavallamento, di età miocenica, a direzione NNW-SSE e vergenza nordorientale (BENEO, 1947; PAROTTO & PRATURLON, 1975; CAVINATO & TOZZI, 1986; FACCENNA & FUNICIELLO, 1993). Sul lato settentrionale e su quello meridionale l'Horst del Soratte risulta delimitato da sistemi di faglie dirette a direzione appenninica NNW-SSE (tratto iniziale della valle del Fosso S. Martino); a questi si sovrappongono, in posizione meridionale, deformazioni a direzione prevalentemente N-S. Attraverso recenti studi di geologia strutturale eseguiti in questa zona (FACCENNA & FUNICIELLO, 1993; FACCENNA, 1994), sono state individuate due zone tettoniche di tipo trascorrente, le cui direttrici principali sono a direzione N-S. Diverse evidenze, dirette e indirette, dimostrano che le deformazioni a direzione N-S si sovrappongono a quelle a direzione appenninica. Tali dati trovano ulteriori conferme anche dalle analisi gravimetriche eseguite in questa regione (DI FILIPPO *et al.*, 1992).

L'analisi morfologica del reticolo idrografico (CICCACCI *et al.*, 1988), conferma la presenza dei lineamenti citati e mostra in maniera chiara come i segmenti fluviali a direzione NW-SE vengono troncati, con brusche catture, dalle aste fluviali a direzione N-S che sono state quindi plausibilmente le ultime a formarsi.

Dal punto di vista idrogeologico, attraverso le discontinuità a direzione N-S avviene la risalita di fluidi di origine profonda con manifestazioni a bassa termalità, ricche di gas. Lungo il loro percorso le acque lasciano un deposito grigio biancastro e il terreno è fortemente alterato. Le acque del Lago Puzzo stesso sono mineralizzate da venute di gas costituito da H_2S (VENTRIGLIA, 1989).

A sud del segmento trascorrente di Fiano Romano e nel tratto meridionale del Fosso S. Martino, sono localizzati depositi travertinosi, una serie di modeste sorgenti termali ed alcuni sinkholes, manifestazioni indirette di un circuito carsico attivo (FACCENNA *et alii*, 1993).

I sinkholes, conosciuti in letteratura anche come «limesinks» o «cenotes», sono piccole depressioni morfologiche di forma circolare, presenti lungo l'alveo del Fosso S. Martino. La loro rapida formazione è legata ai processi di dissoluzione del substrato roccioso carbonatico, posto al di sotto di una spessa copertura di terreni leggermente coesivi rappresentati da sabbie, silt, piroclastiti etc. Le cronache dei fenomeni descrivono episodi rapidi ed improvvisi di abbassamento delle acque nei laghetti già formati accompagnati da boati, emissioni di gas e scosse del

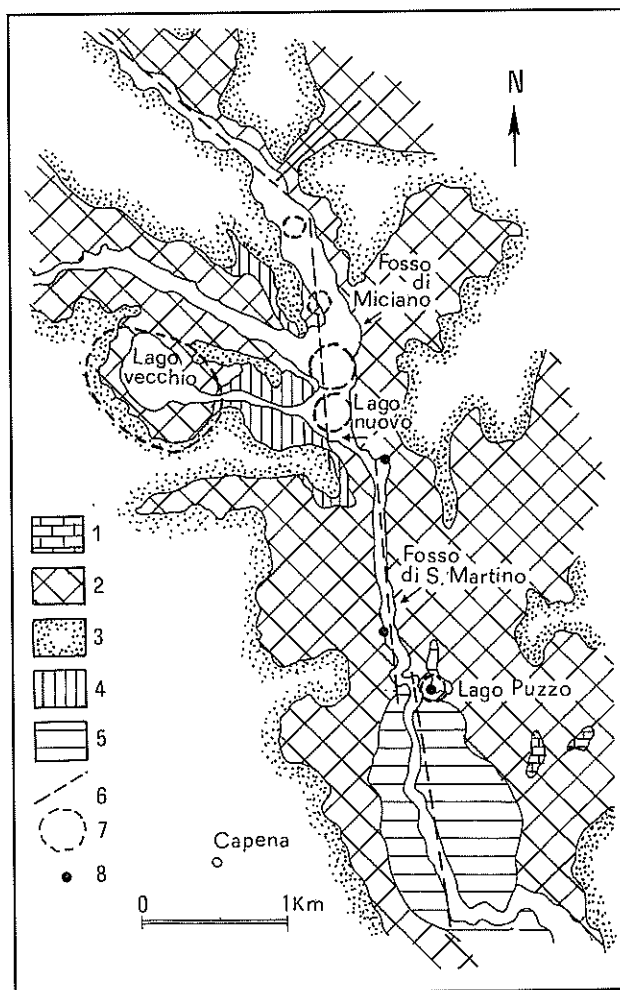


Fig. 2. – Carta geologico-strutturale dell'area. Legenda: 1) Unità carbonatiche Meso-cenozoiche; 2) Unità sedimentarie Plio-Pleistoceniche; 3) Depositi vulcanici; 4) Depositi lacustri; 5) Depositi di travertino; 6) Principali faglie (a tratteggio quando supposta); 7) Sinkholes; 8) Principali sorgenti. (da Faccenna *et alii*, 1993 - ridisegnato da S. Pascolini).

– Geological and structural sketch map of the area. Legend: 1) Mesozoic-Cenozoic carbonate units; 2) Plio-Pleistocene sedimentary units; 3) Volcanic deposits; 4) Lacustrine deposits; 5) Travertine deposits; 6) Master strike-slip faults (dashed when inferred); 7) Sinkholes; 8) Main springs. (from Faccenna *et alii*, 1993 - redrawn from S. Pascolini).

terreno tali da provocare generalmente grande panico nella popolazione. Nel passato gli studiosi hanno perciò pensato a fenomeni legati a qualche attività di tipo tardo vulcanica.

Secondo gli studi più recenti invece la loro genesi sarebbe il risultato di due processi (fig. 3):

a) il primo è dovuto al crollo di cavità sotterranee in rocce carbonatiche, poste al di sotto (50-100 m dal p.c.), di una spessa copertura di depositi leggermente coesivi, la cui formazione è legata a lenti processi di dissoluzione chimica. Attraverso le maggiori fratture tettoniche e le loro intersezioni, avviene la risalita di

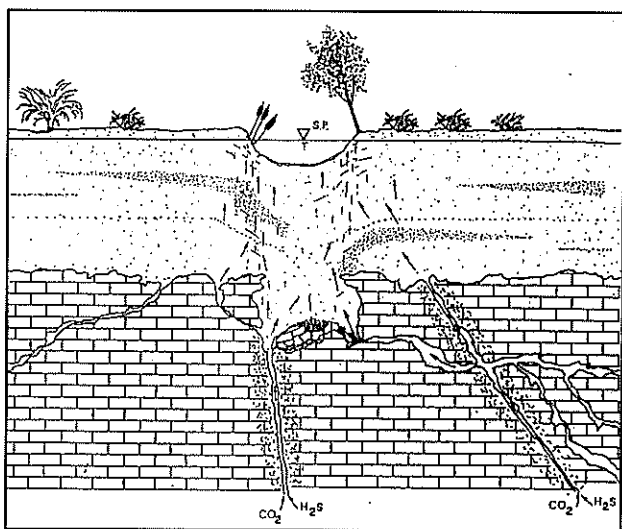


Fig. 3. — Modello schematico di formazione di un sinkhole. I fluidi aggressivi migrano preferibilmente lungo fratture subverticali riattivate in tempi recenti.

(da Faccenna et alii, 1993 - parzialmente modificato).

— *Schematic model of sinkhole development. The aggressive fluids migrate preferentially along the sub-vertical fracture reactivated in recent times.*
(from Faccenna et alii, 1993 - partially changed).

fluidi, ricchi di CO_2 , SO_2 e di H_2S , che operano la dissoluzione delle rocce carbonatiche presenti nel substrato;

b) il secondo è correlato alla lenta migrazione di suolo o di depositi non molto coesivi verso il fondo del substrato roccioso delle cavità carsiche, con il conseguente cedimento del terreno superficiale.

Nel corso dei processi di formazione dei sinkholes avviene anche l'abbassamento dei livelli piezometrici negli strati acquiferi.

4. — LA FORMAZIONE DEL LAGO PUZZO

La sera del 28 ottobre 1856 in località Lago Puzzo si aprì improvvisamente con grande fragore, una cavità che si riempì d'acqua. Ne danno notizia in apposite note alcuni insigni studiosi dell'epoca (PONZI, 1857; RATTI, 1857). Il Ponzi ritenne che il fenomeno fosse una manifestazione di attività post-vulcanica, in netto contrasto con il Ratti, che interpretò il fenomeno come il crollo risultato delle dissoluzione dei calcari sottostanti a terreni incoerenti superficiali; tesi poi ripresa da altri autori (BRUNIALTI, 1895; FOLGHERAITER, 1896; MELI, 1896; MODERNI, 1896;) per spiegare la formazione nel 1895, in un'area vicina, di un'altra cavità denominata Lago di Leprignano.

Secondo i sopracitati autori, e secondo recenti studi (FACCENNA *et alii*, 1993) a queste ultime cause sarebbero da attribuire la formazione del Lago Puzzo e della serie di depressioni, sede di antichi laghi ormai estinti, allineate lungo lo stesso disturbo tettonico e di età crescente da N verso S: Lago Vecchio (o Lago Sinibaldi, di forma circolare con un diametro di 500 m), Fontana Ciocci (con un diametro di circa 250 m), Lago Nuovo (o Lago di Leprignano, di forma ellittica con un diametro di 260 m), e il piccolo sprofondamento in località Pian della Casa, al piede di Monte Paciano, che si formò nel 1897, ma che non diede luogo ad un vero e proprio crollo (SEGRE 1948). La formazione di queste depressioni è stata accompagnata, per i casi documentati storicamente, da boati, lanci di pietre, eruzioni di vapore, tutti fenomeni esauritisi nel giro di poche ore lasciando il posto a voragini che venivano rapidamente colmate da acqua e successivamente da sedimenti.

Nel corso del tempo il Lago Puzzo si sarebbe colmato soprattutto per gli apporti detritici del Fosso San Martino, e nuovamente originato nel 1930 nello stesso luogo e con le stesse modalità del 1856, sebbene con dimensioni maggiori (IL MESSAGGERO, 1930; SEGRE 1948; PATRIZI, 1967;). Come riportano le cronache del tempo (IL MESSAGGERO, 1930;) nel 1930 si verificarono piccole esplosioni freatiche accompagnate a boati ed emissione di gas e la formazione del cratere di Lago Puzzo.

5. — DESCRIZIONE DELLO STATO ATTUALE DEI LUOGHI

Per la descrizione dello stato attuale dei luoghi e delle opere da realizzare si fa riferimento alla planimetria di progetto. (fig. 4). Il Lago Puzzo si apre al contatto fra i travertini e le sabbie marine più o meno cementate di età pliocenica; un bancone di travertino di 6-7 m di spessore domina la sponda Sud del lago. Questo ha forma ellittica allungata in senso N-S e la sua profondità attuale è molto ridotta, non oltre il mezzo metro, dato il notevole apporto solido da parte dell'erosione superficiale. La sponda orientale si presenta ripida, con un'altezza di circa 2 m sul pelo dell'acqua. A monte della sponda stessa si estende un versante coltivato che è stato oggetto di sistemazioni agricole recenti, con notevoli movimenti di terra, tanto da accelerare l'erosione superficiale, costituendo quindi una delle cause del parziale interrimento del lago. Le sponde S e N, invece, sono soggette a feno-

meni di impaludamento con sviluppo di folta vegetazione lacustre. Alla base della scarpata della sponda orientale vi sono alcune sorgenti, mineralizzate fredde con emanazioni di acido solfidrico, che non appaiono legate soltanto alla falda superficiale, relativa al fosso San Martino, ma anche a falde profonde mineralizzate. Tali sorgenti, indicate in carta, avevano la loro emergenza nel lago, ma risultano attualmente nascoste dalla coltre di depositi argillosi che ha livellato completamente il fondo; si notano solo, in assenza di acqua, alcune deboli emissioni gassose dai fanghi del fondo.

Il fosso di S. Martino passa a fianco della sponda occidentale del lago, ed è separato dal lago stesso da uno sbarramento naturale costituito da sedimenti allu-

vionali consolidati da vegetazione di alto fusto (fig. 5). Sembra che il fosso un tempo fosse direttamente collegato al lago; successivamente potrebbe aver alimentato parzialmente il lago attraverso un canale artificiale, di cui si vede ancora il tracciato, che affluiva alla sponda settentrionale. A questo proposito si deve notare che la situazione dei luoghi è attualmente diversa da come descritta nel progetto (che risale nella prima stesura al 1991), in quanto non esiste più un conoide di detrito, ma il fondo del lago è stato livellato dai sedimenti, e la profondità dell'acqua si va riducendo con il passare degli anni. Inoltre le osservazioni compiute di recente hanno permesso di determinare che nella stagione estiva la quota del pelo libero dell'acqua nel fosso è di poco più bassa di quella del cana-

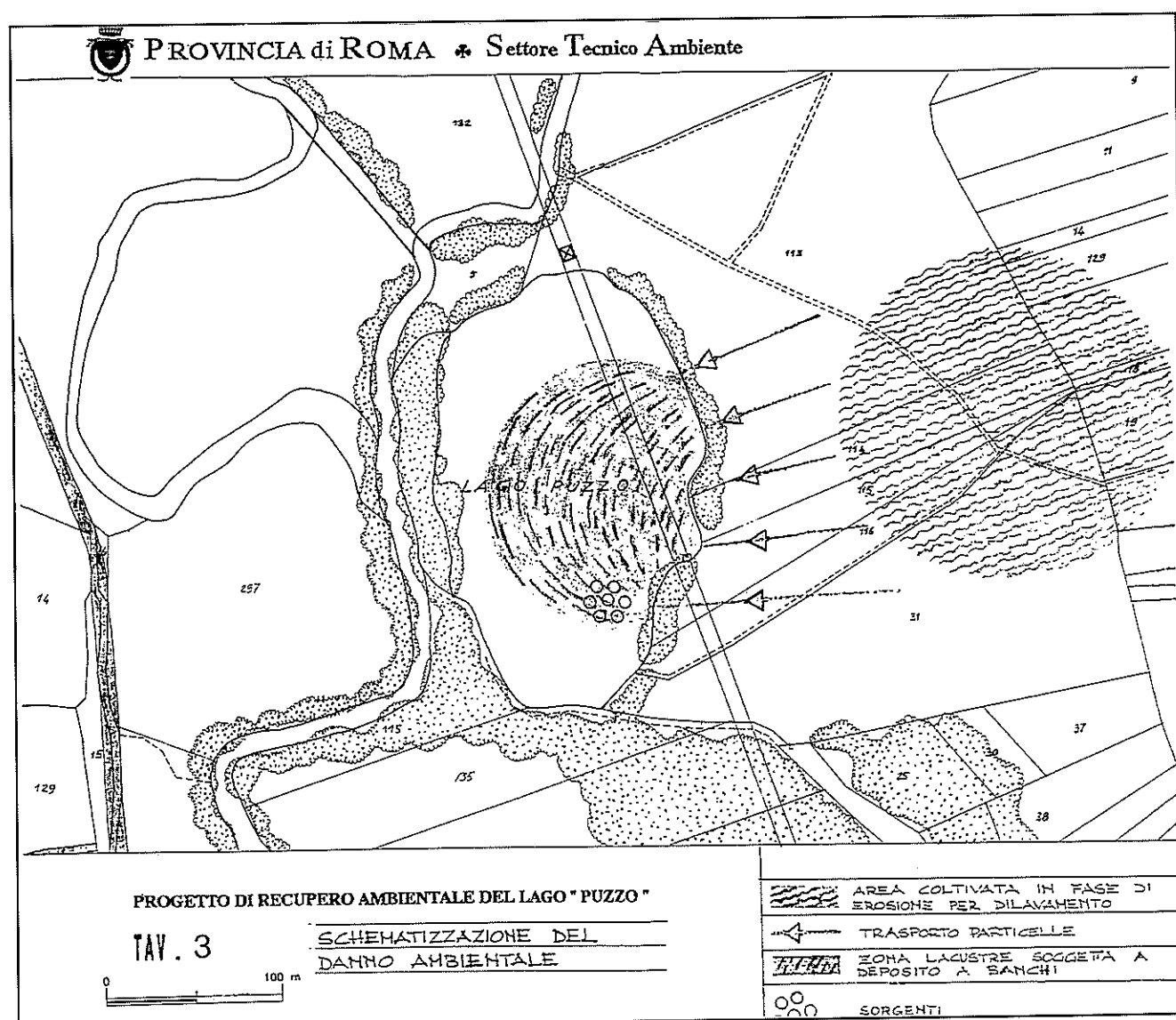


Fig. 4. - Planimetria con la schematizzazione del danno ambientale.

