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Underground Geological Database Management System for Mapping Process Improvement, Case Study of Deep Ore Zone (DOZ) Mine, PT Freeport Indonesia

Harman Setyadi[1], LilikEko Widodo[2], HeriSetiono[3] ,Lasito Soebari[4]

[1]Doctorate Student, Mine Engineering Program, Facultyof Mine and PetroleumEngineering,
Institute Technology Bandung, Jl. Ganesa 10, Bandung 40132
[1]General Superintendent Geologic Data Administration & Maintenance, PT. Freeport Indonesia, Papua
E-mail: Harman.Setyadi@yahoo.co.id; Harman_Setyadi@fmi.com
[2] Earth Resources Exploration Group - Facultyof Mine Engineering and Petroleum
Institute Technology Bandung, Jl. Ganesa 10, Bandung 40132
E-mail: lew@gc.itb.ac.id
[3] Chief Engineer System Development & Management, PT Freeport Indonesia, Tembagapura, Papua
E-mail: Heri_Setiono@fmi.com
[4]ManagerUG Geology Operations, PT Freeport Indonesia M72 Office, Papua
E-mail: Lasito_Soebari@fmi.com

Abstract

The Deep Ore Zone (DOZ) is the underground (UG) mine which is located on the East ErstbergSkarn System (EESS) of Grasberg-Ertzberg Au-Cu district in Tembagapura Papua. The DOZ mine is operated by block cave mine method with average of daily production is 80 ktpd ore. Geological information is the important information required for planning, developing, and monitoring the underground mine.
This project was initiated in 2007 using the commercial database management software. The objective of the project is to establish the common and centralized underground geology data as well as improve the information transparency. Geological data recording in every draw points is to collect information of rock types proportion, grade and dilution estimates, water condition, clay contents. Solid data integration would help in 3D block model versus the drawn material reconciliation as well as mine planning processes.
The first phase of UG geology database management system was successfully to accelerate the creation of routine geological report and improve data and report quality. The second phase of this project was designed to integrate the geo-science data for UG operation support. The paper will be devoted to the management system of geological data collected from production in order to map the characteristics of rock. This may subsequently be used in order to improve all processes including mine planning, production scheduler, draw order, mud rush potential anticipation and mud rush mitigation.

Keywords: *Deep Ore Zone (DOZ), Underground Mine, Database management*

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1. INTRODUCTION

Geological mapping commonly consists of observation of lithological, mineralogical, alteration, and structural aspect. All geological aspect should be recorded using specific techniques and may use the specific recording data sheet, which traditionally using paper sheet. Different Geological information may be collected and recorded by same geologist or different geologist, in the same time or in the different time.

Finally all different data or information should be integrated on the mapping system. Geologists with their geological and or body of knowledge will evaluate and interpretto the geological information (Kenneth, 2012). In the mine operation, support geological information should be converted to the mine support requirement that is included but not limited for the lithology and/or metallurgy characteristic, grade distribution, and geotechnical support.

The Geological mapping process from field data observation, recording, compiling, integration, evaluation and reporting are traditionally required a long time and prone some inconsistent data and missing data. The objective of the data management is to create the standardize data collecting and data recording procedure to establish the common and centralized underground geological data. Centralized data will avoid potential redundant data source for the different data used as well as the data versioning.

Information transparency is assuming that all data was recorded properly in the timely manner. All data or information should be put and published in the integrated database system so the geologists (users) areable to access the data collected byothers geologists and/or other from different data sources related to the geological aspects as well as mine operation.

2. UNDERGROUND GEOLOGICAL SUPPORTS

The main support of underground Geology to the DOZ underground mine is included but not limited for daily, weekly and quarterly support. Daily geological support consistsof: 1) face mapping for development daily observation report of lithology, structural and ore-waste mapping; and acid rock drainage (ARD) assessment from the geological mapping; 2.) daily drilling progress report as quick logging, which was reported for the general geological condition including structure estimate grade, structure, RQD and ground condition assessment for pilot hole; 3.) weekly underground geology support is mainly related to the DOZ underground mine production by means regular weekly draw point geological mapping.

3. UG GEOLOGICAL DATABASE

Underground Geologistsare generally conducting several different mapping and/or data collecting for the geological propose as well as for the mine operation supports. Every mapping task may be conducted by different geologist,they should conduct single or multi-tasking works. The example of single mapping is to do the geological and structural mapping along the development drift. However, in some cases this task should be combined with the geological sampling. Different data type should be recorded in the different format as well as different data storage procedures. Geological draw point mapping is commonly combined to record the fragmentation as well as the wetness condition.

