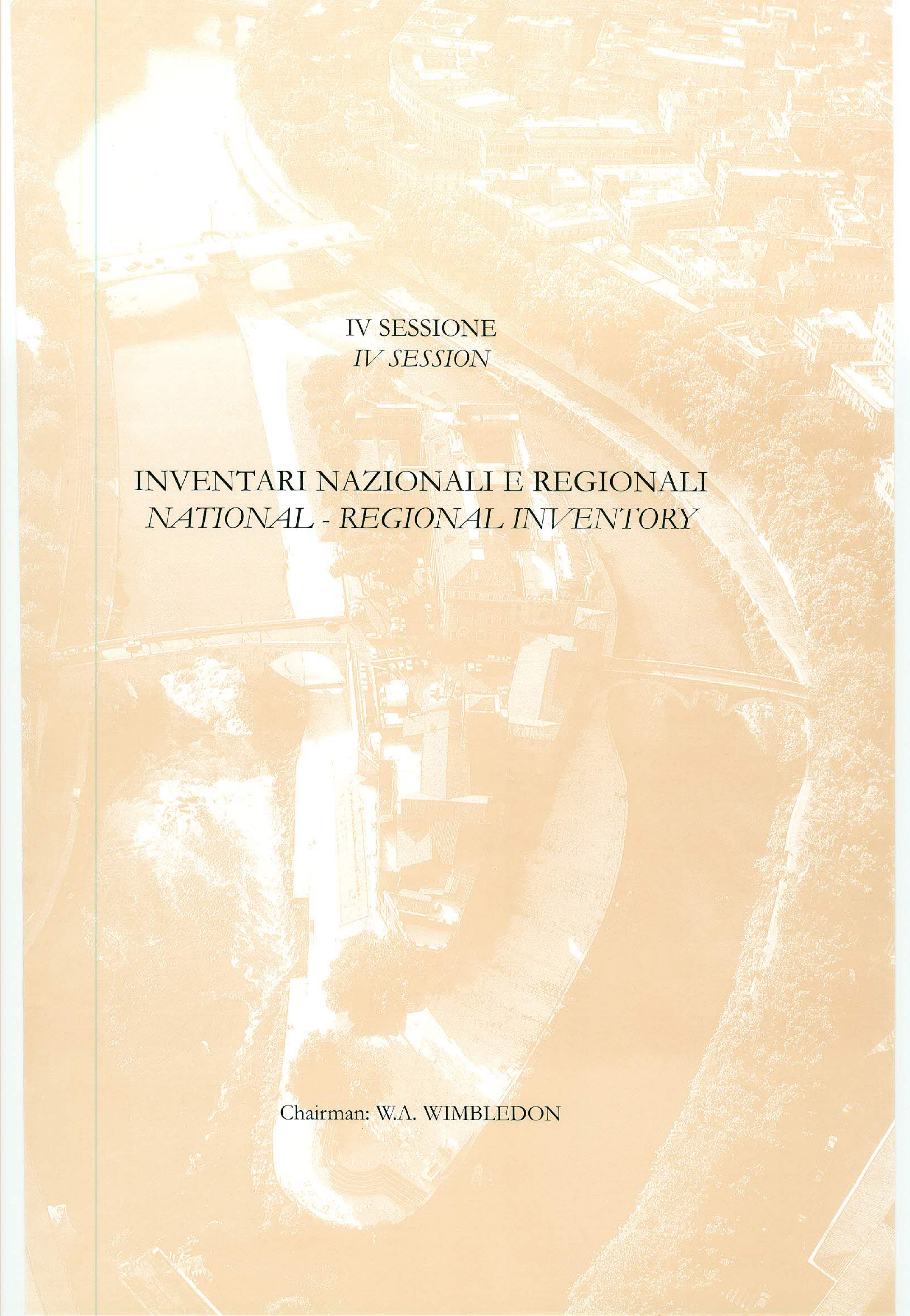

IV SESSIONE
IV SESSION

INVENTARI NAZIONALI E REGIONALI
NATIONAL - REGIONAL INVENTORY

Chairman: W.A. WIMBLEDON

Mem. Descr. Carta Geol. d'It.
LIV (1999), pp. 279-284

The Italian caves register
Il catasto delle grotte d'Italia

FERRARI G. (*) & PICCINI L. (*)

ABSTRACT - Since the beginning of modern speleology, cavers have collected a great number of documents about caves. These documents especially concern the localisation of the entrance and the geological, hydrological, morphological and biological features of caves. All the documents are currently conserved by caving associations and so they are not of easy consultation. To make them available for the community, official registers of caves have been established. Cave registers represent important, but often unknown, geographic inventories. The collected data can be useful for many environmental researches and in particular for geomorphological and hydrogeological researches in karst areas. Indeed many caves have a considerable naturalistic and environmental value and sometime they have the necessary qualities to be defined and protected as a geotope.
In Italy, the first national register of caves was established in 1929 by the Italian Institute of Speleology, but in the sixties it progressively failed because of the difficulties in keeping it up-to-date. The new project of the Italian Caves Register, carried out by the Italian Speleological Society (S.S.I.), concerns a computerised database where the main data of all the Italian caves are registered, while more detailed information can be obtained from regional inventories. The national register will be easily accessible; read-only software for Windows is now developed and it will soon be available on a BBS station and through the Internet.

KEY WORDS - Speleology, cave inventories, karst research

RIASSUNTO - Sin dalla nascita della moderna speleologia, gli speleologi hanno raccolto una grande mole di documenti riguardanti le grotte esplorate. Questi documenti riguardano in particolare la localizzazione degli ingressi, le dimensioni, e le caratteristiche geologiche, idrologiche, morfologiche e biologiche delle grotte. Tutti questi documenti sono conservati in archivi gestiti dalle singole associazioni speleologiche, ma sono in genere difficilmente accessibili al pubblico. Per rendere disponibile alla comunità la massa di dati raccolti sono stati creati dei catasti ufficiali.
I catasti delle grotte rappresentano degli importanti archivi geografici e i molti dati raccolti possono essere di grande utilità per ricerche di tipo ambientale e in particolare per studi a carattere geomorfologico e idrogeologico sulle aree carsiche. Molte grotte hanno inoltre un elevato pregio naturalistico e ambientale e talvolta posseggono le caratteristiche per essere definite e protette come geotopi.
Il primo catasto nazionale delle grotte d'Italia fu istituito dall'Istituto Italiano di Speleologia, nel 1929, ma in breve la sua importanza decrebbe per la difficoltà di mantenerlo aggiornato a causa del crescente numero di grotte esplorate. Oggi, il nuovo progetto del Catasto delle Grotte d'Italia, portato avanti dalla Società Speleologica Italiana (S.S.I.), prevede un database informatico dove sono raccolti i dati principali di tutte le grotte italiane. I dati registrati sono: numero di registro (sigla della regione e numero progressivo), nome di identificazione, localizzazione (comune e area carsica), le dimensioni della grotta e gli autori dei rilievi topografici. Il catasto nazionale non contiene i dati riguardanti le coordinate geografiche degli ingressi, le caratteristiche geologiche, idrologiche e morfologiche, e il rilievo topografico; tali documenti sono reperibili presso i catasti regionali competenti.
Il catasto nazionale, vuole diventare soprattutto un archivio di facile accesso contenente i dati principali di tutte le grotte. A tal fine è stato realizzato un programma di consultazione per Windows, del quale si può richiedere una copia su dischetto, e che presto sarà accessibile presso una stazione BBS e tramite Internet.

PAROLE CHIAVE - Speleologia, catasti delle grotte, ricerche carsiche

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1. – INTRODUCTION

Cave registers probably were one of the first geographical and naturalistic inventories. In Italy, the first registers of caves were established at the beginning of this century. The most important, in Italy and probably in the world, was the register of Venezia Giulia, that in 1920 contained more than 2000 caves; part of this register was published in the volume "Duemila Grotte" of L. V. BERTARELLI & E. BOEGAN (1926), printed by Touring Club Italiano.

In 1929 the Italian Speleological Institute, with its office in Postumia (Slovenia), founded the Register of Italian Caves, with the aim of collecting all the data about caves of Italy; this national office followed the structure of the Venezia Giulia Register and it continued its activity till the 2nd World War, collecting data and surveys of almost 7000 caves (ANELLI , 1941).

During the following years the national register was not able to keep itself up-to-date because of the great number of explored caves; so in the seventies regional registers, normally managed by the federations of regional caving associations, were established. In the eighties, many of the regional registers were transferred into computerised databases. At the present time almost all the Italian administrative regions have cave registers available on personal computers, this circumstance permits to develop a new national register easily up-dating and easily accessible.

2. – STRUCTURE OF THE ITALIAN CAVES REGISTER

The Italian Caves Register is a simplified inventory which contains the main data of all the explored caves in Italy. The guidelines define a cave as a natural cavity, of any origin, accessible to Man, and with a length more than 5 metres. Every cave is marked with the abbreviation for the administrative region followed by a

SOCIETA' SPELEOLOGICA ITALIANA
CATASTO DELLE GROTTE D'ITALIA

T / 1000 / MS

ABISSO OLIVIFER
sinonimi:

Comune: MASSA

Area Carsica: FRIGIDO

Dislivello negativo: m 1215 positivo: m 0 totale: m 1215

Sviluppo spaziale: m 7200 planimetrico: m 4500 Estensione: m 950

Rilievo: G. S. Fiorentino Anno: 1989-1994

note: la cavità presenta due ingressi catastati con due numeri diversi, l'altro ingresso, situato a quota inferiore è catastato con il numero T/MS.1267

Fig. 1. – Example of the database card of the Italian Caves Register.
– Esempio di scheda del Catasto delle Grotte d'Italia.

sequential accession number. Every region has its own numeration, which reflects the order of registration.

A simple card-index (fig. 1) contains the main data of identification, of approximate geographical location, and of dimension. The following are the selected data for the national register; they represent a common 'core' of all the regional registers (CONCI, 1956, BAGLIANI *et al.*, 1990, FALLANI & PICCINI, 1989).

Regione (abbreviation of administrative region) - indicating the administrative district (region in Italy) and consequently the regional register.

Numero (number of register) - the sequential number of registration in the card-index.

Provincia (abbreviation of administrative province) - initials of the administrative province in which the cave is located.

Nome (name) - the official and first name of the cave; local names or toponymy are usually preferred.

Sinonimi (other names) - different names of the same cave; the official name is the first to be published, but some caves are known with names different from the official one.

Comune (administrative municipality) - name of the municipality in which the entrance of the cave is located.

Quota (elevation a.s.l.) - elevation of the entrance above sea level; the datum is taken at the lower rim of the entrance.

Dislivello negativo, positivo, totale (negative, positive and total height) - the first and the second are the differences of altitude between the entrance and the lower and upper points effectively reached in the cave; the total height is the sum of the two.

Sviluppo spaziale, planimetrico, estensione (spatial and planar development, extension) - the spatial development is the real development of cave, practically the sum of all the possible paths in the cave; the planar development is the total planar length of all the branches; the extension is the maximum planar distance between two different extremities of the cave. (The measure of development depends upon the accuracy of survey and the method of computation, for these reasons development is always an approximate value; the development of the greatest cave are usually rounded to the nearest ten metres).

Rilievo (survey authors) - gives the names of the Authors (speleological associations, or people) who did the topographic surveys.

Data (date) - date when the survey was made.

The geographic co-ordinates and cartographic references are available only from regional registers, together with topographic surveys and all the documents regarding geological, hydrological and morphological information.

The national register must be easily accessible, this implies that it cannot contain all data because there is the need to protect the work of cavers from illegal publication and to reduce the length of database; regional registers collect all the documents concerning caves, but in order to protect the caves of considerable naturalistic value not all data can be freely consulted.

3. – THE IMPORTANCE OF THE CAVE REGISTER

Cave registers collect data about physical and biological features of all the caves explored in a region, so they can be considered important inventories of environmental elements. The collected data can be useful for many researches, particularly for geomorphological and hydrogeological researches in karst areas, where caves represent the most important morphologic features.

Furthermore, many caves have considerable naturalistic and environmental value and sometime they have the necessary qualities to be defined and protected as a geotope.

There are many scientific interests and reasons for protection and for conservation of caves; the most important are:

Geology - Caves are natural 'drillings' that allow information to be directly gathered about underground geological settings. The exposure of clean surfaces of no weathered rock often permits a stratigraphic and tectonic resolution not possible in the outcrops on the earth surface. In particular, there can be found the effects of neotectonics; this kind of research can be very important for palaeo-seismic studies.

Hydrology - Karst aquifers are one of the most important resources of drinkable water in the world. In karst areas water underground drainage is controlled by karst conduit network, developed from the infiltration area to the springs; caves are the accessible portion of this network. The study of cave hydrogeology is very important to understand the dynamic of underground flow in karst aquifers, to delimit the feed area of a karst spring and to estimate its pollution vulnerability.

TAB. 1 – The present situation of the regional registers of caves in Italy. 'Great' caves are those deeper than 300 m or longer than 3000 m.

– *L'attuale situazione dei catasti regionali delle grotte in Italia. Si considerano 'grandi' grotte quelle con profondità superiore a 300 m o sviluppo superiore a 3000 m.*

REGION	Number of caves	Number of 'great' caves
Piemonte - Valle d'Aosta	~ 2000	32
Lombardia	~ 3000	26
Veneto	5561	20
Trentino - Alto Adige	1503	7
Friuli Venezia Giulia	5533	41
Liguria	1360	0
Emilia - Romagna	750	1
Rep. di San Marino	50	0
Toscana	1310	41
Marche	500	4
Umbria	859	3
Lazio	~ 1200	9
Abruzzo	~ 500	0
Molise	~ 100	2
Campania	1250	8
Basilicata	210	0
Puglia	1700	1
Calabria	~ 300	1
Sardegna	~ 2000	13
Sicilia	~ 700	4
TOTAL . . .	**~ 30350**	**303**

Ecology and global change - Caves are strictly connected with the surface environment and any change of it is reflected in caves as morphogenetic or deposition events. Thanks to the high preservation potential of caves (the reader must think of the exceptional state of conservation of palaeontological and prehistoric remains in caves) elements may be found for a very detailed reconstruction of past environmental changes. Caves can be exceptional environmental data recorders, therefore they are important for the study of the human effects on the world's ecosystem.

Palaeontology and prehistory - Caves have always been refuges or traps for animals and Man, therefore palaeontological and prehistoric remains in caves are abundant. A great part of our knowledge about animals evolution and prehistory of Man is due to remains discovered in caves.

Biology - The study of cave life is now one of the most important fields of research of evolutionary biology. In fact, caves are biological 'islands' where relict species can survive and where some species have found a refuge with low biological competition.

Tourism - Caves can be an important tourist attraction. Easily accessible caves can offer to nature lovers fascinating excursions. In few carefully estimated cases, particularly attractive caves can be equipped for mass-tourism, with a positive effect on local economy.

Taking account of all these arguments caves often can be considered very important geotopes, in particular, the large karst complex where the geo-ecological history of the last millions years is preserved.

4. – THE COMPUTERISED REGISTER

National and regional registers are central repository of paper-cards and cave maps. Data may be consulted at the office or they may be transferred by mail. Interested people have to contact directly the office to get documents about caves.

The personal computer technology makes possible a different approach to data distribution: copies of a read-only programme of the national register database can be requested, but only the regional co-ordinator, who is in possession of the copy of the read-write programme, can correct data and add new cave-cards.

A first attempt to realise a national computerised cave register was made in 1985 (FERRARI & FORTI, 1995), but it failed because of the two following reasons:

1) several regional co-ordinators didn't possess the necessary computer knowledge to deal with an unfriendly programme;

2) some regional registers developed an own programme and database different from the national one.

The present approach is to collect only the main data from the computerised regional registers, as already explained in the section 2 of this paper. Several data conversions of the regional registers have allowed to realise a database with the data of almost all the Italian regions. A MS-Windows read-only programme is under test, and any potential users can ask for a floppy-disk copy of the read-only programme and of the national database. The next step will be to design and develop an user-friendly backward-compatible regional programme (read-only and read-write versions).

