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GEOL 117 Class 27  
DEEP CIRCULATION AND WATER MASSES  
THE GLOBAL "CONVEYOR BELT"  
Combined deep and surface circulation

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**Intermediate, deep, and bottom water masses: All waters in today's oceans are always moving**

- Bottom Water: The very densest waters sink to the bottom and move along the ocean floor
- Deep Water (Incl. Bottom Water): Very dense water sinks and moves along the ocean floor or not far above it.
- Intermediate Water: Moderately Dense- sinks part way down

Each water mass that sinks from the surface sinks until it reaches a depth where it has less dense water on top and denser water below

**The Most Important Deep Water Masses Form In The Atlantic**

Why the Atlantic?

- Extends to highest latitudes, both north and south
- North Atlantic is relatively high salinity

The most important deep water masses:

- North Atlantic Deep Water (NADW)
- Antarctic Bottom Water (AABW)

**Antarctic Bottom Water (AABW): Sinks near Antarctica**

- Sea ice forming there
- Winter cooling
- Flows north

**North Atlantic Deep Water (NADW): Formed near Greenland**

- N. Atl. surface water has high salinity
- + Winter cooling, + sea-ice formation
- Sinks and flows southward; eventually joins the denser AABW

**Antarctic Circumpolar Water (ACW): Moves dense waters to Indian and Pacific Oceans**

- Upwelling NADW + Antarctic waters
- Flows eastward around Antarctica in a complete circle
- Some of it spills north **to become the deep water of the Indian and Pacific Oceans**

**INTERMEDIATE WATER MASSES- moderately dense; examples:**

1) Mediterranean Intermediate Water (MIW)

High salinity, but warm outflow from Mediterranean Sea  
Sinks to ~1 km in the North Atlantic

2) Sub-polar water masses:

- Antarctic Intermediate Water (AAIW) [in all oceans]

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## PACIFIC AND INDIAN OCEANS

- 1) Deep Waters: ACW becomes deep water for these!
- 2) Intermediate Waters fed from various polar areas

## GLOBAL CONVEYOR BELT -- MOVES HEAT, WATER AND DISSOLVED SALTS Globally

- Combination of deep currents and surface currents forms a huge loop
- Water takes a few thousand years to complete the circuit- very fast compared to geologic processes (and inputs of major ions)
- Also moves salt- keeps the oceans well mixed; no large pockets of stagnant water in the modern oceans

1. NADW sinks
2. Southward flow; mixing w/ AABW
3. Upward flow to join ACW – circles around Antarctica
4. Northward into Indian & Pacific Oceans
5. Eventual Upwelling to join surface currents
7. Gyres move water in large circles, but eventually it makes its way back to areas of the Atlantic where NADW and AABW sink.

From Pacific: Through Indonesia, around Indian Ocean and tip of Africa  
Atlantic **surface gyres move water around, some goes to NADW/AABW formation zones**

### Climate effects:

The global conveyor belt moves heat, salt, and nutrients around the globe

Example: NADW and the climate of Northern Europe

In the North Atlantic region, sinking of water to form NADW draws warm water (supplied by Gulf Stream) farther northward

Warm air created as winds pass over the warm water; Northern Europe receives warm air from this- prevailing westerlies

If NADW flow stopped, the warm water would not go as far north

Northern Europe would become cooler

### Has the global conveyor always worked like now?

- Past 10,000 years -- yes.
- 10-15,000 years ago – NO...it shut down after the end of the last ice age  
Caused by dilute glacial meltwaters- low density prevented sinking of NADW  
NADW shut-down caused Northern Europe to be cold, glaciers advanced
- Many Millions of years ago – NO. Continents in different positions- lack of deep flow and “stagnant” oceans (?)