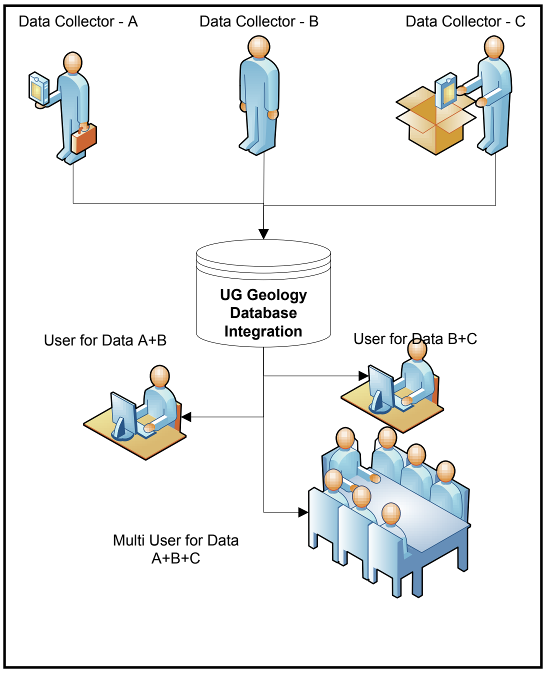

Figure 1: Generalized UG Geological data collecting, database storage and data users.

Figure 1 present the generalized UG Geology data flow. Different data form and different data collecting with potentially have different data format suggested recorded in the single integrated database. User may use only single information or may need combined information collected from different data sources. They also potentially want to visualize several different types of data in the 2D and/or 3D GIS model to evaluate the geological and/or mining status progress. To meet this requirement database system should be developed in flexible way to meet user need.
The updated status mapping should be uses for mapping plan to check potential geological change, especially for the draw point mapping, which performs a time series data. Its mean that in the same point of observation should have different information in different time observation. The static spatial data such as drift mapping should only single observation in one point observation. The updated data in the map was also used for the mapping plan as well as to generate a potential geological map revision. Data flow of the UG geology was simplified as Figure 2. This process also suggeststhat geological database is growing along mine production and development.

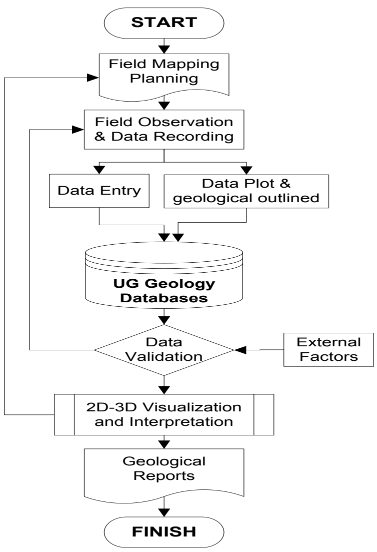

Figure 2: Simplified UG Geology datacollection and storage.

The geological database nature is required the historical record from the initial data collection. The requirement is uses for reviewing the initial geological condition for mine planning and to reconcile with the actual information discovered during the mining live.

Data validation of UG Geological data (Figure 2) is the important task since the geological data commonly collected by the visual observation. The external factors such as the dark, dusty and noisy on the underground mine environment will impacted to the accuracy of the observation. Different observer (geologist) may have different estimation and/or interpretation in the same object. Standardization as well as observation data control should be taken to ensure the data consistency.

4. DATABASE DEVELOPMENT PROGRESS

In the introduction section has been mentioned that there are three major different database uses for UG geology department PT. Freeport Indonesia. Due the different type, characteristic and database stakeholders the data has been stored in the three different databases.

The first major is the UG Geology draw point database. The first phase development had successfully migrated the historical data from the MS Excel and in-house database system onto the integrated UG Cave Management database using the commercial database system platform. Data migration to the commercial database system is to reduce the use of database developer and to have support and system maintenance from the vendor. The other consideration is to use the generic best practice of exploration and mine database administration.

The second type of the UG database is the Geological structure database which has specific data type. At this stage, difference data type and exclusive data type for special purpose have been stored in the independent database but using the same commercial database system. The integrated mapping system, database capturing and 3D visualization have smoothed data recorded process as well as reporting procedure (Manning, 2010).