- Map of environmental damage.



Fig. 5. – Il fosso di S. Martino passa a fianco della sponda occidentale del Lago Puzzo, ed è separato dal lago stesso da uno sbarramento naturale costituito da sedimenti alluvionali consolidati da vegetazione di alto fusto (foto di M. Piro, maggio 1996).

– *The S. Martino ditch passes by the western side of lago Puzzo, divided from the lake by a natural barrage formed by alluvial deposits consolidated by forest trees (Photo by M. Piro, may 1996).*

le artificiale e del fondo del lago, che quindi non viene alimentato, perciò il lago risulta asciutto per la maggior parte dell'anno.

6. – CRITERI PROGETTUALI

Il progetto di recupero ambientale, frutto della collaborazione tra i tecnici del Servizio Geologico e del Settore Tecnico Ambiente della Provincia di Roma, coordinati dall'arch. L. Ciaffaglione (del Settore Tecnico Ambiente), è inserito nell'ambito dei programmi di finanziamento della Legge 21/91. L'ipotesi progettuale prevede un'opera razionale di risanamento, con la finalità di intervenire per lo stretto necessario sia sul luogo specifico che sul terreno circostante, attraverso il ripristino delle condizioni di equilibrio idrologico del Lago. I suddetti interventi sono i soli possibili in quest'area che ricade nell'ambito territoriale 4 (tav. E/37) della regione Lazio (zone di non trasformabilità) dove sono consentiti interventi di manutenzione, presidio e miglioramento dell'efficienza dei beni costituenti caratteri essenziali della natura e del paesaggio. Si è ritenuto opportuno pertanto limitare gli interventi alla zona orientale del lago, dove il danno ambientale è maggiore, e condensare in un'unica area le intenzioni progettuali. Obiettivo prioritario del presente progetto è quello di bloccare l'interramento e il depauperamento idrico del lago ripristinando le condizioni dinamiche preesistenti il danno ambientale, limitando gli apporti solidi in una zona controllata che

funge da «filtro», accessibile per interventi di manutenzione periodici. Il luogo sistemato e recuperato potrà costituire polo di attrazione e di educazione ambientale permanente.

La prima fase di intervento prevista consiste nel dragaggio del materiale alluvionale depositatosi sul fondo del lago e della risistemazione opportuna delle sponde instabili e di un preesistente fosso le cui acque sono quelle che contribuiscono al rilascio di un grande quantitativo di carico solido. Una volta liberate le emergenze di acque mineralizzate dal materiale che le occlude si prevede la ripresa della loro funzione di apporto idrico all'invaso. Il fosso di progetto sarà innestato a monte con gli altri due fossi esistenti che rasentano la conca lacustre, il Fosso San Martino (denominato in questo tratto Fosso Gramiccia) e il Fosso di Lago Puzzo. Dovrà essere realizzato a pendenza decrescente da monte verso valle con un'ampia area allo sbocco al fine di consentire un migliore deflusso delle acque consentendo il deposito del loro trasporto solido prima dell'immissione nel lago. Si otterrà così una migliore circolazione e l'ossigenazione delle acque. L'area sarà infine, sistemata adeguatamente tramite la piantumazione di specie arbustive. Il materiale di risulta del dragaggio e della escavazione del fosso sarà trasportato parte in discarica e parte potrà essere posto a difesa della sponda orientale del lago, dove si provvederà ad una nuova sistemazione generale con la realizzazione di un percorso pedonale integrato da un arboreto comprendente le specie palustri e riparie maggiormente rappresentative delle associazioni vegetali della zona.

Nella successiva fase del progetto si propone la valorizzazione dell'area attraverso la realizzazione di una serie di interventi tra i quali la creazione di percorsi naturalistici a scopo didattico, corredati da una opportuna segnaletica illustrativa per far conoscere ai visitatori i caratteri ambientali e geologici del sito. Inoltre sarà possibile visitare, data la vicinanza dal posto, alcuni centri di interesse storico-archeologico quali l'antica Capena (Lucus Feroniae), una zona necropolare etrusca e la rupe di Castellaccio, antico presidio medioevale. E' previsto infine un incremento della accessibilità ai luoghi con la realizzazione di due aree esterne con relativi avvicinamenti pedonali al fine di una facile fruizione da parte dei futuri visitatori. Nella planimetria allegata (fig. 6) sono rappresentati gli interventi di sistemazione generale qui sopra descritti.

Occorre sottolineare che l'esecuzione dei predetti interventi oltre a garantire la conservazione e la tutela di questo prezioso lembo di ambiente naturale, potrà costituire una occasione di sviluppo occupazionale nel comprensorio in attività eco-compatibili.

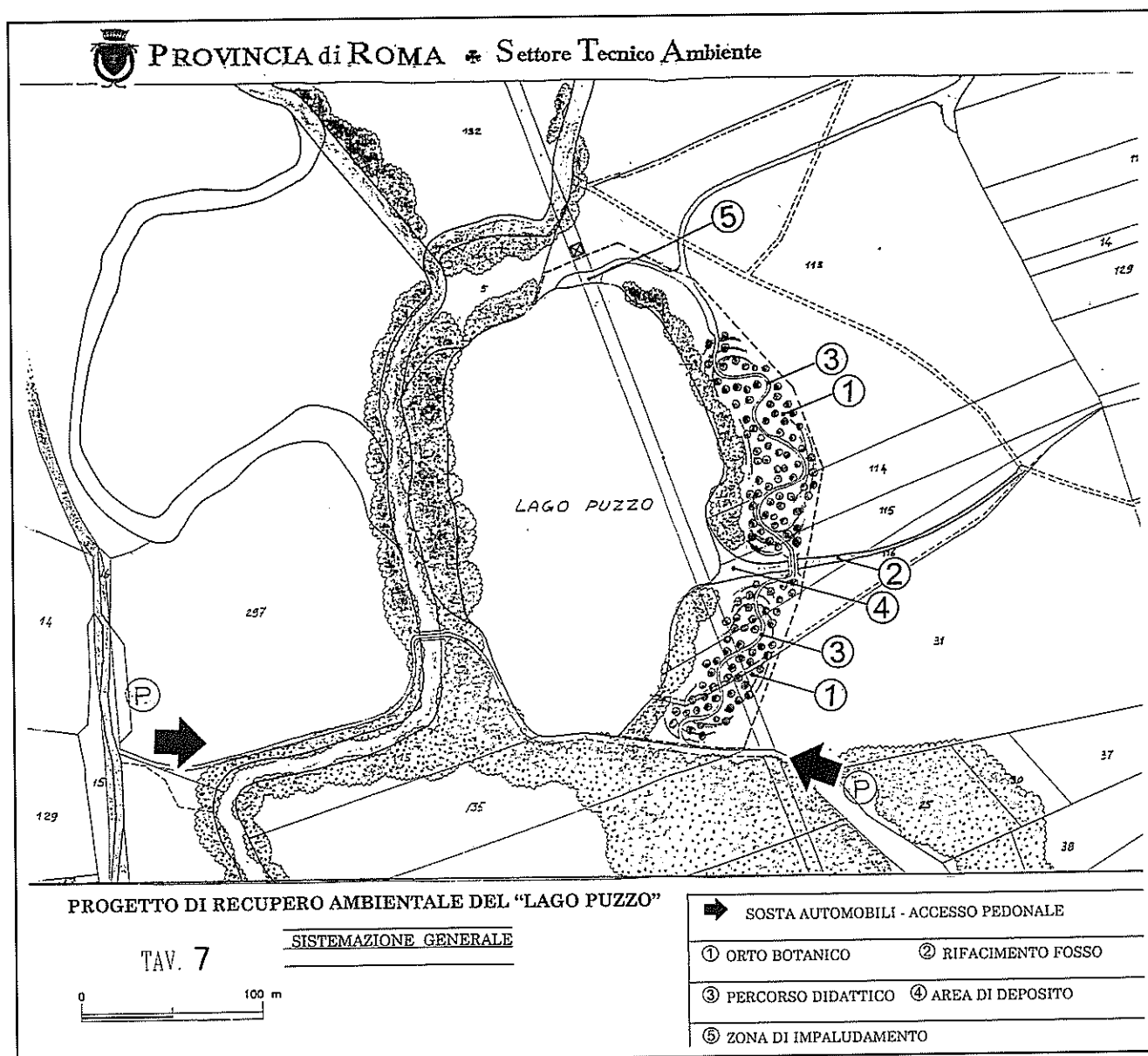


Fig. 6. – Planimetria con gli interventi di sistemazione generale dell'area.

– Map of the intervention for the general settlement of the area.

BIBLIOGRAFIA

- AMMINISTRAZIONE PROVINCIALE DI ROMA, (1991) - *Progetto di recupero di ambientale del Lago Puzzo*. A cura del Settore Tecnico Ambiente, dicembre 1991, Roma.
- BENELO E., (1947) - *Sulla struttura del Monte Soratte (Lazio)*. Boll. Soc. Geol. It., 65: 69-78, Roma.
- BORTOLANI L. & CARUGNO P. (1979) - *Lineamenti geologici strutturali dell'area a sud del Monte Soratte (Lazio centro-settentrionale)*. Boll. Soc. Geol. It., 98: 353-373, Roma.
- BRUNIALTI A. (1895) - *Il nuovo Lago di Leprignano*. L'illustrazione italiana, 22: 339-340, Milano.
- CASTO L. & ZARLENGA F., 1992 - *I beni culturali a carattere geologico nella Media valle del Tevere*. pp. 165, Enea Ed., Roma.
- CAVINATO & TOZZI, 1986 - *Studio strutturale del Monte Soratte*. Rend. Soc. Geol. It., 9: 3-6, Roma.
- CICCACCI S., DE RITA D. & FREDI P. (1988) - *Geomorfologia quantitativa e morfolettica dell'area di Morlupo-Castellnuovo di Porto nei Monti Sabatini (Lazio)*. Suppl. Geogr. Fis. e Dinam. Quater., 1: 197-206, Roma.
- DE RITA D., FUNICIELLO R., CORDA L., SPOSATO A., & ROSSI U. (1993) - *Sabatini Volcanic Complex*. Cons. Naz. delle Ricerche, Quad. Ric. Scient. 114, Progetto Finalizzato Geodinamica, (11): 33-78, Roma.
- DI FILIPPO M., RUSPANDINI T. & TORO B. (1992) - *Evidenze di shear zones in sabina meridionale*. Studi Geol. Camerti, 2: 67-71, Camerino.
- FACCENNA C. & FUNICIELLO R. (1993) - *Tettonica trascorrente tra il Monte Soratte e i Monti Cornicolani*. Il Quaternario, 6 (1): 103-118, Roma.

- FACCENNA C., FLORINDO F., FUNICIELLO R. & LOMBARDI S. (1993) - *Tectonic setting and sinkhole features: case histories from Western Central Italy*. Quaternary Proceedings, 3 : 47-56, Cambridge.
- FACCENNA C. (1994) - *Structural and hydrogeological features of Pleistocene shear zones in the area of Rome (Central Italy)*. Ann. di Geofisica, 37, (1, Aprile): 121-133, Roma.
- FOLGHERAITER G., (1896) - *Sopra il nuovo lago di Leprignano*. Frammenti concernenti la geofisica dei pressi di Roma, 3: 1-17, Roma.
- FORNASERI M., (1985) - *Geochronology of volcanic rocks from Latium (Italy)*. Rend. Soc. Geol. It. Mineral. e Petrogr., 40,: 73-106, Roma.
- IL MESSAGGERO, (1930) - *Un nuovo lago*. 1° febbraio 1930,: 8, Roma.
- MELI R., (1896) - *Breve relazione delle escursioni geologiche eseguite all'Isola del Giglio (Toscana) e al nuovo lago di Leprignano*. Ann. Scuola Applicaz. Ingegneri,: 12-19, Roma.
- MODERNI P., (1896) - *Il nuovo lago e gli avvallamenti del suolo nei dintorni di Leprignano (Roma)*. Boll. Regio Comit. Geol., 27: 46-57, Roma.
- PAROTTO M. & PRATURLON A., (1975) - *Geological summary of Central Apennines. Structural Model of Italy*. Consiglio Nazionale delle Ricerche, Quad. Ric. Scient. 90: 257-331, Roma.
- PATRIZI G., (1967) - *Sullo stato attuale del Lago Puzzo (Fiano Romano, Lazio)*. In Atti del XX Congresso Geografico Italiano, 29 marzo-3 aprile 1967, Soc. Geogr. It.: 3-7, Roma.
- PONZI G., (1857) - *Sulla eruzione solforosa avvenuta nei giorni 20-30 ottobre 1856 sotto il paese di Leprignano in contrada denominata il lago-puzzo*. Atti Pont. Acc. Naz. Lincei, 10: 71-77, Roma.
- RATTI F., (1857) - *Sul laghetto di recente formatosi nelle vicinanze di Leprignano*. In Corrisp. Scient. di Roma per l'avanz. delle Scienze, 5: 65-69, Roma.
- SEGRE A.G., (1948) - *I fenomeni carsici e la speleologia del Lazio*. Pubbl. Ist. di Geogr. dell'Univ., serie A, 7: 113-115, 143-145, 183-184, Roma.
- VENTRIGLIA U., (1989) - *Idrogeologia della Provincia di Roma., Regione Vulcanica Sabatina (Lazio)*. Amm. Prov. di Roma, Ass.LL.PP. Viabilità e Trasporti, 2: 272, Roma.

The concept of world lithosphere reserves

Il concetto di riserve della litosfera terrestre

ALEXANDROWICZ Z. (*) & WIMBLEDON W.A.P. (**)

ABSTRACT – Selected national parks and other protected areas or groups of sites of the considerable values with regard to geological and geomorphological features should be favoured by the international support. The lithosphere reserve is proposed by the Authors as an international category parallel to the biosphere reserve established by the UNESCO - MAB Programme. A network of lithosphere reserves with defined targets and principles of creation could be an effective way of promoting of the geological heritage both in the world and national systems of nature conservation. The concept of the lithosphere reserve as a new international category is presented by the proposed networks for Poland and United Kingdom.

KEY WORDS: nature conservation, lithosphere reserve, Poland, United Kingdom.

RIASSUNTO – Una selezione di parchi nazionali ed altre aree protette o gruppi di siti di valore considerevole dal punto di vista delle caratteristiche geologiche e geomorfologiche dovrebbe essere favorita dal sostegno internazionale. La riserva della litosfera è proposta dagli Autori come una categoria internazionale parallela alla riserva della biosfera stabilita dal Programma UNESCO - MAB. La rete delle riserve della litosfera con obiettivi definiti può essere un modo efficace per promuovere il patrimonio geologico nei sistemi di conservazione della natura nazionali e mondiali. Il concetto di riserva della litosfera, come una nuova categoria internazionale, è presentata per mezzo delle reti proposte per la Polonia ed il Regno Unito.

PAROLE CHIAVE: Conservazione della natura, riserva litosferica, Polonia, Regno Unito.

1. – INTRODUCTION

Geoconservation, internationally, is at early stage of activity: it is still about making contacts between countries recapitulating and expounding national achievements in conserving inanimate nature, and starting to fix and realise common targets. Contrary to this, animate nature conservation has been supported by numerous conventions, organisations and international programmes.

In general, inanimate nature consists of all those “constant” elements resulting from events which took place in the geological past; this part of nature is not fully appreciated, when conservation programmes are being set up. Geoconservation itself concerns the Earth’s historical record, and, as well as this heritage, contemporary, present day abiotic environments. The latter are undergoing natural and anthropogenic changes and these have important influence on the state and diversity of flora and fauna. Defining nature conservation priorities and evaluating the progress of its development depend, among other things, on the application of different rules, types of designation and methods of protection on local and international scales. Popularisation, publicity and publication of research programmes contribute greatly to creating social awareness, including the need to support definite targets in nature protection.

