

Class #20

RESIDENCE TIME RESOURCES IN SEA WATER

RESIDENCE TIME OF DISSOLVED SUBSTANCES IN SEA WATER

Definition: "Average time substance spends in ocean before removal."

Calculation:

$$\begin{aligned}\text{time(res.)} &= \text{mass} \div \text{input rate (mass/time)} \\ &= \text{mass} \div \text{output rate (mass/time)} \\ &\quad (\text{can use either input or output because they are equal at steady state}) \\ \text{mass of dissolved substance in sea water} \\ &= \text{concentration (g/kg)} \times \text{mass of sea water (kg)} \\ \text{input rate by rivers (most important, easy to estimate)} \\ &= \text{conc. in river water (g/kg)} \times \text{river runoff rate (kg water / time)}\end{aligned}$$

Representative values:

Residence times, years

Cl ⁻	80 million
Na ⁺	60 million
Mg ²⁺	10 million
SO ₄ ²⁻	9 million
Ca ²⁺	1 million
PO ₄ ³⁻	0.7 million
Mn	7,000
Fe	100
Al	100

Importance

1) Indication of "reactivity" in sea water

Long residence time (Cl, Na): not very reactive, removed slowly

Short residence time (Mn, Fe, Al): reactive, removed rapidly

2) Helps describe the cycling of these species

e.g., Nutrients (PO₄³⁻ and Fe) cycled rapidly between biological pool and dissolved pool

vs. Cl⁻ and Na⁺

Example: Ca²⁺ vs. Na⁺

River water: [Ca²⁺] > [Na⁺] this gives relative input sizes

Sea water: [Na⁺] > [Ca²⁺] this gives relative masses in oceans

Ca²⁺ removed rapidly as CaCO₃ -- short residence time.

Na⁺ removed slowly, long res time

RESOURCES IN SEA WATER

Lots of dissolved substances, but only a few are commercial resources.

Salt (NaCl)

Evaporation in shallow artificial ponds -- 30% of world's supply

Residual brine (after NaCl ppt.) processed for

Mg (magnesium)

Br (bromine)

Fresh water -- the most value resource!

Desalinization of sea water by ...

- Change in state -- freezing, evaporation
- "Reverse osmosis" -- sea water forced through a membrane that is permeable only to H₂O; salts are "filtered out", discarded with the residual high-salinity water (brine) left after extraction of some fresh H₂O

Desalinization requires lots of energy, thus money! Important source of fresh water in arid regions (coasts, islands) where

- energy is cheap (or money is no problem), and
- cost of alternative sources of water is high.