GEOLOGY, LANDSCAPE, AND CONSERVATION IN THE ROMANIAN GEOPARKS

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Abstract. Measures of protection for geosites were developed in Romania, one of the countries which created a geopark, The Hațeg Country Dinosaur Geopark (The International Geopark UNESCO Hațeg Land), following the UNESCO recommendation. Another geopark is in an advanced stage of creation, The Buzău Land Geopark, an aspiring UNESCO Geopark. Both geoparks contain geosites of outstanding importance: scientific, educational and geotouristic, unfortunately not sufficiently protected and value. That is why a firmly legislation is needed, along with a more profound implication of local, regional and national authorities, for achieving a correct management of those areas.

Keywords: natural heritage, protection, Buzău Land Geopark, The Hațeg Country Dinosaur Geopark (The International Geopark UNESCO Hațeg Land).

Résumé. Des mesures de protection des géosites ont été mises au point en Roumanie, l'un des pays ayant créé un géoparc, Le Géoparc des dinosaures du pays de Hațeg (Le Géoparc International UNESCO du Pays de Hațeg), conformément à la recommandation de l'UNESCO. Un autre Géoparc est à un stade avancé de création, le Géoparc du Pays de Buzău, un futur géoparc de l'UNESCO. Les deux géoparcs contiennent des géosites d'une importance exceptionnelle: scientifiques, éducatifs et géotouristiques, malheureusement pas suffisamment protégés et valorisés. C'est la raison pour laquelle il est nécessaire de légiférer fermement, ainsi que d'impliquer davantage les autorités locales, régionales et nationales, afin de parvenir à une gestion correcte de ces zones.

Mots-clés: héritage naturel, protection, Le Géoparc Pays de Buzău, Le Géoparc des dinosaures du pays Hațeg (Le Géoparc International UNESCO du Pays de Hațeg).

GEOCONSERVATION

There is a growing cultural awareness concerning the variety of landscapes and resources, including the geological ones, along with the conservations of various sites. There is a global need for managing and understanding changes related to natural and anthropic causes of the geological sites and landscapes in a sensitive and sustainable way.

The increasing awareness in understanding the natural heritage and the implication in its conservation are in contemporary societies driving forces in fostering knowledge, conscious citizenship, respect for diversity of the nature, intercultural dialogue, economic and social growth. All these should be reflected in the growing attention governments, societies and international governmental and non-governmental organizations. In many countries, there is a real engagement to ensure the presence of natural heritage in the national educational programmes and the promotion of specific academic and technical training programs in the field of natural heritage protection and conservation. A broad theoretical agreement seems to emphasize that education and professional training represent a key role in ensuring the future to the natural heritage.

The establishment and management of geoparks imply protection of geological sites and landscapes, including the cultural heritage of these regions, leading to a sustainable tourism.

Consequently, the establishment world wide of geoparks has led to local and regional economical growths. The geoheritage movement is strong in Europe, where the organization *ProGEO – The European Association for the Conservation of the Geological Heritage* is leader in geological conservation. ProGEO promotes the protection of significant geosites and landscapes, as well as the whole patrimony of geological features with scientific, educational, tourist and cultural relevance.

In the Geopark territories, special attention is given not only to preserving special geological features, but also to capitalizing those features such as landscapes, archaeological sites, monuments and last but no least flora and fauna. To promote the natural capital of the geoparks, the identification of the whole sites relevant for the geological and palaeontological heritage, but also the representative biological ones, along with the historical monuments is mandatory. A detailed landscape resource analysis is also needed. These features are important not only for scientific and educational points of view, but also for an increasing tourism in the geoparks, leading to a sustainable economic development of the regions where the geoparks are situated. On the other hand, the economic growth should be appropriate with the territory size, otherwise it may impact it negatively; hence, a balance between regional development and preserving the biotic and abiotic nature must be maintained.

The promotion of the natural heritage enhanced the general interest in protecting the whole nature, but increasing access might make protection more difficult; restricting circulation might reduce access and visibility of natural monuments; bringing an object out of its original context may contribute to its conservation, but trigger claims for its return. Therefore, an important issue is how to identify and share best practices developed in the conservation of the biotic and abiotic nature. Around the world, an important commitment of the states, along with research and educational institutions, private organizations and associations in projects, communication and enhancement, with a focus on the protection of natural heritage, may be seen presently.