(*) Academy of Mining and Metallurgy - Institute of Stratigraphy and Regional Geology - 30-059 Kraków - Al. Mickiewicza 30 - Poland.
(**) Countryside Council for Wales - Castleton Court - St. Mellons - Cardiff (UK).

To popularize biotic nature conservation - different forms of influence are applied: one of these has been the setting up of biosphere reserves within the Man and Biosphere programme - initiated in 1968 during the UNESCO Biosphere Conference. Biosphere reserves comprise ecosystems which are representative of the main vegetational biomes occurring in the world. First of all, these reserves ought to serve scientific research focussed on forecasting and controlling changes in the biosphere. About 300 reserves exist, but their distribution within the continents is irregular: a particular concentration exists in Europe. They are characterised by being relatively small areas with considerable natural differentiation/diversity.

Geoconservation has been applied in particular countries through the protection of national networks of selected sites: localities are regulated by law and many comprise relatively small areas, often single objects, sites or monuments. Complexes of geological and geomorphological features (geocomplexes/terrains) are frequently not included. They are perhaps protected in the areas of national parks, landscape parks or in the other categories of large-space protection, where the value and role of inanimate nature are only marginally recognised, being treated as a background for the biosphere. At present, there is no special protection category covering large areas, geocomplexes, which are essential in demonstrating major and characteristic features in geological regions and also for showing natural endo- and exogenic processes. These areas may or may not be of high inanimate nature value.

Geologically and geomorphologically active zones which demonstrate the continuous evolution of the interior and the surface of the Earth are, or should be, particularly predestined to be distinguished in the world nature conservation system. Formal separation of a new category of protection called lithosphere reserves is here suggested, to preserve in a systematic and global fashion those areas of the greatest importance for the Earth sciences. Creation of reserves would generally be limited to nationally protected areas. Such sites might fall within existing biosphere reserves or other protected areas, including national parks, but their creation, research programmes thereon, and management and action plans would need to be specifically aimed at, cater for, their abiotic character and values. Recognition of lithosphere reserves might depend on the Geosites project to define a global context for selection and documentation (O'HALLORAN *et alii*, 1994). Creation of lithosphere reserves, just as with biosphere reserves, would need to be

based on international agreement within UNESCO and areas should form an international network with defined targets and tasks.

2. - LITHOSPHERE RESERVE AS THE PROPOSED CATEGORY

2.1. - TARGETS AND PRINCIPLES

Lithosphere reserves will be equivalent to the biosphere reserves in the world system of nature conservation. The aims and principles of their creation correspond to biosphere reserves (BATISSE, 1982).

Lithosphere reserves should fulfil the following requirements:

- conserving diversity of geological and geomorphological elements within geosystems providing physical and organic continuity of evolution of the Earth's interior and its surface, together with contemporary natural and anthropogenic processes;
- protecting natural surfaces, subsurfaces and submarine zones for geological and geomorphological research;
- giving educational and training opportunities in the Earth sciences, including specializations connected with geoenvironmental protection.

According to the above mentioned targets, lithosphere reserves must first of all have the following specific features:

- representative examples of selected natural geocomplexes and of particularly valuable sites, natural landscape reflecting the main elements of geological structure, as well as landscapes transformed by different farming use or mineral exploitation, provided that these areas can be restored and subjected to natural processes in their further formation;
- sufficiently large areas comprising the different lithostratigraphic units of a defined geological region.

In order to function properly the lithosphere reserve should be permanently protected and provide educational, training and research opportunities, and also be useful for monitoring causes and the rate of change and transformation of the geological environment. After the example of biosphere reserves (BATISSE, 1982), lithosphere reserves might consist of one or few central zones and their buffers. Scientific stations, fields of investigations, settlements, tourist and training centers should to be localised within buffer zones. Scientific stations, fields of investigations, settlements, tourist and training centers should to be

localised within buffer zones. Space arrangement of reserve zones would, first of all, depend on former, detailed evaluation of geological structural elements and relief, and on the focussed, detailed estimation of the state and possibilities use of the area.

2.2. – GENERAL CLASSIFICATION

Areas of various degree of nature originality preservation may be qualified for the lithosphere reserves. They would comprise natural outcrops, structural landscapes, artificial rock exposures and forms of relief transformed by human activities. The traditional/historical areas geological investigations and of scientific hypotheses documentation are particularly noteworthy. Traces of mineral exploitation from the past with cultural monuments are also important when reserves are planned.

Lithosphere reserves represent three types of environment: superficial (surface), subterranean and submarine. Some of the reserves could even comprise the elements of all three environments, but they would be mainly be the superficial ones.

Superficial lithosphere reserves are those areas where numerous and various forms of relief, formation outcrops (including the sites of fossils), structures, minerals, active processes and often geological phenomena occur. The reserves are accessible to various educational purposes and a wide range of scientific studies.

Subterranean lithosphere reserves are zones where natural and artificial objects occur; respectively, caves and other systems of natural drainage belong to the first type, and historical, well preserved mines - to the other. Safety regulations would limit their scientific and didactic use.

Submarine lithosphere reserves comprise littoral and sublittoral zones of particular configuration. These zones illustrate situations of different sediment and erosion processes. This type of reserve would serve mainly for scientific studies.

The above mentioned kinds of reserves undergo various types of dynamic change, which should be the main subject of monitoring and studies. Changes are either permanent or periodic and may depend on climatic conditions, as is often the case with weathering and erosion processes. They can also be episodic, sometimes catastrophic, when for instance they result from earthquakes or volcanism.

The proposed lithosphere reserves can be pointed out as areas particularly suitable for geological and

geomorphological research leading to the estimation of environmental change and evolution controlled both by natural processes and human impact.

2.3. – PROPOSITION OF THE LITHOSPHERE RESERVES

2.3.1. – Poland

The protected areas network is well developed in Poland and consists of particularly interesting areas where their geological structure and relief are concerned (ALEXANDROWICZ *et alii*, 1992). There are 7 biosphere reserves comprising the national parks and the animate nature reserves (fig. 1) (BREYMEYER *et alii*, 1994). Three of them are transfrontier i.e. Polish-Slovak, Polish-Czech and Polish-Slovak-Ukrainian. Three biosphere reserves are planned in Poland. Only some of the presently existing and proposed biosphere reserves fit the programme outline for the proposed category of lithosphere reserves. If the international system of nature conservation legally accepts this category, the following 12 protected areas should be taken into consideration as lithosphere reserves (fig. 1).

Tatra National Park (fig. 1, no 1).

The Tatra Mts are the highest in the Carpathians. Their core consist of Precambrian metamorphic rocks and Variscan granite overlain by Triassic-Cretaceous sedimentary formations (mainly limestones and dolomites) forming nappes overthrust northwards. The glacial relief with cirques, U-shaped valleys, hanging valleys, lakes and moraines is well developed. The timberline is situated about 1550 m a.s.l. and the highest mountain ranges reach 2500 m a.s.l.

Pieniny Klippen Belt, including the Pieniny National Park (fig. 1, no 2; fig. 2).

The Pieniny Klippen Belt is situated at the northern border of the central Carpathians. This is a zone of steep folds, thrust faults and strongly dislocated overthrust nappes. The geological structure is formed of Jurassic and Cretaceous deposits. The most typical are limestones and radiolarites of the Pieniny succession (deep-sea sediments) and limestones abounding with crinoids and other fossils of the Czorsztyn succession (shallow-sea sediments) as well as marls with *Globo truncana* and flysch. Rocks of different resistance form a very picturesque landscape with numerous deep valleys and gorges. The famous antecedent Dunajec water-gap is particularly interesting from a geological point of view.

Babia Góra National Park (fig. 1, no 3).

Babia Góra (1725 m a.s.l.) is the highest range of the Outer Carpathians formed of flysch, mainly of the thick-bedded Magura Sandstones. The whole northern slope of this range is a high rocky head scarp with large block fields and colluvial ridges in a few small lakes. The timberline is about 1360 m a.s.l. while at the top of the ridge-crest periglacial microrelief is noted.

Bieszczady National Park (fig. 1, no 4).

The Bieszczady Range is a part of the Eastern Carpathians. They are mainly formed of the Oligocene

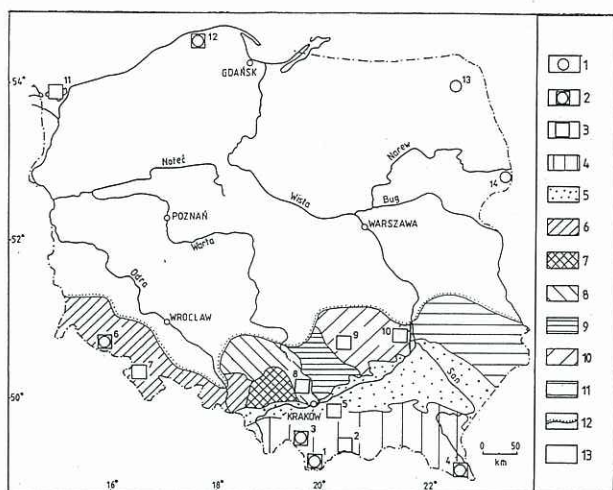


Fig. 1. – Proposed lithosphere reserves and existing biosphere reserves against the background of the geological regions of Poland. 1 - biosphere reserve, 2 - biosphere and lithosphere reserve, 3 - lithosphere reserve; 4 Carpathians: Tatra Mts - crystalline rocks and Mesozoic deposits, Pieniny Klippen Belt - Jurassic and Cretaceous carbonate sediments, Outer Carpathians - Cretaceous-Palaeogene flysch, 5 - Carpathian Trough - Neogene sediments, 6 - Sudety Mts - Precambrian and Palaeozoic rocks, Triassic and Cretaceous deposits, 7 - Upper Silesian Basin - Upper Carboniferous sediments, 8 - Cracow-Silesian Monocline - Mesozoic deposits, 9 - Miechow Syncline - Upper Cretaceous sediments, 10 - Holy Cross Mts - Palaeozoic, Triassic and Jurassic rocks, 11 - Lublin Basin - Upper Cretaceous, Triassic and Jurassic rocks, 12 - southern border of Quaternary cover, 13 - Polish Lowlands - deposits of Pleistocene Glaciations.

– Riserve della litosfera proposte e riserve della biosfera esistenti rispetto all'insieme delle regioni geologiche della Polonia. 1 - riserva della biosfera, 2 - riserva della biosfera e della litosfera, 3 - riserva della litosfera; 4 Carpatzi: Monti Tatra - rocce cristalline e depositi del Mesozoico, Pieniny Klippen Belt - sedimenti carbonatici del Giurassico e del Cretaceo, Carpatzi Esterni - flysch del Paleogene-Cretaceo, 5 Fossa Carpatica - sedimenti Neogenici, 6 - Monti Sudeti - rocce del Precambriano e del Paleozoico, depositi del Triassico e del Cretaceo, 7 - Bacino Silesiano Superiore - sedimenti del Carbonifero Superiore, 8 - Monoclinali Cracoviano-Silesiano - depositi del Mesozoico, 9 - Sinclinale di Miechow - sedimenti del Cretaceo Superiore, 10 - Monti di Croce Santa - rocce del Paleozoico, Triassico e Giurassico, 11 - Bacino di Lublino - sedimenti del Cretaceo Superiore, 12 - confine meridionale della copertura del Quaternario, 13 - Bassopiani Polacchi - depositi delle Glaciazioni del Pleistocene.

flysch (the Krosno Beds), characterised by thick-bedded sandstones alternating with shales. The uppermost part of this range is above the timberline situated at 1100-1150 m a.s.l. Block fields and several types of current marking and trace fossils from this area have been described.

Salt Mine “Wieliczka”, National Monument of History, placed on the First International List of the World Cultural and Natural Heritage by UNESCO (fig. 1, no 5).

Salt manufacturing in the vicinity of Wieliczka near Kraków dates back to the Neolithic period. Salt mining began in the Middle Ages. At present, the mine is about 300 m deep and has over 200 km of galleries, 2000 chambers and 26 surface shafts. The mine work is nowadays limited and will be terminated. The subterranean museum and tourist trail with famous monuments of mining, the network of geological documentary sites and the nature reserve “Crystal Caves” are the principal objects of conservation. Promoting the first underground national park status of the mine should be the priority. The Salifarious formation of the Miocene (Badenian) extends as a narrow strip along the northern border of the Carpathians. The salt deposit is bipartite. The lower, stratified and folded part is covered by megabreccia with huge salt blocks.

Karkonosze National Park (fig. 1, no 6).

The Karkonosze Range with Mount Ćniegka (1602 m a.s.l.) is the highest one in the Sudety Mts. It



Fig. 2. – Pieniny National Park, the main range of mountains - Upper Jurassic-Lower Cretaceous limestone formations. (Photo by Z. Denisiuk).

– Parco Nazionale Pieniny, la principale catena di montagne - formazioni calcaree del Giurassico Superiore-Cretaceo Inferiore. (foto di Z. DENISIUK).

is formed of the Upper Carboniferous granite. The Tertiary planation surface elevated during the Alpine orogenic movements is transformed by glacial processes. Cirques with lakes, moraines and block fields formed during the last glaciation are the typical features of the landscape. Numerous groups of picturesque tors enrich the relief. The timberline is presently about 1250 m a.s.l.

Góry Stokowe National Park (figg. 1, no 7; fig. 3).

Platy mountains unique in Poland and one of the few in Europe presents the tableland (900 m a.s.l.) bounded with rocky scarps rising 300 m above the neighbouring depressions. The relief reflects the geological structure. Two levels of mountain planations are formed of thick layers of cross-bedded sandstones (Cenomanien-Coniacian) divided by the complex of fossiliferous marls. The lower one is crowned with a lot of isolated tors and rocky walls, while two rocky towns are developed within the upper level.

Cracow Upland - Ojców National Park and surrounding nature reserves (fig. 1, no 8).

The Cracow Upland is formed of Devonian and Lower Carboniferous carbonates, Upper Jurassic limestones, Upper Cretaceous marls and Miocene clays. Mesozoic formations dip gently north-eastward as a monocline dislocated by several faults, bordering troughs and horsts. Tectonic structures are distinctly reflected in the relief. Abrasion surfaces overgrown with stromatolites can be observed as traces of Cenomanien and Turonian transgressions. Narrow rocky

valleys and gorges as well as numerous limestone tors are the typical features of the landscape. The rich karst scenery developed in several phases encloses a bulk of caves, rock shelters, hollows, lapies and springs.

Kielce Upland – Holy Cross National Park and nature reserves and monuments in Chęciny – Kielce Landscape Park (fig. 1, no 9).

The Kielce Upland encloses the Palaeozoic massive of the Holy Cross Mts (612 m a.s.l.) and surrounding Mesozoic formations. The range of geological history from Cambrian to Quaternary is unique one in Poland. Numerous protected old quarries are used for geological and environmental teaching. Stratigraphic sequences of different deposits with rich fossil fauna, typical examples of sedimentary and tectonic structures as well as traces of mineralization can be observed. The relics of old mines are historical monuments. Karst phenomena are developed within carbonate formations. Large block fields of Cambrian quartzites formed by periglacial climate during the last glaciation are the typical features of the relief of the Holy Cross Mts.

Krzemionki Opatowskie Nature Reserve and National Monument of History (fig. 1, no 10).

The old Neolithic mine of flints is situated within the large outcrop of Jurassic (Upper Oxfordian) limestones. Numerous shafts, galleries, excavations and mining tools are preserved there up till now. The mine was down to 11 m deep covering a vast area (about 700 shafts). The miners' work traces date back to the Funnel Beaker Culture (4500-5000 B.P.). The underground tourist trail and the museum have been arranged.

Wolin National Park (fig. 1, no 11).

The park is situated in the Wolin Island including the sublittoral zone of the Pomorze Bay. The ridge of terminal moraine (115 m a.s.l.) connected with the latest phase of the last glaciation is the main element of the relief. It is bordered with high cliff. A few huge blocks abounding in fossils occur within the moraine and crop out in the old quarries. Active abrasion and accumulation processes can be observed along the sea shore.

Skowski National Park (fig. 1, no 12).

Different types of environment such as dunes, peatbogs, swamps and sea shore developed in the mentioned area. Mobile dunes up to 56 m high forming a sandy spit cut off the ancient bay of the Bal-



Fig. 3. – Góry Stokowe National Park, Sandstone tor (Upper Cretaceous). (Photo by Z. Alexandrowicz).

