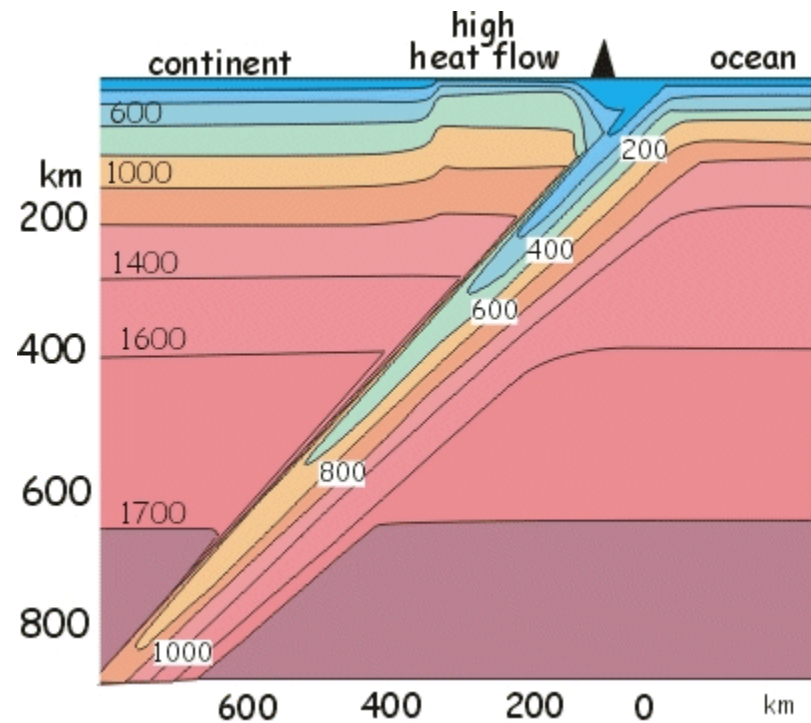


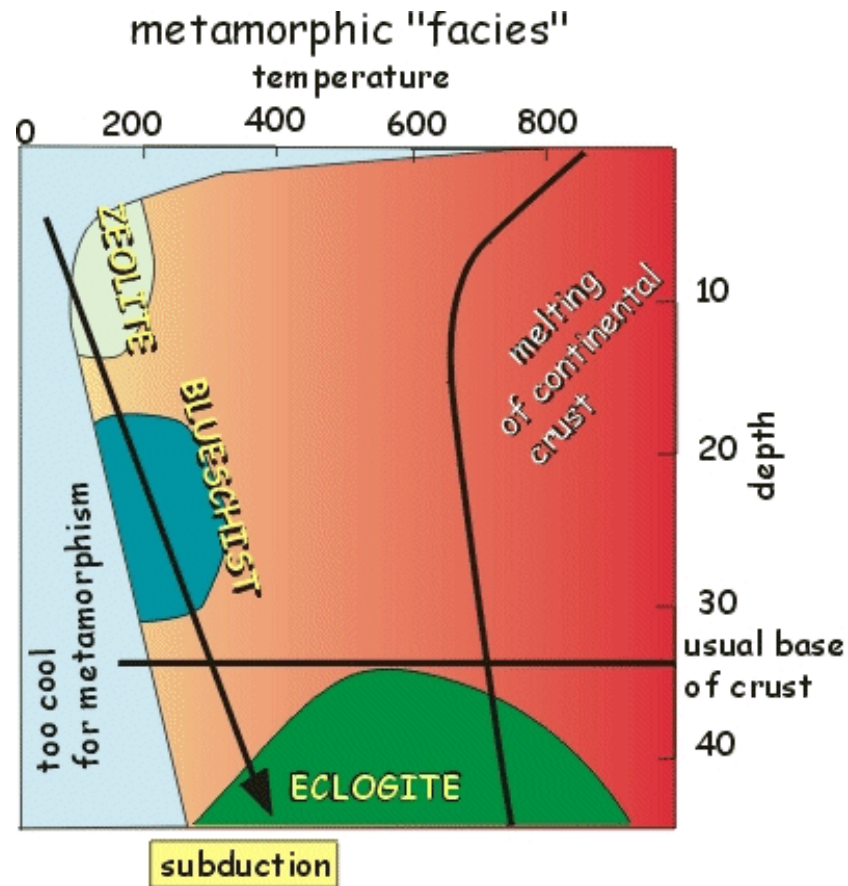
# Petrogenesis of arc magmas

Subduction zone magmatism is a paradox!

