

The influences of non metalliferous ore exploitation on biodiversity and its social impact

1. Abstract

This project focuses on quantifying the effects generated by the limestone exploitation from Băița Crăciunești quarry, considering the degree in which the associated flora and fauna is found and also the social aspects which is interconnected by the development of the limestone quarry. From a geological perspective, our team analyzed the limestone from Băița Crăciunești quarry and based on the fossil samples took from the field we were able to establish a simplistic systematic framework of the paleo-diversity. The nature of the ore is of bioconstruction, and it dates from Upper Jurassic (≈ 162 -145 million years) when impressive coral colonies dominated this region, generating great ecosystems characterized by an explosive biodiversity. In order to establish how extensive the impact is over flora, fauna and the human settlements, we constructed 3D maps of the quarry from which it is highlighted the area of influence of the limestone exploitation. These graphic representations aim to determine either the acoustic impact generated by the mining drill machines or by the displacement of rock masses, or the presence or absence of the associated biodiversity from and around the quarry. For developing the social study we compiled an enquiry on the basis of which we established the statistical analysis. This analysis emphasizes the connection between the human population accustomed with past metaliferous and non metaliferous exploitations and the current one from Băița Crăciunești. Finally, during our field work held on 22nd to 28th July all the flora and fauna photographed was determined and listed as well as the fossil faunistic association.

2. Introduction

The main objective of this project is the study of the Late Jurassic fossil fauna and the present flora and fauna from Băița Crăciunești (Măgura Feredeului) limestone quarry, in relation with the ongoing exploitation which began 36 years ago and may have a lifespan of approximately 100 years.

Any exploitation activity has a damaging effect over the surrounding environment of the quarry, perturbing the natural equilibrium of the ecosystem and perpetually polluting the air, soil, water and phonically. It's well-known that a non-metalliferous exploitation has a less destructive impact over the environment, even so it's our duty to attempt to minimize these noxious effects firstly by respecting the European laws regarding the natural environment and secondly by implementing the concept of sustainable development. Precisely these effects will be quantified, interpreted and presented in this paper, in order to create an exact image of how the influence of the limestone's exploitation from Băița Crăciunești is impacting the neighboring areas.

A unique approach can be provided from a geological standpoint, from which we can recognize the fossil organisms of a paleodiversity that once populated the exploited area, organisms which represent the actual ore (limestone deposit) of Băița Crăciunești quarry.

3. Objectives

The main purpose of this project is to establish the impact of the exploitation over biodiversity as well as over the human population from the surrounding areas.

Furthermore, the faunistic association that contributed to the accumulation of carbonatic material and throughout diagenesis generated the limestone deposits, was revised and determined, as well as the analysis of present biocenose which may lead to a possible identification of endemic or endangered species.

Regarding the establishment of the area of influence imprinted by the limestone exploitation, we generated impact maps that will reveal the damage level sustained by the associated biodiversity of the quarry.

We also conducted a social impact study in the three localities surrounding the Băița Crăciunești quarry (Băița, Peștera și Crăciunești) in order to determine how did the exploitation influenced the human population.

4. Materials

The preliminary data necessary for developing this paper was obtained during the field work conducted between 22nd and 28th of July.

The collected paleontological material (approximately 34 samples) includes large pieces belonging to coral reefs, limestone samples for creating thin sections and a soil sample for micropaleontological analysis. The material's degree of conservation is not ideal; the limestone is strongly affected by the diagenesis process, this being the reason why we couldn't identify which genre or specie are all the fossils belong to.

It were measured 384 GPS points, which were eventually used as input data in modeling software to generate 3D maps that lead to the completion of the exploitation's impact study.

In developing the social impact study there were enunciated 12 questions used on a standard of 82 people residing in the vicinity of the quarry. These questions revealed the age category, their level of studies and some basic questions referring to the type of exploitation, its effects and their level of knowledge regarding any conservation projects of the company, including the "Quarry Life Award" project.

5. Methods

The first step in obtaining the needed data for compiling this project was to consult the scientific papers and expertise articles about the Băița Crăciunești quarry. The second step consisted in making keen observations in the field, geological mapping and collecting samples.

The pictures took in the field were done with a Nikon D3100 with a Nikon Nikkor 55-200 mm lens. Some of the samples were photographed with a Panasonic DMC-L1 camera with a Olympus Zuiko Macro 35 mm macro lens, using a Kaiser camera stand while the rest of the samples were photographed at a Carl Zeiss Stemi binocular magnifier with a Canon digital camera connected to a graphic station that uses a specialized software from Carl Zeiss. Afterwards, the photographs were processed using Adobe Photoshop CS6.

The 3D maps, based on the recorded GPS, points were created using software like Surfer9 and LeapFrog Geo. The quarry's entire photo was imported from Google Earth Pro, geo referenced in Global Mapper 11, where we obtained our topographic data using the data base available in the Faculty of Geology and Geophysics. Later on, the grid obtained from geo referencing was reprocessed and perfected using Surfer9 and LeapFrog Geo. The 3D map of the quarry was created from the points mapped during the field research. Because of some significant difference in level, we asked the employees from Chișcădaga factory to help us out with more precise measurements in order for us to correct our error margin (by cross referencing

it). The heights in the quarry's 3D map were exaggerated, in regards to the local scale, in order to offer a better and detailed image of the quarry.

After completing the social study, we compiled the statistical analysis, which we processed in Microsoft Excel and it is interpreted and discussed in subchapter 7.4. We ignored Ormindea village due to its long distance to the quarry (the effects would be minor).

6. Geographical and geological settings

The Băița Crăciunești (Măgura Feredeului) limestone exploitation is geographically situated in the northern part of the Hunedoara county, at approximately 25 kilometers from the county capital city, Deva. The quarry can be accessed using the 706A county road. The surrounding localities of the quarry where our team carried out the social impact study, are Pestera, Craciunesti and Băița villages.

Geomorphologically speaking, the quarry is situated in a highland area with an altitude that doesn't exceed 700 meters, with average annual temperatures of 8.5-9° C and average annual precipitations of 1000-1200 mm/y. The hidrographic network of the area consists of the river Mureș's confluent, Pestera Valley and Căianului Valley.

From the geological point of view, the area is represented by Late Jurassic reef limestones and limestone breccias, with a yellowy colorit, that are part of the Bihor domain which is characterized by massive limestones. In the lowermost part, this limestone succession starts with Late Callovian – Kimmeridgian (≈162-155 milion years) black and dark gray limestones, followed by a 600 meters thick (Petrescu si Burlacu, 1968) and a Tithonian (the latest age of the Jurassic period, 152-145 my), white, coral rich limestones. From these limestones, coral species such as *Canavaria (Monotrypa) capriotica* Opp., *Eugeniocrinus nutans* (Quenst.), as well as hydrozoans (*Ellipsactinia* sp.) and nerineans were outlined.

While at the base of the quarry, along the faults and fractures can be identified effects of the limestone metamorphization observed though calcite precipitation and recrystalisation as well as cherts. At the upper level are displayed limestone formations with coral remains. In some places the outcropping rock throughout the quarry is covered with a thin layer Terra rossa soil.

7. Results and interpretation

7.1 Geology and paleontology

Based on paleontological information resulted from the analysis of the gathered samples, we can reconstruct the paleoenvironment in which these limestones accumulated. The presence of corals offers us precious information about the bathymetry, temperature and salinity of the marine water. Based on this, we can assume that the limestone accumulated on a shelf area of a marine basin, at a depth of maximum 35 meters. We can also assume that the water had a normal salinity (between 30-40‰ – based on the fact that corals are stenohaline organisms) as well as a temperature that ranged between 22-28°.