The term geodiversity, including the whole geological heritage (rocks, minerals, fossils, geological processes) appeared in connection to the significant achievement of the term "biodiversity" in revitalizing the wildlife conservation. These two concepts are not in contradiction, but complete each other. The geodiversity underpins biodiversity and is its life-support system, therefore creating an inextricable link between the two (Gray, 2013).

In the last decades a new concept of tourism, called geotourism has developed. In this view, people are seeking for aesthetics, i.e. scenic beauty including landscapes and natural monuments, for authenticity, i.e. authentic experiences, for learning about cultural heritage and the preservation of local culture, and last but not least about education for protecting the nature, the last issue combining geoturism with ecotourism.

In assessing the state of the natural sites, recently the use of the geo-eco-bio indicators has been proposed. These constitute geological, environmental and biological indicators, developed for assessing rapid change in the environment. These kinds of indicators express environmental parameters (Berger & Iams, 1996) and the processes that are capable of changing with or without human intervention, as the nature is dynamic; these include also changes in space and time whether or not a human intervention is present. The proposed geo-eco-bio indicators are monitoring rapid changes, usually referring to the last 100 years. The state of the natural heritage might be assessed based on patterns of erosion and deposition, especially along rivers and coastlines, the physical condition of soils, and the stability of slopes that could lead to significant landslides and avalanches. Recognizing the direction and magnitude of rapid landscape changes is essential for attaining a future that is more sustainable. The assessment of changes in the site status based on geo-eco-bio indicator fluctuation on long-term, such as the geological scale, is difficult to realize. Even if the human actions are not considered, a model of climate changes on mid- and long-scales and associated modifications on geomorphology needs to be achieved.

In assessing the state of the environment in general and especially that of the geosites, it is important to know whether change is being driven by physical, chemical or biological pressures. Recently some criteria were proposed (Jayakumar & Ke, 2007) to evaluate geoindicators criteria that

could be used also for the geo-eco-bio indicators in the sustainable management of a geopark, as a whole: (1) Significance: why is it important to monitor this indicator? (2) Human or natural cause: can this geo-eco-bio indicator be used to distinguish natural from human caused change, and if so, how? (3) Environment where applicable: in which general landscape setting would this indicator be used? (4) Spatial scale: at what scale would this indicator normally be monitored in the field? (5) Types of monitoring sites: where specifically should the indicators be measured? (6) Method of measurement: how is this indicator measured in the field? (6) Frequency of measurement: how often should this indicator be measured so as to establish a time series and baseline trend? (7) Limitations of data and monitoring: what significant difficulties are there in acquiring field and laboratory data?

Another issue related to the geoconservation regards the development and implementation of natural hazard and risk maps for environmental management and risk assessment. For these purposes, detailed geological maps (at a scale of 1: 100,000 or 1:50,000) covering the Geopark territory need to be produced, along with nationally coordinated and systematic geomorphologic mapping, topographic maps and the management of the information within the Geographical Information Systems (GIS). Moreover, for preventing illegal activities in the geoparks territories, a detailed knowledge of the whole natural heritage is required, together with a regular monitoring of all the sites and a strong support for studies and research on the biotic and abiotic capital.

This paper is focused on various aspects concerning the protection of the natural (biotic and abiotic) capital in Romania in general, and in *The Haţeg Country Dinosaur Geopark* and *The Buzău Land Geopark*, especially. Besides, considerations regarding the Romanian legislation on the natural capital protection and measures for improving it are presented herein.

ROMANIAN GEOPARKS

So far, in Romania there is only one UNESCO Geopark, situated at the end of the Southern Carpathians – *The Haţeg Country Dinosaur Geopark*, included also in the European Geopark Network. Besides, *The Buzău Land Geopark*, located in the Romanian Carpathian Bend region is an aspiring UNESCO Geopark. Both geoparks comprise significant geological and paleontological sites, but also include a rich cultural heritage.

The Haţeg Country Dinosaur Geopark is world wide famous for the endemic fossil fauna of dinosaurs and other continental fossils (Grigorescu *et al*., 1985; Grigorescu, 2010) but also for its marine geosites, including many macro- and microfossils that allow correlation with other regions, especially from the Alpine areas (Melinte-Dobrinescu, 2010).

