EOSC 112: THE FLUID EARTH

THERMOHALINE CIRCULATION

Oc3 Read: Kump et al. Chap.5, p. 91-101.
Check: Review Questions 1-5, 7-12.

Objectives:

1. **To describe the composition and distribution of salts in oceans;**
2. **To describe the deep-ocean thermohaline circulation.**

1. Salinity S

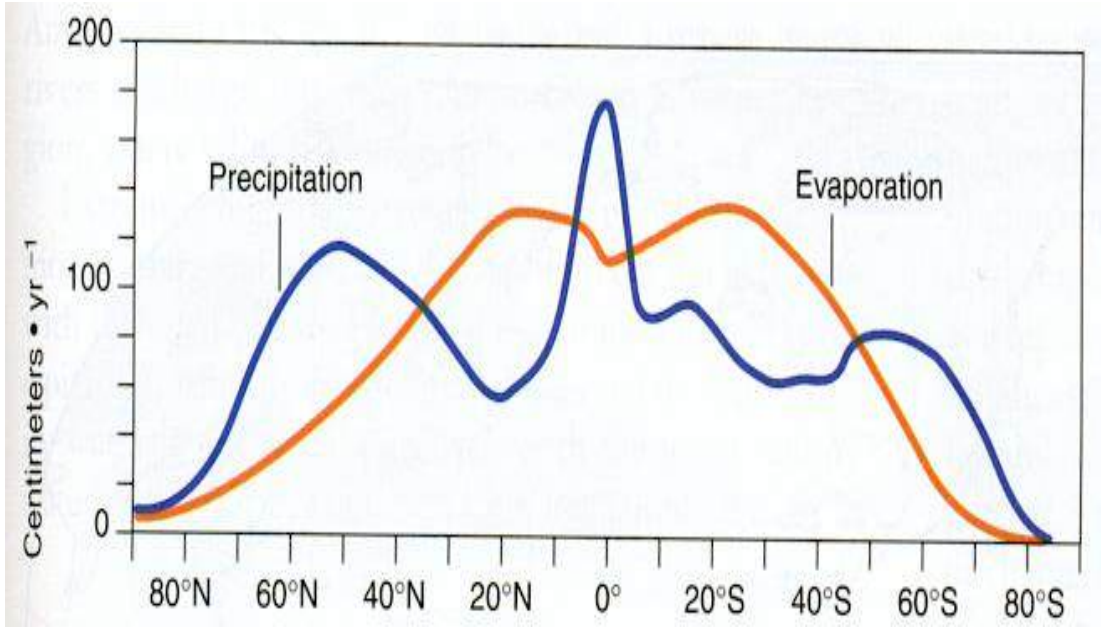
- Average concentration of salt in sea water (i.e. S) is ~3.5% (= 35 ‰ or parts per thousand) by weight (i.e. g/kg water).
- Major constituents of S:

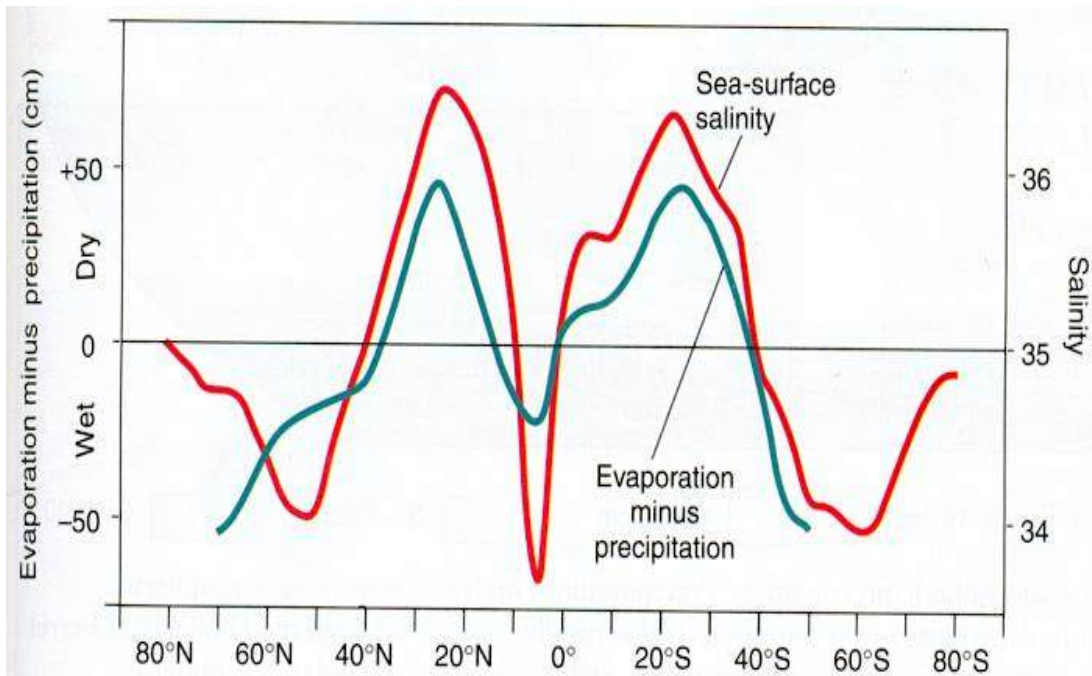
Ions = molecules or atoms with net electric charge

