

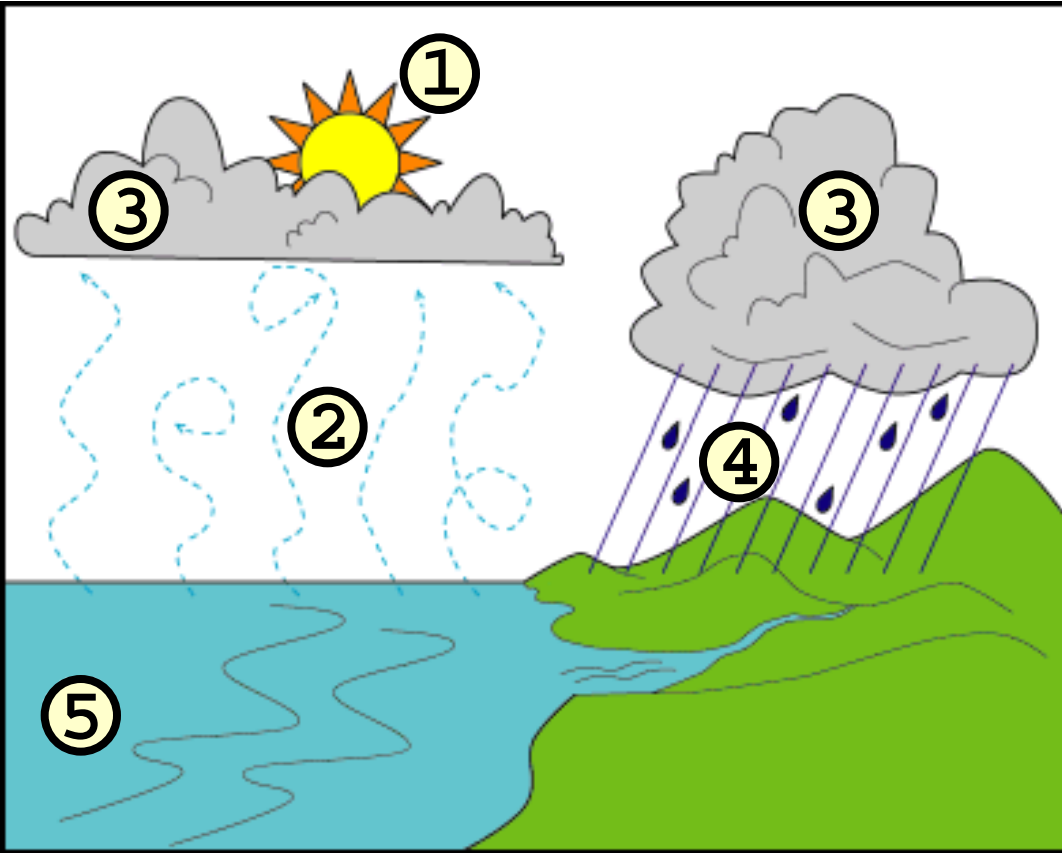
Cycling of Chemical Sediments

Ions are introduced into rivers and ground water by chemical and biological degradation of primary mineral grains

They are then carried to oceans/basins where evaporation concentrates mineral salts

Biota make hard parts with ocean's dissolved mineral content &

Non-biological processes create new chemical sediments



1- Sun warms ocean & atmosphere

2- Water evaporates leaving salt back

3- Clouds form and move water over continents

4- Rain water leaches ions from rock and is transported in rivers to ocean

5- Ocean mixes and delivers solutes to warm places to make more rock!

This process turns granite into limestone!

