Abstract
The 3D geological models are instrumental in addressing practical problems. In this study, Geological databases such as geological boundaries, faults, dip/strike cross sections and so on were constructed to build 3D geological model using the 3D GeoModeller software. Geological sections were automatically created and edited based on this 3D geomodel. Results compared to data acquired during exploitation show that 3D ore deposit models based on geological structural information were reliable, and that the geological sections generally met the need of mining engineering applications.

1 Introduction

Acquiring 3D data directly using current techniques remains a challenge. 3D models are usually created from data of lower dimension. Consequently, 3D geological modeling has recently become a core research topic. Many methods have been proposed based on boreholes (Lemon and Jones, 2003), multi-source data integration (Kaufmann and Martin, 2008) and parallel cross-sections (Herbert et al., 1995), as well as the non-stratified geological object modeling method (He et al., 2005).

The usefulness of 3D geometric modeling to better understand geology is well established (Wijns al., 2003; Wu et al., 2005). Geological structures of mining areas are three-dimensional in space. Dealing with the full dimensionality of geological data has been nearly impossible before the development of 3D software in the 1990’s. The recent development of
software for 3D reconstruction (Lynx, GeoModeller, gOcad, Earth Vision, etc) has opened new frontiers in the earth science leading to n-dimension analyses of the spatial extension of any kind of geological structure and to 3D virtual models. Today, GIS, database, and 3D visualization software are common tools used by geoscientists to image, analyse, synthesize, model, and interpret geological data (Zanchi et al., 2009).

There are many previous works in relation to the visualized 3D geological modeling of mines including the data interpolation techniques and 3D modeling of basic orebody (Wang et al., 2005). A 3D Modeling requires the ability to infer a representation of the real world even where no data are available. This representation can be the final goal of modeling or the geological model can be used to compute simulations to quantify physical processes. In both cases, knowing the geological formation at any places of 3D space is fundamental.

In this study, we tried to build the 3D geological model and to understand geological structures for facilitating mining reactivity of polymetallic mineral deposit of Wondong mining area in Korea.

2 3D Geological Modeling of mining area

A Geologist who interprets the geology of an area is typically interpolating a line in 2D or a surface in 3D such that the interpolated shape, which represents a geological boundary, fits some set of geologic observations. In order to automatically compute a model directly from data, we need an interpolator to compute surfaces which represent geological boundaries or faults.

The BRGM (Bureau de Recherches Géologiques et Minières) has developed a 3D interpolation methods to infer the 3D geometry of geological bodies known by sparse and irregularly located data. These methods use the geometric knowledge coming from the geological maps, cross-sections and bore-holes to test their geological interpretations by building a 3D geological model. In that scope, the following work has already been successfully applied to orogenic, basin and mining domains (Courrioux et al., 2001, Martelet et al., 2004, Maxelon et al., 2005, McInerney et al., 2005).

Information requested for building geological formations in 3D, and their rock relationships are recorded in the stratigraphic column, which automatically drives the relationships between multiple interpolators used to model formations, making the model easy to refine.
and to update. The major feature of the 3D interpolation method is that the 3D geological space is described through a potential field formulation in which geological boundaries are iso-potential surfaces and their dips are represented by the potential gradients (Calcagno et al., 2006). This method needs the position of the interfaces between geological bodies to be known at some place i.e. the ones given by boreholes, map and sections. It also requires orientation vectors that represent the tangential plane of isopotential surfaces and their polarity, in a geological language these are azimuths, dips and polarities of the geological structures commonly measured in the field.

The Wondong mine 3D geological modeling project was designed to understand geological structures for facilitating mining reactivity. The main difficulty of mine developer is to assess the orebody distribution and geological formation. The Wondong mine is a polymetallic mineral deposit mineralized in Pb-Zn, Fe, W-Mo and in Cu-Mo in skarn zones. It was selected to reconstruct the 3D underground geological and ore deposit structures from published geological map including cross-section maps (Figure 1).
The study area is located in the Taebaegsan mineralized zone of eastern part of Korea at 128°57′00″ –128°58′33″ east and 37°15′08″–37°16′41″ north, and covers an area of approximately 6.5 km². The Pb-Zn, Fe and W-Mo mineralizations of Wondong mine area are found in skarn zones which formed mainly in or along the fault shear zones with the N25-40°W and N10-50°E directions, whereas the Cu-Mo mineralization appeared as hydrothermal replacement zones (Hwang and Lee, 1998).
To build a 3D geological model a digital elevation model (DEM) derived from the 1:5,000 digital topography map produced by the National Geography Information Institute (NGII) of Korea has been used to define the topography of the study area and the geological map imagery (digitized from original map produced by Hwang, 1997) and cross-section images have been geo-registered and then geology observations (geological contacts and orientation data) on the map are imported into the GeoModeller software. 3D volumes of each geological body have been modeled using the structural geological map including faults, dip/strikes, fold structure (Figure 2). The structural geological data were interpolated using the potential field interpolation method and refined by modifying the interpreted data points, re-computing the 3D geological map coefficients, visualizing the map on sections and as 3D surfaces, and analyzing the resultant 3D architecture. This procedure was applied in an iterative procedure until the result was deemed to conform to the conceptual understanding of the 3D geological architecture. As the geological formations are known at any place of the 3D geometric model, any section can be easily derived. Typical sections along the orebody (skarn zone) have been constructed to quantify the location of geological bodies (Figure 2). Geological sections -are automatically created based on the established 3D geological model.

3 Conclusions

In this study, geological databases of the Wondong ore deposit located in the Taebaegsan mineralized zone of the eastern part of Korea were constructed. The geological boundary, dip/strike, drill-hole and cross-section information including faults, stratum and ore-bodies derived from published geological map were interpolated using the potential field interpolation method. Geological sections were automatically created and edited based on this 3D geomodel. Results compared to data acquired during exploitation show that 3D ore deposit models based on geological structural information were reliable, and that the geological sections generally met the need of mining engineering applications. However, when the sizes of orebodies are too small, 3D models could not meet the miner’s requirements. Nevertheless, the 3D visualization of orebody together with geological structures of the mine can greatly support exploitation process simulation, project lifecycle management and mine developments.
3D geological model of Wondong mine

Surface map representing geological boundaries, dips/strikes and cross sections

Section A-A’  Section B-B’  Section C-C’  Section D-D’
Figure 2: 3D volumetric geological model of the Wondong mining area, and typical sections along the orebody (skarn zone) have been constructed to quantify the location of geological bodies.

Section E-E’
Acknowledgements

This research was supported by the Main Research Project of the Korea Institute of Geoscience and Mineral Resources (KIGAM) funded by the Ministry of Knowledge and Economy of Korea.

References


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Paper Reference No.: PN-89
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