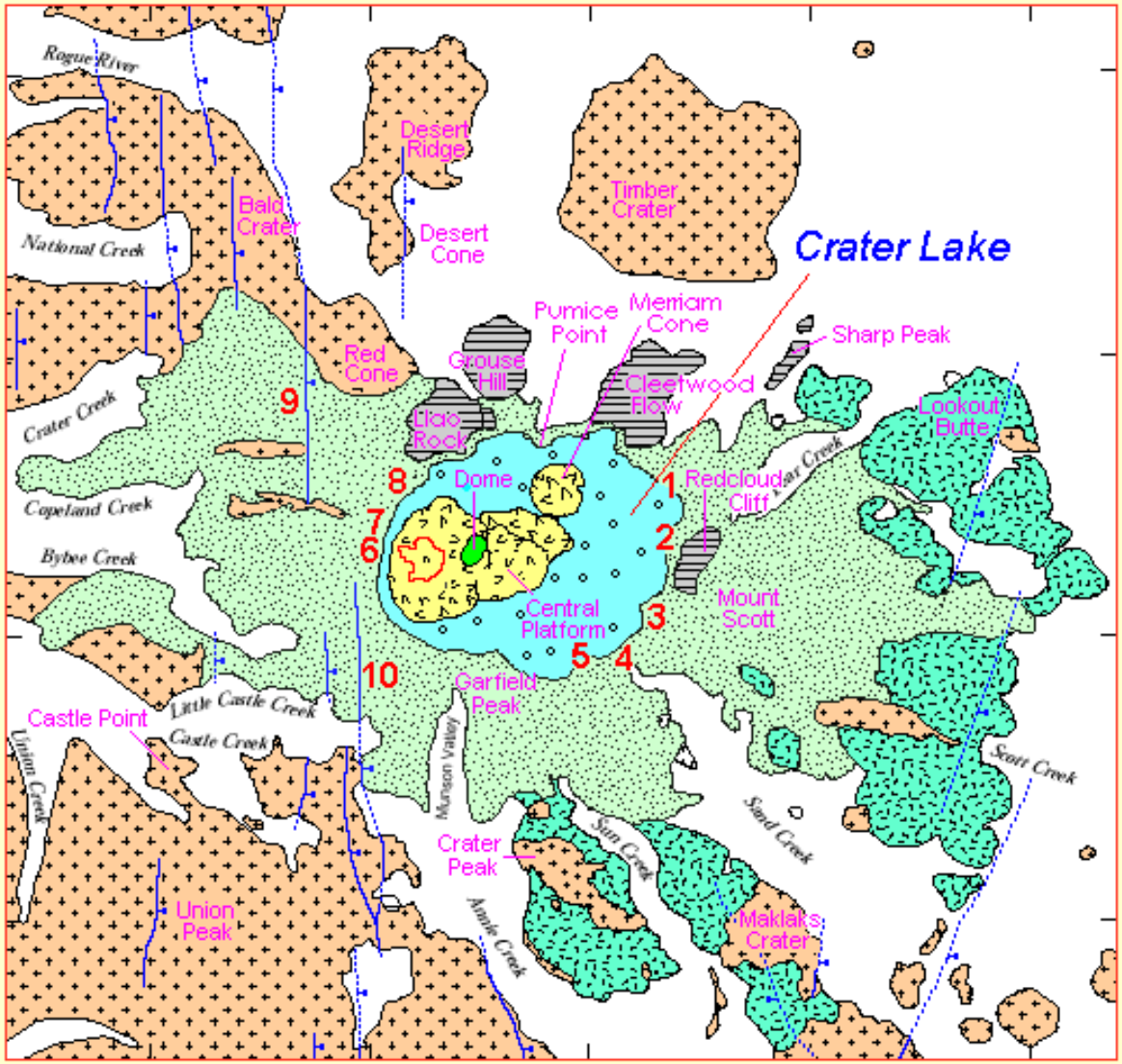
Announcements

- **Reading: p.75-91**
- **HW 1 due April 17**

Crater Lake, OR

Eruption 7000 years b.p. reduced 12000 ft (3700 m) tall mountain to caldera about 6100 ft above sea level

Generalized Geologic Map of Mount Mazama and Vicinity



EXPLANATION

Holocene
- Sediment and submerged caldera walls
- Postcaldera rhyodacite
- Postcaldera andesite
- Pyroclastic-flow deposits of climactic eruption

Mostly Pleistocene
- Predimactic rhyodacite
- Andesite and dacite of Mount Mazama
- Pre-Mazama rhyodacite and dacite
- Basaltic andesite and andesite (various ages)

Contact

Fault

0 5 kilometers

1 ... Wineglass
2 ... Skell Head
3 ... Pumice Castle
4 ... Kerr Notch
5 ... Phantom Ship
6 ... The Watchman
7 ... Hillman Peak
8 ... Devil's Backbone
9 ... Red Cone Spring fault
10 .. Annie Spring fault

USGS

Topinka, USGS/CVO, 2001; Modified from: Bacon, et.al., 1997, USGS Open-File Report 97-487;
Map Data Source: C. R. Bacon, unpublished mapping, 1996; some features from: U. S. National Park Service Map

Harker diagrams
for Crater Lake

What features do you observe in these diagrams?

(X, Y, data clusters)

