

FACULTY OF SCIENCE

DEPARTMENT OF GEOLOGY	
MODULE CODE	APG2B01
MODULE NAME	Applied Engineering and Environmental Geology
CAMPUS	АРК
EXAM	December 2014 (Supplementary)
Date	December 2014
Assessor(S)	Dr Clarisa Vorster & Dr Michiel de Kock
Internal Moderator	
External Moderator	
Duration	3 hours
Marks	180
Number of pages	8 (including front page)
Instructions	Answer all the questions
	Students must hand in the <u>question paper</u> as well as their answer sheets

(4)

SECTION A:

QUESTION 1:

Acid formation in soil is considered to be a prominent chemical weathering mechanism, with **Carbonic acid** being regarded as the most common acid present in soil. Briefly discuss how **Carbonic acid** forms in nature and how the acid interacts with Calcite and Silicate minerals. (You may use chemical reaction equations to support your answer).

QUESTION 2:

Briefly explain what the following properties of soil refers to:

- a) Porosity
- b) Permeability
- c) Strength and sensitivity
- d) Compressibility
- e) Ion exchange capacity

QUESTION 3:

Water is considered to be the most prominent agent of erosion. Briefly discuss the **mechanisms through which erosion of soil by water** can occur.

(5)

QUESTION 4:

Explain how the following factors can play a role in the **occurrence of a mass movement event**:

- a) The angle of the slope
- b) The water content of the soil

(6)

QUESTION 5:

Explain why **Kimberlite Diatremes** can be studied in order to estimate how much material have been removed (eroded away) from the top of South Africa since the Cretaceous.

(10)

(10)

QUESTION 6:

Complete the following sentences on natural water resources:

- a) The Earths hydrologic cycle incorporates the continual and cyclic movement of water between the oceans, ______and land.
- b) In South Africa, most of our fresh water supply is used for practices
- c) In areas where fresh water is scarce, societies have learned to increase water supply by diverting water from distant sources via and channels.
- d) ______ lakes typically have a high nutrient input and low oxygen content, are shallow and rich in algae thereby making them a very poor source of drinking water
- e) ______is the term used by hydrologists to describe the ease with which fluids can flow through a material.

QUESTION 7:

Make use of a **sketch** to explain the difference between the following **ground water zones**:

- Zone of aeration
- Zone of saturation
- Water table
- Capillary fringe.

QUESTION 8:

Saltwater incursion (or intrusion) often affects the quality of fresh groundwater sources along coastal areas. Briefly discuss the balance between fresh groundwater and saltwater bodies along coastal regions AND the reasons why saltwater incursions occur.

(5)

(5)

(5)

QUESTION 9:

Briefly discuss the following groundwater remediation strategies:

- a) Containment
- b) Containment withdrawal
- c) In situ treatment.

(9)

QUESTION 10:

Explain why the **acid mine drainage** problem associated with the Witwatersrand gold mines became a much **bigger problem after some of the gold mines closed down**.

(5)

QUESTION 11:

Shale gas is term used to describe hydrocarbon gas extracted from shale. However, not all shale units are suitable for the extraction of hydrocarbon gas. Discuss the **criteria a shale unit has to fulfil** in order for it to be regarded as a **potential source of shale gas**. **ALSO** discuss why the **certain shale units of the Karoo Supergroup** could be regarded as potential shale gas resources.

(10)

QUESTION 12:

State whether the following statements with regards to climate change are **true or false**:

- a) Variations in coral growth layers are the best known indicators of environmental change.
- b) Glacial deposition features can reveal information on the thickness, areal extent and direction of flow of the former ice masses.
- c) Studies of ice cores obtained from the Dome Concordia region in Antarctica have revealed that present day greenhouse gas levels (CO² and CH⁴) are at least 40% lower than any time over the past 800 000 years.

d) Changes in surface features, such as deforestation and melting of snow and ice can have a profound effect on climate.

QUESTION 13:

Briefly discuss the following proposed carbon dioxide (CO₂) capturing or storage options.