Typical Dissolved Loads In Mid-Latitude Rivers

Dissolved Substance	Granite	Limestone	Gypsum	Shale
$\text{HCO}_3^- + \text{CO}_3^{-2}$	15.9	86.3	101.8	163.6
Ca_2^+	10.0	32.2	121.4	139.4
Mg_2^+	0.9	17.1	40.0	76.8
H_4SiO_4	11.9	10.1	10.2	6.1
SO_4^-	3.2	5.7	383.9	1212.0
$\text{Na}^+ + \text{K}^+$	0.5	1.9	55.3	410.1
Cl^-	0.6	4.7	14.5	12.1
<i>Total</i> ppm	43.0	158.0	727.1	2020.1

Average Composition of Mineral Salts in Ocean

chemical ion	valence	concentration ppm, mg/kg	part of salinity %	molecular weight	mmol/ kg
Chloride Cl	-1	19,345	55.03	35.453	546
Sodium Na	+1	10,752	30.59	22.990	468
Sulfate SO ₄	-2	2701	7.68	96.062	28.1
Magnesium Mg	+2	1295	3.68	24.305	53.3
Calcium Ca	+2	416	1.18	40.078	10.4
Potassium K	+1	390	1.11	39.098	9.97
Bicarbonate HCO ₃	-1	145	0.41	61.016	2.34
Bromide Br	-1	66	0.19	79.904	0.83
Borate BO ₃	-3	27	0.08	58.808	0.46
Strontium Sr	+2	13	0.04	87.620	0.091
<i>Total</i>		<i>35,000</i>			

= 3.5% salt by weight

HOW MUCH SALTIER THAN A RIVER IS THE OCEAN???

-Chloride is the most conservative of the major ions in the ocean because it forms salts after the other ions...

(evaporative sequence later)

-It is also the most abundant ion in the ocean

-So how long does it take the ocean to accumulate its saltiness??

Residence Time of Solutes

$$T = \frac{\text{Ocean Conc. Cl}^- \times \text{Ocean Volume}}{\text{River Conc. Cl}^- \times \text{Annual River Flux}}$$
$$= \frac{1.9\% \times 1.3 \times 10^9 \text{ km}^3}{0.0002\% \times 4 \times 10^4 \text{ km}^3/\text{yr}} \sim 300\text{Ma}$$

Major Types of Chemical Sediments

CARBONATES Limestones & Dolostones

- Modern & ancient production
- Marine & terrestrial environments
- Volumetrically most important type



EVAPORITES Rock Salt, Gypsum

- Modern & ancient production
- Marine & terrestrial environments
- Many economic uses

IRONSTONES Banded Iron Formation

- No modern production- limited to the ancient- poorly understood
- Often deposited with CHERT



