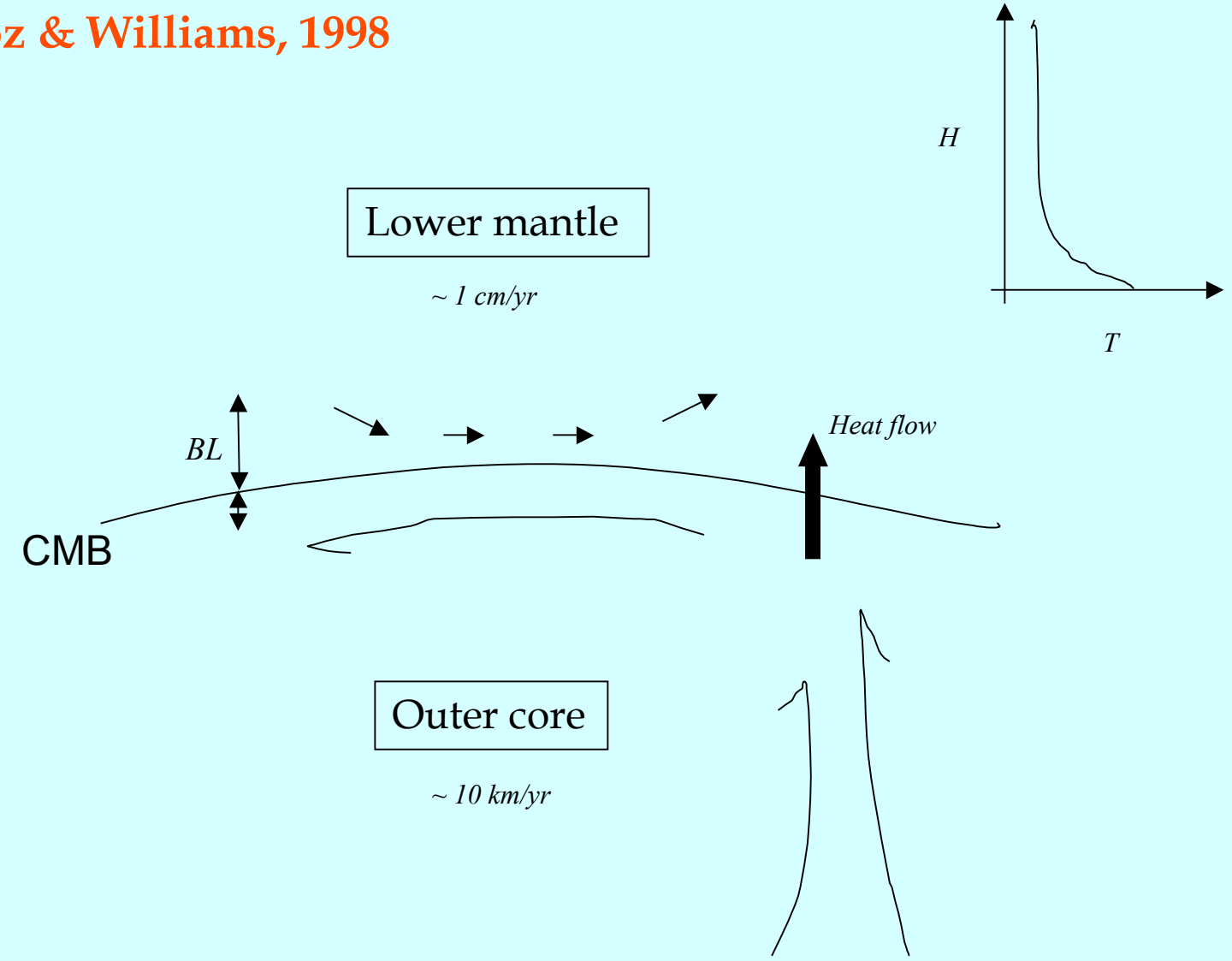
The Core-Mantle Boundary Region

Jeanloz & Williams, 1998



Lower mantle mineralogy

Classical constraints

- Bulk composition: observed top-most mantle sample;

  Peridotitic: 50% olivine + 40% pyroxene + minor phases

- Acoustic properties match seismological observation;

