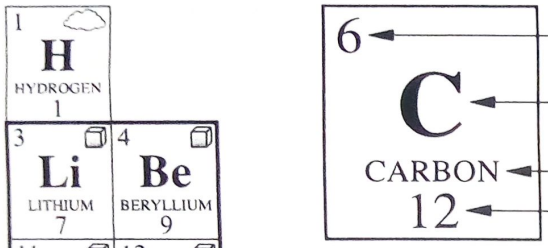
# The Periodic Table of Elements




**Atomic Number** = Number of Protons = Number of Electrons

**Chemical Symbol**

**Chemical Name**

**Atomic Weight** = Number of Protons + Number of Neutrons*

NON-METALS

METALS

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H HYDROGEN 1 | | | | | | | | | | | | | | | | | 2 He HELIUM 4 |
| 3 Li LITHIUM 7 | 4 Be BERYLLIUM 9 | | | | | | | | | | | 5 B BORON 11 | 6 C CARBON 12 | 7 N NITROGEN 14 | 8 O OXYGEN 16 | 9 F FLUORINE 19 | 10 Ne NEON 20 |
| 11 Na SODIUM 23 | 12 Mg MAGNESIUM 24 | | | | | | | | | | | 13 Al ALUMINUM 27 | 14 Si SILICON 28 | 15 P PHOSPHORUS 31 | 16 S SULFUR 32 | 17 Cl CHLORINE 35 | 18 Ar ARGON 40 |
| 19 K POTASSIUM 39 | 20 Ca CALCIUM 40 | 21 Sc SCANDIUM 45 | 22 Ti TITANIUM 48 | 23 V VANADIUM 51 | 24 Cr CHROMIUM 52 | 25 Mn MANGANESE 55 | 26 Fe IRON 56 | 27 Co COBALT 59 | 28 Ni NICKEL 59 | 29 Cu COPPER 64 | 30 Zn ZINC 65 | 31 Ga GALLIUM 70 | 32 Ge GERMANIUM 73 | 33 As ARSENIC 75 | 34 Se SELENIUM 79 | 35 Br BROMINE 80 | 36 Kr KRYPTON 84 |
| 37 Rb RUBIDIUM 85 | 38 Sr STRONTIUM 88 | 39 Y YTTRIUM 89 | 40 Zr ZIRCONIUM 91 | 41 Nb NIOBIUM 93 | 42 Mo MOLYBDENUM 96 | 43 Tc TECHNETIUM 98 | 44 Ru RUTHENIUM 101 | 45 Rh RHODIUM 103 | 46 Pd PALLADIUM 106 | 47 Ag SILVER 108 | 48 Cd CADMIUM 112 | 49 In INDIUM 115 | 50 Sn TIN 119 | 51 Sb ANTIMONY 122 | 52 Te TELLURIUM 128 | 53 I IODINE 127 | 54 Xe XENON 131 |
| 55 Cs CESIUM 133 | 56 Ba BARIUM 137 | | 72 Hf HAFNIUM 178 | 73 Ta TANTALUM 181 | 74 W TUNGSTEN 184 | 75 Re RHENIUM 186 | 76 Os OSMIUM 190 | 77 Ir IRIDIUM 192 | 78 Pt PLATINUM 195 | 79 Au GOLD 197 | 80 Hg MERCURY 201 | 81 Tl THALLIUM 204 | 82 Pb LEAD 207 | 83 Bi BISMUTH 209 | 84 Po POLONIUM 209 | 85 At ASTATINE 210 | 86 Rn RADON 222 |
| 87 Fr FRANCIUM 223 | 88 Ra RADIUM 226 | | 104 Rf RUTHERFORDIUM 263 | 105 Db DUBNIUM 268 | 106 Sg SEABORGIUM 271 | 107 Bh BOHRIUM 270 | 108 Hs HASSIUM 270 | 109 Mt MEITNERIUM 278 | 110 Ds DARMSTADTIUM 281 | 111 Rg ROENTGENIUM 281 | 112 Cn COPERNICIUM 285 | 113 Nh NIHONIUM 286 | 114 Fl FLEROVIUM 289 | 115 Mc MOSCOVIUM 289 | 116 Lv LIVERMORIUM 293 | 117 Ts TENNESSINE 294 | 118 Og OGANESSON 294 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 La LANTHANUM 139 | 58 Ce CERIUM 140 | 59 Pr PRASEODYMIUM 141 | 60 Nd NEODYMIUM 144 | 61 Pm PROMETHIUM 145 | 62 Sm SAMARIUM 150 | 63 Eu EUROPIUM 152 | 64 Gd GADOLINIUM 157 | 65 Tb TERBIUM 159 | 66 Dy DYSPROSIUM 163 | 67 Ho HOLMIUM 165 | 68 Er ERBIUM 167 | 69 Tm THULIUM 169 | 70 Yb YTTERBIUM 173 | 71 Lu LUTETIUM 175 |
| 89 Ac ACTINIUM 227 | 90 Th THORIUM 232 | 91 Pa PROTACTINIUM 231 | 92 U URANIUM 238 | 93 Np NEPTUNIUM 237 | 94 Pu PLUTONIUM 244 | 95 Am AMERICIUM 243 | 96 Cm CURIUM 247 | 97 Bk BERKELIUM 247 | 98 Cf CALIFORNIUM 251 | 99 Es EINSTEINIUM 252 | 100 Fm FERMIUM 257 | 101 Md MENDELEVIUM 258 | 102 No NOBELIUM 259 | 103 Lr LAWRENCIUM 262 |