CHERT

Amorphous Silica- SiO_2

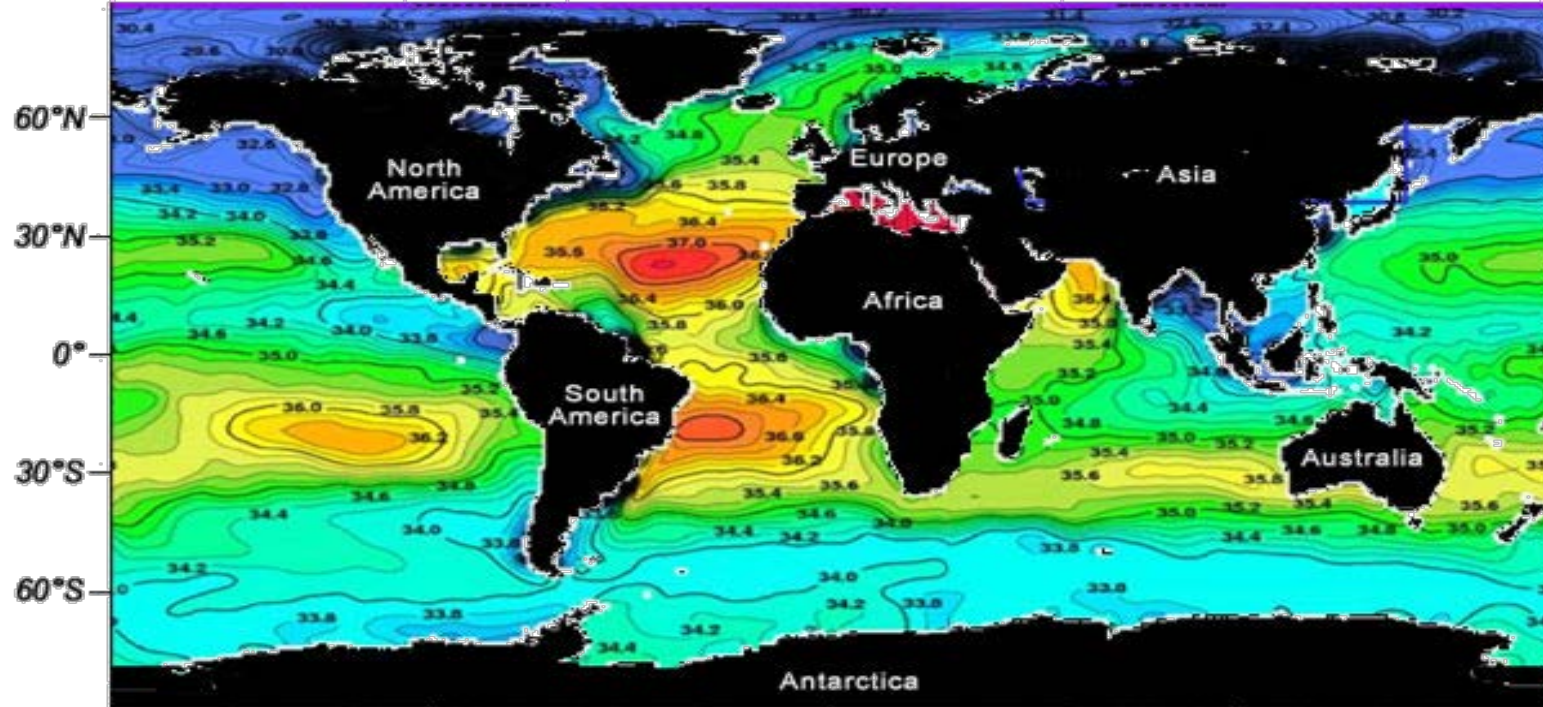
Precipitated abiotically or as biotic hard parts