Network technologies allow a further method for the distribution of data. An official Italian cave register BBS (Bulletin Board System) has been developed by the Veneto Cave Register. It will be completely operative in 1996. Users with a PC and a modem can connect to the phone number 0444/56947. They can browse all the data otherwise available on floppy-disk.

The national register will not be distributed through the Internet. Only a cave atlas, with the largest caves of Italy (about 200 charts), will be available on World Wide Web pages. Each chart reports the essential data about a single cave, with a brief description, contact points, bibliographic references and a digital copy of the survey. The next step will be the development of Web pages for the major karst areas.

5. – CONCLUSIONS

Detailed knowledge of caves and cave systems is an important step towards the understanding of karst areas and related resources. The Italian Caves Register, managed by the Italian Speleological Society (S.S.I.), is the most important instrument to get available such knowledge. Many caves have so important natural features to be considered geotopes, and caves should be considered part of the natural heritage of a region.

A better collaboration between caving associations, ecologist associations and scientific researchers is desirable to study and to protect caves and karst areas.

Caving associations (S.S.I., Regional Caving Federations) are involved in a big voluntary effort to keep the registers up-to-date and to exploit the possibilities of new technologies of data distribution.

At the present, there is few co-operation between caving associations and public authorities, because no national law and only some regional laws have been approved concerning cave registers.

A carefully worded national law should establish:

1) the national cave register as an official institution structured on regional basis; it should be managed by caving associations in collaboration with the public authorities;

2) a set of information services about caves and karst areas, based on the network technologies;

3) a well working co-operation between public authorities and caving organisations concerning projects of research, exploration, protection, training, tourist development, safety and rescue.

Acknowledgement

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BIBLIOGRAPHY

ANELLI F. (1941) - *Il Catasto delle Grotte Italiane presso l'Istituto Italiano di Speleologia.* Rivista del catasto e dei servizi tecnici erariali, Min. delle Finanze, 3.

BAGLIANI F., COMAR M., GHERBAZ F. & NUSSDORFER G. (cur.) (1990) - *Manuale di rilievo ipogeo.* Reg. Aut. Friuli-Venezia Giulia, Trieste 1990, 216 pp.

BERTARELLI L.V. & BOEGAN E. (1926) - *Duemila Grotte.* Touring Club Italiano, 494 pp.

CONCI C. (1956) - *La scheda catastale della SSI per il Catasto delle Grotte d'Italia.* Atti XVII Conv. Geogr. Ital., Bari 1957, 161-168

FALLANI F. & PICCINI L. (1989) - *Criteri per la compilazione delle schede catastali ed il disegno dei rilievi.* Talp, **4**, Fed. Spel. Tosc., 11-16.

FERRARI G. & FORTI P. (1995) - *Il Catasto Nazionale delle Grotte.* Speleologia, **33**: 24-30.

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Conservation of geosites in Finland - a case study from Helsinki

La conservazione dei geotopi in Finlandia - un caso tipico da Helsinki

KANANOJA T. (*)

ABSTRACT – The conservation of geosites in Finland is mostly regulated by the Nature Conservation Act and the Soil Act. The Nature Conservation Act prescribes the establishing of nature reserves, while the Soil Act controls the excavation and exploitation of soil and the use of bedrock as dimensional stone and aggregate. The supreme authority in environmental protection in Finland is the Ministry of the Environment. Bodies subject to Ministry of Environment ensure that the environmental laws are obeyed.
Two extremely old potholes were found in Helsinki in 1993. These potholes are considerably older than other dated potholes in Finland, having formed over 50.000 years, possibly over 100.000 years ago. Therefore, they pre-date the last glaciation and are thus unique in Finland and, most probably, in all Scandinavia. The Helsinki environmental committee has placed the potholes under a protection order as a natural monument and an internationally valuable geosite has been saved.

KEY WORDS: Finland, geoconservation, pothole

RIASSUNTO – La conservazione dei geotopi in Finlandia è regolata prevalentemente dalla Legge per la Conservazione della Natura e dalla Legge sul Suolo. La Legge per la Conservazione della Natura prescrive la costituzione di riserve naturali, mentre la Legge sul Suolo controlla lo scavo e lo sfruttamento del terreno e l'utilizzo delle formazioni rocciose secondo le caratteristiche delle pietre e degli aggregati. La più alta autorità nella protezione ambientale in Finlandia è il Ministro per l'Ambiente. Gli organismi soggetti al Ministro per l'Ambiente assicurano il rispetto delle leggi ambientali.
Due marmitte antichissime sono state scoperte ad Helsinki nel 1993. Queste marmitte sono considerevolmente più vecchie delle altre marmitte finlandesi già datate, essendosi formate più di 50.000 anni fa, forse più di 100.000. Esse perciò risalgono a prima della glaciazione e sono così uniche in Finlandia e, più probabilmente, in tutta la Scandinavia. Il comitato ambientale di Helsinki ha posto le marmitte sotto protezione come monumento naturale ed un sito di valore internazionale è stato così salvato.

PAROLE CHIAVE: Finlandia, geoconservazione, marmitta

1. – LEGISLATIVE BASE

The conservation of geosites in Finland is mostly regulated by two acts, namely the Nature Conservation Act and the Soil Act. The Nature Conservation Act came into force in 1923. Together with the other Nordic countries, Finland was one of the first countries to make nature conservation a statutory duty in those days (HAAPANEN, 1988; PALOKANGAS *et alii*, 1993).

The Nature Conservation Act prescribes the establishing of nature reserves both on state and private lands.

- Small sites can be protected as natural monuments if the site is of scientific or natural significance (HAAPANEN, 1988). Most protected small geosites are designated specially as natural monuments. These are mostly erratics, potholes and caves, with erratics being clearly predominant. Besides these we also have many other small geosites of international and national value, which should be protected very soon. First, however, such sites must be identified and registered (SUOMINEN & KANANOJA,

(*) Geological Survey of Finland - FIN-02150 ESPOO - FINLAND

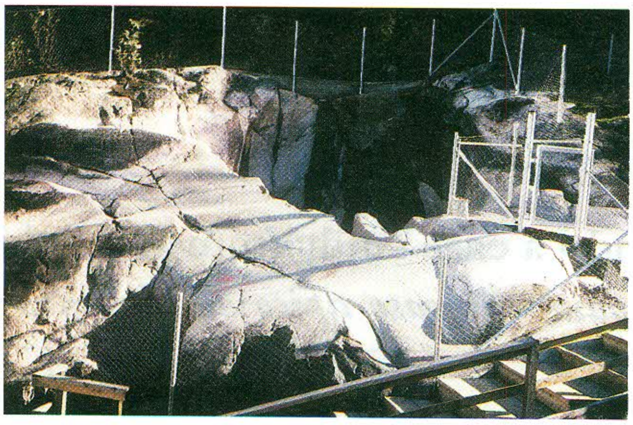

Fig. 1. – The overall view of the potholes after emptying and fencing them. At the foreground, left side, is the smaller pothole; larger pothole is in the background. The ice has flown from north to south (from left to right in the photo).
(Photo by H. HIRVAS)

– *Visione completa delle marmitte di erosione dopo il loro svuotamento e ricinzione. In primo piano, a sinistra, si nota la più piccola; la marmitta più grande è sullo sfondo. Il ghiacciaio ha defluito da nord verso sud (da sinistra a destra nell'immagine).*
Fotografia di H. HIRVAS)

1994). Accordingly, in recent years several geosite inventory projects have been set up to help in establishing new geosites for conservation.

- For larger features such as eskers and mires there are separate protection programmes (HAAPANEN, 1988). In recent years Finland's eskers have been greatly damaged by gravel extraction. The esker protection programme ensures that representative parts of our eskers will be preserved for their landscape, scientific and recreational value. The peatland protection programme is also necessary, because the majority of our mires are no longer in their natural state (HEIKKILÄ, 1994).

There are also numerous geological sites within nature reserves and national parks (KONTTURI, 1991), but by no means all have been listed, because the protected areas were not established for geological reasons.

The Soil Act, which came into force as late as 1982, controls the excavation and exploitation of soil and the use of bedrock for stone and aggregate. The Act forbids the destruction of unique natural occurrences, for example valuable surficial deposits and bedrock sites. However, no permit is needed for extraction for household purposes (PALONKANGS *et alii*, 1993). Such extraction is defined so broadly that a valuable geological site, for example an esker, can be destroyed without the authorities having power to prevent it (ALAPASSI, 1994).

Besides these above mentioned cases the conservation of geosites is also incorporated into the Building Act, the Mining Act and the Antiques Act. The Building Act controls the extraction and excavation of natural recources in areas covered by urban planning or prohibitory measures as stated in the Act. Under the Mining Act everyone has the right to search for ores on land without the permission of the landowner. However, the Act forbids exploration in protected areas. Under the Antique Act historical quarries and mines can be protected (PALONKANGS *et alii*, 1993).

The supreme authority in environmental protection in Finland is the Ministry of the Environment, which was established in 1983. For geosite conservation the land-use department is the most important department at the Ministry of the Environment. It deals with urban planning and other land-use planning, land policy, sustainable use of nature resources, nature conservation, landscape management and recreational use of nature (PALONKANGS *et alii*, 1993). The Finnish Environment Agency (FEA) was established in 1995 to continue the activities of the National Board of Waters and Environment. The FEA is the research institute of the Ministry of the Environment and institute concentrates on R&D underpinning sustainable development. Protection of the ground is also among the activities of the FEA. Since 1991 decision making concerning protection of small sites as natural monuments has been transferred from the provincial government to municipal environmental protection committees at local authority level. This simplifies the conservation of small geosites as natural monuments.

2. – TWO INTERNATIONALLY VALUABLE POTHOLES FOUND IN HELSINKI

Two potholes found in 1993 at Pihlajamäki, Helsinki, during the construction of a pedestrian and cycle route serve as an example. Potholes are formed by the action of glacial meltwater flowing at the base of ice sheet, where stones rolled and eroaded circular depression in the bedrock (ALEXANDER, 1932). All previously known potholes in Finland date from the latest deglaciation, with ages ranging from 10.000 to 12.000 years. The two potholes at Pihlajamäki are considerably older, having formed over 50.000 years, possibly over 100.000 years, ago (HIRVAS, 1995). After the melting of the ice sheet there was nonglacial phase, whose precise duration is not known. During the last glaciation the ice sheet covered the area again and deposited till over the potholes. The Pihlajamäki potholes thus predate the last glaciation since they are overlain and partly filled by till deposited by the most recent ice sheet, and were formed by the action of meltwater at the end of the previous glaciation. The potholes have been formed over approximately 100 years. They are thus unique in Finland and, most probably, in all Scandinavia. The larger pothole is in fact the largest so far recorded from Finland. It is oval in shape, with a maximum diameter of 6.90 m, and a depth of 8.45 m. The diameter of the smaller pothole is 1.60 m and its depth is 3.20 m (HIRVAS, 1995) (fig. 1).

Figure 2 shows a cross section through the larger of the Pihlajamäki potholes. A brief description of the pothole sediments is given below. (A) 1.9 billion years old migmatitic bedrock in which the pothole have formed. (B) represents till formed during the last glaciation, and covers a thin layer of sand (C) that has probably been deposited by melt water during ice retreat. Beneath this sand was a layer of stones and boulders (D), which probably represents material dislodged from the roof of an ice tunnel. Beneath this was a layer of silt and sand (E) deposited by a subglacial river, with the basal unit (F) consisting of 4.5 m of gravel and including grinding stones (HIRVAS, 1995).

Following a submission by the Helsinki Environment Center and based on the decentralisation, authorised by the 1991 decision, the Helsinki environmental committee placed the potholes under a protection order as natural monuments in March 1995, and the pedestrian and cycle route had to be re-located (HIRVAS, 1995). The whole process took only about two years between discovering the potholes and having them protected. Thus, an internationally valuable geosite, which, for a moment actually faced blasting, was saved, thanks to the fast action on the part of the discoverer. There are still a few drillholes visible, which were once filled by dynamite. After construction was stopped the site was jointly taken care of by the City of Helsinki and Geological Survey of Finland; the City emptying and reclamation of the potholes, and the Geological Survey provided scientific assistance by making analyses and writing the text for the information boards (HIRVAS, 1996 pers. com). In addition to its great scientific value, the geosite is also useful for teaching, as there are several schools, and even a university, nearby.

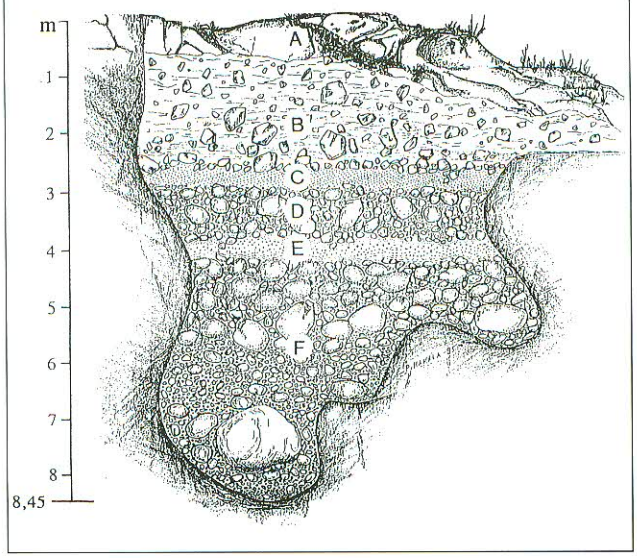

Fig. 2. – Cross section of the larger pothole and the strata found from the pothole. For detailed information see text. (Figure from HIRVAS 1995)

– Sezione verticale della marmitta maggiore, con gli strati rinvenuti nella stessa. Per informazoni dettagliate si consulti il testo. (Disegno da HIRVAS 1995)

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BIBLIOGRAPHY

ALAPASSI M. (1994) – *Turhat sorakuopat ja louhokset turmelevat kallio- ja harjumaiseman (in Finnish). Ympäristö* **8** (1): 10-12, Helsinki.

ALEXANDER H.S. (1932) – *Pothole erosion.* Journal of Geology **40** (4): 305-337, Chigaco.

HAAPANEN A. (1988) – *Nature Conservation.* In: Biogeography, Nature Conservation. Atlas of Finland, Folio 141-143, 1988. National Board of Survey & Geographical Society of Finland, Helsinki.

HEIKKILÄ R. (1994) - *Soidensuojelu Suomessa* (in Finnish). Terra **106** (3): 226-231, Helsinki.

Hirvas H. (1995) - *Pihlajamäen hiidenkirnut viimeistä jääkautta vanhempia* (in Finnish). Kivi **13** (4): 8-10, Helsinki.

Kontturi O. (1991) - *Earth Science Conservation in Finland.* In: 1er Symposium International sur la protection du patrimoine geologique, Digne, France 11-16 Juin 1991. Terra Abstracts, Supplement 2. Terra Nova **3**: 3, Oxford.

Palokangas T., Tarukannel V. & Nuuja I. (1993) - *Uusi ympäristönsuojelun hallinto ja lainsäädäntö* (in Finnish). pp. 357, Ympäristötieto, Jyväskylä.

Suominen V. & Kananoja T. (1994) - *Conservation of Geotopes in Finland.* In: J.-A. Perdhal (ed.) 21:a Nordiska geologiska vintermötet, 10-13 January 1994 Luleå: Abstracts. p. 205. pp. 245, Luleå.

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Siti geologici di rilevante interesse in Abruzzo
Important geosites in Abruzzi

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RIASSUNTO - L'Abruzzo possiede numerosi e importanti siti geologici, soprattutto riguardanti i cicli sedimentario, tettonico, geomorfologico.
Un buon numero di questi siti geologici sono già compresi in aree protette, di cui l'Abruzzo, definito regione «verde» d'Europa, risulta particolarmente dotato. Molti altri siti sono però fuori di parchi o riserve naturali e conseguentemente corrono continui rischi di degrado.
In particolare risultano in pericolo i siti geologici meno «percettibili» da parte dell'opinione pubblica, di progettisti, di amministratori, come un particolare livello stratigrafico od un raro affioramento di fossili.
Occorre quindi iniziare un progetto regionale di individuazione, valutazione, catalogazione e protezione dei siti geologici di rilevante interesse della Regione Abruzzo.
Infine appare fondamentale che tale progetto introduca il concetto di «sito geologico» della IUGS e dell'UNESCO nella legislazione ambientale regionale.

