Available online at http://geology.uaic.ro/auig/
Analele Stiintifice ale Universitatii "Al. I. Cuza" din Iasi
Seria Geologie 61 (1–2) (2015) 41–46

AUI GEOLOGIE

Preserving history. "Calcariul de la Răpidea" 3d virtual tour (Iași, Romania)

Tony-Cristian Dumitriu[1], Mihai Brânzilă[1], Dorin-Sorin Baciu[1]

[1] "Alexandru Ioan Cuza" University of Iaşi, Department of Geology, 20A Carol I Blv, 700505 Iaşi, Romania

Abstract

Considered to be the first Romanian geological scientific paper, "Calcariul de la Răpidea" describes an outcrop from an area that later became the first geological reserve. Geologically, the area belongs to the Moldavian Platform corresponding to Besarabian age (middle Sarmatian) and it is a reserve since 1955. During this span of time, the Repedea reserve has passed through many administrative changes. It was enlarged from 0.019 km^2 to 0.058 km^2 as a strict preservation area and received an additional transition afforested area of 0.385 km^2. Today, the transition area is deforested by locals and the strict protection area is in constant destruction due to garbage disposal and stone extraction. In this paper we propose a new approach regarding the reserve preservation and protection by creating a 3D immersive interactive virtual tour of the area with the help of "Structure form Motion" Photogrammetry, 3D modelling and game industry tools. By providing this 3D virtual tour freely over the internet we hope to raise the awareness among general public and organizations.

Keywords: unity3D, "Structure from Motion" photogrammetry, 3D Virtual Tour, Repedea Hill, geological reserve, Iași, Romania.

1. Introduction

"Calcariul de la Răpidea" (The Limestone from Repedea) is considered to be the first scientific geological paper written in Romanian. The paper was published about 153 years ago by Grigore Cobălcescu, following a personal geological research in an area near the town of Iași.

In the first of August 1955, the area has been declared a natural monument by the Ministers' Council Decision number 1625, protecting a surface of 0.019 km^2. In 1973 the protection surface was enlarged and separated into a scientific area of 0.058 km^2 and a transition area of 0.385 km^2, which remained about the same until today.

Corresponding author's e-mail: dtonycristian@yahoo.com

In the early '90 the transition area was populated with trees and the reserve itself received information panels which were changed during a greening action in 2007.

Over the years, locals have deforested almost the entire transition area and the reserve suffered a lot from garbage disposals and stone extraction following a bad administration.

For this reason we consider that awareness must be raised among general public, governmental organizations and non-governmental organizations in order to preserve the most important part in our long scientific geological history.

Nowadays doing this can be very easy and almost at no cost through virtual reality and internet. Therefore we have chosen to create an interactive 3D virtual tour by integrating 3D models made using different 3D modelling techniques into a so-called game engine.

2. Geological setting

As previously discussed, Repedea Hill represents the main research area in the first Romanian geological paper, written by Grigore Cobălcescu in 1862.

Being situated 9 km south from the town of Iaşi, the area belongs to the Moldavian Central Plateau and corresponds to Middle Miocene, more specifically to upper Besarabian (middle Sarmatian). (Ionesi et al., 2005).

The big quarry outcrop from Repedea hill is about 15 m high; it represents the Repedea Formation' holostratotype and it is separated into: oolitic yellow or grey limestones, lumaselic limestones, sandstones and sands (Ionesi and Ionesi, 2002).

The fauna within Repedea Formation is characterized by Bivalves (different subspecies of *Mactrapodolica <naviculata*, *vasluiensis>*, *Mactrafabreana*, *Plicatiformafittoni*, *Tapes vasluiensis*, *Pholashommairei*), Gastropods (*Gibbulabeaumonti*, *Potamidesnefaris*), Foraminifera (*Triloculinapseudoinflata*, *Quinqueloculinasinzovi*, *Triloculinaukrainicasarmatica*), Ostracods (*Leptocytheremironovi*, *Aurilakolesnikovi*, *Aurilasarmatica*) and Mammals (*Aceratheriumincissivum* premolars) (Ionesi et al., 2005).