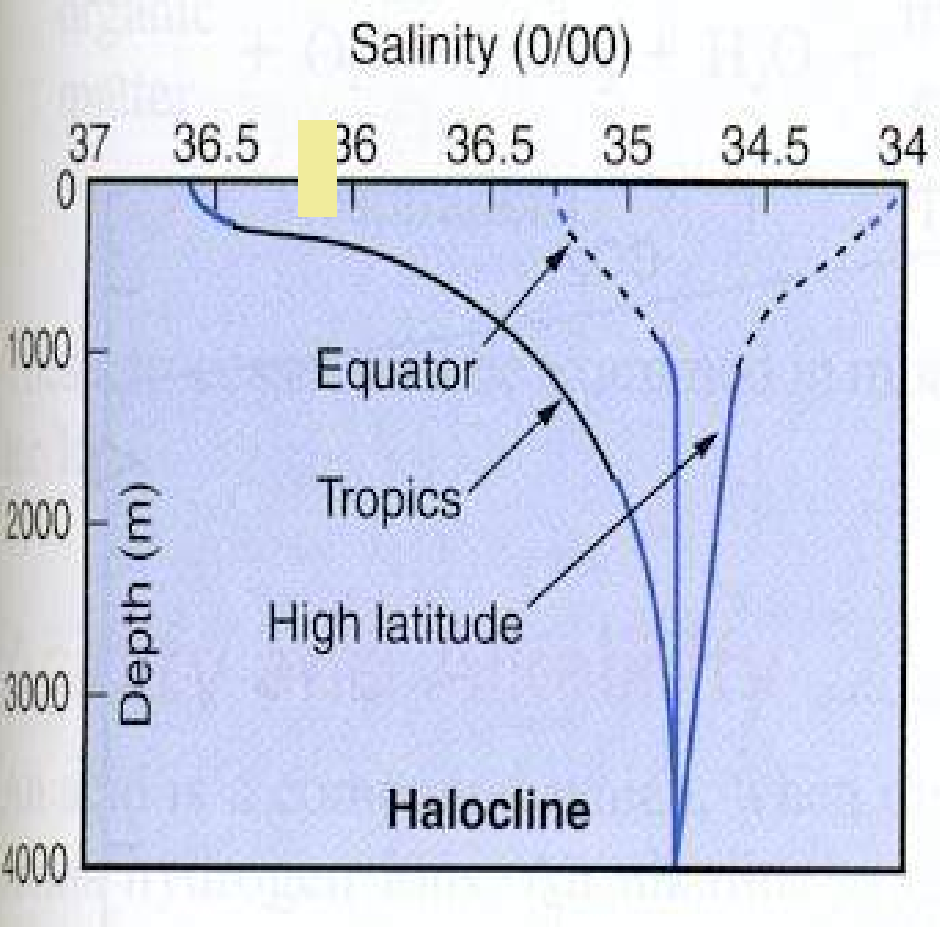
Salt Ion	%
Chloride, Cl^-	55.0
Sodium, Na^+	30.6
Sulphate, SO_4^{-2}	7.7
Magnesium, Mg^{+2}	3.7
Calcium, Ca^{+2}	1.2
Potassium, K^+	1.1
Total	99.3

