GIS DATABASE FOR MINING. CASE STUDY: DEALUL HULEI-MATEIAȘ LIMESTONE QUARRY

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Abstract: *A GIS database is the foundation for performant mining management. In the following article the authors propose the presentation of a geographic database with reference to Dealul Hulei-Mateiaș limestone quarry, Argeș county, Romania.*

Keywords: *GIS, mining surveying, mining industry, open-cast mining, mining management.*

1. GIS introduction

GIS is the English name for Geographical Information Systems, Geographic Information Systems-U.S.A., Geographical Information Systems-United Kingdom, Australia, Canada, Geographic Information Sience-academic[1]. The GIS term has been used for the first time in the year 1968 by Roger F. Tomlinson in his work ,,A Geographic Information System for Regional Planning"[2]. In the year 1960 was developed the first geographical information system in the city of Ottawa, Ontario, Canada for the State Department of Forestry and Rural Development, this system being used up in the 90s [2].

Since the late 70s, GIS systems such as MOSS, GRASS, were developed in the late 80s M&S Computing, later Intergraph, ESRI - Environmental Systems Research Institute, CARIS - Computer Aided Resource Information System, MapInfo Corporation and ERDAS-Earth Resource Date Analysis System, have become the main providers for geographical information systems solutions[2].

The 90s led to the transformation of information from analog to digital format, leading further geographical information systems from the research and development stage in the commercial stage, with the usage of the Internet in providing geographic data.

During the 2000s GIS solutions have matured, becoming more popular in various public or private organisations, open-source solutions for geographical information systems were developed such as Quantum GIS-QGIS, Grass, PostGIS, in which users were involved in the development and promotion of the software; usage of these open source systems-OSS was encouraged at international level.

Currently GIS databases are essential in organizations with effective management. In Romania there is a development in the use of such GIS database both in the private sector, companies in the petroleum industry, electricity distribution, transport, and public sector, examples for the latter case are the implementation of projects like Green Spaces Cadaster, GIS-type solutions in emergency and hazard management and so on.

A database, also known as data bank represents a structured collection of information relating to a particular subject or purpose. Graphical database, also known as digital plan,

represents the totality of spatial and descriptive data, organized according to certain rules, which provides the description, storage and processing of the data relating to real estate for instance.

Regarding the Dealul Hulei-Mateiaș limestone quarry, the sheer volume of multi-source information, different storage mode, analog or digital format stored on magnetic support, imposed organizing the informations into a GIS database. Besides the obvious data management, judicious decision-making at the level of the organization's leadership is based on technical data, specialized reports, which underlie the strategic management decisions in the day-to-day mining operations in the quarry and future development.

2. Dealul Hulei-Mateiaș limestone quarry overview

The exploatation of industrial limestone in the Mateiaș area, Valea Mare Pravăț Village, Argeș County, has began in 1969, whith the construction of Câmpulung cement factory, known until 1989 as "Combinatul de ciment Câmpulung Muşcel", between the 1989 and 1999 known as S.C. CIMUS S.A. and after this year owned by Holcim International Group, as S.C. Holcim Romania S.A., now part of Lafarge Holcim Grup.

Dealul Hulei-Mateiaș limestone quarry is located in the Valea Mare Pravăț Village, Argeș County, positioned at N-E from Câmpulung Mușcel municipality with access to the European Road 574, National Road 73 Pitești-Brașov, positioned at 1.8 km from Câmpulung cement factory. The name Mateiaș comes from the adoptive son of Matei Basarab (b.1580-d.1654), the Voivode of Wallachia between the 1632 and 1654.

Fig. 1. Dealul Hulei-Mateiaș limestone quarry, Argeș county, Romania

In geographical terms, Dealul Hulei-Mateiaș limestone quarry is located at the southern tip of the Iezer-Păpușa Massif between the Argeşel and Dâmboviţa Rivers. The deposit was limited to the area of the Dealul Hulei at 1100 m altitude, and Mateiaş peak, 1241 m altitude are separated by a low altitude valley between 970m and 1000m. Considering the morphology of the land, limestone resources were divided into two distinct perimeters. The deposit is oriented in the SV-NE direction, with a length of approximately 1.5 km and a width of approximately 1.0 km. Mineral resources perimeters are located in the following areas:

-the Dealul Hulei perimeter - delimited in the area Dealul Hulei, which is outlined in the south-western area of the deposit.;

-the Mateiaș perimeter - delimited in the area Mateiaș peak, at the north-east area of the limestone deposit.