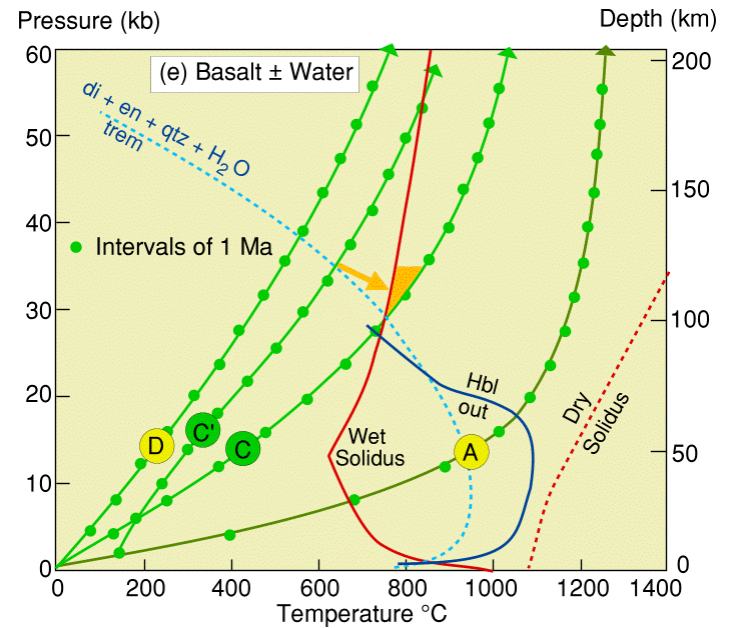
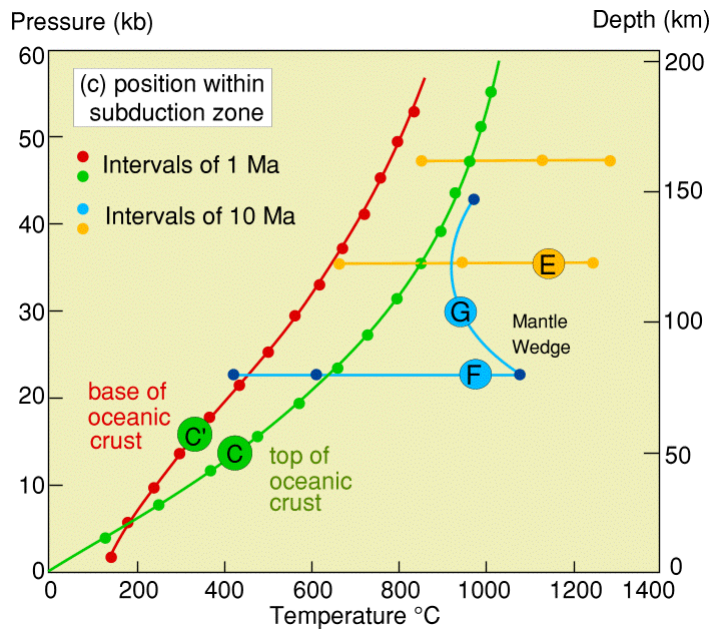
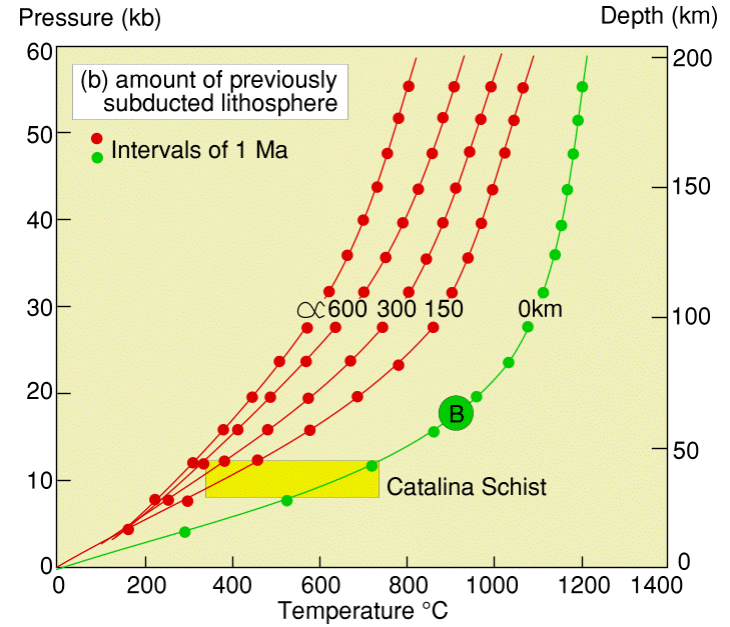
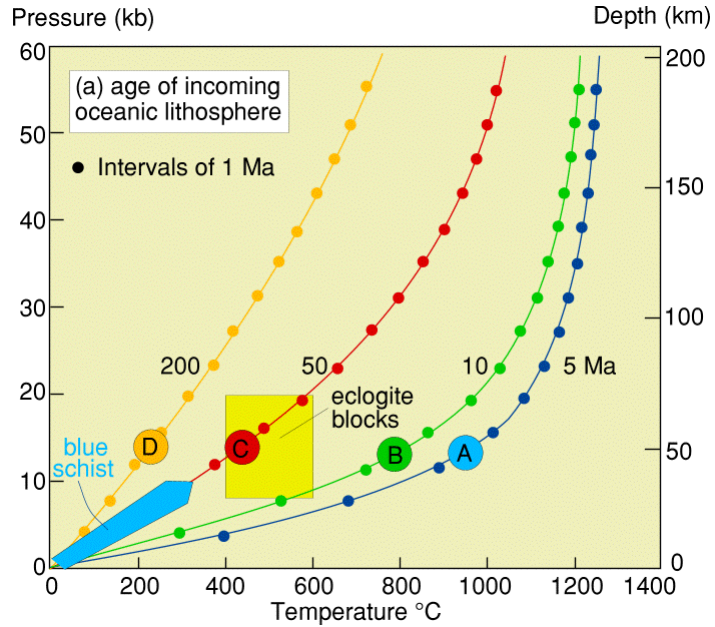
Ocean crust reaching a subduction zone is relatively "**cold**" and "**wet**"



