v. 3, n. 39, 2023

International Journal of Human Sciences Research

TEACHING OF COMPUTER TOOLS APPLIED TO THE STUDY OF THE SUBSOIL

Cienfuegos Suárez, P
Mining Exploitation and Prospecting Department
Spain

García-Ordiales, E
Mining Exploitation and Prospecting Department
Spain

Marqués Sierra, A.L
Mining Exploitation and Prospecting Department
Spain

Covián-Regales, E
Mining Exploitation and Prospecting Department
Spain

Abstract: The application of new information and communication technologies in society, science and technology in general has also reached the exploration of the subsoil, closely related to the exploration of hydrocarbons, and metallic and non-metallic mining. On the other hand, the need to know the subsoil as accurately as possible is related to the cost of the surveys and their depth, necessary for the exploration and exploitation of the subsoil.

These computer tools are also associated with the world of mining in general, since every day it is more necessary to obtain maximum information at minimum cost.

The impossibility of knowing exactly the structure and composition of the subsoil has led to the creation of new computer tools that allow us to predict the lithologies and their physical properties that we can find between two surveys.

Today, after the important development of recent decades, the computer tools industry has created companies such as Schlumberger, with commercial divisions oriented exclusively to the programming of new computer tools that allow the data obtained in a survey to be correlated so that can get more information.

This communication will briefly describe the current state of these tools, as well as their future developments. As an applied case, a new computer tool will be shown, called RECMIN.

Keywords: Computer tools, modeling, Subsoil

INTRODUCTION

The technological advances present today are revolutionizing the way and efficiency of working, and their impact is being reflected in the geological sciences (Ulloa, 2016). The Internet has become an essential technical and didactic support for developing new teaching models. But often, these ICT resources are applied in classrooms without prior assessment or analysis (Pardo and Redondo, 2001).

Computer science, from its beginnings, invaded our society and therefore, our production processes. Likewise, computing has invaded all areas of knowledge, becoming a very valuable tool that allows speeding up the performance of routine work (Oliver and Naval, 1997). In addition, it allows access to information in enormous quantities and allows us to obtain relationships between variables that would be impossible for a human being to execute.

Since the 1980s, while computers became popular in the US, software developers or programmers have been developing their applications based on the market and/or their professional inclinations.

Until relatively recently, the companies that owned the information stored this information in reports written on paper, as well as logs, both styles of documents subject to the inclemencies of the passage of time or accidents such as fires and floods with the consequent loss of information.

All these advances have been absorbed by the mining company immediately in the Western world, initially starting with applications that allowed repetitive operations to be carried out, but did not provide much added value to the information obtained during the exploration and exploitation tasks of a mineral deposit.

The changes that occur in the industry imply that they must be reflected in better teaching of these new applications in the learning procedures of future graduates in mining, civil and geology engineering (Nieto, 2010).

Engineering study plans involve the integration of various formal disciplines at a high level of knowledge (Marchamalo et al., 2010). Engineering in general requires solid knowledge and skills in various subjects specific to the specialty.

The advances in computer tools applied to Research Projects and Exploitation of Mineral Resources have been such that today it is not conceivable to work on a mining project without the help of this type of programs. With them, it is possible to represent any stage of a mining project, such as research, development or design, in a 3D view, showing drillings, surfaces, mineral models and blocks, triangulations, sections, detailed geological or mineral grades, etc.

The changes that are occurring in the teaching of disciplinary subjects of Geography are a product of the introduction of ICT and the new perspectives of teaching in the European Higher Education Area (Nieto, 2010).

MODELING OF SUBSURFACE INFORMATION

A correct analysis of the data acquired during geological investigation is essential both for their interpretation and for their subsequent communication to the scientific community. For this reason, learning a data analysis methodology must be part of the preparation of every geologist throughout their training (Merinero et al., 2012).

The information that we can obtain from the subsoil can be qualitative (interpretive through surface geological information) or quantitative (data provided by surveys and seismic).

