

# **Pasminco Century Mine: Orebody Modelling and Grade Control Utilising Geophysical Blast Hole Logging**

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## **Introduction**

Implementation of the current system of geophysical blast hole logging is an integral process in the development of a high-resolution short-term mining model for grade control and ore production. Development of the system has evolved after an initial period of experimentation and feasibility in year 2000. Since then it has become an essential part of the grade control process for orebody definition. The system also represents significant cost savings compared with ongoing in-fill diamond drilling programs.

The logging system utilises two geophysical parameters, natural gamma and magnetic susceptibility to discriminate between the mineralised black carbonaceous shale and interbedded siderite altered siltstone of the Century Ore Sequence.

## **Geology and Mineralisation**

The Century Zinc-Lead-Silver deposit is located 250 km northwest of Mount Isa, Queensland, Australia. The deposit was discovered in 1990 after drilling a zinc, lead and silver soil geochemical anomaly. The Pasminco Century Mine is a large open pit mining and processing operation with annual ore production rate of 5 millions tonnes. The identified mineral resource is 102.4 million tonnes at 12.2% zinc, 1.7% lead and 45g/t silver (Pasminco Australia Limited Annual Report, 2000).

Century is a stratiform deposit hosted in black shale of the middle Proterozoic Lawn Hill Formation, a sequence of shale, siltstone and sandstone overlain by Cambrian Limestone. The limestone terminates the orebody to the east, with Magazine Hill Fault and Nikkis Fault terminating the ore to the south and north respectively. In the west the orebody is terminated by the present surface level where the orebody outcrops on Discovery Hill. The orebody is divided into two blocks (Southern and Northern blocks) by the east-west trending Pandoras Fault.

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The mineralised sequence is approximately 40m thick and consists of mineralised black shale units interbedded with siliceous siderite altered siltstone units. Mineralisation consists of fine-grained stratiform sphalerite with minor galena and pyrite. Coarser grained discordant vein-form galena and sphalerite are also present. Typically the mineralised shale has a zinc grade from 5-30% and the interbedded siltstone units 1-2% zinc. The orebody is mined as two zones (Upper Ore Zone and Lower Ore Zone) separated by a 5m thick interburden consisting of siderite-altered siltstone. The thicknesses of units have good lateral continuity, but the variation in grade laterally and intense faulting adds complexity to the mining process.

## **Geophysical Data Collection and Interpretation**

Blast hole patterns in the ore zone are drilled on a 5.4m by 6.2m pattern to a depth of 9.5m (includes sub drill) with the average blast pattern containing 70,000 banked cubic meters of material. In the early stages of geophysical data collection every hole within a blast pattern was logged to obtain a greater density of information for the short-term model to resolve areas of complex faulting. As confidence in the short-term resource model has been improved, and in areas of relatively simple geology every second hole in each pattern is now logged.

The dedicated 4wd light vehicle logging unit and single tool set-up makes for time efficient blast hole logging. It is a one-person operation taking approximately 10 minutes to set-up, and average of 5 minutes to log each hole. Within each pattern a number of holes are drilled to 25m depth on a 25 by 25m grid to improve the accuracy of the short-term model and also for the planning of subsequent benches. Logging takes place while the drill rigs are still on the pattern so there are minimal time delays in production. On average 500 holes are logged per month with the data collected from the blast holes accounting for approximately 70% of data used to update the short-term model used in the weekly planning process. Over 7700 blast holes have been logged and interpreted to date.

An automated interpretation program (LogTrans) has enabled greater interpretation speeds for entire blast patterns. The software program uses multi-variate analysis to reproduce manual interpretations. Statistics from logged holes are used to build a dataset that is used for auto interpretation of subsequent patterns. Statistical analysis shows some variation in the magnetic and gamma response for the different units in the ore sequence but also some overlap. There are however a couple of distinct marker horizons. As there are small lateral variations in the geology i.e. thickness and alteration in different areas of the pit the statistics have to be updated regularly to maintain the accuracy of the interpretations.

