

Trace elements in seawater

BY

Dr N Manoharan

Assistant Proffessor

Department Of Marine Science

Bharathidasan University

Tiruchirapalli -24

Trace elements in seawater

- ❑ Trace Elements – Those elements that do not contribute to the salinity. All elements are present.
- ❑ Many of these elements are present at very low concentrations (as low as 10^{-21} M).
- ❑ 1 ppm is equivalent to 1oz of salt in 32 tons of potato chips! 1 ppb is like 1 drop of gin in 100,000 liters (back yard swimming pool) of tonic water.
- ❑ This presents analytical challenges to measure and avoid contamination.

Minor elements in seawater

- ❑ The micronutrient elements N, P, Si, and Fe are essential for biological production in the ocean.
- ❑ Their abundance is controlled by horizontal and vertical circulation and by biogeochemical processes of utilization and regeneration.
- ❑ Of other elements, even dissolved gold is found in the water of all oceans. Although present in very small concentrations (0.000004 mg/litre), there is 5.6 million t of gold in all the Earth's oceans, but the dilution is such that it cannot be extracted economically.

Why study trace element distributions?

1. Many are nutrients and required to sustain life (e.g. P, N, Fe, Cu)
2. Others are toxic (e.g. Cu, Hg)
3. Some are tracers for redox conditions (Cr, I, Mn, Re, Mo, V, U)
4. Some form economic deposits such as manganese nodules (e.g. Cu, Co, Ni, Cd)
5. Some are tracers of pollution (e.g. Pb, Pu, Ag)

Shapes of Profiles – clues for controls

Conservative - Cesium (Cs); Molybdenum (Mo) - under oxic conditions

Nutrient Like – Biological control

Shallow (soft parts) and Deep (hard parts) Regeneration

Zinc (Zn)

Cadmium (Cd)

Nickel (Ni)

Copper (Cu)

Barium (Ba)

Surface Enrichment – Atm input, River/Coastal inputs

Lead (Pb)

Manganese (Mn)

Mid-depth Maximum – Hydrothermal inputs, Oxygen minimum

Manganese (Mn)

Iron (Fe)

Near Bottom Enrichment – sediment source

North Sea Metals (Cd, Cu, Mn)

Deep Depletion - scavenging

Lead-210

Aluminum (Al)

Manganese (Mn)

Copper (Cu)

Periodic Table																	
1 1 H 1.0079	2 He 4.0026																
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.18
11 Na 22.99	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.8
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (97.91)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.9	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (144.9)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.5	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244.1)	95 Am (243.1)	96 Cm (247.1)	97 Bk (247.1)	98 Cf (251.1)	99 Es (252.1)	100 Fm (257.1)	101 Md (258.1)	102 No (259.1)	103 Lr	

Lanthanide Series

Actinide Series

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (144.9)	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.5	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244.1)	95 Am (243.1)	96 Cm (247.1)	97 Bk (247.1)	98 Cf (251.1)	99 Es (252.1)	100 Fm (257.1)	101 Md (258.1)	102 No (259.1)	103 Lr

Group Legend

Alkali Metal	Actinides
Alkali Earth	Lanthanides
Metal	Non-metal
Trans. Met.	Halogen
Noble Gas	

Trace Elements

- ❑ Aside from the 12 elements that are major or minor constituents and some elements that are dissolved gases, all other dissolved elements in seawater are present at concentrations less than 1 ppm and are called trace elements
- ❑ Many trace elements are essential to life.
- ❑ All elements are toxic at some concentration, but some are toxic at relatively low concentrations and a few are toxic at concentrations that are not far above their seawater concentration.