IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

OREBODY MODELING AND RESERVE ESTIMATION BY USING SURPAC

P. TAVITI NAIDU[1], K. VINEETHA[2], P. JEEVESH[3], C. PAVAN KUMAR[4], K. SAI TEJA[5], MD. MOMIN ALI[6]

[1-6]MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS), MAISAMMAGUDA(H), GUNDLAPOCHAMPALLY VILLAGE, MEDCHAL-MALKAJGIRI (DT), TELANGANA (S), INDIA

Abstract:

Generally, the size of the database is just too bulky to manage studies with hand effort. Thus, numerical algorithms and mathematical approaches necessitate computer applications to beat huge computational time and processes. Currently, many computers aided systems and software for geological modeling. The accuracy and speed of computers enable the evaluation of varied scenarios within reasonably short times in this technological world. Computer systems have been demonstrated very essentially for mining and geological studies. With the help of a mine planning and design software SURPAC, a geological database of Gold ore was created. The coordinates and alignment of the borehole points and their constituents and their grades were fed into. The deposit which has been studied is Gold ore. Block modeling was done with the help of a downhole composite and the volume of the total block model was also calculated. Geostatistical analysis of the database data, and the estimation of the block model using the sample grade or bodyweight value. Thus, we can ensure that the analytical calculation results are in a reasonable estimation process.

Keywords:

Block modeling, Geological database, Reserve modeling, Reserve estimation, SURPAC.

1. Introduction:

The advancement in computer technology has started the development of software applications. SURPAC is one of the software applications that was developed to be used in the mining industry. This SURPAC software should be addressed by a specialized staff composed of mining engineers, surveyors, and geologists. Each of them has a separate module dedicated. The surveyors create a Digital Terrain Model (DTM), geologists create a digital model of the deposit, and mining engineers use it to estimate the production of useful minerals. Underground minerals, metals, and nonmetals are invisible whose shapes, quality compositions, and quantities are not known. Geological explorations and investigations aimed at determining the unknown minerals and metals.

At the start of the process, topographical and lithology data are gathered and a database is generated by using SURPAC. Depth, thickness and grade changes, ore volume, shape and extensions, and properties are determined by mathematical and algorithm approaches using this database. All numerical estimations are used to get out visuals to bring out ore body model. The concrete data to define the shape, location, quality, and quantity of an ore body is by bore cores. GPS data is usually taken to draw topographical maps and surfaces. Underground maps like thickness and grade contours are drawn also. Topographical coordinates are combined with stratigraphic information, a 3-dimensional data set is handled. After following several mathematical techniques, 3- a dimensional ore body model is often obtained. Besides the physical ore model, the quality composition should even be known.

This is often crucial because further engineering activities have a cheap aspect to perform. With the known volume of block properties like thickness and grade of ore at each particular block, it becomes possible to convert this information to an economical aspect. (Volume × tonnage factor × grade = block reserve.) Surveying includes 3-dimensional components x, y, z (easting, northing, elevation) which are used for surface modeling. Drill hole data depth and layer information contribute to explaining how the geological structure is in the three dimensions. Drill holes also carry the knowledge about ore grade. Geological interpretation of stratigraphic layers provides a 3-dimensional ore body model.

2. Area of study:

The studied area for this project is a Gold ore mine. The geological data of a bounded area has been provided for this project work.

3. Future scope of work:

- With the help of the three-dimensional model, it will be very easy to calculate ore reserve estimation by the options available in SURPAC under the design menu.
- Eliminating the process of drilling the excess amount of overburden, which reduces the economy and time-capital.
- Enables mining practitioners to quantify and evaluate mineral deposits and to plan the efficient extraction of reserves.