Primary, parental, primitive, and evolved magmas

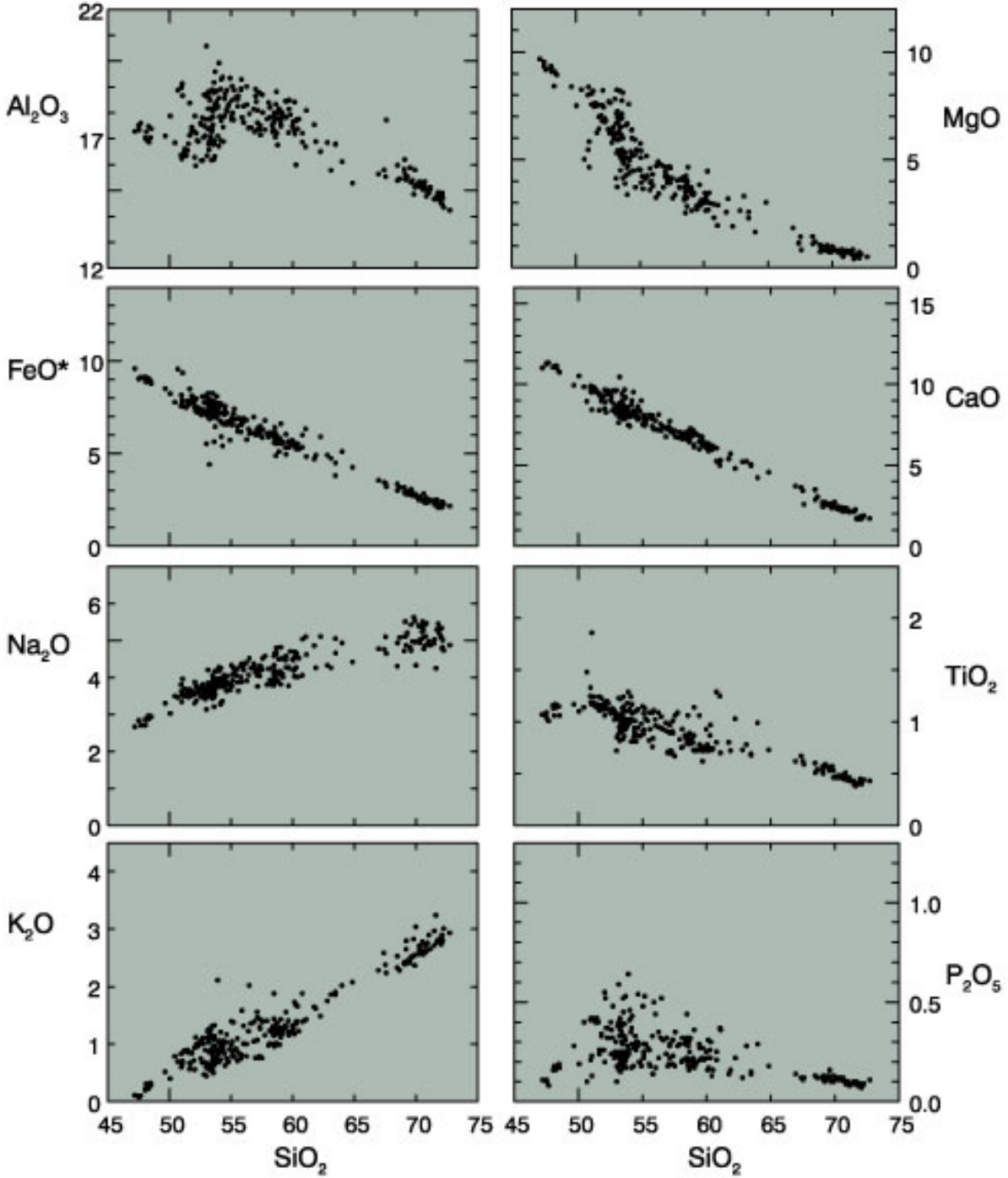


Figure 8-2. Harker variation diagram for 310 analyzed volcanic rocks from Crater Lake (Mt. Mazama), Oregon Cascades. Data compiled by Rick Conrey (personal communication).

Harker diagram
for Crater Lake

Describe trends qualitatively with fractional crystallization

- Trends = liquid line of descent
- The most primitive lava on the diagram is the parent magma
- What phases typically crystallize from magmas?
- Adjust % of remaining components (Na, K)

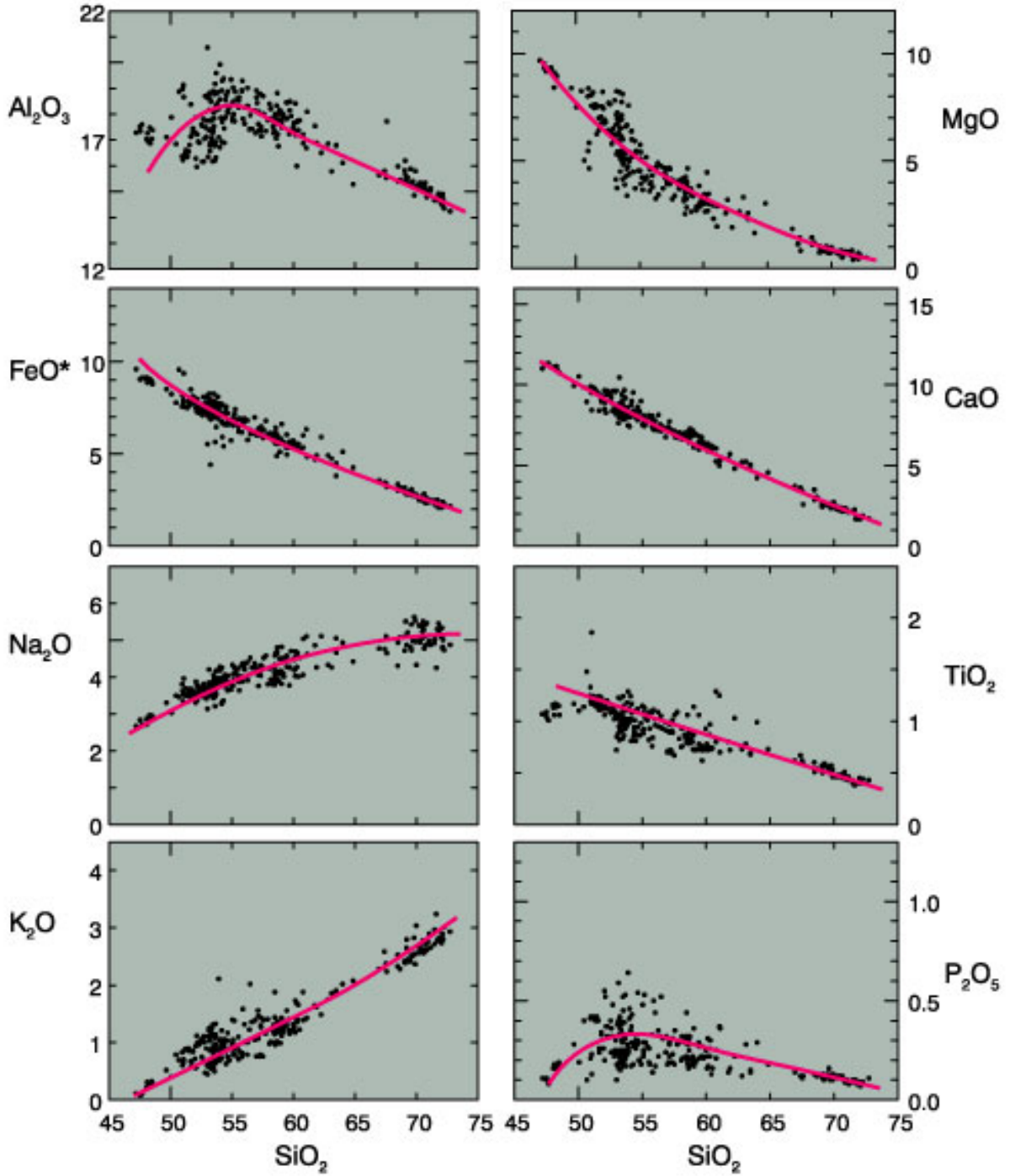
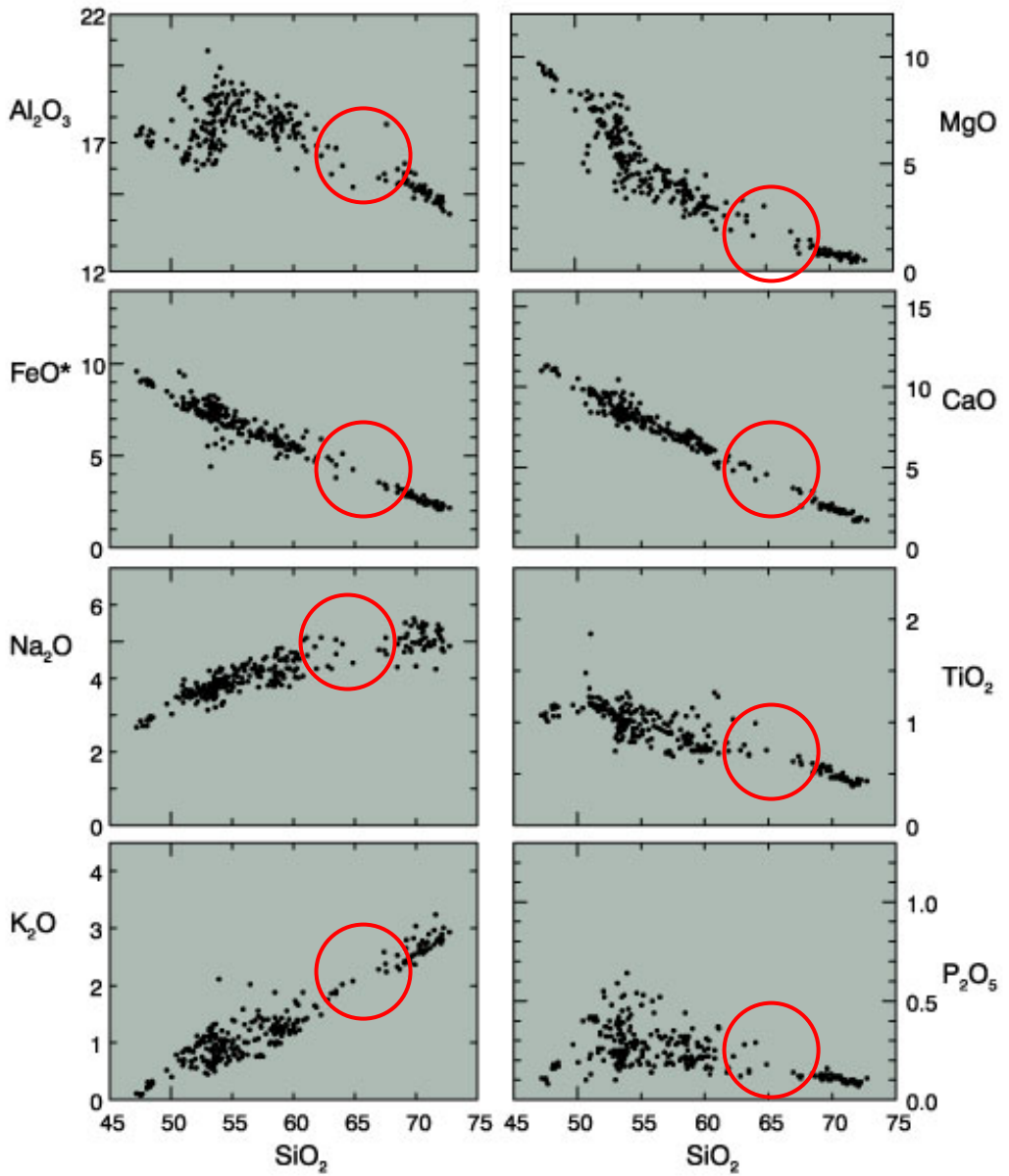