Marine and Freshwater occurrences



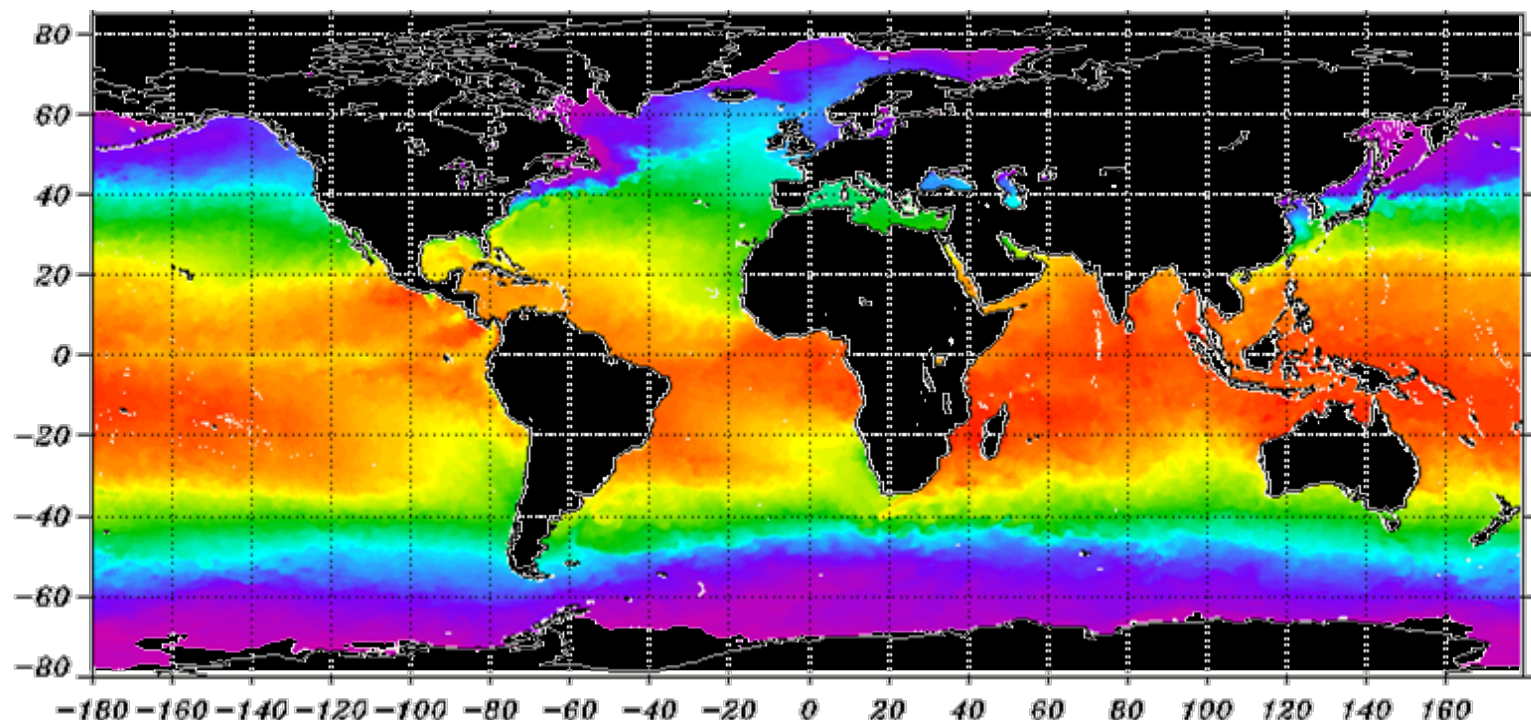
Other Chemical Sediments

- Phosphorites: little known about origin
- NOT ~~COAL~~... a detrital material

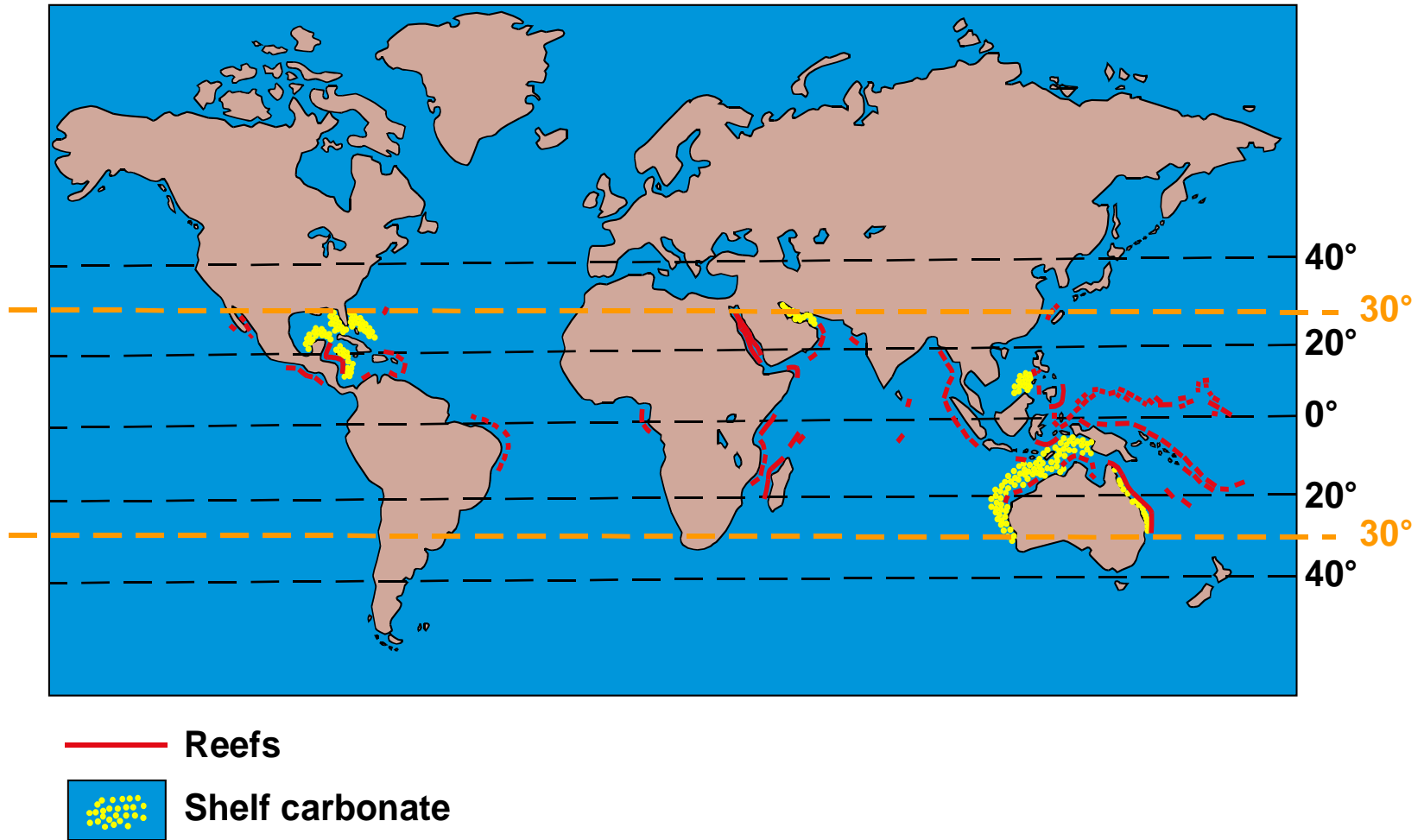