# Petrogenesis of arc magmas



# Thermal structure of subduction zones

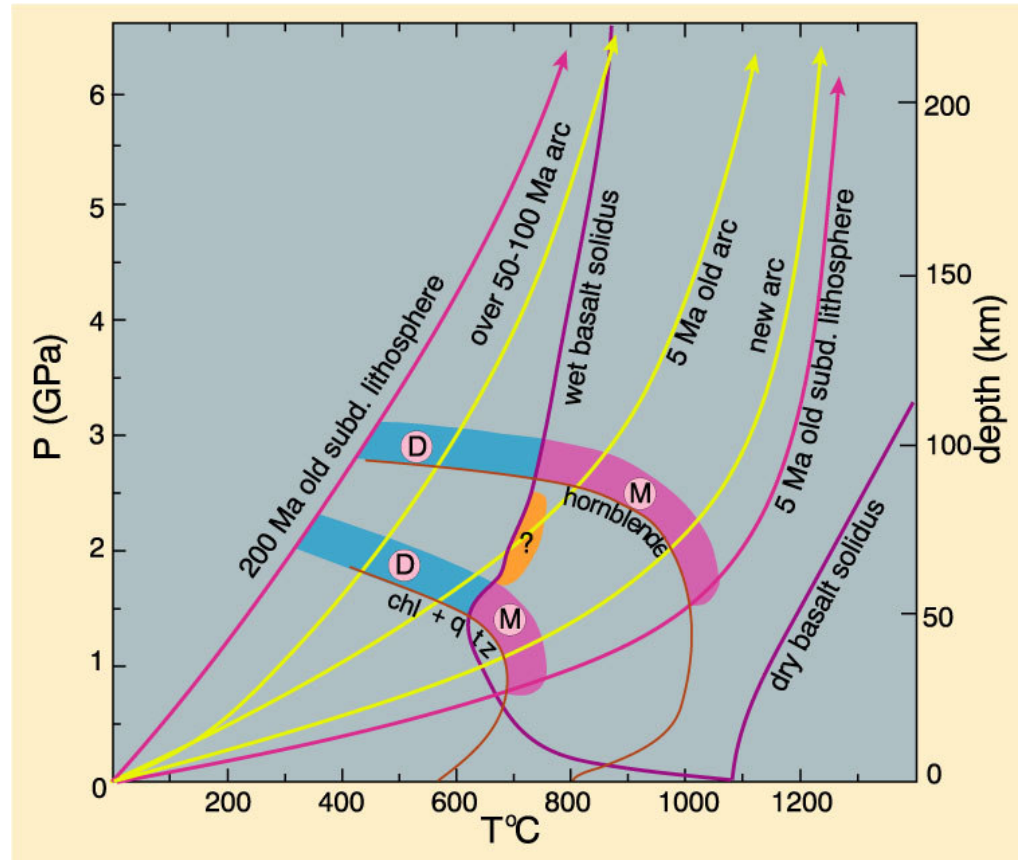


# Thermal structure of subduction zones

- (a) age of the incoming oceanic lithosphere
- (b) amount of previously subducted lithosphere
- (c) extent to which the subducting slab induces flow in the mantle wedge

**Dehydration (D)** takes place in mature arcs with old lithosphere

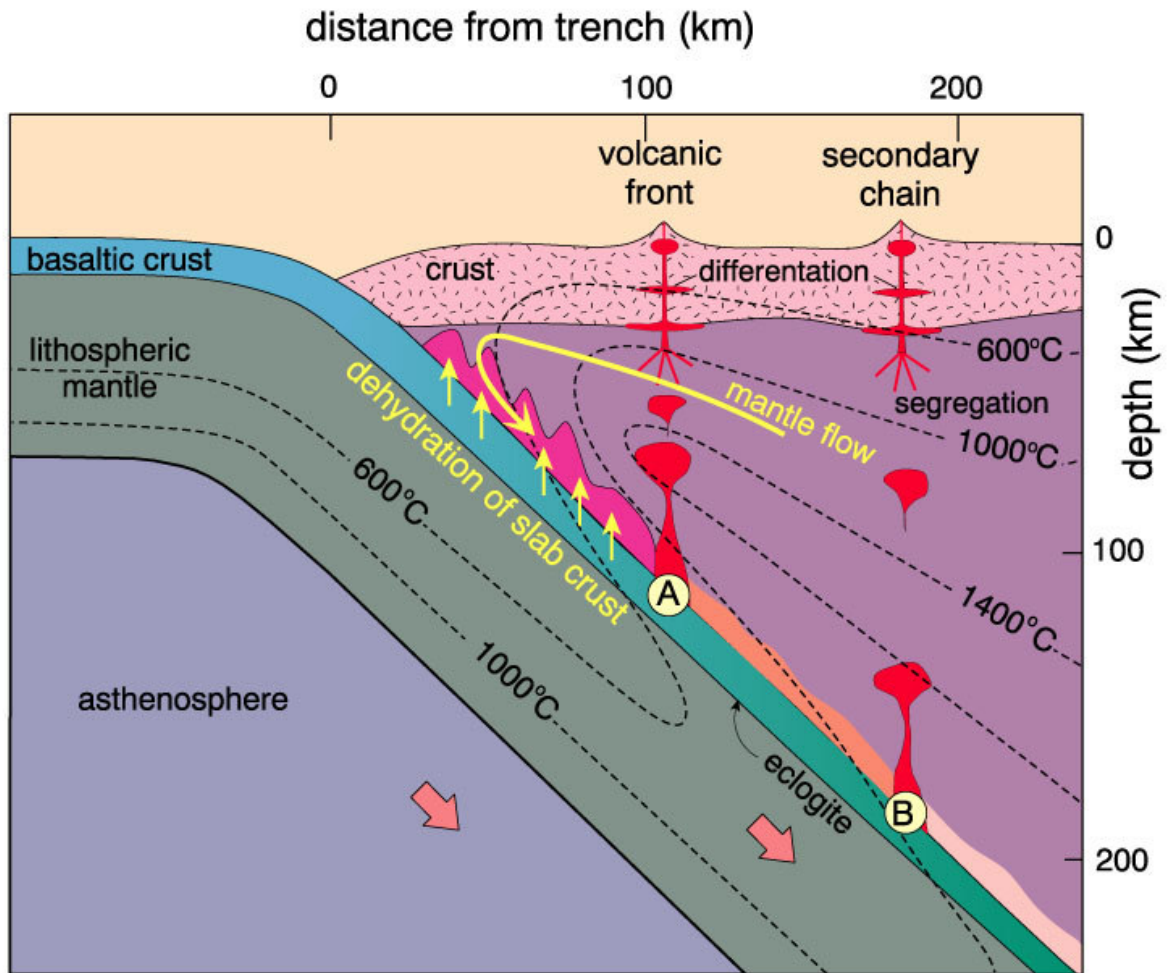
**Slab melting (M)** occurs in arcs subducting young lithosphere



Peacock (1990,1991,1996)  
Peacock et al. (1998)

# Generation of arc magmas

Dehydration of slab crust causes hydration of the mantle (violet), which undergoes partial melting as amphibole (A) and phlogopite (B) dehydrate



Tatsumi (1989), Tatsumi & Eggins (1995), Winter (2001)