4. Methodology:

To fulfill the above-said objectives, the following methodology has been adopted:

i)Literature reviews – Collection of all the past research works done by numerous academicians/researchers/scientists from both national and international.

ii)Data collection and preparation – my Survey data has been accumulated to import into the software (SURPAC) for the preparation of the geological database.

iii)Investigation – The investigation was carried out in different stages:

- Firstly, preparation of the geological database is done.
- Displaying all drill holes from the imported data.
- Sectioning of the drill holes was studied and analyzed.
- Formation of an orebody is done based on the position of drill holes.
- Estimation of the reserve of the gold ore body.
- Mathematical and Statistical analysis were analyzed accordingly.
- Grade estimation is done through various methods.
- Determination of the cut-off grade of the ore is determined.

iv)Design and analysis –

- A 3-D Block modeling of the ore body is obtained.
- Application of cut-off grade for the identification of ore is determined.
- Mining blocks graphically analyzed.

5. Results and Discussions:

5.1 creation of geological database:

The database creation procedure mainly includes collecting all exploration data in the mining area. The geological data includes trenching, drilling, and exploration results which can be used for recording the distribution of lithology and geological disturbances through geological logging, and then importing the data into Surpac to establish a 3D geological database with proper format. The use of geological databases to store geologically relevant information can establish a 3-D geological model of the mining area more accurately, completely and construct the foundation for subsequent resource estimation. In this paper, the relevant geological information of 94 boreholes in the mining area was collected, and four basic tables such as the collar, geology, sample, and survey tables were established. Among them, the collar table mainly comprises the collar coordinates of the borehole, drilling depth, drilling type, drilling time, and hole path; the geology table includes about the drilling depth, rock, hole_id, sample_id; the sample table mainly includes about the hole depth, gold, sample_id; the survey table mainly includes the azimuth and dip of the drilling and the depth of the inclination.

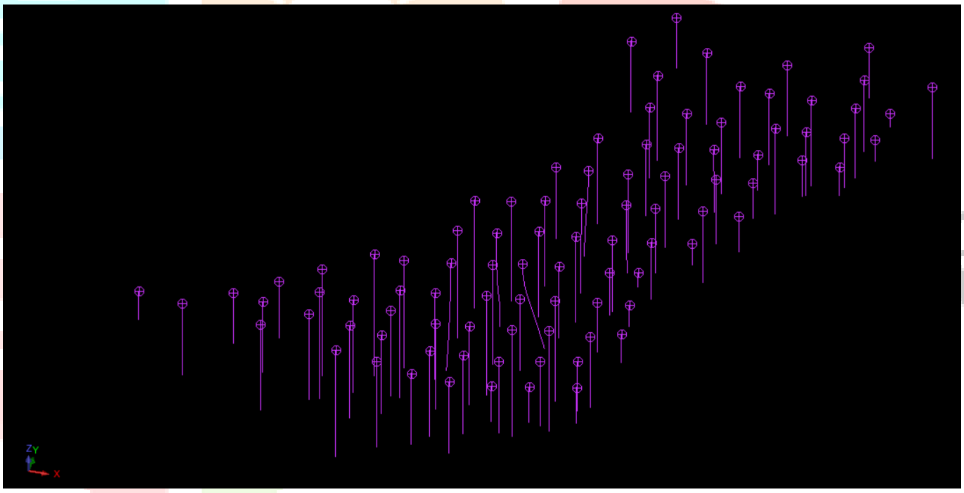

Figure-1 creation of a geological database

5.2 Study about the drill holes:

Once the whole data has been processed in the software, the drill holes can prospect as shown in the figure. Once the drill holes have been displayed, the geology orientation and the lithology are distinguished by using color variants. The mineral concentrations down the borehole are differentiated with different colors. These particular values have come from the sample and geology tables. As the gold ore body has the major mineral is gold. Once the borehole has been exhibited, the surface condition has to be known, and the ore body has to be generated to know the volume of ore which is also known as reserve estimation after compositing has been done. The surface conditions cannot be predicted from the known boreholes.