– Parco Nazionale di Góry Stokowe, picco di arenaria (Cretaceo Superiore). (foto di Z. ALEXANDROWICZ).

tic Sea and created Leba and Gardno Lakes. Still active eolian processes, expressed by the typical relief and causing the movement of dunes (a few meters high) are the dominant feature of the Park of the unique value in Europe. Relics of buried soils, peats and trunks are traces of the landscape transformation during the Holocene.

2.3.2. – United Kingdom

Britain lacks national parks in the sense that the phrase is used most countries, they are not areas set aside specifically for nature conservation, but planning authority areas with distinctive landscape and scenic characters (often determined by geology). So for Britain we cite examples of group of sites and terrains which appear relevant to the discussion, both inside and outside the parks. Below are briefly listed some few tentative suggestions for lithosphere reserves in line with the outline aims given above. For simplicity, all areas noted are of classical importance in the development of geology, and are localities which are well documented.

Westphalian (Upper Carboniferous Coal Measure) section - Swansea, Neath, and Brecon Beacons National Park.

These are outcrops in valley-side crags and multiple complementary stream sections in the uplands and upland fringes of the South Wales Coalfield, many sections, cumulatively comprising many hundreds of meters of section, in riverine and floodplain sediments with coals and marine bands. They constitute the best accessible sections in Europe for the Westphalian B-D interval.

Landoverly (lower Silurian) type area, Dinefwr.

Many forestry tracks, stream sections, road cuttings and hillside crags combine to provide the type sections for the lowest beds of the Silurian. The mosaic of sites makes it possible to map the three dimensional depositional history this key area.

Upper Jurassic - basal Cretaceous (Kimmeridge, Portland, Purbeck and Wealden strata) of the east coast of Dorset.

Includes multiple Sites of Special Scientific Interest/Heritage Coast and the historical type areas for various chronostratigraphic and rock units. A range of geological and coastal geomorphological features are available for study. These are classic sites for the

study of Mesozoic stratigraphy, faunas and environments, charting the marine to non-marine Jurassic-Cretaceous transition.

Variscan Front, tectonic structures of South Wales and Pembrokeshire Coalfields.

Two areas, one in the Pembrokeshire National Park, in many kilometres of eroding coastal cliffs, and in crag outcrops in the Brecon Beacon National Park, further east, exhibit the Variscan front and other major structures in deformed Carboniferous and Devonian rocks, including some of the first mapped terrains globally, by Logan and de la Beche. Superlative sections allow detail study of these Variscan terrains which occur here with no younger cover.

Silurian – lower Devonian earliest vascular land plants – Pembrokeshire National Park, Dinefwr, Breck-nock, Brecon Beacons National Park.

Continuous coastal sections, isolated quarries and hillside crags and scarps afford many kilometres of outcrop of late Silurian and early Devonian shoreface and non-marine sediments. A variety of sites chart the appearance of land floras, vascular and non-vascular, and the first radiations of such plants. In the upland areas glacial landscapes are superbly developed.

Coastal geomorphological features Chesil Bank and Lulworth area - Dorset.

Classic depositional and erosional landforms have been studied here for 150 years, including the double tombolo of Chesil Beach (a pre-Holocene remnant beach) and Portland harbour beach. The Lulworth, Durdle Door and Mupe arch and stacks are text-book examples of differential coastal erosion.

REFERENCES

- ALEXANDROWICZ Z., KUŁEMIERZ A., URBAN J. & OTĘSKA-BUDZYN J. (1992) - *Evaluation of inanimate nature of protected areas and objects in Poland*. pp. 140, 1 map, Polish Geol. Inst., Warszawa.
- BATISSE M. (1982) - *The Biosphere Reserve: a tool for environment conservation and management*. Environmental Conservation, 9 (2): 101-112.
- BREYMEYER A. (ED.), DENISIUK Z., DMOWSKI K., DOBROWOLSKI K., GOCZOŁ-GONTAREK M., GONTAREK M., JEÉRASZKO-DYROWSKA D., KOT M., KRZAN Z., OKOŁOW CZ., PARUSEL J., PIOTROWSKA H., SIARZEWSKI W., SKAWIŃSKI P., STOYKO S., TERRY J. & WOJTERSKI T. (1994) - *Biosphere reserves in Poland*. pp. 156, Polish Nat. MAB Committee, Warszawa.
- O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (1994) - *Geological and Landscape Conservation*. pp. 520, Geological Society, London.

Provocative thoughts on earth heritage conservation or 'does protection of life form an obstacle to overcome for EHC?'

Riflessioni provocatorie sulla Conservazione del Patrimonio della Terra ossia 'la forma di protezione della vita è un ostacolo da superare per la Conservazione del Patrimonio della Terra?'

JACOBS P. (*)

ABSTRACT – In the mainstream of environmental care, Earth Heritage Conservation (EHC) is slowly but steadily progressing. According to recent developments in various countries as exemplified by (mainly European) initiatives, EHC is about to become common knowledge in the geological community. However, as it still lacks a broad and solid scientific base, EHC's future development might suffer from being too 'site-focused'. To answer questions about (and beyond) EHC, the need for a rationale and a strategy is urgently felt.

In this paper, the author communicates his personal ideas about the actual position and the role of EHC in the broader framework of the international concern about the 'quality of life' and the way to achieve this goal. It is the author's belief that EHC only represents a small but specific part of the important role that geology will have to play in the 3rd millennium. The various aspects of geology's future role and its actors are outlined. A comparison between the biology and geology idioms in conservation matters is drawn, and a way is indicated to raise public awareness.

KEY WORDS: Role of geology, Earth Heritage Conservation role, strategy, challenge.

RIASSUNTO – Nella corrente principale della cura per l'ambiente, la Conservazione del Patrimonio della Terra (EHC) sta lentamente ma costantemente progredendo. Secondo i recenti sviluppi in vari paesi, come spiegato dalle iniziative (principalmente europee), l'EHC è prossima a diventare una conoscenza comune della comunità geologica. Però, poiché manca ancora un'ampia e solida base scientifica, lo sviluppo futuro dell'EHC potrebbe trarre svantaggio dall'essere troppo «focalizzato sul sito». Per rispondere alle domande sulla (e oltre) l'EHC, si sente un urgente bisogno di una analisi ragionata e di una strategia.

In questo articolo, l'autore comunica le sue idee personali circa la posizione attuale ed il ruolo dell'EHC nel più vasto panorama dell'interesse internazionale circa la «qualità della vita» ed i modi per raggiungere questo traguardo. È convinzione dell'autore che l'EHC rappresenti solo una parte piccola ma specifica del ruolo importante che la geologia dovrà svolgere nel terzo millennio. Vengono delineati i vari aspetti del futuro ruolo della geologia e i suoi attori. Viene tracciato un confronto tra gli idiomi della biologia e della geologia in materia di conservazione e viene indicata una strada per attirare l'attenzione del pubblico.

PAROLE CHIAVE: Ruolo della geologia, ruolo della Conservazione del Patrimonio della Terra, strategia, sfida.

1. – THE 'MODERN TIMES' PLAGUES

Are geologists selfish people, or is there a narcissus hiding in each of us? Or are we masochists? One could think so if one considers the amount of complaints from geologists about quarries and sections being destroyed or filled in with water or waste. And what is our reaction about depletion of mineral, hydrocarbon or water resources? Or pollution? Or do geologists consider themselves as just poor scientists who continuously failed to provide an adequate answer in prediction of earthquakes, landslides and volcanic eruptions? Is our contribution to 'global change' and 'sea level rise' successful? Honestly, do we not feel a bit guilty for having done not enough to solve these 'modern times' problems?

(*) Department of Geology and Soil Science - University of Gent, Krijgslaan 281/S8 - B-9000 Gent (Belgium).

The last five decades are characterized by unlimited economic growth. Geologists were deeply involved in both exploration and extraction. But did we care about non-renewable resources or sustainable development? Did we consider extraction aftercare? Did we adapt our extraction techniques? In my opinion, the answers to these questions will form the overall challenge for the new millennium: clean up the mess mankind (including geologists) made.

2. – AN IMPORTANT ROLE FOR GEOLOGY

In this overall challenge, geologists will play an important role, internally as well as externally.

2.1. – INTERNALLY

2.1.1. – *Industry and the private domain*

Internally, we will have to reorientate our education programmes in an environment-friendly way, far away from the 'unlimited resources values' we stuck to until now. Academia and geological surveys will have to take on a major part of this task. But above all, we will have to reorientate our exploration and extraction techniques. Here, the role of academia and industry is of paramount importance. For those who are not familiar with the latest developments in industry, it might look strange to learn that industry is seriously considering to drastically change its strategy and policy in the years to come. Prevention and risk assessment is high on its agenda. Just a few examples to illustrate industry's new attitude, certainly inspired by economic and financial survival on the one hand, but also by concern about the environment and public awareness and control on the other:

- in the search for giant hydrocarbon fields, the BP exploration branch now takes into account a risk assessment of '10 000 years no-event' for upper-slope conditions (HILL, 1996);
- reorientation of 'research and development' into 'enhanced oil recovery (EOR)' and prevention resulted in multiplication of the financial efforts for oil exploration by a factor of 5;
- actually, multinational mineral companies discuss internally a drastic change in mining policy (WARIN, 1996);
- experts of the British Geological Survey (BGS) calculated the storage capacity of porous sandstone formations under the North Sea to be large enough to store 800 gigatons of CO₂ from North Sea gas and oil production for the coming 800 years; respecting actual

criteria, the absorption of the European CO₂-emission could compensate for the greenhouse effect, and thus contribute to the restoration of ecological balances to levels active before disruption.

2.1.2. – *Academia and the public domain*

The private sector is apparently preparing to assume its responsibility in its own economic and industrial domain. This implies that academia will have to cover the field of prevention against natural risks in the public domain. We will have to increase considerably our efforts in natural hazard prediction and risk assessment. If Governments want to protect their populations from floods, earthquakes, landslides and volcanic eruptions, they will have to invest in fundamental and applied geological research in these vital issues.

In the near future, the demand for engineering and applied geology initiatives in the wide field of public protection and prevention will increase:

- natural hazards risk assessment (prediction of earthquakes, floods, volcanic eruptions, landslides);
- environmental constraints on large constructions in civil engineering, and site investigation;
- important (if not radical) changes in exploration and extraction techniques.

2.2. – EXTERNALLY

But there is also a role for geology to play externally. Whether they like it or not, geologists will have to open up to society. We will have to realize that outside the closed world of geology, there is another world, completely different from our's. To be understood, we will have to make use of the media, the economic impact of geology possibly being the vehicle. However, if the public only ever hear about geology in the context of conflict with other interests with which they may be more familiar (and thus to which they may consequently be more sympathetic), the image of geology in general (and EHC in particular) may not benefit. As we have nothing to gain from conflictual situations, academia in synergy with industry should promote, initiate and stimulate initiatives (e.g. sustainable development) in all fields related to geology.

3. – ENVIRONMENTAL PROBLEMS AND THE QUALITY OF LIFE

Environmental problems of all kind (natural risks like floods and droughts, desertification, global chan-

ge, ozone depletion, ...) are considered nowadays as serious threats, disequilibrating irreversibly the fragile balance of life forms, that ultimately could lead to extinction of both fauna and flora. Mankind reacted by protecting endangered species (including ourselves!) but without taking away the causes of threat. And moreover, geology did not provide an adequate answer to natural hazards (like earthquakes, volcanic eruptions, ...), that were looked upon as scientifically interesting phenomena or *curiosa* rather than a 'matter of life or death' for the population concerned.

But man-induced environmental problems (non-renewable resources, demographic explosion, food production, pollution, monument deterioration, ...) could in the end also dramatically reduce the quality of life. Mankind's reaction resulted in social and cultural protection, including monument conservation.

4. – THE ROLE OF EARTH HERITAGE CONSERVATION

This knowledge spread widely and provoked a drastic change in mentality, that resulted in a worldwide concern for conservation of biodiversity and of natural and man-made ecosystems or habitats. It made cultural and biological conservation more popular and a first-order priority. But unfortunately it did not raise public awareness for Earth Heritage Conservation (EHC) (a few exceptions not mentioned).

Honestly, what have we been doing in EHC up to now? A historical overview illustrated with a panoply of European EHC examples and developments as a result of different (philosophical) approaches and accents (JACOBS *et alii*, in print), shows that we mainly have been busy with protection of stratigraphy, palaeontology and some geomorphology. Although there is nothing wrong with that, we kept ourselves happy with the preservation of 'dead material'. (For the outside world, rocks are dead material). So why is EHC not (yet) popular? As EHC deals with 'the life of dead rocks', it does not protect 'life from extinction', nor does it increase the 'quality of life' if too site-focused. Therefore EHC is not a hot topic on the political agenda. So the question is: perhaps protection or conservation of 'life' in general acts counterindicative for EHC in particular because EHC has nothing to do with life?

We also preached to the converted, and we think we owe it to ourselves to continue to do so by multiplying our national and international examples of EHC as an important task for academia and geological

surveys. We will have to learn from biologists in the way they succeeded in passing to the public their message of 'protection and conservation of the biological quality of life'. Complementary to this 'biological and cultural protection of life', we will have to find a way to translate our message into a geology idiom of 'protection and conservation of economic and industrial quality of life', of which obviously geological surveys and industry will be important messengers and actors.

5. – DEMAND FOR A STRATEGY

These quotations demand not only for a scientifically based rationale, that is currently being developed (WILSON, 1994), but also for a clear and well-defined strategy. As biologists and landscape conservationists already did, perhaps EHC-conservationists should use 'conservation of cultural heritage' as a vehicle. The latter:

I) is not connected to 'protection of life from extinction' as such;

II) is connected with 'historic aspects of human activities' (like arts, buildings and monuments, economic activities, ...);

III) calls upon a combination of aesthetic feeling and academic thinking;

IV) deals with 'quality of life' as there is a close connotation with economic and social aspects (like touristic values initiating local economic development, or linking up with industry to assure sustainable development for an ever increasing number of people in the 3rd millennium).

6. – PROGRESS

Geologists deal with time. Therefore, they should be interested in the last 5000 years of Earth history, and in the way its development was determined by the ascent of mankind and its behaviour. We certainly made technological progress, but what about knowledge? Did our knowledge progress? What were the major breakthroughs, in geology e.g.? Honestly, we had to wait for the theory of 'plate tectonics' to start to understand the relationships between phenomena like earthquakes, volcanics, orogenies, sea level fluctuations and sedimentation as being part of one and only 'living-earth system'.

And that's just what made biology attractive: it deals with a living world. People think that geology

mainly deals with a 'dead world', which does not look very appealing to them (except for a few bona-fide amateur-geologists collecting fossils and minerals). For the moment geology is not in a position to compete with biology for public interest.

'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 systems of immense richness and diversity' (ELLIS, 1996, p. VIII),

In spite of the above knowledge, pure geological considerations are mostly overlooked or neglected for various reasons. Perhaps because we didn't plead our environmental geology arguments convincingly enough.

7. – ECONOMIC AND INDUSTRIAL IMPACT OF GEOLOGY

Geologists need to find ways to address the public through the media by demonstrating the economic and industrial impact and importance of geology (ore, water and hydrocarbon exploration are probably good vehicles). The man-in-the-street is not interested in rocks as such (exception made for the collectors), but might be interested in what's inside rocks and the hidden role they play in his daily life. This role exemplifies the economic impact of geology on the quality of life. Undoubtedly there is a lot of concern about the conservation of this quality of life, and people are willing to make sacrifices to maintain it at the highest possible level without further disequilibrating fragile balances. This attitude might provide us an ideal opportunity to stress the importance of our profession by illustrating at every occasion what the contribution of geology is and could be in all attempts to maintain this high-level quality for people in the industrialized world, and to higher the quality level for people in the less-industrialized world.

8. – THE CHALLENGE OF THE 3RD MILLENNIUM

The challenge for the 3rd millennium is to bridge the gap between the 'haves and the have-nots', by raising the quality of life for the have-nots without loss

of quality for the haves. This movement does not only pose a problem of quality, but also a problem of quantity. It forms a huge challenge for mankind, and as geologists we have to be aware of the fact that there is an important and decisive role to be played by geology:

- the energy and mineral resources demand will probably continue to increase in order to assure the quality of life for a constantly increasing number of people;

- pollution clean-up will be of paramount interest if we want to keep this planet viable and restore the fragile ecological equilibrium, actually out of balance due to irreversible processes induced by human behaviour.