# Calc-alkaline vs. tholeiitic differentiation

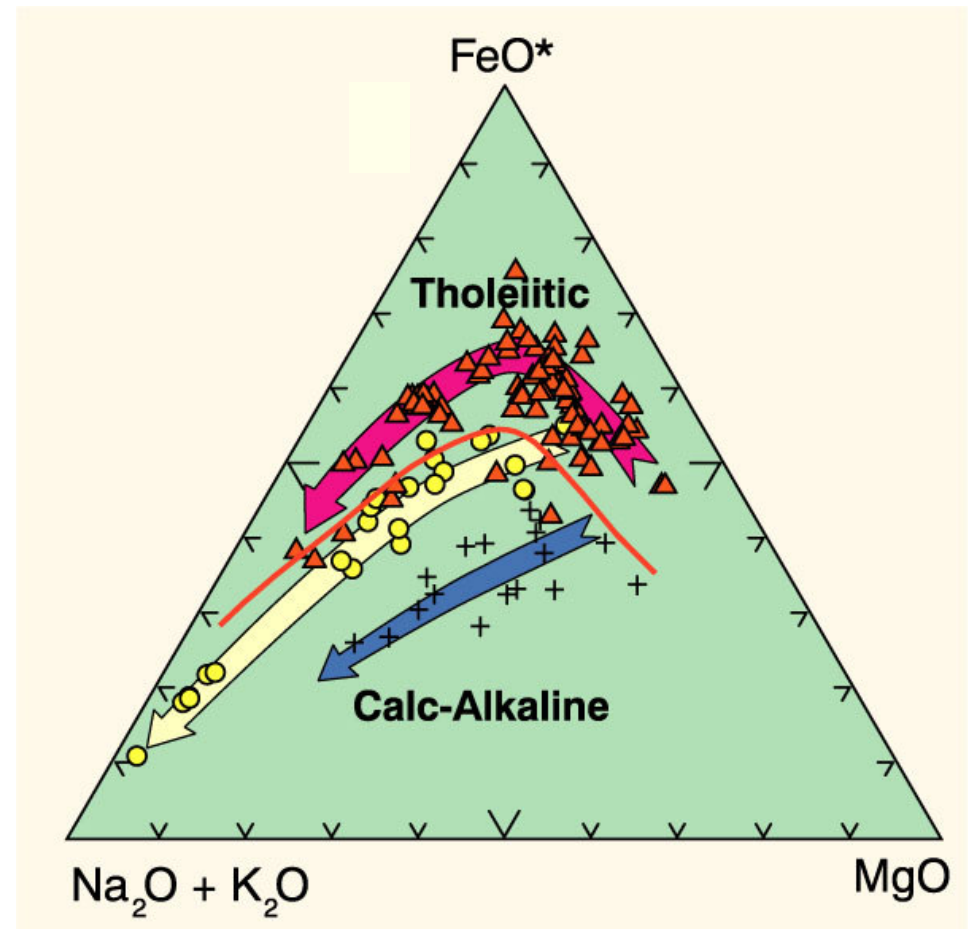
## Calc-alkaline series

restricted to subduction zones

## Lack of Fe enrichment

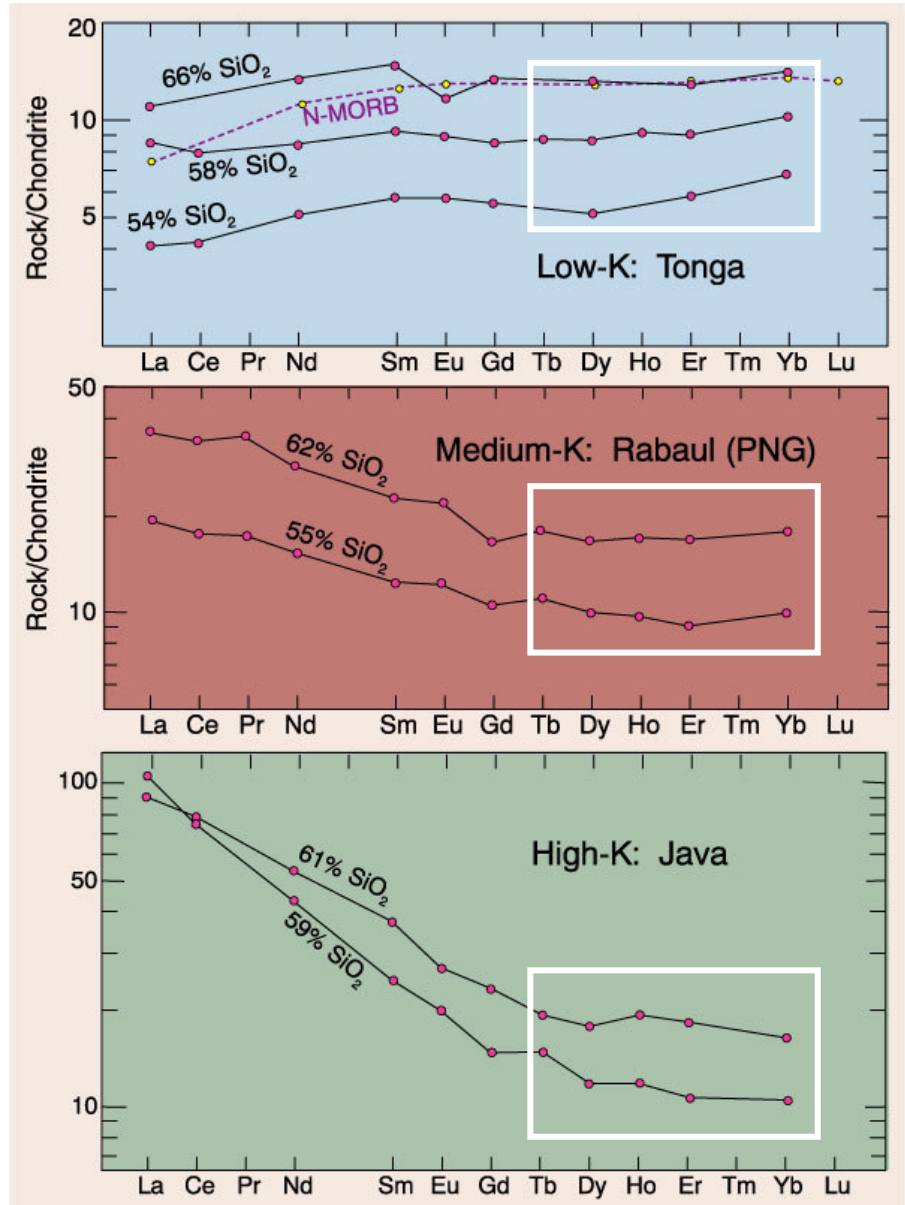
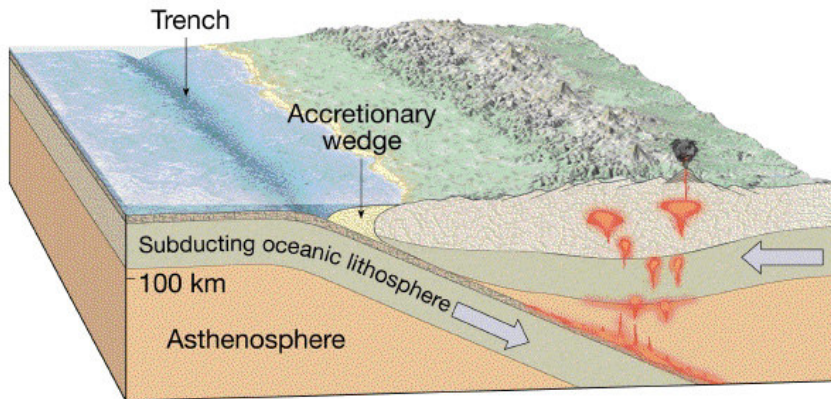
Related to the high water content of calc-alkaline magmas in arcs  $\rightarrow$  high  $f_{O_2}$

