**Subject:** Isotope Geology **Subject Code:** ES4208 **End Semester Spring 2019**
**Time: 2.5 hours** **Full Marks: 50**
**Instruction:** For each section, use a separate answersheet

## Section A

1. a) Calculate the $\delta^{18}O$ value of raindrops forming in an air mass whose initial $\delta^{18}O$ value was –10‰, assuming that 25% of the water has condensed and that $\alpha$ (vapor-liquid)=0.9909 (5)

b) Show that in 1°C change in temperature can impart 0.2‰ change in $\delta^{18}O$ value of carbonate, if $\delta^{18}O$ value of water remains constant. (4)

c) What is clumping of isotopes? Explain the principle of clumped isotopes paleo-thermometry. (1+2)

2. a) In a palaeosol, the $\delta^{13}C$ value of carbonate is -5‰ and the $\delta^{13}C$ value co-existing soil organic matter is -15‰. Can this palaeosol be used to reconstruct past atmospheric $CO_2$? Explain (3)

b) Explain the principle of alkenone based palaeo-barometry. (3)

3. a) Why it is important to collect soil carbonate from depth below 30-40 cm for isotiopic studies? (3)

b) Calculate the expected $\delta^{13}C$ value of soil carbonate if the abundance of $C_3$ plant is 70% and $C_4$ plant is 30%. Assume the $\delta^{13}C$ value of $C_3$ and $C_4$ plants is -28‰ and -12.5‰ respectively. (3)

4. a) How to reconstruct past rainfall and vegetation using isotopic composition of lake organic matter. (5)

b) The $\delta^{13}C$ value of graphite and carbonate given below are from a particular area. Calculate the temperature of metamorphism based on these values. Comment on the variation on the estimated temperature of metamorphism.

| Sample no | $\delta^{13}C_{graphite}$(‰) | $\delta^{13}C_{carbonate}$(‰) |
|---|---|---|
| 1 | -22.0 | -7.0 |
| 2 | -24.0 | -11.0 |
| 3 | -20.0 | -17.0 |

(3+3)

## Section B

1. In a plot of $\epsilon_{Nd}$ vs. $^{87}Sr/^{86}Sr$:
   a) Draw the fields for OIB and MORB. (2)
   b) Between OIB and MORB, which one is more enriched? Why? (1+2)

2. What are the problems associated with $^{210}Pb$ dating of sediments? How would you circumvent the problems? (3+2)

3. In the estuary of a river, the freshwater of the river mixes with the seawater. Derive an expression for the Sr concentration and $^{87}Sr/^{86}Sr$ of the estuary using the composition of river water ($R_{riv}$, $[Sr]_{riv}$) and seawater ($R_{sw}$, $[Sr]_{sw}$). Given that the fraction of freshwater in the estuary = $F_{riv}$. R stands for $^{87}Sr/^{86}Sr$. (5)

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