

Lab.No.6

Isotope: Element with nucleus having the same number of proton and different number neutron.

mass no. \leftarrow m

E \rightarrow element

atomic no. \leftarrow n

m =mass number (proton + neutron)

Isotopes can be divided into two main groups:

1) Stable (non radioactive) isotopes

2) Nonstable (radioactive) isotopes

Heavy isotope \rightarrow higher mass no.

Light isotope \rightarrow lower mass no.

Isotopic Fractionation:

The distribution of the isotopes of one element between two minerals in different proportions.

Application of stable isotope in ore geology:

- 1- To find the temperature of formation of minerals
- 2- To determine the origin of the mineralizing fluids
- 3- To determine the source of materials necessary in the formation of the ore deposits

Table (1)

Sample no.	Mineral	Measured $\delta^{18}\text{O}\text{‰}^\circ$ min	Measured $\delta\text{D}\text{‰}^\circ$ min	Calculate $\delta\text{D}_{\text{H}_2\text{O}}$	Calculate $\delta^{18}\text{O}_{\text{H}_2\text{O}}$
1	Plagioclase	7.1			
	Biotite	4.5	-85	-62	
	Hornblende	5.9	-73	-55	
2	Plagioclase	7.6			
	Biotite	5.0	-78	-57	
3	Quartz	9.2			
	K-Feldspar	8.3			
	Plagioclase	8.2			
	Biotite	4.3	-73	-45	
4	Biotite	4.0	-75	-47	
	Quartz	9.3			
	K-Feldspar	8.5			
5	Quartz	9.4			
	K-Feldspar	9.9			
6	Quartz	10.3			
7	Quartz	9.3			
8	Quartz	9.7			
	Sericite	6.9	-59	-32	
	Chlorite	4.5	-65	-25	
9	Quartz	12.0			
	Sericite	9.3	-68	-33	
10	Quartz	9.2			
	Sericite	8.2	-78	-43	
	Kaolinite	9.4	-79	-44	
11	Quartz	10.9			

The analysis of the isotopic composition of both the oxygen and hydrogen for gangue minerals associated with El-Salvador porphyry copper deposit is shown in Table (1).

- 1) Calculate the temperature of formation of the ore using the given mineral pairs in each sample from the isotopic composition of oxygen and the corresponding fractionation constants given in table (2)?
- 2) Calculate the oxygen isotopic composition of the fluids at the above temperature?
- 3) Plot the values of $\delta^{18}\text{O}_{\text{H}_2\text{O}}$ & $\delta^{\text{D}}_{\text{H}_2\text{O}}$ for the available samples using diagram (1)?
- 4) Discuss the origin of the mineralizing fluids?

Table (2) Constants of the isotopic fractionation factors between mineral & fluid for oxygen isotope at different temperatures.

Mineral	A	B	Temperature C°
Quartz	+ 3.38	- 3.4	200 - 300
Muscovite	+ 2.38	- 3.89	350 - 650
Muscovite	+ 1.90	- 3.10	500 - 800
Feldspar	+ 2.91	- 3.41	
Alk.Feldspar	2.91	- 3.41	350 - 800
Plagioclase	2.888	- 3.7	500 - 800
Magnetite	- 1.59	- 3.6	700 - 800
Magnetite	- 1.47	- 3.7	500 - 800
Calcite	+ 2.78	- 3.4	0 - 800
Anhydrite	+ 3.878	- 3.4	100 - 500
Rutile	- 4.1	+ 0.96	575 - 775
Biotite	+ 0.41	- 3.453	500 - 800