Figure 8-2. Harker variation diagram for 310 analyzed volcanic rocks from Crater Lake (Mt. Mazama), Oregon Cascades. Data compiled by Rick Conrey (personal communication).

The Daly Gap

- Fractional crystallization?
- Partal magma mixing?
- Oxide crystallization?



Ocean-ocean → Island Arc (IA)

Ocean-continent → Continental Arc or

Active Continental Margin (ACM)

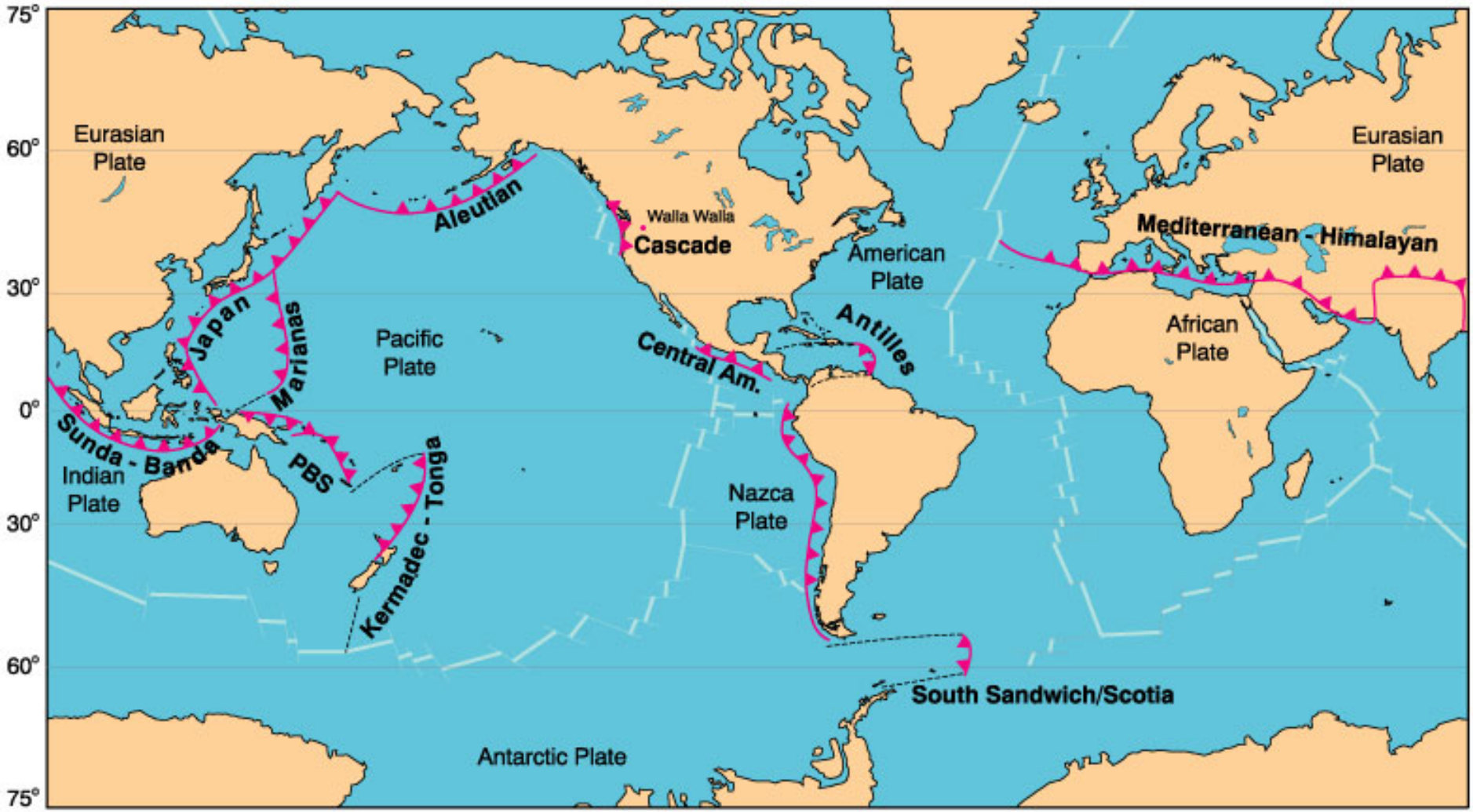


Figure 16-1. Principal subduction zones associated with orogenic volcanism and plutonism. Triangles are on the overriding plate. PBS = Papuan-Bismarck-Solomon-New Hebrides arc. After Wilson (1989) Igneous Petrogenesis, Allen Unwin/Kluwer.