**KEY**

- = Solid at room temperature
- = Liquid at room temperature
- = Gas at room temperature
- = Radioactive
- = Artificially Made

* The atomic weights listed on this Table of Elements have been rounded to the nearest whole number. As a result, this chart actually displays the **mass number** of a specific isotope for each element. An element's complete, unrounded atomic weight can be found on the It's Elemental website: http://education.jlab.org/itselemental/

AUSTIN GERRARD BANDA

**UNIVERSITY OF ZAMBIA**
**UNIVERSITY EXAMINATIONS – NOVEMBER 2021**

**GGY4031: SEDIMENTOLOGY**
**(PAPER I – THEORY)**

**TIME:** THREE (3) HOURS

**INSTRUCTIONS:** ANSWER ANY 5 QUESTIONS. EACH QUESTION CARRY EQUAL MARKS. WELL – LABELLED SKETCHES & DIAGRAMS ARE REQUIRED FOR A FULL MARK

1. Distinguish between the following:

   (a) Bindstone and Framestone.

   (b) Matrix and cement in carbonate rocks.

   (c) Glaciolacustrine and glaciomarine

   (d) Planar cross-bedding and Trough cross-bedding

   (e) Bed load and Suspended load

2. (a) With the aid of a neatly labeled sketch, describe the ideal turbidite (Bouma) sequence.

   (b) Outline the 4 functions, which Facies Models should fulfill.

   (c) With an aid of a table, differentiate between terrigenous clastic and carbonate sediments

   (d) Describe briefly the characteristic (diagonostic) features of glacial deposits.

3. (a) Briefly outline two methods by which sedimentary structures are classified indicating their limitations.

   (b) Outline the characteristics features of eolian deposits

   (c) Explain how lakes are created.

4. (a) Differentiate between proximal and distal trends of an alluvial fan setting.

   (b) In the study of depositional environments, modeling of depositional systems is important. Outline the common elements you would consider in developing a model of a braided river system.

   (c) In Meandering River systems, in-channel deposits are very common. A good example is a point bar sequence. Describe an "ideal" point bar sequence with the aid of a sketch.

5. (a) The Zambian Copperbelt Lower Roan Group is interpreted as being deposited in a shallow marine environment. One such sub-environment is the peritidal systems which includes tide dominated lagoons and tidal flats. Outline the common elements of the peritidal system model.