The Haţeg Country Dinosaur Geopark is a member of the European Geoparks Network and UNESCO Global Geoparks. Its main geological values are the dinosaur-bearing deposits; the faunal assemblage from the end of the Cretaceous also includes representatives of all the major vertebrate groups from fishes to mammals (Grigorescu *et al*., 1985; Grigorescu, 2010). About 15 dinosaur taxa are currently recognized, besides skeletal elements, mostly found as isolated bones, rarely articulated partial skeletons, eggs in original nests and sometimes hatchling remains were also found in several localities of the Haţeg Basin (Grigorescu, 2010). There are remarkable products of the volcanic eruptions contemporary with the dinosaurs (two geotourist trails are organized along the Densuş River, near the homonymous village and around the medieval watch tower of Răchitova).

The initiation of the Haţeg Country Dinosaur Geopark was made based on its rich continental macrofaunal record, unique in Europe. For this reason, detailed investigations led by Professor Dan Grigorescu, who coordinated teams of students from the University of Bucharest, Faculty of Geology and Geophysics, systematically started since the last three decades. The rich macrofaunal assemblages, recorded both in the NW and SE regions of the Haţeg Country Dinosaur Geopark, include over 60 taxa, ranging from fishes to amphibians, mammals, turtles, lizards, snakes, crocodylians, pterosaurs, dinosaurs and birds (Grigorescu *et al*., 1985; Grigorescu, 2010).

Since the last two decades, the detailed geological, including palaeontological investigations enlarged, being focused not only on the continental deposits, but also on the marine sediments, exposed in significant outcrops that may be seen in the whole Haţeg region. Unfortunately, in the present only few continental and marine sites, i.e. the Palaeontological Site from Tuştea, with dinosaur remains, IUCN category IV, described as 'The Reptilian Paleofauna from Tuştea' and 'The Palaeontological Site from Ohaba-Ponor' containing Cretaceous marine faunas, such as bivalves and ammonites, are protected. It should be noted that many other sites of the Haţeg Country Dinosaur Geopark, with an outstanding scientific value and educational significance, are not protected, such as: 'The Transition between marine to continental sediments of the Cretaceous end', cropping out in the Densuş village, 'The Palaeontological Site from Strei', exposing the youngest Cretaceous marine macrofossils 'The Volcanic rocks from Răchitova', and the examples may continue. The Palaeontological Site from Ohaba-Ponor is the single marine site protected in the whole Haţeg Country Dinosaur Geopark. In this outcrop, a mid Cretaceous transition from a deltaic to an infralittoral palaeoenvironment that shifted to a shallow marine one is exposed. Besides, in the infralittoral sediments, the calcarenites contain an impressive number of marine gastropods with thick shells, especially *Actaeonella* (Fig. 1). The site is located in the village Ohaba-Ponor, very accessible, no protection has been made for it; tourists and local people are collecting fossils. Besides, some landslides and a stream are yearly destroying this unique site. A particularity of the marine deposits that occurs in the Haţeg Country Dinosaur Geopark is the presence of the red beds at various Cretaceous intervals. These are not continental, but of marine origin. One of them, such as the red marine marlstones (Fig. 2) cropping out in the NW Haţeg region, represent oxic deposits, sediments in a very deep marine palaeoenvironment. Their occurrence may be correlated with similar deposition known from many other regions, including the Carpathians and Alpines ones. The aforementioned type of rocks occurs on small areas, mainly in the hilly region of the NW Haţeg, at the contact with the crystalline basement. They are not easily accessible and are not situated in the neighbourhood of any locality. Another marine succession (Fig. 3) composed by variegated (red, grey and green) marlstones and claystones (The Fizeşti Formation) occurs in the SE part of the Haţeg region. Lateral lithological changes are also known within this unit; in some sections (i.e., N of the Fizeşti village), the lower part of the formation is composed by white-grey and green marlstones. The marine character of this succession is argued by the presence of identified marine macro- and microfossils, such as echinoids, foraminifers and calcareous nannoplankton, indicating that the age extends in the Late Cretaceous. The red beds are situated on a hill in the Fizeşti village and are very well exposed. They are accessible, but no touristic trails are proposed and, as the fossils are quite rare, people are not paying particular attention to this site.

Fig. 1. *Actaeonella* (gastropods) shells exposed in the Palaeontological Site from Ohaba-Ponor (Photo Mihaela Melinte-Dobrinescu).

