

NATIONAL EXAMINATIONS – December 2009

98-Mmp-A1 General Geology and Exploration

3 hours duration

NOTES:

- A. 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.
- B. This is an **CLOSED BOOK EXAM**. Candidates may use one of two calculators, the Casio or Sharp approved models.
- C. **FIVE (5) questions constitute a complete exam paper. YOU MUST ANSWER QUESTIONS 1 TO 4.** Candidates must choose one more question from any of the remaining questions. Where stated in the examination, please hand in any additional pages with your exam booklet.
- D. The first of any of Questions 5 to 7 as it appears in the answer book will be marked, unless the candidate clearly indicates that another question should be substituted for a specified question that was answered previously.
- E. Each question is of equal value. The marks assigned to the subdivisions of each question are shown for information. The total marks for the exam is 100.

***** IMPORTANT: YOU MUST ANSWER QUESTIONS 1, 2, 3, and 4 *****

1. Consider the following 5 ore minerals:

- | | |
|--------------------|-----------------|
| (i) covellite | (iv) pyrrhotite |
| (ii) sphalerite | (v) pyrolusite |
| (iii) arsenopyrite | |

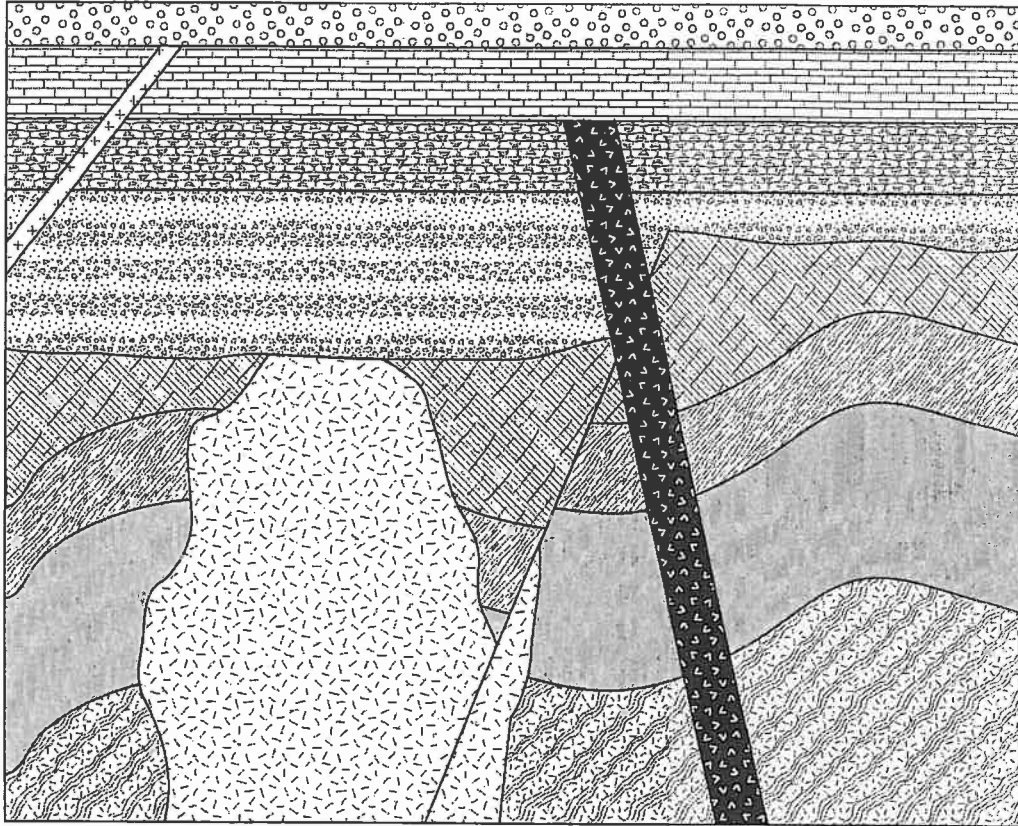
- a) For each ore mineral listed above, state its most common (typical) colour, as seen in a hand specimen. *{5 marks}*
- b) For each ore mineral listed above, state the element of the Periodic Table for which it is a major ore mineral. *{5 marks}*
- c) For each ore mineral listed above, state one diagnostic physical property which may be used to identify the mineral in a hand specimen. *{5 marks}*
- d) Excluding any of the ore minerals listed above, state an ore mineral for each of the following elements: *{5 marks}*

- | | |
|----------|---------|
| (i) Ni | (iv) Sn |
| (ii) Cr | (v) U |
| (iii) Cu | |













2.