   (b) Describe the factors that influence the development of delta systems and its importance.

   (c) Briefly outline the characteristic features of ocean basins.

6 (a) How are carbonate minerals formed?

   (b) With an aid of a sketch, show the zonation of marginal reef

   (c) Outline the stages of vertical zonation of reef growth

   (d) Through the geological time scale reef builders have been recognised. List three of such builders and indicate which one (s) where active during the deposition of the Lower Roan Group deposition on the Zambian Copperbelt

7 (a) List the five common evaporite minerals

   (b) Briefly explain the four Common Techniques used in Basin Analysis

   (c) Basin Analysis is an important tool in the study of any sedimentary basin. Briefly describe two application of basin analysis giving Zambian examples in each case.

   (d) Outline principal kinds of depositional basins as defined by Mitchel and Reading (1986)

GOOD LUCK

END OF EXAM

AUSTIN GERRARD BY

# THE UNIVERSITY OF ZAMBIA

## UNIVERSITY EXAMINATIONS – NOVEMBER 2020

## GGY 4031 - SEDIMENTOLOGY

## PAPER II – PRACTICAL

**INSTRUCTIONS:** ANSWER ALL QUESTIONS. SKETCHES AND DIAGRAMS ARE IMPORTANT FOR A FULL MARK

**TIME:** THREE (3) HOURS

As a Geological Survey of Zambia Sedimentologist, you were assigned to map and interpret an outcrop in the Gwembe Valley. Whilst you were in the field, you put together a Graphic Log of the area (Table below). In the lab you described the mineralogy of the two sandstones (**A and B**) you collected from the field.

### GRAPHIC LOG

| Unit No. | Thick -ness | Upper Contact | Lithology | Primary Sedimentary Structures | Samples / Palaeo-Current (°) |
|---|---|---|---|---|---|
| 8 | 3m | Sharp | Shaly to coaly mudstones with 1m coal seam intercalations | Fissile in places, rootlets and plant impressions | |
| 7 | 4m | Sharp | Fine- to medium-grained sandstones with carbonaceous mudstone to claystone towards top | Horizontal bedded with laminated carbonaceous mudstone and claystone towards top | |
| 6 | 5m | Sharp depositional | Coarse-grained to pebbly sandstone | Trough cross-bedding alternating with planar x-beds | (°)<br>60; 80; 70; 50; 45; 90; 110; 85; 75; 60<br>**Thin Section B** |
| 5 | 4m | Sharp erosional | Matrix supported conglomerates with isolated boulders in places. Intercalations of sandstones observed | Massive with crude bedding locally horizontal bedding | |
| 4 | 3m | Sharp depositional | Clast-supported conglomerates up to coble size | Complex bed forms with tabular sheets | |
| 3 | 4m | Sharp depositional | Pebbly sandstones with minor intercalations of layered siltstones. | Trough cross-bedding | (°)<br>190; 200; 230; 205; 270; 295; 275; 290; 200, 260. |
| 2 | 3m | Gradational | Nearly horizontally | Parallel laminated in the | (°) |

09/05/2018

8. (a) On what basis are Carbonates classified or divided..... Type of carb grain & grain matrix ratio 2 marks

(b) What are the 3 components of Carbonate Rocks and DEFINE them .....9 marks

(c) Name the four main types of clasts in Carbonate Rocks.....4 marks

(d) Name the commonly used in the field Carbonate classification .....2 marks

(e) This classification recognises 6 rock types. Name and define them.....18 marks

9. (a) What is the difference between Sedimentary Environment and Sedimentary Facies.....4 marks

(b) In interpreting a sedimentary environment in which a sequence of sediments or rocks occur, outline the 6 things that you have to consider..... 12 marks