PAROLE CHIAVE: Geologia ambientale, siti geologici, Abruzzo

SUMMARY - The Abruzzi Region shows geological features mainly related to sedimentary, tectonic, geomorphological cycles. From the stratigraphic sequences (i.e. carbonatic shelf, arenaceous-argillitic turbidites, continental deposits) to the Apennines orogenesis, and from the erosion-karstic processes to the natural hazards features, the region exhibits a wide range of geosites.
Several of them are included in the numerous preservation areas of Abruzzi, considered an European "green region": 3 national parks, 1 regional park, 13 natural reserves. However, many other geotopes lie out of these areas, thus being at risk.
In addition, the existence of peculiar geotopes, not easely "perceptible" as geomorphological monuments, such as a cascade, a pinnacle, a rock arch, is to be outlined. These can be represented by a particular stratum or a palaeontologic outcrop and are undoubtedly of great scientific value.
Therefore all the above geotopes need a regional project for their characterization, listing and protection. Moreover, we suggest the introduction of the "geosites" concept in the Abruzzi environmental legislation.

KEY WORDS: Environmental geology, geosites, Abruzzi

1. – INTRODUCTION

The Abruzzi Region shows a considerable number of important geological sites, connected to sedimentary-stratigraphic, tectonic and geomorphological environment. The most interesting kind of rocks are the carbonatic ones, abundant in this region.

Many of these geological sites are included in protected areas, even if their scientific knowledge, listing, diffusion and real protection are not really realized.

The Abruzzi Region is today considered as the "European green Region" because three national parks, a large regional park and fourteen natural reserves are included in it.

Only one of the three national parks, the Abruzzi N. P. (44.000 ha) founded in 1922, is acting and operative. The other two, the Gran Sasso-Laga N. P. (143.000 ha) and the Maiella N. P. (73.000 ha), founded by the recent national law about protected areas

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TAB. 1 – Natural Reserves (geosites) already established by Abruzzi Region
– *Riserve naturali di tipo geologico già costituite dalla Regione Abbruzzo*

NAME	MUNICIPALITY	ha
Sorgenti del Pescara	Popoli (PE)	49
Zompo lo Schioppo	Morino (AQ)	1.025
Voltigno e Valle d'Angri	Ofena, Villa S. Lucia (AQ)	5.172
Gole del Salinello	Civitella Tronto (TE)	800
Calanchi di Atri	Atri (TE)	380
Grotte di Pietrasecca	Carsoli (AQ)	110

394/91, are being really constituted. The Velino-Sirente regional park (60.000 ha), even institued with the same law, is in the same way coming true.

The Abruzzi Region has founded fourteen natural reserves and six of them are peculiar for important geological sites, as in evidence in tab. 1.

The institued decrees, give really the reason for the N. R. foundation as geological value only in case of Atri badlauds, of Pietrasecca caves and partly of Zompo lo Schioppo waterfall. This happens because in the Italian environment field the biological culture prevails over the geological one.

Many interesting geological sites exists out of these protected areas and therefore at risk of being damaged. These sites need an immediate location and recording.

2. – WHICH ARE THE IMPORTANT GEOLOGICAL SITES?

The conceptual and methodological criteria for the editing of a regional inventory about important geosites, are numerous and heterogeneous (WIMBLEDON, 1990; AUTORI VARI, 1991; GONGGRIJP, 1992; WILSON, 1994; ARNOLDOUS-HUYZENDVELD *et alii*, 1995; VDOVETS, 1996).

By these contributions, the criteria that qualify the definition of a geological peculiarity or a geological monument or geotope or geosite of great interest, are the following:

– rarity and scientific value;
– the representation;
– accessibility and the enjoyment;
– vulnerability;
– landscape value ("natural beauty").

It is important, now, to specify the categories connecting the different geological sites. The ideas are different even in this case; in this paper the categories showed in tab. 2 are proposed.

3. – A FIRST PROPOSAL OF GEOLOGICAL SITES INVENTORY FOR ABRUZZO REGION

An inventory about the most important geological sites for Abruzzi Region, certainly unfinished, has been proposed for the first time, on the ground of literature data and of our territorial knowledge.

TAB. 2 – Geosites types
– *Categorie di siti geologici*

GEOMORPHOLOGY
- Formation which indicate the morpho-evolutive history of a particular area (canyons, dolinas, glacial cirques, faults, landslides, volcanic morphologies) - Important formation for the landscape (pinnacles, erosions, geological and/or geomorphological monuments)
GEOLOGY
- Interesting stratigraphic sections - Sections with particular sedimentary structures - Applied geology (quarries and mines) - Important tectonic and metamorphic structures
MINERALOGY AND PETROGRAPHY
- Mineral deposits without an economic importance - Mineral deposits with economic importance - Rare mineral deposits - Lithotypes with scientific and/or economic importance
HYDROGEOLOGY
- Important springs for water chemistry - Important springs for groundwater circulation - Waterfalls
PALEONTOLOGY
- Fossil vertebrates - Fossil invertebrates - Fossil plants
PEDOLOGY
- Main kind of paleosoils

From the proposed list is in evidence that there exist direcly "perceptible" sites, by experts but even by public opinion, planners and managers. The Abruzzi Region has decided to protect six important geological sites, since some time ago (tab. 1) and this is the proof of what we explained before.

Sites not easily "perceptible" exist, as a particular stratigraphic level or a rare outcrop of fossils, with the same scientific importance and the same need of protection.

3.1 – GEOMORPHOLOGICAL SITES

(AQ = L'Aquila, TE = Teramo, CH = Chieti and PE = Pescara - Provinces)

Erosion:
- Atri (calanques), Natural Reserve; TE
- Valle dell'Alento (calanques); CH
- Anversa Abruzzi (calanques); AQ
- Balzolo - Pennapiedimonte (rock arch - limestone); CH

Canyon:
- Gole del Salinello, Gran Sasso-Laga National Park; TE
- Gole di Celano, Regional Park Velino-Sirente; AQ
- Valle dell'Orta (I Luchi); PE
- Vallone di S. Martino (valle di S. Spirito); CH
- Gole del Sagittario; AQ
- Foce di Barrea; AQ
- Gole di S. Venanzio (Molina Aterno); AQ

Fig. 1. – Polje of Voltigno.
– Campo carsico del Voltigno.

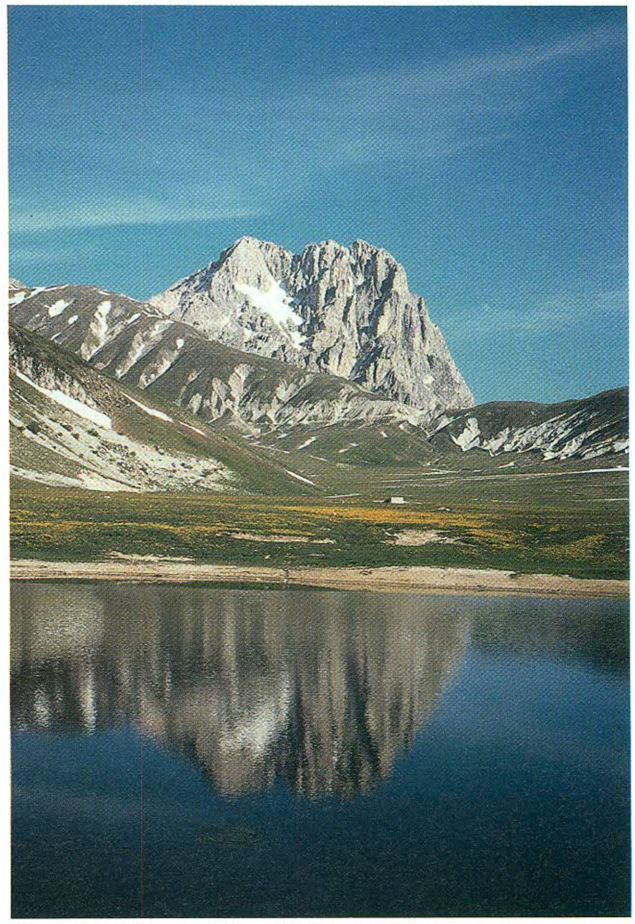

Fig. 2. – Campo Imperatore and Corno Grande (2912 m a.s.l.).
– Campo Imperatore e il Corno Grande (2912 m s.l.m.).

Karstic:
- Voltigno (polje); AQ (fig. 1)
- Amplero (polje); AQ
- Fossa Raganesca (dolina); AQ
- Fosso Spedino (dolina); AQ
- Montagna di Godi (dolina field); AQ
- Pietrasecca/Ovito-Cervo (caves), Natural Reserve; AQ
- Stiffe (caves-outcrop); AQ
- Quarto del Barone-S. Chiara (mixed alluvium-karstic formations); AQ

Glacial:
- Calderone (glaciers and snow field), Gran Sasso-Laga National Park; TE
- Campo Imperatore (glacial-karstic roof), Gran Sasso-Laga National Park; AQ (fig. 2)
- Campo Pericoli (glacial-geologic roof), Gran Sasso-Laga National Park; AQ-TE
- Fondo Femmina Morta, Maiella National Park; AQ

Fig. 3. – Capo Pescara Springs.
– *Sorgenti di Capo Pescara.*

• Valcannella (permafrost), Maiella National Park; CH
• Anfiteatro Murelle, Maiella National Park; CH
• Circhi Monte Greco (even archaeologic); AQ

Landslides:
• Frattura (Lago di Scanno); AQ
• Caramanico (valle dell'Orta), Maiella National Park; PE

3.2 – GEOLOGICAL SITES

Stratigraphy:
• Pietrasecca (Creta-Miocene); AQ
• Fonticelle (Pietrasecca) (Tortonian-Messinian); AQ
• Vallone Inferno (Corno Grande) (Trias-Lias); AQ
• Montagna dei Fiori (livello Bonarelli); TE
• Castelli - Rigopiano (ripple marks); TE
• Valle Giumentina (Quaternary); CH
• Monte Acquaviva, Maiella National Park; CH
• Bassa Valle dell'Orta-Bolognano, Natural Reserve; PE

Tectonic structures:
• Monte La Queglia (stress anticlinale); PE
• Faglia di Castel del Monte (fault); AQ
• Faglia del Parasano (fault), loc. S. Veneziano (seismic); AQ
• Claystones with microfolds (Gran Sasso-Laga National Park); TE

3.3 – MINERALOGICAL AND LITHOLOGICAL SITES

• Lecce vecchia (bauxite deposits); AQ
• Atri-Pineto (mud volcano - gaseous hydrocarbons); TE
• Ovindoli (solid hydrocarbons); AQ
• Tocco Casauria (solid hydrocarbons); PE

3.4 – HYDROGEOLOGICAL SITES

Springs:
• Capo Pescara (Popoli), Natural Reserve; PE (fig. 3)

- Vera (Paganica), Natural Reserve; AQ
- Acque Vive (Taranta Peligna); CH
- Lavino (sulphureous springs), Touristic Park; PE
- Zompo Lo Schioppo (springs-waterfall); AQ

Waterfall:

- Sfischia (Valle dell'Orfento), Natural Reserve; PE (fig. 4)
- Fiume Verde (Rossello); CH
- Fosso Cavata; TE

3.5 – PALEONTOLOGICAL SITES

Vertebrates:

- Scontrone (Tortoniano); AQ
- Palena (fishes and plants); CH

Invertebrates:

- Vallelonga (rudistids); AQ
- Focalone, Maiella National Park; CH

Plants:

- Torre dei Passeri Travertines (Valle del Pescara); PE

3.6 – PEDOLOGICAL SITES

Paleosoil:

- Andosoils of Aremogna (Roccaraso); AQ

4. – CONCLUSIONS

This inventory about important geological sites of Abruzzi Region, explained by this paper, consists only in a first step to the most important goal of geological heritage protection. It needs to organize detailed maps with an adeguate cartography and with environmental geology data, for each sites of the list and made right research on the territory to individuate other important geological sites.

On the ground of mature experiences in others European Countries, the individuation criteria should be more sophisticated.

An open, logical and with a scientific value inventory will be possible by degrees, and it will be an important instrument for the introduction of the "geosites" concept, as recommended from IUGS and from UNESCO, in the environmental regional legislation.

Fig. 4. – Sfischia Spring (Orfento valley).
– *Sorgente della Sfischia (valle dell'Orfento).*

BIBLIOGRAPHY

Arnoldus-Huyzendveld A., Gisotti G., Massoli-Novelli R. & Zarlenga F. (1995) - *I beni culturali a carattere geologico: i geotopi. Un approccio culturale al problema.* Geol.Tecn. e Ambientale, **4**: 35-48, Roma.

Autori Vari (1991) - *I° Symposium International sur la protection du patrimoine géologique.* Terra Abstract Supplement, **2**, Digne, France, 11-16 juin 1991.

Gonggrijp G.P. (1992) - *Earth-Science conservation in the Netherlands.* I° Symposium International sur la protection du patrimoine géologique. Mem.Soc. Geol. de France, N.S., **165**: 139-148.

Vdovets M.S. (1996) - *Creating a database of geological heritage of Russia with use of the computer information retrieval system.* ProGEO II° International Symposium on the conservation of our geological heritage. Roma, 20-22 maggio 1996, Mem.Descr.Carta Geol. Italia, questo volume.

Wilson C. (Ed.) (1994) - *Earth Heritage Conservation.* Geological Society & Open University, pp. 272.

Wimbledon W.A. (1990) - *2° European Heritage Sites and Type site inventories.* In: Andersen et al., Jb. Geol. B.-A., **133**: 657-658.

Mem. Descr. Carta Geol. d'It.
LIV (1999), pp. 295-298

The inventory of the geological cultural heritage of the Latium Region (Italy)
Il censimento dei beni culturali a carattere geologico della Regione Lazio (Italia)

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ABSTRACT - The results of a census of the Geological Heritage in the Latium region are described in the paper. The work was carried out by the Regional Center for the Documentation of the Cultural and Environmental Heritage of the Latium Regional Administration. The research was carried out in three experimental areas: Middle Tiber Valley, Alban Volcanic District and Pontina and Fondana Plains, it allows the recognition of 132 geotopes with high scientific value.

KEY WORDS: Geotopes, Catalogue, Lazio, Italy

RIASSUNTO - Vengono riportati i risultati della campagna di censimento e catalogazione dei Beni Culturali a carattere geologico condotta dal Centro Regionale per la Documentazione dei Beni Culturali e Ambientali della Regione Lazio. La ricerca, che è stata effettuata in tre aree campione del territorio regionale, Media Valle del Tevere, Distretto Vulcanico Albano, Pianura Pontina e Fondana, ha permesso di individuare complessivamente 132 geotopi di rilevante valore scientifico.

PAROLE CHIAVE: Geotopi, Catalogo, Lazio, Italia.

1. – INTRODUCTION

In 1981 the Lazio Region founded the Regional Centre for the Cultural and Environmental Heritage Documentation (CRD) which is a field of today's Assessorship at Politics for Culture, Spectacles, Tourism and Sport promotion. The CRD, for the law L.R. 31/91, has different and many tasks with the aim of promoting a better knowledge of the regional territory. The main activity, of census and catalogue, has been managed through 9 different subjects: archaeology, architecture, anthropology, history of art, geography, history, geology, botany and zoology. This activity has been developed in conformity with the Plan for census and catalogue of Lazio's cultural and environmental goods, which was passed with the Resolution of Regional Council n. 642 of May 16th 1979, that divided the Lazio Region in 8 sample areas.