Often, ecology and biological conservation came in conflict with economic priorities. This does not need to be the case with EHC as industry is progressively answering the social and ecological requirements of society. Strengthening links with industry will create new possibilities for EHC, that will increase public awareness and guarantee equal opportunities for a quality life to everybody in an internationally interdependent world. Geology and EHC can not stand aside at the moment that philosophical discussions try to formulate a new rationale for a 'world-in-rapid-motion'. Biology (not only through protection and conservation of fauna and flora, but also through recent developments of biotechnology and biochemistry) succeeded surprisingly in participating in and influencing these discussions substantially. Beyond any doubt geology might contribute significantly to this debate by introducing EHC in its broadest sense (i.e. including sustainable development, non-renewable resources, site investigation, groundwater and soil pollution sanitation, etc.).

9. – A HOLISTIC VIEW ON PLANET EARTH

EHC does not stand alone; it only forms a constituting part of a holistic view on 'Planet Earth'. In 'Earth Heritage Conservation', (WILSON, 1994, mainly p. 156-157) a definition of EHC is outlined that is embedded in a holistic view with a strategy:

'Simply defined Earth Heritage Conservation (EHC) is concerned with the maintenance of landforms, natural and artificial exposures of rocks, and sites where geological processes can be seen in action today. But why should we value our Earth Heritage? We value the physical and biological resources that sustain

the activities of society. We exploit these resources to provide ourselves with food, water, heat, shelter and transport. But we also value the planet's physical resources in a cultural sense. This is because we wish to continue to seek the means to advance our knowledge of processes both in the past and at the present time. Equally importantly, we value the beauty of the physical world as an inspirational and aesthetic resource. Thus we have two value sets which sometimes conflict with each other. One is concerned with the exploitation and conservation of physical resources as commodities and the other with conserving them as 'heritage'. The latter set of 'heritage values' is inextricably linked to our own history as a species, because not only do we find beauty in unspoilt wilderness and landscapes, but we also value landscapes – both rural and urban – which we have created.

Figure 1 summarizes the distinction between the extractive and cultural physical resources of the Earth; a similar diagram could be drawn for biological resources. There is now much debate about physical resources conservation in the context of sustainable development, which is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This debate is relevant to our cultural heritage too, and so Earth Heritage Conservation can be defined as being *concerned with sustaining the part of the physical resources of the earth that represents our cultural heritage, including our geological and geomorphological understanding, and the inspirational and aesthetic response to the resource.*

The landscape and its geological foundation provide the essential framework upon which all aspects of natural and semi-natural environments are built, controlling such critical features as topography, microclimate, water distribution and soil type. Natural features are a vital part of the world's heritage, and conservation of this heritage ensures that future generations can continue to

learn about the geological history of the planet and their immediate environment through education and research, and that the public can enjoy the beauty of natural physical features.

A broad view of the role of geology and landscape in conservation takes into account sustainability, landscape conservation, local conservation and community initiatives, site conservation and public awareness, and international conservation. All these themes underline the duty of care that the geological profession has in conserving the cultural resource, which contributes to the preservation of the environment and enhancing the quality of life.

For EHC to succeed nationally and globally, both geologists and non-geologists need to be persuaded about the merits of the following justifications for conserving sites:

- because we are committed to preserving our heritage for the future;
- to allow research for the advancement of science and for the success of industry;
- to train Earth scientists;
- to provide an essential teaching facility for schools;
- as a focus for substantial leisure activities (collecting, caving, walking, etc.);
- because sites have aesthetic, amenity, historical, cultural and wildlife value.'

10. – CONCLUSION

Nowadays, environmental problems of all kind are considered as serious threats, which could ultimately lead to extinction of vulnerable or irreplaceable forms of fauna and flora, or reduce the quality of life. Reaction of mankind has resulted in protection of endangered species and in social and cultural protection including monument conservation, but without taking away the causes of threat. And although progress has been made, up to now geology was not able to provide an adequate answer to natural hazards (like earthquakes, volcanic eruptions, ...) as well.

These 'modern times' plagues provoked a worldwide concern for conservation of biodiversity and of natural and man-made ecosystems or habitats, and tur-

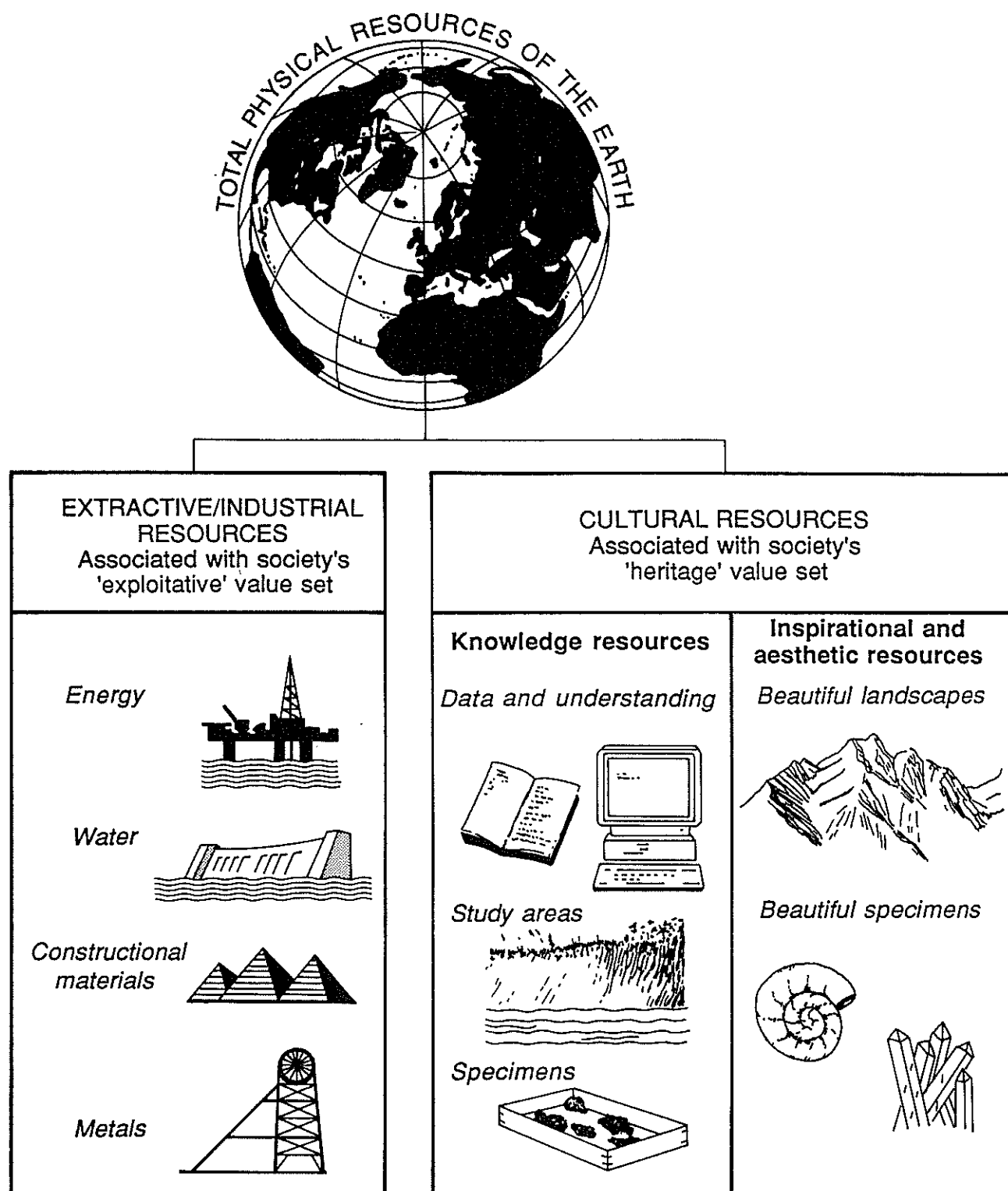


Fig. 1. – The extractive and cultural physical resources of the Earth (from WILSON, 1994).

– Le risorse estrattive e culturali fisiche della Terra (da WILSON, 1994).

ned cultural and biological conservation into a first-order priority, especially in the industrialized countries. Stimulated by steadily growing public control, these countries are capable technically and financially to invest in their own economic and industrial survival in order to maintain their quality of life at the highest possible level.

Unfortunately quality of life did not raise public awareness for EHC (a few exceptions not mentioned). As EHC deals with 'the life of dead rocks', it is not an appealing 'protect life from extinction' project, nor does it increase the 'quality of life'. Therefore EHC is not a hot topic on the political agenda yet.

To achieve this goal, a clear and well-defined strategy is necessary. Perhaps EHC-conservationists should use 'conservation of cultural heritage' as a vehicle because the latter:

I) does not suffer from a 'protection of life from extinction' syndrome;

II) but is connected with 'historic aspects of human activities' like arts, buildings and monuments;

III) calls upon a combination of aesthetic feeling and academic thinking;

IV) and deals with 'quality of life' as it connotes with economic and social aspects.

For the moment geological interest is only present in the subconsciousness of the general public. It should therefore be lifted to the surface through well thought-out education and strategy to stimulate and

increase public awareness. Sites of geological and geomorphological significance surely play an illustrating and thus important role in this process, but should not be treated as 'stand alone' objects. Before these 'books of geology' can be read and the 'library' understood and considered as an integral part of our heritage, we will have to teach the public the way they should read them. In this respect, EHC is part of a holistic geological view on 'Planet Earth', based on the profound but sometimes invisible or hidden influence that geology exerts on our daily life.

BIBLIOGRAPHY

ELLIS N.V. (Ed.) (1996) - *An Introduction to the Geological Conservation Review*. pp. 131, Joint Nature Conservation Committee, Peterborough.

HILL A.W. (1996) - *Site Investigation Studies into Seabed Stability of Slope Areas*. Abstracts Applied Geosciences, 61, The Geological Society, London.

JACOBS P., MARTINI G., SPITERIA. & WILSON C. (in print) - *Earth Heritage Conservation: towards a global strategy and philosophy*. Zbl. Geol. Paläont. Teil I, Stuttgart.

WARIN O.N. (1996) - *Mineral Exploration into the Millennium*. Abstracts Applied Geosciences, 75, The Geological Society, London.

WILSON R.C.L. (1994) - *Earth Heritage Conservation*. pp. 272, The Geological Society in association with The Open University, London.

Geological heritage of Northwestern Russia: experience in conservation

Il patrimonio geologico della Russia Nord-occidentale: l'esperienza nella conservazione

SYSTRA Y.J. (*)

ABSTRACT – The paper discusses some problems in the protection of tremendous geological heritage in NW Russia – a territory which lies primarily in the eastern part of the Fennoscandian Shield. In the past 5-6 years a number of new wildlife areas as well as nature and national parks was created there. Some of them have many valuable geological sites. However, to reliably protect the region's abundant and diverse geological heritage, long-term work should be done to reveal and delineate territories of scientific interest and to provide a legislative basis for their conservation.

KEY WORDS: Geological heritage, Precambrian, geological diversity, deep processes.

RIASSUNTO – Questo articolo tratta di alcuni problemi nella protezione del grande patrimonio geologico nel nord-ovest della Russia – un territorio che si estende principalmente nella parte orientale dello Scudo Finnoscandinavo. Negli ultimi 5-6 anni sono stati creati in quella zona un certo numero di riserve così come parchi naturali e nazionali. Molti di loro contengono siti geologici di notevole valore. Però, per proteggere in modo affidabile il notevole e vario patrimonio geologico della regione, dovrebbe essere sviluppato un lavoro a lunga scadenza per rivelare e delimitare i territori di interesse scientifico e per fornire una base legislativa per la loro conservazione.

PAROLE CHIAVE: Patrimonio geologico, Precambriano, diversità geologica, processi profondi.

(*) Institute of Geology - Karelian Research Centre - Russian Academy of Sciences - Pushkinskaya St., 11 - Petrozavodsk, Karelia (Russia).

The northwestern part of the Russian Federation lies on the oldest Archean and Proterozoic strata in the eastern Fennoscandian Shield. Here, crystalline rocks cover an area of over 350 thousand square km in the Murmansk region, the Republic of Karelia, the northern part of the Leningrad region and the western part of the Arkhangelsk region (fig. 1). South and southeast, the Precambrian basement is

overlain by a Vendian - Paleozoic subhorizontal platform cover.

In the last 50000 years the region was repeatedly covered with 2-3 km thick continental ice. The last event during which the ice gradually retreated took place only 17-9,3 thousand years ago. There are many sites where the glacier moved and stopped and where temporary watercourses and ice lakes were formed in

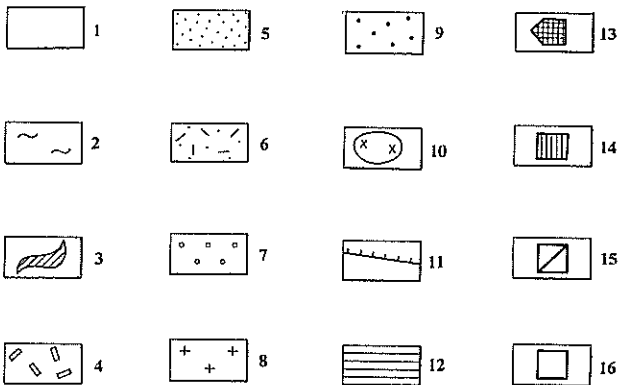
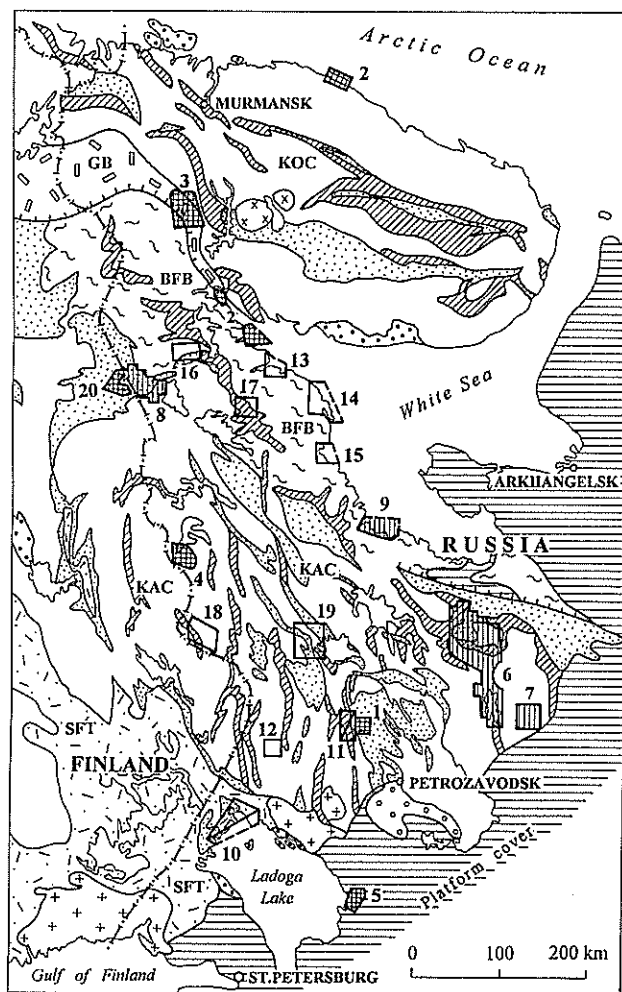


Fig. 1. — The map of the main protected and planned to protect nature territories with geological heritage objects in NW Russia.

Early Archean: 1 - basement granite and diorite gneisses, in some places with relicts of sedimentary - volcanic rocks; 2 - migmatized gneisses and amphibolites of Belomorian series. Late Archean: 3 - Lopian greenstone belts. Early Proterozoic: 4 - granulite belt; 5 - Karelian complex of sedimentary and volcanic rock; 6 - Kalevian flyschoidal sediments; 7 - Vepsian sandstones and quartzites. Late Proterozoic: 8 - Rapakivi granites; 9 - sedimentary - volcanic sequences. Paleozoic: 10 - Khibiny alkaline massifs. 11 - big thrust zones, 12 - Vendian - Paleozoic platform cover.

On map: KOC - Kola craton, KAC - Karelian craton, GB - granulite belt, BFB - Belomorian folded belt (terrain), SFT - Svecofennian terrain.