Fig. 2. Cretaceous (Cenomanian) marine red beds (Ştei Formation) cropping out in the NW Haţeg region (Photo Mihaela Melinte-Dobrinescu).

Fig. 3. Variegated (red, grey and green) shales (The Fizeşti Formation) exposed in the Fizeşti village (Photo Andrei Briceag).

Fig. 4. The marine fossiliferous site from Strei (Photo Andrei Briceag).

The marine Upper Cretaceous sedimentation ends in the SE Haţeg area with the *Actaeonella* and *Hippurites* bearing conglomerates and sandstones of the Strei Formation, (Fig. 4), which may be assigned to an infralittoral palaeoenvironment. This unit is followed by the continental Maastrichtian sediments, i.e., silts, sandstones and microconglomerates of the Sânpetru Formation. There is no direct palaeontological evidence to assign a certain age to the youngest marine Upper Cretaceous sequence of SE Haţeg – the Strei Formation. Yet, in the sandstones and conglomerates with *Actaeonella gigantea* and *Hippurites* spp., there are Cretaceous poorly preserved calcareous nannofloras, probably reworked, including also the late Campanian taxa *Uniplanarius sissinghi* and *Uniplanarius trifidus*. As no typical Maastrichtian nannofloras were noticed, probably, the youngest marine deposits were sedimented within the late Campanian interval (Grigorescu & Melinte, 2002). This site is unique not only in the The Haţeg Country Dinosaur Geopark, but also in the Southern Carpathians. Its macrofaunas and the palaeonevironmental setting allow the correlation of latest Cretaceous marine deposits from similar sediments described as the Gosau Facies in the Alpine region.

The youngest marine sediments from the NW Haţeg area are the turbidites of the Răchitova Formation, with the stratotype situated in the Răchitova village (Grigorescu & Melinte, 2002). This unit is the youngest marine Cretaceous occurrence in the region, being Coniacian up to late Campanian in age. A significant outcrop of the Răchitova Formation upper part may be seen in the western part of the Densuş village. This is the single place in the Haţeg area where the contact between the Late Cretaceous marine deposits and the continental ones, crossing the Cretaceous-Tertiary boundary is exposed (Melinte-Dobrinescu *et al*., 2010). The outcrop itself is remarkable not only for the outstanding scientific value but also for its landscape and for the trace fossils that may be frequently seen on the thin sandstones enclosed in the marine sediments. Unfortunately, no protection for this important outcrop is realized. Moreover, in front of it a permanent sheepfold was placed exactly in front of the outcrop, limiting the access and bringing serious damages in the area.

In The Haţeg Country Dinosaur Geopark there are also many historical monuments, with a great educational and touristic value. Vey old churches, such as Densuş, Sfântă Măria Orlea, Colţi, along with citadels and fortresses, and Roman sites represent an important cultural heritage of the region. The Saint Nicholas Church from Densuş (Fig. 5) is probably the oldest church in Romania. Most probably is was built on the structure of a Pagan (Roman) temple dating from the 2nd century A.D, with additions from the 7th, 13th and 15th centuries, and even its origin is still subject of controversy (Luca, 2005). To note that the altar of The Saint Nicholas Church from Densuş is closer to the South than to the East, which would suggest that it was once a pagan temple, because all early Christian houses of worship have the altar towards the East, as the Christian churches in the present. The bizarre

architecture of St. Nicholas Church from Densuş cannot be referred to any known style; moreover, there is a variety of materials used in the construction: stone, including the river stones, bricks and especially sculptured marble plates taken from the buildings and tombs of the former Roman Dacia capital city, Ulpia Traiana Sarmizegetusa, after its destruction.

Recently, geophysical investigations (i.e., geoelectrical measurements) have been realized, in order to point out possible archaeological sites in the yard and neighbourhood of this significant historical monument (Rădulescu *et al*., 2007). By comparison of data with observations from existing archeological profiles, the data gathered by the geophysical method allow the identification of new arcaheological sites immediate surroundings of the church as well as in its yard.

Fig. 5. The Densuş Church (Photo Camelia Varzaru).

Fig. 6. The rupestrian hermitage of Iosif from Bozioru (Photo Adrian Gherghe).

Some of the geological and palaeontological sites are already subject to various damages, natural such as landslides, water and wind erosion, but also anthropic. Besides, it is not to neglect the activity of 'fossil hunters' in the Geopark, who along with those searching for antique (i.e., Dacian and Roman) artefacts represent a real danger in preserving the Geopark integrity.