Basically, the information to be extracted from the subsoil is related to the existence of one or several specific lithologies, their petrophysical properties and their suitability for the purposes sought by humanity. In these times we live in, there is the need for energy resources (gas and oil) and the need for raw materials (metallic and non-metallic deposits for the production of consumer goods).

The information to be stored and subsequently represented in 2D or 3D is basically the following: lithology, stratigraphy, fractures (orientation and inclination), depth, drilling diameters, casing diameters, cementation stages and their different compositions, losses during drilling fluids, temperatures, as well as all the information obtained from the set of "logs" that are made in a survey.

Once this information is stored in each survey, the information between surveys is interpretive and for this purpose statistical and geostatistical techniques are used, such as the different types of meshing (gridding), the multiple information interpolation algorithms (Kriging, inverse distance, etc) and knowledge of the stratigraphic and geostructural styles of the geological environment where the drilling or drilling campaign has been carried out.

Once the decision has been made to invest in conducting a poll or a polling campaign, the information obtained must be carefully stored for the future. There are several types of computer tools for processing subsoil information:

- On the one hand, there are those computer programs that only represent the geometric parameters of a borehole design and in a summary manner other types of information provided by the borehole such as frequency of fractures, RQD, etc. A typical program may be RockWare's Prosect© (Figure 1).

- On the other hand, during the execution of a survey, a large amount of information is generated regarding the rock it crosses, its tension state, its lithology, petrophysical characteristics, ground fracturing, etc. All this information is recorded by the sensors appropriate to each characteristic (through "logs" or diagraphs) and represented in computer tools, which allow its collection and storage in databases and its subsequent analysis, correlation and interpretation almost automatically. Here most of the specialized computer tools stand out, highlighting names such as WellCAD©, TechLog©, and Interactive Petrophysics© among others.

- Finally, there are those programs that perform support tasks for the drilling engineer on site, acting as a digital form and support in typical calculation tasks during a drilling operation such as selection of materials, diameters, types of cement, etc. Among the latter, we could highlight the "i-handbook" (Schlumberger) or the Halliburton digital notebook, which is really an electronic notebook or form that serves to support the engineer. The Schlumberger iHandbook program is a free program that allows you to have a small manual of formulas and basic operations in the execution of surveys as a pocket-sized electronic book.

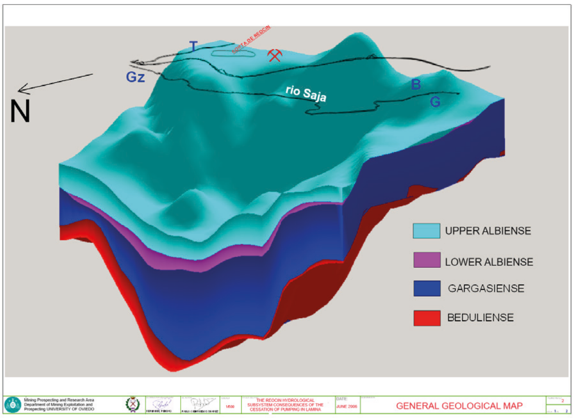

Figure 1. Example of 3D modeling with real subsurface information.

DEVELOPMENTS OF CURRENT AND FUTURE COMPUTER APPLICATIONS

From the dawn of professional computing to the present day, computer programs have evolved from those that performed tedious or repetitive tasks that could easily be done with a traditional calculator to large programs or application suites that allow the integration of large databases that Otherwise it would be unthinkable to explode.

Today there are numerous computer applications used to store and manage subsoil information (Jimeno, 2000). –

In the 90s of the last century there were programs like Rockworks© that only allowed use through command lines. In the mid-90s, the development of programming languages allowed the use of computer tools that allowed the visualization of information and the orders to be carried out with it (López Jimeno and Bustillo Revuelta, 1997) (Figure 2).

We can mention mining management programs such as VULCAN© (Maptek), or PETREL© (Schlumberger), including Oasis Montaj©, GEMCOM©, DATAMINE©, MIcromine©, MineSight©, RockWorks© (RockWare), etc... All of them are programs that go beyond simple information storage. They allow you to manage all the subsoil information of an exploration program, including the exploitation of a mineral or hydrocarbon deposit (Figure 3).