Protected territories: 13 - created before 1990; 14 - established after 1990; 15 - in the stage of creating; 16 - new planned areas. Numbers on map show protected territories: 1 - Kivach Reserve, 2 - Kandalaksha Reserve, 3 - Lapland Reserve, 4 - Kostomus Reserve, 5 - Nizhnesvir Reserve, 6 - Vodlozero National Park, 7 - Kenozero National Park, 8 - Paanajarvi National Park, 9 - Soroka Nature Reserve, 10 - Ladoga Skerries Nature Park, 11 - Hirsas State Geological Reserve, 12 - Tolvojjarvi Nature Park, 13 - Keret Nature Park, 14 - Kalgalaksha Nature Park, 15 - Pongoma Nature Reserve, 16 - Kuukasjarvi Geological Reserve, 17 - Hisovaara Geological Reserve, 18 - Tuulijarvi Nature Reserve, 19 - Jelmozero Nature Reserve, 20 - Oulanka National Park (Finland).

— Mappa dei principali territori protetti o in procinto di essere protetti come patrimonio geologico nel NO della Russia.

Archeano antico: 1 - Basamento granitico e gneisses dioritici, in alcune zone con resti di rocce sedimentarie-vulcaniche; 2 - gneiss migmatizzati e anfiboliti della serie Belomorian. Tardo Archeano: 3 - Zona a pietre verdi di Lopian. Proterozoico antico: 4 - zona granulitica; 5 - complesso Kareliano costituito da roccia sedimentaria e vulcanica; 6 - Depositi flyschoidi Kareliani; 7 - Arenarie e quarziti Vepsiani. Tardo Proterozoico: 8 - graniti Rapakivi; 9 - sequenze sedimentarie-vulcaniche. Paleozoico: 10 - Massicci alcalini di Khibiny. 11 - Zona di grande fratturazione, 12 - Piattaforma di copertura Vendiana Paleozoica.

Sulla carta: KOC - Kola craton, KAC - Karelian craton, GB - zona granulitica, BFB - Zona a pieghe Belomorian, SFT - terreno svecofenniano.

Territori protetti: 13 - creati prima del 1990; 14 - stabiliti dopo il 1990; 15 - in fase di creazione; 16 - nuove aree programmate.

I numeri sulla mappa indicano i territori protetti: 1 - Riserva di Kivach, 2 - Riserva di Kandalaksha, 3 - Riserva di Lapland, 4 - Riserva di Kostomus, 5 - Riserva di Nizhnesvir, 6 - Parco Nazionale di Vodlozero, 7 - Parco Nazionale di Kenozero, 8 - Parco Nazionale di Paanajarvi, 9 - Riserva Naturale di Soroka, 10 - Parco Naturale degli Scogli del Ladoga, 11 - Riserva Geologica di Stato di Hirsas, 12 - Parco Naturale di Tolvojjarvi, 13 - Parco Naturale di Keret, 14 - Parco Naturale di Kalgalaksha, 15 - Riserva Naturale di Pongoma, 16 - Riserva Geologica di Kuukasjarvi, 17 - Riserva Geologica di Hisovaara, 18 - Riserva Naturale di Tuulijarvi, 19 - Riserva Naturale di Jelmozero, 20 - Parco Naturale di Oulanka (Finlandia).

Quaternary time. Aesthetically, drumlin fields and many esker ridges form a beautiful landscape. Such territories should be special attention. Some of them form part of the wildlife areas and national parks opened lately. Others, e.g. the Tolvojarvi area, Karelia, provide a basis for the territories to be protected. In the future, close attention will be given to the conservation of the Quaternary geological heritage and the protection of rare, well established forms and unique sites in densely populated areas and in places where they are in danger.

Some glacier-polished, surprisingly fresh Precambrian rocks are unique witnesses of early stages in the Earth's evolution. The Precambrian heritage is represented by various geological processes, e.g. near - surface sedimentation and volcanism, the formation of intrusion, dyke and vein zones at shallow depths, the developing of intrusive bodies covering an area of about 1000 square kilometres and deep-seated zones that suffered granulite-facies metamorphism and ultrametamorphism. Considering the fact that all primary and repeatedly superimposed folding as well as metamorphic and igneous processes were manifest over a time span of almost 2.0 Ga from Early Archean (ca. 3.5 Ga ago) to the end of Early Proterozoic time (ca. 1.7 Ga ago) and that there existed considerable lateral differences in their intensity between one or another area, one can imagine the diversity of the region's geological heritage.

Attempts made in the late 1980s to decentralize the management system which existed in Russia, provided an impetus to conservation activities. In some parts of Russia, e.g. Karelia, land can now be sold or rented on a long-term basis. Additional efforts are, therefore, needed to boost nature protection activities here.

The region discussed is of great interest for the study and preservation of the Early Precambrian heritage. There are no other territories in Europe where Archean complexes are exposed so extensively.

Until 1990, the region had only 5 small strict nature reserves (fig. 1) to protect rare and endangered species of plants and animals, sometimes a nature beauties (fig. 2, A). The main problem in protecting Russia's geological heritage is that all strict nature reserves are supervised by the Federal Ministry of Environment, national parks are managed by the Russian Federal Forest Service and nature parks, wildlife areas and reserves by local forest departments and committees for the environment. There are no geologists in their staff. Therefore, even in national parks and wildlife areas unique geological sites are not used for educational purposes or as beautiful tourist attractions.

In 1995, a new Federal Law "On Specially Protected Natural Territories" came into effect. For the first time, all issues pertaining to the protection of valuable sites such as geological and paleontological areas and sites are covered in a law. However, even these territories will not be supervised by local geological committees. Instead, they will be controlled by nature protection and forests.

Thanks to Karelian enthusiasts, we have proved that geologists must also be involved in the protection of new territories of nature reserve and special scientific interest. The protected areas created in the past five years are the Vodlozero National Park (almost 0.5 million ha) at the boundary between the Republic of Karelia and the Arkhangelsk region, the Paanajarvi National Park (103,3 thousand ha) at the Finnish-Russian border, Kenozero National Park in the Arkhangelsk region and the Soroka Nature Reserve on the White Sea coast (fig. 1), where various landscapes and ecosystems are now protected together with numerous Precambrian and Quaternary sites of geological interest.

The Paanajarvi National Park, which lies in the Karelian craton - Belomorian terrain (folded belt) suture zone is one the most interesting geological territories in Northern Europe (fig. 3). The unconformable Archean-Proterozoic contact extends across the park without any traces of thrusting.

Here, the Early Proterozoic sequence is one of most complete in the region (fig. 2, B). Researchers believe that the Kivakka layered massif is the most representative such kind intrusive body in Europe. Both Archean and Proterozoic granitic intrusions are known in the area. South of the park, Archean diorites constitute the big Paajarvi uplift, which remained stable throughout the entire geological history, and are only cutted by numerous dykes and intrusive complexes. The uplift forms the northern terminus of the Karelian craton.

Various gneisses with amphibolite lenses and stringers are exposed northeast of Lake Paanajarvi. They are strongly folded and migmatized - the trait characteristic of the entire Belomorian terrain.

The park is also remarkable for a variety of non-coeval rupture dislocations. The earliest deep-seated fracture zones are traced by Olanga Group layered peridotite-gabbro-norite intrusions. Fragments of deep fault zones scattered among gneisses indicate small ultramafic (olivinite) bodies that are presumable 1.96 Ga old.

Younger strike-slip faults, formed after the latest folding as narrow, 100-150 m deep depressions to which the hydrographic network of the region is confined, are well-defined in rugged low mountain

relief. In these 50-200 m wide and many kilometres long zones the rocks are strongly foliated, sheared and broken. Small folds, kink-zones, local lineations etc. are formed. The cracks are most commonly mineralized, and total fissuring is much greater here than outside the zones. The deepest (128 m) Paanajarvi Lake is confined to a tectonic dislocation.

The Paanajarvi National Park has unique nature. Because of rugged topography the park's territory is unequally exposed to sun light. Therefore, many northern and southern plants, whose areal lie much farther north or south, respectively, co-exist there. Mountains Nuorunen and Kivakka display Europa's southernmost tundra. The park can thus be recommended for inclusion into the UNESCO World Natural Heritage List.

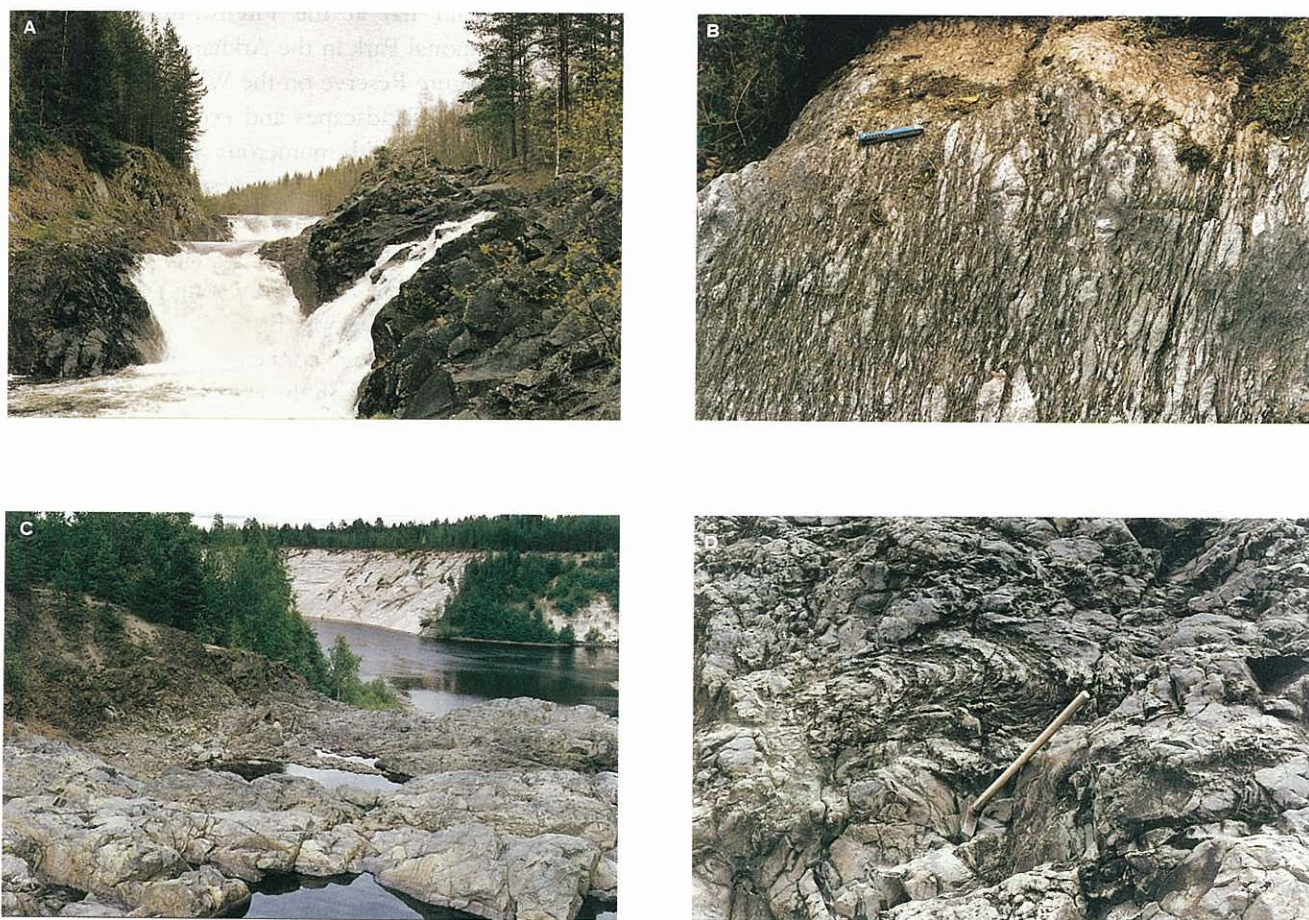


Fig. 2. – Geological monuments in protected areas of the Republic of Karelia, NW Russia.

A - waterfall Kivach on Suna River in Early Proterozoic basalts (ca. 2.2 Ga). Kivach Strict Reserve.

B - Early Proterozoic quartz porphyry's agglomerate lavas (ca. 2.45 Ga). Eastern end of Lake Paanajarvi. Paanajarvi National Park.

C - Early Proterozoic (ca. 2.2 Ga) eruptive centre in basalts. Hirvas village. The old bed of river near the Paljeozero Power Station. Hirvas State Geological Reserve.

D - The same. Well exposed lava flows near the eruptive centre.

– Monumenti geologici nelle aree protette della Repubblica di Karelia, Russia NO.

A - Cascata di Kivach sul Fiume Suna nei basalti del Proterozoico antico (ca. 2.2 Ga). Riserva Rigida di Kivach.

B - Porfidi quarziferi del Proterozoico antico (ca. 2.45 Ga). Limite orientale del Lago di Paanajarvi. Parco Naturale di Paanajarvi.

C - Centro eruttivo del Proterozoico antico (ca. 2.2 Ga) in basalti. Paese di Hirvas. Il vecchio letto del fiume vicino alla Centrale di Paljeozero. Riserva Geologica di Stato di Hirvas.

D - Idem. Flussi di lava ben evidenti vicino al centro eruttivo.

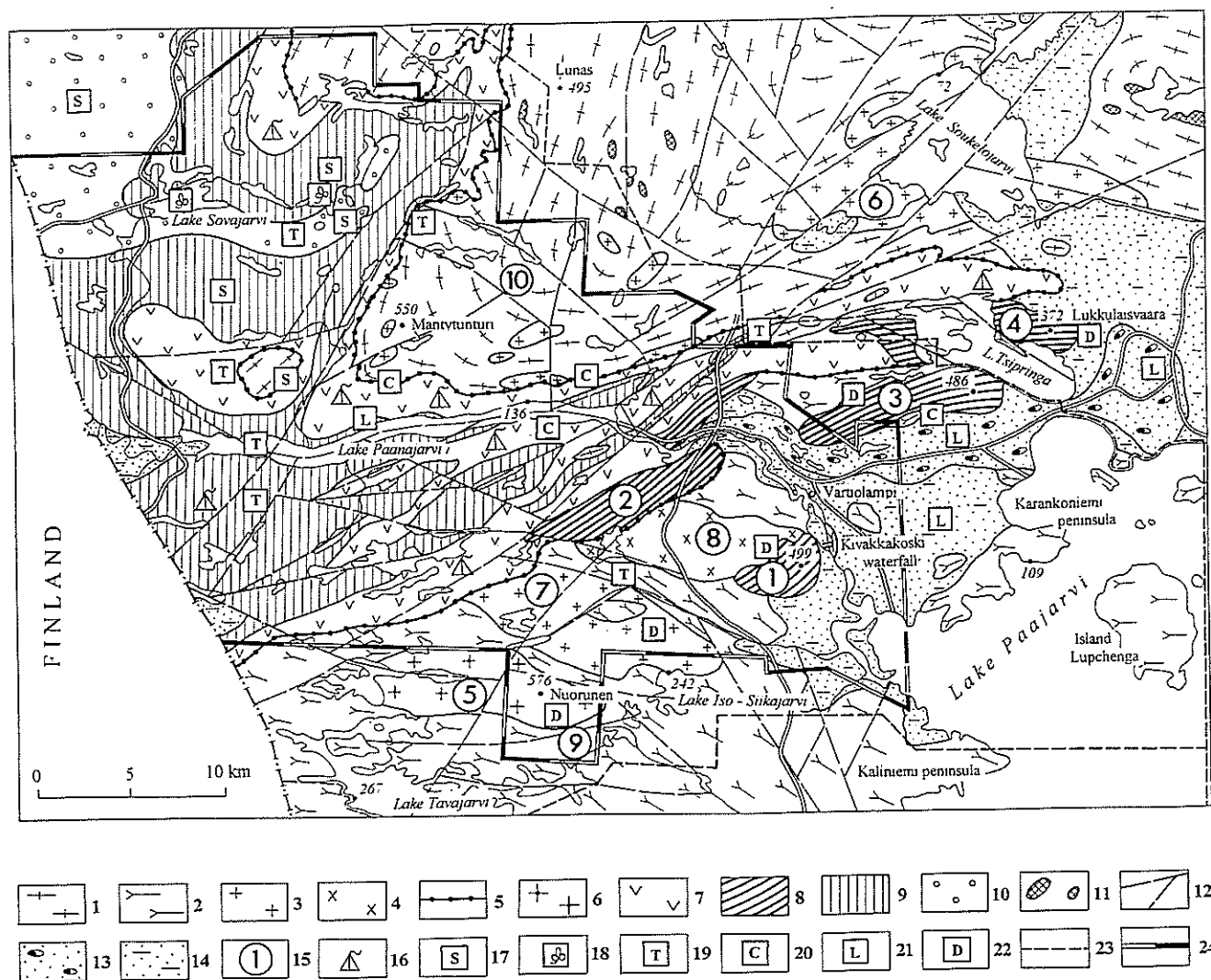


Fig. 3. – Geological map of the Paanajarvi National Park and its surrounding.

