NATIONAL EXAMINATIONS – December 2005

98-BS-14 Geology

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.

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, and are generally of equal value. The total marks for the exam is 100.

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

1.

a) In the accompanying map of the Earth (Fig. 1, next page), the continents are shown in white and the oceans are shown in grey. In addition, the boundaries between tectonic plates are shown as solid black lines. {*5 marks*}

(i) Name the 2 tectonic plates on the map which are labelled 1 and 2.

(ii) Highlight the following tectonic features by writing directly on the map at any appropriate location the capital letters (X, Y, Z) listed below corresponding to each feature:

[X] a divergent plate boundary
[Y] a mountain range resulting from plate subduction
[Z] a hotspot

b) Sketch a cross-section of the Earth (roughly to scale), labelling all of the important zones. {*5 marks*}

c) Earthquakes have the potential to affect the lives of many people around the globe. {*5 marks*}

(i) Define the following term: Benioff zone

(ii) Approximately how much more energy does an earthquake with a Richter magnitude of 7.6 release than an earthquake with a Richter magnitude of 4.6?

(iii) List three factors that affect the amount of destruction caused by seismic vibrations.

d) Sketch Bowen's Reaction Series and indicate a corresponding igneous rock type that would typically form at each stage of crystallization. {*5 marks*}

***** IMPORTANT: REMOVE THIS PAGE FROM THE EXAM PAPER!! *****

Clearly PRINT your name on this page and hand it in with your answer booklet.

See Question 1 for instructions.

NAME: _____

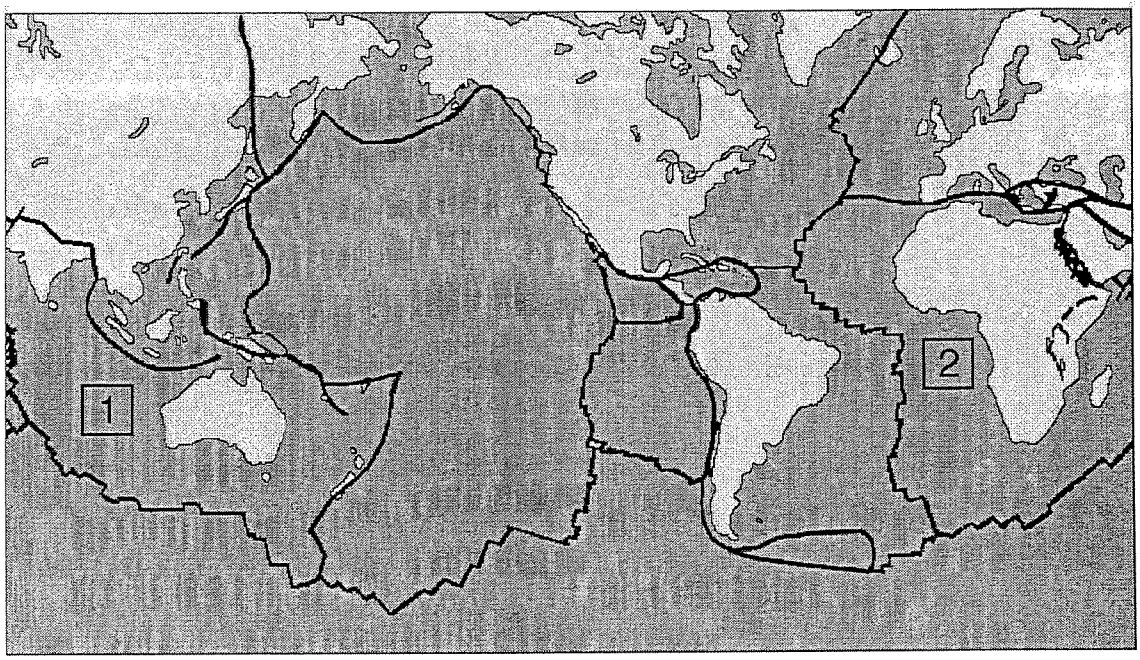


Fig. 1

2.

a) List 5 physical properties of minerals that can be used in their identification. {*5 marks*}

b) Name one natural mineral for each of the following categories: {*5 marks*}

(i) silicate
(ii) oxide
(iii) sulphide
(iv) halide
(v) carbonate

c) Differentiate between the following minerals: {*5 marks*}

(i) orthoclase and plagioclase
(ii) muscovite and biotite
(iii) diamond and carbon
(iv) calcite and dolomite
(v) amphiboles and pyroxenes

d) Sketch the Rock Cycle to show how the 3 main types of rocks are related and the natural processes that relate them. {*5 marks*}