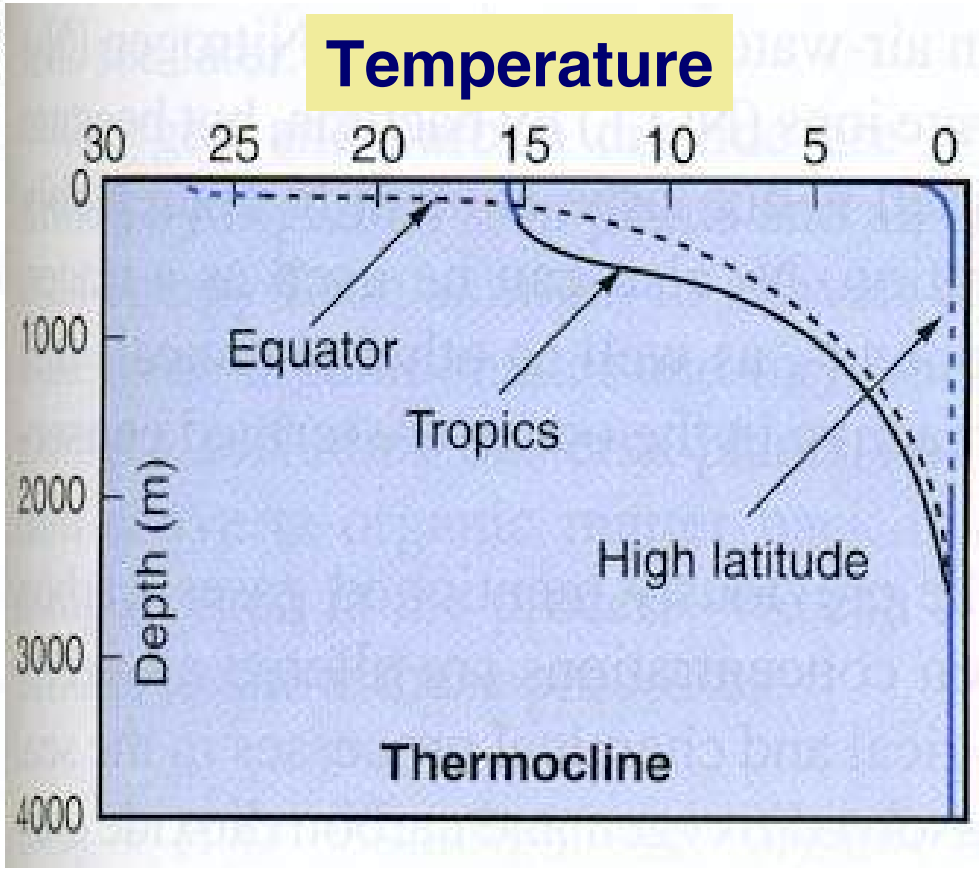
- **Where do Salts come from?:**
  Erosion (weathering) of crustal rocks.
- **Constancy of composition:**
  Total amount of major dissolved ions can vary in the ocean, but their relative proportions remain virtually constant.
- **How to measure salinity?:**
  Higher S => more ions => increased electrical conductivity.
  S measured by a CTD (Conductivity-Temperature-Depth) probe.

Latitudinal distribution of Sea Surface Salinity (SSS) follows Evaporation-Precipitation (E-P) curve.