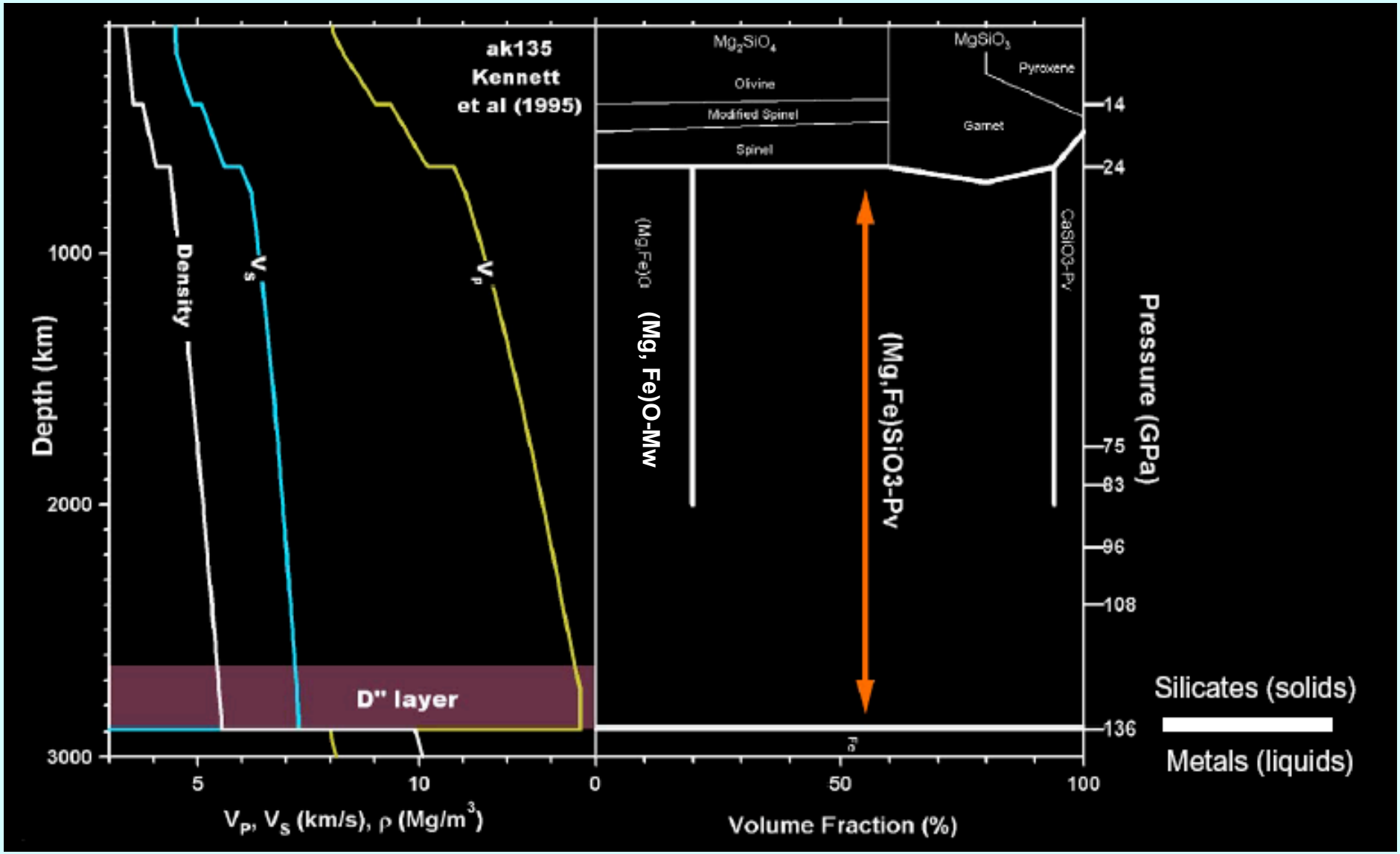
- Is similar to chondritic meteorites;

- Can produce basalt upon partial melting at low pressures (cf. MOR);