Due to the growing number of computer tools for subsurface data visualization, GIS companies such as ArcGIS©, Mapinfo© have also joined the traditional mining computer tool companies, developing specific modules dedicated to the representation of drillings and their associated information. that complement their main programs, such as TARGET© for ARCGIS from Geosoft or DISCOVER© and ENGAGE3D© for MapInfo©.

We must not forget that currently with the development of PDA-type portable equipment, programs such as ArcPAd for ARCGIS© or CoreCAD© for PPC have emerged, which allow information to be stored directly in digital form and through data transmission technologies such as Bluetooth and WIFI. send the data directly to the data storage and management computers instantly (Figure 3).

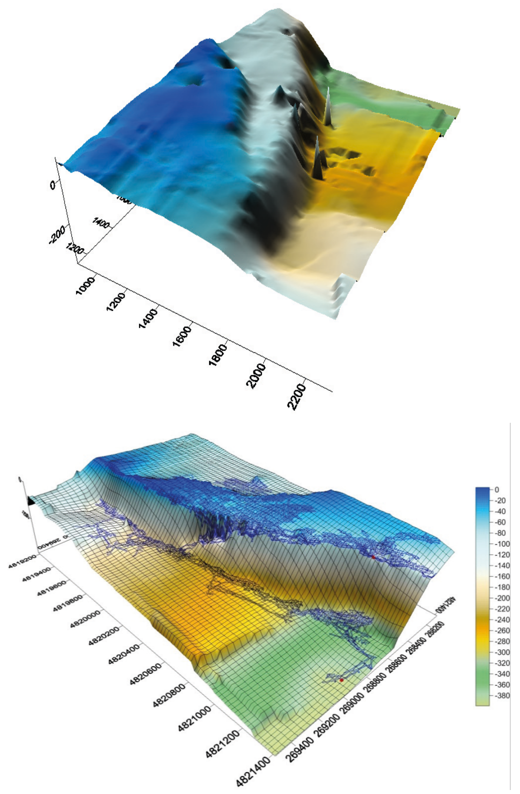

Figure 2. Georeferenced 3D topographic model showing the location of the mining works.

The future development of the drilling technique, apart from new research in new materials, directional motors, alloys, etc., in relation to information management, will most likely tend to the use of new technologies such as computer vision, data analysis. images, decision making through machine learning, artificial intelligence and implementing robotics and especially microrobotics (or microbotics) in the execution of surveys that allow very quick decisions to be made during drilling (MWD, directed drilling, multilateral). Every day they are used more and much importance is given to taking samples and petrophysical values "in-situ", assisted by computer applications.

Thus, new information visualization environments emerge, complemented by seismic and surveys using screens or viewing rooms called 3D -VISIONARIUM), which allow you to navigate spatial data through the use of natural movements of the body and carry out interdisciplinary work in a shared virtual environment. Currently, the world's main energy companies have rooms of this type among their research resources.

In many exploration campaigns, especially for hydrocarbons, seismic is used at first and later surveys are carried out that allow the information to be "gathered". It also allows you to navigate spatial data through the use of natural body movements and perform interdisciplinary work in a shared virtual environment.

In recent years, different mobile devices have emerged with features such as WIFI, which allow the transmission of data in real time from the location of the survey operation to the office. For this, the appearance of PPC (Portable Personal Computer) equipment has made possible the implementation of programs such as CoreCAD© that allow the direct entry of data in the field and its direct or deferred transmission to more powerful programs such as WellCAD© where they can now be analyze and relate data.

On the other hand, public administrations in our country and around the world are making and have made a great effort to digitize current information.

All of this comes together in a single purpose, which is the use of a computer tool where this information is gathered with the aim of extracting new information or using it as a decision-making tool based on all the information provided.

