OPEN PIT MINING DESIGN AND PLANNING

MEMBERS
- Callata Cárdenas Roger Fernando
- Ortiz García Ricardo Adán
- Palomino Vergara Alejandro Jesús
INDEX

ABSTRACT - SPANISH

ABSTRACT - ENGLISH 6

INTRODUCTION 6

PROJECT DATA 7

LOCATION 7
ACCESS 9
WEATHER 10

GEOLOGY 10

REGIONAL AND LOCAL 11

PROBE INFORMATION ANALYSIS 11

STATISTICAL ANALYSIS 11
UN COMPOSITATED DATA 11
OPTIMAL COMPOSITE LENGTH 12
COMPOSITED DATA 13
GEOSTATISTICAL ANALYSIS 14

RESOURCES AND STOCKPILE ESTIMATION 15

ESTIMATION METHOD 15
RESOURCES MODEL VALIDATION AND STATISTICS 16
RESOURCES MODEL 19
STOCKPILE MODEL 20

MINE DEVELOPMENT AND CONSTRUCTION (LAYOUT) 25

MINING OPERATION 25
BENEFIT PLANT 25
STOCK PILES 25
TAILING AREA 25
DUMP 25
WORKSHOPS 25
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>25</td>
</tr>
<tr>
<td>Camp</td>
<td>25</td>
</tr>
<tr>
<td>Mine Production Plan</td>
<td>26</td>
</tr>
<tr>
<td>Economic Analysis</td>
<td>28</td>
</tr>
<tr>
<td>Conclusions</td>
<td>30</td>
</tr>
<tr>
<td>Recommendations</td>
<td>31</td>
</tr>
<tr>
<td>Annexes</td>
<td>32</td>
</tr>
<tr>
<td>Annex A: Statistical Analysis of Uncomposited Data by Metal</td>
<td>32</td>
</tr>
<tr>
<td>Annex B: Statistical Analysis of Composited to 5M Data by Metal</td>
<td>37</td>
</tr>
<tr>
<td>Annex C: Geostatistical Analysis for Each Element</td>
<td>42</td>
</tr>
<tr>
<td>Annex D: Probability Plots</td>
<td>45</td>
</tr>
<tr>
<td>Annex E: Mineral Tonnage by Phases and Banks</td>
<td>48</td>
</tr>
<tr>
<td>Annex F: Mining Plan by Years and Banks</td>
<td>52</td>
</tr>
</tbody>
</table>
TABLE INDEX

Table 1 Concession Data of the Corani Project ................................................................. 9
Table 2 Average Laws and Deviation of Metals in the Deposit (Uncomposed) ...................... 11
Table 3 Average Laws and Deviation of Metals in the Deposit (Composed) .......................... 13
Table 4 Dimensions of the search ellipsoid for each element obtained from the experimental variograms in the chosen direction 120° / 0° ........................................................................ 14
Table 5 Parameters of the omnidirectional experimental variograms and in the 120° / 0° direction for each element ............................................................................................................. 15
Table 6 Top-Cut AG, PB y ZN ............................................................................................... 15
Table 7 Parameters for Resource Classification ...................................................................... 15
Table 8 Model Validation with Drills .................................................................................... 16
Table 9 Average Laws by Resource Class estimated with Kriging and Distance Inverse ........ 17
Table 10 Average Laws of the Resource Model by Bank estimated with Kriging and Distance Investing ...................................................................................................................... 18
Table 11 MSOpit Parameters ............................................................................................... 20
Table 12 Tonnage and average laws by Category (Oxides, Sulf Prim, Sulf Sec, Desm) for each Pit.. 21
Table 13 Fine by Category (Oxides, Sulf Prim, Sulf Sec, Desm) for each Pit........................... 21
Table 14 NPV and contribution to the NPV for each Pit calculated from Sales and Costs ........ 22
Table 15 Production plan by year ......................................................................................... 27
Table 16 Production plan of Year 1 by Quarters ................................................................... 27
Table 17 Project Cash Flow ................................................................................................... 28
Table 18 Project Cash Flow (Year 1) by Quarters ................................................................. 29
Table 19 Statistical Analysis of uncomposited Ag laws in the Deposit .................................. 32
Table 20 Statistical Analysis of uncomposited Au laws in the Deposit ................................... 33
Table 21 Statistical Analysis of uncomposited Cu laws in the Deposit ................................... 34
Table 22 Statistical Analysis of uncomposited Pb laws in the Deposit ................................... 35
Table 23 Statistical Analysis of uncomposited Zn laws in the Deposit ................................. 36
Table 24 Statistical Analysis of composited Ag laws in the Deposit ..................................... 37
Table 25 Statistical Analysis of composited Au laws in the Deposit ..................................... 38
Table 26 Statistical Analysis of composited Cu laws in the Deposit ..................................... 39
Table 27 Statistical Analysis of composited Pb laws in the Deposit ..................................... 40
Table 28 Statistical Analysis of composited Zn laws in the Deposit ..................................... 41