Early crystallization of Fe-Ti oxide phases, i.e. magnetite or hornblende (if high  $Na_2O$ )



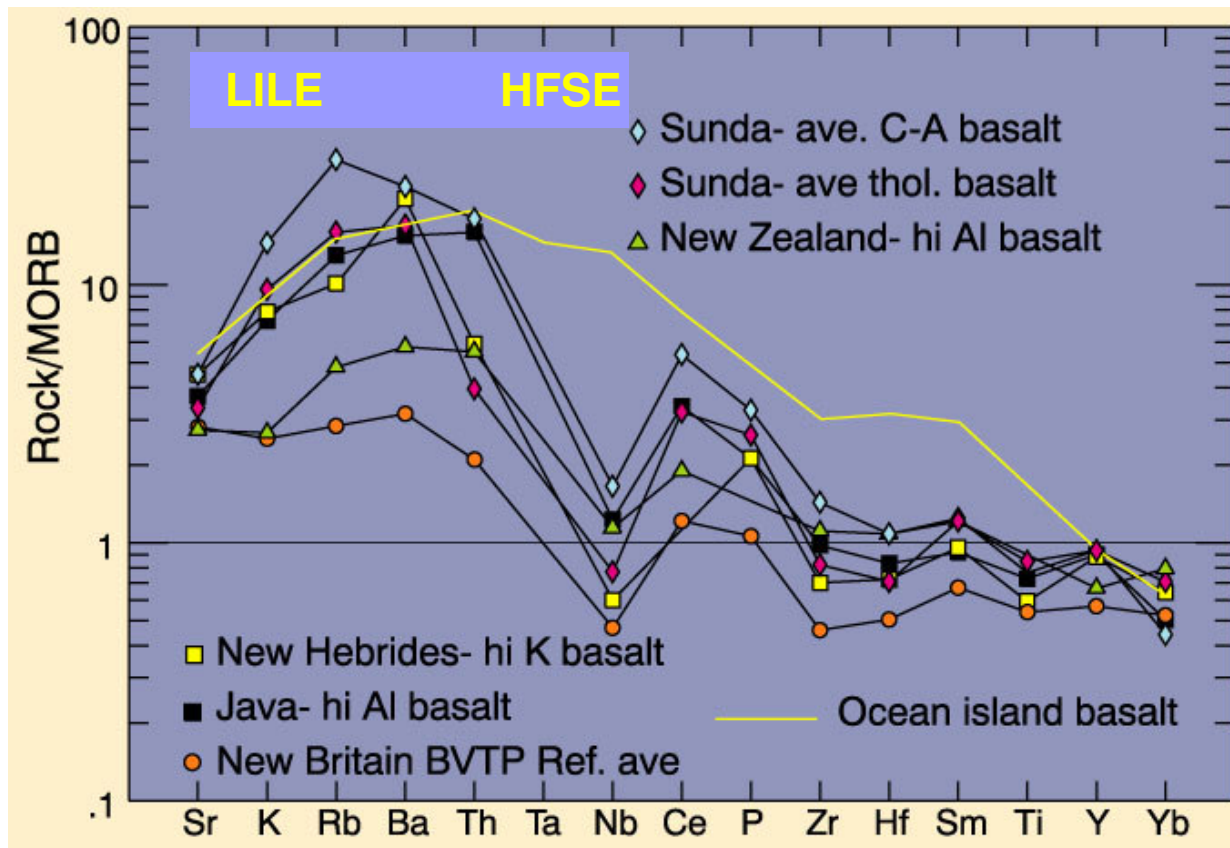
# Trace Elements (REEs)

Flat HREE pattern:  
No garnet-bearing  
(eclogite) source



Gill (1981),  
Sun & McDonough  
(1989)