The current work of mining takes place in the Dealul Hulei perimeter, with cadastral no. 80805, with an area of 76243 sq.m. located in the Valea Mare-Pravăţ Village, Argeș County. The product exploated in the quarry is the limestone which is delivered in two distinct sorts, 0-50 mm and 50-100 mm, used in the construction industry.

The mining characteristics of Hulei Hill -Mateiş limestone quarry

Regarding the characteristics of the mining querry, the average height of the treads is 10-15m, the primary blasting is made with explosives by vertical drilling and rarely by horizontal drillings[3].

The vertical parameters of executed drillings are:

- average height of treads: 10-15m;
- average lenght of the holes: 11-16m;
- minimum distance between holes: 3.5-5m;
- gap between holes: 3.5-5m;
- hole diameter: 115mm;
- horizontal inclination of the hole: 80 degrees from the horizontal;
- explosive charge per meter of hole: 10 kg / m.

The horizontal parameters of executed drillings are:

- hole length: 4-5m;
- gap between holes: 1.5-4m;
- hole diameter: 115mm;
- explosive charge (nitramonium) per linear meter of hole: 8-10 kg / m.

For the Dealul Hulei-Mateiaș limestone perimeter was established a specific nitramonium explosive consumption of 0.14-0.18 kg / t.

The secondary blasting aimes shredding of oversize pieces of rock, larger than 1.2 x 1.2 x 1m, resulting from principal blasting with vertical or horizontal drill holes. Those pieces of rock that exceed the size of feeding port of the crusher (1.6 x 1.2m) are considered oversize pieces. Grinding is performed mechanically using a hydraulic picon or by blasting with explosive materials.

Grinding with explosive materials is carried out by drilling mine holes or drilling in the oversized rock pieces, loading them with explosives and detonating. Riogel or dynamite are used as explosives and initiation is done with a detonating tip or riokord, pyrotechnic staples and Bickford wick, or Nonel initiation system.

The specific explosive used for secondary blasting is 0.2-2.5 kg TNT / t. Using the vertical drilling holes technique, the weight of the oversized rock pieces was reduced up to 3% compared with the minaret galley balls, and their share dropped up to 1%.

Loading and transport of exploated material

The loading of the unrocked material, limestone from the working front, is carried out with the CAT 988 G front loaders with the load productivity of 455-560 t / h depending on the working conditions, the duration of a cycle is 30-60 seconds, and the loading duration for a truck - maximum 3 minutes. The material transport from the working front to the crushing plant is carried out using Belaz 7555B trucks with a capacity of approximately 55t.

3. Compiling the GIS database

The GIS database was complied with ArcGIS software, developed by ESRI-Environmental Systems Research Institute, and is accessible from the online environment via ArcGIS Server. The database is a relational geodatabase that stores and manages geographic information, spatial data such as shapefile - *.shp and georeferenced raster images. Due to the nature of the information contained therein, in secret of service area, access to the database is

based on credentials such as user and password. The information contained in the database is mainly from the internal source of the organization and in a lesser extent from an external source (eg. buildings and terraines included in the integrated cadaster and land registry system). The data contained in the database is raster type, for example high resolution 50 mm orthophotoplan mosaic, or vector type, such as mining perimeters, urban limit, geological informations, contours etc. Data from external source as well as some of internal source have the Stereographic Projection System 1970-Dealul Piscului 1970 and is transcalculated into the WGS 84 Coordinate System before publishing on the server. For good management of raster format materials, they were converted to *.ecw format, an optimized size format, convenient for server storage. Analogue materials have been scanned and georeferenced for use in the digital environment. Also, CAD vector materials such *.dxf, *.dwg format have been imported and converted into *.shp, GIS specific format, though not always these work environments are perfectly interoperable.[4]

The data was grouped according to origin and nature in:

- general mining data;
- data regarding real estate issues;
- geological data;
- cadastral, topographic and geodetic data.