Early Archean (older than 3.15 Ga): 1 - gneisses and migmatites of the Belomorian series, 2 - Tavajarvi diorite complex. Late Archean (3.15 - 2.65 Ga): 3 - Soukkelojarvi type granite, 4 - granosyenite, 5 - Archean - Proterozoic boundary, Early Proterozoic (2.45 - 1.90 Ga): 6 - Nuorunen type granite, 7 - Sumian quartz porphyrys and andesitic basalts, 8 - layered peridotite - gabbro-norite intrusions, 9 - Jatulian sediments and sandstones, 10 - Ludicovian sediments and volcanites, 11 - bodies of metaolivinite, 12 - main strike-slip fault zones. Quaternary sediments of fluvioglacial deltas (13) and planes (14), 15 - the most interesting geological objects: 1 - Kivakka massif, 2 - Komettovaara, 3 - Tsjpringa, 4 - Lukkulaivaara, 5 - Nuorunen, 6 - Soukkelojarvi, 7 - Kaunisjarvi and 8 - Jyvajarvi massifs, 9 - Tavajarvi diorite complex, 10 - Belomorian gneisses and migmatites.

Sites of geological interest: 16 - volcanic textures and sequences, 17 - sedimentary sequences, 18 - stromatolites, 19 - tectonic monuments, 20 - contact relationships, 21 - beautiful landscapes, 22 - dyke swarms, 23 - the boundary of near-park protected zone, 24 - the national park boundary.

– Mappa geologica del Parco nazionale di Paanajarvi e dei suoi dintorni.

Archeano Antico (più antico di 3.15 Ga): 1 - gneiss e migmatiti della serie Belomorian, 2 - Complesso dioritico di Tavajarvi. Tardo Archeano (3.15 - 2.65 Ga): 3 - granito del tipo di Soukkelojarvi, 4 - granosyenite, 5 - limite Archeano - Proterozoico. Paleozoico antico (2.45 - 1.90 Ga): 6 - granito del tipo di Nuorunen, 7 - Porfidi quarziferi e basalti andesitici di Sumian, 8 - intrusioni stratificate peridotitiche - gabbro - noritiche, 9 - sedimenti e arenarie di Jatulian, 10 - sedimenti e vulcaniti Ludicoviane, 11 - Corpi di metaolivinite, 12 - Zone di faglie trascorrenti. Depositi del Quaternario di delta fluvioglaciali, (13) e piani (14), 15 - i più interessanti elementi geologici: 1 - massiccio di Kivakka, 2 - Komettovaara, 3 - Tsjpringa, 4 - Lukkulaivaara, 5 - Nuorunen, 6 - Soukkelojarvi, 7 - Kaunisjarvi e 8 - Jyvajarvi massicci, 9 - Complesso dioritico di Tavajarvi, 10 - gneiss e migmatiti Belomoriane.

Siti di interesse geologico: 16 - tessiture e successioni vulcaniche, 17 - successioni sedimentarie, 18 - stromatoliti, 19 - monumenti di natura tettonica, 20 - superfici di contatto, 21 - meravigliosi paesaggi, 22 - gruppi di dicchi, 23 - il confine della zona protetta intorno al parco, 24 - il confine del parco nazionale.

Legislative acts, required for the opening of the Ladoga Skerries Nature Park and the Hirvas State Geological Reserve, are now under way. The former has a big variety of Proterozoic rocks with Archean granite-gneiss mantled domes that constitute the Ladoga series. The park has over sixty sites of geological interest. The Hirvas area is structurally unique: there, Archean scarps and compressed Proterozoic structures were formed at the Archean-Early Proterozoic boundary. Of great interest is the fact that three noncoeval Early Proterozoic complexes rest here on each other with angular and structural unconformities. They all lie on the Archean basement with crusts of weathering.

Also of interest is indication of long volcanic activity apparent at one site.

Volcanic centres of three ages: Late Archean (ca. 3.0 Ga) and Early Proterozoic (ca. 2.4 and 2.2 Ga) lie in a circle with a radius of less than two kilometres. The youngest were the first eruptive centres found out in Precambrian rocks of Karelia (fig. 2, C and D). Thus, volcanic activity lasted here discontinuously 800 million years.

New protected territories are being successfully formed in the Arkhangelsk region near the Karelian boundary, where the Kenozero National Park and some nature reserves as wildlife areas were set up. In the Murmansk region, the Enijarvi and Kutsa wildlife areas will be re-opened in the former Finnish territory. The latter has some geological sites of utmost interest such as the Vuorijarvi alkaline massif with numerous dykes, Proterozoic multiple folded rocks in the Nivajarvi area etc.

Although structurally complex geological sites are often significant in terms of nature conservation, it is not enough to set up reserves and national parks. To protect the geological heritage, one must know regio-

nal geology as well the characteristics of each structure, site and monument to be protected.

It would be perfect if all type sections and sequences, the most typical representatives of intrusive and dyke complexes, rare mineralization zones, folded and rupture units typical of every epoch and all Precambrian traces of ancient life were preserved for future generations of geologists. Preliminary calculations have shown that in NW Russia there are a few thousand ancient Precambrian sites and territories of regional and interregional significance; many sites are of local interest.

In the next few years new protected geological territories will be established along the Russian - Finnish border, around the White Sea etc. Although special protected territories are being successfully created in NW Russia, it is desirable to outline an international project to form a network of protected geological sites and territories for the entire Fennoscandian Shield.

This network could be formed by national sites of scientific value in Finland, Sweden, Norway and Russia.

The educational aspect of wildlife conservation is highly important for local population, schoolchildren and youth. Geology and geological sites are understood only by specialists. A lot of time and effort is needed to teach people, who see rocks every day, read their beautiful history written in an old stone book. The educational level of aboriginal population and primarily youth is important for the state and protection of the environment and the natural (geological etc.) heritage in the near future.

It is essential that nowadays regions of Russia have relevant laws to provide a protected territory status for one or another site with due regard for the interests of aboriginal population.

Destroying of geotopes - examples from Slovenia

Devastazione dei geotopi - esempi dalla Slovenia

PAVLOVEC R. (*) & POHAR V. (*)

ABSTRACT – The present article deals with examples of threats to the geotopes in Slovenia. In one of the cases an important geotope was uncovered. Other examples represent geological specialities that cannot be protected for economical reasons (quarries, mines). Furthermore, the destroying of geotopes by geologists as well as amateurs and general public is very dangerous as well. It can be prevented only by an appropriate education.

KEY WORDS: Geology, geotope, geological heritage.

RIASSUNTO – Questo articolo si occupa di esempi di devastazioni ai geotopi in Slovenia. In un caso è stato scoperto un geotopo. Altri esempi rappresentano le specie geologiche che non possono essere protette per motivi economici (cave, miniere). La devastazione dei geotopi da parte dei geologi o dei collezionisti e del pubblico in genere è molto pericolosa. Essa può essere prevenuta solo per mezzo di una appropriata educazione.

PAROLE CHIAVE: Geologia, geotopo, patrimonio geologico.

1. – INTRODUCTION

Apart from a wide range of geological curiosities already under protection, there exists in Slovenia a series of geological places of interest and it would be rather useful to safeguard them as well as to establish different categories of protection. It is not always feasible just by introducing administrative measures. And last but not least, economical reasons prevent the protection of some geotopes. Sometimes the protection has even affected the preservation. People were informed about the places, they started to visit and devastate them partially or entirely. Only an appropriate education of general public and also of some geologists

might solve the problem. In this respect Slovenia has not reached a satisfactory state.

2. – CASES FROM SLOVENIA

2.1. – PALAEOLITHIC STATION

Potočka zijalka is an important high mountain prehistoric finding place of aurignacian hunters. It is situated at the southern slope of the Olševa mountain at the height of 1700 m, close to the border between Austria and Slovenia. The discovery of this Palaeolithic station is very important. In the year 1928, professor Brodar went as a mountaineer to the Olševa mountain. When he passed by Potočka zijalka he came across a pile of excavated cave bear bones. Believing that the cave bear bones are closely connected with the traces of a human being, he started with systematic excavations. He discovered one of the most important Palaeolithic stations then in Europe. Thus, a "poaching researcher" must have unintentionally shown the way to prof. Brodar. It is an interesting example how looting of an important geotope led to the discovery of a Palaeolithic station.

Regarding the number of bony nibs (130) Potočka zijalka belongs to the richest aurignacian finding places in Europe. In the time when it was discovered such sites were classified to the cool period according to French standard. However, the level above the sea plus the cultural and palaeontologic finds of Potočka zijalka proved the warm climate and a forest nearby. In

(*) Professor Doctor Rajko Pavlovec, Senior university teacher & Doctor Vida Pohar, Katedra za geologijo in paleontologijo - Univerza v Ljubljani (Chair of geology and palaeontology, University of Ljubljana) - Aškerčeva 2, SLO - 1000 Ljubljana.

this way it helped to classify the Würm glacial period to stadials and interstadials. It is also important for the stratigraphy of the Upper Pleistocene.

As uncontrolled excavations are still occurring, the closure of the entry of the cave is being considered. The same holds true for another important Palaeolithic station Divje babe in the central Slovenia. (BRODAR S. & BRODAR M., 1983; TURK *et alii*, 1989).

2.2. – MINES

The protection of geotopes in mines meets special problems. Considering the beauty and the special forms of the wulfenite, the site represents an important geotope. However, the site could not be protected during active mining. Similar problems occurred in some other mines, too. In Stari trg near Trepça (Kosovo), there are more than 100 different minerals of beautiful crystals and associations, such as sphalerite, flint, calcite, arsenopyrite. Perhaps the almost transparent vivianite is the most precious among the above mentioned stones.

Melica, a mine of lead and zinc ore in the north of Slovenia, was closed down. In the mine, wulfenite (lead molybdenum oxide named after the botanist F.X. Wulfen) can still be found on the traces of the entire ore deposit. Extraordinarily beautiful yellow, reddish, or a bit brown lamellate crystals from Melica are well known. Crystals as cubes, pyramids and dipyrramids are very rare. Extended dipyrramids are extremely hard to find.

Protection of these important geotopes in mines is a special problem. In Melica, the protection of some tunnel parts containing wulfenite is being discussed by the local authorities. Some of the most beautiful items have been inserted in the mineralogical collections, though. (KRIVOGRAD, 1978; ŠTRUCL, 1978).

2.3. – GEOLOGICAL PATHS

In Slovenia educational paths, i.e. forest-paths, forest-geological and geological paths are very popular. They are arranged, marked and have printed guides. So far, the foresters have been taking care of most of them. Yet, right now, it is not clear who is going to be in charge of them in the future, because new systems are being introduced. Entirely geological paths usually belong to the level of communities. Now an enlargement of the partially protected area near Ljubljana is under way. Fossils have been found in the

Upper Triassic limestones (such as type-locality of the species *Trigonodus carniolicus*), moreover, this area boasts of interesting tectonic forms, karst phenomena and stones used for decorative purposes. The arrangement of a geological park is being considered, too. Now, already, finding fossils is rather hard as many collectors are really keen on taking them away from the finding places.

Some years ago the Geological Institute of Ljubljana, helped by the Association of Friends of Minerals and Fossils from Trliè, started to trace a geological path across Slovenia. According to this ambitious plan the path should even be prolonged to the parts of the former Yugoslavia. Yet the work was stopped already in the middle of Slovenia and only two sections have been finished. A printed guide is available for the first section, only.

Such popularization of geology results in a great danger for the finding places of fossils, minerals and other curiosities. Sometimes general public is faced with the geotopes, but is not able to appreciate them properly. In this way some finding places were destroyed and the specimens have been sold. Protecting most of the geotopes is, physically, not possible. Laws, regulations and control of their implementation in the solitary nature do not help much. The only possibility is the education of people how to keep and esteem the geotopes and other interesting places in nature. (BUSER, 1987; MAJCEN *et alii*, 1944; PAVŠIČ, 1987).

2.4. – QUARRIES

Interesting geotopes are frequently found in the quarries. However, stopping the works for their sake is not possible. In Èrni Kal near Trieste, there is a great quarry in Eocene limestone. Blasting sometimes opens filled karst caves. In one of them, they have found the tools of a Neanderthal man and in an other there were bones of some Pleistocene animals that are very scarce in Slovenia. These are: horse – *Equus caballus*, rhinoceros – *Dicerorhinus kirchbergensis* and others. In the limestone they have found the biggest snail in Slovenia so far – *Campanile giganteum*. Nests, lens and other forms of foraminifers give interesting palaeoecological data.

The works in the Èrni Kal quarry are going on, gradually destroying valuable geotopes. The only solution is the protection of the waste area in the quarry and continuous control of the newly opened surfaces. (BRODAR, S., 1958; MIKU *et alii*, 1995; RAKOVEC, 1958).

2.5. – MUSEO COLLECTIONS

As an example, we shall mention one of the best preserved mammoth skeletons in Central and West Europe. In the year 1938, *Mamuthus primigenius* was found in Nevljje near Kamnik (BUDNAR-LIPOGLAVŠEK, 1944; KOS, 1939). The skeleton is located in The Slovene Museum for Natural Sciences. Individual parts of the skeleton have started to decay rapidly and they are being restored. In this way, the «artificial» geotope will be rescued from complete decay. However, this is not the case of the almost complete skeleton, decaying unfortunately, of a mastodon *Mammuth borsoni*, which was discovered in Velenje and is nowadays exhibited in the Velenje Museum. Its restoration is not yet under way. (RAKOVEC, 1968).

3. – CONCLUSION

There are many problems that have arisen during the protection of geotopes. Considering different possibilities and ways how to protect them is necessary. Apparently, destroying is not always harmful and protection is not always useful. We have to care about the geotope after it has been defined. In connection with the announcement of a geotope we have to name a competent holder, responsible for its regular maintenance who will also receive adequate financial means for it. At the same time we have to carry out the education and inform the government and other bodies about the importance and value of geotopes. In Slovenia, this has not yet been arranged properly.

REFERENCES

- BRODAR S. (1958) - *Èrni Kal, nova paleolitska postaja v Slovenskem Primorju* (*Èrni Kal, eine neue Paläolithstation im Küstengebiet Sloweniens*). Razprave 4. razr. SAZU, 4: 5-44, Ljubljana.
- BRODAR S. & BRODAR M. (1983) - *Potočka zijalka, visokoalpska postaja avrižnacijskih lovcev* (*Potočka zijalka, eine hochalpine Avrižnacijsstation*). Slov. akad. znanosti in umet., Cl. 4, Opera, 24: pp. 213, Ljubljana.
- BUDNAR-LIPOGLAVŠEK A. (1944) - *Rastlinski ostanki in mikrostratigrafska mamutovega najdišča v Nevljah* (*Pflanzenreste und Mikrostratigraphie der Mammutfundstelle von Nevlje*). Prirodoslovna izvestja, 1: 93-188, Ljubljana.
- BUSER S. (1987) - *Vodnik po Slovenski geološki poti* (*Slovene geological route*). Geol. zavod, pp. 122, Ljubljana.
- KOS F. (1939) - *Nevljski paleolitiki* (*Das Paläolithikum von Nevlje*). Glasnik Muzej. društva Slov., 20: 25-65, Ljubljana.
- KRIVOGRAD F. (1978) - *O mineralih meliškega rudnika* (*Mineralien in der Lagerstätte Melica, Slowenien*). VI. mednarodna razstava mineralov (VI. Internat. Mineralienmesse), Društvo prijateljev mineralov in fosilov, 10-12, Trlič.
- MAJCENT T., JOŠT S. & ŠTOR L. (1994) - *Geološka uena pot na Gorce* (*Geological path to Gorce, Slovenia*). Zveza kultur. organizacij, pp. 54, Laško.
- MIKU V. & PAVLOVEC R. (1995) - *Poll Campanile giganteum (Lamarck, 1804) iz spodnjepleistocenskih apnencev pri Èrnem Kalu* (*Gastropode Campanile giganteum di Inteziano inferiore in calcare di Èrni Kal, Slovenia*). Annales, 7/95: 157-160, Koper.
- PAVŠIČ J. (1987) - *Ljubljansko barje v geoloških obdobjih* (*The Ljubljana Moor through geologic history*). Kulturni in naravni spomeniki, 169: pp. 69, Ljubljana.
- RAKOVEC I. (1958) - *Pleistocenski sesalci iz Jame pri Èrnem Kalu* (*The Pleistocene Mammalia from the cave Èrni Kal in Northern Istria*). Razprave 4. razr. SAZU, 4: 365-433, Ljubljana.
- RAKOVEC I. (1968) - *O mastodontib iz Šaleške doline* (*The Mastodons from Šalek valley*). Razprave 4. razr. SAZU, 11/8: 301-350, Ljubljana.
- ŠTRUCL I. (1978) - *Einige über Wulfenit und sein Vorkommen in der Lagerstätte Melica*. VI. mednarodna razstava mineralov (VI. Internat. Mineralienmesse), Društvo prijateljev mineralov in fosilov, 13-16, Trlič.
- TURK I., CULIBERG M. & DIRJEC J. (1989) - *Paleolitsko najdišče Divje babe, I v dolini Idrijce. Zatočišče neandertalcev* (*Paleolithic site Divje babe*). Kulturni in naravni spomeniki, 170: pp. 73, Ljubljana.