- a) Sketch Bowen's Reaction Series and indicate a corresponding igneous rock type that would typically form at each stage of crystallization. {8 marks}
- b) Describe how intrusive ultramafic igneous rocks are generally classified. You may also use a sketch or diagram in your explanation. {4 marks}
- c) The ores of which elements of the Periodic Table are commonly associated with intrusive ultramafic rocks? {3 marks}
- d) Name the most common or typical rock type which hosts the following ore deposits: {5 marks}
 - (i) Pb-Zn deposits in sedimentary rocks
 - (ii) W skarn deposit
 - (iii) U ores in sedimentary rocks
 - (iv) banded iron formations
 - (v) placer diamond deposits

3.
a) Consider the geological cross-section below.



LEGEND (in alphabetical order)

	Basalt		Limestone		Schist
	Fossiliferous Chert		Pegmatite		Shale
	Gneiss		Quartzite		Slate
	Granite		Sandstone		Volcanic Breccia and Tuff

For the geological cross-section above, select the best answer for each of the following multiple-choice questions. **Please record your answers in the answer booklet. Do NOT circle your answers on this exam paper.**
{10 marks}

- (i) A list of rocks, In order of oldest to youngest, would be
 - [A] quartzite, slate, schist, basalt
 - [B] gneiss, schist, chert, granite
 - [C] granite, basalt, pegmatite, schist
 - [D] schist, limestone, sandstone, pegmatite
 - [E] none of the above
 - (ii) A list of geologic events, In order of oldest to youngest, would be
 - [A] deposition of sandstone, metamorphism, igneous intrusion
 - [B] deformation, sedimentary deposition, metamorphism
 - [C] metamorphism, faulting, granitic intrusion
 - [D] metamorphism of limestone, deformation, faulting
 - [E] none of the above
 - (iii) A list of geologic events, In order of oldest to youngest, would be
 - [A] faulting, metamorphism, intrusion of pegmatites
 - [B] metamorphism of sediments, dyke intrusion, volcanism
 - [C] granitic intrusion, faulting, erosion
 - [D] metamorphism of limestone, deformation, faulting
 - [E] none of the above
 - (iv) A list of geologic environments in which these rocks would have formed, in order of earliest to latest, are
 - [A] burial in the lower crust, surface exposure, deep ocean
 - [B] sandy beach, warm and shallow sea, burial in the mid-crust
 - [C] deep ocean, warm and shallow sea, burial in lower crust
 - [D] surface exposure, burial in lower crust, deep ocean
 - [E] none of the above
 - (v) There has been:
 - [A] rotation on the fault plane
 - [B] compaction of sediments prior to dyke injection
 - [C] deformation without metamorphism
 - [D] synchronous intrusion events
 - [E] none of the above
- b) Joints and joint sets are common in many geological terranes. Define these underlined terms and explain why they are extremely relevant to mining engineering. {10 marks}

4.

- a) Ores can form in a variety of geological environments. For each of the environments below, state the most likely type of ore deposit to be formed and give one corresponding locality from around the globe. {10 marks}
- (i) subaerial environment subjected to chemical weathering
 - (ii) continental shelf subjected to volcanic processes
 - (iii) oceanic abyssal plain subjected to submarine precipitation
 - (iv) marginal basin in an extensional environment subjected to submarine volcanism
 - (v) old Archean crust subjected to localised explosive CO₂ volcanism originating from the mantle
- b) Discuss how fluids can be important agents in the creation of ore deposits in different levels of the Earth's crust. {10 marks}

***** IMPORTANT: COMPLETE ONLY ONE MORE QUESTION ***
FROM QUESTIONS 5, 6, OR 7**

- 5.
- a) Briefly describe the five main methods of geophysical surveying. For each, state the physical property that is being measured. *{10 marks}*
- b) For each of the following ore deposits below, state which geophysical method would be the best one to use in order to detect it. *{5 marks}*
- (i) pyrrhotite massive sulphide in a layered mafic complex
 - (ii) buried stream channel containing placer gold
 - (iii) disseminated Pb and Zn in carbonate rocks
 - (iv) oil traps in a sedimentary basin
 - (v) uranium ore in a conglomerate
- c) For each of the five geophysical methods, state one complicating factor inherent to the natural environment which may affect the results. *{5 marks}*

6.

- a) A junior exploration company is about to embark on an exploration program to find a gold deposit in the Canadian Shield. Outline and briefly describe the appropriate steps that should be followed in the design of a successful surficial geochemical survey. *{10 marks}*

- b) Briefly explain how each of the following techniques can be useful in the exploration for ore deposits. *{10 marks}*
 - (i) airborne and satellite techniques
 - (ii) fluid inclusions
 - (iii) radioisotopes
 - (iv) X-ray fluorescence
 - (v) lasers

7.

- a) Briefly describe the three main methods of drilling and state one advantage for each. {9 marks}
- b) Briefly outline the various drilling parameters which must be taken into account when designing a drilling program. {7 marks}
- c) Once a reserve of economic-grade ore has been proven, explain why bulk sampling should be carried out. {4 marks}