(c) Define Facies Models.....2 marks

(d) Give 5 ways in which you can express facies models.....10 marks

(e) What are the four functions of facies models ..... 8 marks

10. The Udden-Wentworth scale is a commonly used scale in Sedimentology.

Fill in the missing words .....10 marks

10/10

| | US standard sieve mesh | Millimeters | Phi (ϕ) | Wentworth size class |
|---|---|---|---|---|
| GRAVEL | | 4096 | −12 | (a) boulder ✓ |
| | | 1024 | −10 | |
| | | 256 | −8 | (b) cobble ✓ |
| | | 64 | −6 | |
| | | | −5 | Pebble |
| | | 16 | −4 | |
| | 5 | 4 | −2 | |
| | 6 | 3.36 | −1.75 | (c) granule ✓ |
| | 7 | 2.83 | −1.5 | |
| | 8 | 2.38 | −1.25 | |
| | 10 | 2.00 | −1.0 | (d) very coarse sand ✓ |
| SAND | 12 | 1.68 | −0.75 | |
| | 14 | 1.41 | −0.5 | |
| | 16 | 1.19 | −0.25 | (e) coarse sand ✓ |
| | 18 | 1.00 | 0.0 | |
| | 20 | 0.84 | 0.25 | |
| | 25 | 0.71 | 0.5 | |
| | 30 | 0.59 | 0.75 | |
| | 35 | 0.50 | 1.0 | |
| | 40 | 0.42 | 1.25 | Medium sand |
| | 45 | 0.35 | 1.5 | fine |
| | 50 | 0.30 | 1.75 | (f) fine sand ✓ |
| | 60 | 0.25 | 2.0 | |
| | 70 | 0.210 | 2.25 | |
| | 80 | 0.177 | 2.5 | |
| | 100 | 0.149 | 2.75 | |
| | 120 | 0.125 | 3.0 | |
| | 140 | 0.105 | 3.25 | (g) very fine sand ✓ |
| | 170 | 0.088 | 3.5 | |
| | 200 | 0.074 | 3.75 | |
| | 230 | 0.0625 | 4.0 | |
| MUD | 270 | 0.053 | 4.25 | (h) coarse silt ✓ |
| | 325 | 0.044 | 4.5 | |
| SILT | | 0.037 | 4.75 | |
| | | 0.031 | 5.0 | Medium silt |
| | | 0.0156 | 6.0 | (i) fine silt ✓ |
| | | 0.0078 | 7.0 | Very fine silt |
| | | 0.0039 | 8.0 | |
| CLAY | | 0.0020 | 9.0 | (j) clay ✓ |
| | | 0.00098 | 10.0 | |
| | | 0.00049 | 11.0 | |
| | | 0.00024 | 12.0 | |
| | | 0.00012 | 13.0 | |
| | | 0.00006 | 14.0 | |

AUSTIN GERR...
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# UNIVERSITY OF ZAMBIA

