UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF GEOLOGY

B ENG TECH: EXTRACTION METALLURGY

MODULE GMESCA2

ENGINEERING GEOLOGY (METALLURGY) 2A

CAMPUS **DFC**

JUNE EXAMINATION

DATE: 04 JUNE 2020 **SESSION: 12:30-15:30**

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MODERATOR: **MR F SENZANI**

DURATION: 3 HOURS **MARKS 200**

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INSTRUCTIONS: **ANSWER ALL THE QUESTIONS**

REQUIREMENTS: **ANSWER SCRIPT**

Section A

Question 1:

State whether the following statements are true or false:

1.1 Chromite, the only ore of chromium is normally composed of iron and chrome oxides in the ratio of 68 % chrome to 32 % iron, although this ratio may differ if aluminium and manganese are present as substitutes.

1.2 Examples of copper sulphide minerals include chalcopyrite, bornite and arsenopyrite.

1.3 An ore body is a three-dimensional mass/volume of gangue minerals enclosed by host rocks.

1.4 The term *"tenor"* can be used indicate the amount of diamonds present in a kimberlite.

1.5 Magmatic mineral deposits do not vary considerably in composition.

1.6 The chromite deposits of the Bushveld Complex are examples of immiscible liquid separation.

1.7 Late magmatic deposits such as residual liquid segregation usually crystallize after the silicates.

1.8 Volcanogenic Exhalative (SEDEX) deposits consist of massive accumulations of sulphide minerals (usually > 60% sulphides).

1.9 Pegmatite deposits can host gemstones such as tourmaline and topaz.

1.10 Residual deposits generally form as a result of weathering be it chemical or mechanical weathering.

1.11 The feldspar group of minerals is the most common and abundant in the Earth's crust and these tend to breakdown to form clay minerals.

1.12 The term laterite is used to describe a residual deposit that contains oxides and hydroxides of Fe, Al, Ti and Mn.

1.13 Resistant minerals are also known as placer minerals.

1.14 Garnets are not resistant minerals and thus cannot be placer minerals.

1.15 Andalusite is an example of an igneous mineral found in the hornfels in the Bushveld Complex.

1.16 Pegmatites form early on in the crystallization of a magma.

1.17 Early-crystallizing minerals, if denser than the magma will sink through the still liquid fraction of the magma and become segregated in bodies of possible economic size.

1.18 Hydrothermal fluids remain at the same temperature regardless of the distance from the intrusion.

1.19 Banded ironstones are an example of chemically formed deposits.

1.20 Organisms can play an important role in concentrating certain elements.

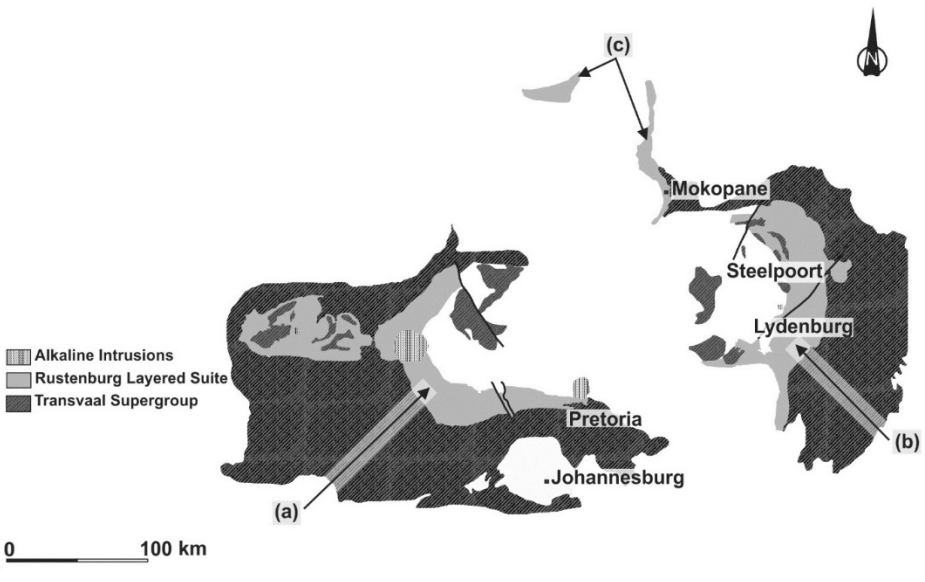
1.21 Black smokers are present day examples of volcanogenic massive sulphide deposits.