Corals – grouped in the Scleractinia order, have populated the seas starting from Triassic (~252 milion years) until present days. The coral fossils found are both colonial and solitary and lived during the Late Jurassic period (≈163 milioane de ani), in the photic zone of the seas just like the present days corals, in symbiosis with photosynthetic algaea generating an extremely sensible ecosystem, with an incredible degree of biodiversity. (Neagu et al., 2002)

Alongside these, we also identified molluscs such as clams (Class Bivalvia), echinoderms (Class Echinoidea, Subclass Euechinoidea, Order Clypeasteroidea: sea urchins and Class

Crinoidea: sea lilies) as well as microorganisms (benthic foraminifers – Phylum Foraminifera). It's well known the association of miliolids (Order Miliolida), and agglutinated foraminifers (Order Allogromiida) with the coral reefs environments represented by shallow, agitated and nutrient rich waters. Miliolids appeared during Early Carboniferous (≈ 395 million years) and reached present day. They have benthic forms (living in the sediment-water interface) with an calcareous, porcelaneous test and are characteristic for shallow water environments found along coastlines. Agglutinated foraminifers live in much more diverse environments, from marshes to shelves and even to deep water environments. These foraminifers date between Early Cambrian (≈ 542 million years) and until present day. Both the foraminifers and the corals give us important details about their living environments, due to their sensibility to any variation in temperature, salinity, water composition and bathymetry (Bellier et al., 2010). Also, the echinodermites are closely linked to the basin's seafloor, either by moving on the floor (sea urchins) or by being attached to it (sea lilies – fixed into the sediments on the seafloor) (Neagu et al., 2003). In our case, we identified sea urchin spicules and sea lilies peduncles, elements that can only offer a Class level determination.

Based on the thin sections and microfacies analysis, we obtained information regarding the carbonate particles and the matrix/cement between them, as well as their structures and textures, needed for establishing the depositional environment. The Băița Crăciunești limestone is a packstone type characterised by the presence of ooids, peloids, bioclasts, intraclasts and fenestral structures in which we have found benthic foraminifers such as miliolids (Figure 2c) and agglutinated foraminifers (Figure 2d). The large number of diaclasses filled with precipitated calcite and the small number of bioclasts proves the fact that these limestones were exposed to diagenesis, with cementation and microbial micritisation processes as effects (Figure 2a, 2b). This is an intertidal zone type of microfacies and as a result, we can assume an intense microbial activity which contributed to the limestone's consolidation processes (peloids, micritisation). Also the fragments of the organisms (foraminifers, molluscs) from that period generated bioclasts while the chemical processes during the diagenesis (the formation of limestone) generated ooids and fenestral structures. The diaclasses filled with precipitated calcite are also a result of chemical dissolution as well as of tectonic compressions, which also produces faults, fissures and fractures.

7.2 Biodiversity

It must be stated that the plants and animals presented in this paper are species that we encounter on field between 22 and 28th of July and that were later determined.

The area that limits the limestone quarry from Băița Crăciunești (Măgura Feredeului) is characterized by a great variety of both flora and fauna, influenced by the terrain and climate. The maximum height is 700 meters so the vegetation is represented by the beech forest, the beech and sessile oak forest is observed at the beech forest upper side and a transitional forest between the beech forest and the coniferous forest, where we can find the mountain elm (*Ulmus montana*) and Norway maple (*Acer platanoides*).

The beech forest, characteristic to the low mountain areas and high depression areas, is dominated by the pedunculate oak (*Quercus robur*), sessile oak (*Quercus petraea*) and field maple (*Acer campestre*). The lower areas, with meadows, are characterised by shrubs like european cornel (*Cornus mas*), common hawthorn (*Crataegus petraea*), "lemn râios" (*Evonymus verrucosa*), old man's beard (*Clematis vitalba*), rose hip (*Rosa canina*), common hazel (*Corylus avellana*). The northern flank of the quarry is populated by common walnut (*Juglans regia*), lime

trees (*Tilia* sp.), apple trees (*Malus domestica*) and black locust (*Robinia pseudoacacia*). The grassy plants are represented by common invasive species, such as: field bindweed (*Convolvulus arvensis*), common chicory (*Cichorium intybus*), coltsfoot (*Tussilago farfara*), dandelion (*Taraxacum officinale*), viper's bugloss (*Echium vulgare*), European dewberry (*Rubus caesius*), musk thistle (*Carduus nuta*), etc. These plants are found on the entire surface of the quarry, where there can be found soil.

The fauna found in Băița Crăciunești quarry is influenced by the altitude, climate, vegetation and the degree of human intervention.

The reptiles are mostly represented by common lizards such as *Lacerta viridis* and *Lacerta agilis* and frogs. It was also pointed out the presence of many different species of vipers (*Vipera berus*, *Vipera ammodytes*) in the quarry.

The avifauna. Among the birds that reside the area surrounding the quarry, we identified some of the most common in the area, right on the edge of the quarry. Some of them have nests in the trees nearby, such as: water pipit (*Anthus spinoletta*), common raven (*Corvus corax*), jackdaw (*Corvus monedula*), Eurasian jay (*Garrulus glandarius*), white wagtail (*Motacilla alba*) and wood nuthatch (*Sitta europaea*).

The insects are represented by a large number of Odonate in the waters accumulated in the quarry's sterile dump, both from the Anisoptera group (*Libellula depressa*) as well as from the Zygoptera group (*Ishnura elegans*). The presence of Odonates indicates the quarry's low level of pollution because it is well-known that these insects deposit their eggs in areas with clean water, especially the species from the Zygoptera Order.

Another group of insects that are very common for this area is the Lepidoptera Order, with many species that pollinate the flowers from and surrounding the quarry. We also found other common insects such as: crickets (*Liogryllus campestris*), migratory locust (*Lacusta migratoria*) and beetles (*Anomala solida*).

7.3 Influence of the exploitation over biodiversity

It is a well-known fact that all type of exploitations (metalliferous, non-metalliferous or petroleum) create negative effects upon the biodiversity and the surrounding environment (natural or anthropic).

To present the way in which limestone exploitation affects the environment, a series of graphical representations were used and were interpreted accordingly. Using the data collected from the field research and by quantifying them in specialized software lead to the creation of four different maps and one block diagram. In every map, the height of the mesh (the quarry's 3D format – Annex 4) was exaggerated in order to offer a better understanding of the quarry's geometry and to better observe the difference in levels (height) within it.

The first map clearly shows the way in which the quarry was designed. Two fronts can be observed: a southern one (the smaller one) and a northern one (the larger one). Also other parts of the exploitation can be identified: the waste dump south between the two fronts, the rock grinder platform situated south-west of the quarry, a rehabilitated waste dump west of the quarry and a good example of an abandoned limestone quarry situated east from Băița-Crăciunești quarry. And of course, Peștera village can be seen quite close in the north-western vicinity of the quarry.

The second map was generated using the data and observations from the field (Annex 6). Two different areals can be distinguished: a red one and a yellow one. These two different

surfaces represent the direct impact generated by the quarry on the environment. The surface with the highest impact is delimited that way because within it constant negative effects are generated (eg: the heavy-duty vehicles) and also because it doesn't have a significant biodiversity. This surface includes both front and the waste dump. Both fronts seem to lack vegetation, apart from the plant species that grow along the road and the species that grow on the isolated quarry levels that stopped being exploited (the species didn't grow in situ, they were transported by land slides). The waste dump presents similar characteristics as the two fronts. It is obvious that the rock grinder platform and the roads leading to the quarry are situated in the highest impact zone. The zone with the lowest impact on biodiversity is marked with yellow. This zone doesn't generate pollutants, but being in the immediate vicinity of the quarry, it acts as a dust filter (calcarous particles with lutitic measurements), it absorbs shocks generated after the blasts to break the limestone apart and it diminishes, modestly, the acoustic effects made by the excavators, heavy-duty machinery, detonations, etc. As it turns out, the activities that go on daily within the quarry doesn't seem to hinder the normal growth and expansion of wildlife in the marked yellow surface.