The third database is the Exploration database, which is used for drilling information data repository. Exploration database is the data source for the mineral resources modeling and calculation. Mine geology as part of the advance exploration that is responsiblefor evaluating drilling project related for geotechnical and hydrology for underground mine. Moreover it is also used for infill drilling and/or delineation drilling project. Drilling data is use for reserve – resource modeling. Geotechnical drilling is regularly requested to improve mine design development and mine operation. Hydrology drilling was designed for dewatering project, which is run by Hydrology Department. Further detail exploration database model was prepared and presented in different paper of this symposium.

Infill drilling is requested to ensure the resource calculation and model, which is reviewed in the regularly basis. In some cases, specific metallurgical test is required from drill core data to study and to better understand ore characteristics. Infill drilling is an additional information, which is possible to be used for revising the existing resource or reserve model. An example of infill drilling for Big Gossan mine (BG2720-40), which shows the revised ore boundary that may impact mine planning (Figure 3).

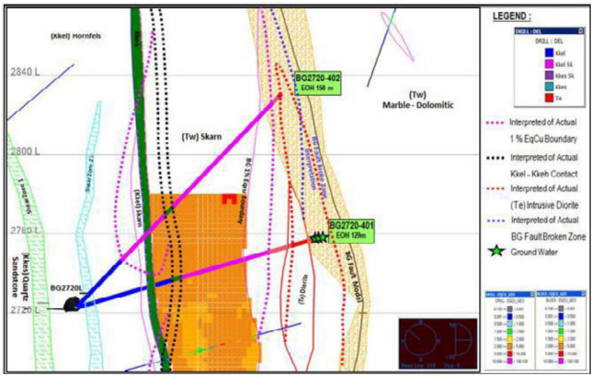

Figure 3: Cross-section of DDH BG2720-40 showing the 1% mineralization boundary (purple) and the new interpretation (Mine Geology, 2012).

5. DATA TRACKING AND AGGREGATION

Figure 4 shows the monthly data comparison between lithology composition trends and copper grade trend. An example of the advance data integration need: ore production grade evaluation in comparison with lithological composition is required to integrate two separated database systems, which are geological data and Mill production database system.Data collecting itself has different time frame. Mill data production is recorded using time basis, which represents the whole mine production, while geological data is collected using weekly basis at an individual draw point. Data aggregation process of each data is required before comparison to see the general overview.

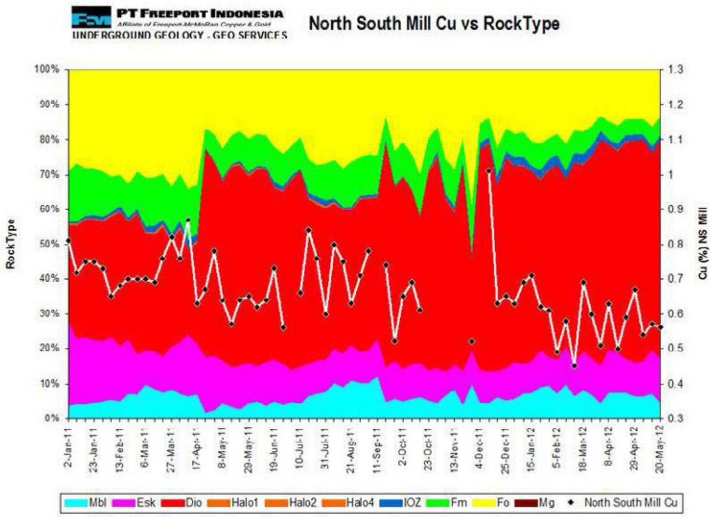

Figure 4: Graph of DOZ Mine rock types distribution versus Cu grades (white line) from January 2011 to May 2012 (Mine Geology, 2012).

Data tracking is other important task in the integration system, which is to ensure that all data beingstored is ready to use. The current database is a static system, which meansno warning system if any part of the process does not work properly. The manual tracking was conducted by meansof assign somebodywho was appointed as data stewardto regularly check and ensure that all process work properly.

6. FURTHER DATABASE DEVELOPMENT

Data collection related to the DOZ underground operation is not only from UG geology but also from other departments, such as Cave Management, Geotechnical and Hydrology as well as UG Engineering Department. In other hand, others evaluation and/or decision require data not only from their department but also fromother parties. UG Geological data, which records every draw point informationthat consists of rock types proportion, grade and dilution estimates, water condition, clay contents. Thisinformation in turn was used for mud rush potential anticipation and mud rush mitigation.