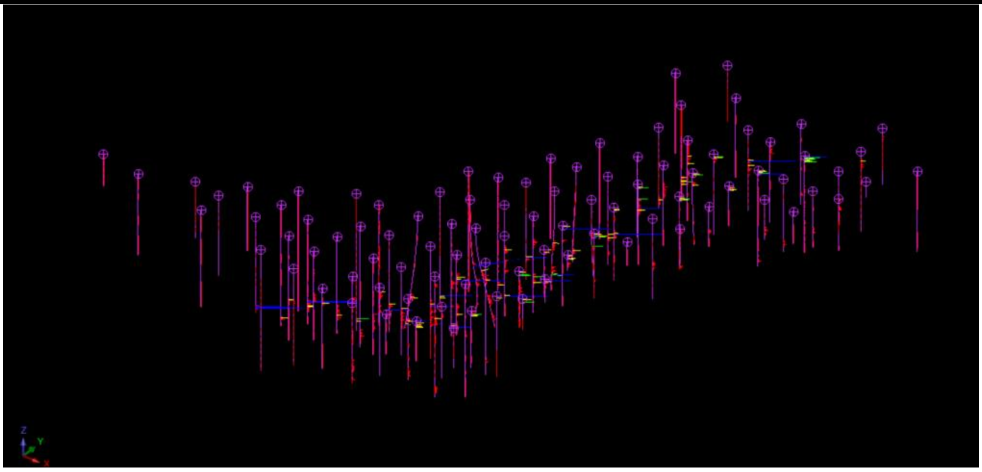

Figure-2 Displaying the drill holes of the geological database

5.3 Analysis of drill holes by creating strings and intersecting them to form an orebody:

In Surpac, string data are always raw point and line data. All data are stored as strings. A string is an order of three-dimensional coordinates representing some physical feature. As drawn lines in a sketch define vital features, so too do strings. Related strings are stored together in ASCII files called string files, recognized by a .str extension. A string file can include up to 32000 different strings. Each file is recognized by a two-part name - the two parts are nominated separately in practice, but they are combined to form a filename acquired to the computer on which the software is being run. Here the first part is called the Location code. This is an alphanumeric character identifier usually chosen to specify what the strings in the file represent, e.g. contour, borehole, etc. A second part is an ID number defining the file as a member of a set of files. This is a numeric character identifier.

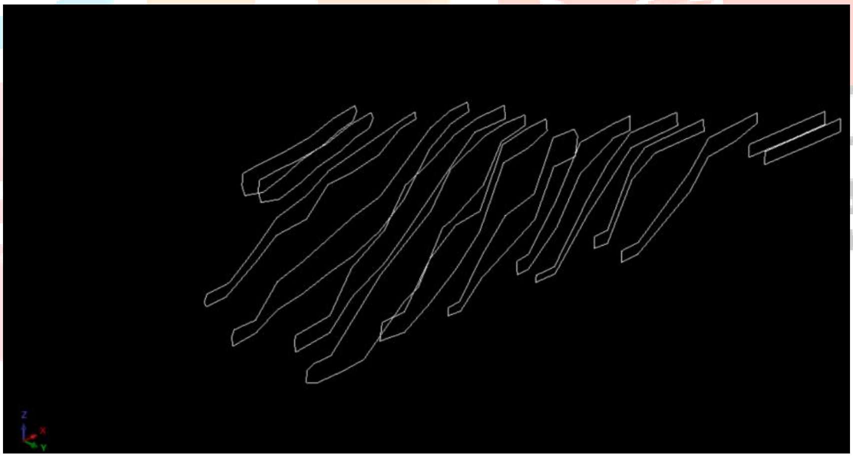

Figure-3 Creating strings

5.4 DTM's (Digital Terrain Models):

Digital Terrain Models or DTM's are how Surpac models surface. Surfaces are used in Surpac for such things as 3D visualization and estimation calculating volumes. Almost any superficial feature can be modeled as a DTM: natural topography, lithological contacts, bedrock/overburden contact, or water table are such kinds of examples. DTM's should come from String data. Where string files contain the raw data, whereas DTM files contain a mapping of trios of points in the String file that constitute a triangle. DTM's are made of triangles, with each point of each triangle equivalent to a point in the original String file. Accordingly, DTM files are not valid without the original String files. That is, a DTM file cannot be opened if the original String file of the same name does not exist in the database.