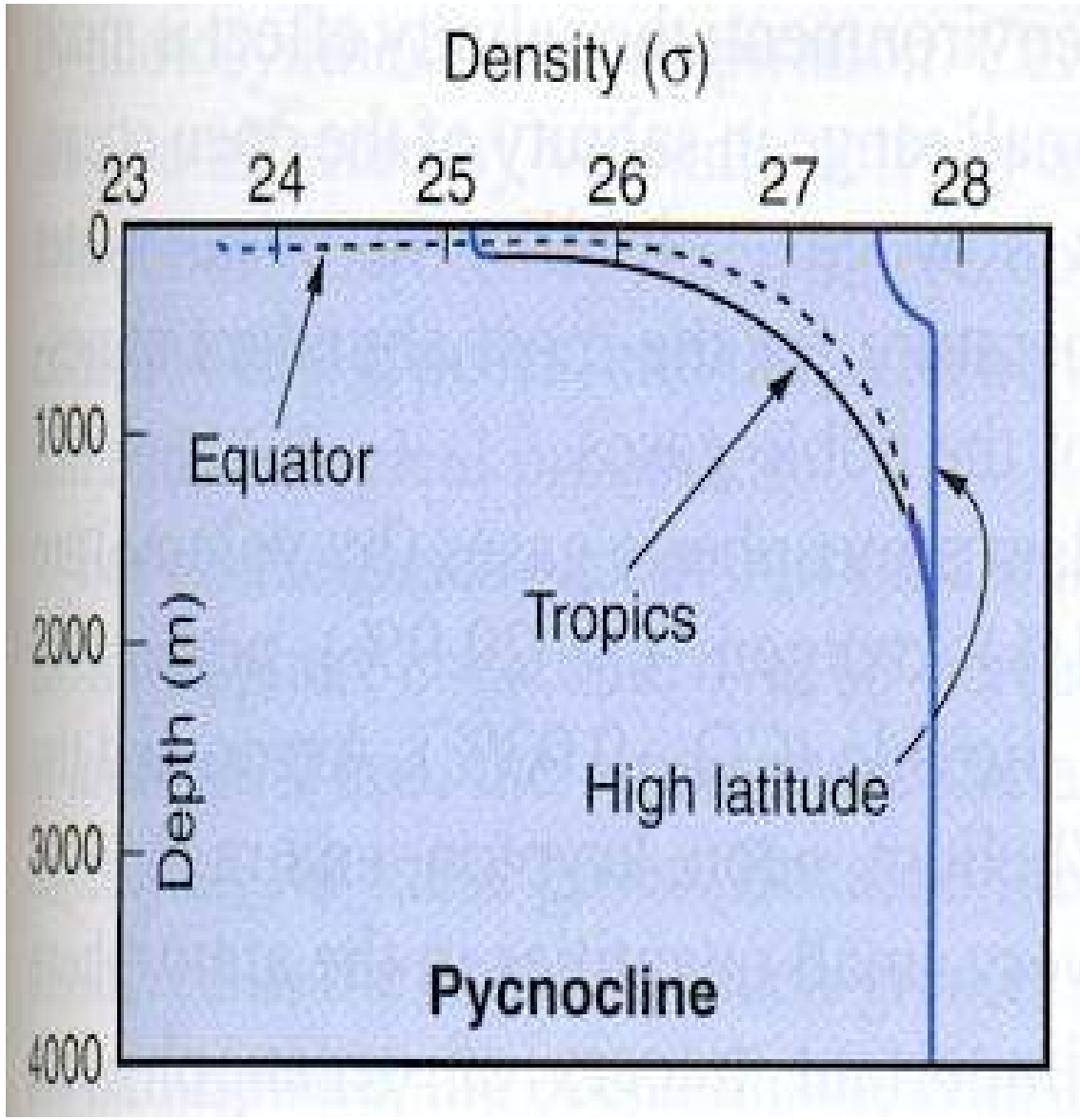




Halocline = region of strong change of S with depth, at ~ 200m-1000m.

Density

- In open ocean, density ~1.022-1.030 g/cm^3.
- Density determined by T, S & pressure p.
- At mid & low latitudes, density profile approx. T profile.