To increase the accuracy of the final interpretation LogTrans contains a utility (NewStrat) that imposes a stratigraphic order on initial interpretations. NewStrat uses minimum and maximum thicknesses of units and preferential marker horizons to improve reliability. This has worked well for the Southern ore block where there is very little change in unit thickness due to faulting. On the eastern edge of the Northern Ore block where there are complex areas of faulting resulting in loss and/or repetition of entire units a different approach to refining interpretations will be needed. Constant improvement of the NewStrat utility is an ongoing process. The final interpretations for each hole are checked and minor adjustments made before loading into the database.

To ensure the integrity of the data collected with the probe a dedicated calibration hole is logged on a monthly basis. The calibration hole passes through the entire ore sequence and is

located in the planned Stage 7 Pit area. Any problems with the probe e.g. the performance of the sensors, will affect the ability of the auto interpretation program to discriminate individual units and provide accurate interpretations. A second tool was purchased to cover any downtime experienced. To date the logging system has shown a high level of equipment reliability.

The geophysical interpretations and the short-term model are reconciled by data collected in the field. Survey pick-ups of stratigraphic contacts on active mining faces and geological floor mapping have shown the geophysical interpretations to be accurate.

### **Short Term Model and Ore Outline Generation**

Once interpretation of a blast pattern is complete, the information is imported into the geological database. Accurate surveyed blast hole collar locations are used in the database, with blast holes assumed to be drilled vertical, as designed. Once a blast pattern has been imported into the database it can be accessed in one of the mine planning software packages used on site. At this stage the blast holes can be brought up on screen, and are compared with other geological information to confirm that an accurate interpretation has taken place. Once the quality of the data is validated, points representing the location of ore contacts are extracted from the new pattern, and appended to master files containing all information from logging and interpretation to date.

Using a combination of this data, geological mapping, diamond and reverse circulation percussion drilling and interpreted points three-dimensional surfaces of ore contacts are created. The majority of geological contacts in the Century deposit are quite faulted and reasonably gently dipping, with an average bedding dip approximately twenty degrees. As a result of this, making allowances for blast heave to help to ensure the accuracy of the surfaces and minimise ore loss and dilution is important.

After a blast has taken place, the location of blast hole collars can still be seen in the majority of cases. These locations are accurately surveyed, and vectors of movement due to blasting at each collar calculated. These calculated vectors are then broken down into three dimensions of movement. For each of these dimensions a grid file is generated, usually on a two metre by two-metre basis covering the entire pattern, with each grid point containing information on the amount of movement caused by heave. This information is then used to correct the locations of the different ore contact surfaces that were generated. A depth factor is applied in an attempt to allow for variations in movement due to depth. The final result is a three dimensional grid with a two by two metre plan spacing representing each ore contact within the blast. These can then be contoured to generate ore boundaries at different levels, as well as being loaded into the Dig2000 system.

### **Dig 2000**

Dig 2000 is a system that integrates GPS and machine sensors to show the operator the position of the bucket in real time. Design surfaces such as ore contacts, floor levels, pit wall and ramp designs are uploaded into the system. A computer display mounted in the cab contains cross-sectional and plan views of the digger and bucket position in relation to these design surfaces. This allows the operator to gain an understanding of the geometry of the

surface and the amount of material to be removed to achieve more accuracy in the selective mining process.

### **Summary**

The geophysical blast holes logging system has proved to be a reliable production tool to provide detailed geological data to produce ore contact outlines. Integrated with automated data processing software, resource-modelling software a blast pattern can be processed and ready for ore mining within one day. The ore production system is complimented by uploading the ore contact surfaces into a GPS guided excavator resulting in a highly efficient ore mining system.

### **References**

Pasminco Australia Limited, (2000). Pasminco Limited Annual Report 2000.