Benha university
Faculty of science
Geology Dept.

Examination of Geochemistry (433 G)for the 4th level students (special Geology), Jan 2019.

4th Level
Date: 13 / 1 /2019
Time: Two Hours

Answer the following questions.

1) Choose the best answer for the followings: **(24 Marks)**

1. In peraluminous rocks, we expect to find an Al_2O_3 rich mineral present as a modal mineral such as – – – – – – or an Al_2SiO_5 mineral like – – – – – .
   a. diopside – corundum
   b. corundum– diopside
   c. **topaz – sillimanite**
   d. corundum – topaz

2. Basalts with normative compositions that contain no Qtz or Opx, but contain Ne are silica undersaturated (the volume Ne– Plag– Cpx– Ol) they may be – – – – – – .
   a. **Basanites**
   a. Hornblendite
   b. Quartz Tholeiites.
   c. Olivine Tholeiites.

3. In basic magmas the alkaline elements such as K and Na behave as – – – – – – elements, so crystallization of Mg & Fe– rich phases tends to cause both SiO2 and alkalis to – – – – – .
   a. Comaptible – incerease
   b. Comaptible – decrease
   c. incompatible – decrease
   d. **incompatible – increase**

4. Potassium never forms its own phase in – – – – – – – – – – – – – – – – ; its concentration rarely exceeding 1500 ppm; but K is certainly not – – – – – element in granites
   a. **MORB – trace**
   b. MORB – incompatible
   c. OIB – trace
   d. OIB– incompatible

5. Compatibility of an ion is controlled by two things: its valence and its ionic radius Both must approximate those of the – – – – – – element for the – – – – – – element to be compatible in the mineral.
   a. compatible –incomatiple
   b. incompatible –comatiple
   c. **major– trace**
   d. trace – major

6. If two ions have a similar radius but different valence, the ion with the higher charge is more readily incorporated into the solid over the liquid. Thus Cr+3 and Ti+4 are almost always preferred in solids as compared to liquids.
   a. Mg2+ – Ni2+
   b. Fe2+ – Ni2+
   c. K – Rb
   d. **Cr+3 – Ti+4**

7. Hf usually does not form its own mineral; it is – – – – – – – – in zircon.

a. precipitated
b. **camouflaged**
c. admitted
d. captured

8. $K^+ + Si^{4+} \leftrightarrow Sr^{2+} + Al^{3+}$ is good example for– – – – – – to balance charge.

a. free substitution
b. **coupled substitution**
c. compatible substitution
d. incompatible substitution

9. – – – – – – – – – – – – involves entry of a foreign ion with an ionic potential less than that of the major ion.

a. Free substitution
b. Camouflage
c. **Admission**
d. Capture

10. Melt of amphibole– bearing rock will → increase K/Rb in the partial melt.

a. **K/Rb**
b. K/Ba
c. Ba/Sr
d. Pyroxene/Hornblende

11. The ratio Ba/Sr increases with crystallization of plagioclase

a. K/Rb
b. K/Ba
c. **Ba/Sr**
d. Cr/Sc

12. – – – – – – – – Substitutes for Ca in plagioclase (but not in pyroxene), and, to a lesser extent, for K in K– feldspars.

a. **Sr**
b. Ba
c. Ti
d. Sc

13. – – – – – – Commonly incompatible (like HREE). Strongly partitioned into garnet and amphibole. Sphene

a. U
b. Th
c. **Y**
d. Ni

14. The HREE readily substitute for – – – – – – in garnet, and hence can be concentrated by it.

a. Fe^{2+}
b. **Al^{3+}**
c. Cr^{3+}
d. Ti^{4+}

15. MORB exhibits a LREE depleted pattern; upper continental crust is LREE enriched with a negative **Eu anomaly**

a. enriched– deplete
b. **depleted – enriched**
c. enriched – enriched
d. depleted – depleted

16. Removal of early formed olivine would decrease the Mg/Fe^{2+} concentration

a. increase
b. **decrease**
c. stabilize
d. not affect

17. The N–MORB shows a large LREE depletion, and a positive slope.

a. E–MORB
b. **N–MORB**
c. OIB
d. OIA

18. In MORB (mid-ocean ridge basalts) and OIB (oceanic island basalts) CO_2 and H_2O concentrations may be roughly similar and are quite-------- low (<0.5%)

a. low <5%
b. low <0.5%
c. high >5%
d. high <0.5%

19. Magma viscosity increases with increasing SiO2 concentration in the magma. This is because---.

a. viscosity is the resistance to flow.
b. viscosity depends on the composition of the magma, and temperature.
c. lower SiO_2 content magmas have higher viscosity than higher SiO_2 content.
d. **lower temperature magmas have higher viscosity than higher temperature**.

20. Certain minerals are practically confined to deep-seated intrusive rocks, e.g., ----------and ------.

a. muscovite and Microcline
b. microcline and orthoclase
c. albite and muscovite
d. leucite and olivine

21. Trace elements will prefer ……

a. liquid phase.
b. solid phase.
c. **either solid or liquid phase**.
d. to have own structure phase.

22. Which of the following statements is not true about the trace element?

a. can be substituted for network-forming cations in mineral structures
b. appear in the mineral's chemical formula
c. the same elements could be compatible or incompatible.
d. could be plotted on both Spider and Harker diagrams.