3.

a) Differentiate between the following: {*6 marks*}

(i) porosity and permeability
(ii) aquiclude (or aquitard) and aquifer
(ii) stalactites and stalagmites

b) What is the velocity of groundwater flow in an aquifer with a hydraulic conductivity of 10^{-2} m/s which has a recharge point at an elevation of 150 metres above sea level and a discharge point at an elevation of 130 metres above sea level over a horizontal distance of 100 metres? State the name of the general law that governs the rate of groundwater flow. {*5 marks*}

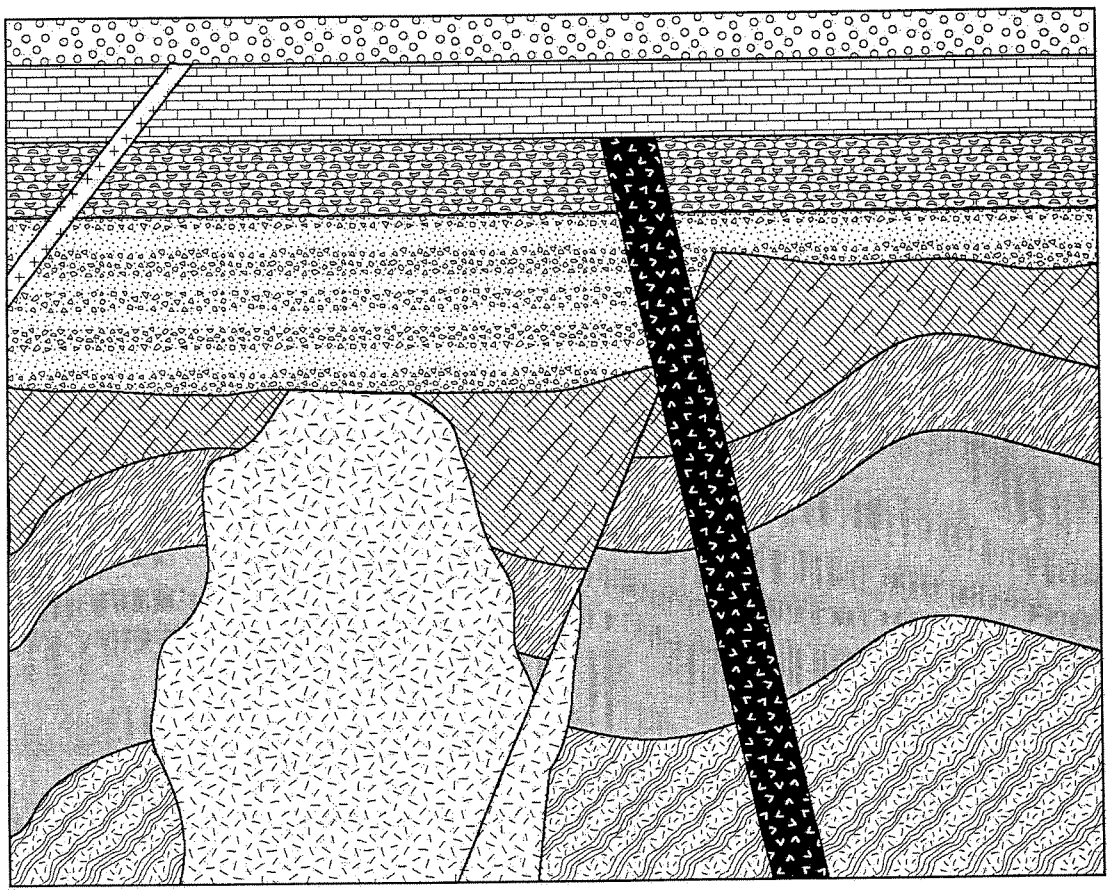
c) Using well-labelled sketches, show how each situation below may result in both flowing and dry wells which may be located near each other. {*6 marks*}