Other researches have been concentrated on different aspects, like the study of endokarst structures (Lesenciuc, 2010) and the changing properties of the limestone from a monastery wall, due to long time exposure to weather (Brânzilă and Ştefan, 2009).

3. Methods

Addressing the issue of raising awareness among general public and specific organizations led to the choice of an application that can support high amounts of detail (in terms of 3D models), can support real world data (even if the data needs to be transformed) and can generate an immersive and friendly interactive environment. The chosen application is called Unity3D, it falls in the category known as game-engines. It has been successfully used by Minocha (2013) and Minocha et al. (2014) to generate a virtual geological field trip for students that could not participate in real ones, due to medical problems.

In order to make a complete virtual reality tour of the area in Unity3D, it is necessary to create all the 3D models separately and then to import them into the same space.

The first stage in creating the tour was to prepare the Digital Terrain Model

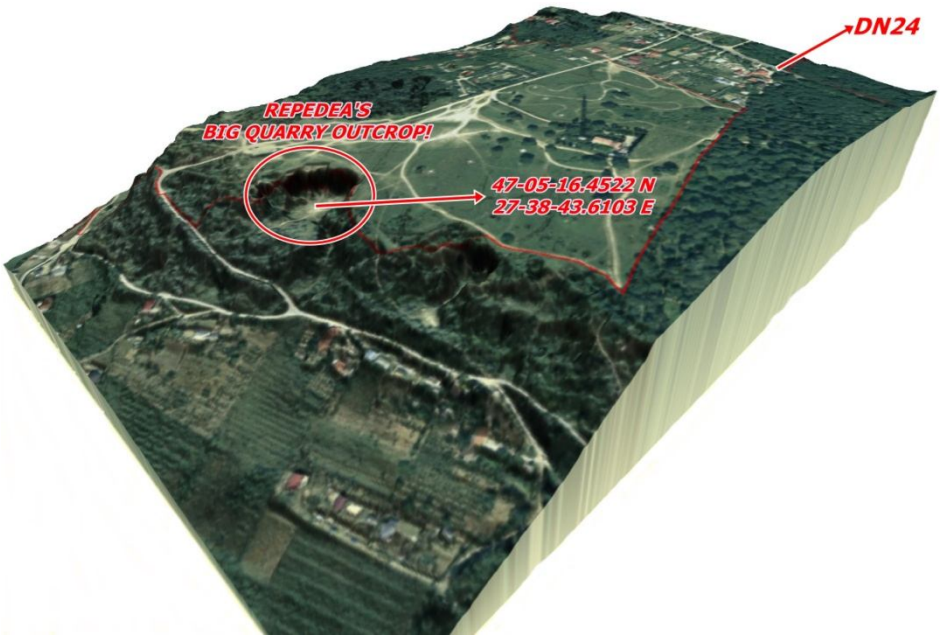


Fig. 1 Repedea Hill aerial and Digital Terrain Model map, with geographic coordinates of the Big Quarry Outcrop location.

(DTM obtained from photogrammetry data and SRTM data which was modeled in a 3-D modeling software) and the aerial imagery of the area (Fig. 1) with QuantumGIS, VTBuilder (from Virtual Terrain Project application suite) and MeshLab. Using QuantumGIS, the aerial image was exported into ASC format (DTM) and JPG format (the aerial image) respectively.

The next process consisted in transforming the DTM readable format by Unity3D (ex. OBJ format). Therefore, the DTM was imported into VTBuilder application, from where it was exported to VRML format, using "Export to…" function from "Elevation" menu. The transition between VRML and OBJ format was achieved with MeshLab through "Import" and "Export" functions in the "File" menu.

The actual 3D modelling process began with a field research, where 60 photographs with geolocation were taken (Fig. 2), in order to perfectly align and scale the future 3D models with GIS data (DTM and aerial image).