The philosophic thought about this Plan is evident in the conclusions expressed at the end of this paper and formulated from the Commission "Census and Catalogue of Cultural and Environmental Goods" at the end of the First Regional Conference about the Cultural and Environmental Goods Policy, that took place at Rome in November 1977. The main aims of this Plan have been constantly considered and identified in protecting Cultural Goods and the cultural and natural heritage of the territory, with the aim of achieving good economic and politic management. There is in this Plan a new meaning for the concept of protection "no more as issuing of administrative measures for the simple goods preservation, but as an active protection even promoted and realized from the citizens with the consciousness of the necessity to defend and to put the common heritage to its best use".

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Knowledge of the territory and its diffusion are the main concepts in the Plan's philosophy. The territory can be considered as "real space where the societies work by their cultural abilities, in relation with natural environment" or as "a total container of Cultural and Environmental Goods", saving, in this way, the unity of the concept of Cultural good, considering the traditional division between man made and natural "goods".

Considering the naturalistic one, the Plan introduces the concept of geotope (without a perfect definition) to indicate operational guide-lines dividing these natural "goods" by disciplines (geological goods, mineralogical, palaeontological, botanical, fauna) and from a point of view of the complexity of the ecological system considered: single specimen, single populations, deposits, single taxonomic entities, phytocenosi, zoocenosi, whole ecosystems, geomineralogical and geomorphologic complexes, and geotopes, biotopes, areas, territories or part of them that are part of this naturalistic realities.

2. – CENSUS OF CULTURAL HERITAGE IN A GEOLOGICAL WAY

2.1. – Criteria of selection, sample areas.

The census of the geotopes of Lazio, which started in 1987 from a co-operation between CRD and ENEA (Environmental Department) (Casto *et alii*, 1991), has been developed in three of the eight sample areas (indicated by the Plan): Media Valle del Tevere (area 8) (Casto & Zarlenga, 1992), Colli Albani (area 2) (Casto & Zarlenga, 1996) and Pianura Pontina and Piana di Fondi (area 4) (Casto & Zarlenga, 1997). The selection criteria adopted reflect the Wimbledon's classification of the "categories" (1990), relating this classification to the Italian legislation to the local geology and to the national context; the "Best Sites" the "Unique Sites" the "Firsts" and the "Patterns" have been considered.

The scientific value depends on the rarity (with regard to the formation process and to the scientific meaning in a regional scale); diversity; historical value and "key position" (for the scientific value); condition of the access route and accessibility (for the educational value); vulnerability (in relation to threats) and scenic value expressed as natural beauty. Determinate groups of goods have been selected: stratigraphic sections, sections with peculiar sedimentary structures, faults well evident, folds, fold systems, overthrusts, sections with important sedimentological evidence; applied geology (quarries and mines). Furthermore, mineral deposits with or without economic importance; rare mineral deposits; outcrops of particular effusive and intrusive rock types; important formations for the morphologic and evolution history of a particular area: river-terraces, sea-terraces, craters, cones of scoriae, caldera, karstic formations, geological and geomorphological monuments; beautiful landscapes; springs with importance for chemistry and the groundwaters circulation; fossil deposits with invertebrates, vertebrates and plants; the main natural history museums in the research areas (tab. 1).

2.2. – Lines of the research

The methodology of the research has been developed in more phases which consist of:

1) bibliographic research

2) geomorphological prospecting, elaborated with remote sensing or by air photography supported by checks of country calibration

3) compiling the census cards.

Bibliographic research

This kind of research has been carried out during the preliminary phase, covering Authors of the last century and of the beginning of 1900, the later publications between the beginning of 1900 and 1960, and the latest synthesis of the last ten years.

The palaeontological part of this research (Casto *et alii*, 1987; 1993; Casto e Cuggiani, 1993; 1993a) was very important and it has been the subject of a bibliographic survey made by CRD researchers, in 1985-86.

This census was published in 1987 and has been used for geotope research. The 1800-1900 references are related to the Media Valle of Tevere and the Colli Albani area, where the 89% of the publications are palaeontological or volcanological.

Publications between the two World Wars till the beginning of the 1960 concerned the Pianura Pontina (Blanc and Segre on Quaternary of Pianura Pontina and fossils of Grotte del Circeo) and Colli Albani, while the Media Valle of Tevere area was poorly represented; it was not well known from a geological point of view until the publication of geotopes census (Casto & Zarlenga, 1992) there had been a hiatus between the 1900 studies and the precise recent ones.

The studies of Monti Lucretili and the Geological Map of Italy (with the normal scale limitations) were the only specific work in that area.

TAB. 1. – Categories of geotopes
– *Categorie dei geotopi*

GEOLOGY
– stratigraphic sections
– sections with particular sedimentary structures
– rock sections which indicate particular phases and conditions of volcanic activity
– faults of a particular importance
– folds, folds system, overthrusts
– applied geology (quarries and mines)

PETROGRAPHY and MINERALOGY
– mineral deposits without an economic importance
– mineral deposits with economic importance
– rare mineral deposits

GEOMORPHOLOGY
– formations which indicate the evolution of the morphological history of a particular area: fluvial terraces, sea terraces, high structurals, craters, cones of scoriae, caldera, karstic formations, etc.
– geological and/or geomorphological monuments
– areas of landscape beauty

HYDROGEOLOGY
– springs important for water chemistry
– springs important for groundwaters circulation

PALAEONTOLOGY
– fossil deposits of invertebrates
– fossil deposits of vertebrate
– fossil deposits of plants

MUSEOLOGY
– main scientific museums in the investigated area

Remote sensing of geomorphology

The geomorphological elements which could have cultural significance had been highlighted by remote sensing with air photography (flight Lazio Region, 1982). The photo-interpretation has been supported by checks in the field.

The census card

Every geotope has been explained by a standard recording card so as to give synthetic information about the Lazio territory to different users (researchers, students, public managers, etc.) that might use the Regional Centre of Documentation archives. The card is composed of fields recording data about the topographic location (Province, municipality, place-name, geographic co-ordinates, I.G.M. Sheet and Table – 1:100.000 and 1:25.000 –, which allow the geo-referentiation), the description of the most important peculiarities, the scientific value, the preservational state, the stressors and the possible risks, the restraints that lay on the site and a foundamental bibliography about the same geotope.

One or more "compilers" have a reserved special space, for "key words", which come from the "International Lexicon of the Earth Science" (CARIMATI *et alii*, 1984), and the Pianura Pontina e Fondana area publication, from the "Interdisciplinary scheme of classification of the environmental and territorial documentation" (RALLO, 1994).

The census areas of the geotopes (D.C.R.642/79).

Area 8

This area is included in the territories of the following municipalities: Magliano Sabina, Collevecchio, Stimigliano, Forano, Poggio Mirteto, Ponzano Romano, Filacciano, Torrita Tiberina, Nazzano, Fiano Romano, Capena, Montelibretti, Montopoli in Sabina, Castelnuovo di Porto, Fara in Sabina, Riano, Sant'Oreste, Monterotondo; the first six of them are part of the Rieti Province, the others of Roma Province.

Media Valle del Tevere is part of this area, between Magliano Sabina e Monterotondo, also the west side of Monti Lucretili reliefs and the eastern part of Sabatinian volcanic reliefs.

From a country recognition sixty sites have been located and detailed on census cards in a short form.

Fifteen sites have geological evidence connected to tectonics and/or sedimentation (important relief faults, high-structural, sedimentary, clear and didactically useful structures); nineteen present elements referring to the stratigraphy and palaeontology and they are geotopes of primary importance for the study of geology of that zone; five are mineral springs distinguished for a particular chemistry and/or underground circulation of waters; sixteen has clear geomorphological elements: river terraces and/or erosion surfaces; four sites are connected to Sabatinian volcanism, and only one site (the "Sasso di Fiano") is in the landscape "beauty" category.

Area 2

This areas consists in seventeen Municipalities, all located in the Roma Province:

Albano Laziale, Marino, Castel Gandolfo, Nemi, Frascati, Rocca di Papa, Lanuvio, Ariccia, Monte Compatri, Colonna, Rocca Priora, Grottaferrata, Ardea, Monte Porzio Catone, Ciampino, Pomezia, and Genzano di Roma.

The main part of the volcanic district of Colli Albani is in this area; in Ardea and Pomezia Municipality, located on the coast there are sediments correlated with the Plio-Pleistocene of the perithyrrenian margin.

Fourtyfour sites have been selected during the census; twentyfour of them are geomorphological sites (volcanic cones and calderic depressions); nine are rock sites with peculiarities (rarity and/or clearness of exposition) and some of them are in active or disused quarries; five are sites where there are very important stratigraphic, tectonic and/or palaeontological elements; four are springs (one is the Squarciarelli, with historical importance), and two are places where mineralogical species has been discovered, with a great scientific value for rarity, for crystal size and/or for their perfection.

All can be considered as a landscape's beauty and they can be classified in that or in the other categories.

Area 4

This is an area which concerns ten municipality's territories, in Latina Province: Campodimele, Fondi, Latina, Lenola, Monte San Biagio, Pontinia, Sabaudia, San Felice Circeo, Sperlonga, and Terracina.

In this area is the main part of Pianura Pontina and Fondana and only a short part of Monti Ausoni, of Monti Aurunci (on the west side) and the Albano Volcanic District.

Twentyeight sites with cultural value have been selected by the inventory, twelve of them are in "hydrological goods" category (springs and lakes), seven have good elements for stratigraphic and structural geology of the area (geological section, palaeontological deposits, Monte Circeo is very important for the discovery of *Homo sapiens neandertalensis*), six are in the "geomorphological goods" category where is possible to identify the sea-terraces, karstic formations (some of them of landscape beauty), along the Sperlonga coast and inland of Terracina Commune (Campo Soriano). Two sites show the outcrops of the Laziale Volcano and, lastly, the Riparo Salvini is an historically and scientifically important geotope for the discovery of the stone industry of the Upper Palaeolithic.

3. – CONCLUSIONS

In the three sample areas examined, 132 sites have been identified that can be considered as "Cultural Goods". By investigation made in the field after the census, it has been discovered that some of them have disappeared (Cava di Galantina in Poggio Mirteto Municipality) or are really damaged as is the case with the historical peperino quarry, "Le Petrare", close to Marino, which is now a training wall for rock-climbers school. The lack of a real conscience about protection and evaluation of the geological heritage from the political authorities, together with the limited aesthetic sense, expression of poor basic culture, bring about damage to the landscape in areas where the high scientific value is connected with naturaness.

Situations like these are common in the area of Colli Albani, as the abusive discharges in the chestnut wood, in the area inside the Parco Suburbano of Castelli Romani or in the area of crumbling buildings.

The census of Geological "Goods" carried out from the Regional Centre of Documentation, should lead to the adoption of a policy recognising knowledge of territory and its utility, of instruments for a effective planning and use of the territory, as well and for the evaluation and protection of related cultural heritage.

The census, furthermore, even if it is limited (for the moment) to only 3 areas of Lazio Region, is based on guide-lines explained by the "Census Plan". It should alert public opinion about the importance of the geotopes in the region, wishing furthering the hope that the concept of geotopes could be part of the political and administrative culture of our country.

BIBLIOGRAPHY

CARIMATI R., POTENZA R. & TESTA B. (1984) - *Lessico internazionale di Scienze della Terra.* pp. 233, C.N.R. ed., Roma.

CASTO L. & CUGGIANI M.C. (1993) - *Norme di compilazione per la scheda territoriale (PT) e per la scheda per specie (PS).* pp. 22. C.R.D., Assessorato alla Cultura, Regione Lazio ed., Roma.

CASTO L. & CUGGIANI M.C. (1993a) - *Note illustrative della Carta dei giacimenti fossiliferi della Media Valle del Tevere.* pp. 47, C.R.D., Assessorato alla Cultura, Regione Lazio ed., Roma.

CASTO L., CUGGIANI M.C. & ZIZZARI P. (1993) - *Note illustrative della Carta dei giacimenti fossiliferi: Foglio 387 - Albano Laziale e Foglio 388 Velletri.* pp. 19, C.R.D., Assessorato alla Cultura, Regione Lazio ed., Roma.

CASTO L., POLIZZANO C. & ZARLENGA F. (1991) - *Protezione ambientale: beni geologici.* Energia e Innovazione, Anno 37 (1-2), 64-69.

CASTO L., SANSONI A., VENTURA G. & ZIZZARI P. (1987) - *Risultati della ricerca paleontologica nell'ambito del Piano di Censimento e Catalogazione dei Beni Culturali e Ambientali della Regione Lazio.* Boll. Serv. Geol. d'It., **106**: 299-314.

CASTO L. & ZARLENGA F. (1992) - *I beni culturali a carattere geologico nella Media Valle del Tevere.* pp. 165 , ENEA ed., Roma.

CASTO L. & ZARLENGA F. (1996) - *I beni culturali a carattere geologico nel Distretto Vulcanico di Albano.* pp. 143, ENEA ed., Roma.

CASTO L. & ZARLENGA F. (1997) - *I beni culturali a carattere geologico nella Pianura Pontina e Fondana.* ENEA ed., Roma.

RALLO F. (1994) - *Schema interdisciplinare di classificazione della documentazione ambientale e territoriale.* pp. 96, C.N.R. ed., Roma.

WIMBLEDON W.A. (1990) - *2° European Heritage sites and Type site inventories.* In: Andersen et al. Jb. Geol. B.- A., 133: 657-658.

Mem. Descr. Carta Geol. d'It.
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Criteria for revealing geosites in an effort to compile a global list

Criteri per rivelare i geotopi nello sforzo per la compilazione di una lista globale

LAPO A.V. (*)

ABSTRACT - The following criteria are useful for revealing geosites in an effort to compile a global list: best or largest appearance of a geological phenomenon; rare and unique; first recognition and mining; patterns; oldest and youngest appearance of a geological phenomenon; significant ongoing geological process; documented event; geodiversity.
A sufficient exposure of the territory and, in the case of geomorphological sites, an adequate morphological manifestation of landforms are also required for this purpose.

KEY WORDS: Geosite, geological heritage, Global list of geosites.

RIASSUNTO - I seguenti criteri sono utili per rivelare geotopi nello sforzo per la compilazione di una lista globale: la bellezza o l'ampiezza del fenomeno geologico; la rarità e l'unicità; la prima identificazione o scavo; l'esempio; la più antica o la più recente apparizione di un fenomeno geologico; un significativo processo geologico in evoluzione; l'evento documentato; la geodiversità.
Vengono anche richiesti a questo scopo una adeguata esposizione del territorio e, nel caso di siti geomorfologici, una adeguata manifestazione morfologica del paesaggio.

PAROLE CHIAVE: Geotopi, patrimonio geologico, lista globale dei geotopi.

1. – GLOBAL LIST

It seems that a choice of criteria for revealing the geosites is a preliminary stage for compiling a Global list of geosites, now co-ordinated by the new IUGS Global Geosites Working Group (GGWG). For this purpose, first of all an experience of work for the implementation of "The UNESCO World Heritage Convention" (1972) might be useful. Then, according to "Operational guidelines for the implementation of the World Heritage Convention" (1988), in order that "a geological or geomorphological property" (in other words, a geosite) should be of outstanding universal importance, it must meet one or more of the following criteria:

1) be outstanding examples representing the major stages of the Earth's evolutionary history; or

2) be outstanding examples representing significant on-going geological processes...; or

3) contain superlative natural phenomena, formations or features..." (quoted from JOYCE, 1993).

At the same time, for solving the problem under consideration W.A. WIMBLEDON's idea (ANDERSEN *et alii*, 1990) of discerning the following "categories" of geosites is very important:

1) best sites;

2) unique sites;

3) firsts;

4) patterns.

In fact, there are rather definite criteria for revealing geosites and that is why it seems that WIMBLEDON's early proposition along with "Operational guidelines...", quoted above, may be used as a basis for further development (WIMBLEDON *et alii*, 1997). So I will try to take some steps in this direction using well known geosites as examples.

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2. – BEST SITES

There is no question, that "best" is a very important criterion for revealing the geosites. According to this criterion, we have to reveal geosites of every kind best in the World. It seems that a detailed typology of the geological heritage sites (LAPO & PASHKEVICH, 1996) will be useful in this connection. The main problem is to determine the best geosite for every subtype of this typology. Certainly, it is rather difficult, but I think we must develop the research just along this line.