Based on the latest study by LAPI-ITB (2011), itconcludes that the mud rush or wet muck evidence is contributed from water (wetness), fine material, and draw point disturbances during mucking activity. Table 1 is thesummary of the mud rush or wet muck potential occurrence ant it indicators summarized from Butcher et all (2005), Samosir (2008), Rachmad (2011), Lasito (2011), UG Geotechnical & Hydrology (2011) in LAPI 2011.

Table 1: The summary of mud rush element and it indicators for DOZ mine.

1	Total fine mater, Fine material source, clay content, lithological change and type (Geology)
2	Rain fall, water travel time, water content in draw point, water saturation, clean water occurrence, hydraulic connectivity (Water).
3	Disturbance by mining activity,mine production, non-continuously drawing productivity
4	High angel (> 45°) of material at draw point
5	Increasing height of draw (HoD)
6	Material migration from higher level, indicated by increasing yellow garnet.

Table 1 indicates that database development for mud rush mitigation requires several data sources. At the end, the integration data was proposed to understand the overall figure of the process or situation on the whole area interested as Knowledge Data Discovery (KDD). Figure 6was designed to be suggested for the Exploration Data Mining and Business Intelligence (KDD) for Underground mine related to geo-science information. This may subsequently be used in order to improve all processes including mine planning, production scheduler, draw order, mud rush potential anticipation and mud rush mitigation.
The data collection with scattered data in different place and different format is challenging of further development. At the first phase of data collection, called as data discovery,is the process to understanding where the data source and what kind the data. During this phase is possible that there may some inconsistenciesin data gathering method as well as data readiness, for example the latest HoD data is recorded in February 2012, while the latest geological data is recorded in May 2012 for data extraction in June 2012. Figure 5 shows the data trend, which also presents the data availability. Understanding of data meaning and purpose is also important part in data validation and consolidation. Reviewing data using simple chart (Figure 5) and/or plot in the map as well as discussing with the data owner is the way to understand the data meaning in order to develop the System Management & Quality Assurance (Figure 6).

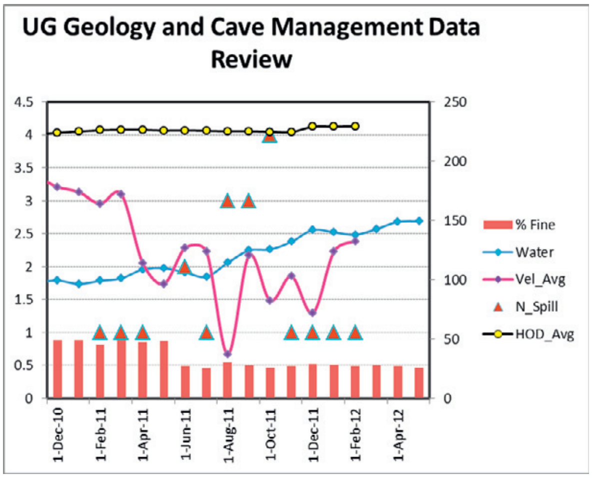

Figure 5: An example data review and validation for further database development for mud rush mitigation.

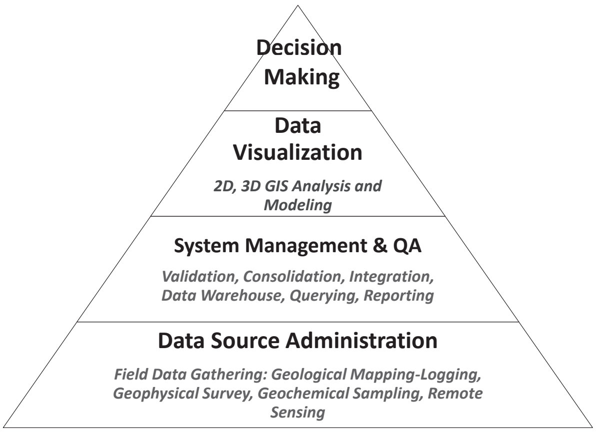

Figure 6: The suggested exploration data Mining and business intelligence (modified from Saptawati, 2011).

7. CONCLUSION

Based on the study and development, the first phase database management system successfully established by UG geology to accelerate the creation of routine geological report and improve data and report quality.

Further development and enhancement, which involves several departments with different type of data and different method of data gathering,will create more complex database system and should require standardization.

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