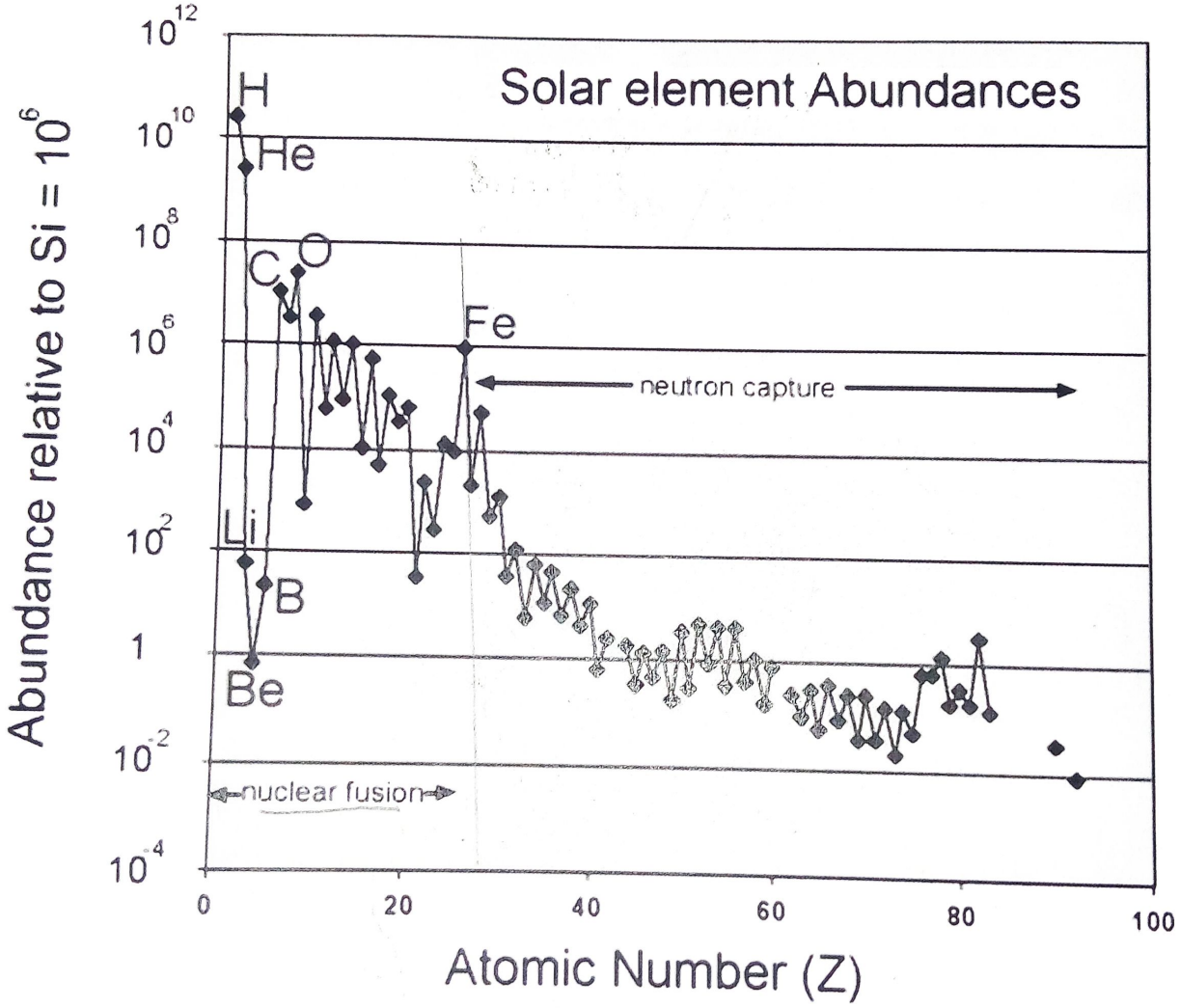
## DEPARTMENT OF GEOLOGY

## GGY 4090 – GEOCHEMISTRY TEST

**INSTRUCTIONS:** ANSWER **ALL** QUESTIONS

**Q1.** a) Discuss the origin of the chemical elements in the solar system

**b)** Discuss at least three (3) important observations that you can make from this figure below in connection to the abundances of chemical elements in the solar system




**Q2.** The mineralogy of each solar system can be predicted fairly satisfactorily from its position in the proto-solar nebula and therefore from its temperature. Discuss how the temperature during the formation of solar system accreted the Goldschmidt's Classification of solar system elements

**Q3.** A rock sample was found to contain gangue mineral such as hematite and ore mineral such as malachite.

a) Write the balance hydrolysis reaction which led to the formation of a gangue mineral hematite
b) Write the balance reaction which led to the precipitation of ore mineral malachite

**Q4.** Draw the Eh-pH diagrams for various cobalt (Co) species ($Co^{2+}$; $Co(OH)_2$; $Co_3O_4$). Use the thermodynamic data provided in Table 1.

