

## Geological Sites of Special Scientific Importance (GSSSI): an approach to Bulgarian and Balkan geotopes

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### Introduction

Geological sites (geosites, geotopes) protected by the Bulgarian laws are usually impressive natural sites of geomorphic character (picturesque rock groups, upright rock beds, gorges, natural erosional rock bridges, erosion forms, waterfalls, caves, karst areas and different karst forms and sources, capped earth pillars, morains and other glacier formations, separate rock sculptures, dunes, lakes, marshes, etc.), and only in single cases, geological features with importance for the geological structure of Bulgaria and the Balkan Peninsula. One of the objectives of the First Subregional Meeting "Conservation of the Geological Heritage in Southeast Europe" was to draw the attention of geologists from the Balkan countries towards geological sites that are not so attractive for the general public but should be highly estimated by professional geologists. Such is also the aim of the present paper.

The IUGS Global Geosite Working Group produced a database form (Anon., 1995) that classifies the geosites into several Earth Science Categories listed hereafter: A. Palaeobiology; B. Geomorphic; C. Palaeoenvironmental; D. Igneous, metamorphic & sedimentary; E. Stratigraphic; F. Mineralogic; G. Structural; H. Economic; I. Historic; J. Relationships: tectonic plates; K. Astroblemes; L. Continental/Oceanic global scale features; M. Submarine. Geosites are also regarded as being important for the characterization of: I. major stages of Earth history; II. ongoing geological processes; III. geomorphic, physiographic features.

### Classifications of the geological sites

In the broadest sense, and only with the most utilitarian approach, the geological heritage may be classified on the basis of its utility as raw materials. Thus, it can be subdivided into ores, non-metallic raw materials, ornamental stones, oil, gas, coal, bituminous shales, waters (mineral, karst, ground), and rocks and minerals that cannot be used at the current level of science and technology. The utilization of the geological heritage by the mining industry is in such a case governed only and simply by the economy. Another element of the geological heritage viewed under such a narrow angle is the geological documentation.

The scientific approach is looking for a classification that would take into account all features of the geological heritage that makes it precious for society and science. In such a case, the utilization of a part of the geological heritage by the mining industry is taking into account also the scientific and aesthetical value of this part of the heritage, and all harmful consequences that would follow the irreversible loss of this part. The geological sites and objects can be subdivided from such positions into: 1) mineral occurrences (mineralogical features); 2) water sources (mineral, karst, etc.); 3) rocks (petrologic features); 4) fossils; 5) stratigraphic sections and other stratigraphic features; 6) structural-geological features; 7) complex geological sites; 8) old and/or abandoned quarries and mines; 9) unique objects and sites; 10) geomorphic features.

Taking into account only the dimensions of

the site (object), the geological heritage may be classified into: 1) objects (fossils, minerals, rock specimens); 2) sites (outcrop, section, small quarry, separate shaft or gallery); 3) areas (geological structure or body; huge quarry, mine; geological or geomorphic panorama); 4) geological documentation.

The relative importance of the geotopes may classify them as being of local (locality, district), national, subregional (Balkan Peninsula), regional (the European continent) or world importance. The Bulgarian law gives to the Ministry of the Environment the right to declare a protected site or a reserve. Protected sites are under the supervision (according to their character) of several Government agencies: Ministry of the Environment; National Service for the Protection of Nature; Committee of Forests; Committee of Geology and Mineral Resources; Ministry of Health; the local councils and mayors, etc.

Although many geomorphic sites possess a considerable scientific value, they are mostly protected by the Law (Spassov, 1966; Todorov, 1976, 1981, 1990) due to their aesthetical value and their impact on the general public. These are landforms sculptured by the external Earth forces, and namely water (in all forms) and air (winds). The rocks already existed as geological bodies formed by endogenous or exogenous processes, and possessed their composition and structure partially preserved in the process of destruction by the external forces. Thus, the existing landforms are the result of interaction between the destructive external forces, and the pre-existing geological bodies, and both factors are controlling the formation and evolution of the existing landforms.