Another map, the third one (Annex 7), was created by using the data collected from the zones with medium vegetation. In this map, four distinctive area are shown, everyone one of them having different types of vegetation (the exception is marked with blue and it represents the area where the fossils were found). Carefully surveying the quarry, different types of innaccessible surfaces with vegetation seem to pop everywhere. They are actually formed with the help of land slides from the upper level, that transport the soil (with or without fully grown plants) and consequently the plant seeds contained in it to form a new patch of greenery in the quarry. The places are marked with orange on the map. Marshlike areas on the map are colored brown and they form because the southern part of the waste dump is easily flooded, becoming a paradise for hydrophile species. And last, the green areas represent forests along the quarry's curvature. Therefore, plants can be found inside the maximum impact area (mentioned in the second map – Annex 6), but these plants didn't evolve in situ, the majority of them were transported there with the help of land slides.

The fourth and last map (Annex 8) was realised to try and visualize the way sound waves generated by mining drill machines are perceived. The first method tested involved recording the sounds into digital devices and then analyzing them. The data obtained didn't seem reliable, probably due to the poor quality of the devices. The second method was quite successful because you can analyze the sound in real time. The principle is rather simple. A group of five people split up to key points: two near the mining drilling machines, one in Crăciunești village, one on the hill (south of the waste dump) and the last one at road intersection near the entrance of the old abandoned quarry. Communicating continuously, it was obvious that the sound was powerful at one end and unperceivable on the other (the intensity of the sound drops towards the central-eastern zone or it lowers from the south-eastern margin towards the north. Thanks to this simple method, managing generate a map with perceivable sound waves was quite simple. Though this map was generated using the basics of human hearing, reported to some animal species, the sound waves would be amplified significantly.

7.4 Social impact study

This social study was compiled in order to observe the interface/link between an area with a rich historical background in mining metaliferous and non metaliferous resources and the general assessment of the local population towards the ongoing exploitation. A total of 82 residents (we

prioritized those that resided there for a long period of time) from the villages Crăciunești (20 individuals), Peștera (26 individuals) and Băița (42 individuals). The target group selected for this enquiry/questionary are the village's residents mentioned above, within the age of 20 to +55 years. This age interval was selected because individuals from this category were present and conscious towards any change that arose during the evolution of each exploitation and their adjoint effects.

In the following paragraphs we will present the statistical analysis obtained on the basis of the 12 questions that constitutes the enquiry. This questionnaire encompasses information related to age category, level of studies, basic data about the limestone exploitation and projects of biodiversity conservation, effects generated by the exploitation as well as any change that intervened after HeidelbergCement Group took over CarpatCement company.

Regarding the age category, 43,6% of the people have over 55 years, 24,1% are between 46 and 55 years, 14,7% are included in the interval 36-55 years, 8,6% have 26-35 years and only 4,7% are 20 to 25 years old. Most of the inhabitants, more precisely 72,25%, have the necessary level of studies to fully comprehend the effects generated by an exploitation (34,65% high school graduates, 23,2% technical school graduates, 14,4% college graduates), the rest of 27,75% (20,1% middle school graduates, 7,65% primary school graduates) are roughly represented by the elders who probably didn't had access to more advanced studies, even so they represent a valuable source of information towards observing the evolution of all exploitation activities from the area.

Based on the viewpoints obtained we succeeded in highlighting the evolution of how the parameters of the exploitation changed once the company was undertaken by the German group in 1998. Most interviewed individuals (53,15%) have appraised a major improvement since this undertaking took place. They reported that the level of dust, noise and vibrations has dropped considerably, thanks to the implementations of new technology (maintenance of the roads and quarry through a continuous spraying for dust reduction) and the increase in efficiency of pyrotechnic methods. A percentage of 44,5% didn't perceive any considerable differences, but they also reported an improvement. Only 2,56% observed a turn for the worse since the undertaking. In order to attain an impartial study, the villagers were asked if they happen to have family members employed directly or indirectly in the company. From them, 67,73% don't have working family members in the company whilst 29,6% declared that they have and only 2,56% are working for the company. Although the majority of people have ascertained an improvement since Heidelberg Group undertook CarpatCement, individuals were also questioned about the nowadays effects generated by the exploitation of the Băița Crăciunești quarry. A total of 61,3% don't feel any type of effect caused by the ongoing exploitation while 16,8% sense light tremors, 7,4% hear acoustic sound generated by the mining drill machines, 10,6% feel dust and 2,56% are experiencing vibrations, dust and acoustic sound. Some of the locals from Băița complained to have found mutiple vipers in their households in a short period of time, indulgind in the idea that all the activity from the quarry may cause the reptiles to migrate towards the neighbouring areas (this idea can generate a detailed study about the migration of the reptile in the adicent region of the quarry).

When it comes to the general conception of the locals regarding the exploitation, 72,73% have a good and very good opinion towards it, being aware of its necesity and importance, 19,7% agree with the exploitation and 7,4% do not support its development. Also, the population was asked if they consider a necesity the implementation of a rehabilitation project after the

quarry closes. An important percentage of them, 84,6% agreed with the rehabilitation of the area once the quarry will be shut down, while 15,4% don't agree with this idea of a project, arguing that nature regains its own equilibrium after the human activity ends. Taking into account that Băița village had and still has a mining tradition, an overwhelming majority of 98,4% knew about the limestone exploitation and its main uses in the industry (cement, whitewash, etc.). Even so only 22,29% knew about the "Quarry Life Award" project, all of them were informed either by the company representatives or by relatives or neighbours.

Alongside the aspects discussed above, the locals were asked to voice their opinion regarding which changes should the company make. A common issue for all the mentioned villages is the lack of working places, therefore 32,5% of the villagers want new employment jobs. All the changes mentioned by the population differ from village to village, hence in Peștera village approximately half (46,15%) of the locals want the asphaltating/concreting of the main village road whilst 23,1% would prefer less dust in the atmosphere. In Crăciunești and Băița, 50,6% of the people demand new employment jobs inside the company, plus 4,7% that want more advanced technology when exploiting and generating cement and other products, and the 2,35% which desire the cease of viper migration into their households.

8. Conclusions

Concerning the paleontological study, we identified 4 phylum which encompasses the corals, the sea shells, sea urchins and sea lilies as well as microorganism known as foraminifera. The age of these fossils is Upper Jurassic. The paleoenvironment was identified on paleontological and microfacies basis, being enclosed in the intertidal or coastline, where the biotic activity is booming and expanding. Studying this limestone we came across a segmentation of the quality of it, thus at the lowermost level the rock is intensely diagenised and calcite recrystallisation can be observed, especially on the faults and fissures. At the upper side of the limestone were identified fossils, but when it came to determining them through the thin sections, all of their morphologic elements were erased as a result of an intense diagenesis process. Macroscopically, we were able to quickly identify the corals and the echinoids.

Regarding the status of biodiversity, the quarry is situated in an area with a varied flora and fauna, including the beech forest, and the beech and sessile oak forest. The grassy plants are represented by invasive species common to the whole temperate area. The fauna includes diverse species of butterflies and dragonflies, followed by less species of birds and reptiles. Taking into consideration the entire biodiversity observed during our field work, we couldn't identify endemic or endangered species.

In conformity with the impact study on biodiversity, all the four 3D maps generated demonstrate that the effects are at their worst within the quarry, on the lowest levels and on top of the waste dump. The influence is exponentially diminished towards the exterior of the quarry. It was amazing to observe the way in which the soil slipped along the line of faults and fractures, transporting land with plants altogether to form a new mini system on the lower levels. Also, the transported soil toward the quarry contains invasive plants.

Generating the maximum impact surface and acoustic wave maps, it's easier to understand why mammals aren't present near the quarry (being sensible to anthropic activity).