1.22 Minerals with a low relative density (RD) are suitable for the formation of placer mineral deposits.

1.23 The largest gold deposits in South African are hosted by the rocks of the Barberton Supergroup.
1.24 An increase in heat can change the ranking of coal from bituminous to anthracite.
1.25 Glossopteridae, a class of plants dominated Northern-hemisphere coal swamps.
1.26 There are hundreds of kimberlite bodies in South Africa, all of which host payable diamond ore.
1.27 The Black Reef is a gold bearing horizon found in the Witwatersrand Supergroup.
1.28 The geological community is now in agreement that the gold hosted in the Witwatersrand Supergroup was deposited only as placer bodies.
1.29 The most important source of copper is the Phalaborwa Complex.
1.30 Gold in the Barberton Supergroup is deposited from hydrothermal fluids in fractures and structural traps.
1.31 The Black Reef is known as a scavenger reef as the gold in the Black Reef originates from the underlying Witwatersrand conglomerates.
1.32 Platinum-group metals (PGMs) cannot be used as catalysts due to their low melting points.
1.33 The UG2 has very high grades of copper, nickel and gold.
1.34 Structural control was relatively unimportant in the formation of the gold deposits from the Barberton Supergroup.
1.35 Prior to coal forming times a glacial period had existed and aided in forming the depressions in parts of the world.
1.36 Platinum-group metals occur as a by-product from mining of gold-bearing conglomerates of the Witwatersrand Supergroup.
1.37 Due to their high relative density (RD) diamonds can be extracted from the ore using gravity separation.
1.38 The platinum-group element deposits of the Bushveld Complex formed as a result of magmatic processes.
1.39 Residual deposits are typical primary deposits.
1.40 Feldspars are a type of residual clay.

[40]

Question 2:



Refer to the Figure above which is a geological map of an economically important mineral deposit.

2.1 Label (a), (b) and (c) as found in the Figure above.

(6)

2.2 What type of deposit (i.e. magmatic or secondary) is depicted in the Figure above?

(4)

2.3 What type of precious metal mineralization do the rocks in the Figure above host?

(2)

2.4 List at least three horizons from the Figure above that contain economically important PGE mineralization.

(6)

2.5 List the minerals that the platinum-group minerals are associated with in the Merensky Reef.

(4)

2.6 How are ores of this type of deposit processed?

(3)

2.7 Explain where the platinum-group metal content is the highest in the UG2.

(2)

2.8 What is the classical example of the Merensky Reef found in the Western limb of the Bushveld Complex also known as?

(2)

2.9 Where do the economic PGMs occur within the Merensky Reef and the UG2, i.e. in what minerals do they occur as well as what minerals are the PGMs associated with?

(5)

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Question 3:

3.1 In a short and concise sentence explain the difference between chromium, chromite and chromitite.

(6)

3.2 In a concise sentence explain the difference between a primary and a secondary mineral deposit

(4)

3.3 In which horizon from the Bushveld Complex are copper, nickel and gold mined as by-products?

(2)

3.4 List the agents that are responsible for decay of organic matter which leads to peat formation.

(5)

3.5 Of the five agents listed in Question 3.4 above which two are the most effective decay agents?

(2)

3.6 What are the four components found in coal?

(4)

3.7 What are the main minerals that make up the ash composition of coal? List only four in your answer.

(4)

3.8 List the three types of analyses used to determine the rank and type of coal

(3)

3.9 Bituminous coal can be divided into two groups. List these two groups and indicate what the coal in each group is used for.

(4)

3.10 List two coal fields in South Africa from which a majority of the coal is produced.

(2)

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Question 4:

Give one word for the following:

4.1 The most important ore of aluminium.
4.2 The highest rank of coal.
4.3 Placers formed by river action.
4.4 The actual amount of metal in an ore.
4.4 Secondary minerals formed by descending solutions.
4.5 Associated non-metallic or metallic minerals considered worthless at the time of exploration of an ore body.
4.6 Rock type used as evidence for glaciation.
4.7 These elements are excellent catalysts.
4.8 Deposits associated with hot water-rich fluids.
4.9 Concentration of economic minerals by wind action.
4.10 Minerals that concentrate by gravity without flowing water.
4.11 Surface iron salts resulting from the evaporation of groundwater.
4.12 Calcium sulphate mineral formed through evaporation.
4.13 Mineral with a fibrous habit and used in many applications such as heat and acid resistance.
4.14 The name of phosphate deposits formed from sea birds' excrement.

4.15 Fools' gold (mineral name).
4.16 The metamorphic mineral that forms when shale undergoes thermal metamorphism to form hornfels.
4.17 Topaz and beryl occur in this rock type.
4.18 Scattered throughout the rock/orebody.
4.19 An unusually coarse-grained rock which may contain some rare minerals.
4.20 Diamonds occur as inclusions in this rock type.

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Question 5:

Explain what is meant by the following terms commonly used in the coal mining industry:

5.1 Moisture content
5.2 Ash content
5.3 Volatile matter content
5.4 Calorific value
5.5 Rank

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Section B:
Multiple choice
Write down the question number and the correct letter only in the answer sheet, i.e. 1a.