This character of the geotopes favours a most convenient twofold classification that defined two large groups: geotopes (geosites) of special scientific importance (GSSSI) and geotopes (geosites) of aesthetic value (GAV).

The classification of the geotopes of aesthetic value is based on the agent (process) that played the main part in their formation and evolution. The following GAV are distinguished as products of: 1) water erosion (streams, rivers, lakes, seas); 2) aeolic activity; 3) glacier activity; 4) karstification; 5) denudation and accumulation during young (Neogene and Quaternary) crustal movements.

Products of erosion are usually the most attractive and majestic landforms. They are subdivided into 1) upright impressive rocks (including "stone mushrooms", "obelisks", etc.) sculptured into hard metamorphic, igneous or sedimentary (terrigenous or carbonate) rocks ("Vratsata" near Vratsa; "Choudnite skali" in

the Eastern Stara Planina Mountains; "Belogradchik rocks", "Lakatnik rocks", etc.); 2) rocky gorges, as the Iskur Gorge, Zemen Gorge, Kresna Gorge, Trigrad Gorge, etc.; 3) rocky river and sea coasts (the rocks at the Cape Kaliakra; the rocks along the river Rousenski Lom near the village of Ivanovo, etc.); 4) rocky crowns (near Belogradchik, Teteven, etc.); 5) rock bridges ("Choudnite mostove" near the village of Zaburdo; the rocky bridge at the village of Mostovo, Rhodope Mts.); 6) waterfalls; 7) rocky landforms in relatively loose sedimentary rocks (loose sandstones and conglomerates with Neogene or Quaternary age), as coulisses, obelisks, pyramids, columns, capped columns, mushrooms, etc. ("Melnik Pyramids", "Stob Pyramids", "Kutina Pyramids"). In the last case, stopping of erosion (due also to human activity, as artificial woods) leads to a fast destruction of the site because of coverage by soil and vegetation, and its loss as a typical natural feature.

The most prominent products of aeolic activity are the dunes, and moraines, "Roches moutonnées" and glacier lakes result from Quaternary glaciation. Karst products are extremely attractive, and namely Karen, funnels, karst sources, caves and their formations (stalactites, stalagmites, stalactones, coulisses, draperies, etc.).

The natural landscape is particularly important both from scientific and aesthetic viewpoints. Products of Neogene and Quaternary denudation, erosion and accumulation as, e.g., denudation surfaces (peneplains, pediments), river terraces (denudation or accumulation) and river beds (modern and old; meanders, etc.), relict peaks, plateaus, hills, etc. are all of utmost importance for preservation of the natural environment.

The geological sites have a mighty aesthetic effect, and have been preserved and worshipped since most ancient times.

The geological Sites of Special Scientific Importance (GSSSI) may be classified into several categories based on different principles (Anon., 1995; NCC, 1991; Wimbledon, 1995). One of these principles concerns the level of importance, and the GSSSI could be correspondingly referred to as being of importance for the corresponding country (here, Bulgaria), the subregion (Balkan Peninsula), the region or continent (Europe), or the planet Earth. The practice in the United Kingdom considers only two categories of that kind, and namely: geological SSSI and Regionally Important Geosites (RIGS). Another principle is relative to the particular geological science, and the GSSI could be correspondingly classified (with

reference also to the classification of Anon., 1995) as:

- fossil localities of special importance (A);
- rare mineral localities (F);
- important petrological features (D);
- stratotypes of lithostratigraphic or chronostratigraphic units, of local or of worldwide character (E);
- structural features (G);
- sites exposing important relations between different geological bodies (partly J);
- wide and complex geological panoramas exposing unique geological features of complex character.