Structure of an Island Arc

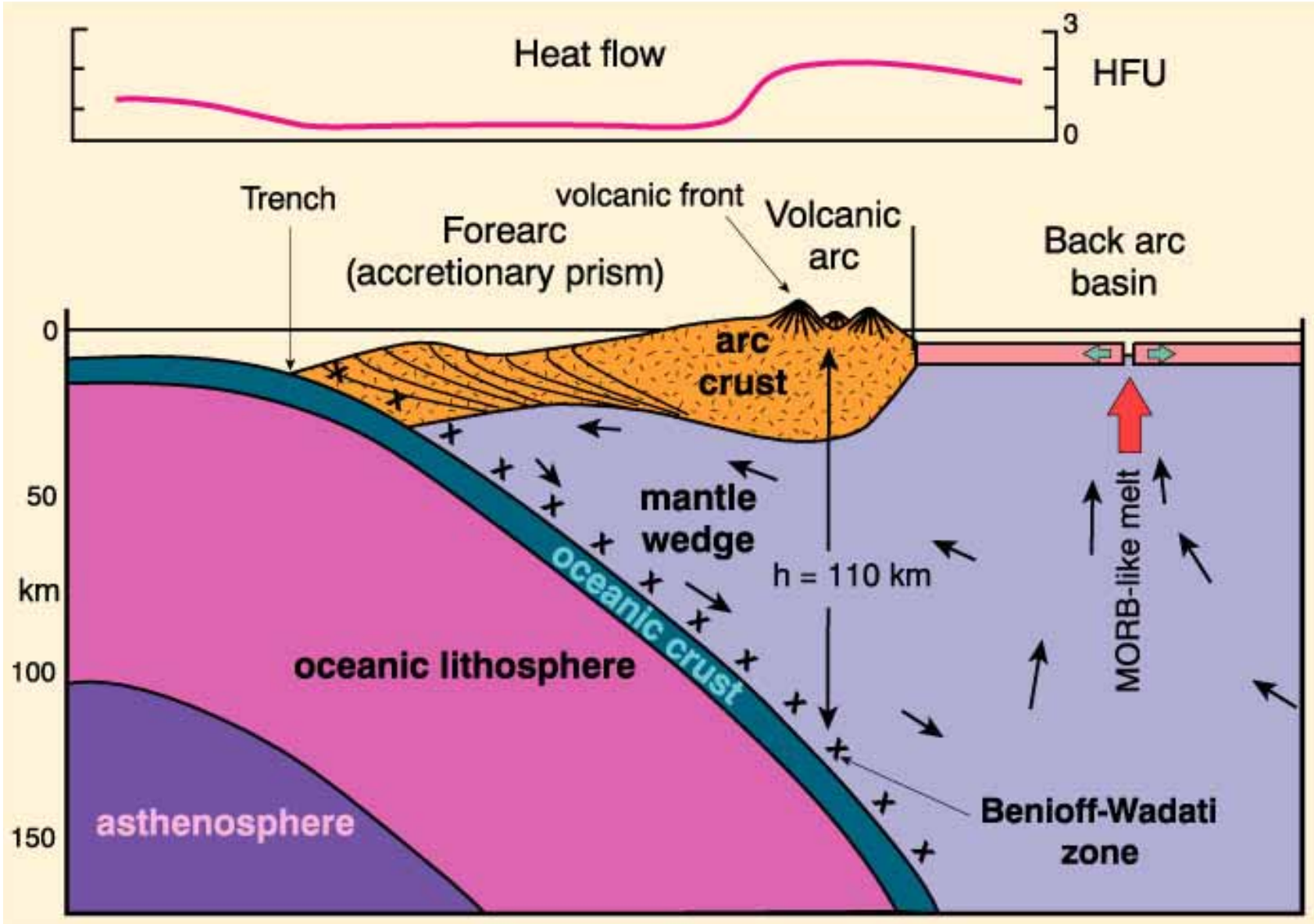


Figure 16-2. **Schematic cross section through a typical island arc after Gill (1981), Orogenic Andesites and Plate Tectonics. Springer-Verlag. HFU= heat flow unit (4.2×10^{-6} joules/cm^2/sec)**

Continental Arc Magmatism

What components contribute to melts that end up erupting or stagnating in the crust?

What processes can induce melting?

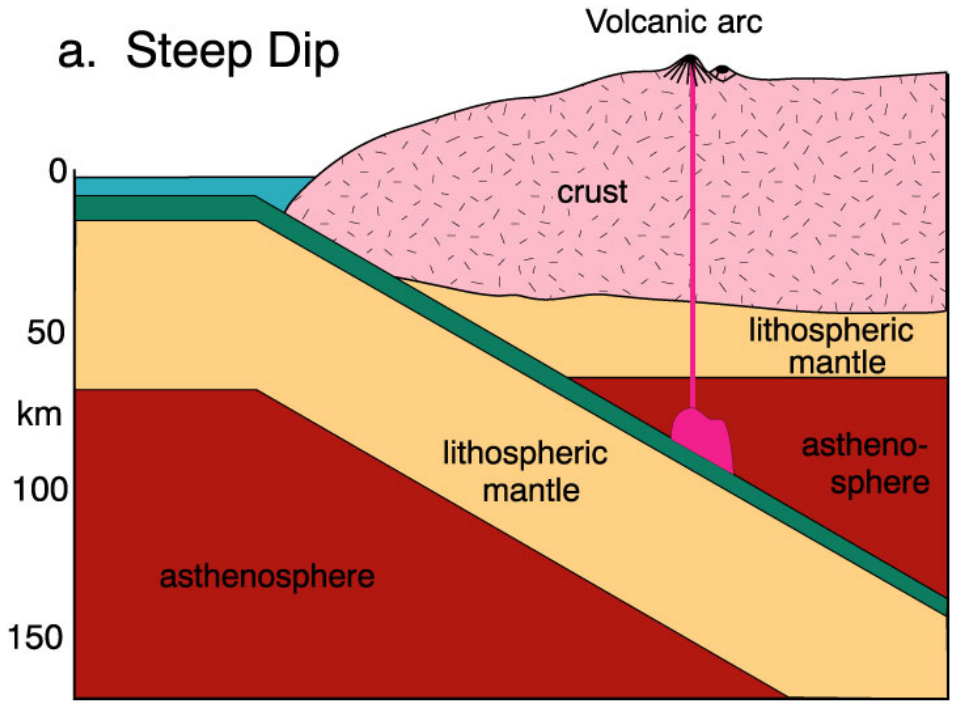
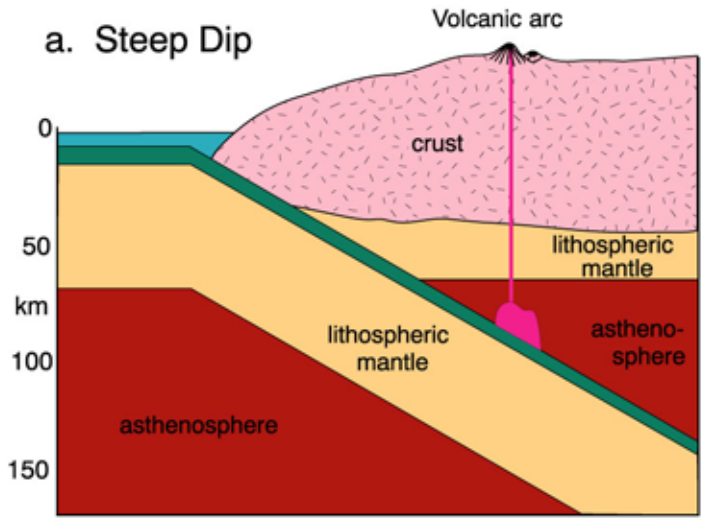


Figure 17-2. Schematic diagram to illustrate how a shallow dip of the subducting slab can pinch out the asthenosphere from the overlying mantle wedge. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Components that contribute to continental arc melts