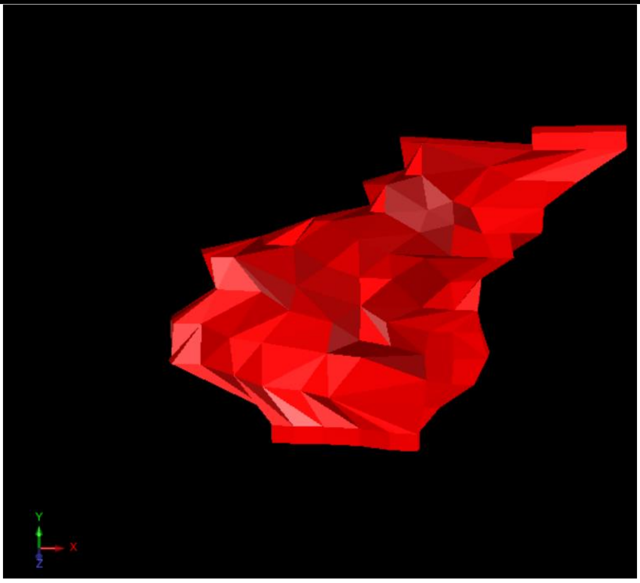

Figure-4 DTM(Digital Terrain Model)

5.5 Block Modeling:

The Block model is a form of spatially-referenced database that provides a means for modeling a 3-D body from point and interval data such as drill hole sample data. The Block model comprises interpolated values rather than true measurements. It provides a method of estimating the volume, tonnage, and average grade of a 3-D body from sparse drill hole data. From the available exploration data, a geological database is created to determine the extent of ore deposits and characteristics. The borehole data are composited to use to find geo-statistical values of the deposit. The boreholes are displayed based on the collar values taking into account the coordinates. It only involves the extent of the ore body. To design a block model of the ore body, constraints must be added to it which is the solid model itself. After the constraint has been connected a block model of the ore body is created. A full-body volume analysis has been done of the created block model to compare between the volume of the ore body which has been determined earlier and the volume of the block model of the ore body. It has been strictly advised that the difference in the volume of the block model and the solid model should not exceed 1%. The above block model is also known as the parent block model. Here to view the ore body block model, the constraints must be added every time. If saved also it cannot be saved as the constraints have not been inputted in the database of the block model. Accordingly, a constrained block model has been created taking the input from the solid ore body model and saved to get the block model in the shape of the ore body.

