

Oceanography 635

Isotopic Marine Geochemistry

Lecturer: Yuan-Hui (Telu) Li

Credits: 3

Pre-requisite: College Chemistry, Physics, and Calculus

Location: MSB 315; Tuesday and Thursday, 12:00 to 1:15 pm.

Course description:

The objective of the course is to apply unstable and stable isotope tracers to study biogeochemical processes and their rates in the oceans, e.g. water mass movement and mixing rates; material transfer rates across air-sea and water-sediment interfaces; biogeochemical cycling rates of metals; sediment accumulation and mixing rates; adsorption-desorption kinetics; dispersion rate of pollutants in environment; isotopic composition changes in the ocean with age etc.

1. Principal of isotopic chemistry: atomic nuclei, radioactive decay and growth, radiation detection and measurement, stable isotopic fractionation and measurements. (Four weeks)
2. Natural U-Th decay series disequilibrium in the sea: systematic survey in air, soils, river, ocean water column, suspended particles, sediment traps, bottom sediments (including ferromanganese nodules and phosphate nodules), and pore water. (Three weeks)
3. Cosmogenic and anthropogenic radionuclides in the ocean: production and pathways of ^{14}C , ^{137}Cs , ^{90}Sr , $^{238,239,240}\text{Pu}$, ^{241}Am , ^3H , ^{39}Ar , ^{26}Al , ^{32}Si , $^{7,10}\text{Be}$, $^{127,129}\text{I}$ and $^{32,33}\text{P}$ in the atmosphere, on lands and in the ocean. (Four weeks)
4. Stable isotope tracers: applications of $^{18}\text{O}/^{16}\text{O}$, $^{13}\text{C}/^{12}\text{C}$, $^{34}\text{S}/^{32}\text{S}$, $^2\text{H}/\text{H}$, $^{15}\text{N}/^{14}\text{N}$, $^3\text{He}/^4\text{He}$, Pb isotopes, $^{87}\text{Sr}/^{86}\text{Sr}$, $^{187}\text{Os}/^{186}\text{Os}$, $^6\text{Li}/^7\text{Li}$, $^{56}\text{Fe}/^{54}\text{Fe}$, $^{11}\text{B}/^{10}\text{B}$ etc. in oceanographic problems. (Four weeks)

Some useful constants:

Seconds per year = 3.14×10^7 ; minutes per year = 5.2×10^5

Surface area of the Earth = $5.1 \times 10^{18} \text{ cm}^2$

Mass of the atmosphere = $5.1 \times 10^{21} \text{ g}$

Ocean: area = $3.6 \times 10^{18} \text{ cm}^2$; mean depth = 3800 m; volume = 1.37×10^{21} liters

River runoff rate = 37×10^{15} liters/year; river suspended particle flux = $16 \times 10^{15} \text{ g/y}$

Mid-ocean ridge hydrothermal solution flux = 0.14×10^{15} liters/year

Avogadro's number: 6.022142×10^{23} atoms/mole

1 atomic mass unit (amu) = $1.660539 \times 10^{-24} \text{ g}$ = 931.494 MeV

Mass of helium atom = 4.00260335 amu

Mass of hydrogen atom = 1.007825046 amu

Mass of proton = 1.007276467 amu

Mass of neutron = 1.008664916 amu

Mass of electron = 0.0005485799 amu = 0.5109989 MeV

Speed of light = 299792.458 km/sec

$1 \mu\text{g } ^{238}\text{U} = 0.743 \text{ dpm}$; $1 \mu\text{g } ^{232}\text{Th} = 0.244 \text{ dpm}$; $1 \mu\text{g } ^{235}\text{U} = 4.68 \text{ dpm}$

$1 \text{ g C} = 13.6 \text{ dpm}$; $^{14}\text{C}/^{12}\text{C}$ atomic ratio (for $\Delta^{14}\text{C} = 0 \text{ o/oo}$) = 1.18×10^{-12}

$^2\text{H}/\text{H}$ atomic ratio (for T. U. = 1) = 1×10^{-18}