- Continental crust
- Mantle wedge
- Subducting lithosphere



Volcanic rocks in island arcs and continental arcs vs. other localities

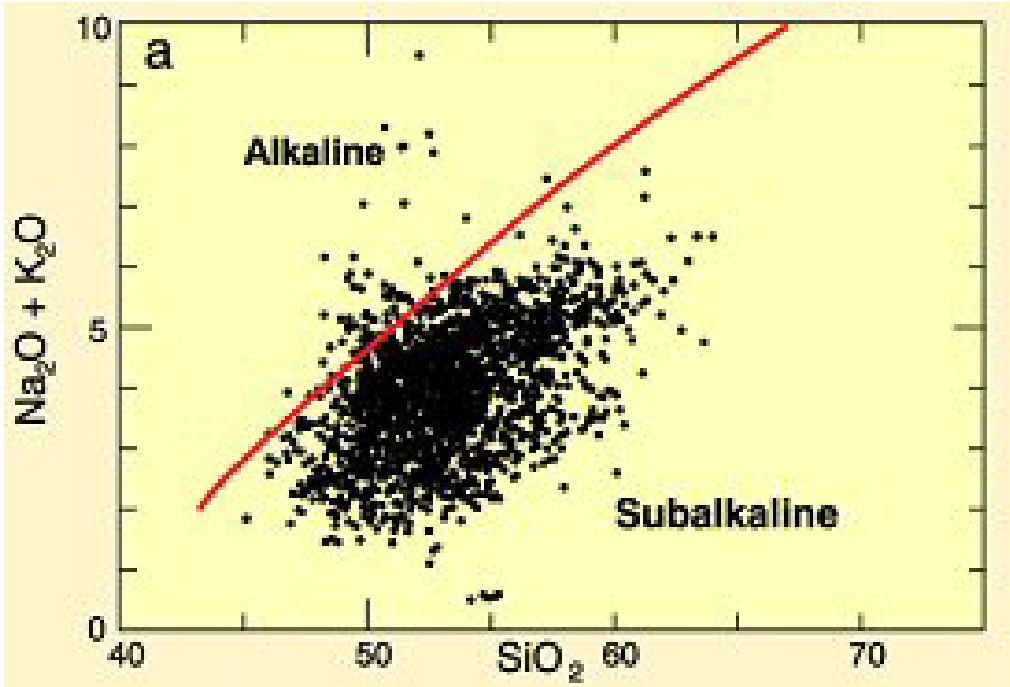
Sub-alkaline series

Tholeiites (basalts)

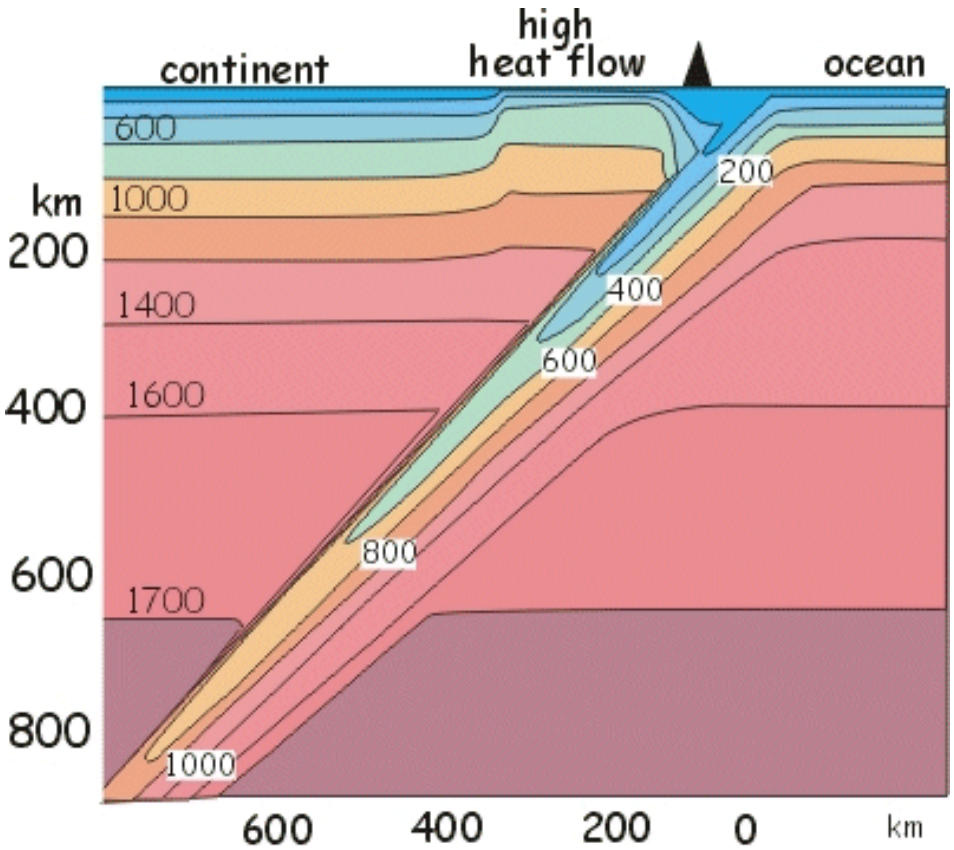
****Calc-alkaline magmas:**
enrichment in SiO_2, FeO*/MgO, and H_2O (K_2O more complicated) relative to tholeiites

(Andesites, dacites)

Alkaline magmas
(rhyolites)