The importance of fossil localities may depend whether the fossils are commonplace or rare on the national scale or subregional scale. The richness in taxa, or the abundance of specimens of a single species may be an additional parameter. The famous Pikermi deposit (near Athens) of Neogene fossil mammal fauna has found already its place in the World Geological Heritage List. Other important deposits of Neogene fossil fauna may be listed as, e.g., the Kalimantsi and Kromidovo localities in Southwest Bulgaria (Nikolov, 1985), the Dorkovo locality near Velingrad, West Rhodopes, etc. Localities and sections rich in Triassic (Greece, Northern Dobrogea in Romania, etc.) and Jurassic ammonites, brachiopods, bivalves, etc. should be also taken in consideration. The extremely rich fossil site of ammonites and inocerams at the village of Kladoroub (Belogradchik area) is unique for the Maastrichtian of Carpathian type (Tzankov, 1964), and also deserves to be included in the subregional Geological Heritage List. The conservation of the fossils and their localities is very similar to that of rare mineral species. The protection of the sites from excessive sampling for amateur collections or commercial interest is the first step that should be followed by restrictions of the sampling for educational and even research purpose. The unique specimens already sampled and described in scientific publications should be correspondingly kept in museums.

The localities of rare mineral species may be mineral deposits that are (or have been) mined for the extraction of mineral raw materials, or rock occurrences that contain some rare minerals. Some of the deposits are of national importance. Such a deposit may be a single deposit of a given mineral or mineral association in the country or may contain beautiful crystals of a mineral. Deposits of unusual or unique character for the subregion or the region would enter correspondingly the subregional or

regional list whereas the World List of the Geological Heritage should include unique minerals or mineral associations as, e.g., the deposits of charoite in Russia. A possible Balkan example is the gold and thallium-antimony-bearing Alshar polymetallic deposit (Boev et al., 1993) with its unique mineral association that contains about 50 minerals including bravoite, maucherite, falkmannite, andorite, ramdohrite, fizelite, polyvazite, native gold, antimonite, realgar, bertierite, auripigmentum, lorandite, vrbaite, regenite, picopolite, rebulite, simonite, bernardite, alsharite, etc. A great problem is the conservation of such deposits that has several facets, as, e.g., how to find a compromise between the economical (mining) and conservation interests; how to organize the conservation of extracted rare minerals and/or crystals in museums, and the conservation of abandoned galleries or mines.

The localities that possess rare petrological features may be also deposits of rare or unique rock types (as, e.g., some of the rare petrological rock types in the Kola Peninsula in Russia) or localities with typical interrelations of different petrological bodies. Consecutive formation with clear interrelations of products of several metamorphic phases has been observed in a huge rock fragment in the river Chetirka, West of Blagoevgrad (Zagorchev, 1976). The following metamorphic phases belonging at least to two metamorphic cycles in the rocks of the Troskovo Group of the Ograzhdenian Supergroup are observed: i) first-phase amphibolite-facies regional metamorphism; ii) granitization and migmatization; iii) formation of metasomatic garnet-oligoclase-quartz veinlets along cross-cutting fractures; iv) formation of quartz veins; v) formation of basic dykes that displaced the quartz veins; and vi) a second-phase amphibolite-facies regional metamorphism with beginning migmatization that affected also the basic dykes of the previous phase. Interesting examples of interrelations of different metamorphic and igneous products can be observed also in the rock of the Chepelare Formation of the Rhodopean Supergroup on the road between the villages of Polena and Kadiytza (Zagorchev, 1995. Intrusive contacts between different granitoid plutons with assimilation or hybridization phenomena (as in a quarry at the Verigovo quarters of the town of Hisar, Sredna Gora Mountains — Zagorchev, 1973; Zagorchev, Moorbath, 1986) are rarely observable and may be of great importance for the national or subregional geology. Classical intrusive contacts with contact metamorphism (skarns or hornfelses) or localities that expose several

metamorphic events with dividing intrusive or metamorphic markers in between them are other examples. The quarries at the village of Bulgarovo (Burgas District, Srednogorie Zone) provide a striking example of Upper Cretaceous pillow-lavas that have been transformed into peculiar alkaline rocks (bulgarites, hedrumites) as a result of autometamorphic and metasomatic processes (Stanisheva-Vassileva, 1989). Here again, the complicated conservation problems touch the conservation of important petrological features during the mining (quarrying) activities; conservation of important quarry walls of abandoned quarries during re-cultivation; conservation of extracted important specimens in museums; regulation of the access for sampling during research and education activities, etc.