At the same time, in some cases it is necessary to give a preference to something that is the largest. For example, the Shunga Deposit of shungite in Karelia (Russia) is the largest in the World as to accumulation of carbonaceous matter in the Lower Proterozoic, the Popigai Astrobleme in the North of Siberia is the largest (100 km in diameter) in the World among well exposed Phanerozoic Astroblemes, and the Flint-Mammoth Cave (Kentucky, USA) is the largest (341,1 km long) cave in the World. In other words, these are "superlative natural phenomena, formations or features" (see above).

Therefore, best or largest appearance of a geological phenomenon is one of the proposed criteria for revealing the geosites.

3. – UNIQUE SITES

Examples of "unique sites" are a natural nuclear reactor in Oklo, Gabon, and such a unique cosmic event geosite as the Tunguska (North of Siberia) phenomenon of 30.06.1908. But it is necessary to take into consideration, that it may turn out that in future it will be merely the first observation of the phenomenon, which in its turn will become rare but not unique. Therefore, it seems that it will be better to call this criterion "rare and unique".

4. – FIRSTS

Concerning "firsts", it could be better to say in this case "first recognition", meaning the first recognition of one or another geological phenomenon. There are some examples of this kind in the paper quoted above (ANDERSEN *et alii*, 1990). In addition to them some other examples could be given. There are holostratotypes of stages, such as the Gzhelian near Moscow; there are also initial localities of definite kinds of fossils, such as the Ediacara Vendian biota in Australia, or, another thing, initial localities of well-known minerals, such as ilmenite in the Ilmen' Mountains in the Urals, and rocks, such as sviatonossite in the Sviatoi Nos Cape on the Baikal Lake. The oldest mining localities are something of a specific case, but in fact they are also suited to the idea of "the firsts". So we can call the last case as "first mining", and as a result the criterion under discussion in general may be called as "first recognition and mining".

5. – PATTERNS

As to "patterns", WIMBLEDON has defined them as geosites "which demonstrate the salient or significant features, be they hard or soft rock or landform, which occur in or typify an area, large or small" (ANDERSEN *et alii.*, 1990). Key sections provide good illustration of using this criterion for revealing geosites.

In addition to WIMBLEDON's criteria, mentioned above, it seems to be pertinent to discuss some other geological criteria. Let us consider them one after another.

6. – OLDEST AND YOUNGEST

The first of them is the oldest and the youngest appearance of a geological phenomenon. In fact, there is a particular case of the criterion "to be outstanding examples representing the major stages of the Earth's evolutionary history" mentioned in "Operational guidelines..." (see above). In this respect the simplest case is fossil sites, among which the oldest appearance means localities of remains of first representatives of the major taxa of biota, and the youngest one - localities of remains of last representatives of extinct taxa. Using this criterion, one can reveal East Pilbara ("North Pole") in Australia, the oldest (3500 Ma) microfossil site in the World. It is also true for sites of the Isua Supracrustal Belt in SW Greenland, where the oldest rocks in the World (3900-4100 Ma) are exposed. An exactly converse example is the Tyrnauz Deposit in the Caucasus where one of the youngest granite in the World, dated at 2,48 Ma, is represented.

7. – GEOLOGICAL PROCESSES

A significant on-going geological process, as it was mentioned in "Operation guidelines...", may be also used as one of the criteria for revealing the geosites. One example of such kinds of geosite, the on-going Oklo natural nuclear reactor, was mentioned above. As another illustration we refer to localities of present-day mineral formation, such as salt lakes. It is also true for localities of present-day formation of rocks, for example, rather exotic ones, as geyserite and travertine. Otherwise, an apt example is also the great deltas, where accumulation of recent turbidites takes place. Finally, localities of manifestation of recent tectonics are good examples of geosites which may be revealed using this criterion.

8. – DOCUMENTED EVENTS

The next criterion for revealing geosites is based on a fact that one or another geological event was observed there by inspection and documented immediately after it occurred. The geosite of the cosmic phenomenon at Tunguska of 30.06.1908 has been already mentioned above. Other examples are a group of meteoritic craters in the Sikhote Alin Ridge (the Far East of Russia) resulting from a rain of meteorites (dated 2.02.1947), and the Proval Bay of the Baikal Lake which was formed as a result of a disasterous earthquake (January 10-12, 1862).

9. – GEODIVERSITY

Geodiversity is the last, but not least, of the discussed criteria for revealing geosites. By this is meant a great diversity of these or those attributes of a particular geological phenomenon. It may have a great diversity of minerals in the geosite (e.g., in the Khibiny and Lovozero Alkaline Massifs in the Kola Peninsula there are more than 500 minerals), or a great diversity of fossils (e.g., more then 100 species of foraminifers in the Sterlitamak Shikhans in Bashkiria, or a great diversity of rock types (it makes no difference whether they are sedimentary, magmatic or metamorphic).

10. – SUMMARY GEOCRITERIA

All-in-all, the following geological criteria are useful for revealing geosites:

– best or largest appearance of a geological phenomenon;
– rare and unique;
– first recognition and mining;
– patterns;
– oldest and youngest appearance of a geological phenomenon;
– significant on-going geological process;
– documented event;
– geodiversity.

To be included in a global geosite list a geosite should conform to one or more of the criteria mentioned above. It seems that a sufficient exposing of the territory and, in the case of geomorphological sites, an adequate morphological manifestation of landforms are also required for this purpose.

11. – COINCIDING VALUES

All the criteria discussed above are geological ones. But in some cases for sites of geological interest various non-geological criteria should also be taken into consideration. These criteria may be the following: picturesque landscape, great present-day biodiversity and the presence of endemics, as well as the presence of archaeological subjects.

The first example of such geosite is the Baikal Lake which is equally interesting as a very deep contemporary rift depression, the largest body in the World of the purest, the most transparent fresh water and, finally, as a site of very diverse endemic fauna.

And the second, tragic example, which is appropriate to be recalled here, in Italy, is Pompeii. It is universally known, that it is not only the archaeological site of World significance, but also a geosite, owing to the products the violent Vesuvian eruption which took place one day in year 79 A.C.

Certainly, such kind of sites are considered as sites of other, non-geological, categories of natural and cultural heritage, but they also have to be included in a global list of geosites.

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BIBLIOGRAPHY

ANDERSEN S., BLACK G.P., DUFF K.L., ERIKSTAD L., GONGGRIJP G.P., KONTTURI O., SCHONLAUB H.P. & WIMBLEDON W.A. (1990) - *Earth-science conservation. An absolute need for science and education*. Jb. Geol. B.-A., **133** (4): 653-669, Wien.

JOYCE E.B. (1994) - *Assessing the significance of geological heritage sites: from the local level to world heritage*. Mem. Soc. geol. France, n. ser., **165**: 37 - 43, Paris.

LAPO A.V. & PASHKEVICH N.G. (1996) - *Typology of the geological heritage sites of Russia*. ProGEO-95 Proceedings. SGU, Uppsala (in Print).

WIMBLEDON W.A.P., ANDERSEN S., CLEAL C.J., COWIE J.W., ERIKSTAD L., GONGGRIJP G.P., JOHANSSON C.E., KARSI L.O. AND SUOMINEN V. (1997) - *GEOSITES - a global comparative site inventory to enable prioritisation for conservation*. In press in Mem. Desc. Della Carta Geol. d'Italia.

Mem. Descr. Carta Geol. d'It.
LIV (1999), pp. 303-308

A holistic approach to conserving the Earth's natural heritage
Un approccio olistico alla conservazione del patrimonio naturale della Terra

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ABSTRACT - Earth heritage conservation in England has evolved from a predominantly site-based system of identification, protection and management of key sites. Recent strategic approaches now emphasise the need to integrate a site based system with a wider programme of engendering support amongst influential landusers, government and the wider public. A review of other national approaches shows that a common overarching aim exists - namely, to ensure that the best of the Earth's rocks and landforms are protected and valued. All methodologies, including that used in England, are recognised as alternative and equally valid ways of achieving this aim. It is argued that the need for sites, and the need for greater education in Earth heritage conservation are complementary. International 'guide' organisations, such as ProGEO, are vital to help each country to achieve the common aim of Earth heritage conservation by the method most appropriate to their national situation.

KEY WORDS: Geology, conservation, England

RIASSUNTO - La conservazione del patrimonio della Terra in Inghilterra si è evoluta a partire da un sistema di identificazione, protezione e gestione dei siti chiave prevalentemente basato sui siti. I recenti approcci strategici enfatizzano ora la necessità di integrare un sistema basato sui siti con un più vasto programma di supporto alla produzione tra i maggiori sfruttatori del suolo, il governo ed il pubblico più in generale. Una rassegna degli altri approcci nazionali mostra che esiste uno scopo comune a tutti: praticamente, assicurare che i più bei paesaggi e le più belle formazioni rocciose della Terra siano protetti e valutati. Tutte le metodologie, comprese quelle utilizzate in Inghilterra, sono riconosciute come metodi alternativi ed egualmente validi per raggiungere questo scopo. Viene sostenuto che la necessità dei siti e la necessità di una maggiore educazione alla conservazione del patrimonio terrestre sono complementari. Organizzazioni internazionali «guida», come ProGEO, sono essenziali per aiutare ciascun paese a raggiungere lo scopo comune della conservazione del patrimonio terrestre con il metodo più appropriato alla specifica situazione nazionale.

PAROLE CHIAVE: Geologia, conservazione, Inghilterra

1. – A COMMON VALUATION OF THE EARTH'S GEOLOGICAL HERITAGE.

The desire to ensure that the best of the Earth's rocks, landforms, minerals and fossils are protected and valued is central to all approaches to conserving our geological and geomorphological heritage. This common goal has involved people worldwide, in government, academia and in local communities, working toward a greater appreciation of geology and protection of its most important sites.

The rationale for geological or Earth heritage conservation has been explored in other places (WILSON, 1994; ELLIS *et alii* 1996), but the main components are:

– recognition that geology and landscape are intrinsic parts of our natural world;

– recognition that the Earth has had, and continues to have, a fundamental influence on civilisation through our interaction and use with rock, mineral and the land itself;

– the need for sites for research and education to advance our scientific and technological understanding, and

– a need to engender a wider understanding of the benefits that knowledge of past geological environments brings, and the lessons for the future that can be learnt from them.

Whilst the aims of Earth heritage conservationists are broadly similar, their methods are not. This is in many ways a result of national inheritance, as conservation practice is evolving in different countries in different ways, following separate legal and cultural patterns.

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Earth heritage conservation is in all cases, however, essentially a field-based subject. This is primarily a function of the need to view the geological record in context and related to this, the recognition that how we read this record and what we make of it (the theoretical and technological aspects) are rapidly evolving. Because of its field (and therefore site) basis, the practice of Earth heritage conservation tends to have strong links with other field-based conservation practices such as wildlife and archaeology. In consequence, Earth heritage conservation is practiced in many countries by nature conservationists and any legal recognition is through nature conservation legislation. Equally, many geological and landform sites are linked more to landscape features and values, and in some countries, there is a traditional link with landscape protection, such as national parks and monuments. This difference between the wildlife/archaeological (scientific) approach and the landscape (aesthetic) approach has often lain at the heart of different viewpoints on the methodology of achieving the aims of Earth heritage conservation.

Earth heritage conservation in Britain has always been an integral part of nature conservation, and its aims and methodology have been shaped accordingly. However, in recent times, the methodology of Earth heritage conservation in England (and in Scotland) has been revisited. This has shown that both the scientific and aesthetic aspects of Earth heritage and more widely, nature conservation, can work together to achieve conservation aims.

2. – EARTH HERITAGE CONSERVATION IN GREAT BRITAIN.

The conservation of geological and geomorphological features in Britain has a statutory basis. A network of sites or 'geotopes' has been established which are protected by national law (Wildlife and Countryside Act, 1981). These geotopes form part of a network of important nature conservation sites known as 'Sites of Special Scientific Interest'. English Nature, the national body responsible for nature conservation (including wildlife conservation) in England since 1991, has a duty to identify and safeguard the geology and geomorphology of this network from potential threats such as development, coastal defences and general degradation.

The origin of this legislation lies in post-World War II Britain when much of Britain's legal system and land use policies were reviewed. The 'Wildlife Conservation Special Committee' was set up to investigate and advise on nature conservation across Britain. They reported in 1947 that there was a need to safeguard special areas exhibiting geological and physiographical features. This far-sighted recommendation was included in the National Parks and Access to the Countryside Act 1949 which first set up the SSSI system.

Today, approximately 3000 nationally important geological and geomorphological sites exist in Great Britain, 1300 of which are in England. These top sites were identified by a structured review of Earth science sites which worked on the basis of distinct fields of interest. The full rationale and methodology for this appraisal of British Earth science sites, known as the 'Geological Conservation Review', has recently been set down formally for the first time (ELLIS *et alii*, 1996). Examples of these fields include stratigraphy, structural geology, igneous geology, coastal geomorphology and Mesozoic vertebrata. Within these broad areas, specific 'blocks' of sites were identified, for example, Wenlock, Variscan Structural sites, Caledonian Igneous sites, Cave sites and Jurassic-Cretaceous Reptilia sites. All were selected on the basis of detailed advice from the foremost researchers in each field.

Although some SSSIs are conserved as nature reserves on both a national and local basis, most are owned and managed by private individuals or companies. Conservation of sites is achieved through national development planning law and working with site owners to maintain and enhance the interest of the site and to promote its use for education and research. Planning authorities in Britain must take into account the national importance of SSSIs when deciding applications for development on or near a site. English Nature will normally advise the planning authority on the impact of a proposed development on the site, and where a development would damage the interest, have powers to prevent the planning authority from allowing that development.

For each SSSI a number of operations are also identified which the owner cannot undertake without first consulting English Nature. An example is the use of spoil from an old mine to repair tracks, where the spoil might contain important, rare minerals.

Whilst the system of sites in Britain, both at the national and regional level (RIGS), is adequate to represent and maintain the key elements of British Earth science, threats to these sites continued at a high level throughout the 1980's and into the 1990's. As a consequence, a great deal of time was needed to maintain and manage the sites. Detailed research has provided a series of technical solutions to maintain the interest at many different types of site (NCC, 1990b; ENGLISH NATURE, 1993), reducing management costs. The experience of English Nature in maintaining the SSSI, series however, identified that the maintenance of a site series alone was insufficient to achieve the overall aim of a wider understanding and valuing of the Earth science as well as protection of key elements.

In a system where sites are offered absolute and total protection, there is less need for public or other support. However, the British system does not afford guaranteed protection to nature conservation sites. Decisions on competing and threatening uses of these sites are taken by local planning authorities, and although the legal system affords protection, it may be decided that other interests outweigh the importance of the geology. Therefore, even in a site - based system as in England, there is a need for raised awareness and education. Developers, landowners, planners, politicians and the general public are generally unaware of the rationale and need for conserving our Earth's natural heritage of rocks, minerals, fossils and landforms. As a result, there is little public support for Earth heritage conservation in comparison to wildlife or archaeological conservation. The need to develop greater public awareness therefore underpins the direction that Earth heritage conservation has taken in England.

In 1990, the NCC published a cohesive strategy which for the first time directed and focused work on conserving the country's Earth science resource (NCC, 1990a). Six themes were laid down in the strategy, and in the following six years, these have been taken forward successfully by English Nature (Tab. 1). Since this strategy was introduced, three significant developments have shaped English Nature's approach to conserving the national heritage of Earth science and helped us to integrate the subject of Earth science conservation with related subjects such as wildlife, archaeological and landscape conservation.

The 1992 Earth Summit in Rio de Janeiro, Brazil placed the concepts of **sustainable development and biodiversity** on the international agenda. **Agenda 21** places emphasis on Government, business, the voluntary sector and individual citizens to participate in the formation of national and local strategies for sustainable development. This provides tremendous opportunities for Earth science conservation if it is regarded as part of the wider natural resource.

The Malvern International Conference on Geological and Landscape Conservation (1993), strengthened links between nations and promoted the appreciation of Earth resources and processes and their sustainable use. International co-operation and sharing of expertise is key to progressing Earth science conservation, and English Nature has participated both with the Malvern Task Force and now with ProGEO.