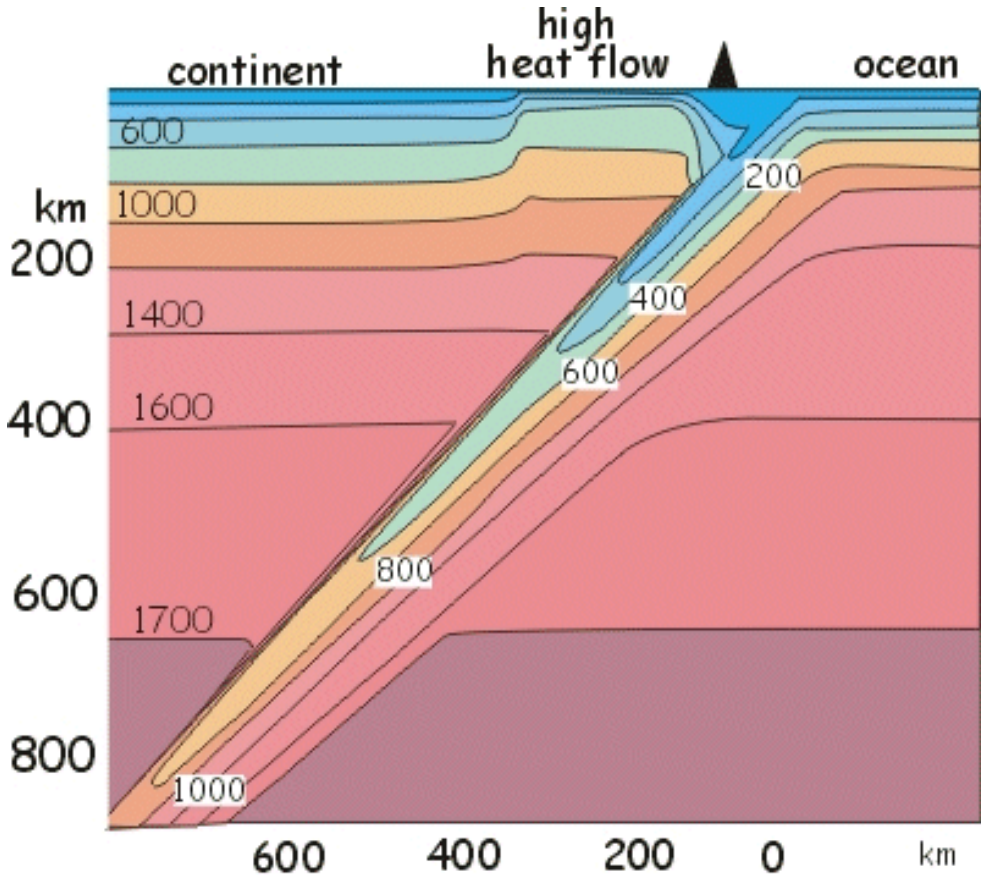
Mantle Wedge



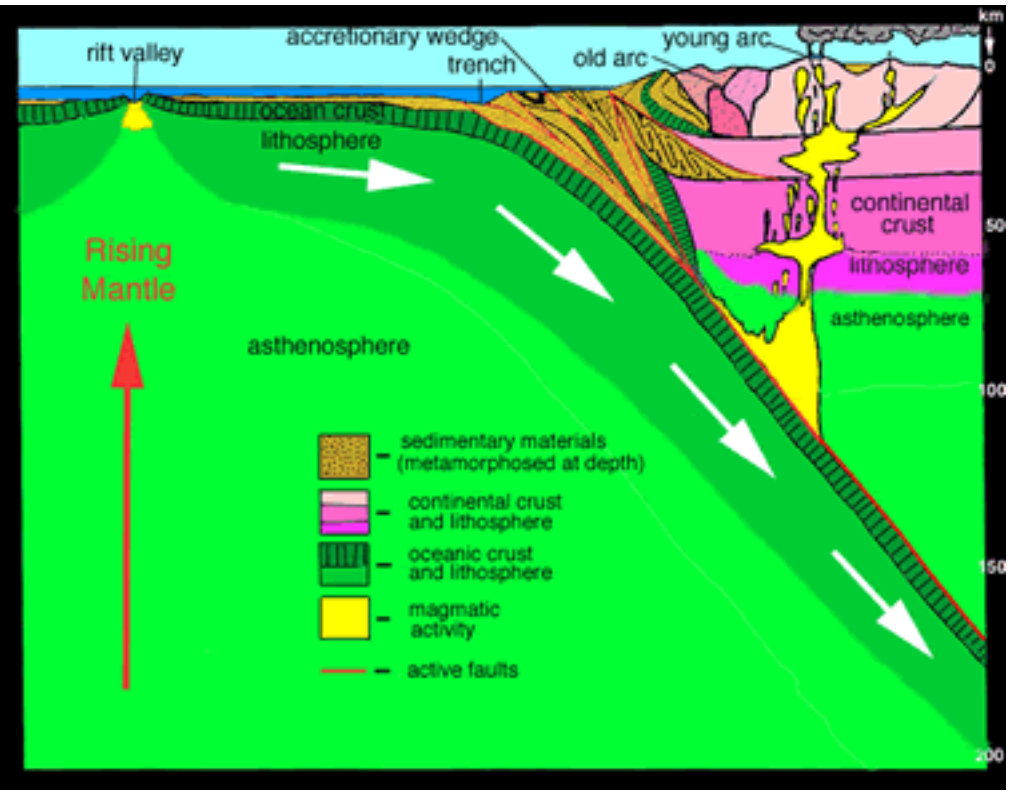
- Composition: ultramafic
- Flow lines generally downward
- Sitting above colder subducting crust- how do we initiate melting in mantle wedge?

Subducting lithosphere

- Again, it's cold- why would it melt?
- Can we figure out a way to determine how much the subducting slab is contributing to the melt?



Dehydration reactions in a subducting slab



- What minerals are present in top/middle of oceanic lithosphere before subduction?
- Clays, micas, carbonates, sulfates, amphiboles (as P increases)

$$Mg_7Si_8O_{22}(OH)_2 = 7MgSiO_3 + SiO_2 + H_2O$$

Dry and water-saturated solidi for some common rock types

The more mafic the rock the higher the melting point

All solidi are greatly lowered by water

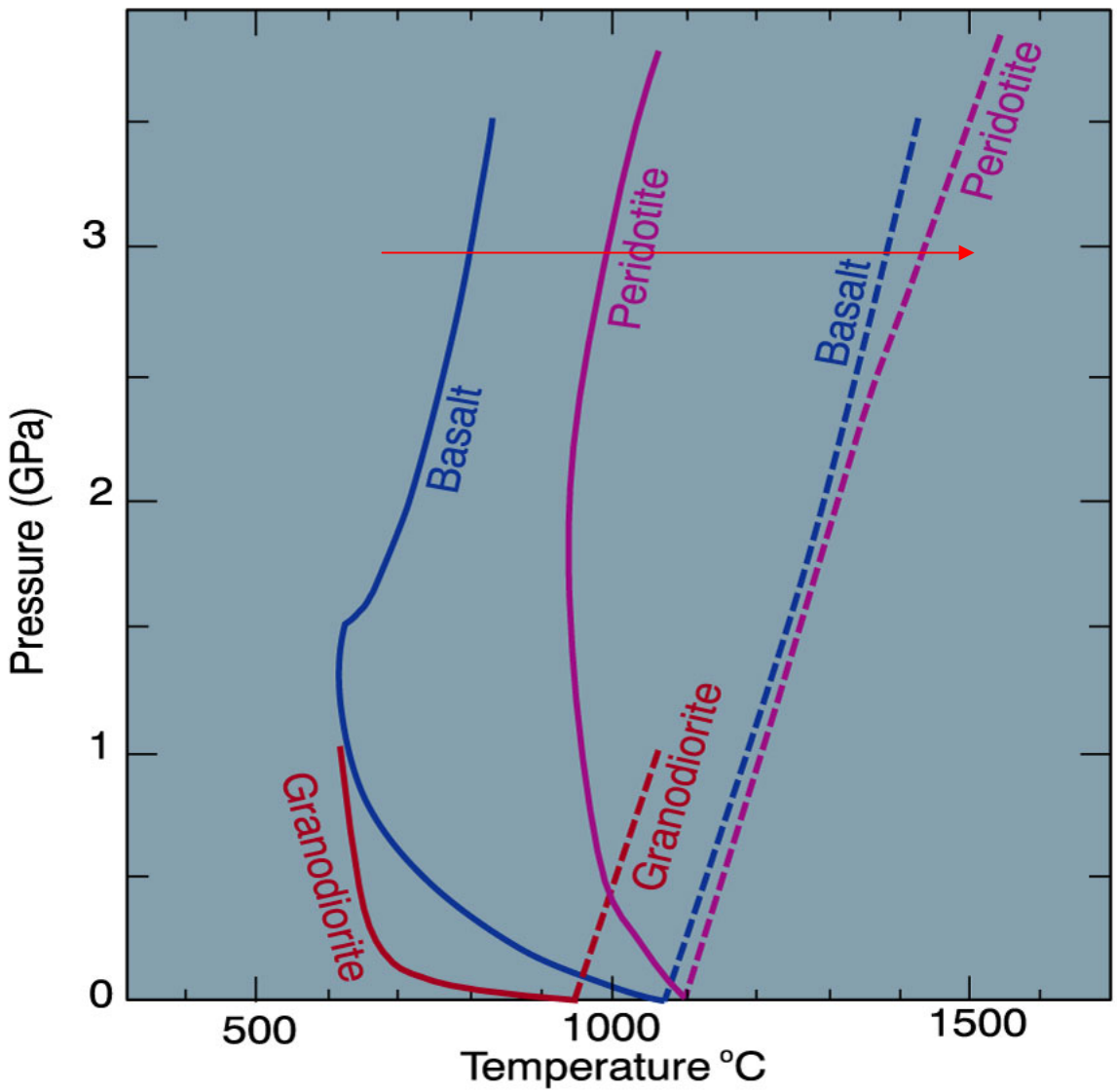
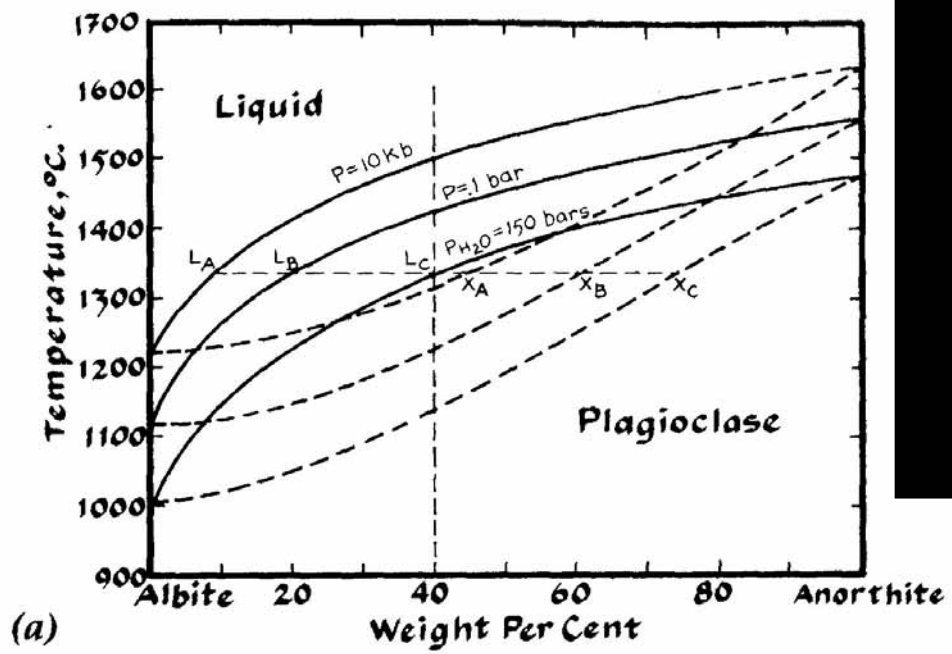