Hot
Salty

Cold
Fresh

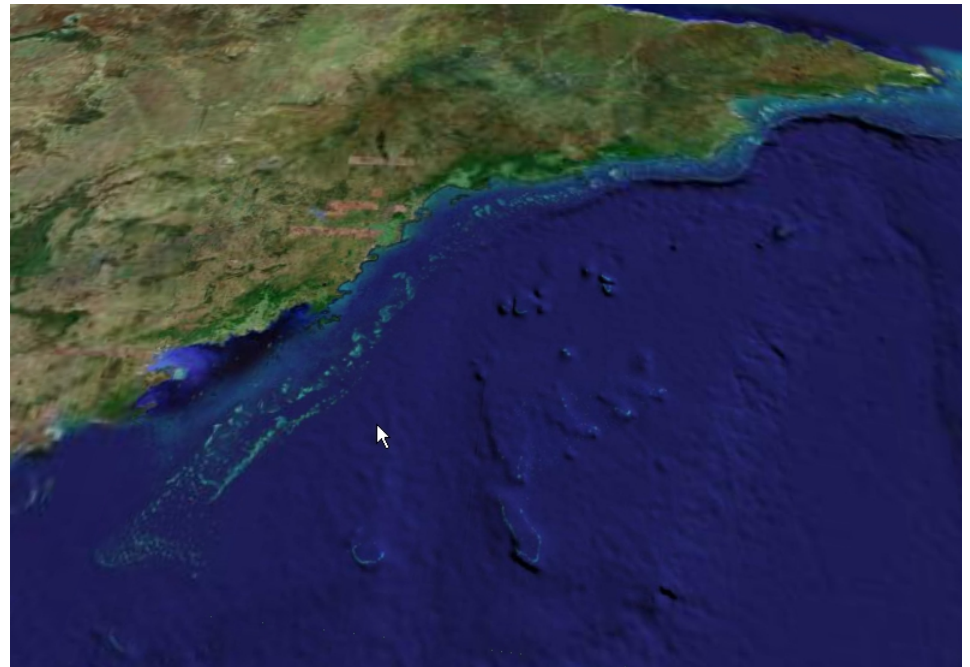


Influence of Temperature



Influence of Clastics

- GBR, NE Australia
 - Minimal clastic input = great reefs
- Indian coast
 - Abundant clastic input = no reefs