The Buzău Land Geopark is famous for its geodiversity (Melinte-Dobrinescu *et al*., 2010) – including unique geosites in Europe such as The Mud Volcanoes from Berca, The Amber Mines from Colți, The Salt Mountain from Lopătari, The Everlasting Fires, The Meledic Plateau – and also for its spectacular landscapes and impressive cultural heritage, i.e., Paleolithic cave painting and medieval rupestrian hermitage from Bozioru and Aluniş, caved in massive Oligocene sandstones (Fig. 6).

In the Buzău Land Geopark, there are two categories of IUCN protected areas: category III and category IV. A good example of protection is represented by the IUCN category IV protected areas Mud Volcano from Pâclele Mari and Mud Volcano from Pâclele Mici. In all, 30 ha have been protected since 1924; now the protected sites NATURA 2000[1] include 93.8 ha.

In the Berca region, a high number of surface vents, pools, cones and holes may be seen, i.e. 64 at Pâclele Mari and 37 at Pâclele Mici (Brustur *et al*., 2015). The active and inactive cone-shaped vents have a maximum height of 2 m. Gas (mostly methane – Baciu *et al*., 2007) emissions (Fig. 7) reach the atmosphere throughout faults, from 3,000 m depth. Salty waters occur at the surface together with the mud; hence, the salty soil determines the occurrence of halophyte plants, such as *Nitraria schoberi* and *Obione verucifera* on the plateau where the mud volcanoes are situated; these are protected floras and are unique in Europe (Evelpidou *et al*., 2010). The protected fauna comprises small mammals,

[1] Law No.5/6.03.2000.

such as ground spirrels (*Spermophilus citellus*), turtles (*Emys orbicularis*), frogs (*Bombina variegata*) and lizards such as *Lacerta praticola* and *Elaphe sauromates* – the last species known to local people as 'the big dragon'.

The Mud Volcano from Pâclele Mari and the Mud Volcano from Pâclele Mici, situated in the Berca area, are well-known in the country and abroad; they represent a geosite intensively promoted, being one of the very few mud volcanoes in Europe. Even the aforementioned sites which are well protected need to be regularly and actively monitored.

All over the year the tourism is very well developed, i.e., there are yearly 25,000–30,000 visitors, 30% being from abroad. The significant tourism of the region is enhanced by advertising, firmly protection of the sites and good infrastructure.

At a few kilometres far from the above-mentioned sites, other mud volcanoes emerged, namely "La Fierbători" and "Beciu". They are quite different from Pâclele Mari and Pâclele Mici mud volcanoes, as there are no cones, but vents of 1–1.5 m in diameter, with mud and oil; from the Mud Volcano "La Fierbători" plateau spectacular landscapes on the Buzău Valley may be seen. Notably, this site is not protected and not promoted; these, along with the poor infrastructure and hence difficult access to this site lead to a very little development of the tourism, i.e. may be few tens, mainly from Romania.

Another value on the The Buzău Land Geopark, situated in the territory of the Colți locality, is represented by amber, occurring in sediments dated as 34 to 23 million years (Upper Eocene to Lower Miocene). In Colți is located the single museum in Romania, devoted to the amber occurrences and the amber artefacts.

Fig. 7. The Mud Volcanoes Pâclele Mici from Berca
(Photo Andrei Briceag).

'The Buzău Amber' is a protected area since 2000, being of IUCN category III (geological and paleontological natural reserve), with a surface of 2.52 ha, corresponding only to the richest amber site in the area, the former mine. The Strâmba – Comarnici mine is one of a total of seven in the region. The first exploration of amber in Romania by rudimentary ditches, shafts and galleries started in the southern part of the Eastern Carpathians (Colți village), in 1828. Major productions registered between 1924 and 1935, from 67 to 130 kg per year. In the 19th century, the amber was representative for Romania, so it was the symbol of the country to the World's Fair in Paris (Exposition Universelle, Paris, 1867). Notably, the amber was first mentioned in Romanian documents in 1578; Prince Mihnea and his wife, Princess Neaga, visiting the Aluniș Church (Buzău County), endowed this settlement with land, where "amber shards of rare beauty" may be found (Ghiurcă, 1999).