23. Which pairs of the following is not true during the ascending of magma?

a. Temperature Drops - Increase in viscosity
b. Crystallization begins -Decrease in viscosity
c. More polymerized- Increase in viscosity
d. H2O concentration drops - Increase in viscosity

24. A normal geothermal gradient is approximately _____ .

a. 3000 degrees C per km
b. 300 degrees C per km
c. 30 degrees C per km
d. 3 degrees C per km

2) Determine whether each of the statements below is true or false. Correct the false if any? (12 Marks)

1. True.
2. False diagrams compare elements with large differences of absolute abundance using either ~~log or~~ linear scale
3. False On spider diagram, elements arranged in order of increasing compatibility (i.e., the more incompatible at the left).
4. False, At depth in the Earth, nearly all magmas contain gas. Gas gives magmas their explosive character, because the volume of gas **expands** as pressure is reduced.
5. True.
6. False, Mixtures of minerals always have the **lower** melting points as the pure minerals would.
7. True.
8. True.
9. False, When the parent magmas of basalts crystallize, they preferentially crystallize the more magnesium-rich and iron-poor forms of the silicate minerals olivine and pyroxene.
10. False, Mode is a set of realistic observable minerals that could crystallize from a magma with the same chemical composition as the rock.
11. False, S-type granitoids normally intrude in relatively small volumes, particularly in active margins and continental collision zones.
12. True.

3) a. Discuss the general characteristics of A– , S– , M– and I– type granites? (4 Marks)

Type	SiO_2	K_2O/Na_2O	Ca, Sr	A/(C+N+K)*	Fe^{3+}/Fe^{2+}	Cr, Ni	$\delta^{18}O$	$^{87}Sr/^{86}Sr$	Misc	Petrogenesis
M	46-70%	low	high	low	low	low	< 9‰	< 0.705	Low Rb, Th, U Low LIL and HFS	Subduction zone or ocean-intraplate Mantle-derived
I	53-76%	low	high in mafic rocks	low: metal-uminous to peraluminous	moderate	low	< 9‰	< 0.705	high LIL/HFS med. Rb, Th, U hornblende magnetite	Subduction zone Infracrustal Mafic to intermed. igneous source
S	65-74%	high	low	high peraluminous	low	high	> 9‰	> 0.707	variable LIL/HFS high Rb, Th, U biotite, cordierite Als, Grt, Ilmenite	Subduction zone Supracrustal sedimentary source
A	high □□77%	Na_2O high	low	var peralkaline	var	low	var	var	low LIL/HFS high Fe/Mg high Ga/Al High REE, Zr High F, Cl	Anorogenic Stable craton Rift zone

b. Hypothetical garnet lherzolite = 60% olivine, 25% orthopyroxene, 10% clinopyroxene, and 5% garnet (all by weight), using the data in the next table determine the bulk distribution coefficient for Erbium in garnet lherzolite? (4 Marks)

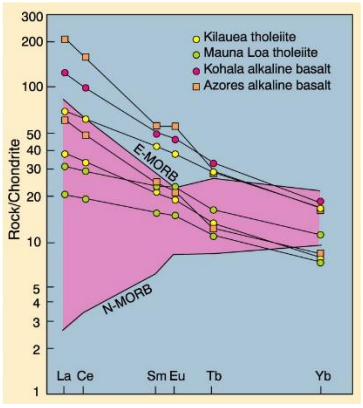
	Olivine	Opx	Cpx	Garnet	Plag	Amph	Magnetite
La	0.007	*0.03*	0.056	0.001	0.148	0.544	2
Ce	0.006	0.02	0.092	0.007	0.082	0.843	2
Nd	0.006	0.03	0.230	0.026	0.055	1.340	2
Sm	0.007	0.05	0.445	0.102	0.039	1.804	1
Eu	0.007	0.05	0.474	0.243	0.1/ 1.5 *	1.557	1
Dy	0.013	0.15	0.582	1.940	0.023	2.024	1
Er	0.026	0.23	0.583	4.700	0.020	1.740	1.5
Yb	0.049	0.34	0.542	6.167	0.023	1.642	1.4
Lu	0.045	0.42	0.506	6.950	0.019	1.563	

Data from Rollinson (1993). * Eu3+/Eu2+

$$\overline{D_{Eu}} = (0.6 * 0.007) + (0.25 * 0.05) + (0.10 * 0.474) + (0.05 * 0.243) = 0.07625$$

c. Based on your study of trace element geochemistry; briefly point to the main differences between MORB and OIB? (4 Marks)

- The large ion lithophile (LIL) trace elements (K, Rb, Cs, Ba, Pb^{2+} and Sr) are incompatible and are all enriched in OIB magmas with respect to MORBs
- The ratios of incompatible elements have been employed to distinguish between source reservoirs
    a. N-MORB: the K/Ba ratio is high (usually > 100)
    b. E-MORB: the K/Ba ratio is in the mid 30's
    c. OITs range from 25-40, and OIAs in the upper 20's
- HFS elements (Th, U, Ce, Zr, Hf, Nb, Ta, and Ti) are also incompatible, and are enriched in OIBs > MORBs.
- OIAs tend to be depleted in Ni and Cr relative to OITs and MORBs, which, along with the higher Mg#s, suggests they have experienced fractionation of these phases prior to eruption.
- Ratios of these elements are also used to distinguish mantle sources
- The Zr/Nb ratio for N-MORB generally quite high (>30) while for OIBs are low (<20)



– Good Luck–

Dr. M. M. Mogahed