NATIONAL EXAMINATIONS – December 2012

09-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.
1. Consider the following 5 ore minerals:
   (i) covellite
   (ii) sphalerite
   (iii) arsenopyrite
   (iv) pyrrhotite
   (v) pyrolusite

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
   (ii) Cr
   (iii) Cu
   (iv) Sn
   (v) U
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
- Fossiliferous Chert
- Gneiss
- Granite
- Limestone
- Pegmatite
- Quartzite
- Schist
- Shale
- Siltstone
- 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. \(10 \text{ marks}\)

(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 CO\(_2\) 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. \(10 \text{ marks}\)
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) radicisotopes  
(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