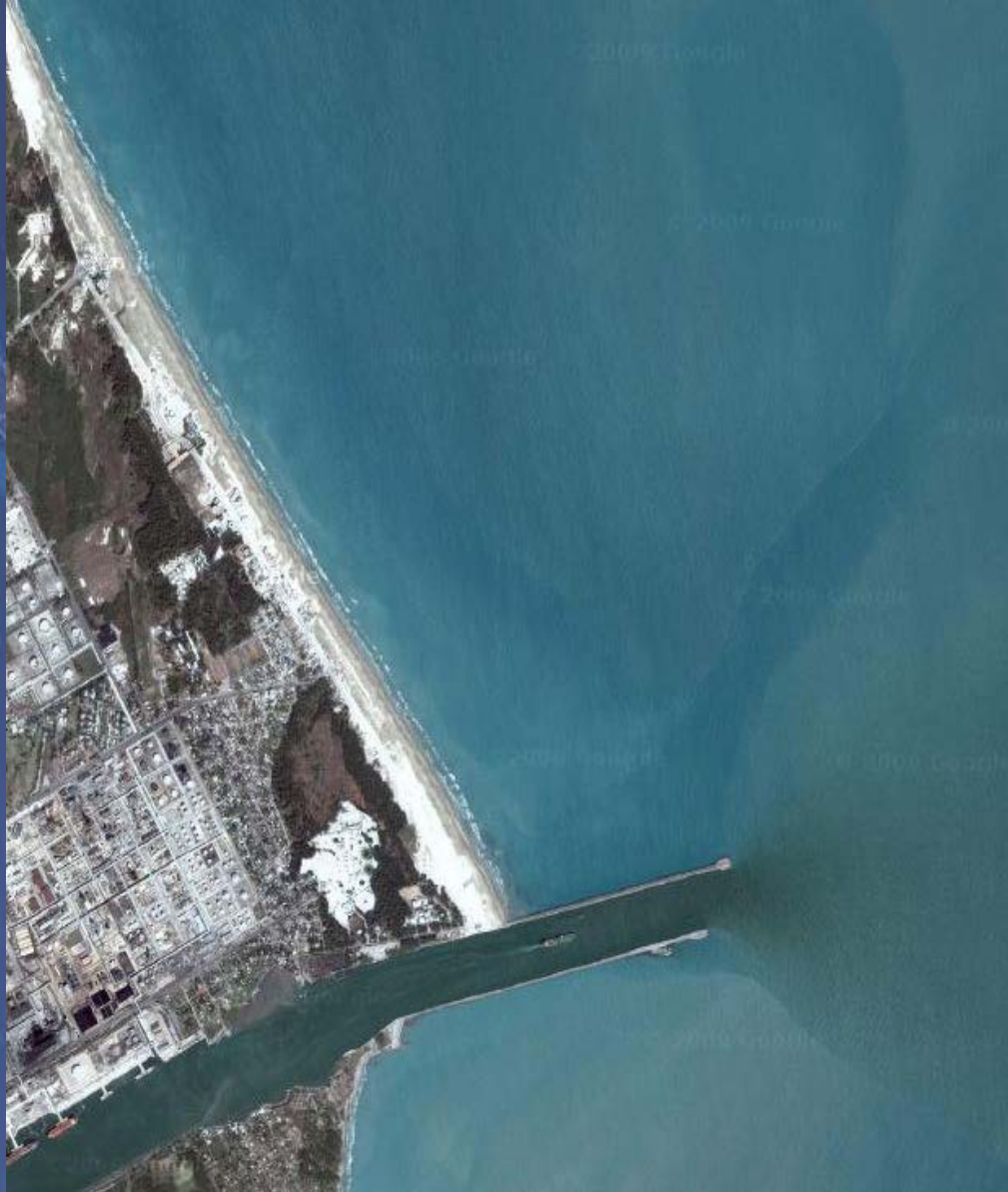


Question: WHERE DO CARBONATES FORM?

Answer: WHERE'S THE BEST SPOT FOR SPRING BREAK?

Cancun = YES

Brownsville = NO



Chemical Sediments in non-marine environments: NON-MARINE CLOSED-BASINS

Great Salt Lake



Dead Sea



Accumulate solutes like oceans but can be much more concentrated because basins are small