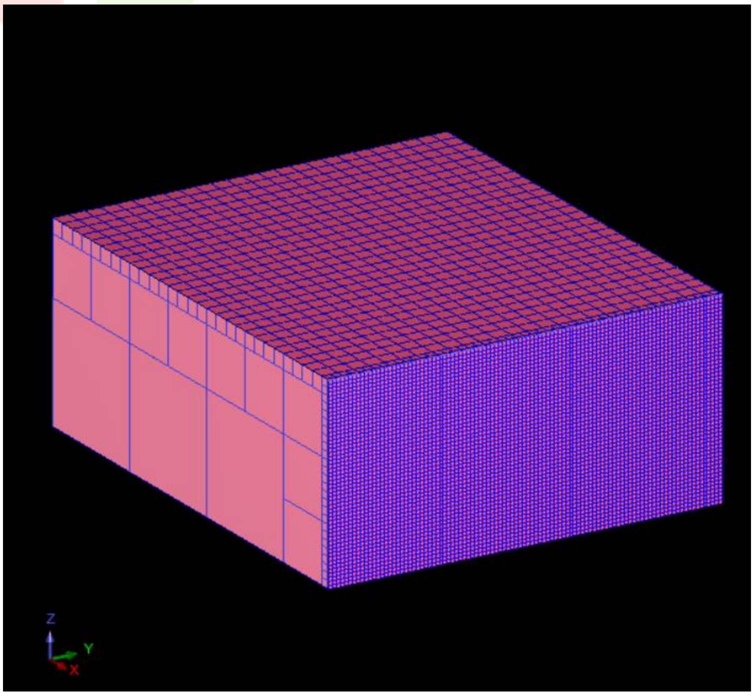

Figure-5 Display of Block modeling

5.6 Solid Modeling:

Here the process has executed the development of the ore body. The ore body has been developed from the boreholes through frequent sectioning and digitizing of the boreholes. To prepare an orebody, several sections are developed, and all the sections are joined together using a triangulated method to generate an orebody. Prior to the development of the ore body, it should be known that all the boreholes have not been useful in the evaluating and estimating of the ore body as they contain less percentage of mineral concentration that has to be mined. The calculation of the ore body is completely dependent on the user of the software. During sectioning, firstly, a section has been defined and then a row of boreholes has been set for digitizing. Through computerization, the volume of ore to be mined has been determined. Some boreholes have been exempted from sectioning. This means that the grade of the mineral which will give profit is quite less or absent. So, it could increase the cost of extraction adding to the overall cost of mining. After sectioning a row of boreholes the section has been saved, and then the sectioning of the next row is carried out. All the section files have been saved in the same file initiating it each time. After sectioning all the boreholes have been done and saved which is in the form of a string file. These are the segments that have been evolved by the sectioning and digitizing of the boreholes. The following work is the development of the required ore body by joining the segments, but before this, the interior of the segment has been triangulated, and then between the segments has been triangulated to create the final ore body. But once the triangulation job has been done it requires justification so that it does not have any error in triangulation. Sometimes triangulation gives an error due to the generation of open segments. The triangulation inside the segment has assured that the segment is closed. If the justification becomes false, the area and the volume of ore cannot be determined. Thus the ore body has to be justifiable. A 2D or 3D grid system can also be executed to know the layer extents of the ore body where Max Z value- (-20.442m) and Min Z value- (237.734m). Once the ore body has been developed and validated, the calculation of the area covered by the solidified ore body and the volume of ore can be determined, and the report has been saved in '.pdf.' format or any other text format that the software maintains.

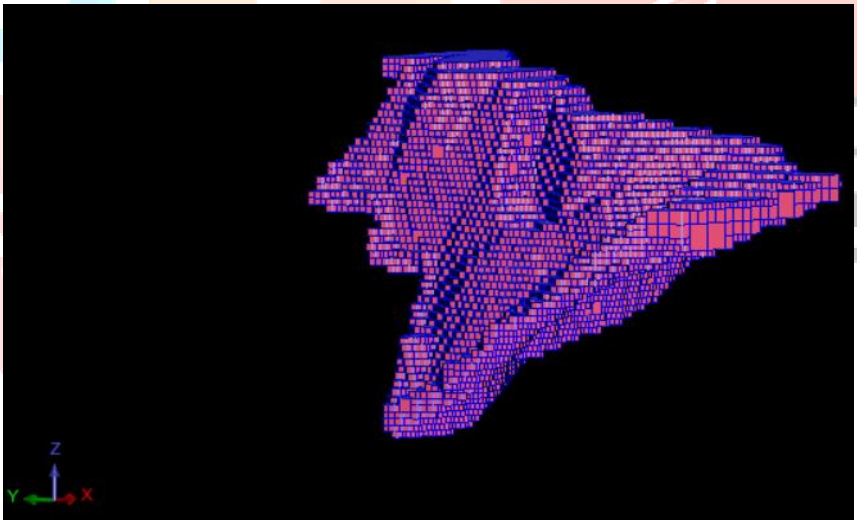

Figure-6 Display of Solid modeling

SOLID MODELLING OBJECT REPORT
Layer Name : vjpsa.dtm

Object: 8
Trisolation: 1
Validated = true
Status = solid

Trisolation Extents
X Minimum: 1402.760 X Maximum: 1976.275
Y Minimum: 7091.301 Y Maximum: 7590.869
Z Minimum: -20.442 Z Maximum: 237.274
Surface area: 357671
Volume : 3460976

