GY 302: Crystallography & Mineralogy

Lecture 17: Ore Assessment

Instructor: Dr. Douglas Haywick
Mineral Quiz 1 results

1: Antimony (14%)
2: Cinnabar (93%)
3: Nickeline (21%)
4: Stibnite (21%)
5: Molybdenite (86%)
6: Silver (71%)
7: Pyrrhotite (57%)

2016: Average: 66.3%        Highest Grade 94%
2015: Average: 59.9%        Highest Grade: 86% (1)
2014: Average: 60.4%        Highest Grade: 91% (1)
2013: Average: 69.1%        Highest Grade: 91% (2)
2012: Average: 61.9%        Highest Grade: 91% (2)
2011: Average: 60.4%        Highest grade: 80% (2)
Today’s Agenda

1. How do you assess the economic potential of an ore deposit (preparation for Assignment 7)

Note: This week’s online lecture review will be done next Tuesday

Soup day next Tuesday October 18th (12:15 to 1:00 PM)
Any dietary restrictions?
Ore Assessment

Say that one day you are out and about in the middle of nowhere and you get lucky .....
Ore Assessment

Say that one day you are out and about in the middle of no where and you get lucky ..... 

GOLD!

http://www.travelpod.com
Ore Assessment

If you were an economic geologist, you would more likely get lucky this way .....
Ore Assessment

Now what?
Ore Assessment

Job 1: Stake your claim

http://www.kshs.org/cool3/reader.htm
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Job 1: Stake your claim

Placer Claim  Load Claim

http://www.gemologistsam.net/how-to-file-a-gold-mining-claim/
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Big Company’s (Majors) Claim Large Areas

http://www.nsuperior.com
Ore Assessment

Job 2: Assess the quality your claim; sample across the site

http://www.wildnessutah.com/learn/gold-prospecting.html

http://www.proactiveinvestors.com/
Ore Assessment
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Job 3: Assess the quality your claim; assaying of samples

http://www.assaying.org/
Ore Assessment

Job 4: Map out assay data across your claim; delineate economic zones for development (historical example).

Detail of an assay map of the Sheriff Mine, c. 1939, showing variations in vein thickness and ore values. Note the occurrence of arsenopyrite, identified as "Arsen Ore" (map center), where gold values ranged from $4,354 to $10,150 per ton. One small square represents one foot. Asa Baldwin, "Assay Map, Sheriff Claims"

http://www.historycooperative.org/journals/sia/29.2/white.html
Ore Assessment

Job 4: Map out assay data across your claim; delineate economic zones for development
(modern example)
An aerial view of the Oxiana open pit mine at Prominent Hill, in Australia (Cu-Au). Production began 2009. In 2010 Prominent Hill produced 112,171t of contained copper and 196,400oz of gold. In 2011, copper production was 107,744t and gold production was 160,007oz. Prominent Hill's 2012 output was at 101,737t of copper production and 140,746oz of gold.

http://www.abc.net.au/news/stories/2008/02/20/2167577.htm
Ore Assessment

Job 7: Keep looking for new economic ore zones

http://technology.infomine.com
Ore Assessment

Things to consider before you commit to developing an economic property:
Ore Assessment

Things to consider **before** you commit to developing an economic property:

• is it actually economic at current and anticipated commodity prices?
Ore Assessment

Things to consider before you commit to developing an economic property:

• is it actually economic at current and anticipated commodity prices?
• are your development costs going to overwhelm profits?
Ore Assessment

Things to consider before you commit to developing an economic property:

• is it actually economic at current and anticipated commodity prices?
• are your development costs going to overwhelm profits?
• are your production costs going to kill profits?
Ore Assessment

Things to consider before you commit to developing an economic property:

• is it actually economic at current and anticipated commodity prices?
• are your development costs going to overwhelm profits?
• are your production costs going to kill profits?
• who can you get to partner up financially in developing the property?
Ore Assessment

Things to consider before you commit to developing an economic property:

- is it actually economic at current and anticipated commodity prices?
- are your development costs going to overwhelm profits?
- are your production costs going to kill profits?
- who can you get to partner up financially in developing the property?
- how long will the mine last
Ore Assessment

Things to consider before you commit to developing an economic property:

• is it actually economic at current and anticipated commodity prices?
• are your development costs going to overwhelm profits?
• are your production costs going to kill profits?
• who can you get to partner up financially in developing the property?
• how long will the mine last
• how will you pay for shutdown costs?
Assignment 7: Assessing the Economic Potential of Ore Deposits

**Assignment 7: Ore Assessment**

**GY 302: Crystallography and Mineralogy**

**Your Task:** One of the important jobs that economic geologists do when employed by mining companies or government geological surveys is to assess the economic potential of new ore deposits. Once the limits of the ore body have been delineated, it is up to the project geologists to determine if a profit can be made in establishing a mine at the site. Numerous factors need to be considered. How much ore is there? What is its grade? What rate of extraction/processing can be done? How long can the mine operate? What is the cost of processing? These are also startup costs. Last year, you could have easily borrowed money from a bank to get started. In today’s economy, even profitable mine sites are difficult to develop because of lack of funds (i.e., banks will not loan money).

