Computer Aided Evaluation of a Magnesite Ore Body

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ABSTRACT: The geology and mining system (JMS) is a computer aided valuation system capable of generation of survey, stratigraphy, assay databases, drill hole and bench compositing, 2D and 3D log sectioning, contouring, 3D surface generation, cross-sectioning, 3D ore body modeling, designing of open pit, volume and reserve estimation and economical valuation. In this research, JMS is applied in evaluation of a magnesite ore body in Kütahya, Turkey. Thirty-seven drill holes are used to build a collar, geology and assay databases. Basic statistical analyses are followed by drill hole and bench composite calculations. Besides, variogram models of thickness and grade are generated. Topographical elevation, ore thickness and grade contours are drawn as well as 3D surfaces. Ore body is also modeled in 3D and reserve amount is estimated. Regarding ore extensions, an open pit is designed in which pit volume and included ore are also calculated.

1 INTRODUCTION

Computer aided valuation and mine design systems provide great facilities in project development and planning. There are many commercial software systems integrating geological assessment and mine planning and design utilities (Surpac, 2003; MineSight, 2003; Gemcom, 2003; GDM, 2003; Techbase, 2003; Datamine 2003; Lynx Mining, 2003; Minex, 2003). The Geology and Mining System (JMS) is a new program package for mine valuation and design, including fundamental functions of commercial systems (Erarslan, 2003). This system has been developed for educational purposes. However, it provides the utilities to some extent that widely used systems provide (Fig.1).

Figure 1. Cover of the JMS 1.0 (Erarslan, 2003)

Main functions of the JMS for open pit mine fields are given below:

- Drill hole database building including topography, stratigraphy, and assay databases,
- Drill hole and bench compositing,
- Drill hole log sectioning and three dimensional drill hole sections,
- Topography, thickness and grade contouring,
- Three dimensional surface modeling,
- Taking parallel sections through surfaces,
- Three dimensional ore body modeling,
- Volume and reserve calculations by several methods,
- Basic statistics and variogram modeling,
- Open pit design,
- Calculating excavator-truck fleet and dragline bench dimensions,
- Economical assessments (such that net present value, future worth, etc.).

Graphical outputs of the system are displayed in drafting packages such as AutoCAD, 3D Studio MAX, Bryce, etc.

In general speaking, the system provides computer aided valuation of geological data. Geostatistics, inverse distance square methods are employed for spatial data estimation.

The JMS field application is realized in the valuation of a magnesite field in Kütahya, Turkey.

2 DESCRIPTION OF GEOLOGY AND MINING SYSTEM (JMS)

Reliability of a valuation system is strictly related with a correct database. The JMS has an easy and practical database generation utility (Fig. 2).

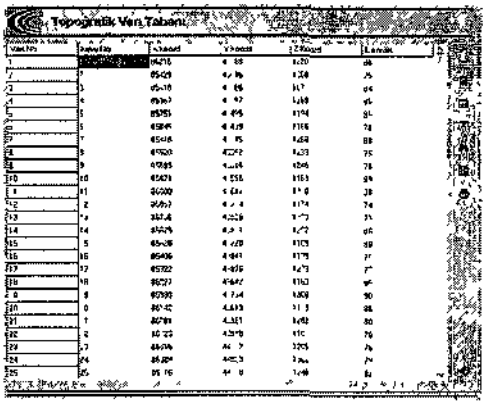

Figure 2 Database generation utility of the JMS.

Drill holes collar coordinates, lithological data, and assay values are recorded in different files.

In the system, compositing are performed both along drill hole and bench levels. Bench composites are also the base for ore body block modeling.

Drill hole sections could be taken entirely in 3D or hole by hole in 2D. Besides, the JMS enables drawing of contour maps of topography, ore thickness, grade and any other parameter that user desires as well as drill holes location maps.

The system provides three dimensional surface drawing utility (Fig.3). Topography, thickness, grade surfaces could be visualized as well as surface of any other parameter defined by user. Successive cross-sections could also be taken through a particular direction. In case of having a vein type ore body, geological cross-sections could also be taken.

The JMS provides three dimensional ore body modeling ability. This could be realized by combining successive parallel geological cross-sections or block modeling (Fig.4). Block modeling is based on bench composites while geological sections could be determined in the section editor of the JMS. Both approaches give volume icport about ore body.