- a) CO₂ gas absorption using solvents
- b) Oxy-fuel combustion.
- c) CO2 storage in depleted oil and gas reservoirs
- d) Structural trapping (CO₂ storage in sedimentary layers)

(12)

(4)

TOTAL SECTION A: 90 MARKS

SECTION B:

QUESTION 1 (40 marks)

1.1 Ground conditions are often established through drilling.

1.1.1 Explain what you understand under the term "ground conditions"

(4 marks).

1.1.2 Discuss rotary percussion (DTH) drilling and diamond core drilling methods of investigation, and list the pro's and con's of each.

(10 marks)

1.2. Refer to the sketch map of the Johannesburg area below. A vertical borehole is drilled in the position indicated and stopped when basement rocks are intersected. Complete the table below by identifying (Stratigraphic name, i.e., Group or Formation) and describing the lithologies (i.e., Granodiorite and granite) intersected by the borehole. For each intersected unit, also indicate the age of the unit as accurately as possible (e.g., 3120 ± 5 Ma).



(20 marks)

1.3. The quality of diamond drill core can vary significantly depending on lithology, but also on the experience of the driller.

1.3.1. Explain how you would calculate the rock quality designation (or RQD) of the diamond drill core.

(3 marks)

1.3.2. Explain with sketches how you would estimate amount of dip of units intersected by the vertical borehole in the map above.

(3 marks)

QUESTION 2 (20 marks)

Refer to the two news stories:

Nkandla 'at risk of earthquakes and flooding'

15 NOV 2013 00:00 | ANDISIWE MAKINANA





A high risk of earthquakes, volatile politics and high levels of rape in the Nkandla region are some of the reasons the state had to upgrade the security at President Jacob Zuma's private home in Nkandla, according to Parliament's joint standing committee on intelligence.

The committee released its findings based on a classified report, which was drafted by a task team appointed by the security cluster ministers to investigate the security measures at Zuma's Nkandla home.

But there are still no details on what the R206-million was spent on.

SA EARTHQUAKE WAS MINE-RELATED

The Council for Geoscience has confirmed the quake is the largest mine-related seismic event ever recorded.



FILE: The Council for Geoscience has confirmed the Orkney earthquake is the largest mine-related seismic event ever recorded. Picture: Sxc.hu.

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Barry Bateman | 2 months ago

PRETORIA – The Council for Geoscience South Africa has confirmed the Orkney earthquake on 5 August is now the largest mine-related seismic event ever recorded in South Africa.

This emerged at a Council for Scientific and Industrial Research (CSIR) seminar on earthquakes hosted in Pretoria.

The tremor was centred in Orkney, a town situated around 120 kilometres southwest of Johannesburg with a high concentration of deep gold mines. 2.1. Refer to the two newspaper stories above. According to one of these reports the high risk of earthquakes at Nkandla is given by government as one of the reasons for the elevated costs associated with the upgrades of President Zumas's home.

In the second report the causes of an earthquake measuring 5.5 on the Richters Scale, which had hit the town of Orkney on 5 August 2014 are discussed.

2.1.1. Explain why and how earthquakes occur.

(4 marks)

2.1.1. Based on your knowledge of earthquake occurrences in South Africa, explain how you would estimate the risk of a large earthquake affecting the area of Nkandla.

(6 marks)

2.1.2. Johannesburg is classified as a seismic Zone II. What does this mean, and what are the implications for construction?

(4 marks)

2.2. Apart from earthquakes, certain parts of Johannesburg are also at risk of landslides.

2.2.1. Indicate on the map in question 1.2, which areas of Johannesburg are at risk, and ...

(2 marks)

2.2.2. Explain why these areas are at risk (in other words explain which characteristics of the rocks and topography result in this increased risk)

(4 marks)

QUESTION 3 (10 marks)

3.1. What are sinkholes and dolines, and how do they form?

(8 marks)

3.2. Write the reaction for the solution of limestone by groundwater.

(2 marks)

QUESTION 4 (20 marks)

4.1. What is indicated by the Weinert's number, and how is it calculated? (5 marks)

4.2. Discuss the residual soil profiles that you expect to develop in the in two areas indicated on the map of question 1.2 (Both are of the same lithology, indicated by green. The areas are in the City Centre and south of Mondeor). What are the problems that can be expected when building on these soils? (15 marks)