# MORB-normalized spider diagrams

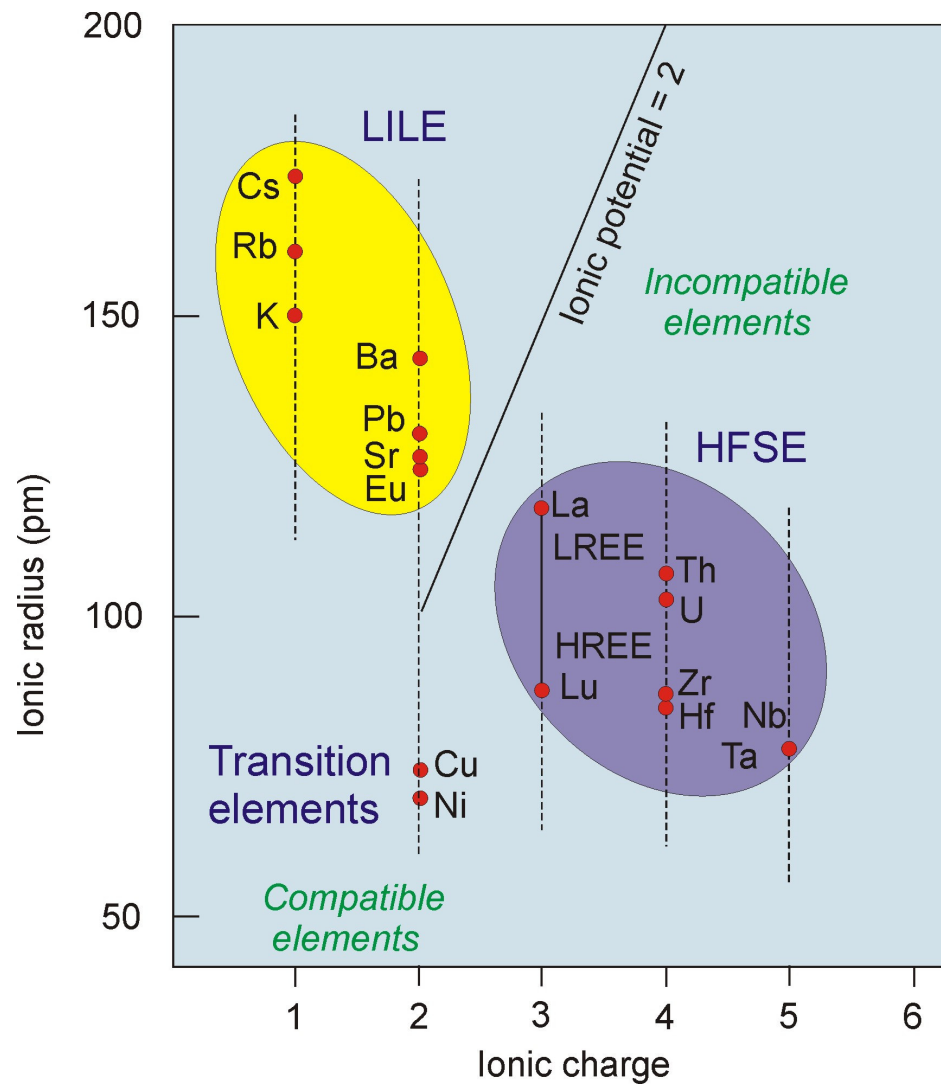


**Fluid-assisted enrichment?**

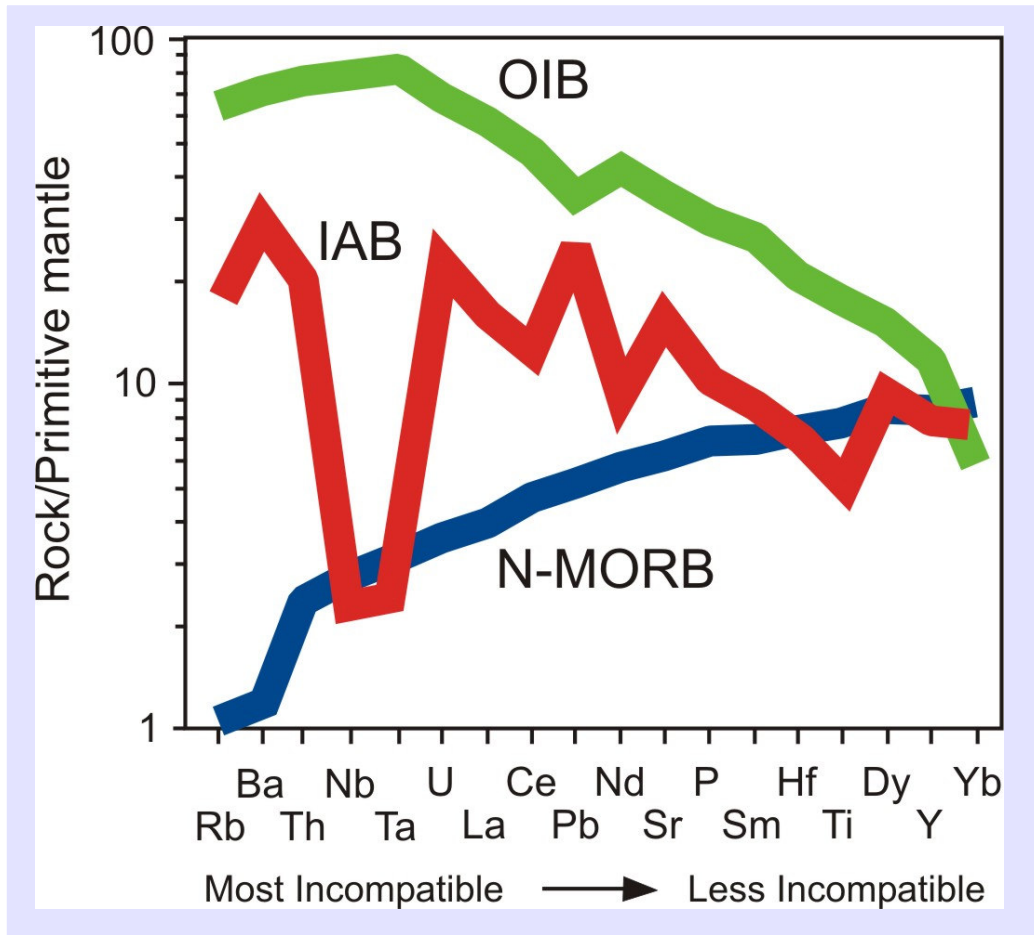
Sun & McDonough (1989),  
Winter (2001)



Plot of ionic radius versus ionic charge with fields of large ion lithophile elements (LILE) and high field strength elements (HFSE).  
Ionic potential = charge/size ratio