The 60 photos were also used as graphic references along with Google's Street View of the area, for 3D modelling of the perimeter features (power poles, television poles, buildings, trees, roads).

Beside these photos, we also used 410 photos taken in 2013 from the Repedea's big quarry outcrop (Dumitriu, 2013) and another 250 taken in 2015, in order to obtain a 3D accurate model of the outcrop. In this respect, "structure from motion" photogrammetry with the web-based application known as Recap Photo was performed. In order to obtain a 3D model through this application, the photos

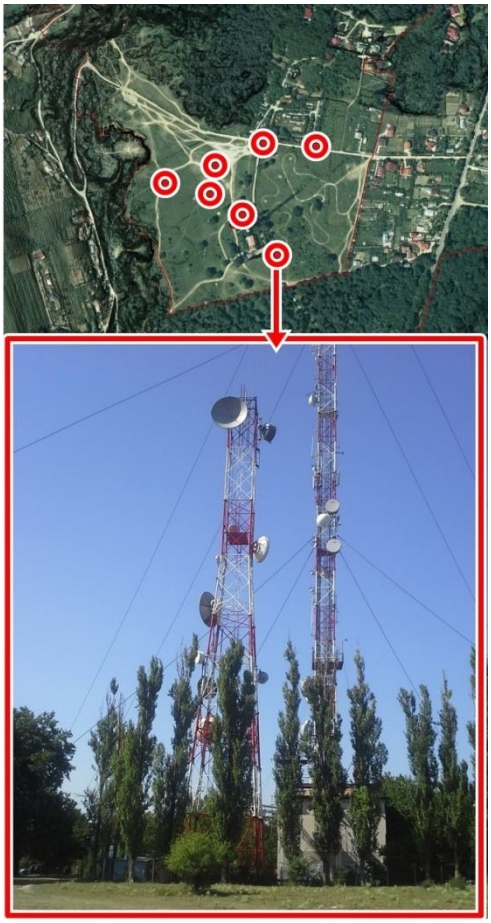


Fig. 2 Example of map locations for some of the 60 pictures taken. Below is the one of the picture showing the television tower.

needed to be uploaded to Recap Photo server and run the process afterwards, using an Autodesk account. Because Recap Photo can only process 250 photos at once, the 660 photos have been separated into four groups in which some photos were intentionally repeated so that the final 3D models could have some overlapping parts.

The resulting 3D models were cleaned, aligned and resized with MeshLab and then exported to OBJ format file (Fig. 3).

Using Unity3D editor both DTM and 3D model of the outcrop were imported. In order to be able to align the two models properly, we transformed the DTM mesh file into a Unity terrain using "Object2Terrain" C# script. After this process, the 3D outcrop was aligned to DTM, using Unity Editor's transform tools and Unity Editor's "Terrain Engine".

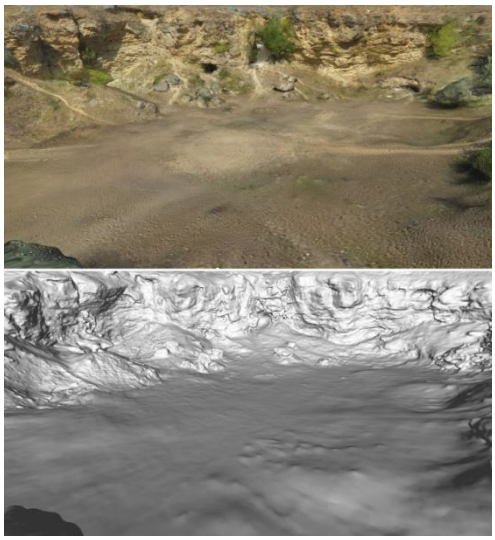


Fig. 3 Repedea's Big Quarry Outcrop. Upper image- 3D outcrop mesh with textures. Lower image - 3D outcrop mesh without textures.

The rest of the models were made either with Skethup (buildings, fences and vehicles) or directly with Unity (roads, poles and vegetation). The final models were then aligned to their real world positions, using both aerial images and photos taken from the field.