Stratigraphic features of national importance embrace all stratotypes of formal lithostratigraphic units as well as lektostratotypes or some complementary sections. Unique or particularly well exposed sections are of subregional or world-wide importance. The section of the Pindos - Olonos Zone near Karpenission (Fleury, 1980) covers a beautifully exposed mostly pelagic sequence from the Triassic to the Palaeogene, and is certainly at least of subregional importance. Unconformable depositional contacts, condensed sections and other stratigraphic and sedimentological features should be specially considered. Other complex examples will be given below. The conservation problems are related mostly to the fast deterioration of sections exposed by road or railway cuts due to weathering or/and human activities.

The structural features of national importance are usually good outcrops of folds (including unusual fold types, interference features or refolded folds with interrelations of several cleavages or lineations), thrusts, normal faults or strike-slip faults. Exceptional cases of such structural features may be classified as sites of subregional or world-wide scientific importance, as, e.g., the Gurbino thrust and the Murvodol anticlinaloid (Kyustendil District, SW Bulgaria). The panoramic outcrop on the massif of the peak Cherni Kamak at the village of Tserovo, Iskar Gorge, displays in a unique manner the character of the Late Alpine tectonostratigraphic units in the western parts of the Balkan fold-and-thrust belt (Tzankov, 1995). Another regional structure (the Laramian Belogradchik anticlinorium) is the best preserved in Eastern Europe megaantiform of that kind (Tzankov, 1971), and some parts of it should be placed under protection. These sites include also the

amazing by their beauty as erosional forms but also very important as a sedimentological phenomenon Lower Triassic psammo-psephitic deposits of the Belogradchik Rocks.

Complex relations between different geological bodies are of paramount importance for establishing the geologic evolution of a tectonic zone or region. Some of these features may be only of national importance whereas other are of subregional or world-wide importance. Some examples from SW Bulgaria (Murvodol anticlinaloid, Gurbino thrust and the section Rayantsi) may give an idea about the features of such sites. They exhibit both stratigraphic (stratotypes of formal lithostratigraphic units), structural (imbrications, cleavage/bedding relations, strain indicators enabling detailed strain analysis, folds, thrusts, unusual structure – antiformal syncline, late fibrous veins, faults) and geodynamic (fossilized deep marine environment) features.

## Elements for the description of the GSSSI

The description of the protected geological SSSI should contain standard (compulsory) information as well as additional elements that are not obligatory for placing the site under protection.

The elements of the standard (obligatory) information should be:

- (1) Name – formally accepted name that enters all formal documents, and/or principal name (wide-known) with data for all synonyms
- (2) Location (address) that includes:
  - (2.1) Name of the closest town or village
  - (2.2) Name of the district centre
- (3) Type of the GSSSI according to the adopted classification
- (4) Dimensions (in m) of the phenomenon, as, e.g., height, length; number of the composing elements, etc.
- (5) Area of the Site (km<sup>2</sup> or m<sup>2</sup>)
- (6) Number and date of the formal document; number and date of publication
- (7) Lithostratigraphic information: formal or informal lithostratigraphic units, with basic description and bibliographic data (first author, revising authors, etc.)
- (8) Basic lithological (petrological) description
- (9) Age of the phenomenon, and evidence (biostratigraphical, radiogeochronological) about the age (with bibliographic data)
- (10) Characteristic features of the phenomenon that make it a GSSSI (detailed description)

supported with maps, sections, bloc-diagrams, photographs, drawings, etc.)

(11) Hypotheses (if existing) about the origin (with bibliography)

The complementary descriptions may contain:

(1) More detailed geographic data, and data about the origin of the geographic name

(2) Characteristic geographic reference points near the site.

## Bulgarian Law for the Protection of Nature

(“Durzhaven Vestnik” (Official Gazette), 47/1967; emended 3/1977; 39/1978; 28/1982; 26/1988; 86/1991)

The natural sites of particular scientific importance are specially mentioned (articles 14 and 18) in the Bulgarian Law for the Protection of Nature. Only several articles and paragraphs will be cited hereafter that refer to different aspects of the geological heritage.