# MORB-normalized spider diagrams



**Schematic profiles of  
basalts from different  
tectonic settings**

**MORB: Mid-Ocean-  
Ridge-Basalt**

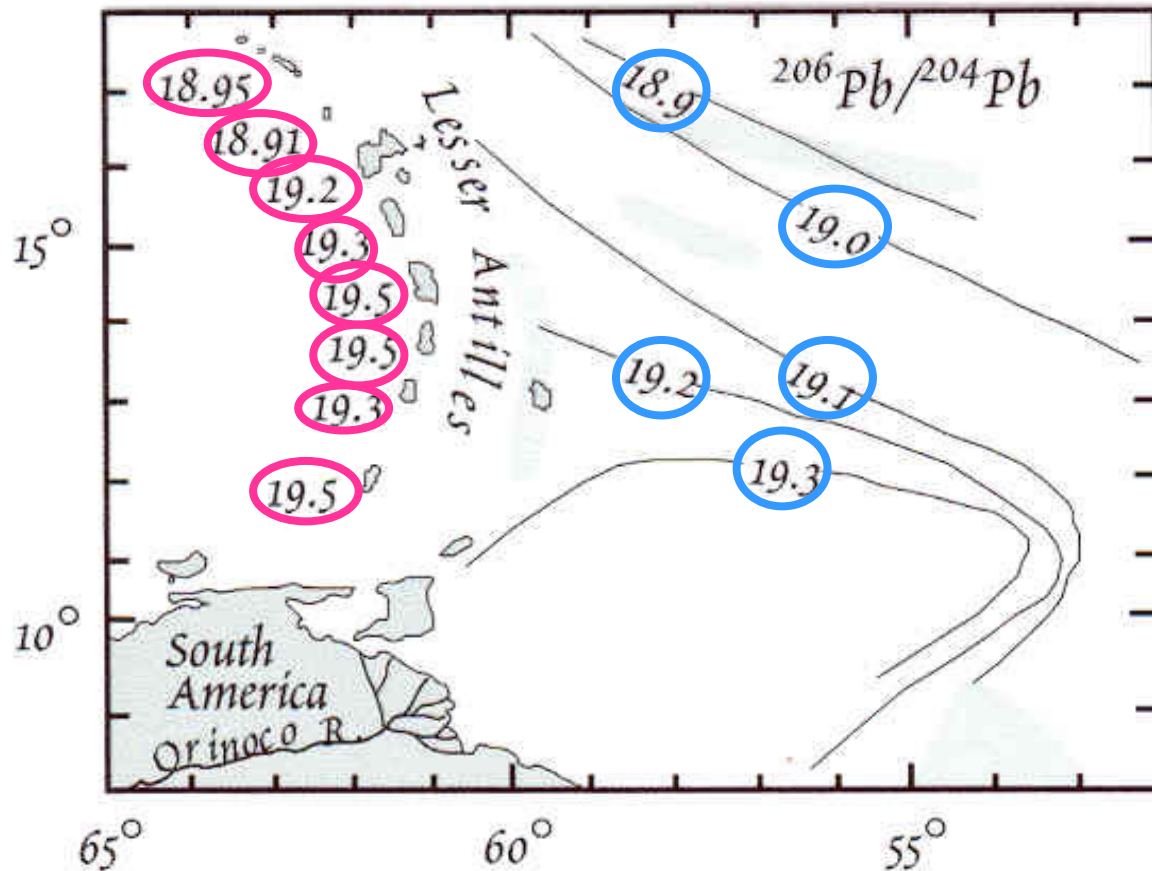
**OIB: Ocean Island  
basalt**

**IAB: Island Arc Basalt**

# Pb isotopes

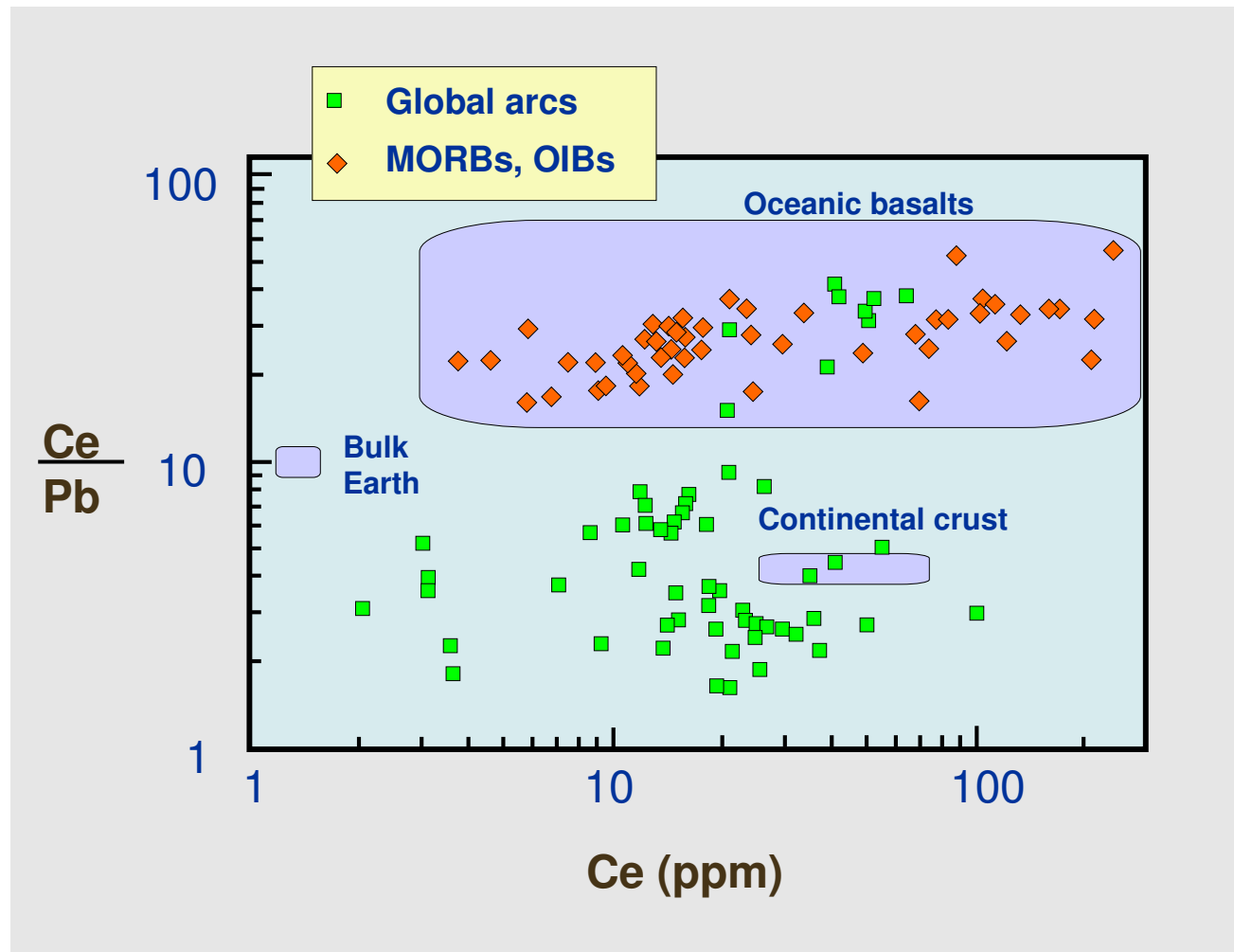


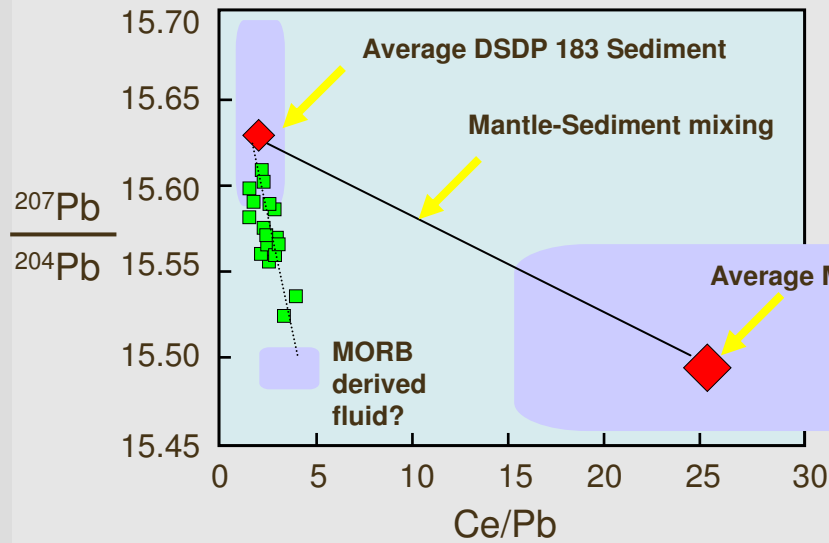
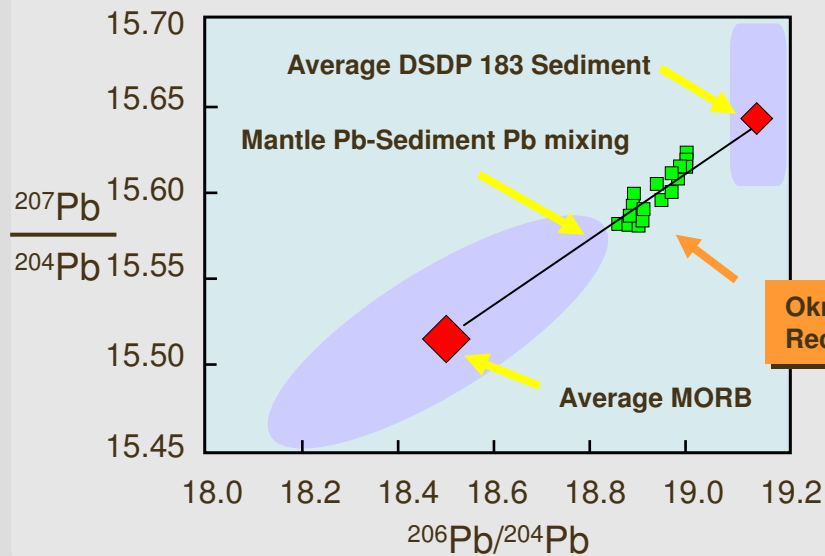