In addition, we inserted placards that provide information to the user, such as arrows that indicate the outcrop location, information about the outcrop itself and also information about the rules in a reserve.

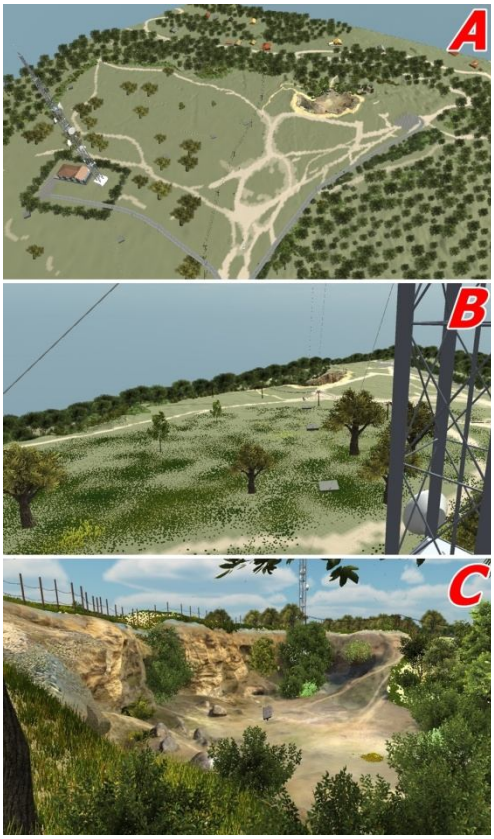


Fig. 4 Some parts of the 3D virtual environment during its conception. A-overview of the area ; B-image from the television tower; C-image from the north side of Repedea's big quarry outcrop.

4. Results and conclusions

Using the techniques and application mentioned above, we were able to create an immersive interactive 3D virtual environment (Fig. 4) and Plates 1 and 2 (only included in the online version of the paper), that can be used in both digital preservation of the area and raising the awareness among people regarding the value and fragility of the reserve.

Allowing people to actually interact with the surrounding environment without posing any threat to the reserve is an ideally way to get them to learn things about the area and become conscious about the rules and laws that protect it.

Because it resembles a video game, the interactive virtual space can be used with ease not only by adults, but by children as well, which could learn a sense of responsibility towards protected areas.

By providing this 3D virtual tour over the internet (http://geology.uaic.ro/3d-geological-modelling/) it is hoped that it will increase the sensibility among different people and organization towards the area, thus safeguarding the future of Repedea's geological reserve.

References

Brânzilă, M., Ştefan, P., 2009. Golia monastery from Iaşi (Romania) – Alteration and deterioration of the building limestone. Analele Ştiinţifice al Universităţii "Al. I. Cuza" din Iaşi, Geologie, **55**, 2, 5–18.

Cobălcescu, G., 1862. Repedea Limestone. Revista Română pentru Ştiinţe, Litere şi Arte, **II**, 585–699. (In Romanian).

Dumitriu, T.C., 2013. Towards digital preservation of Repedea's big quarry outcrop using "Structure-from-Motion" photogrammetry tools. Analele Ştiinţifice al Universităţii "Al. I. Cuza" din Iaşi, Geologie, **59**, 2, 19–40.

Ionesi, L., Ionesi, B., 2002. The Repedea Formation and its lithological variations (Moldavian Platform). Mem. Sec. Şt., Ser. IV, **XXV**, 85–116. (In Romanian).

Ionesi, L., Ionesi, B., Roşca, V., Lungu, A., Ionesi, V., 2005. Middle and Upper Sarmatian on Moldavian Platform. Edit. Acad. Rom, 558p.

Lesenciuc, D., 2010. Endokarstic relief within the natural reserve area of "Repedea hill fossil site".Forum geografic. Studii şi cercetări de Geografia şi protecţia mediului, **9**, 31–40.