FIGURES INDEX

Figura 1 Location of Corani Project ................................................................................... 8
Figura 2 Geological Map of the Puno Region - Corani Project ........................................... 11
Figura 3 Metals Laws variation Graph related to the Ag law in uncomposited lengths of drill in the deposit ...................................................................................................................... 12
Figura 4 Length Determination of the composite ................................................................. 13
Figura 5  Metals Laws variation Graph related to the Ag law in composited lengths of drill in the deposit

Figura 6  Histogram of the Resource Model by Lithology

Figura 7  Histogram of the Resource Model by Class

Figura 8  Plan view of the Resource Model and parameter table by block

Figura 9  Distribution of Ag Laws in the Resource Model

Figura 10  VAN, Mineral and Disassembly by Pit

Figura 11  EW view of the Mining Phases

Figura 12  NS View of the Mining Phases

Figura 13  Plan View of the Mining Phases

Figura 14  Final economic envelope (Pit 14 - Phase4)

Figura 15  Final view in 3D Pit (Pit 14)

Figura 16  LAYOUT of the Mining Unit

Figura 17  Production Plan (Mineral-Clearance) by year

Figura 18  Histogram of uncomposited Ag laws in the deposit

Figura 19  Histogram of uncomposited Au laws in the deposit

Figura 20  Histogram of uncomposited Cu laws in the deposit

Figura 21  Histogram of uncomposited Pb laws in the deposit

Figura 22  Histogram of uncomposited Zn laws in the deposit

Figura 23  Histogram of composited Ag laws in the deposit

Figura 24  Histogram of composited Au laws in the deposit

Figura 25  Histogram of composited Cu laws in the deposit

Figura 26  Histogram of composited Pb laws in the deposit

Figura 27  Histogram of composited Zn laws in the deposit

Figura 28  Omnidirectional Variogram for Silver

Figura 29  Directional Variogram at 120° / 0° for silver

Figura 30  Omnidirectional Variogram for Gold

Figura 31  Omnidirectional Variogram for Copper

Figura 32  Directional Variogram at 120° / 0° for Copper

Figura 33  Omnidirectional Variogram for Lead

Figura 34  Directional Variogram at 120° / 0° for Lead

Figura 35  Omnidirectional Variogram for Zinc

Figura 36  Directional Variogram at 120° / 0° for Zinc

Figura 37  Probability Plot AG

Figura 38  Probability Plot PB

Figura 39  Probability Plot ZN
ABSTRACT

This research consists in the conceptual study of an open-pit mining project. From a database formed by the characteristics of a set of drillings made to the mining project’s deposit, the grades and the lengths of the drillings were analyzed, and a composition of the drillings were elaborated. Then, we analyzed geostatistically the composition, and we estimated mineral resources and reserves, making a model for each one. From mineral reserves model and geographic relief of the zone, we had to start designing our project’s layout, where we can define the location of the enough infrastructure to our project to have a good operating performance, considering economic, social, environmental and legal to make a suitable design. Within the necessary infrastructure are the access roads, the pit, the processing plant, dump, etc. Once the layout of the project is considered, we analyze the mine production plan, where we will detail the production of mine, plant, stock piles and the life of mine. Finally, the sizing of mining equipment, estimation of operating costs, estimation of capital costs and the economic analysis were carried out, realizing the cash flow where we would observe the profitability of the studied project.
CONCLUSIONS

- The considerations taken in this conceptual study have a low level of certainty and detail because there are no complementary studies necessary for a complete analysis. However, it is an acceptable basis to present and describe a project in broad strokes.

- The Minesight / MSOpit program allows to obtain the economic envelopes of the model, in this case; the nested pits, from which the operating pit must be designed.

- The data considered as input, to obtain the economic envelopes, has blocks of measured, indicated and all the inferred resources. This consideration is due to the small amount of Measured and Indicated Resources for this level of detail.

- The Economic Evaluation has been carried out to know if the project (mining plan) generates value for the company, for this, a Cash Flow Projection has been developed, in our case the free cash flow. Likewise, the Profit and Loss Statement have been projected and the profitability indicators have been calculated: Net Present Value (NPV), and Internal Rate of Return (IRR). Finally, we can conclude that the project is profitable since it has a positive NPV about US $ 1,078,199 (000) and an IRR of 50% which makes the project low risk considering a discount rate of 8%.

- The development of the Production Plan and the Economic Analysis are complementary in any mining project, for this we must follow the following Flow Diagram.
For a result of the economic evaluation closer to reality, it is necessary to carry out a detailed analysis of the estimate of Capex, Opex and Equipment Dimensioning. Approximate values of Operating Cost and Investment according to the level of Production have been considered for this Project, so error bias is likely.