Let’s consider:

The average time that a substance remains dissolved in seawater. We call this the “residence time” of an element or substance.

| Residence Time (yrs.) = | \[
<table>
<thead>
<tr>
<th>\text{Total amount in seawater (kg)}</th>
<th>\text{Input rate (kg/yr)}</th>
</tr>
</thead>
</table>

where Input rate = average concentration in rivers (kg/km\(^3\)) x river discharge (km\(^3\)/yr)

We will see how this works: first for water, then for total salt, and finally, for some individual elements. These calculations give us insights into how the system works.
How long does it take to cycle ocean water through rivers and back again?

Residence time of water in the ocean

Volume = $1.4 \times 10^9$ km$^3$

River Influx = $3.7 \times 10^5$ km$^3$/yr

$t = \frac{\text{Volume}}{\text{Influx}}$

$\begin{align*}
   t &= \frac{1.4 \times 10^9 \text{ km}^3}{3.7 \times 10^5 \text{ km}^3} \\
   t &= 4000 \text{ years}
\end{align*}$
The Grand Geochemical Cycle

• How much time to make the ocean salty?

• About $5 \times 10^{22}$ grams of dissolved solids in ocean
• Rivers bring in about $2.5 \times 10^{15}$ gm dissolved solids per year

--think about it!

• Should only take about $2 \times 10^7$ years (20 million yrs.) to bring oceans to present salinity

Assuming:
• Rivers have kept approx. same input through time
• Oceans have kept approx. same composition through time

--but we know oceans are 3.8 billion yrs. old

• This confirms that there must be output of material from ocean!!