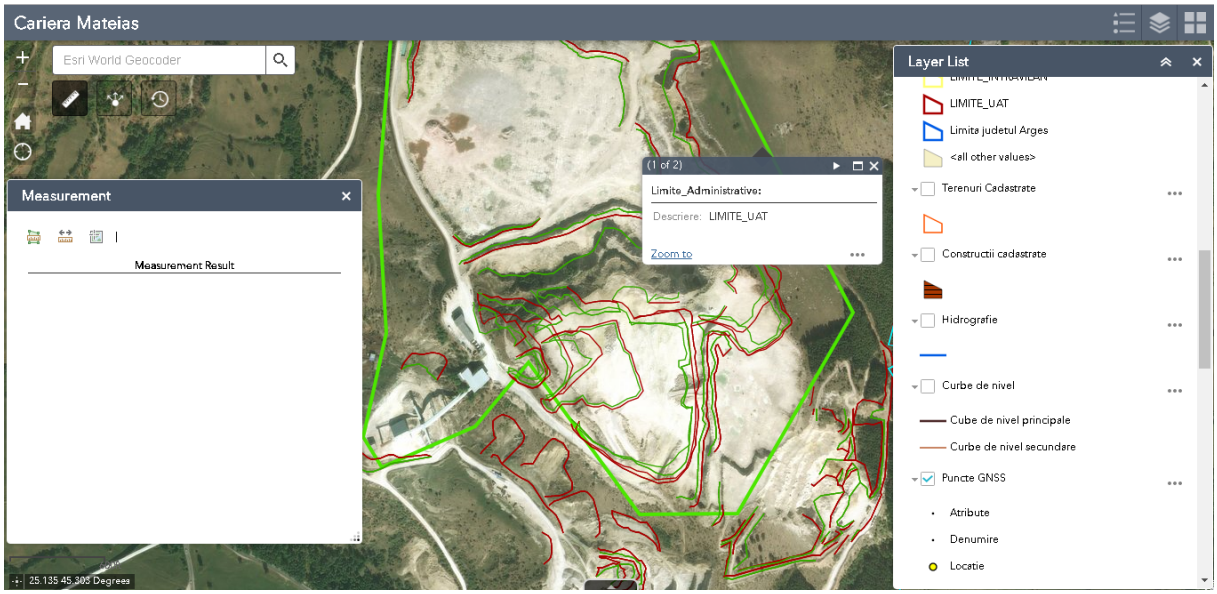

Fig. 2. GIS database viewed in online environment

Regarding the general mining quarry data, informations are structured in layers such as:

- trimestrial evolution;
- new mining perimeter;
- Mateiaș mining perimeter;
- old quarry perimeter.

Regarding the real estate aspects of the Dealul Hulei-Mateiaș quarry, the created database has the following layers:

- land owned by the quarry;
- leased land, concessioned land, managed by the quarry and owned by Valea Mare Pravăț Village Hall, Arges County;
- land under real estate acquisition;

- land likely to be acquired, the owners of which agree in principle with the real estate transaction;
- land whose owners do not want to trade;
- land irrelevant to quarry;
- land of interest belonging to the public domain of Dragoslavele village, Arges county.

This informations are of interest to the future development of the mining quarry, for property management, for the proposed procurement plan.

Regarding the geological aspects of Dealul Hulei-Mateiaş quarry we have the following structured data in layers:

- the spatial position of the drilling;
- position of various limits of geological structures - crystalline limestone, turbiditic;
- the spatial limit of geological studies conducted since 1971 to present date;

This information basically reveals the size of the existing limestone deposit, future directions of quarry expansion, depth, thickness, dispersion / agglomeration, inclination of the limestone deposit.

- The spatial position of the various economic objectives in the vicinity of the quarry (Mateiş Mausoleum, Mateiaş Chalet and Restaurant, individual dwellings). They are of interest in complying with a safety zone on noise pollution, structural safety, since primary blasting is achieved by using explosives placed in vertical and horizontal drill holes.

