National Exams May 2013

09-Mmp-A4, Mine Valuation and Mineral Resource Estimation

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. One only reference sheet, 8.5 x 11 inch, hand written both sides is allowed in the exam. This is not an open book exam, therefore only the approved Sharp or Casio type calculators are permitted.

3. Compulsory Question 1 and FOUR (4) other questions constitute a complete exam paper.

   Only question 1 and the first four optional questions as they appear in the answer book will be marked. You must select four questions from the "optional" Questions 2 to 7. Be sure you understand that two of Questions 2 to 7 must not be answered.

4. Compulsory Question 1 is worth 40 marks. Each optional question is of equal value (15 marks). Four optional questions plus Question 1 constitute a complete exam paper.

5. Many questions require an answer in essay format. Clarity and organization of the answer are important. Use neat sketches and drawings to illustrate your answers whenever possible.

Question 1 (40 marks) *You must answer all of this question, parts 1.1 to 1.7 inclusive*

Question 1.1 (6 marks)

- There are three levels of taxes on mining in Canada, what are they. (2 marks)
- Which tax jurisdiction allows 100% deductability of taxes paid to the others. (1 mark)
- For tax purposes a mining venture is broken into 4 groups for tax purposes, what are they. (2 marks)
- What is the significance of "The first day of the first ninety day period throughout which the mill operated consistently at 60% capacity or more". (1 mark)

Question 1.2 (6 marks)

A (semi) variogram typically describes the continuity of mineralization. Using a neat sketch variogram,

- What are the units of the X and Y axes of the variogram
- What is the nugget and what, in simple terms, does it represent.
- What is the range and what, in simple terms, does it represent.

(2 marks each)

Question 1.3 (6 marks)

Describe and discuss the merits and weaknesses of

- Polygonal
- Inverse power distance
- Ordinary Kriging

in estimating grades and tonnages of an ore-body. (2 marks each)

Question 1.4 (6 marks)

Define the following in the mining economics/finance/accounting sense

- Net cash flow, R
- Discount rate, r
- Duration (time) of cash flow(s), t
- Present value or worth, PV
- Net present value (or worth), NPV
- Effect of NPV analysis on reclamation costs (1 mark each)

Question 1.5 6 marks

- With respect to smelter contracts, what do you understand by "price participation". (4 marks)
- Why is it necessary for a "medium cap" mining company to negotiate a smelter contract prior to opening a mine. Are there similarities in the lack of guaranteed pipeline capacity prior to opening an oil-sand mine. (2 marks)

Question 1.6 5 marks

Ore-bodies often contain what might be described as "blebs", irregular bulges on the edges of an ore-body or large irregular bubbles of ore of decreasing size/value surrounding an ore-body. usually in some preferred direction.

- How would you amend the drilling techniques used to avoid overestimation and underestimation of the mineralized volume defining the "blebs" in the ore-body. Neat sketch plans/sections may help in your explanations.

Question 1.7 5 marks

- Define the term NSR (net smelter return) as applied to mine cash flows. Also define the term NSV (net smelter value).

Question 2 15 marks

- What is the formula for a two structure spherical variogram model with a known nugget, variance components and ranges. (3 marks)
- Explain why the "nested spherical variogram" with 2 structures can approximate almost any of the classical variogram types. (2 marks)

A two structure spherical variogram has the following attributes

C0	0.05		
C1	0.20	Range 1	500
C2	0.20	Range 2	900

- What is the sill of the variogram
- What is the variogram value at distance 0
- What is the variogram value at distance 250
- What is the variogram value at distance 700
- What is the variogram value at distance 1100

(2 marks each)

Question 3 15 marks

Describe and differentiate between the following geostatistical estimation (kriging) techniques;

- Simple
- Ordinary
- Indicator

(3 marks each)

Describe the **interaction** between the following

- volume- variance relationship
- "mineable reserves"
- selective mining units
- M. David's one quarter drill spacing rule
- block estimates (6 marks)

Question 4 15 marks

You are expected to use your calculator to calculate discounting factors. You may also have included them in the reference sheet you brought to the exam.

An investment pays a net cash flow of $1000 per year for 4 years. The interest rate is assumed constant at 5%.

- What is the NPV of the investment assuming payments are made at year end. (2 marks)

The capital invested today to achieve the cash flows is $3500.