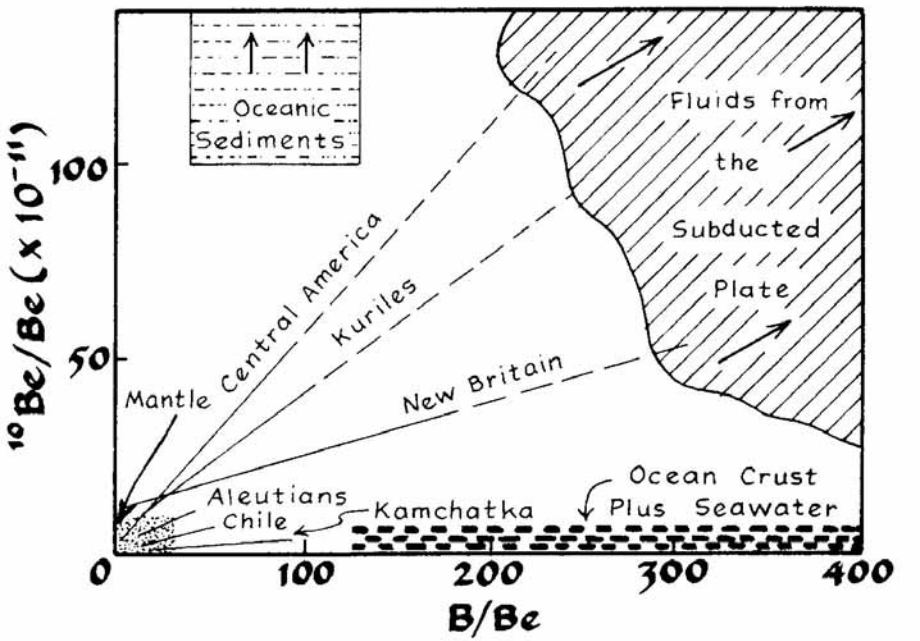
Figure 7-21. H_2O-saturated (solid) and H_2O-free (dashed) solidi (beginning of melting) for granodiorite (Robertson and Wyllie, 1971), gabbro (Lambert and Wyllie, 1972) and peridotite (H_2O-saturated: Kushiro *et al.*, 1968; dry: Ito and Kennedy, 1967).

The effect of adding a little water to the mantle wedge

- Induce melting simply by adding water, instead of increasing temperature
- A few wt% of water has a larger affect than a few wt% of common cations.
- H_2O = 18.01
- FeO = 71.85



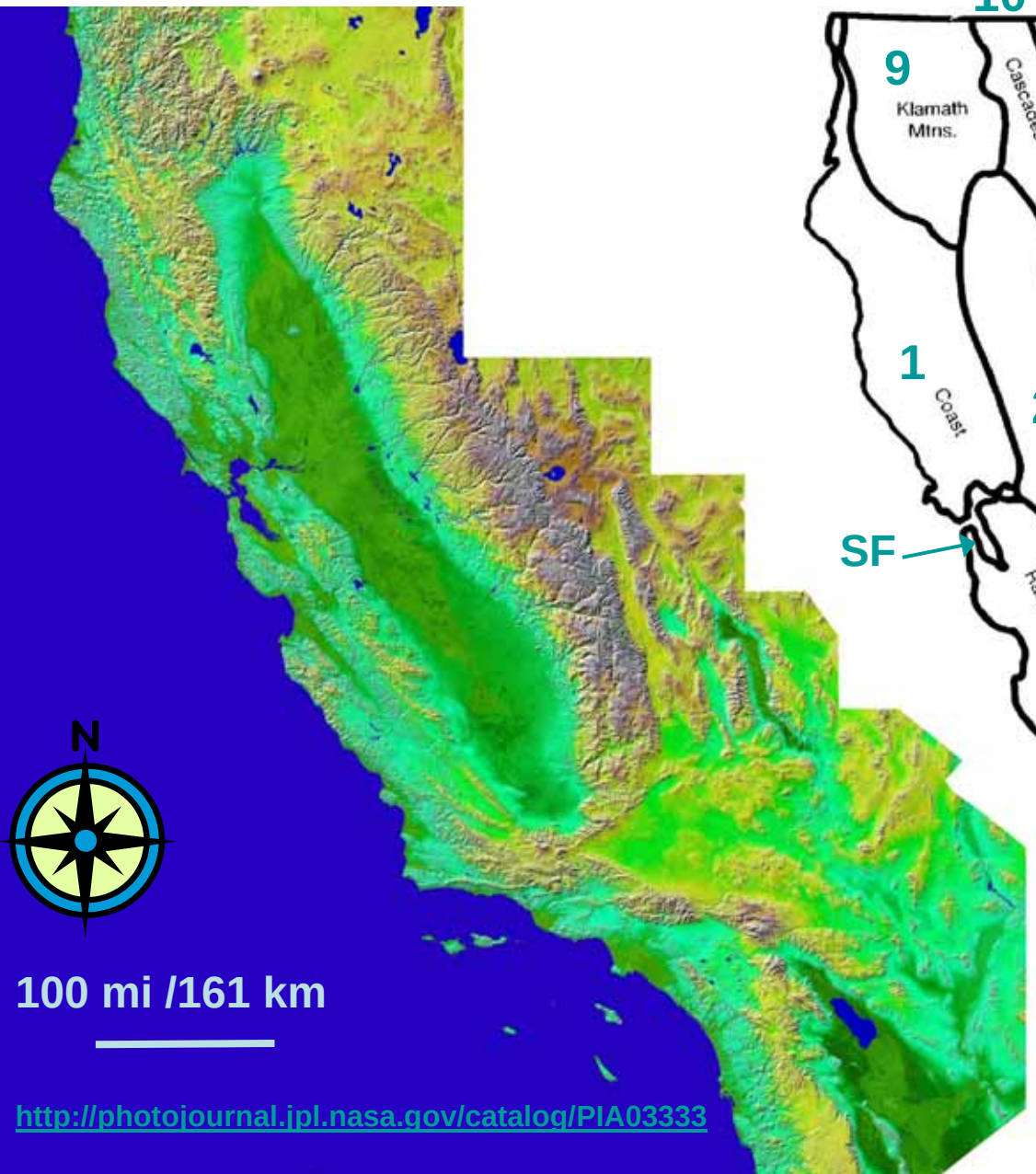
Q: How much fluid/sediment from the subducting slab gets into the final melt?



- Boron: tracer of sediments
- ^{10}Be: produced in the atmosphere (O,N): tracer of seafloor sediments and rate of subduction – $t^{1/2}$ of 1.5 ma
- A: Not sediment itself. Some, but not all of fluid.

- Does all the water come out? Does some keep going into the mantle? How?