…Details are uncertain yet

Lower mantle mineralogy

High-pressure experiments

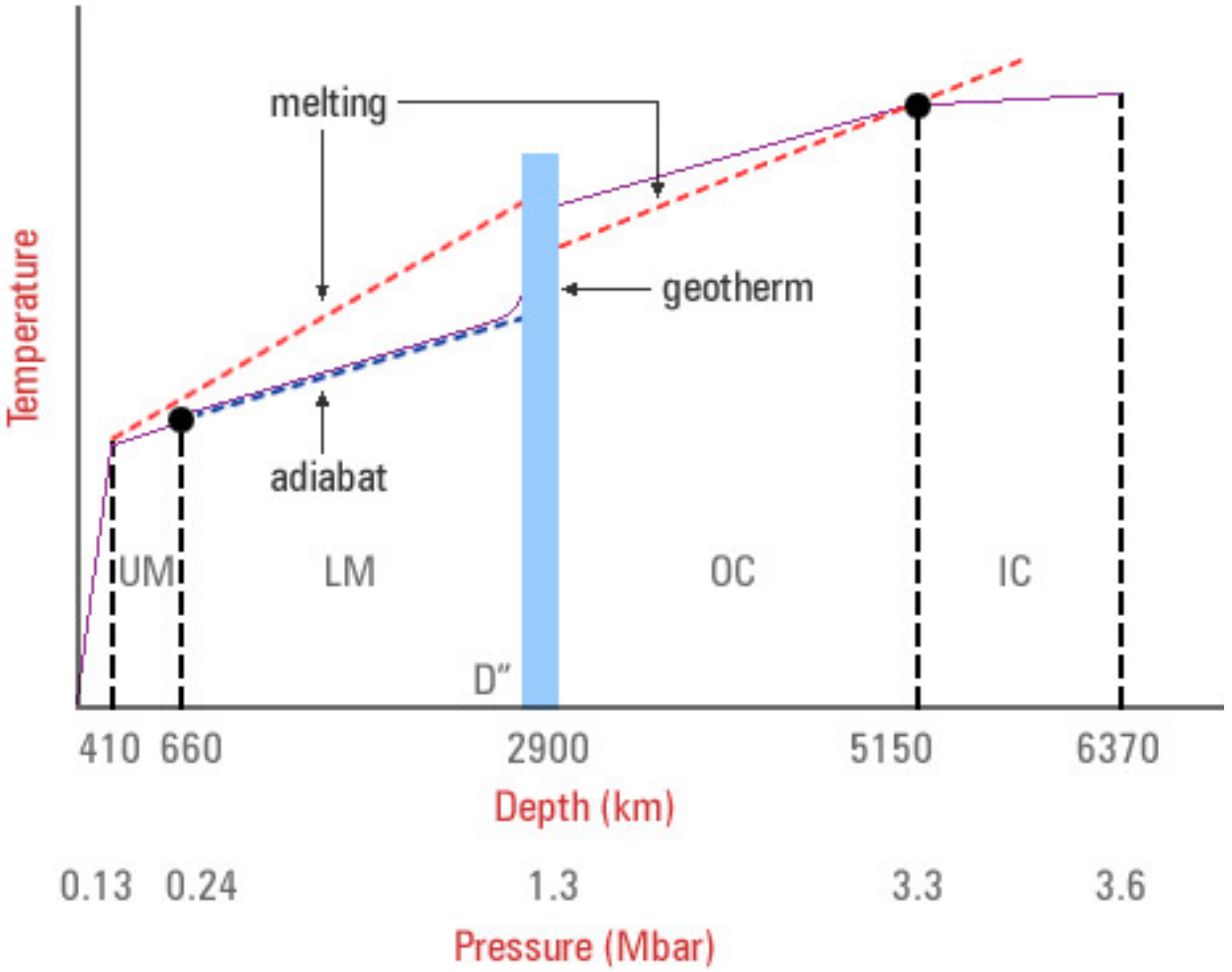


Outer core composition

- Properties are similar to Fe;
- Among candidates, Fe is most abundant in the universe;
- Earth's magnetic field requires electrically conducting fluid;
- 10% less dense than Fe → Fe-rich alloy;

  (resulting in large uncertainties in the estimated T of CMB)