2. Deep-water formation & circulation

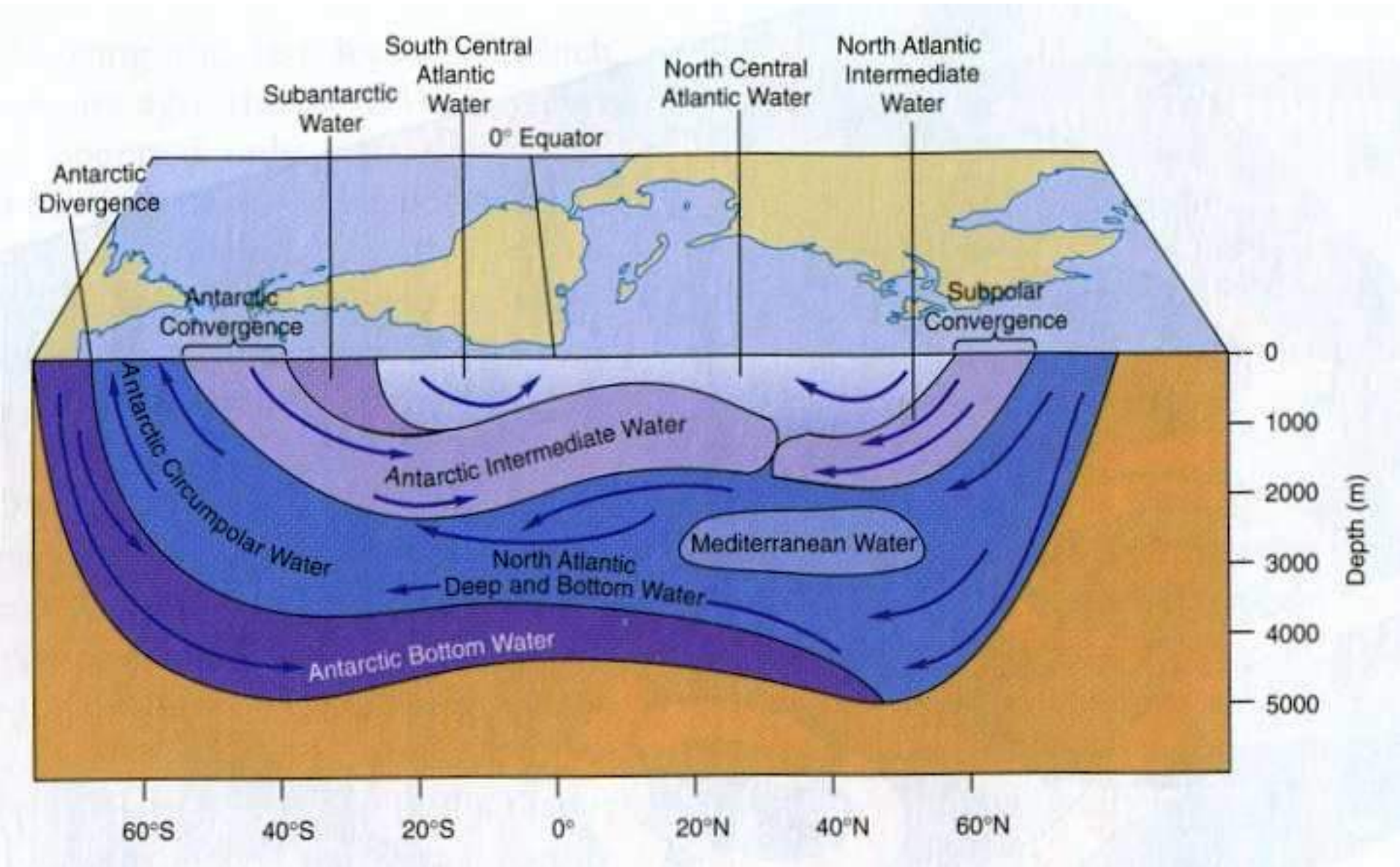
- What conditions are needed to form bottom water?