NEW COMPUTER TOOLS IN MINING: RECMIN©

There are a variety of computer tools for mining applications, but recently other free computer tools have appeared in the mining industry. This is the case of RECMIN, which complements the use of these programs in each stage of a mining project, from the research phase to the exploitation and closure of the mine, and is applicable in both business and academic environments. Being able to work with 3D views and place the project and designs on a screen, where we can rotate, zoom, move, etc., helps to visualize "real" situations of something that is still in a design stage and helps make decisions (Luengo-Padrones, 2013).

Currently, new computer tools have emerged that make it possible to integrate all the information obtained from the subsoil and manage it in such a way that new information is obtained through the interrelation with other data sources such as those obtained by geographic information systems (GIS) technology, remote sensing or geochemical analyzes (Figure 3). As an example in this presentation, we will use a computer application called RECMIN.

RecMin© (Mining Resources) is a complete package of programs, in demo and commercial versions, designed to manage research projects and exploitation of mineral resources. RecMin© is a set of integrated and interrelated computer tools developed by Dr. Cesar Castañón Fernández, which has been implemented in several mining companies and universities around the world. This computer tool can be downloaded for free from the Internet, and it is also being updated and improved frequently(www.recmin.com).

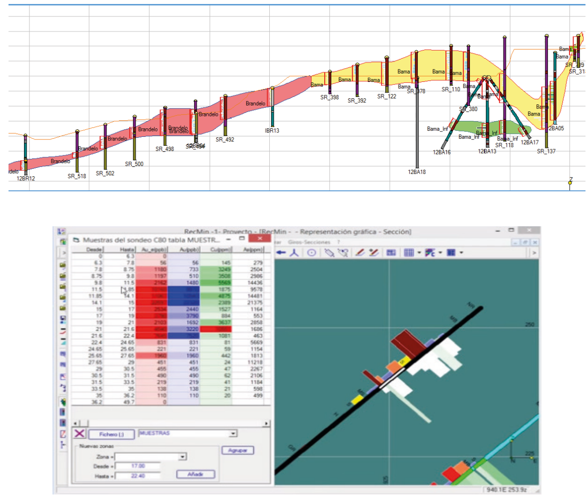

Figure 3. Representation of geological profile from drilling data (RECMIN©).

With the advantage of the open format of its files, a new viewer has been developed to view mining projects in 3D (figure 4).

The development objectives were the following:

- Use of open format files to read the objects to be represented.
- Simplicity in program management to move, rotate, zoom objects with simple movements of the computer mouse.
- Possibility of modifying other options, such as the intensity and direction of the light.
- Able to select transparent objects individually, modifying the degree of transparency.
- Capable of smoothing surfaces and volumes represented by triangulation.
- Able to add new files to the same view.

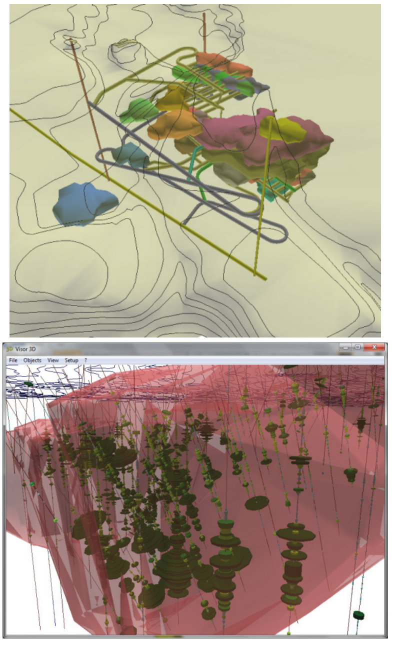

Figure 4. 3D visualization of subsoil mining works and drillings with lithological information (RECMIN©).

TEACHING EXPERIENCE OF COMPUTER APPLICATIONS IN MINING

Teaching is an arduous task in all subjects, but in an area as young as computer applications dedicated to a specific purpose, it causes the student to lose interest and motivation in learning.

During several courses, the experience accumulated in teaching computer applications or tools has allowed us to define an optimal way of teaching.