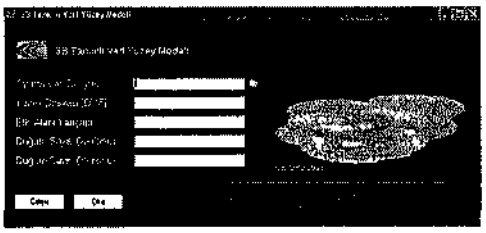

Figure 3 Three dimensional surface modeling

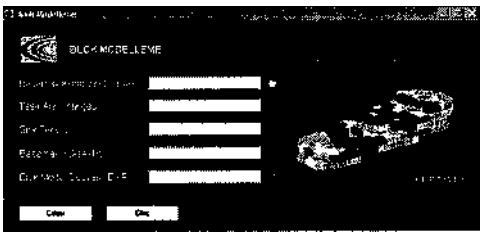

Figure 4. Block modeling utility of the JMS.

The system estimates ore volume and reserve by using several methods. Volume between geological sections, volume by average ore thickness and ore body limits area, block model volume and volume by grid polygons are approaches used in volume and reserve estimation.

The JMS provides basic statistics about drill holes, ore thickness and grade. Besides that, variogram model could also be developed. Open pit design is another utility provided by the JMS (Fig.5).

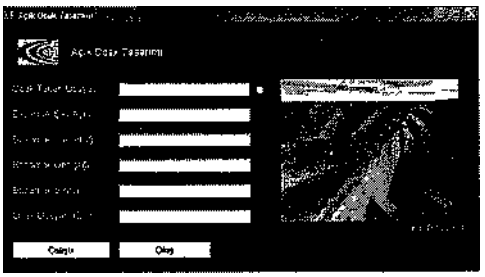

Figure 5. Open pit design uuhty.

After studying contour maps, 3D models and ore limits, a pit base could be introduced to the system by the polygon editor. It is also available that open pit and ore body could be displayed together so that design of pit could be examined (Fig.6).

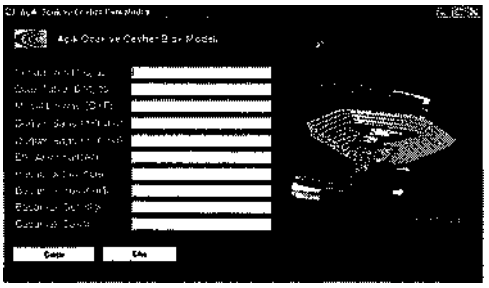

Figure 6 Open pit and ore body.

Besides, the JMS provides utilities for computation of blasting holes geometry, excavator-truck numbers and dragline bench dimensions. Additionally, basic economical assessments could also be performed on mine projects by calculation of net present value, future value, annual value and project rate of return (Erarslan, 2003).

3 USING JMS FOR MAGNESITE ORE BODY

The JMS is applied to a magnesite ore body in Kütahya, Turkey. Collar, stratigraphy and assay data of 37 drill holes with were used to build the database. The drill holes are located along South-west to North-East.

The statistics utility of the system reports the total depth of drill holes as 2216m. Minimum and maximum values for coordinates, thickness and grade and Skewness and Kurtosis values are also reported. Additionally, histograms are drawn for grade and thickness (Fig. 7).

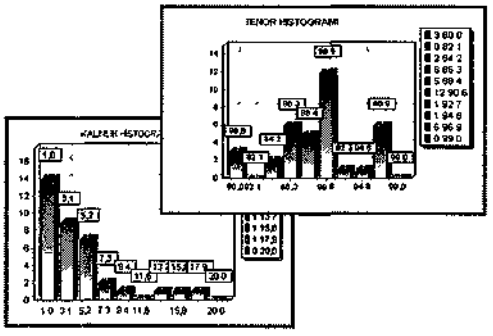

Figure 7. Histograms of grade (upper) and thickness

Basic Statistical assessments are supported by geostatistical valuation. Variogram models for topographical elevations of drill holes, ore thickness and grade are developed (Fig. 8).

Radius of influence is estimated to be 120m within an isotropic structure regarding the variogram model. This radius is used in estimation of several parameters at grid nodes and blocks. Estimation method is inverse distance square interpolation.