Figure-7 Solid Modeling Report

5.7 Statistical Analysis:

Brief analysis in Surpac by using the mean and variance top cut diagram inside the Basic Statistics window. The diagram frames the mean against the Coefficient of Variation (COV) at various grade cutoffs, allowing the geologist to examine which cut-off will yield an acceptable COV and its effect on the mean grade. To help geologists in making these decisions, the development of a tool called the 'mean and variance top cut diagram', located inside the Basic Statistics window. The diagram plots the mean against the Coefficient of Variation (COV) at various grade cutoffs, allowing the geologist to assess which cut-off will yield an acceptable COV and its impact on the mean grade. A histogram and cumulative frequency curve will then be exhibited.

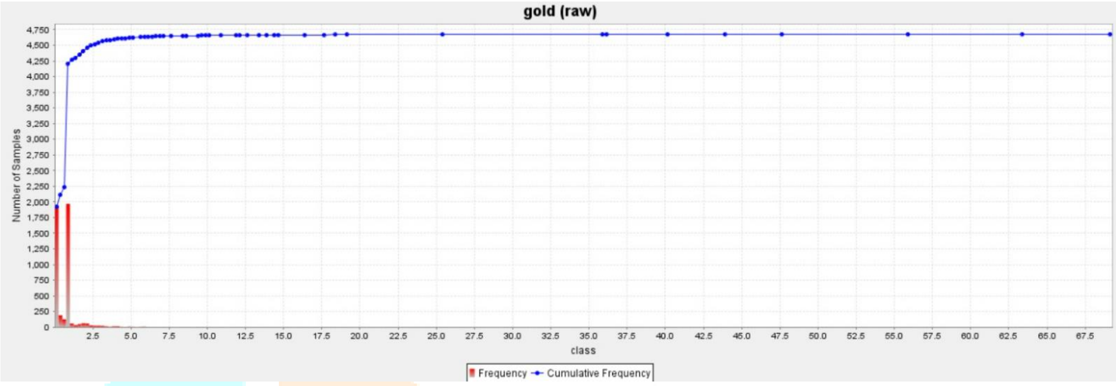

Figure-8 Statistical Analysis of Gold ore

5.8 Composite Modeling:

For grade value evaluation of the block, the model should be processed with the assay values of the mineral, but they are in a different database which is Geological Database. So the data has to be extracted from the database in a string file, and this file should be used in the 1st model of estimation. Here the samples at equal intervals should be normalized. One block will take samples at an equal interval of different samples from different boreholes by using the string file generated after compositing has been done. While processing the attributes in the table while processing the description field number appropriate to each attribute should be remembered as it will be needed for future utilization. Once the string file has been created it is used for the grade estimation of the block model. Once the process has been completed, the attributes for each block can be viewed by using the option in the drop-down menu.

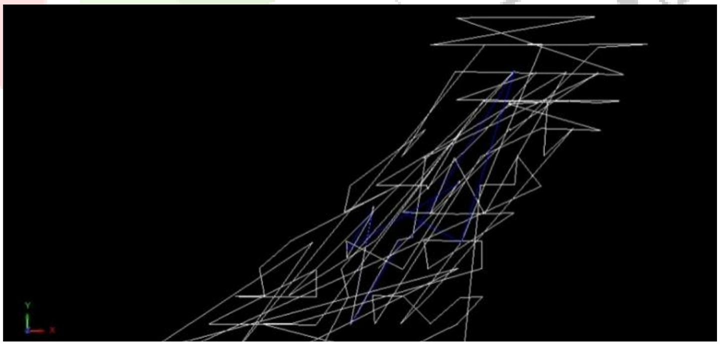

Figure-9 Composite modeling

5.9 Variogram modeling:

Using variogram modeling as a second representation of ore body grade estimation, the block model is estimated for the grade. The input file is the composite file whose variogram is to be generated. The variogram is saved and is used for grade estimation generating new attribute fields and storing the grade value in that field.