In England, English Nature has in the last few years embraced a holistic, 'natural world' view of nature conservation. We have reviewed our whole approach to wildlife and Earth Science conservation using the theme of Natural Areas (DUFF, 1994). Natural Areas are tracts of land, unified by underlying geology, landforms and soils, which display characteristic vegetation and species, and support broadly similar patterns of landuse Because the character of Natural Areas depend on their underlying geology and geomorphological processes, this creates links between

TAB. 1. – Strategic themes of the 1990 Earth science strategy for Great Britain, and achievements against each theme, 1996

– *Temi strategici della strategia scientifica per la Gran Bretagna del 1990, raggiungimento di ciascun obiettivo nel 1996*

1. *Maintaining the SSSI network as SSSIs*	Notified 97% all identified GCR sites in England Specialist management advice on sites
2. *Expanding the RIGS network*	Co-ordinated development of a national network of locally important sites
3. *Developing new conservation techniques*	Commissioned work on new engineering techniques including techniques for coastal managed retreat, quarries and road cuttings
4. *Improving site documentation*	Produced site management documents for all Earth science SSSIs in England
5. *Increasing public awareness*	Journals, books, leaflets and Earth Heritage magazine
6. *Developing International links*	Assisted with Malvern International Conference and Malvern Task Force

the geological and other aspects of the land, and importantly, provides opportunities to create closer working links with land managers such as farmers and wildlife conservationists.

To take the 1990 Strategy forward, English Nature have recently launched a new strategy with five strategic themes (Tab. 2) (ENGLISH NATURE, 1996; KING *et alii*, 1996a; KING *et alii*, 1996b). These themes take into account the new conservation priorities, building upon the foundations created in achieving the 1990 strategy. The conservation of Earth science sites using this approach is a significant advance on a solely site-based, geotope method. It bases itself on people as well as sites, such that in Britain, the term Earth **heritage** conservation has replaced 'Earth science conservation' and 'geological conservation'.

3. – COMPARISON OF METHODOLOGIES USED IN OTHER COUNTRIES

Conservation of geological features in England has developed from a mainly site-based system towards one in which the system is supported through wider appreciation of the need to conserve the Earth's heritage. Other countries have analogous systems. Conservation of Earth science sites in Romania is viewed as part of the nature conservation resource, with protection through a system of National Monuments (GRIGORESCU & NORMAN, 1990). Some countries such as Canada and Spain, have stringent regulations in specific areas of conservation, such as protection against irresponsible fossil collecting (NORMAN, 1994; ALCALÁ & MORALES, 1994). In Germany, the geotope concept (STÜRM, 1992; WIEDENBEIN, 1994) covers over ten thousand sites, protected on a regional basis, although no national overview exists. This system is more comparable with the British system as these sites are viewed in a holistic sense as part of the cultural heritage of the region. They are also increasingly being used as an educational and amenity resource, for example the 'Geo Zentrum' of the Eifel Region of western Germany, which utilises the superb volcanic maars and fossiliferous rocks of the area as well as its mineral springs.

In contrast, countries such as Slovenia and New Zealand have no specific Earth heritage legislation, and support for geological conservation has been sought in order to justify selection and conservation of a systematic series of sites. In Slovenia, little protection or support exists for geological sites amongst government, and public support is seen as a necessary prerequisite to achieving national governmental legal protection (HLAD, 1996). In New Zealand, earth science

TAB. 2. – Summary of aims of the 1996 Earth heritage strategy for England
– *Sommario degli obiettivi della strategia per il patrimonio della Terra per l'Inghilterra del 1996*

Theme 1	Managing and safeguarding the resource Having a set of SSSIs and RIGS, we will now concentrate on the positive management of these sites, enhancing their potential use for others
Theme 2	Integrating Earth heritage and the holistic approach The Natural Areas approach as outlined can be used to integrate Earth heritage interests more directly into key nature conservation schemes. This will include assessing the resource against sustainability criteria.
Theme 3	Influencing the influencers We will continue to press for increased recognition of the importance of Earth Heritage conservation with local and central government, and major developers. We will provide best practice examples to planners, offer training schemes, and forge working partnerships, following the principles of Agenda 21. For example, we are working with mineral extraction companies (particularly aggregates which is the largest sector) to achieve a better understanding and environmental performance by the industry through joint training and research.
Theme 4	Raising awareness One of the major problems for Earth heritage conservation remains the need to increase public support. We will use promotional methods to achieve this, through our targetted magazines, publications and media such as press, television, and local interpretation centres
Theme 5	Involving the public We also need to involve the public in Earth heritage conservation, to increase their interest and enjoyment of the subject. We will create new local nature reserves with local communities and look to improving links with museums, geological societies and schools

conservationists are directly lobbying government for inclusion of geological and geomorphological sites within nature conservation legislation (BUCKERIDGE, 1994).

4. – INTERPRETATION

Whatever methodology is used by individual groups and nations, the end aims are similar and in line with those outlined earlier. The Malvern International Task Force for Earth Heritage Conservation, for example, deals mainly with involving people in general support for the concept of Earth heritage conservation, and proposes that the subject is 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"* MALVERN International TASK FORCE FOR EARTH HERITAGE CONSERVATION, 1996). The last part of this definition (our emphasis) embraces both the pure scientific and the wider natural world approach of public education and enjoyment. Equally ProGEO, which emphasises the need to protect important geological sites, has objectives which include '*the conservation of Europe's rich heritage of landscape, rock, fossil and mineral sites*', providing information to a wider public and '*an integrated approach to nature conservation, promoting a holistic approach to the conservation of biological and physical/ geological phenomena*' (PROGEO, 1996).

Regardless of whether a site-based system for conservation is in place or not, it is important to achieve in addition, a wider appreciation of the value of sites.

5. – CONCLUSIONS

The common aim of all Earth heritage conservationists is a wider appreciation of the value of the Earth sciences and the conservation of the most important geological sites.

lish Nature have worked towards this aim by identifying a series of national sites which are protected in legislation which promotes proper management by landowners. The selection and management of these sites, as laid out in NCC's 1990 strategy was a firm foundation but formed only part of the conservation aims. In the long term, in English Nature, we believe that the key to conserving any network of sites is to place emphasis on **using** them to increase public appreciation and awareness of geology's value as part of the overall natural and human heritage.

The English experience is, however, only one method of achieving our common goal. Each nation has its own unique culture and legal system, and therefore different methodologies may be more suitable. Each country may take a different route to reach the same goal, for example one country may place more emphasis on public education and non-legal methods of safeguarding our heritage. Another state may require, or be able to implement, stronger site - based protection. All routes are, however, equally valid if the end aim is achieved. The benefits of a greater awareness of these different national experiences are immense. To paraphrase the Latin saying, '*mille via ducunt hominem per secula Roma*'- All roads lead *from* Rome.

Individual national and international organisations may then have different roles as expert 'guides' along distinct parts of these routes, sharing experience and fostering common goals. The role of ProGEO may for example lie more in advising and supporting the development of a coherent network of international 'Geosites' in Europe. The Malvern Task Force is a group which is developing wider public support and understanding of Earth heritage conservation internationally. Both these and other roles (such as an 'overseeing' function, something which a body such as UNESCO might perform) will be vital and complementary in achieving a common and agreed aim - the conservation of the Earth's rocks and landforms as part of our overall natural and human heritage.

REFERENCES

ALCALÀ L. & MORALES J. (1994) - Towards a definition of the Spanish palaeontological heritage. In - O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (eds) - *Geological and Landscape Conservation*: 117-120. Geological Society, London.

BUCKERIDGE J.S. (1994) - Geological conservation in New Zealand: options in a rapidly eroding environment. In - O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (eds) - *Geological and Landscape Conservation*: 117-120. Geological Society, London.

DUFF, K.L. (1994) - *Natural Areas: an holistic approach to conservation based on geology*. In - O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (eds) - *Geological and Landscape Conservation*: 117-120. Geological Society, London.

ELLIS N.V, BOWEN D.Q., CAMPBELL S., KNILL J.L., MCKIRDY A.P., PROSSER C.D., VINCENT M.A. & WILSON R.C.L. (1996) - *An Introduction to the Geological Conservation Review.* Joint Nature Conservation Committee, Peterborough.

ENGLISH NATURE (1993) - *A review of practical techniques for Earth science conservation.* English Nature, Peterborough.

ENGLISH NATURE (1996) - *Conserving England's Earth Heritage.* English Nature, Peterborough.

HLAD B. (1996) - *Geoconservation and environmental education.* Mem. Desc. della Carta Geol. d'Italia. (in Print), Roma.

GRIGORESCU D & NORMAN D. (1990) - *Earth science conservation in Romania.* Earth science conservation **27**: 6-8, Peterborough.

KING A.H., MOAT T. & PROSSER C.D. (1996) - *Conserving England's Earth heritage - past, present and future.* ProGEO-95 Proceedings (in Print), Stockholm.

KING A., PROSSER, C. & MOAT T. (1996) - *Towards the Millenium - Conserving England's Earth Heritage.* Earth Heritage **5**: 10-11, Peterborough.

MALVERN INTERNATIONAL TASK FORCE FOR EARTH HERITAGE COMSERVATION (1996) - *Earth Heritage Conservation.* Joint Nature Conservation Committee, Peterborough.

NATURE CONSERVANCY COUNCIL (1990) - *Earth science conservation in Great Britain - a strategy.* Nature Conservancy Council, Peterborough.

NATURE CONSERVANCY COUNCIL (1990) - *A handbook of Earth science conservation techniques.* Nature Conservancy Council, Peterborough.

NORMAN D. (1994) - Fossil collecting: international issues, perspectives and a prospectus. In - O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (eds) - *Geological and Landscape Conservation*: 117-120. Geological Society, London.

PROGEO (1996) - *The European Association for the Conservation of the Geological Heritage.* pp. 6, figg., ProGEO Cardiff.STÜRM B. (1992) - *Geotop. Grundzüge einer Begriffsentwicklung und Definition.* In: WIEDENBEIN F.W. & GRUBE A. (eds) - *Geotopschutz und geowissenschaftlicher Naturschutz.* Workshop-Abstracts 141. University of Erlangen Nuremberg, Nuremberg.

WIEDENBEIN, F.W. (1994) - Origin of the term 'geotope' in German-speaking countries. In - O'HALLORAN D., GREEN C., HARLEY M., STANLEY M. & KNILL J. (eds) - *Geological and Landscape Conservation*: 117-120. Geological Society, London.

WILSON R.C.L. (EDITOR) (1994) - *Earth Heritage Conservation.* The Geological Society, London & The Open University, Milton Keynes.

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Inventory of glacial relief forms in Serbia and necessity for their protection

Il catalogo delle forme glaciali dei rilievi in Serbia e le necessità per la loro protezione

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ABSTRACT: In this paper we give an overview of the reserach project titled Glacial Relief in Serbia. Research activities have been focused in the area of Sar planina and Prokletije where majority of glacial relief forms are situated. We emphasize insufficiency of the number of properly protected objects of geological heritage. We also suggest a number of specific forms of glacial relief that need to be protected: entire glacial series situated on vertical profiles of slopes, such as cirques with multitude of glacial lakes. Additional value of these areas are numerous rare and endangered plant and animal species and their ecosystems.

KEY WORDS - Inventory; Glacial Forms; Protection; Serbia;

RIASSUNTO - In questo lavoro vengono fornite informazioni riguardo al progetto di ricerca intitolato Rilievi Glaciali in Serbia. Le attività di ricerca sono state focalizzate nell'area di Sar planina e di Prokletije dove è situata la maggior parte delle forme glaciali presenti sui rilievi. Si evidenzia l'insufficienza del numero degli oggetti del patrimonio geologico correttamente protetti. Inoltre si suggerisce un numero di specifiche forme del rilievo glaciale che necessitano di protezione: serie glaciali complete sui profili verticali dei pendii, come i circhi con numerosi laghi glaciali. Numerose specie di piante e di animali rari e minacciati ed i loro ecosistemi rappresentano dei valori aggiuntivi.

PAROLE CHIAVE - Inventario; Forme glaciali; Protezione; Serbia.

1. – INTRODUCTION

Protection of geological heritage in Serbia has not been receiving proper attention so far. Necessity for protection of geological objects (STEVANOVIC, 1950) and paleonthological remains (PRIBI, 1961) has been emphasized on many occassions, however, with exception of occasional inclusion of interesting specimens in museum collections or introduction of protection for certain objects, little has been done for this purpose. A number of speleologic objects were placed under protection in 1949: Zlotska pecina, Prekonoska pecina, Ravna pecina and Propast chasm, Radoseva pecina - Velika Atula and Gaura Mare - Velika pecina. Petnicka pecina was protected in 1950, Ravanicka pecina in 1951, Potpecka pecina in 1953, Samar pecina and natural bridge Samar in 1955, natural bridges in canyons of Vratna and Zamna in 1957, Djavolja varos in 1959, and geologicalal sites Lojanik and Prebreza in 1963. Number of protected geomorphologic objects rapidly increased in the period 1970 - 1990 so that today we have some 70 geological objects under protection, mostly as natural monuments. Most protected objects belong to the group of karst phenomena (holes, caves, natural bridges, stone windows, gorges and canyons, waterfalls, bygrenic beds, springs and wells, etc.). Only a small number of the objects under protection regards the elements of geological heritage

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(geotectonic, stratigraphic, hydrogeological, petrographic, mineralogical, palaeontological). The fact that there is only 70 geological and geomorphologic objects, among some 1.300 protected in Serbia, clearly shows that this number is much too small and absolutely insufficient for presentation of extraordinary values of geological diversity of Serbia. There is no doubt that in future efforts aiming at protection of nature we will have to pay greater attention to protection of geological and geomorphologic heritage, which include pedological and archeological values. One of the first steps in this direction is joining of the Institute for the Protection of Nature of Serbia to the European Association for Conservation of Geologicalal Heritage, which has been promoting the ProGEO project over the last few years. This Association has recommended this project to be carried out by competent institutions and experts in geological sciences at the level of individual countries, followed by coordinated joint efforts aiming at production of unique European list of geological heritage. Being the only institution in Serbia in charge of protection of nature, the Institute for the Protection of Nature has launched an initiative for establishment of the National Council for Geological Heritage in charge of preparation and adoption of long term policy in the filed of protection of geological heritage and definition of criteria for selection of objects and uniform methodology for protection of geological objects. Here is a suggestion concerning protection of representative sites featuring glacial relief forms, as a special addition to the project of protection of geological heritage which has yet not been placed under protection.

2. – GLACIAL RELIEF IN SERBIA AND ITS PROTECTION

JOVAN CVIJIC opened a new chapter in the history of geomorphological science when in 1891 he predicted presence of traces of glacial period in the area of Ljuboten (Sar planina) and carried out a thorough study of glaciation processes in Rila (1897). During the course of his work (1891; 1897; 1899; 1903; 1913; 1914) JOVAN CVIJIC established the main characteristics of glacial relief present in the mountains of the Balkans. Another researcher who produced groundbreaking results in this field was NIKOLIC (1912; 1913; 1914; 1914a), who concntrated his research efforts on the traces of old glaciers on Sar planina, Korab, Kopaonik, Stara planina and Suva planina. Other Authors who wrote about glacial relief on our highest mountains Sar planinma and Prokletije were MILOJEVIC (1937), endash Prokletije, RADOVANOVIC and NIKOLIC (1959) - Prizrenska Bistrica river basin, RSUMOVIC (1960) - glacial traces on Golilja mountain. Among recent research projects the following definitely deserve to be mentioned: GAVRILOVIC (1970; 1976) - mountains of eastern Serbia (actually, the whole of Serbia), PETROVIC (1979) - glacial relief on mountain Mokra Gora, MENKOVIC (1972; 1978; 1985; 1989; 1994) - Prokletije, Sar planina, Koritnik, Djeravica, BELIJ (1994) - the north-eastern side of Sar planina.