(i) perched water table
(ii) heavy pumping

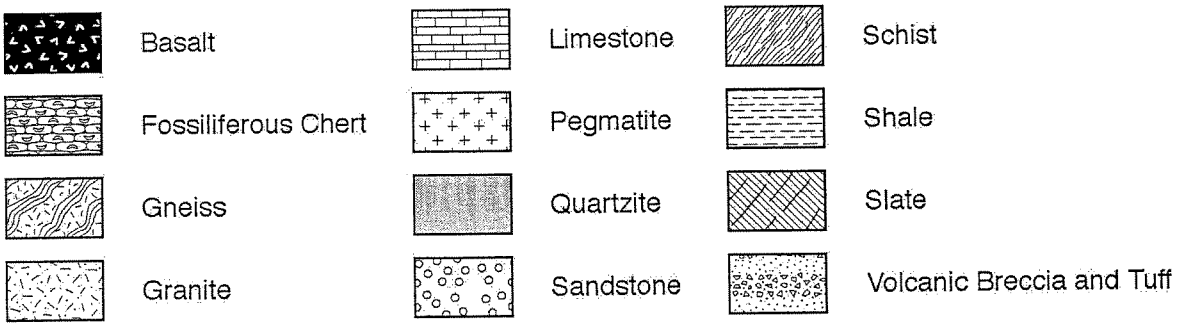
d) Define an artesian well and what is required for an artesian system to exit. {*3 marks*}

4.

a) Consider the geological cross-section below.



LEGEND (in alphabetical order)



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.** *{5 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) Consider a region that was originally composed of flat-lying sedimentary rocks that were subsequently deformed and then eroded to a flat plain. For each feature below, sketch a geological map (i.e. in plan view) of what you would expect to see, showing at least 3 layers of rocks. Place a North arrow in each of your sketches and also indicate the oldest rocks with an "O" and the youngest rocks with a "Y". *{5 marks}*

(i) an anticline shallowly plunging towards the south
(ii) a symmetrical syncline with a horizontal fold axis running east-west

c) List 3 kinds of geological unconformities and illustrate each using a sketch. *{5 marks}*

d) Rock properties may have important implications for engineering works. *{5 marks}*

(i) What property of basalt would make it undesirable as a repository for nuclear waste?
(ii) What property of schist may cause problems in tunnelling operations?
(iii) What property of sandstone can make it useful as a hydrocarbon-bearing reservoir?
(iv) What property of granite makes it useful as building stone?
(v) What property of limestone makes it prone to groundwater drainage problems?

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

5.

a) List and briefly define 5 landforms created by glacial erosion in an alpine setting. {*10 marks*}

b) Name: {*5 marks*}

(i) 2 glacial landforms that are good sources of sand and gravel
(ii) a streamlined hill typically formed from glacial till
(iii) a hill made a stratified glacial sediment
(iv) the long, streamlined grooves formed when rock fragments are dragged across bedrock by advancing glaciers

c) It is often important for engineers to understand the nature of permafrost. {*5 marks*}

(i) Define the following two terms: [1] permafrost and [2] solifluction
(ii) State three possible engineering procedures that can be used to minimize the impact of human structures in permafrost terranes.

6.

a) List the various ways in which a stream can transport sediment. {*3 marks*}

b) Briefly define the following terms: {*6 marks*}

(i) saltation
(ii) stream competence
(iii) stream piracy

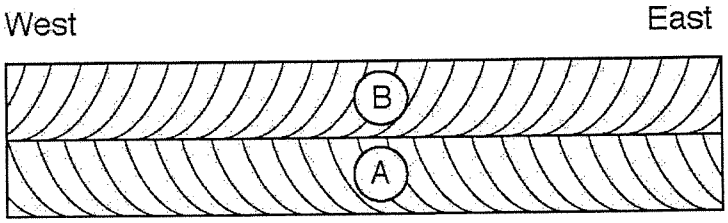
c) Briefly describe the formation of a natural levee and how it relates to a back swamp and yazoo stream. {*6 marks*}

d) Explain what the following statement means and why it is true: "When an area changes from rural to urban, the lag time of stream discharge is shorter and the flood peak is higher." {*5 marks*}

7.

a) State and define the two ways wind erosion may occur. *{4 marks}*

b) Below is a schematic oriented cross-section through some cross bedding in a sandstone. *{5 marks}*



(i) For each rock unit (A and B), state the direction the wind was blowing.
(ii) Using a sketch, briefly show how cross beds are formed.

c) Consider a coastline with bays and headlands. Using a sketch, briefly explain where beaches form and why, and why headlands are often steep-sided. *{6 marks}*

d) What type of mass wasting is most likely to occur: *{5 marks}*

(i) along a strongly jointed rock formation in the mountains?
(ii) along the slopes of volcanoes?
(iii) along the side of a hill after a heavy rainfall?
(iv) due to successive wetting and drying of soil on a gentle slope?
(v) along an arcuate surface within unconsolidated material?