Montserrat



Sediment recycling  
at subduction zones

# Lead-element paradox



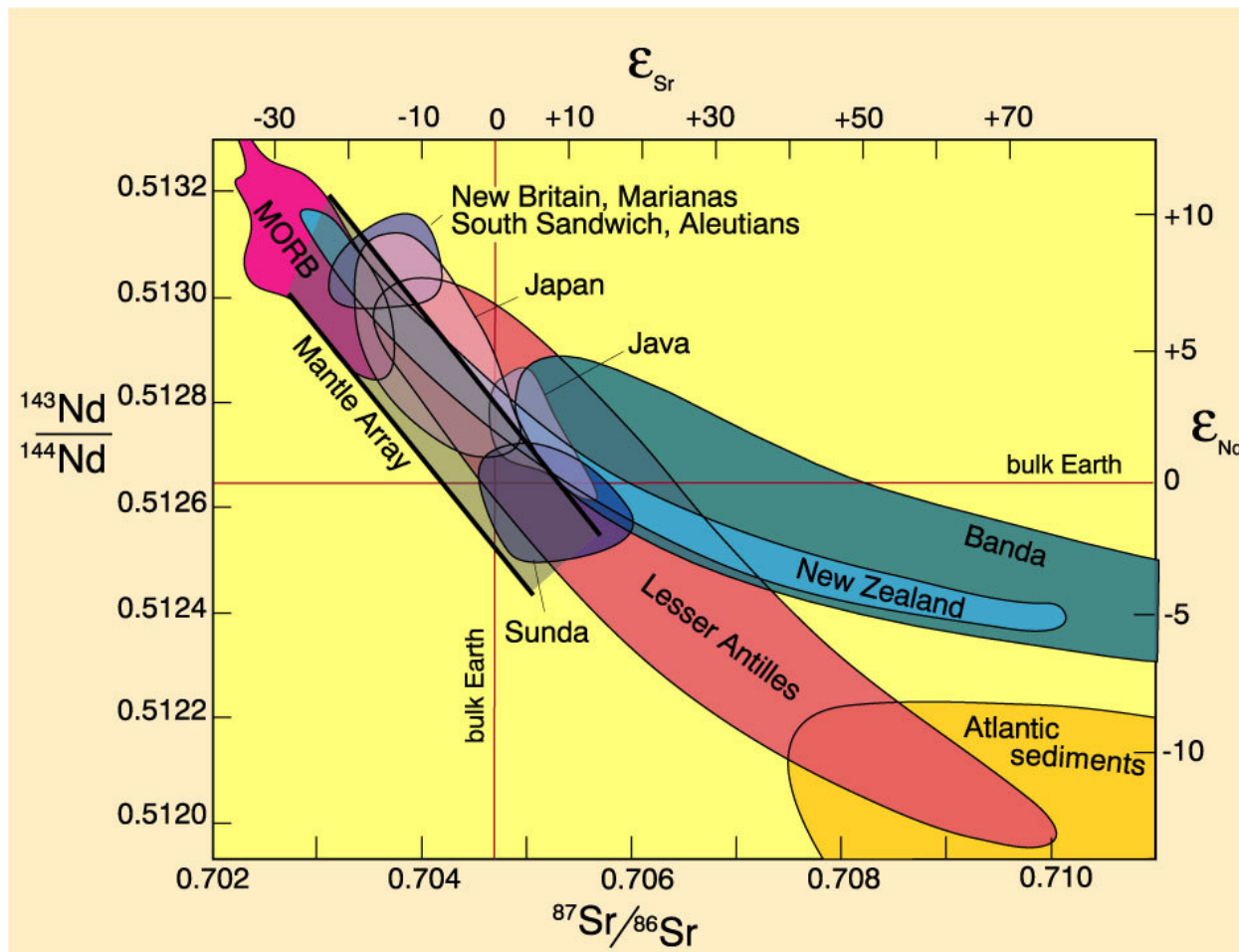


Miller et al. (1994)  
 Nature 368

Source enrichment  
 or melting?

Agent of mass  
 transfer is a fluid

# Sr-Nd isotopes



Arculus & Powell (1986), Gill (1981), McCulloch et al. (1994), Atlantic sediments from White et al. (1985)