As well as each drill log could be represented with collar, stratigraphy and assay details, all drill logs could also be represented in three dimensions (Fig. 9).

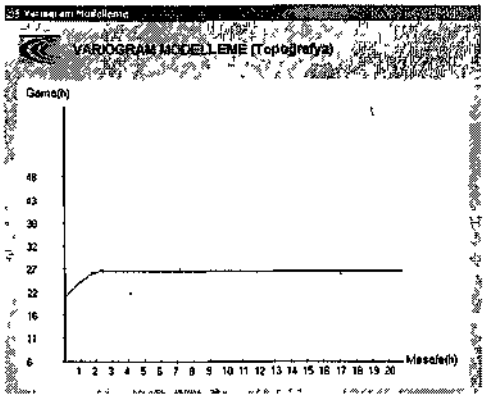

Figure 8. Variogram modeling

Figure 9 Drill logs in three dimensions.

The contour maps of topography, thickness and grade are drawn. The maps are shown in Figure 10 successively.

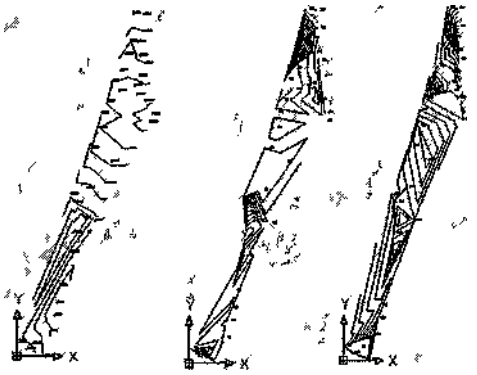

Figure 10 Topographical, thickness and grade contour maps

Topographical contours are ranged between 992 to 1026m, while thickness varies between 1 to 20m and grade changes from 80% to 90% Contour maps are also supported by three dimensional surfaces (Fig 11)

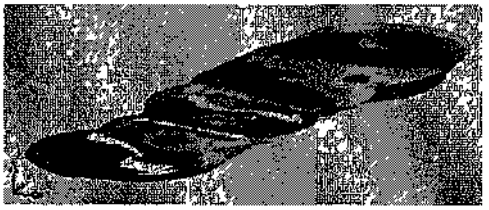

Figure 11 Topographical surface

Following surface generation, parallel surface sections and geological sections are taken (Fig 12)

Figure 12 Geological sections in y (Noıth)-dırectıon

Three dimensional modeling of ore body is crucial in valuation Hence, ore model of the magnesite body is also generated and visualized (Fig 13)

Figure 13 Ore body block model

Regarding ore limits, a pit is designed with 10m bench height and 70° bench slope angle (Fig 14)

Figure 14 Open pit design

Generated pit and ore body model are represented together to observe their interaction (Fig 15)

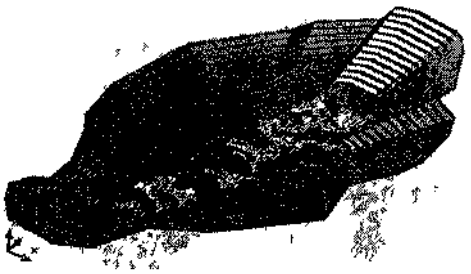

Figure 15 Open pit and ore body block model

Besides, numerical results are handled, too Using variogram modeling, radius of influence is found to be 120m The area that ore body extends is 359978 53m^2 Average ore thickness is 5 31m Volume of ore body is estimated as 1,485,045 75m^3 by block model method, 1,909,886 00m^3 by ore limits area and average thickness approach and 1,820,971 12m^3 by grid polygons (100x100) method

4. CONCLUSION

In this study, the JMS software package for mine valuation and design is applied to a magnesite field in Kütahya, Turkey. Thirty seven drill holes are used to generate the database. Holes logs are drawn one by one in two dimensions and entirely in three dimensions. Drill hole and bench composites are calculated. Contour maps of topography, thickness and grade are drawn as well as three dimensional surface generation and cross-sectioning through mem. Besides, following the three dimensional ore body block modeling, open pit is designed. Ore volume and reserve are calculated by several methods.

NOTE: The JMS (Turkish Version) is available at http://mf.dumlupinar.edu.tr/JMS

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