However, the times of fierce competition and great scientific discoveries pertaining to glacial geomorphology of the Balkans belong to the past. Our knowledge of glaciation in the mountains of Serbia is nowadays relatively profound and well systematized. There are minor traces of glaciation on many mountains of Serbia (Kopaonik, Golija, Suva planina and Stara planina), however the regions displaying the most prominent examples of glacial relief are situated on Sar planina and Prokletije, the highest mountains of Serbia and mountains with most emphasized glaciation during Pleistocene. Prokletije were the major center of glaciation in the Balkans during the Pleistocene. The snow-limit was situated at altitude between 1.400-1.500 m and vast mountain areas above this limit were under perpetual snow and ice. Large cirques formed in preglacial spring area produced glaciers which descended down the mountain slopes. The largest glacier, of valley-type, composite and very ramified is situated in the river basin of Pecka Bistrica. It came down to Metohija valley and left sediments of frontal moraines, 530 m thick, on the basis of which was calculated its length of 25 km. In the spring area of Decanska Bistrica river a ramified valley glacier, which is the second largest glacier with its length of about 20 km, was formed. There was a 14 m long glacier in the spring area of Erenik river and another 12 m long glacier in the river basin of Locanska Bistrica. On Rusolija and Zljeb plateau there was a karst-type glacier with numerous hanging glacial tongues. The only valley glacier found on Mokra Gora mountain is the one situated in Crna reka, at the same time there were cirques and hanging glaciers between mountain peaks. Leaving aside glacial traces in carbonate base (Hajla, Rusolija, Zljeb, Koprivnik, Mokra Gora), where typical features of glacial relief have been deformed and defaced, the best preserved glacial traces are to be found in spring areas of Decanska Bistrica and Erenik rivers. The following objects have been suggested for protection as objects of geological heritage: cirques surrounding Djeravica and those in spring areas of Erenik and Koznjarska Bistrica rivers, tributaries of Decanska Bistrica and 10 glacial lakes, numerous morain ramparts and randomly scatterred erratic blocks. Composite carbonate cirque on the north side of Nedzinat, with Veliko and Malo Nedzinatsko lake, has all the qualities of an exquisite object. Establishment of their boundaries and definition of the regime of protection are planned as a part of activities of the Institute for Protection of Nature of Serbia pertaining to preparation of documentation necessary for planned establishment of the national park \ldblquote Prokletije\rdblquote. Being morphologically more simple, Sar planina underwent glaciation mostly on the north slopes, above 1.600-1.700 m. There were numerous cirque glaciers in the north-eastern part of the mountain (Lepenac river basin) and some of these descended to the bottom of the river valley. The largest one was Sirinic, 6-7 km long.

In the north-western part of the mountain glaciation occured in the high regions of Sar planina creating a big plateau glacier, covering surface of some 90-100 km^2 and projected glacial tongues forming a star. During the later period of glaciation there were only valley glaciers and the longest of them were situated in the valley of Brodska river (8 km), in the valley of Restelica river (7 km) and there is a lateral hanging glacier in Celepinska valley (5 km). The following objects have been suggested for protection as objects of geological heritage:

– the peak of Ljuboten and Ropot cirque;

– Livadicki cirque and Livadicko lake;

– the cirque in the spring of Durlov potok;

– the composite cirque by Jazinacka lakes and Virovi cirque;

– glacial series in the spring of Bukoravacka river (Prizrenska Bistrica);

– the cirque in carbonates of Kobilica;

– the double cirque Kotao in the spring of Duska river;

– Severna Rudoka cirque;

– Severna Mala Vraca cirque.

The carbonate pyramide of Ljuboten, with gigantic scree deposits, is an exquisite phenomenon in itself. The cirque in Ropotski potok, discovered by Cvijic during his research in 1890, was the first example of glacial relief found in the Balkans. Livadicki cirque, under the Livadicki peak, in the spring area of Kaludjerska river, situated at the height of 2170 m, sized 220 x 120 m, surrounds Livadicko lake like a theatre. It is an example of perfectly preserved, school-specimen of glacial relief in shale. During the last glacial period the spring of the Durlov potok was transformed into a cirque. Relatively short river flow is descending in cascades over the series of gradually sloping sections. Block-moraines and a large stone-glacier inside the cirque are excellentlly preserved. Jazinacki cirque, in the spring of Suva river, is of huge dimensions, complex, and composed of 4 minor cirques, with a group of constant and periodical lakes, the largest of which is Veliko Jazinacko lake (2.180 m) with dimensions of 150 x 90 m, surrounded by older glacial moraines and younger block moraines. Jazinacki cirque with Virovi and bordering Blatesticki cirque are obvious examples of geomorphological contents diversity. Diversity and wealth of geomorphological forms and processes, fossil remains from various periods of geological past and contemporary elements concentrated in a relatively small area, reflect tumultuos geological past and intense geomorphological dynamics. Many of those processes are still going on, in front of our eyes, so that these cirques deserve to be called an open geomorphological text-book, as they give an accurate picture of wealth of geological diversity of regions with fossil glacial relief. The cirque in the spring of the Bukoravacka river hides, the highest glacial lake in our country, the Gornjeselsko lake at 2410 m, vigorous spring of Prizrenska Bistrica and exceptionaly well preserved frontal moraines above Gornje Selo at 1400 m. There are plans for establishment of geomorphological reserve in this area, containing the whole glacial series from cirques, through glacial waves, to frontal moraines. On the limestone section of Sar planina mountain crest (Kobilica peak) resistant rocks form jagged edge, whereas the cirque depression is filled with large blocks sacattered over moraine ramparts. In the spring of Duska river, flowing between Trpeznica and Celepinski peak, there is the double cirque Kotao with well preserved moraine ramparts. Cirques covered with snowfield block-moraines and ploughing blocks were formed on the north slopes of Rudoka and Mala Vraca during the latest period of glaciation, characterized by other contemporary periglacial forms.

3. – COMPLEX PROTECTION OF NATURE IN HIGH-MOUNTAIN REGIONS

Long presence of man in our high mountains, traditional seasonal cattle-breeding, inordinate and often unreasonable exploitation of woods, opening of mines and their infrastructure, and, lately, building of gigantic tourism and sport centers, with cable railways and ski lifts, roads and numerous summer cottages are threatening nature and sensitive eco-systems, often resulting in catastrophic consequences. For this reason it is necessary to protect the nature in high mountain regions, including geomorphological traces of glacial period and flora and fauna. High mountain-ridges and cirques bottoms are lairs of numerous endemic and rare plant and animal species. Sar planina and Prokletije, which are the largest and highest mountains in our country, are the most significant centers of high-mountain endemism in the Balkans and in Europe. The greatest value is found in local endemic species growing in most inaccessible parts of these mountains as a result of long lasting geomorphological, genetic and ecological isolation and presence of very specific influences of surroundings which have directed them to take the original evolutionary course of aiming at highest level of adaptibility. Cirques of Jazinacko lake on the north side of Sar planina display high levels of complementarity of geomorphological and floristic elements. In their typical high mountain landscape featuring fossil glacial relief we find woods of endemic-relict pine (*Pinus peuce*) mix with high mountain bushes (*Rhododendron ferrugineum and Juniperus nana*) and herbaceous communities comprising endemic plants (*Potentilla doerfleri, Crocus scardicus, Soldanella dimoniei, Fritillaria graeca*, etc.), Alpine-Carpatian (*Primula minima, Geum montanum, Armeria alpina, Salix retusa*, etc.) and Arctic (*Juniperus sibirica, Cerastium lanatum, Juncus trifidus, Campanula scheuchzeri, Saxzifraga moschata, Gnaphalium supinum*, etc.). The outstanding limestone peak of Ljuboten is dominated by *Dryas octopetala* and very rare *Linaria alpina* in community *Carex laevis-Heliantemum alpestre* Horv., and local endemic *Sempervivum macedonicum* and *Dianthus scardicus* are known as the symbols of silicate crests. The high-mountain regions of Prokletije are exceptionally rich with Alpine and arctic-alpine elements which, depending on geological base, are diferentiated into species growing on silicate base (*Primula minima, Salix retusa, Saxifraga stellaris, Doronicum glaciale, Campanula alpina, Gentiana kochiana, Phyteuma confusum, Carex curvula*) and species growing on carbonate base (*Dryas octopetala, Silene acaulis, Anthyllis alpestris, Poligonum viviparum, Thlaspi rotundifolium, Saxifraga aizoides, Cerastium alpinum*). Highly developed glacial relief of the highest mountains in Yugoslavia, as well as the outstanding diversity of geologicalal/pedological base and presence of different geomorphological processes, have created a very complex mosaic structure of ecosystems, with frequent changes in small space, making Sar planina and Prokletije the mountains with the most significant centers of diversity of flora, vegetation and fauna. Combination of erosive and acumulative relief forms in cirques and numerous glacial lakes provides a habitat for many rare plant and animal species and their eco-systems. Together with fragile eco-systems of glacial lakes and peat bogs they form a system of exceptional complementarity. Generally speaking, the high mountains of Yugoslavia, especially Sar planina and Prokletije, represent one of the rare remaining oasis in Europe, displaying well preserved natural environment of fossil glacial relief in which we find original flora from various geological periods, thus adding to floristic wealth of the whole continent. What we need are adequate measures for protection and care for complementary values of the high mountains in Yugoslavia, aiming to preserve geological and genetic heritage, diversity of species and eco-systems and nature in general.

BIBLIOGRAPHY

BELIJ S. (1994): *Savremeni periglacijalni procesi i oblici reljefa severozapadne Sar-planine.* Otisak iz monografije Sarplaninske zupe Gora, Opolje i Sredska - Odlike prirodne sredine, Posebna izdanja Geografskog instituta Jovan Cvijic SANU, 40/I, 113-144, Beograd.

CVIJIC J. (1891.): *Eine Besteigung des Sardagh.* Jahresberichte des Verins der Geographen an der Universitat Wien, **16**: 44-50, Wien.

CVIJIC J. (1903.): *Novi rezultati o glacijalnoj eposi Balkanskog poluostrva.* Glas Srpske kraljevske akademije, **65**: 185-333, Beograd.

CVIJIC J. (1913.): *Ledeno doba u Prokletijama i okolnim planinama. Glas Srpske kraljevske akademije*, **91**: 188-267.

CVIJIC J. (1914.): *Tragovi starih glecera u Srbiji.* Glasnik Srpskog geografskog drustva, **3-4**: 211-212, Beograd.

GAVRILOVIC D. (1970.): *Mrazno-snezanicki oblici u reljefu Karpatsko Balkanskih planina Jugoslavije.* Zbornik radova Geografskog zavoda PMF, **17**: 11-22, Beograd.

GAVRILOVIC D. (1976.): *Glacijalni reljef Srbije.* Glasnik Srpskog geografskog drustva, **56**: 9-19, Beograd.

MENKOVIC Lj. (1972.): *Glacijacija i kvartarne tvorevine na podrucju Prokletija, Peci i Djakovice.* Vesnik Zavoda za geoloska i geofizicka istrayivanja, **29/30**: 207-217.

MENKOVIC Lj. (1978.): *Glacijalni i nivacioni reljef severozapadnog dela Sar-planine.* Vesnik Zavoda za geoloska i geofizicka istrazivanja, **35**: 99-115, Beograd.

MENKOVIC Lj. (1985.): *Glacijalna morfologija Koritnika.* Priroda Kosova, **6**: 31-39, Pristina.

MENKOVIC Lj. (1989.): *Geomorfoloska studija sire oblasti Sar-planine, doktorska disertacija, manuskript.* str. 273., Geografski fakultet PMF, Beograd.

MENKOVIC Lj. (1994.): *Tragovi glacijacije u podrucju Djeravice - Prokletije.* Geografski godisnjak, **30**: 139-146, Kragujevac.

MILOJEVIC B.Z. (1937.): *Visoke planine u nasoj kraljevini.* str. 459, Beograd.

NIKOLIC R. (1912.): *Glacijacija Sar-planine i Koraba.* Glasnik Srpskog geografskog drustva, **1**: 72-79, Beograd.

NIKOLIC R. (1912a): *Glacijacija Sar-planine i Koraba.* Glas Srpske kraljevske akademije, **87**: 49-97, Beograd.

NIKOLIC R. (1913.): *Sumnjivi glecerski tragovi na Suvoj planini.* Glasnik Srpskog geografskog drustva, **2**: 298-304.

NIKOLIC R. (1914.): *Glecerski tragovi na Kopaoniku.* Glasnik Srpskog geografskog drustva, **3-4**: 212-214, Beograd.

NIKOLIC R. (1914a): *Sumnjivi glacijalni tragovi na Staroj planini.* Glasnik Srpskog geografskog drustva, **3-4**: 214-215.

PETROVIC J. (1979.): *Lednicki reljef na Mokroj Gori.* Zbornik radova PMF, **9**: 591-597, Novi Sad.

PRIBIC L. (1961.): *Glavna nalazista preistorijskih sisara i lovne divljaci u Srbiji.* Glasnik Muzeja sumarstva i lova, **1**: 1-17, Beograd.

RADOVANOVIC M., Nikolic S. (1959.): *Sliv Prizrenske Bistrice.* Zbornik radova Geografskog instituta PMF, **6**: 37-72.

RSUMOVIC R. (1960.): *Reljef sliva Golijske Moravice. Posebna izdanja Geografskog instituta SANU*, **16**: 128.

STEVANOVIC P. (1950.): *Zastita geolosko-paleontoloskih i mineraloskih objekata.* Zastita prirode, **1**: 11-26, Beograd.

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Contributo alle conoscenze dei beni culturali naturali nel comune di Teramo
Contribution to the knowledge on the natural cultural heritage of the Teramo area

DI EUSEBIO F. (*) & MANETTA M. (**)

RIASSUNTO - Vengono di seguito descritti e segnalati alcuni beni naturali culturali situati nel territorio del comune di Teramo. L'area presa in considerazione è caratterizzata dalla presenza di affioramenti prevalentemente terrigeni, e, subordinatamente, da litotipi calcareo-marnosi. L'attuale quadro geomorfologico è condizionato sia dai litotipi affioranti che da fattori legati alla neotettonica nonché da interventi di natura antropica.

PAROLE CHIAVE: Appennino centrale, Geotopi, Litotipo, Morfosculture

ABSTRACT - In this article will be considered some of the environmental and heritage characteristics of the Teramo area. This area is characterized mainly by the terrigenous facies and marly-limestone lithotypes. Present geomorfology is determined either by the outcropping lithotypes or by anthropic factors.

KEY WORDS: Central Apennines, Geotopes, Lythotype, Morphological sculpture

1. – INTRODUZIONE

Il presente lavoro interessa una parte del territorio del comune di Teramo che, per le sue caratteristiche geologiche e geomorfologiche, può essere considerato un campione rappresentativo della fascia pedemontana dell'Abruzzo centro-settentrionale. Di seguito vengono descritti alcuni Beni Culturali di natura Geologica e Geomorfologica che presentano un interesse naturalistico, scientifico e paesaggistico con il fine di approfondire e diffondere la cultura *ambientale*, sia per quanto attiene la parte interpretativa dell' evoluzione del rilievo, che per la pianificazione territoriale. Inoltre, poiché da diversi anni nel nostro Paese, come nel resto d'Europa, si è affermata una politica più attenta all'ambiente, *la filosofia della tutela del paesaggio* è un obiettivo prioritario di tutte le Amministrazioni Centrali e Locali (ARNOLDUS *et alii*, 1995; CASTO & ZARLENGA, 1992; 1995).

I criteri di valutazione adottati basati su diversi aspetti, (FABBRI & ZARLENGA, 1996) in relazione alla diffusione delle *singolarità geologiche* nell'area studiata, tengono conto delle condizioni e rarità del bene geologico, della diversità e del valore paesaggistico o di bellezza naturale.