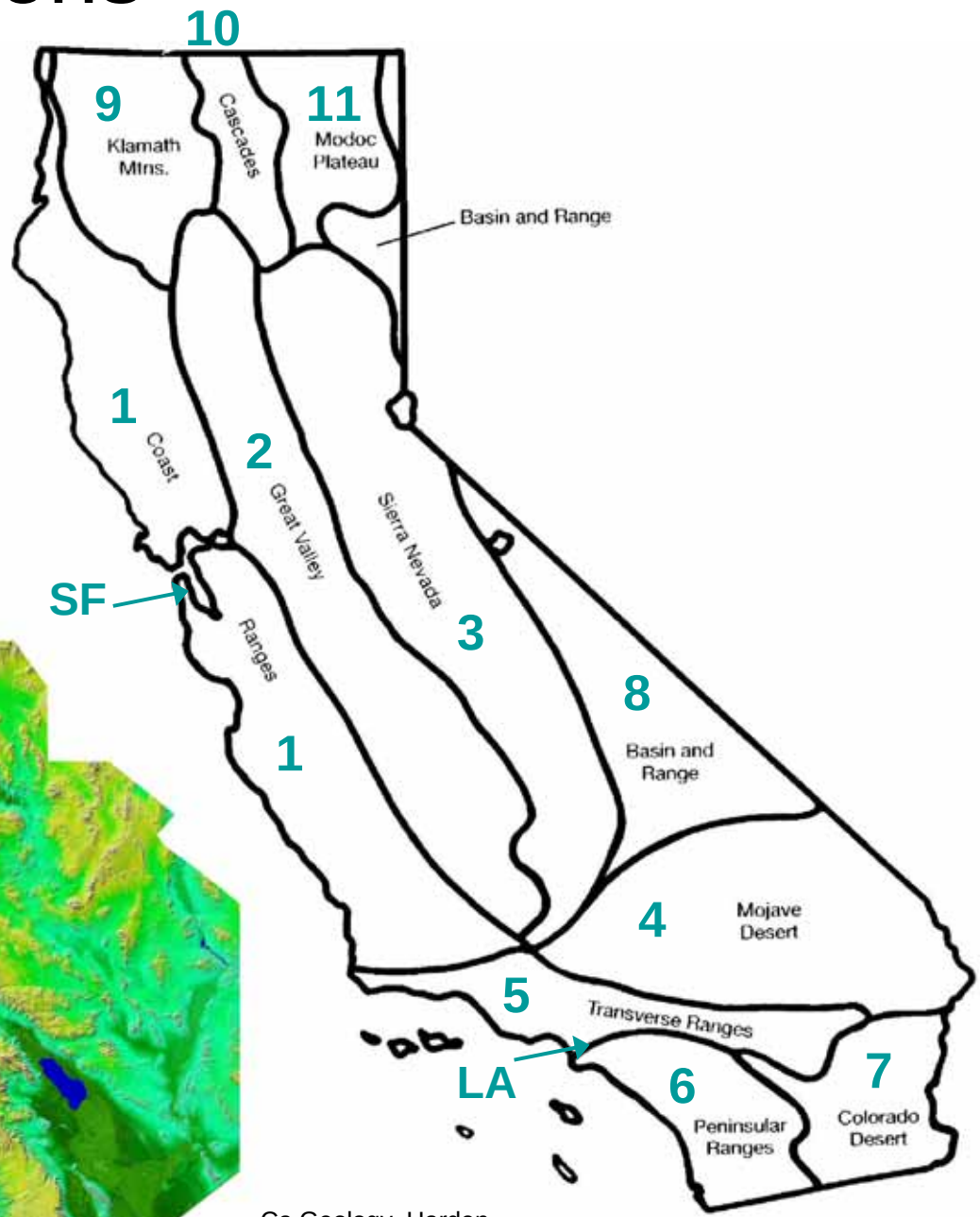
California Regions



N

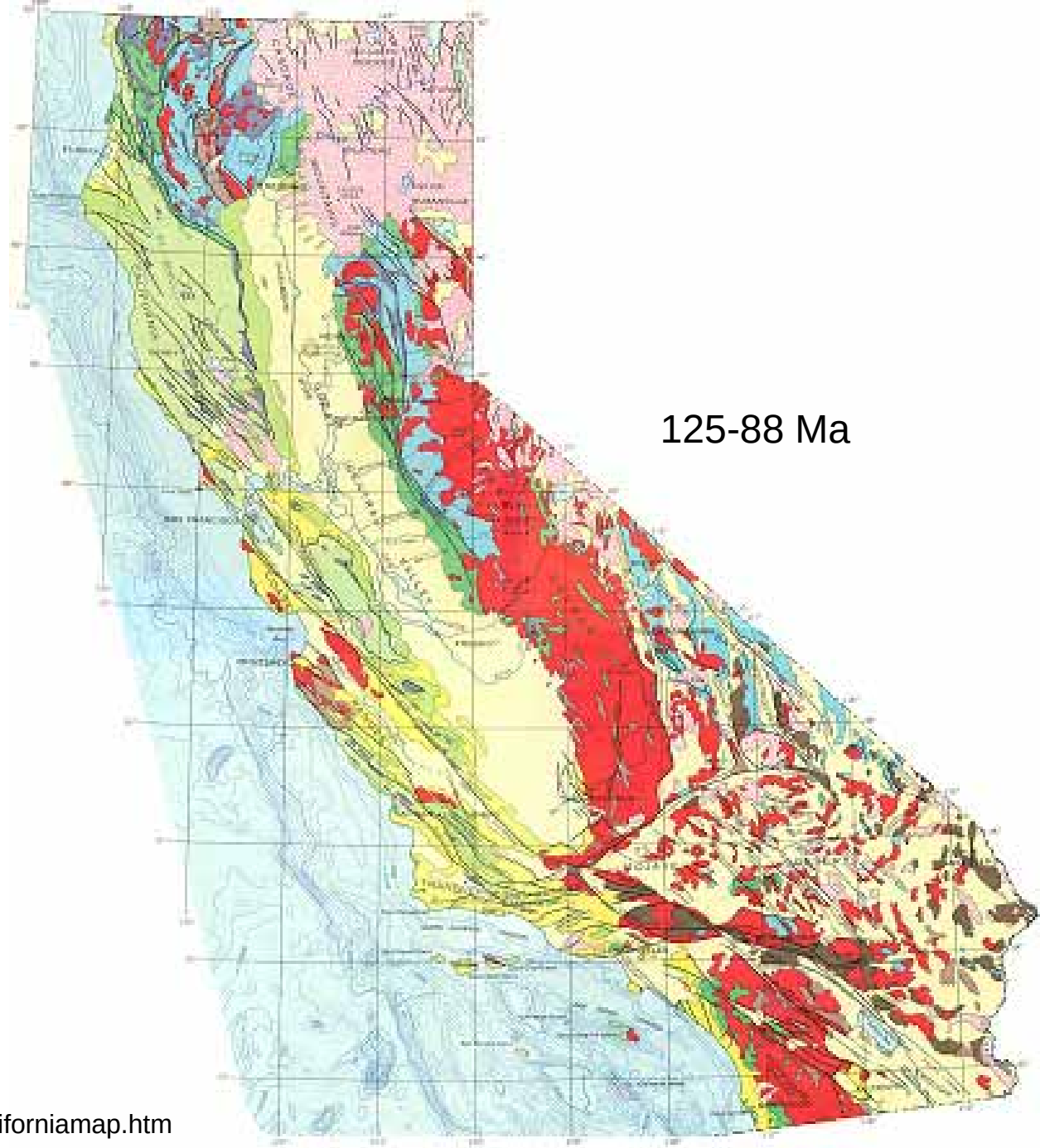
100 mi /161 km

http://photojournal.jpl.nasa.gov/catalog/PIA03333



Ca Geology, Harden

CA Geologic Map



125-88 Ma

http://geology.about.com/library/bl/maps/blcaliforniamap.htm