9. Annex

Annex 1: Figure cited in text

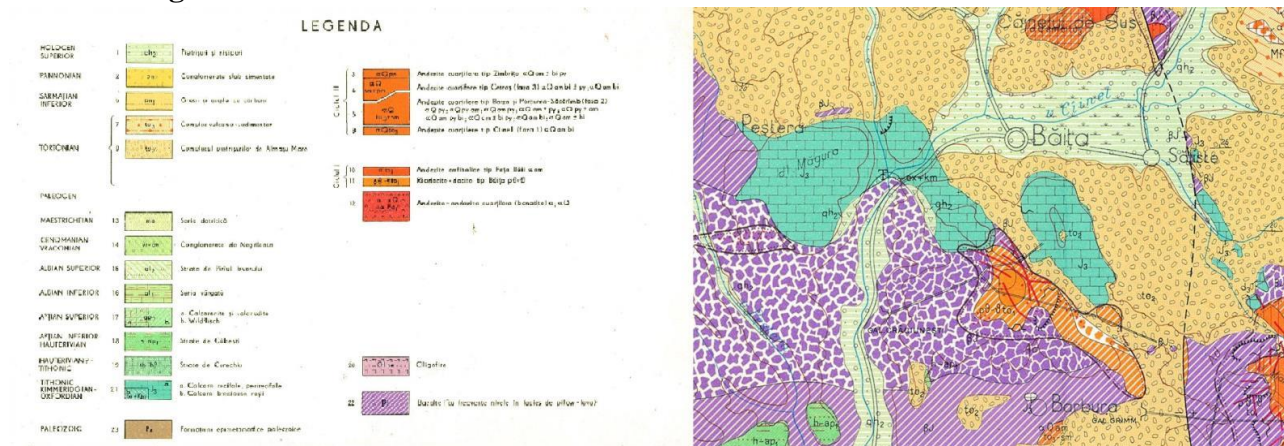


Figura 1 - Hartă geologică (După Harta Geologică 1:50000 a Republicii Socialiste România, foaia 73d Brad –L-34-70-D)

Annex 2- Index of flora-fauna from Băița Crăciunești quarry

Plants

Calystegia silvatica

Convolvulus arvensis

Scabiosa ochroleuca

Linaria vulgaris

Chrysanthemum leucanthemum

Erigeron annuus

Tragopogon dubius

Verbascum nigrum

Lotus corniculatus

Melampyrum bihariense

Campanula persicifolia

Campanula patula

Campanula rapunculoides

Campanula trachelium

Epilobium angustifolium

Dianthus carthusianorum

Lythrum salicaria

Ca Echium vulgare

Echium vulgare

Cichorium intybus

Insects

Libellula depressa (mascul), Ordinul Anisoptera

Libellula depressa (femelă), Ordinul Anisoptera

Ishnura elegans (mascul), Ordinul Zygoptera

Vanessa atalanta

Coenonympha pamphilus

Anomala solida

Coccinella septempunctata

Lacusta migratoria

Lacusta migratoria

Birds

Corvus corax

Anthus spinoletta

Garrulus glandarius

Sitta europaea

Carduelis carduelis

Motacilla alba

Reptiles

Lacerta agilis

Lacerta agilis

Annex 3: Systematics of the Upper Jurassic fauna from Băița Crăciunești quarry

Macroorganisms (Neagu et al. 2002, 2003)

Corrals

Supraphylum COELENTERATA

Phylum CNIDARIA

Class Anthozoa

Subclass Zooantharia

Ordinul Scleractinia

Shells

Phylum MOLLUSCA

Class Bivalvia

Echinoderms

Phylum ECHINODERMATA

Subphylum CRINOZOA Subphylum ECHINOZOA

Class Crinoidea Class Echinoidea

Subclass Euechinoidea

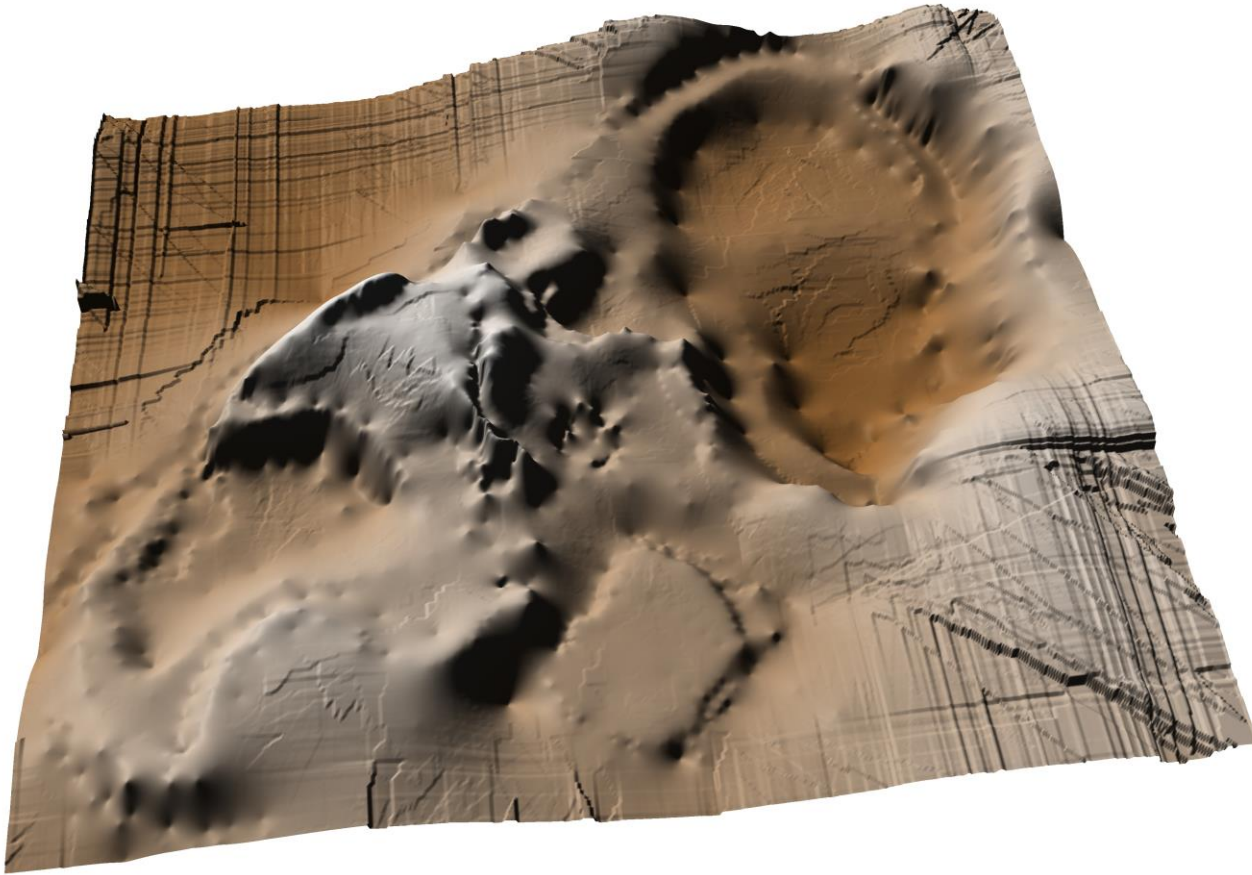
Order Clypeasteroidea

Microorganisms (<http://www.marinespecies.org/foraminifera/>)