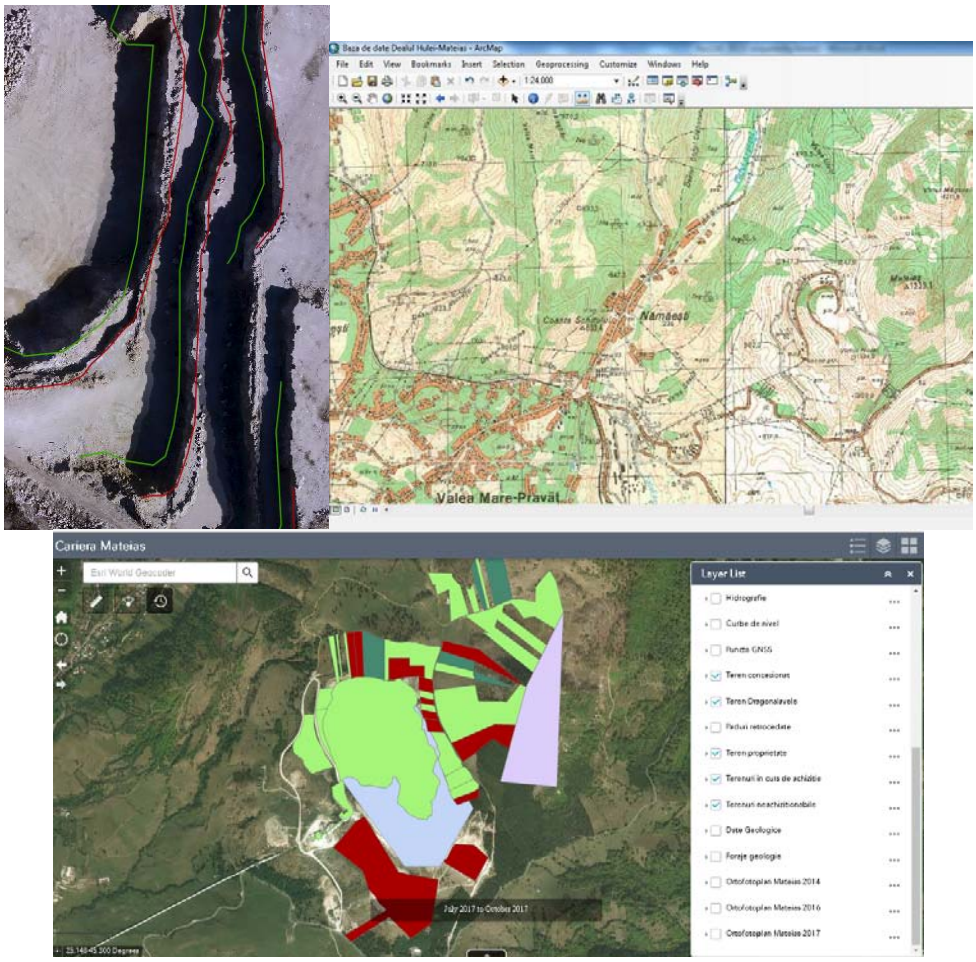

Fig. 3. View from the GIS database: up left orthophotomap mosaic with 50mm pixel resolution; up right Topographic map scale 1: 25000; bottom center-real estate informations

4. Conclusions

Given the multitude informations organized in layers, the decision flux regarding the mining exploatation, the Dealul Hulei-Mateiaş limestone quarry development is realized with the help of the GIS database, the management being an efficient one. Technical informations are at the disposal of end-users, quarry chief and the personel involved in the management process. The end users have the opportunity to query the database and view technical information, reports made by multidisciplinary teams, made up of geologists, geotechnical tehnicians, land surveyors, mining engineers, chemists. The management of the database, its population and maintenance are carried out by GIS professionals.

Some of the advantages of the GIS database are:

- rapid access to information, easy-to-use, comparing various information and expeditious generation of statistics;
- improving real estate management;
- lithological study;
- creating real-time thematic maps by combining existing raster layers and vector into the database;
- safe use of data using user and password credentials.

Specialized studies are conducted by highly qualified personnel with specific training. The theme of this study will be treated extensively in the doctoral thesis of PhD. stud. eng. Costin-Sebastian MANU.

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