The first description of the amber from the Romanian Kingdom was published at the end of the 19th century (Helm, 1891), when in the Buzău region the amber called "Rumänite" was identified. This amber was distinguished, based on its physical and chemical properties, from the Baltic amber (= the Succinite). Another amber variety was described as Almaschite and recognized as a new mineral (Spencer, 1931). The amber occurrences are known also from other Carpathian areas, including the Southern Carpathians (Murgoci, 1903) and the Eastern Carpathians (Schrockinger, 1875; Murgoci, 1923; Brustur *et al*., 2015), but the one from Colți of the Buzău Land Geopark is the most famous.

In the Colți-Aluniș area, there are two main varieties of amber: (i) an old one, Oligocene in age (around 30 million years), red to brownish, which often has cracks impregnated with organic material; (ii) a younger variety, Miocene (around 20 million years), which has light colours. Vegetal and animal organism remains, fossilized in the amber, were often found in the area. Plants and animals are very well preserved because the resin is a very good environment for a preserving bodies, including fossilization. The fossilized remains include insects, butterflies, arachnids, ants, termites, mosquitoes, wasps, plants fleas, scorpions, phalangidae, different types of larvae, as well as lichens, pollen and coniferous acicular leaves.

A particular geological occurrence in The Buzău Land Geopark, quite well-known and promoted on various sites is represented by Babele (= The Old Ladies) from Ulmet, which yearly benefit from the attention of many tourists. There, Middle Miocene (Sarmatian) spectacular metric concretions (described in Romanian geological literature as 'trovant' – Murgoci, 1907) occur on hill crests (Fig.8).

Besides the impressive landscape, the concretions are also important for scientific point of view, including their macrofossil (mainly bivalves) content. Due to their shape, local people named these rocks 'The Old Ladies' (= Babele), describing them as 'living stones' or 'growing stones', while many tourists assigned them to UFO's shape.

Fig. 8. The concretions from Ulmet (Photo Gabriel Ion).

The intra-Carpathian Neogene volcanism is reflected, in the territory of The Buzău Land Geopark, by the occurrence of resedimented volcanic rocks, such as tuffs. One of these occurrences is the Mânzălești locality and was included since 1995 in the Geological and Palaeontological Nature Reserve, corresponding to the IUCN category III. The protection refers to a white stone, namely 'La Grunj' of Middle Miocene age that occupies a surface of 0.025 ha at the base, is 18 m in height and 15 m in diameter.

Salt deposits, along with various phenomena related, such as salt diapirs, salty springs and salt caves (including Europe's biggest salt cave, and the second in the world, The Cave B6S Meledic, 3234 m in length and 44 m deep located in the Meledic Plateau) occur also in the territory of The Buzău Land Geopark. The Salt Mountain, an impressive salt dome from Lopătari is the biggest nature reserve

of The Buzău Land Geopark, comprising, since 2000, an area of 136 ha of geological, speological, botanical and zoological Nature Reserve, corresponding to the IUCN category IV.

The Salt Mountain (Fig. 9) is represented by massive salt deposits, interbedded with reddish, green and grey clays. In general, the occurrence of the lowermost Miocene salt is linked to the diapirism phenomenon, as indicated by the presence of chaotic salt breccia deposits.

Fig. 9. The Salt Mountain from Lopătari (Photo Adrian Popa).

Due to the presence of many salt breccia outcrops located in the central and eastern parts of the Geopark, there is a high risk of landslides and rockfalls. Notably, some of the landslides and debris flow are already affecting the geological sites from the central region of The Buzău Land Geopark. On the other hand, recent subsurface faults, activated by climate processes (intervals with high rainfalls alternating with intense and prolonged drought) combined with the effect of subcrustal earthquakes from the highly seismic Vrancea region, caused frequent landslides (the best known one is located at the Rătești Monastery, 5 km NW from the Berca town).

The Subcarpathians that overlap The Buzău Land Geopark territory are characterized by the existence of two distinct areas, western and eastern, which differ from lithological and tectonical points of view. The area located W of Slănicului de Buzău Valley is characterized by complex tectonics, which contain digitations and many faults, anticlines and synclines, but also by various lithology including calcareous and siliceous sandstones, bituminous clays and marls (Ștefănescu *et al*., 1989). These characteristics determine in the W part the circulation and accumulation of the deep waters.