Minocha, S., 2013. 3D virtual geology field trips. 2nd Monthly International Workshop on Science Exibits in online 3D environment,

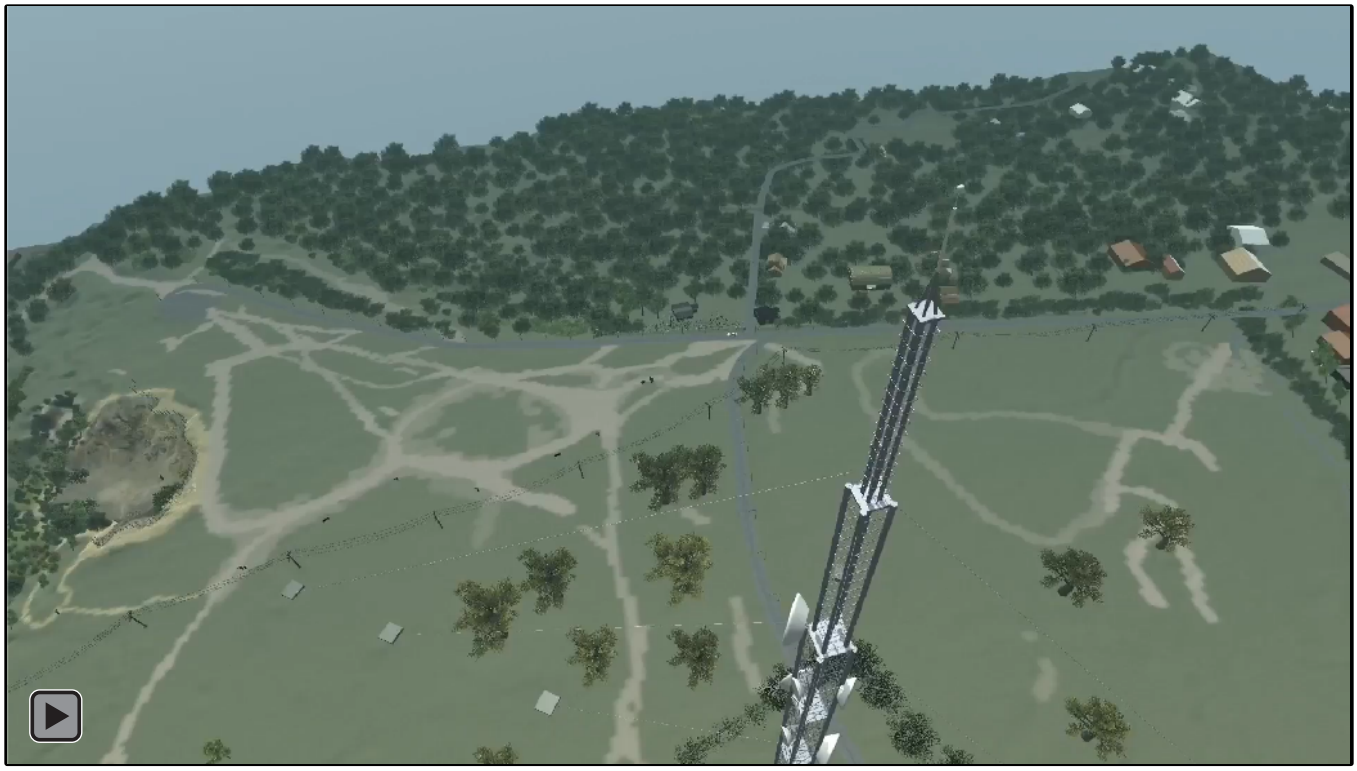
Abyss Observatory in Second Life (3D virtual world).

Minocha, S., Davies, S.J., Richardson, B., Argles, T., 2014. 3D virtual geology field trips: opportunities and limitations. Computer and Learning Research Group Conference. The Open University, Walton Hall, Milton Keynes, UK.

PLATE 1

Sample video from the 3D Virtual Tour showing and overview of the area

PLATE 2



Sample video from the 3D Virtual Tour showing the Repedea's Big Quarry Outcrop