6. Conclusion:

Once estimation of the ore body has finished the report of the ore body has been generated which shows the volume, tonnage, average grade of the minerals of the ore body. Summary reports have also been generated as per attributes inputted which include calculating reserve as per depth and different mineral grades. The overall surface area is 357671m² and the volume is 3460976m³.

7. References:

-

1. Agarwal, H. (2012): Modeling of Opencast Mines using Surpac and its Optimization. E-Thesis (2012). National Institute of Technology, Rourkela.

2. Dagdelen, K. (2001): Open-pit optimization- Strategies for improving the economics of mining projects through mine planning. International Mining Congress and Exhibition of Turkey- IMCET 2001. Pages: 117-121.

3. Haldar, S. K. (2013): Mineral Exploration- Principles and Practices. Elsevier Publications. Pages: 157-182.

4. Huang, Ping, Yang, Peng, Chen, Yizhou and Chenjun, Liu (2011): "Three-Dimensional model of Cangshang Gold Mine based on Surpac." International Journal of Advancements in Computing Technology. Dec 2011, Vol3 Issue 11. Pages: 299-306 (8p).

5. Jiang, Xue-liang, Yang, Hui and Wen, Chang-ping (2013): "Excavation Simulation of Open Cut Mining Slope Containing Goaf Based On Refined Three-Dimensional Geological Model With Surpac and FLAC 3D." EJGE Vol. 18 (2013), Bund. B. Pages: 345-364.

6. Karu, V., Vastrik, A. and Valgma, I. (2008): Application of Modeling Tools in Estonian Oil Shale Mining Area. Oil Shale, 2008, Vol 25, No. 2 Special, Estonian Academy Publishers. Pp 135-144.

7. Kasmaei, Sara, Gholamnejad, Javad, Yarahmadi, Alireza and Mojtahedzadeh, Hosein (2010): Reserve Estimation of the high phosphorous stockpile at the Choghart iron mine of Iran using geostatistical modeling. Mining Science and Technology 20 (2010), Elsevier Publications. Pages: 855-860.

8. Moharaj, M. C. and Wangmo, Y. (2014): Ore Body Modeling and Comparison of Different Reserve Estimation Techniques. E-Thesis (2014). National Institute of Technology, Rourkela.

9. Roy, Indranil and Sarkar, B. C.: Orebody Modeling: An Integrated Geological-Geostatistical Approach, Department of Applied Geology, Indian School of Mines, Dhanbad.

10. Xiao-ming, Liu, Zhou-quan, Luo, Qing-fa, Chen, Xunfang, Zhang and Qing-ling, Zhu (2009): "3D dynamic monitoring of collapse area based on CMS-Surpac." IEEE Journal. Pages: 637-641.

11. Zhi-yong, Zhou, Jiang-hong, Chen and Ke-ping, Zhou (2004): "Application of Surpac Vision software in establishing a model of the ore body." Modern Mining 04-2004.

12. Zhou Quan, Luo, Xiaoming, Liu, Jiahong, Su, Yabin, Wu and Wangping, Liu (2006): "Building of Three Dimensional Models of Deposit based on Surpac." Metal Mine (04-2006).

13. Zhou-quan, Luo, Xiao-ming, Liu, Zhang, Bao, Hao, Lu and Chang, Li (2008): Cavity 3D modeling and correlative techniques based on cavity monitoring. Journal of Central South University of Technology (2008) Vol 15, Springer Publications. Pp 639-644.