***Thermodynamic data of Cobalt***

| **Item** | **$\Delta G^o_f$ (Kcal/gfw)** |
|---|---|
| $Co^{2+}$ | -13.00 |
| $Co(OH)_2$ | -107.53 |
| $Co_3O_4$ | -184.99 |
| $H_2O$ | -56.69 |
| $H^+$ | 0 |

$Co^{2+} + 2H_2O \rightleftharpoons Co(OH)_2 + 2H^+$

$3Co(OH)_2 \rightarrow Co_3O_4 + 2H_2O + 2H^+ + 2e$

$3Co^{2+} + 4H_2O \rightarrow Co_3O_4 + 8H^+$

$3Co^{2+} + 4H_2O \rightarrow Co_3O_4 + 8H^+ + 16e$

# UNIVERSITY OF ZAMBIA EXAMINATIONS

## SCHOOL OF MINES

## GEOLOGY DEPARTMENT

**NOVEMBER, 2021**

## GGY 4090 – GEOCHEMISTRY

**INSTRUCTIONS: THE PAPER COMPRISES TWO (2) SECTIONS. ANSWER TWO (2) QUESTIONS IN EACH SECTION. HOWEVER, QUESTION ONE (1) IN SECTION A IS COMPULSORY. ANSWER EACH SECTION IN A SEPARATE BOOKLET**

**TIME ALLOWED: 3 HOURS**

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## SECTION A

**Q1.** Manganese (Mn) in nature occurs mainly in form of oxides ($MnO_2$; $Mn_2O_3$; $Mn_3O_4$) through hydrolysis process

i. Write the **balance chemical hydrolysis** reactions involving **Mn oxides**
ii. Construct the **Eh-pH diagram** for the system **Mn-O-$H_2O$** using the graph paper provided
iii. Based on the results in (ii) above, discuss the **behavior of Mn with pH**

***Thermodynamic data of manganese is listed below***

| | $\Delta G^o$ (Kcal/gfw) |
|---|---|
| $Mn^{2+}$ | -54.52 |
| MnO | -18.74 |
| $MnO_2$ | -111.17 |
| $Mn_2O_3$ | -210.59 |
| $Mn_3O_4$ | -306.69 |
| $MnOH^+$ | -96.80 |
| $H_2O$ | - 56.69 |

**Q2.** a) Briefly describe the **origin and processes** which resulted in the elemental abundances and their distributions in solar system

b) Discuss the observed **general trends and distributions** in the elemental abundances in the Solar System shown in Fig. 1 below