The teaching methodology begins by showing the student the result of what is going to be taught. Fortunately, nowadays visualization plays a very important role in our society. Therefore, the presentation of the result that is intended to be obtained has allowed us to verify that it maintains interest and motivation for learning.

Our teaching experience has shown that its study requires that students acquire an adequate level of skills in spatial vision and understanding of geology subjects and those related to mining and mining exploitation. An important aspect is to implement the teaching methodology called the case method.

Small subsoil research projects are taught, showing how and in what quantity and quality the necessary data is obtained and subsequently reorganized in databases.

Lastly, and very important, it is to teach students where and how to locate the abundant information that for years has been accumulating and making available to users on the web pages of the Internet.

CONCLUSIONS

1. The development of the mining industry requires the implementation in university studies of subjects related to the digital processing of information, through the teaching of computer tools that speed up the processes of exploration and exploitation of new mining resources.

2. 2. Computer technology has managed to reach high levels of sophistication, to the point of having absolute control when it comes to the storage, management and visualization of the subsoil, being today one of the most promising industries.

3. These tools allow you to speed up work in data management and allow you to discover and correct errors made, applying effective work time to tasks of interpretation and added value of the work.

4. Due to its high cost, only some high-level companies can afford to purchase it. On the other hand, the long training periods of the operators of these tools mean that it is necessary to incorporate specialized personnel.

PERMISSIONS FOR THE INCLUSION OF CONTENT FROM OTHER SOURCES

The people who hold the authorship of this work claim to have the appropriate permissions, in writing, for the inclusion of images, drawings, tables, graphs and/or any other visual or textual element that is not their property. They assume any violation that may be made regarding authorship or copyright rights. Likewise, they release the Atena publishing organization from responsibility for any violation of legality with respect to the contents of this work.

REFERENCES

- Jimeno, L. (2000). Manual de Aplicaciones Informáticas en Minería. Editorial: Entorno Grafico. Madrid.

- López Jimeno, C., & Bustillo Revuelta, M. (1997). Manual de evaluación y diseño de explotaciones mineras. Gráficas Arias Montano. Madrid.

- Luengo-Padrones, I. (2013). Estudio exploratorio de la calidad de los recursos TIC en la Red para su posible aplicación en las clases de Geología de Bachillerato. Tesis de Master. Facultad de Educación. Universidad Internacional de La Rioja. 51 p.

- Marchamalo, M., de Navascués, I. M. P., Pérez, E. S., & Marín, R. M. (2010). Geología aplicada y geomática: experiencia docente de integración en el currículo de ingeniero civil. In Actas de las I Jornadas sobre Innovación Docente y Adaptación al EEES en las Titulaciones Técnicas (pp. 163-166). Godel Impresiones Digitales, SL.

- Nieto Masot, A. (2010). El uso didáctico de los sistemas de información geográfica en el Espacio Europeo de Educación Superior. Tejuelo Vol. 09, nº 1.

- Oliver, C., & Naval, M. L. (1997). Ordenador como herramienta auxiliar en el laboratorio de Geología en Educación Secundaria. Enseñanza de las Ciencias de la Tierra, 5(2), 159-164.

- Riquelme, A., Cano, M., Tomás, R., Jordá Bordehore, L., Santamarta Cerezal, J. C., Pastor Navarro, J. L. & Murcia Alcaraz, I. (2016). Uso de información digital 3D en la parte práctica de la asignatura Geología Aplicada a la Ingeniería Civil.

- Riquelme, A., Cano, M., Tomás, R., Abellán Fernández, A., & Santamarta Cerezal, J. C. (2015). Desarrollo de aplicaciones informáticas con fines docentes en el campo de la Ingeniería del Terreno.

- Pardo Santano, P., & Redondo, M. R. (2001). El uso didáctico de los programas de simulación y su aplicación en la enseñanza de las Ciencias de la Tierra. Pulso: revista de educación, (24), 47-58.

- Ulloa, A. (2014). Nuevas herramientas, tecnologías y técnicas aplicadas en las ciencias geológicas: Panorama actual y perspectivas futuras. Revista Geológica de América Central, 187-200.