  (a) intense cooling, or

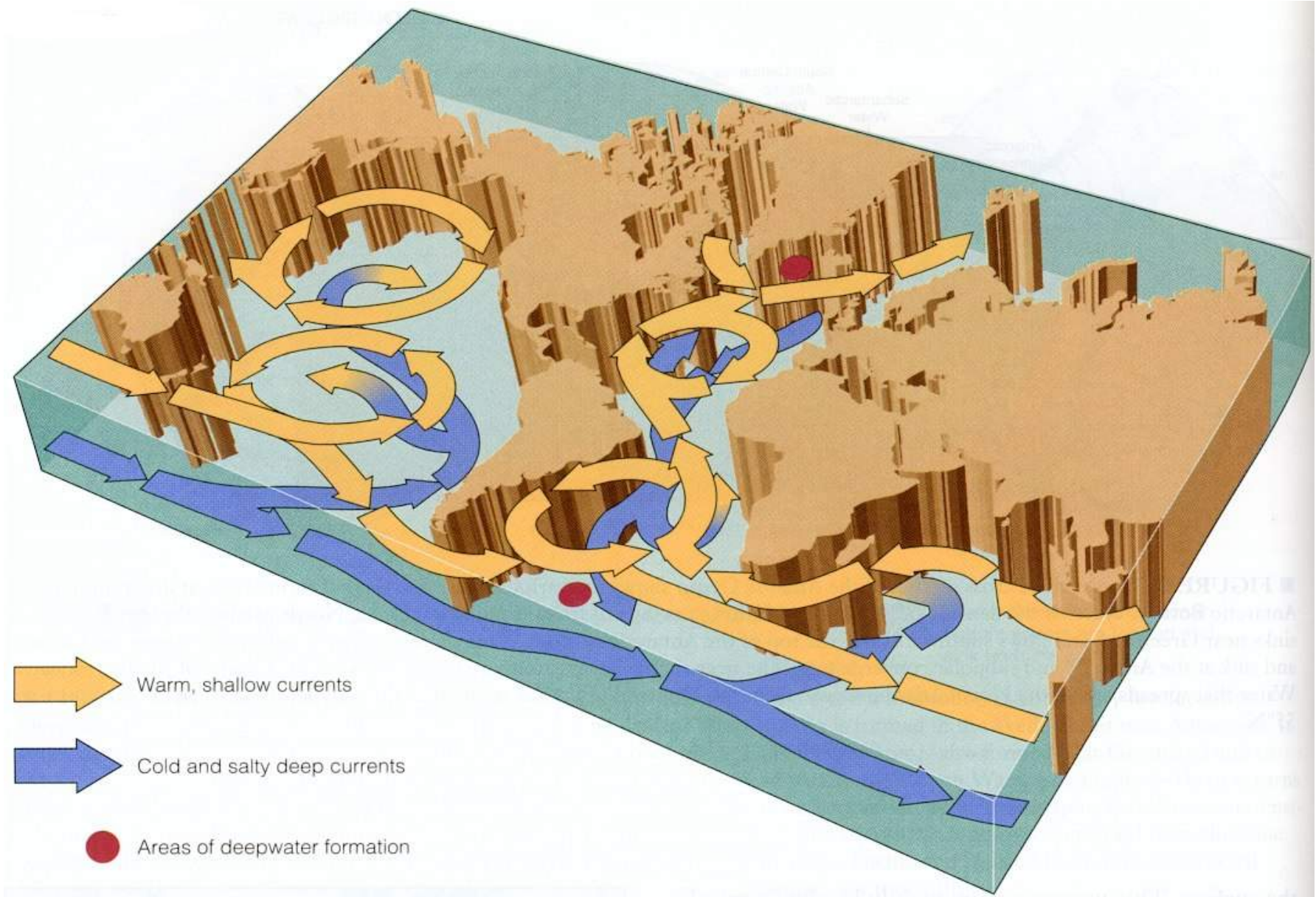
  (b) increase in S. Usually both (a) & (b) required.

- Polar regions during winter: intense surface cooling & ice formation.
- As sea water $\rightarrow$ ice, much of salt expelled into surrounding water => little salt in the ice, but increased S of surrounding water.

- Deep/Bottom waters formed in Atlantic Oc.
- N. Pacific too low in S to form bottom water



Thermohaline circulation



Thermohaline circulation

- Thermohaline circulation results from the sinking & rising of water masses due to density changes from T & S changes.
- Top 1 km dominated by wind-driven ocean circulation; below 1 km, thermohaline circulation dominates.
- Flow of deep water & upper water => "conveyor belt".
- It brings nutrients up from deeper waters and oxygen down from surface