1. A residual clay deposit:
   a. may form from the weathering of feldspars
   b. may form from the weathering of granite
   c. may consist of kaolinite and montmorrilonite
   d. all of the above
   e. a and b only
   f. none of the above

2. Diamonds found in river gravels are an example of:
   a. injection deposits
   b. magmatic processes
   c. alluvial processes
   d. magmatic dissemination

3. Refractory gold:
    a. is a specific type of gold that is deposited hydrothermally
    b. is gold that is difficult or expensive to recover
    c. is gold recovered from gold mine dumps
    d. is gold that has a high refractive index

4. The gold in the Barberton Supergroup formed due to:
    a. placer processes
    b. hydrothermal fluids
    c. supergene enrichment
    d. organically enhanced processes

5. Because the platinum ores in the Merensky Reef occur within sulphides:
    a. substantial PGM's are recovered as by-products
    b. substantial copper and nickel are recovered as by-products
    c. it may aid their recovery by means of piggy-back flotation
    d. a and b only
    e. b and c only

6. Bituminous coal:
    a. is the same as lignite
    b. may have coking properties
    c. is of lower rank than lignite
    d. none of the above

7. Calorific value:
    a. is part of proximate analysis
    b. is the loss of mass on heating to 900°C
    c. is of little importance in anthracite
    d. none of the above

8. Guano:
    a. is an algae eaten by fish
    b. is a variety of dolomitic stromatolites
    c. is mined with copper at Phalaborwa
    d. is a biochemical phosphate deposit
    e. none of the above

9. Bauxite:
    a. is an important source of manganese
    b. is a mixture of hydrous aluminium silicates
    c. is an important source of magnesium
    d. is an important source of aluminium

10. Placer deposits are most likely to form if:
    a. the minerals are melted
    b. the country rock is siliceous
    c. a small dyke-like intrusion occurs nearby
    d. cooling takes place rapidly
    e. none of the above

11. Diamonds have the following properties:
    a. are hard
    b. have a high relative density
    c. fluoresce under X-ray light
    d. all the above

12. Deposition in an alluvial placer can be favoured by:
    a. a decrease in the water velocity
    b. an increase in the water velocity
    c. the presence of insoluble minerals
    d. none of the above

13. The increasing grade of coal is primarily a function of:
    a. decreasing pressure
    b. the type of hydrothermal fluid
    c. increasing metamorphism
    d. the length of time being exposed on surface

14. Two ferromagnesian minerals are:
    a. garnet and quartz
    b. orthoclase and amphibole
    c. biotite and calcite
    d. olivine and pyroxene
    e. augite and plagioclase

15. Which of the following asbestos minerals form as a result of alteration of amphibole minerals:
    a. chrysotile
    b. crocidolite
    c. amosite
    d. b and c only
    e. none of the above

16. Biochemical factors :
    a. are important only during the first stage of the coalification process
    b. continue throughout the life of a coal seam
    c. are produced by peat water
    d. none of the above

17. Diamond bearing alluvial gravels are mined along these rivers:
    a. Vaal and Orange
    b. Vaal and Groen
    c. Orange and Wit
    d. Orange and Crocodile

18. In magmas when the basic consituents (i.e. rich in Fe and Mg) have been subtracted:
    a. the magma becomes richer in silica
    b. there is an increase in pressure
    c. the is an increase in temperature
    d. all of the above
    e. none of the above

19. The Bushveld Complex:
    a. contains economic gold in granites
    b. consists of the Western belt (limb) and an Eastern belt (or limb)
    c. contains pyroxenites
    d. b and c only
    e. none of the above

20. This property **least** favours a minerals mechanical concentration:
    a. low specific gravity
    b. no cleavage
    c. tenacity
    d. malleability

21. Chalcopyrite contains:
    a. gold, iron and copper
    b. copper, iron and sulphur
    c. chalcocite, iron and sulphur

22. Magmatic deposits:
    a. are associated with volcanic activity
    b. are associated with hot water-rich fluids
    c. are associated intrusives

23. The highest rank of coal is:
    a. bituminous
    b. lignite
    c. graphite
    d. anthracite

24. The primary crustal source rock of diamonds in South Africa is:
    a. dolerite
    b. andesite
    c. kimberlite
    d. all of the above
    e. none of the above

25. Limestone and banded iron formations are examples of:
    a. clastic sedimentary deposits
    b. placer deposits
    c. supergene deposits
    d. chemically formed deposits

26. Important diamond-bearing kimberlite pipes can be found in:
    a. Kimberley
    b. Pretoria
    c. Modderfontein
    d. a and b only
    e. none of the above

27. Coalification
    a. is essentially a process of metamorphism
    b. during this process an increase in heat and pressure results in an increase in carbon content
    c. results in the increase of volatile content
    d. a and b only

28. Coking coal is used for:
    a. power generation
    b. cement manufacture
    c. manufacture of iron and steel
    d. industrial uses

29. Geologically speaking kimberlites are:
    a. relatively young
    b. relatively old
    c. none of the above

30. Apart from kimberlite pipes, diamonds also occur in:

a. placers
b. beach deposits
c. aeolian deposits
d. kimberlite fissures
e. all of the above

[30]