- Is the investment justified at the 5% interest rate. (1 mark)

With regard to mine feasibility and operations

- Some practitioners use the maximum NPV generated in a mining project to estimate cut-off grades. How is such a study carried out to determine which material falls into this "Category 1".
- What should happen to the material which is below the above cut-off grade but exceeds the "corporate" required interest rate for projects and is placed in "Category 2".
- What should happen to material which has a positive cash flow at the time of mining but is not included in the above two categories (1 and 2) and is placed in a further "Category 3".
- Should category 2 and/or 3 material be placed in selective stockpiles close to the mill for re-loading and processing in the mill at the completion of the primary mining operation.
- Discuss how the value of this stockpiled material milled at the end of mine life could be included in a feasibility study as "ore" given that it is the most heavily discounted at start-up.
- Discuss how the maximum NPV process has destroyed the value of lower grades in the deposit, and is there a role for government in ensuring the maximum recovery of "ore" has been accomplished. (2 marks each)

Question 5 15 marks

With regard to smelter contracts;

- What do you understand by the terms "quotational period" and "payment", and give examples demonstrating typical wording/terminology.

A copper smelter contract for a sulphide copper ore has the following penalties,

Arsenic	$4.00 per metric tonne for each 0.1% of As in excess of 0.1%
Moisture	$2.00 per metric tonne for each 1% moisture in excess of 8% per wet tonne
Copper	A 1 unit deduction

A mine produces 20,000 dry tonnes of copper concentrate annually containing 22% copper, 0.2% As, 0.10 ounces per tonne (optonne) Au and 10% H_2O, and this has been sent to a smelter (all on a % etc. dry tonne basis).

- What are the penalties payable.
- What is the percentage of copper payable.

The gold payment is made when the Au content of the concentrate exceeds 0.03 ounces per tonne of concentrate (>0.03). The smelter pays for gold in excess of 0.03 optonne as follows

90% between 0.03 and <= 0.09 optonne

94% between 0.09 and <= 0.15 optonne

95% if > 0.15 optonne

- What is the amount of gold payable.

(Question 5 Continued)

With respect to disputes,

- What is the function of an "umpire" and what facilities provide such services
- When are umpire services required and typically what splitting limits are applicable for copper, gold and arsenic.
- Which of the three assays available are used, and who pays for the umpire services. (1 mark)

A refining process follows smelting and costs might be charged on a tonne of concentrate supplied basis for copper, or on a payable precious metal basis.

- Explain "charge per tonne of concentrate" versus "charge per payable metal in concentrate".

(2 marks per dot ● except the one case noted which carries 1 mark)

Question 6 15 marks

In mineral exploration and evaluation there are topics which must be addressed and understood during the evaluation of mineralization which may or may not result in an ore-body. Provide a description of work and possible outcomes for each of the following eight headings

1. Discovery
2. Preliminary surface evaluation
3. Detailed surface evaluation
4. Subsurface evaluation
5. Feasibility
6. Development
7. Production
8. Reclamation

(2 marks each except item 1 which carries 1 mark)

Question 7 15 marks

- Find the NSR for each of the four metals tabulated (copper, zinc, silver, gold) (8 marks)

Given

Metal Prices

Cu	$7500/t
Zn	$1875/t
Ag	$28/troz
Au	$1600/troz

The symbol "t" refers to metric tonne and "troz" troy ounce

Smelting/Transportation Costs

Copper concentrate	(containing 20%Cu)	$185
Zinc concentrate	(containing 52%Zn)	$350
Silver and Gold	no charge, recovered in concentrator	

Smelter Recoveries

Cu	60%
Zn	80%
Ag	14%
Au	55%

- Use your NSR's to find individual metal and total NSR of a blast hole sample with the following assay; 0.2% Cu, 0.8% Zn, 0.30 g/t Ag and 0.02 g/t Au (4 marks)

The NSR calculation provides a suitable result for cash flow when concentrate leaves the mill.

- How can the NSR be modified to give the mining engineer/geologist the cash flow of broken rock ready for digging in an open pit mine. Such a modification would be invaluable in aiding the decision to send material to the mill or stockpiles and waste dumps. Comment on the value of the modification you have suggested. (3 marks)

End of Exam