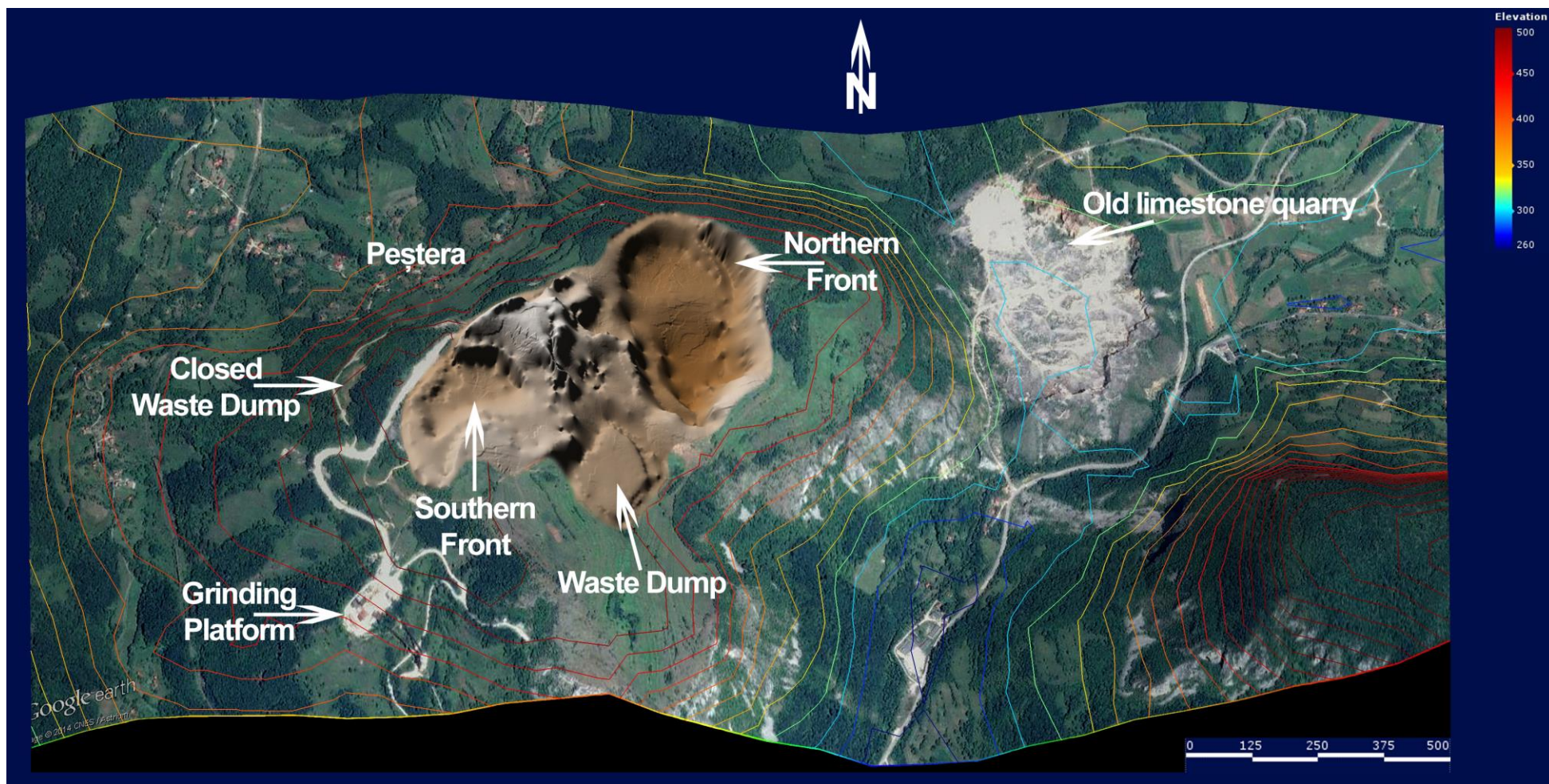
Phylum FORAMINIFERA

Order Miliolida Order Textulariida

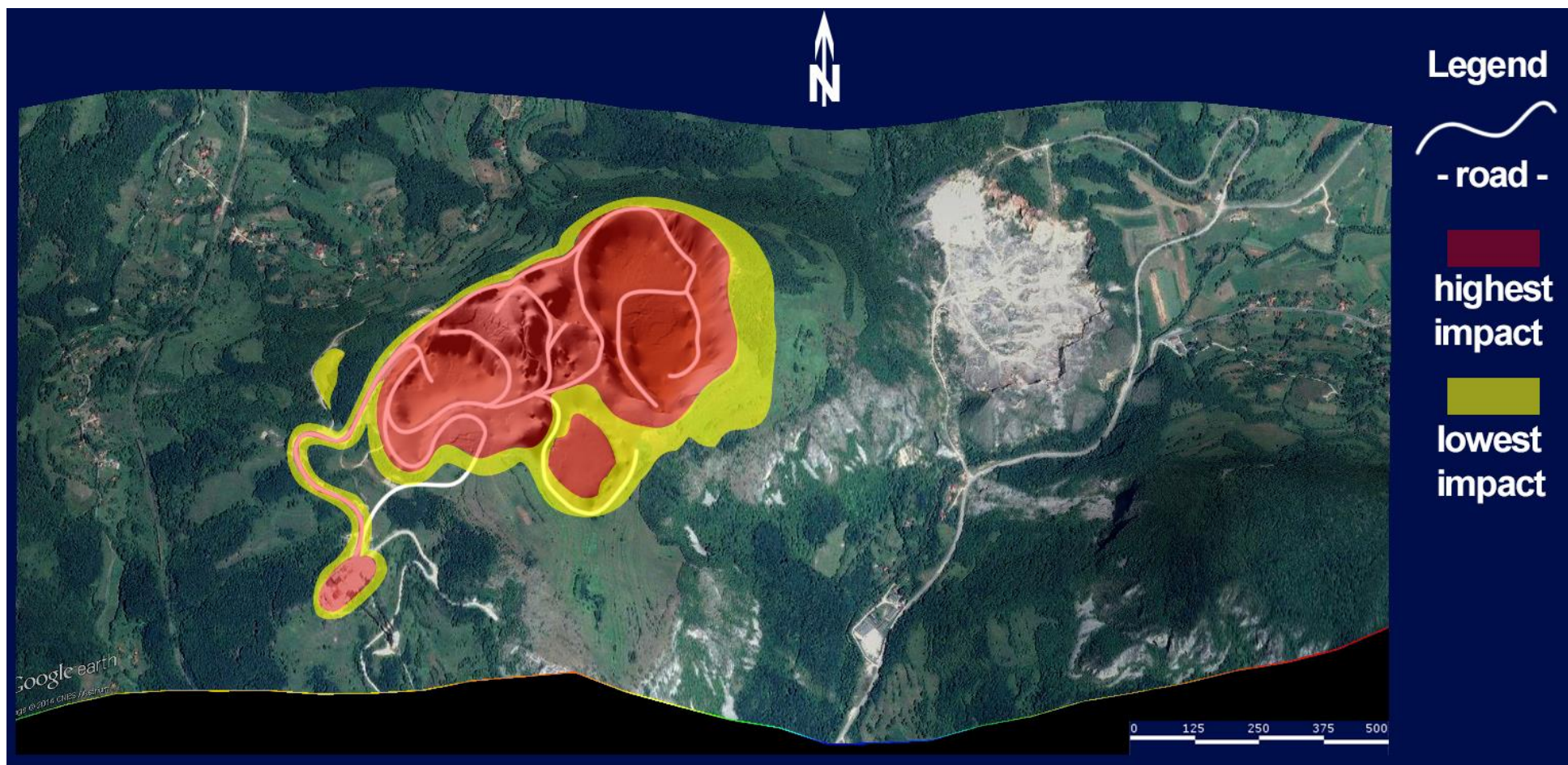
Superfamilia Miliolacea Family Charentiidae