Efforts towards an international "geoconvention": Convention focused on the Diversity of Geosystems, Geoprocesses and Geotopes

*Sforzi verso una «Geoconvenzione» internazionale: una Convenzione
focalizzata sulla Diversità dei Geosistemi, dei Geoprocessi e dei Geotopi*

STÜRM B. (*)

ABSTRACT – At first, a brief overview shows the recent endeavours undertaken in favor of an International Geoconvention. In order to give an impression of the potential effects of such a convention, a possible structure of contents is outlined. Conclusion: The still weak position and the slight or even missing integration of geoconservation into relevant policy spheres as e.g. physical planning on one hand and the increasing pressure on sensitive geosystems and worthwhile geotopes on the other hand, shall give rise to strengthen the efforts towards an International Geoconvention.

KEY WORDS: Geoconservation, international convention.

RIASSUNTO – All'inizio, una breve panoramica mostra i recenti tentativi intrapresi in favore di una Geoconvenzione Internazionale. Al fine di dare un'idea dei potenziali effetti di una tale convenzione, viene delineata una possibile struttura dei contenuti. Conclusioni: La posizione ancora debole e la scarsa o addirittura assente integrazione della geoconservazione negli ambienti rilevanti della politica, come ad esempio la pianificazione della natura da un lato e la pressione crescente sui geosistemi sensibili e sui geotopi di rilievo dall'altro, dovranno produrre una intensificazione degli sforzi verso una Geoconvenzione Internazionale.

PAROLE CHIAVE: Geoconservazione, convenzione internazionale.

1. – EFFORTS WHICH HAD ALREADY BEEN UNDERTAKEN UP TO NOW:

- *The declaration of the 1st International Symposium on the Protection of our Geological Heritage* (Digne, France, 1991) requests all national and international authorities to take into consideration and to protect the geological heritage by means of all the necessary legal, financial and organisational measures.
- *The resolution of the Malvern International Conference on Geological and Landscape Conservation* (Great Malvern, Great Britain, 1993) stresses to the first time explicitly, that there is a need for an international geoconvention and that justification for, potential scope and objectives of such an agreement should be examined in depth.
- *The resolution of the 1st International Subregional Meeting on Conservation of the Geological Heritage in South-East Europe* (Sofia, Bulgaria, 1995) underlines the need for the full integration of geotope protection in national and european legislation and in initiatives for biodiversity and landscape conservation as well.
- During the *1st ProGEO General Assembly* (Sigtuna, Sweden, 1995) a first framework approach of an International Geoconvention was presented (STÜRM, 1995).

(*) Bruggmühlestrasse 11 - CH-9403 Goldach (Switzerland).

2. – ARE THE RECENT ENDEAVOURS SUFFICIENT, OR SHOULD THEY BE STRENGTHENED?

It's obvious, that the resolutions and declarations of our meetings are hardly perceived by relevant governmental bodies and non-governmental organisations as Planning Associations, Environment Protection Organisations, Nature and Landscape Conservation Organisations and so on.

Consequently our position and influence within the struggle of interests, which determine the development of our natural environment is still by far too weak. Two examples for this:

Physical Planning (Town and Country Planning): Apart from some encouraging examples, geoconservation is still scarcely or at least not sufficiently integrated in physical planning, although physical planning offers powerful tools for coordination and for steering the spatial development (STRASSER *et alii*, 1995; STÜRM, 1991; 1994; 1995; WRIGHT, 1994).

Regional development Policies: Regional policies gain more and more importance, but this strategic context is hardly influenced by geoconservationists. Recent regional policies pursue development strategies with a considerable potential for geotope protection. A good example are the general statements of the "*ALPINE CONVENTION*" generally agreed in 1991. This international convention aims at the safeguarding of the natural, social and cultural diversity of the alpine regions and the sustainable use of their resources. Our objectives and endeavours fit perfectly in that strategic context. The Alpine Convention would have offered good opportunities to introduce different aspects of geoconservation. But we missed that chance during the initial phase, probably mainly due to our fairly weak constitution, rather than to a lack of knowledge.

This weak position of geoconservation and its weak influence on significant policy spheres contrast with the still growing pressure on geospheric values as valuable and sensitive geosystems, geoprocesses, geotopes and geosites.

3. – WHAT CAN WE EXPECT FROM A GEOCONVENTION?

Is an International Convention able to improve our rather unfavorable situation and to make geoconservation so effective as bioconservation (biosphere focused conservation)?

A possible **structure of contents** shall make the vision of a geoconvention better conceivable:

PREAMBLE

Definition of the conventions's key-subjects

For example:

- Geoconservation.
- Geological heritage.
- Geosphere.
- Geosystem.
- Geoprocess.
- Geotope.
- Geosite.

Objectives

For example:

- Promotion of the sustainable use of the geosphere and the protection of geotopes.
- Integration of geoconservation into relevant policy spheres like physical planning etc.
- Improvement of the legal basis for geoconservation.
- Improvement of conservation procedures and techniques.
- Creation of international awareness and responsibility.
- Stimulation of international cooperation and coordination.

Principles for interaction with relevant policy spheres

For example:

- Geoconservation by physical planning, nature and landscape conservation, environmental impact assessment etc.
- Implementation strategies.

Statutory tools and procedures

For example:

- Criteria, guidelines, procedures for identification, documentation and evaluation of subjects of international significance.
- Directions and rules for supervision and control of progress.

- Principles for coordination and information exchange between Signatory States and International Organisations, like e.g. UNESCO, IUCN, IUGS, Statutory bodies of existing relevant International Conventions, like the "WORLD HERITAGE CONVENTION", the "BIODIVERSITY CONVENTION" etc.

Statutory bodies

For example:

- Standing committee and other involved bodies.

Ancillary measures

For example:

- Fund rising and financial support.

Final clauses

For example:

- Ratification and amendment procedures.

We can expect no miracles by an International Geoconvention. Such a convention will bring not more and not less than all other already existing similar conventions, as e.g. the "BIODIVERSITY CONVENTION". But this is certain, a specific convention focused on geospheric values would serve as backbone for our activities and thereby help us to gain more hearing; that means more influence on decisive decision making processes and last but not least more support by the international community.

An other aspect: Until nowadays most of the geo-conservationists do their work on a voluntary basis. A Geoconvention could help to transform geoconservation into an official public task. Such a stable operational basis is absolutely necessary if we want to achieve our common general aim, the sustainable use of the geosphere and the durable protection of its geotopes, before it's too late.

REFERENCES

- STRASSER A., HEITZMANN P., JORDAN P., STAPPER A., STÜRM B., VOGEL A. & WEIDMANN M. (1995). *Protection des Géotopes en Suisse: Rapport de stratégie*. Académie suisse des sciences de la nature.
- STÜRM B. (1991). *Intégration de la protection du patrimoine géologique dans l'aménagement du territoire en Suisse*. In: Mémoire de la société géologique de France, 165.
- STÜRM B. (1994). *The Geotope Concept*. In: O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (eds), *Geological and Landscape Conservation*. Geological Society, London, 27-31.
- STÜRM B. (in press.) - *The influence potential of physical planning, a big chance for geotope protection and geosphere focused landscape management*. 1st International Subregional Meeting on Conservation of the Geological Heritage in South-East Europe, 1995, Sofia.
- STÜRM B. (in press.) - *First framework approach and steps towards an International Geoconvention*. 1st ProGEO General assembly, 1995, Sigtuna.
- WRIGHT R. (1994). *Local authority planners, what can they do to conserve our geological features and landforms?* In: *Earth Heritage 2/1994*, English Nature, Scottish Natural Heritage and Countryside Council for Wales.

The geoconservation in Greece: legal basis-existing situation *La geoconservazione in Grecia: la situazione attuale della legislazione*

THEODOSSIOU-DRANDAKI I. (*)

ABSTRACT – The idea of geoconservation and the registration of representative sites was undertaken for the first time at the Institute of Geology and Mineral Exploration in 1982, an attempt that didn't continue until 1995 when a new working group was established in order to: a) compile systematically a complete network of the most representative greek geotopes, b) find out how geoconservation appears into the greek legislation, c) promote the idea of geoconservation.

KEY WORDS: Geoconservation, Grece, legislation.

RIASSUNTO – L'idea della geoconservazione e la catalogazione dei siti rappresentativi fu presa in considerazione per la prima volta all'Istituto di Geologia e dello Sfruttamento Minerario nel 1982, un tentativo che non è continuato fino al 1995, quando è stato costituito un nuovo gruppo di lavoro con lo scopo di: a) compilare sistematicamente una mappa completa dei più rappresentativi geotopi greci, b) verificare come la geoconservazione venga considerata dalla legislazione greca, c) promuovere l'idea della geoconservazione.

PAROLE CHIAVE: Geoconservazione, Grecia, legislazione.

Greece due to its geographic position on the convergence area of two tectonic plates presents a complicated geological structure and great variety of geoforms and formations. It's our duty for the sake of the international scientific community and the entire world to record and promote them.

The first attempt for a registration of natural monuments, according to the existing legislation, was undertaken, in 1982, by the geologists of the Institute of Geology and Mineral Explorations, under the supervision of Dr. I. Bornovas director at that time of the Geology and Geological Mapping Department.

A report for about 50 sites, having in a rough way the concept of geotopes, was compiled, accompanied by topographic maps and deposited at the Ministry of Civilization.

This effort didn't continue. Since 1995 a working group for geoconservation has been composed at IGME, having as primary objectives:

a) To examine the situation in Greece regarding the conservation of geological-geomorphological heritage.

(*) Institute of Geology and Mineral Exploration - 70 Messoghion str. - Athens 11527 (Greece).

b) To promote the idea of geoconservation.

c) To make a list of geotopes, worthy preservation, in national, balcanic and european level. Geotopes should be selected in order to compose a network of the geology of the country.

d) To interfere for the enacting of relevant legislation at the authorities and the European Union, in collaboration with other organizations in the field of geoconservation.

The registration forms have already been distributed to IGME's geoscientists with detailed guide lines and soon they will circulate widely in the whole greek geological community and to the foreign geoscientists working in Greece, translated in English and French.

At the same time, we are trying to compile a geographical information system in order to have digital information. We prepared also a CD commented for the students and the public. This form was addressed as well to the geologists of IGME for the updating of 1:50.000 geological maps.

For filling in the forms, we insist in the idea of the network of sites, because, till now, several of the areas declared for protection have been chosen randomly without a systematic study. Saying network, I mean these representative sites from which the geology of the country can be extracted.

But the idea of network is not an easy thing to do. How to start creating a network?. Starting recording f.i. only the volcanicity and creating a network of volcanic sites? Or only the terrace systems? Or for instance, all Jurassic formations? etc. That, means we tried to find a unit for the network in order for us to start and become familiar with it gradually.

But difficulties never stop. Because if we start f.i. with representative terrace systems, the geoconservation would become an affair of quaternarists for some years and the geologists involved would be very few. So we decided to start compiling a form with a lot of informations to be filled in each geologist for his own field of research, no matter in which topic of geology or geomorphology but always with the idea of representativity and network to play the first role. Thus, the sites can afterwards be compared enabling us to create a cadastral out of them.

But difficulties with the network don't stop even here. In order to create a network in balkan, european or international level, we have, to standardize, as far as possible the forms. They should contain common precise specifications, having conceived the meaning of the network in the sameway, so order that the sites can be compared in that level in order to compile a geo-

graphical information system and a relational D.B. We need a functioning network of information and contacts between us in order to build a systematic network of geotopes. In that way I hope that everything will get better for the geoconservation issue.

If we have a look at the greek legislation, we realize that till the end of the past century (we should take into account that Greece wonned its independence after the greek revolution in 1821) only certain law decrees were enforced, referring to the state's will to establish a physical environment protection policy. In this century by a law of 1932 on antiquities, still in force, and its supplementary law of 1950, the possibility of declaring certain areas as landscapes of special natural beauty was established. That is the reason that Archaeological Service is still authorized for the protection of natural areas.

By a 1937 law, provided for the establishment of up to five National Parks as areas of special protective Status, it is mentioned for the first time, among other things, "the conservation of geomorphological formations". In 1969, this law incorporated into the Forest Code and amended on, by a Law decree of 1971, provides, among other things, the possibility of Natural monuments to be preserved. Therefore the forestal Service is authorized for Natural monuments protection, as well as for the application of this law resulted in the declaration of 10 National Parks, 19 aesthetic forests, 5 Natural Monuments.

The first constitutional regulation for the protection of the natural environment is laid down in article 24 of 1975 constitution.

Consequently, in 1986 the legal framework of the natural environment protection is renovated with the law 1950. In this law, the category of natural formations, landscapes and landscape elements to be protected is mentioned. The Ministry of Planning, Environment and Public works is responsible for the application of this law. Therefore, civil engineers and architects are often authorized for the protection of natural environment.

Besides, there are also the international conventions and more precisely in the case of Greece, the convention for the protection of the World Cultural and Natural heritage of 1971, ratified in 1981 with a national law. Thirteen very famous monuments have been characterized as worldwide cultural monuments. Only two of them (Meteora and Athos mountain) are both natural and cultural monuments according to this law.

Based on this legislation, the categories of the areas mentioned above have been enlisted in a protection status. It cannot be said, however, that the variety

of the natural characteristics occurring in Greece, is covered effectively by law. The Greek nature is privileged with representative biotopes and geotopes enclosing particular geological, geomorphological and physiographic formations or unique landscapes of superb beauty and special physiognomic and cultural features.

The percentage of areas under protection in Greece, is very low. Half per cent according to my sources. Possibly the lowest in Europe.

Furthermore, effective protection and rational organization has not been ensured yet, even for the areas already enlisted in the protection status. Their significance and value as well as the necessity for special treatment and management have not been evaluated accordingly.

As it is evident from the above briefly presented legislation, geological formations, geoforms, geotopes and geoconservation are not properly reported. All references are very general. Therefore geologists are not authorized for the conservation and protection of what they know better than anyone else.

In Greece the idea of geoconservation is not very spreaded.

With our efforts things are changing and geoconservation is getting it's true dimensions.

BIBLIOGRAPHY

- BLACK P.G. & GONGGRIJP P.G., (1990) - "Fundamental thoughts on Earth-Science Conservation", *Jb. Geol. B.A.*
- BORNOVAS, J. (1982) - Report on the Natural landscapes of Greece, requiring protection. *Report for the Ministry of Culture.*
- GONGGRIJP G.P. & BOEKSSCHOTEN G.J. (1981) - Earthscience conservation: no science without conservation.- *Geol. en Mijnbouw*, 60: 433-445.
- KASSIOUMIS, K. (1994) - Nature protection in Greek legislation, protected areas and conservation authorities. *Geotechnical Scientific subjects*, 5: f. 3/94.
- THEODOSSIOU-DRANDAKI (1995) - Geological heritage is a heritage as well and it needs, our concern Article in review TICCHI (The international committee for the conservation of industrial heritage, *Greek section*), 3: 10/95.
- WIMBLEDON W.A., BENTON M.J., BEVINS R.E., BLACK G.P., BRIDGLAND D.R., CAMPBELL, S., CLEAL C.J., COOPER R.G., & MAY V.J. (1995) - The development of a methodology for the selection of british geological sites for conservation: part 1. *Modern Geology*, 20: 159-210.