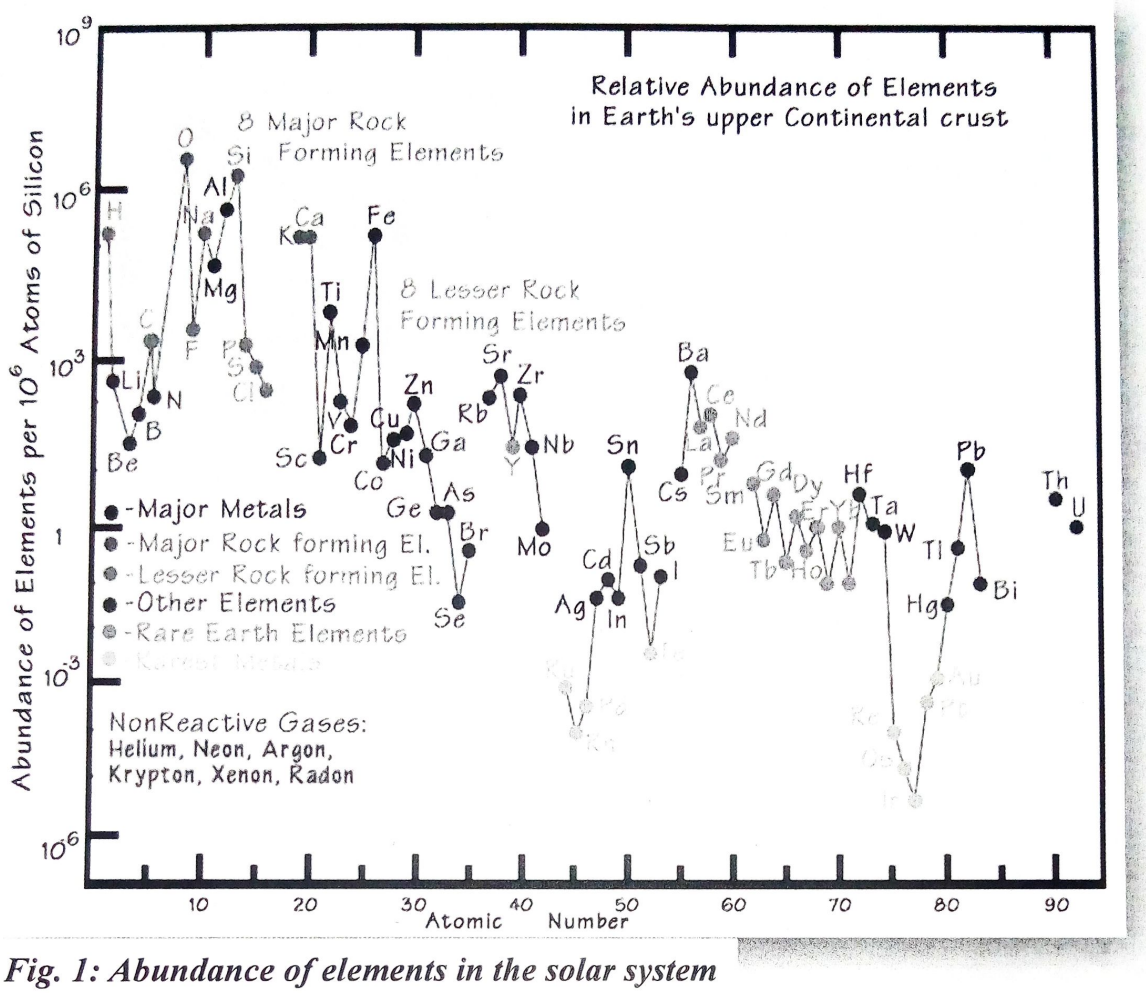



***Fig. 1: Abundance of elements in the solar system***

c) Write short notes on the **Goldschmidt's Classification** of elements

**Q3.** a) Define **Law of mass action**

b) State **five classes** of reactions that can be considered in thermodynamic equilibrium

c) A sample of groundwater passing through a gypsum layer was found to contain 8.4 x $10^{-5}$

$^{5}$M in $Ca^{2+}$ and 7.2 x$10^{-5}$M in $SO_4^{2-}$.

i. Write the **Gypsum dissolution reaction equation**
ii. Calculate the Ion Activity Product **(IAP)** of the reaction
iii. Illustrate with **reasons** the equilibrium state of the solution **with respect the gypsum**

