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MODERN TRENDS OF GEODETIC MEASUREMENTS IN THE UNDERGROUND MINE "SASA" OF LEAD AND ZINC ORE

Abstract

This paper gives an overview of development the modern trends of geodetic measurements in the underground mine of lead and zinc ore "Sasa" in Makedonska Kamenica. The precise geodetic measurements are of crucial importance, especially in the mines with underground exploitation. The precise geodetic data have a very big impact on safety in preparation the underground mine facilities, as well as in every working process in the mine exploitation.

Keywords: *geodesy, mining, measurements, instruments*

INTRODUCTION

The application of geodesy in mining, especially in mines with underground exploitation, with all its specificities is a big challenge for any surveyor in every sense of the word. All the measurements, calculations, tools and displaying the measured data in the underground mines, are not very different from those methods applied on the surface. The difference is that the conditions, in which the measurements are carried out in the underground mines, require full attention of the surveyor both in terms of safety for him and his co-workers as well as for the equipment.

1 DEVELOPMENT OF MODERN TRENDS OF GEODETIC MEASUREMENTS IN THE UNDERGROUND MINES

The faster development of computer technology, as in all areas of everyday life, inevitably brought revolutionary changes in geodesy. These development changes are not only in geodetic measurement technology, but also in processing methods and how the data is displayed. Surveying instruments are themselves mini computers with their speed and accuracy allow skipping and acceleration of many steps leading to the final product (maps and plans). All this developments greatly facilitate the work of surveyor and reduce the required to spend in the underground mining facilities to carry out the necessary measurements [3]. As the main representative of the new technology, the total station LEICA TCR (800) (Figure 1), which fully meets all needs of the surveyor in performing the geodetic measurements in the underground mines [1]. The underground mine "Sasa" use this total station LEICA TCR (800) for geodetic measurements (Figure 1).

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Figure 1 *Total Station "LEICA TCR" in the underground mine "Sasa"*

2 APPLICATION OF TOTAL STATION "LEICA TCR" IN THE UNDERGROUND MINE "SASA"

The big advantage of using this surveying instrument is that it does not require any trigonometric forms for registration the measured values (angles, lengths), because this instrument stores, processes and outputs the obtained data coordinates and elevations of all measured parameters [2]. For the purposes of "translating" the measured data, the instrument uses the appropriate software "Leica Office Tools", which is actually a part of the whole package. The measured data from the instrument to the computer are received in the form as in Figure 2.

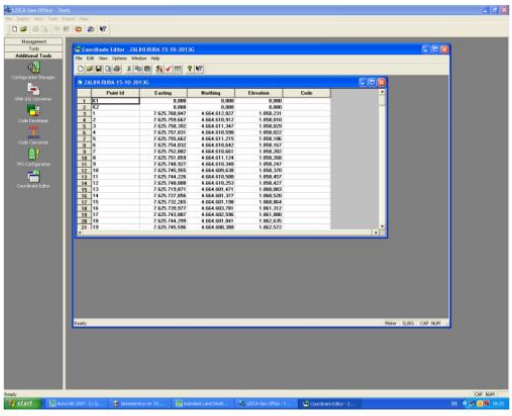

Figure 2 *Processing data from instrument using the software "Leica Office Tools"*

Furthermore, data are processed in the "Text format" and as such are imported using the CAD program; in our case it is "Autodesk Land", where in the working area of software, data are obtained in the form of: symbols, point numbers and elevations of the items in the appropriate coordinate system (Figure 3). It should be noted that in data importing, an option can be selected that includes:

1. Plane surface by omitting the elevation (H), which still remains as numerical data visible on screen
2. Three dimensional coordinate system with three coordinates (X, Y, Z).

If the elevations of points are not necessary, it is best to choose the first option because if the second option is chosen, the lengths that are measured will be inclined (not reduced) and it can give a false representation in the plane of the map or plan.

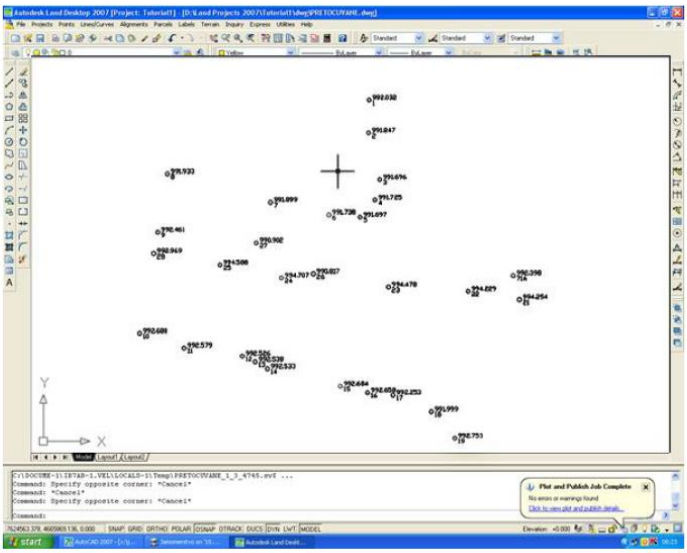

Figure 3 *Importing data into CAD program "Autodesk Land",*

With the points obtained in graphical shapes, the objects are formed simply by connecting them and thus getting a complete view of measured object, as shown in Figure 4. To connect the points with the obtained elevations and shape, the software "AutoCAD" can be used.