The presence of salt domes, clays and gypsum affect the deep water chemistry, giving them a high degree of mineralization. As a result, in the territory of The Buzău Land Geopark, numerous chlorosodical springs occur, of which the best known are the ones from Meledic and Găvanele hills and the ones from Murătoarea and Scoroșești valleys, and also the one from Bădila (W from Pârscov locality). The latter one is characterized by high rate flowing determining impressive salt efflorescence, which represents the 'Sarea lui Buzău' IUCN category III protected site.

The region located to the east of Slănicului Valley is characterized by a less complicated tectonic, i.e. the presence of few anticlines and synclines. From a lithological point of view, poorly consolidated deposits prevail, such as sandy sandstones, sands and gravels, with groundwater bodies disposed differentially.

On the interfluves, the groundwaters are found at high depths, while in the valleys, the richest aquifers reserves are confined in proluvial and terrace deposits. The mineralization of the groundwaters from this area is relatively high, causing hydrochemical zonality (Posea, 2006).

One of the richest areas in mineral springs is located in the vicinity of Fișici and Muncelu Cărămănești localities. Thus, there are mainly S and Fe springs in the Fișici, Nucu and Găvanele villages, while towards east of the Muncelu Cărămănești village there are chlorosodical springs.

An important protected site in the The Buzău Land Geopark is represented by the Bădila Limestone Blocks that is a protected area of national interest corresponding to the IUCN category III (nature reserve of geological and paleontological) on the territory of the commune Vipereşti, on the left bank of the Buzău River. Locally the site is named "La Surduci" and contains over 40 rocky blocks (different sizes and shapes) consisting of limestones and gray conglomerates, dating from Mesozoic (Jurassic).

Paleontologically, in the sedimentary rocks were found several fossils of gastropods (snails), corals, ammonites (molluscs) and foraminifera, all assigned to the Jurassic (Pană & Nimigeanu, 1982). The huge limestone blocks represent a very unusual occurrence, being located in an area where there are no massive limestones of which could have originated.

The fact is all the more surprising, because limestone formations have a different age than the surrounding area, the latter being much younger (Neogene), while the limestones are Jurassic. Even the Bădila Limestone Blocks are spectacular and they create an impressive landscape in the riverbed, being also a significant nature reserve, but it is no advertise, consequently no visitors are able to attend this site.

Last, but no least, the Everlasting fires represent another unique phenomenon of The Buzău Land Geopark. Flames, which may be 1 m in height, occur in an area of around 200 m^2 nearby the Terca village. The presence of the fires is related to gas emanations, mostly methane, coming from the depth, where oil and gas accumulated. The rocks containing the hydrocarbons are faulted and allow the penetration towards the surface of the gases.

The presence of the everlasting fires is enhanced by the seismic activity of the area (included in the highly seismic Vrancea zone). Depending of these geological phenomena in the area, the everlasting fires show a variable intensity, even if they occur all seasons. Unfortunately, the site is quite difficult to access, only by walking; in absence of any information or guiding, the tourists that would admire them are very few.

CONCLUSIONS

In Romania, there was an involvement concerning the natural heritage since the 19th century, but a constant and consistent commitment, especially for protecting the geological and palaeontological sites is to be noticed form the second half of the last century (Bleahu *et al*., 1976). In a first attempt to describe the most important geosites, the above-mentioned authors identified up to 90 significant ones. In the present, in Romania, from the total of almost 1,000 natural reserves[2] that are of IUCN categories I, III and IV, almost one quarter are represented by geological and paleontological sites.

Romania is one of the first countries to recognize the Geopark as a protected area. However, the Geopark is included, together with other types of protected area, such as Natural Sites belonging to the Universal Patrimony, in the category of protected areas of international interest[3]. Specific geoconservation practices should be elaborated for protecting the whole patrimony of a Geopark, i.e. geological, palaeontological, geomorphological, ethnographical and historical-archaeological.

[2] https://ro.wikipedia.org/wiki/Lista_rezervatiilor_naturale_din_Romania

[3] Romanian Law No. 49/2011 that completes the Urgency Ordinance of the Government No. 57/2007.

A real advancement in protection could be realized by the nomination of an institution able to implement the protection of the geodiversity and biodiversity in the Romanian Geoparks. Integration of the research results in educational and cooperation programmes, along with the involvement of the authorities at local, regional and national level is the single way to successfully achieve the management of the Romanian geoparks whole patrimony that display a significant richness and diversity.

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