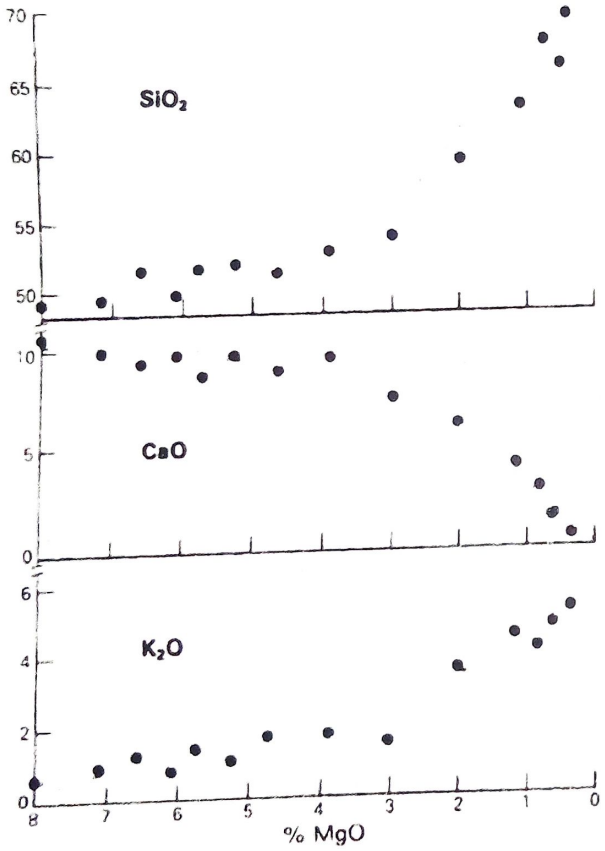
## SECTION B

Q4. Write brief notes on the geochemical reactions which would take place during progressive medium pressure regional metamorphism of a sequence of sedimentary rocks which contains sandstone, shale, pure dolomite and a siliceous limestone (25 marks).

Q5. Discuss the following in relation to magmatic systems: i) major elements, ii) minor elements, and iii) trace elements (25 marks).

Q6. a) Briefly discuss chemical variation diagrams and their use in petrogenetic studies ($12^1/_2$ marks).

b) Study the figure below of geochemical results of cogenetic volcanic rock samples and explain the possible fractionation crystallisation processes which took place ($12^1/_2$ marks).




*END OF THE EXAM... GOOD LUCK*

# UNIVERSITY OF ZAMBIA EXAMINATIONS

## SCHOOL OF MINES

## GEOLOGY DEPARTMENT

**NOVEMBER, 2021**

## GGY 4090 – LOW AND HIGH TEMPERATURE GEOCHEMISTRY
## PAPER II PRACTICAL

**INSTRUCTIONS: ANSWER ALL QUESTIONS**

**TIME ALLOWED: 3 HOURS**

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**Q1.** You conducted X-Ray Fluorescence **(XRF)** analyses on two (2) rock samples so as to determine the mineral deposits associated with these rocks. The results of your analyses are shown in Table 1 below.

*Table 1. Whole Rock Geochemical Analyses of Rock samples*

| **Major Oxides** | A | B |
|---|---|---|
| $SiO_2$ | 45.5 | 66.12 |
| $TiO_2$ | 0.11 | 0.79 |
| $Al_2O_3$ | 3.64 | 15.82 |
| $Fe_2O_3$ | 10.4 | 0.23 |
| MgO | 33.1 | 0.45 |
| CaO | 3.1 | 3.62 |
| $Na_2O$ | 0.11 | 2.84 |
| $K_2O$ | 0.2 | 6.11 |
| $P_2O_5$ | 0.01 | 0.05 |
| $H_2O$ | 0.45 | 3.12 |
| **Trace elements** | | |
| Sr (ppm) | 17.8 | - |
| U (ppb) | 18 | 750 |
| La (ppb) | 51 | 551 |
| Eu (ppb) | 131 | - |
| V (ppm) | 128 | 101 |
| Cr (ppm) | 9000 | - |
| Ni (ppm) | 6500 | 2250 |
| Zn (ppm) | 350 | 6200 |
| Zr (ppm) | - | 201 |
| S (ppm) | 4200 | 8250 |

a) Discuss *with reasons* the type(s) of magma source associated with the analysed two (2) rock types (A and B)

b) Calculate the major potential host (rock-forming) minerals from the major oxide analyses

c) Calculate the potential ore minerals from the trace elemental analyses

*NOTE: Use the periodic table provided where necessary*

**Q2.** A client provided you with a rock sample for geological analyses labelled X

i. Tentatively, describe the visual host(s) (gangue) and ore minerals associated with this rock sample

ii. Write the balance geochemical reaction equations of the formation of the host(s) (gangue) and ore mineral(s) you have just described above (***Hint:*** Consider some potential hydrolysis/redox/precipitation reactions)

iii. Discuss the effects of pH on the ore mineral(s) observed (***Hint:*** Pour HCl/water onto the samples)

**END OF EXAM**