This method actually achieve the main goal of geodesy and its application in the underground mines, and that is to give more realistic and accurate representation to all underground mining facilities to all engineers working in the mine and to receive the quality geodetic maps in the electronic form for carrying out their obligations under the set tasks.

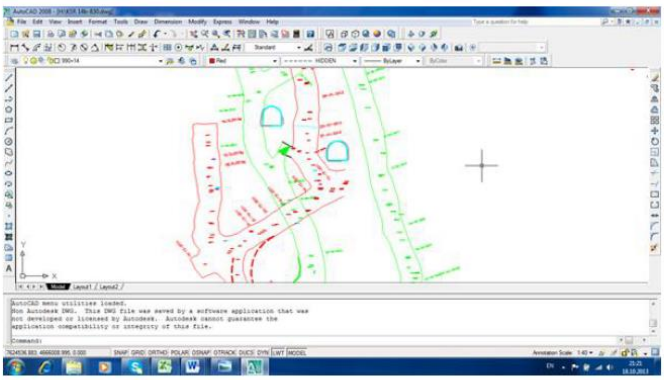

Figure 4 *Formation of objects in "AutoCAD"*

2.1 Development of Plans and Maps

Advances in preparation of maps and plans as the end products of survey are primarily the graphic accuracy of the map or plan, which was always questionable due to many reasons such as: the scale, type of paper, the method of storage, deformations of plane surfaces, geodetic instrument for drawing, etc. The electronic representation of maps or plans (Figure 4) is free from all these problems both in the preparation and in their further use.

The historical development of these plans and maps is exactly the same as the preparation of maps and plans for surface measurements, such as cadastral, urban planning, construction and other needs, starting from different types of paper, tracing paper, paper pasted on aluminum foil, to today's electronic programs for displaying maps and plans, and their quick and easy reproduction in any size (Figure 5).

Figure 5 *Maps and plotter for printing*

Although perhaps with a little dose of mistrust it may be talked about maps and plans of the past, however, these are wonderful works which are made with a lot of effort, precise standards and rules so with all of its advantages and disadvantages they are also used as needed in everyday operation [4, 5].

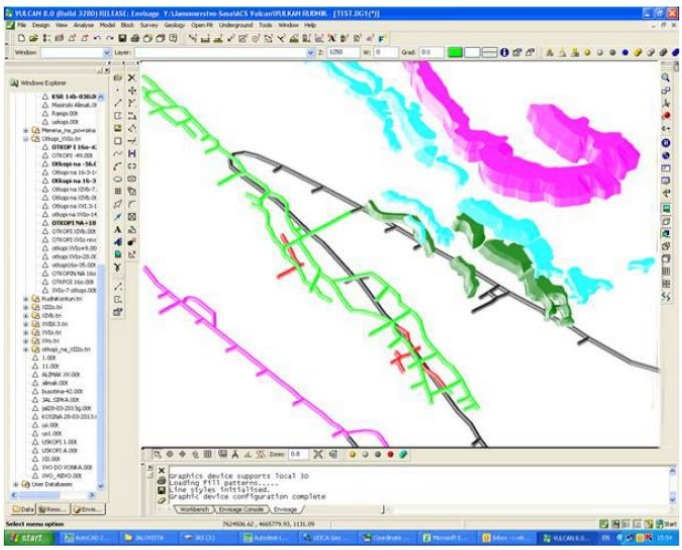

Figure 6 *Three dimensional representation of underground mining facilities*

3 THREE DIMENSIONAL REPRESENTATION OF UNDERGROUND MINING FACILITIES

Another step further to more realistic representation of underground mining facilities is their three dimensional representation (Figure 6).

From a large range of software packages designed for this purpose (PROMINE, VULCAN, SURPAC, DATAMINE and others), the initial experiences promise still more revolutionary changes in display the underground mining plans and maps. This is of particular importance because the actual representation of underground mining facilities is very important in planning of any new mining development. The underground mine "Sasa" used for this purpose in the past the software "Promine", in addition to the "AutoCAD", and today the upgraded to the software "VULCAN" [2].

Proper development of these 3D models in greatly facilitated the preparation of profiles in any given direction, as well as calculation of surfaces and volumes of the ore zones. When it talking about making the correct three dimensional representation of

underground mining facilities, it is emphasized that a care must be paid because theprograms work on their own algorithms and mathematical relations and there are often inappropriate choice of the points on which the model can give a misleading view of the object.

In the last few years, geodetic measurement technology went even further with GPS technology, which uses satellites for positioning anywhere on the earth with pretty solid accuracy (Figure 7), which, however, unfortunately cannot be used for measurements in the mines for underground exploitation.

Figure 7 *GPS satellites for positioning objects*

CONCLUSION

Despite great advances in geodetic equipment and computer technology, the fact remains that the underground mine surveyor works in very specific conditions. Today, the underground mines are much safer as opposed to years ago in terms of reliable ways for safe support of underground mining facilities, ventilation, safety measurements at work, etc., but we must unpredictable nature of all underground mines must never be forgotten.

However, the thought of being able to see parts of the planet that were created millions of years in the past, causing a certain amount of excitement and privilege to see things that few people can see. In some cavities between the ore zone there are beautiful crystals that cannot be described in words and forms that geometry that does not know.

It is interesting that even in the mines working people of different professions, but they are primarily the miner, and then everything else.

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