Art. 2. To protection, regulation and amelioration are subject: the earth, waters, internal sea waters included, the sea of the territory and the exclusive economic zone of the country, the air, mineral deposits, onshore sands, the natural vegetal and animal world, the natural environment, the typical landscape and remarkable natural objects.

Plans and projects of the territorial management as well as plans for construction, exploitation and other activities, are elaborated and approved following the requirement to admit no damage, destruction, pollution and spoiling nature.

Art. 14. As protected are proclaimed natural sites that possess a particular scientific, historical or cultural value, specific natural beauty or are used as places of recreation and tourism.

Art. 15. The protected natural objects are: reservations, national parks, natural monuments, localities with typical landscape, historical places and precious vegetal and animal species.

Art. 18. As natural monuments are proclaimed natural objects with geological, palaeontological, botanical or other character that, irrespectively of the location and environment, possess scientific, cultural, historical or aesthetic value.

Art. 19. As protected localities are proclaimed nature places with typical landscape — gorges, defiles, etc. that can be used as places for tourism and recreation.

Art. 24. The exploitation, management, restoration and conservation of the protected natural sites is made under the provisions of this

law and the regulations for its implementation under the general direction and control of the Ministry of Environment.

Art. 25. The act of proclaiming a natural site as protected does not change the character of ownership but places the management, exploitation and preservation under the regulations of this law.

The protected natural sites: reservations, national parks, natural monuments and historical places are classified as objects of world, national or local significance, and are inscribed in the State Records.

The Regulations (Council of Ministers, Decree 6/10.04.1969, emended 1978) for the implementation of the Law for Protection of Nature contain specific texts about the responsibilities of the Ministry of Architecture and the Management of the Territory; the Ministry of Agriculture; the Ministry of the Environment; the Committee for Forests; the Committee for Geology and Mineral Resources; the Ministry of Health; the Committee for Tourism; the District and local councils. All plans, projects, etc., the regime of admittance of scientists, tourists, etc., and the planning of scientific and other studies within the reservations, national parks and natural monuments, have to be approved by the Ministry of the Environment after consultations and consent of the Bulgarian Academy of Sciences (articles 2, 4, 5, 6, 10, 11, 16, 17, 18, 19, 20, 23, 24, 25, 27, 30, 32, 33, 34, 35, 39).

## Strategy of the Earth Science conservation in the domain of GSSSI

The strategy in the domain of conservancy of the geological SSSI should take into account the existing different level of understanding, protection, management and monitoring in the Balkan countries. The following lines are inspired mostly by the discussions during the First Subregional Meeting, and the strategy existing in the United Kingdom (NCC, 1991). The potential participants in the strategy could be:

— the subregional working group ProGEO-1 founded at the Meeting;

— the Environment Geology Commission of the Carpatho-Balkan Geological Association (CBGA);

— the national agencies for protection and conservation of Nature;

— the Earth Science societies and the Nature lovers' societies in the respective countries and their members;

- geological institutes and faculties, schools, etc.;
- national geological surveys;
- national ministries or agencies for forests, tourism, etc.;
- museums;
- local authorities;
- mining and quarry companies, landowners and site managers;
- country wildlife trusts, national parks and reserves.

The strategy should be concentrated on several key themes as follows:

Theme 1. Developing subregional and national strategies; developing international links and support

Theme 2. Elaboration of subregional and national lists of the geological heritage, and legal action for proclaiming the geological SSSI (and RIGS in the sense of NCC, 1991, or geosites of local scientific importance) under State protection thus constituting GSSSI and local geosite networks in each country and on the subregional scale

Theme 3. Maintaining the GSSSI and local geosite networks with appropriate conservation measures

Theme 4. Introducing existing and developing new conservation techniques

Theme 5. Elaborating and improving site documentation and the conservation of samples

Theme 6. Increasing public awareness.

It is evident that our countries have a long way ahead in the domain of Earth Science conservation, in order to join the high standards achieved in other European countries. It is our duty as geoscientists conscious of our geological heritage to make any possible effort in developing and implementing the strategy in this important field.

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