2. – INQUADRAMENTO GEOLOGICO E STRUTTURALE

La geologia del territorio teramano (fig. 1) compreso nel settore centro appenninico, è il risultato di una evoluzione prevalentemente mio-pliocenica, di un sistema catena-avanfossa-avampaese, con vergenza adriatica, cioè con una migrazione delle compres-

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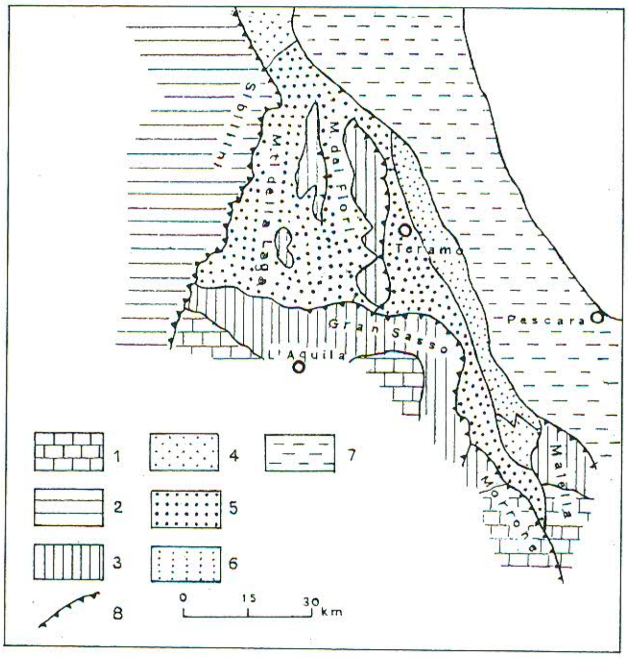

Fig. 1. – Inquadramento geologico regionale del teramano.
1) Successione calcareo-dolomitica in facies di piattaforma carbonatica (Trias superiore-Miocene medio); 2) Successione calcareo-silico-marnosa in facies pelagica (Giurassico - Miocene medio); 3) Successione calcareo marnosa e calcareo-clastica in facies di transizione prossimale (Giurassico-Miocene medio); 4) Formazione gessoso-solfifera (Miocene superiore); 5) Formazione della Laga (Messiniano); 6) Formazione Cellino (Pliocene inferiore); 7) «Argille grigio-azzurre», sabbie, arenarie e conglomerati (Pliocene medio-Pleistocene inferiore); 8) Fronti di sovrascorrimento affioranti. (Da ADAMOLI L., 1994)

– Geological schetch of Teramo area.
1) Calcareous- dolomite sequence in facies of carbonate platform (upper Trias-middle Miocene); 2) Sequence calcareous-silico-marly-pelagic facies (Jurassic-middle Miocene); 3) Sequence calcareous-marly and clastic-calcareous in proximal transition facies (Jurassic- middle Miocene); 4) Formation gessoso-solfifera (upper Miocene); 5) Laga Formation (Messiniano); 6) Cellino Formation (Pliocene); 7) Grey-blue clays, sands, sandstone and conglomerates (middle Pliocene-lower Pleistocene); 8) Outcrop of overthrust. (ADAMOLI L., 1994).

sioni dai settori occidentali verso settori più orientali adriatici.

L'evoluzione geodinamica dell'Appennino centrale, di cui il territorio teramano fa parte, è descritta e discussa in numerosi lavori dai quali è tratto il presente inquadramento schematico (ACCORDI & CARBONE, 1988; ADAMOLI, 1980, 1994; ADAMOLI *et alii*, 1991; GHISETTI & VEZZANI, 1986a; MATTEI M., 1987; PAROTTO & PRATURLON, 1975). È stata controllata dalla presenza di almeno due fondamentali unità paleogeografiche-strutturali, piattaforma carbonatica laziale-abruzzese e bacino pelagico umbro-marchigiano, che si sono impostate a partire dal Trias superiore sul margine meridionale della Tetide. Durante il Messiniano-Pliocene inferiore nell'Abruzzo teramano, in relazione alla fase compressiva ed al corrugamento appenninico, si individuarono due distinte avanfosse articolate in una serie di dorsali e di depressioni allungate longitudinalmente: il Bacino della Laga più interno e più antico ed il Bacino del Cellino più esterno. Una schematizzazione della situazione geologica dell'area può essere così descritta:

– successione di natura carbonatica, meso-cenozoica costituita da formazioni calcareo-dolomitiche, calcaree e calcareo-silico-marnose affioranti nel settore della catena del Gran Sasso e nella dorsale M. dei Fiori - M. di Campli - Montagnone;

– due diverse formazioni date da depositi terrigeni torbiditici, neogenici, che si sono deposte in due bacini adiacenti, il bacino della Laga ed il bacino del Cellino, costituite da arenarie, marne ed argille;

– depositi marini sabbioso-argillosi (fig. 2) e conglomerati del Pliocene superiore-Pleistocene che affiorano solo nella parte più orientale del territorio teramano.

L'assetto strutturale regionale è formato da tre unità tettoniche principali (ADAMOLI, 1994), geometricamente sovrapposte tra loro:

– Unità del Gran Sasso;

– Unità M. dei Fiori - M. di Campli - Montagnone;

– Unità della Laga.

La struttura di quest'ultima, che comprende quasi tutto il territorio del comune di Teramo, è caratterizzata, limitatamente ad aree circoscritte, da settori a giacitura sub-orizzontale e direzione N-S, separati da pieghe di modeste entità e da faglie. Gran parte del territorio, di contro, presenta strutture a pieghe asimmetriche coinvolte da fronti di sovrascorrimento (quest'ultimi sono in massima parte sepolti) e da faglie. Nella fascia più orientale i depositi costituiti da emipelagiti marnose, argillose e siltose presentano un andamento a monoclinale immergenti ad est.

3. – CARATTERI GEOMORFOLOGICI GENERALI

L'attuale quadro geomorfologico dell'area é il risultato di diversi fattori quali le caratteristiche lito-strutturali del substrato, l'evoluzione neotettonica, la successione degli eventi climatici quaternari e non ultima

Fig. 2. – Formazione delle emipelagiti marnose, argillose e siltose in località Villa Falchini.

– *Hemipelagic formation, clay and siltstone in Villa Falchini area.*

l'attività antropica, soprattutto quella più recente. Alle caratteristiche litostratigrafiche del substrato, costituito in prevalenza da alternanze di materiali arenacei e argillosi e in subordine da materiali calcarei, è connessa la genesi di versanti diversamente acclivi, con rotture di pendio e scarpate di erosione selettiva. In particolare appare netto il contrasto tra scarpate strutturali (orlo di scarpata con influenza strutturale) ubicate in corrispondenza degli affioramenti arenaceo-pelitici e i versanti più dolci modellati sulle argille e sulle alternanze pelitico-arenacee. Per quanto riguarda il fattore tettonico ha avuto fondamentale importanza nella morfogenesi dell'area il sollevamento generale che l'ha interessata in tempi recenti (a partire dal Pleistocene inferiore). Tale fenomeno ha indotto un generale e rapido approfondimento dell'erosione lineare sia pure con fasi di minore intensità o di stasi in relazione alle diverse condizioni climatiche che si sono avvicendate nell'area a partire dal Pleistocene medio. Ne è derivato un paesaggio caratterizzato da forte energia di rilievo e da versanti discretamente acclivi in dipendenza, come si è detto, dalle condizioni lito-strutturali del substrato. Alla successione delle diverse fasi climatiche del passato si debbono le alternanze di periodi a prevalente erosione lineare e di periodi a prevalente sedimentazione lungo le aste vallive. I depositi alluvionali che si osservano sugli attuali fondi vallivi o che appaiono terrazzati poco al di sopra di questi sono da collegare ai diffusi fenomeni di erosione sui versanti conseguenti ai massicci disboscamenti effettuati dall'uomo in epoca storica.

Più in generale si può affermare che l'attività antropica (agricoltura, urbanizzazione, estrazione degli inerti dagli alvei, regimazione delle acque etc.) ha costituito il principale fattore di controllo della morfogenesi fluviale recente ed attuale, introducendo nel quadro evolutivo dell'area processi di erosione e di accumulo notevolmente più rapidi ed intensi di quelli dovuti a cause naturali.

4. – BENI GEOLOGICI E GEOMORFOLOGICI

4.1. – Forme dovute all'azione della gravità

Le tipologie più ricorrenti nell'area sono gli scorrimenti rotazionali e planari (slides) e i colamenti (flows) (Varnes D.J., 1978). Queste frane interessano per lo più le coperture eluviali e colluviali, ma anche il substrato roccioso, per lo più di natura argilloso-sabbiosa. Le modalità con cui avvengono il distacco e la discesa delle masse dipendono da diversi fattori, tra i quali i più importanti sono la natura litologica dei materiali, il loro assetto strutturale e la morfologia del versante interessato. La zona di distacco, avvenuta la frana, si presenta di solito incavata nel versante a forma di nicchia, circondata da una scarpata (fig. 3). In località Miano è stata rilevata nel corpo di frana una «trincea» parallela al versante ed alcune contropendenze (Di Eusebio, 1987). Da segnalare diversi paesaggi calanchivi che rappresentano la forma finale un tipo di erosione «a solchi».

Fig. 3. – Frana di tipo slide in località Miano.

– *Landslide in Miano area.*

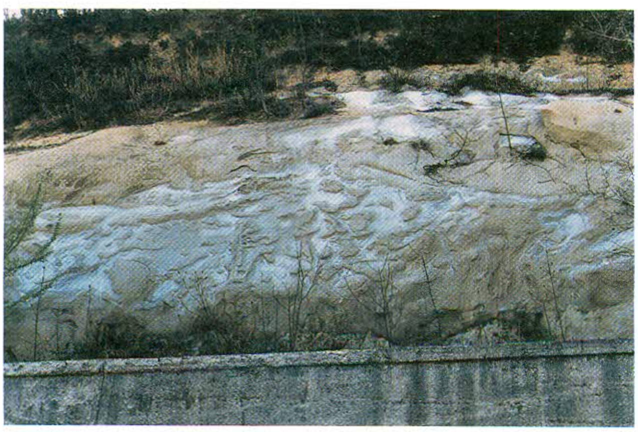

Fig. 4. – Morfoscultura su associazione arenacea in località Ponte Fosso Venacorvo S.S. 81.

– *Morphological sculpture on arenaceous formation in Ponte Fosso Venacorvo area S.S. 81.*

Fig. 3. – Frana di tipo slide in località Miano.

– *Landslide in Miano area.*

4.3. – Morfosculture

Il processo si innesca per il permanere dell'acqua meteorica in corrispondenza di alcuni punti di discontinuità della roccia. In questi punti meno esposti all'aria e al sole, l'acqua permane più a lungo innescando un processo di alterazione chimico-fisica. Inizia a formarsi così, con una prima desquamazione della roccia, una piccola nicchia (fig. 4). In questa, incavata e più protetta dal sole e dall'aria e quindi dall'evaporazione, si può fermare dell'altra acqua, favorendo così il procedere dell'azione erosiva, che approfondirà sempre più la cavità primitiva.

4.4. – Paleosuperfici

Anche se con un nome generico, si segnalano alcune paleosuperfici (fig. 5), (Di Eusebio, Leva & Manetta, 1996) modellatesi in un contesto morfoclimatico del tutto diverso da quello attuale. La formazione di due «generazioni» di superfici é resa possibile dal rapido sollevamento verificatosi presumibilmente tra il Pleistocene Medio e il Pleistocene Superiore: la ripresa dell'erosione dei corsi d'acqua ha consentito così lo sviluppo di valli fortemente incise, distinguendosi dalle forme più pianeggianti originatesi nel «ciclo» precedente.

5. – PROSPETTIVE FUTURE

Le aree campioni ed i beni individuati, dovrebbero essere valorizzati con la creazione di percorsi sia scientifici che didattici attraverso la creazione di sentieri, opuscoli esplicativi, utilizzo di una cartellonistica e non ultimo con il recupero di alcuni vecchi casolari adibiti all'uopo a piccoli musei.

La difficoltà maggiore potrebbe derivare nel momento in cui si voglia attuare una politica di protezione delle aree o dei beni naturali, anche se alcune Amministrazioni Locali (quelle più sensibili) negli ultimi tempi hanno preso in considerazione la possibilità di poter considerare questo programma come «lavori socialmente utili» e di conseguenza destinare alcuni giovani, che prestano questi servizi presso l'Amministrazione, ad attività che hanno come scopo quello di gestire il patrimonio geologico.

BIBLIOGRAFIA

ACCORDI G. & CARBONE F. (Editors, 1988) - *Carta delle litofacies del Lazio-Abruzzo ed aree limitrofe.* C.N.R. Prog. Fin. Geodinamica, QUADERNI Ric. Scient., **114** (1988), (5): pp. 223. Roma.

ADAMOLI L. (1980) - *Contributo alle conoscenze geologiche e petrografiche della Formazione della Laga.* «Notizie», C.C.I.A.A. - Teramo n: 8, 31-48.

ADAMOLI L., BIGOZZI A, CIARAPICA G. CIRILLI S., & PASSERI L. (1991-92) - *Settore 7. Corno Grande - M. Camicia.* In : Damiani A.V., Chiocchini M., Colacicchi R. Mariotti G., Parotto M., Passeri L. & Praturlon A. « Elementi litostratigrafici per una sintesi delle facies carbonatiche Mesocenozoiche dell'Appennino centrale». Studi Geologici Camerti, volume speciale, CROP 11, 187-213.

ADAMOLI L. (1994) - *Studio dell'ambiente geologico, geomorfologico ed idrogeologico della provincia di Teramo.* Amm. Prov. Teramo.

ARNOLDUS - HUYZENDVELD A., GISOTTI G. & MASSOLI-NOVELLI R. & ZARLENGA F. (1995) - *I beni culturali a carattere geologico: i Geotopi. Un approccio al problema.* Geol Tec. & Amb. 4 /95.

CASTO L. & ZARLENGA F. (1992) - *I beni culturali a carattere geologico nella Media Valle del Tevere,* pp. 165, ed. ENEA, Roma.

CASTO L. & ZARLENGA F. (1995) - *I beni culturali a carattere geologico del Lazio. Il distretto vulcanico di Albano,* pp. 143, ed. ENEA, Roma.

CENTAMORE E., CANTALAMESSA G., MICARELLI A., POTETTI M., RIDOLFI M., CRISTALLINI M. & MORELLI C.. (1993) - *Contributo alla conoscenza dei depositi terrigeni neogenici di avanfossa del teramano (Abruzzo settentrionale).* Boll. Soc. Geol. It., **112**: pp. 63-81.

DI EUSEBIO F. (1987) - *Rilevamento geomorfologico ad indirizzo applicativo di un'area circostante la città di Teramo.* Università di Urbino. Tesi inedita

DI EUSEBIO F., LEVA D. & MANETTA M. (1996) - *Carta dei beni naturali culturali del comune di Teramo.* Amm. Comunale di Teramo

FABBRI M. & ZARLENGA F. (1996) - *I beni naturali culturali geologici.* Verde Ambiente n. 1, gennaio/febbraio 1996.

GENTILI B. & PROCACCINI E. (1994) - *Studio geologico del Piano Regolatore* Generale. Amm. Comunale di Teramo

GHISETTI F. & VEZZANI L. (1986 a) - *Assetto geometrico ed evoluzione strutturale della catena del Gran Sasso tra Vado di Siella e Vado di Corno.* Boll. Soc. Geol. It., 105, 131-171.

MATTEI M. (1987) - *Analisi geologico-strutturale della Montagna dei Fiori (Ascoli Piceno Italia Centrale).* Geol. Romana, **26** (1987): 327-347, 9 fig., 1 carta f.t., Roma.

PAROTTO M. & PRATURLON A. (1975) - *Geological summary of the Central Apennines. In: «Structural Model of Italy».* Quad. de «La Ricerca Scientifica», C.N.R., **90**: pp. 257-311, Roma.

RICCI LUCCHI F. & PAREA G.C. (1973) - *Cicli deposizionali (mega sequenze) nelle torbiditi di conoide sottomarina: Formazione della Laga (Appennino marchigiano-abruzzese).* Atti Soc. Nat. Mat. in Modena, **104**: pp. 247-283.

VARNES D.J. (1978) - *Slope movements types and processes.* T.R.B. Spec. Rep., **176**, Nat. Acad. Sc., Washington.