This exercise will introduce you to the economic realities of mineralogy. Consider the diagram on the next page. It shows the extent of a copper ore deposit located in an isolated area of Papua New Guinea. You have been contacted by a local investment firm that is considering helping to fund the development of a small per mine at the deposit. The junior mining company that found the deposit is a small Australian exploration firm (AusCo). They don’t normally produce the deposits they find (i.e., they are not a mining firm), but would like to work this one if it is profitable. If the deposit is not worth mining it, they would be willing to sell their interests in the property to mining giants Rio Tinto or BHP. AusCo is looking to cut a deal with an investment bank.

Assaying data has shown that the deposit consists of 2 zones. Both zones are essentially rectangular in extent. Zone 1, the rich interval, contains an average 2 wt% copper, 1 wt% chalcocite, 0.3 wt% chalcopyrite, and 2 wt% chalcopyrite. The average specific gravity of the ore in zone 1 is 3.45 g/cm³ (3450 kg/m³). The average specific gravity of the ore in zone 2 is 3.12 g/cm³ (3120 kg/m³). The plan is to extract the rich ore zone first and then, if economically feasible, expand the pit into zone 2.

In Papua New Guinea, average extraction/mining costs are relatively high ($US 5000/tonne), and the infrastructure is poor. Consequently, startup costs for a small relatively small extraction operation (2,000 tonnes/month) will be in the order of $US 12 million dollars. There are also no final processing facilities available. That will have to be done in Australia, so budget $US 500,000 for shipping/fines processing. The deal that AusCo would like to make with investment bank is to get an interest free loan payable in full within 3 years. In return for the loan, the investment firm gets 35% of the profit from year 3 onwards until the mine is closed.

At current copper prices, and considering the processing extraction and shipping costs as well as reasonable operational expenses, how much money can AusCo expect to make from the high grade deposit per year? How long will they be able to mine it before the high grade deposit runs out? Can they pay off the loan within 3 years?

Is zone 2 currently economical? If so, how much money will AusCo make per year and how long will this deposit last? If it isn’t currently economical, what price of copper will be needed to make

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1 That means today—check a commodity on the internet for the most recent copper price.

2 AusCo is a 3 person operation; 2 geologists and a secretary. Salary expenses are estimated to be $150K per year. Also budget in additional $150K per year for assaying and personal travel expenses.
Assignment 7

Ore Assessment

At current copper prices\(^1\), and considering the processing/extraction and shipping costs as well as reasonable operational expenses\(^2\), how much money can AusCo expect to make from the high grade deposit per year? How long will they be able to mine it before the high grade deposit runs out? Can they pay off the loan within 3 years?

Is zone 2 currently economical? If so, how much money will AusCo make per year and how long will this deposit last? If it isn’t currently economical, what price of copper will be needed to make it so? Assume extraction/processing costs remain the same for the foreseeable future. Ultimately, would you recommend that the investment firm write AusCo a check for $US 12,000,000.00?

Please submit your assessment in the form of a professional letter written to the following investment firm:

Ponzi Investing Pty.
1313 Slim Road
Hobart, 7000 Tasmania
Australia

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\(^1\) That means today: check a commodities site on the internet for the most recent copper prices.

\(^2\) AusCo is a 3 person operation; 2 geologists and a secretary. Salary expenses are estimated to be $150K per year. Also budget an additional $25K per year for assaying and personal travel expenses.
Table 1: Worksheet for estimating copper production/gross revenue for the Zone 1 mine site.

$US \underline{\hspace{2cm}} \ \text{current price per pound of Copper}

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Mol. Wt.</th>
<th>Wt% Cu in mineral</th>
<th>Wt% Cu in ore</th>
<th>Total wt Cu per m³ ore</th>
<th>$US gross per m³ ore</th>
<th>$US gross per tonne ore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digenite Cu₉S₅</td>
<td>732.24</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalcocite Cu₂S</td>
<td>159.16</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalcopyrite CuFeS₂</td>
<td>183.53</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Gross per tonne of Ore

Less processing/smelting costs in PNG of $\underline{\hspace{2cm}}$/month

Less transport/processing costs in Australia of $\underline{\hspace{2cm}}$/month

Total Net per tonne of Ore

Total Gross per month based upon $\underline{\hspace{2cm}}$ tonnes mined

Less salary costs of $\underline{\hspace{2cm}}$/month

Net profit/(loss) per month ($US)

Net profit/(loss) per year ($US)
# Assignment 7

**Table 2: Worksheet for estimating copper production/gross revenue for the Zone 2 mine site.**

$US \underline{__________} \text{ current price per pound of Copper}

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Mol. Wt.</th>
<th>Wt% Cu in mineral</th>
<th>Wt% Cu in ore</th>
<th>Total wt Cu per m$^3$ ore</th>
<th>$US$ gross per m$^3$ ore</th>
<th>$US$ gross per tonne ore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digenite $Cu_9S_5$</td>
<td>732.24</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalcocite $Cu_2S$</td>
<td>159.16</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chalcopyrite $CuFeS_2$</td>
<td>183.53</td>
<td>2.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Gross per tonne of Ore**

Less processing/smelting costs in PNG of $\underline{_______}$/month -

Less transport/processing costs in Australia of $\underline{_______}$/month -

Total Net per tonne of Ore

Total Gross per month based upon $\underline{_______}$ tonnes mined

Less salary costs of $\underline{_______}$/month -

Net profit/(loss) per month ($US$)

Net profit/(loss) per year ($US$)
Today’s Stuff To Do

1. Assignment 7 (group)
2. Lecture test 2 coming up soon!

Next Time

1. Halides (Lecture 13)
GY 302: Crystallography and Mineralogy

Lecture 17: Ore Assessment

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