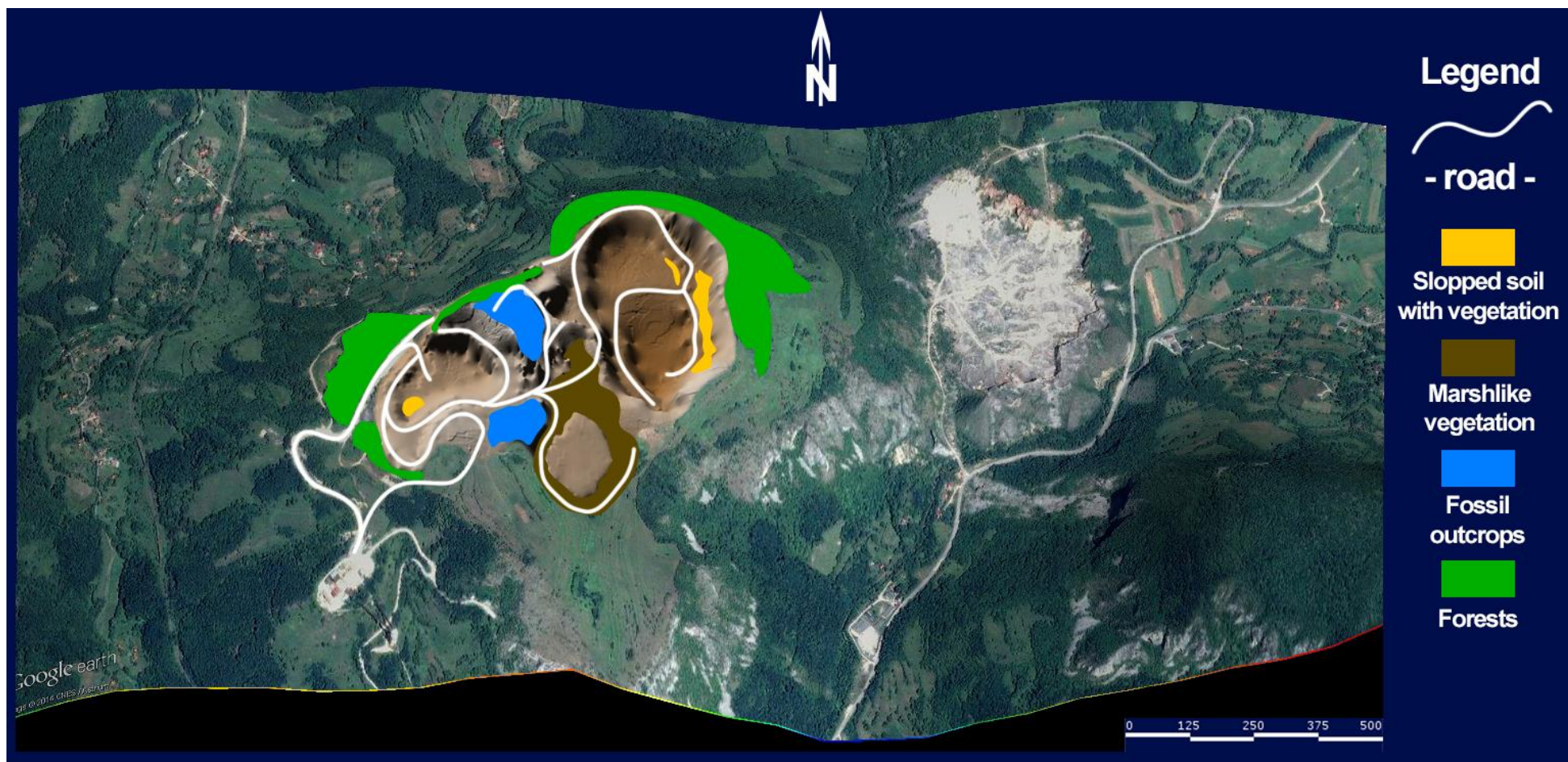
Annex 4 – 3D representation of Băița-Crăciunești quarry



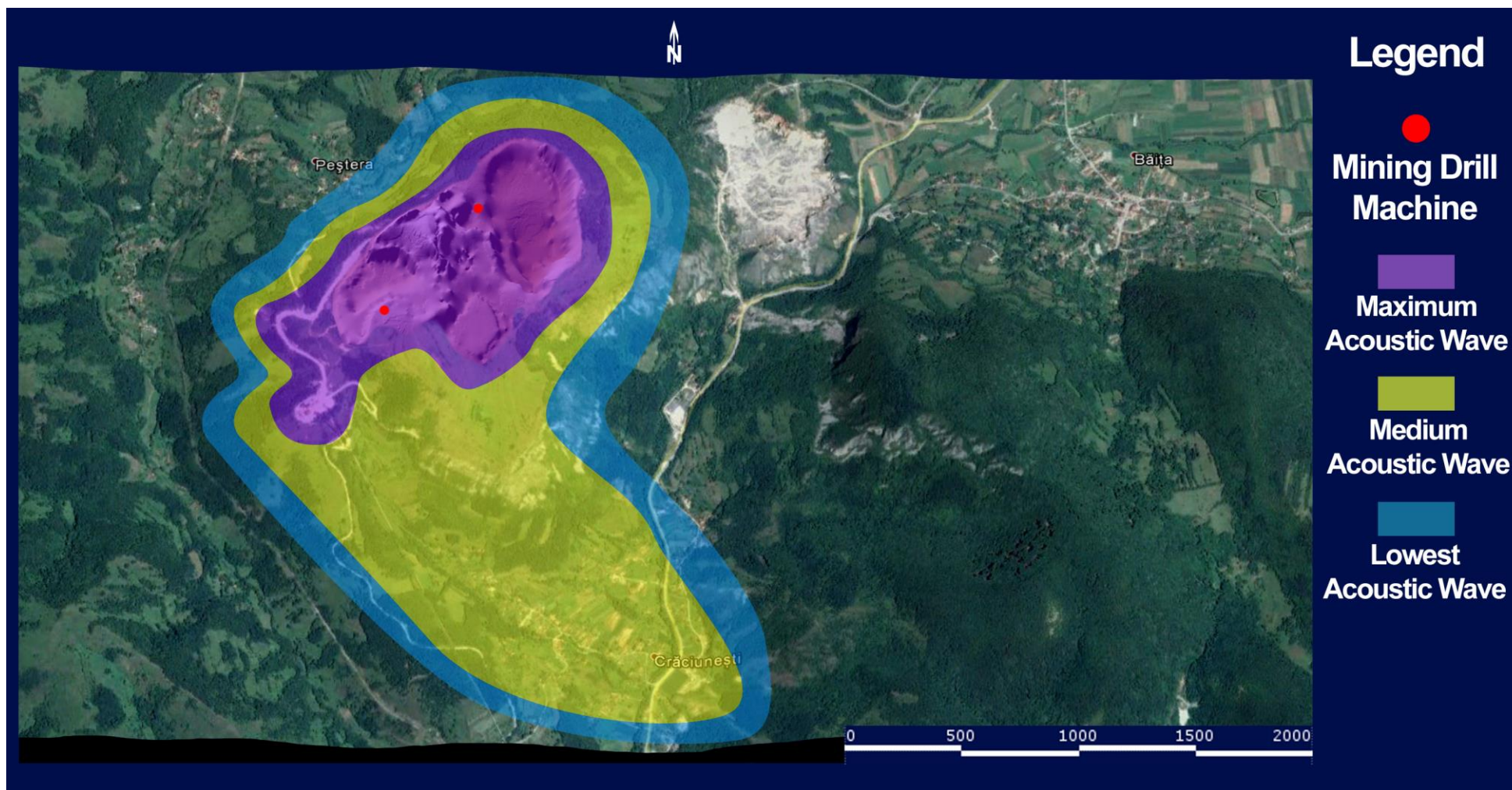
Annex 5 – Overview map of Băița-Crăciunești quarry



Annex 6 – Effective impact map of Băița-Crăciunești quarry



Annex 7 – Vegetation variation of of Băița-Crăciunești quarry



Annex 8 – Acoustic wave map of Băița-Crăciunești quarry

PLATE I

- A. Longitudinal section of some recrystallized corals;
- B. Solitary micritised coral in transverse;
- C. Benthic foram from Miliolida Order;
- D. Agglutinated foraminifera test;
- E. Colonial corals reef;
- F. Colonial corals reef;

PLATE I

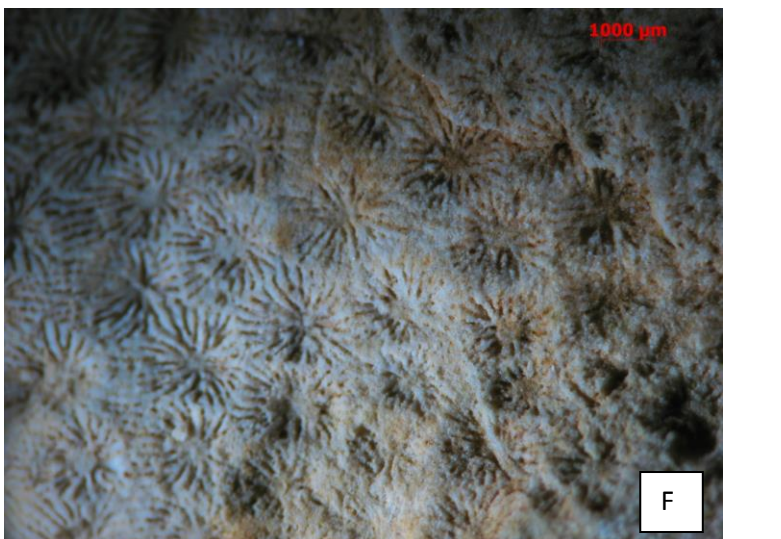
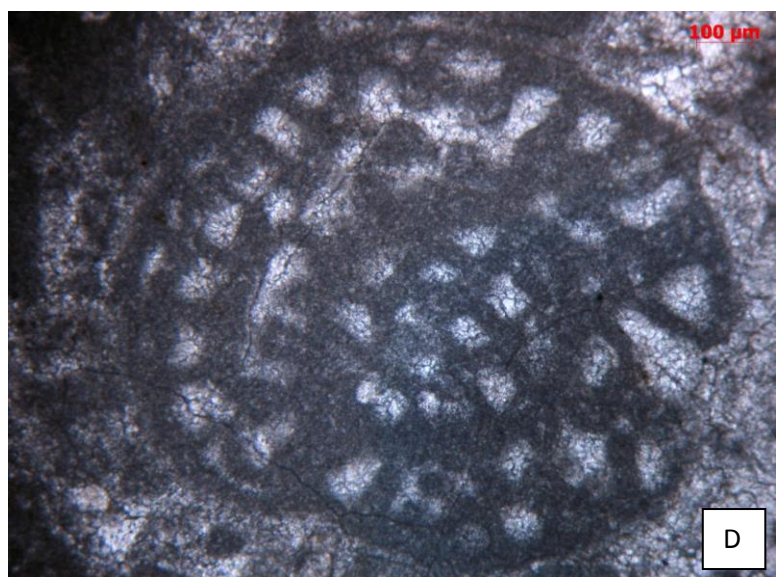
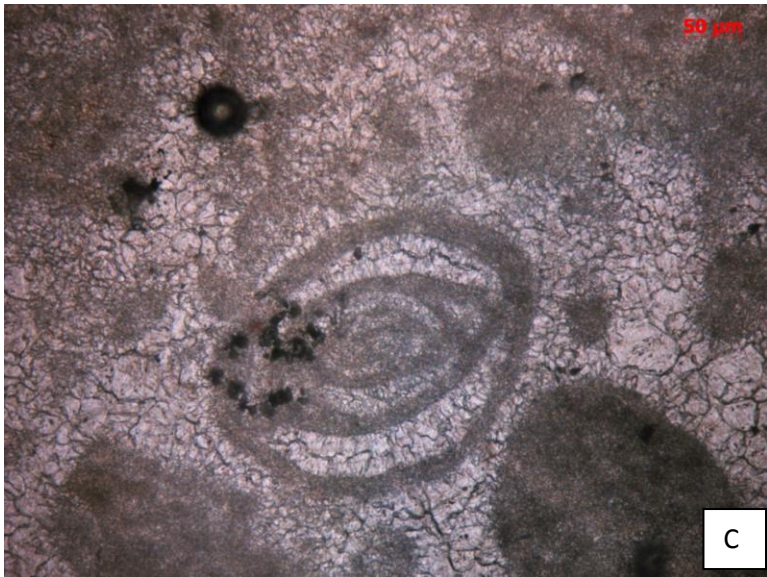
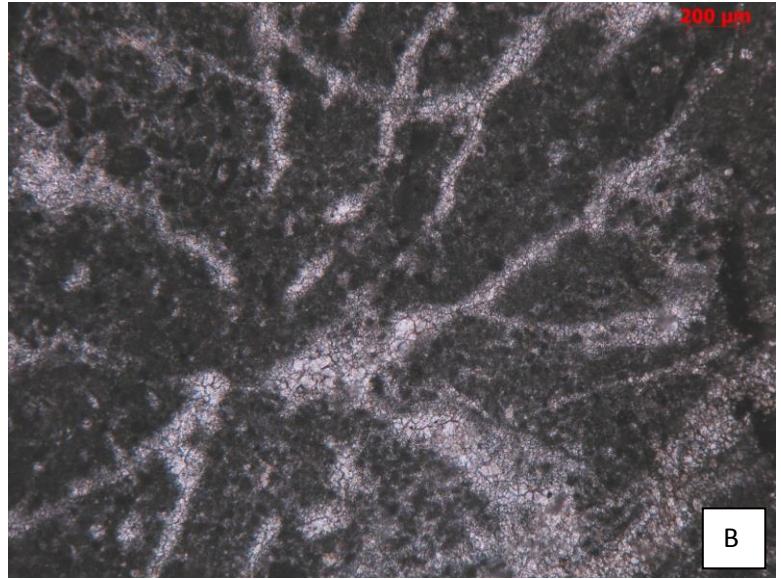
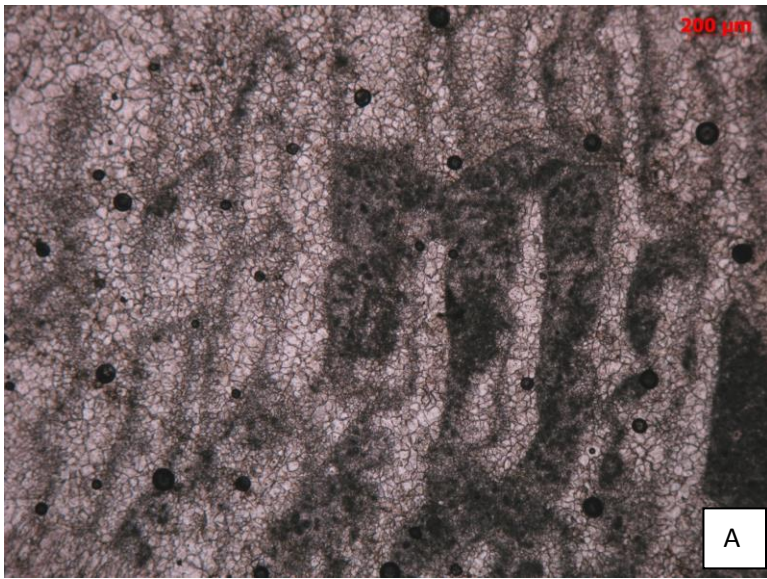


PLATE II

- A. Reef limestone;
- B. Reef limestone;
- C. Reef limestone;
- D. Reef limestone;
- E. Reef limestone;
- F. Reef limestone;

PLATE II



PLATE III

- A. *Calystegia silvatica*
- B. *Convolvulus arvensis*
- C. *Scabiosa ochroleuca*
- D. *Linaria vulgaris*
- E. *Chrysanthemum leucanthemum*
- F. *Erigeron annuus*

PLATE III



PLATE IV

A. *Tragopogon dubius*

B. *Verbascum nigrum*

C. *Lotus corniculatus*

D. *Melampyrum bihariense*

PLATE IV



PLATE V

A. *Campanula persicifolia*

B. *Campanula patula*

C. *Campanula rapunculoides*

D. *Campanula trachelium*

PLATE V



PLATE VI

A. *Epilobium angustifolium*

B. *Dianthus carthusianorum*

C. *Lythrum salicaria*

D. *Carduus nutan*

PLATE VI

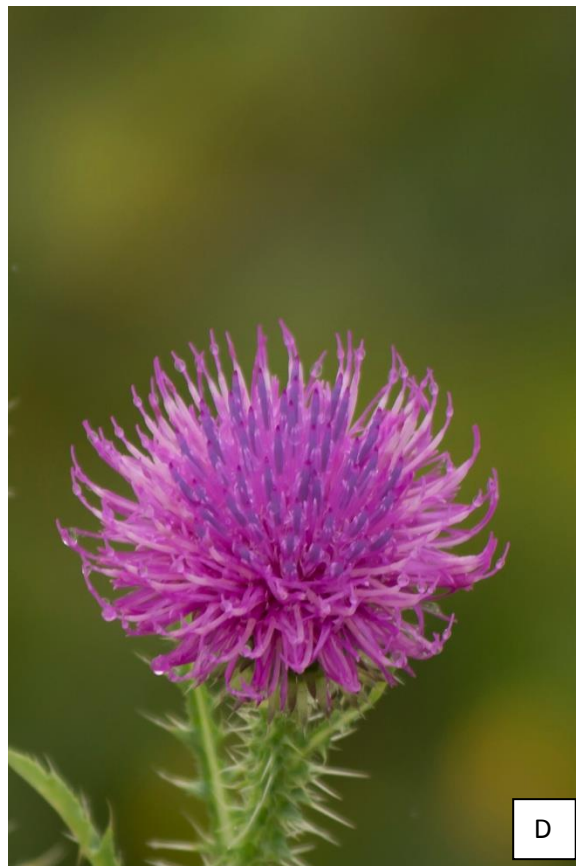


PLATE VII

A. *Echium vulgare*

B. *Cichorium intybus*

PLATE VII



PLATE VIII

A. *Libellula depressa* (male), Order Anisoptera

B. *Libellula depressa* (female), Order Anisoptera

C. *Ishnura elegans* (male), Order Zygoptera

PLATE VIII



PLATE IX

A. *Hypparchya semele*

B. *Vanessa atalanta*

C. *Coenonympha pamphilus*

D. *Plebejus argus*

E. *Lantides boieticus*

F. *Coenonympha pamphilus*

PLATE IX

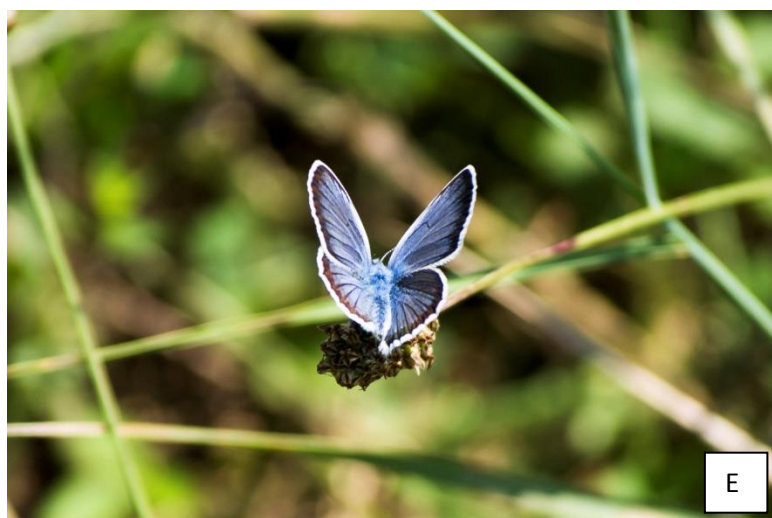
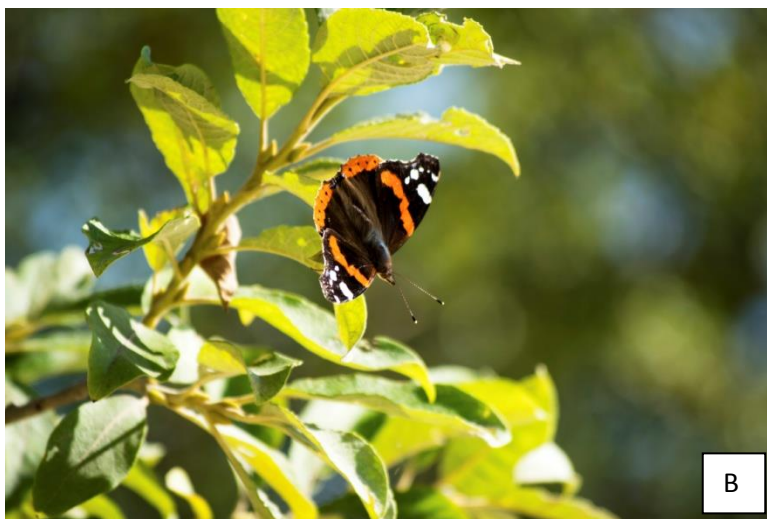


PLATE X

A. Anomala solida

B. Coccinella septempunctata

C. Lacusta migratoria

D. Lacusta migratoria

PLATE X

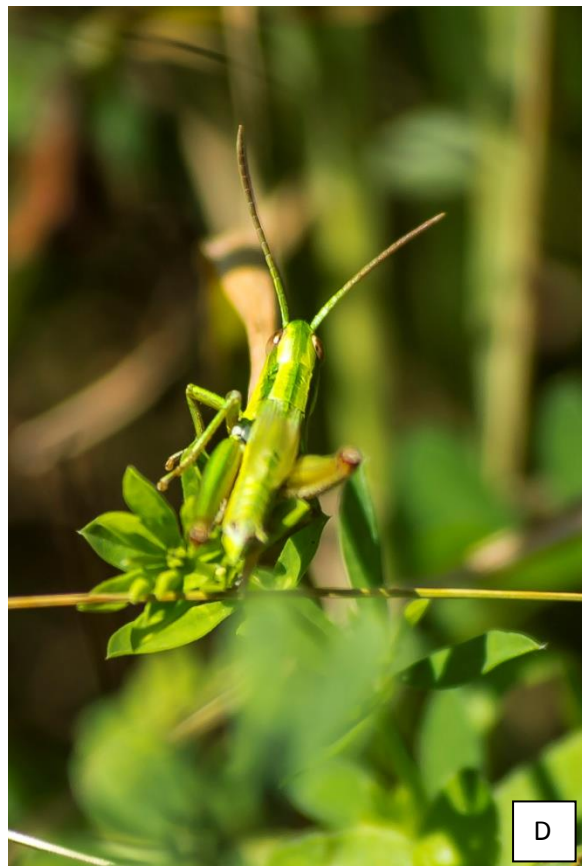


PLATE XI

A. *Corvus corax*

B. *Anthus spinoletta*

C. *Garrulus glandarius*

D. *Sitta europaea*

E. *Carduelis carduelis*

F. *Motacilla alba*

PLATE XI

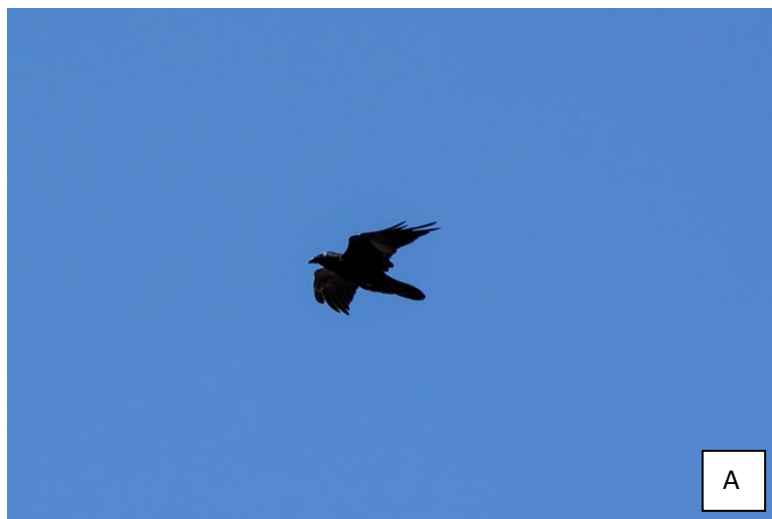


PLATE XII

A. *Lacerta agilis*

B. *Lacerta agilis*

PLATE XII



10. References

*** Text accessed at 28.09.2014 on the website: <http://www.marinespecies.org/foraminifera/>

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