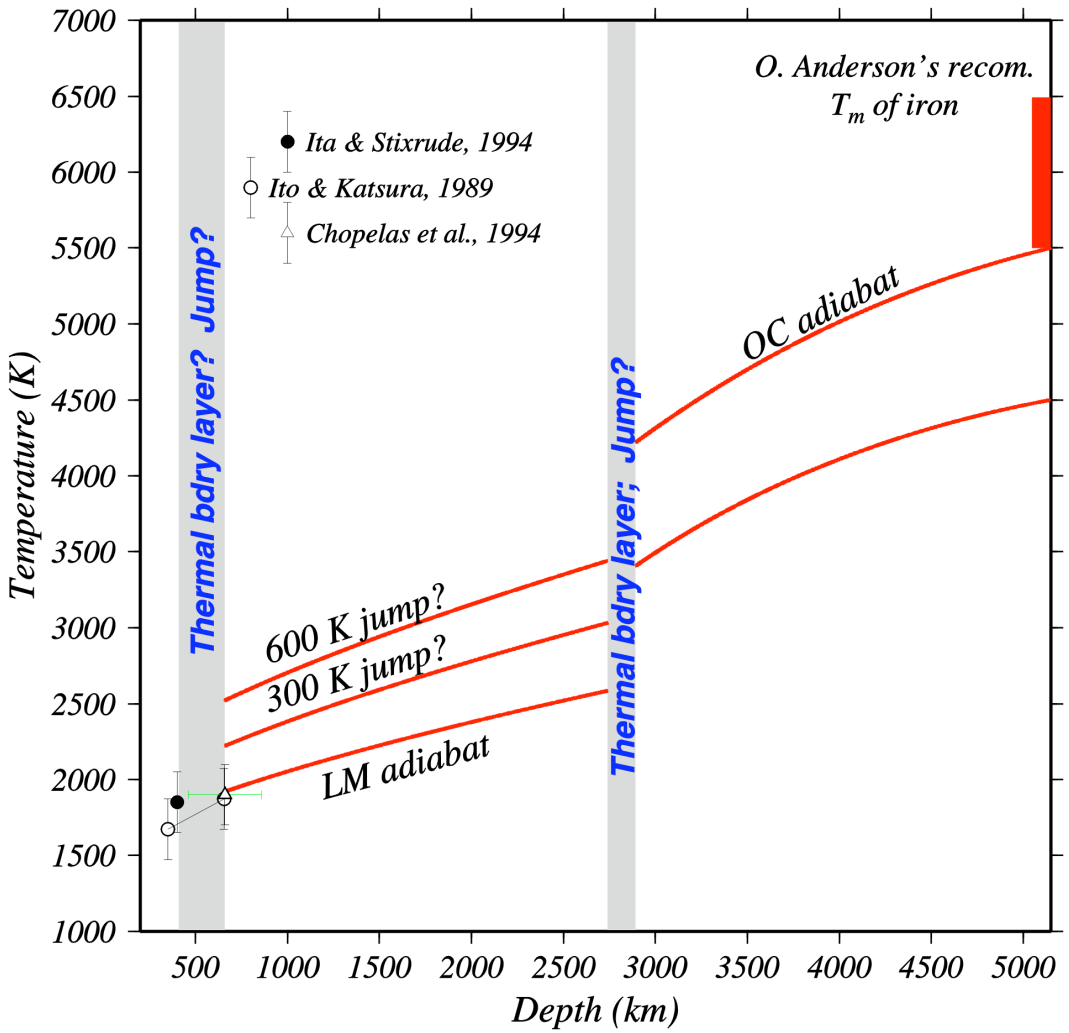
Thermal profile of Earth



[*Boehler*, 1996]

Thermal profile of Earth

A suite of free parameters...



[*Kuo & Chen*, in prep.]

Chemical reactions at CMB

Ultrahigh pressure & temperature experiments

$$(Mg_xFe_{1-x})SiO_3 + 3[(1-x)-s]Fe =$$

$$xMgSiO_3 + sSiO_2 + [(1-x)-s]FeSi + [3(1-x)-2s]FeO$$

[Knittle & Jeanloz, '86; '89]

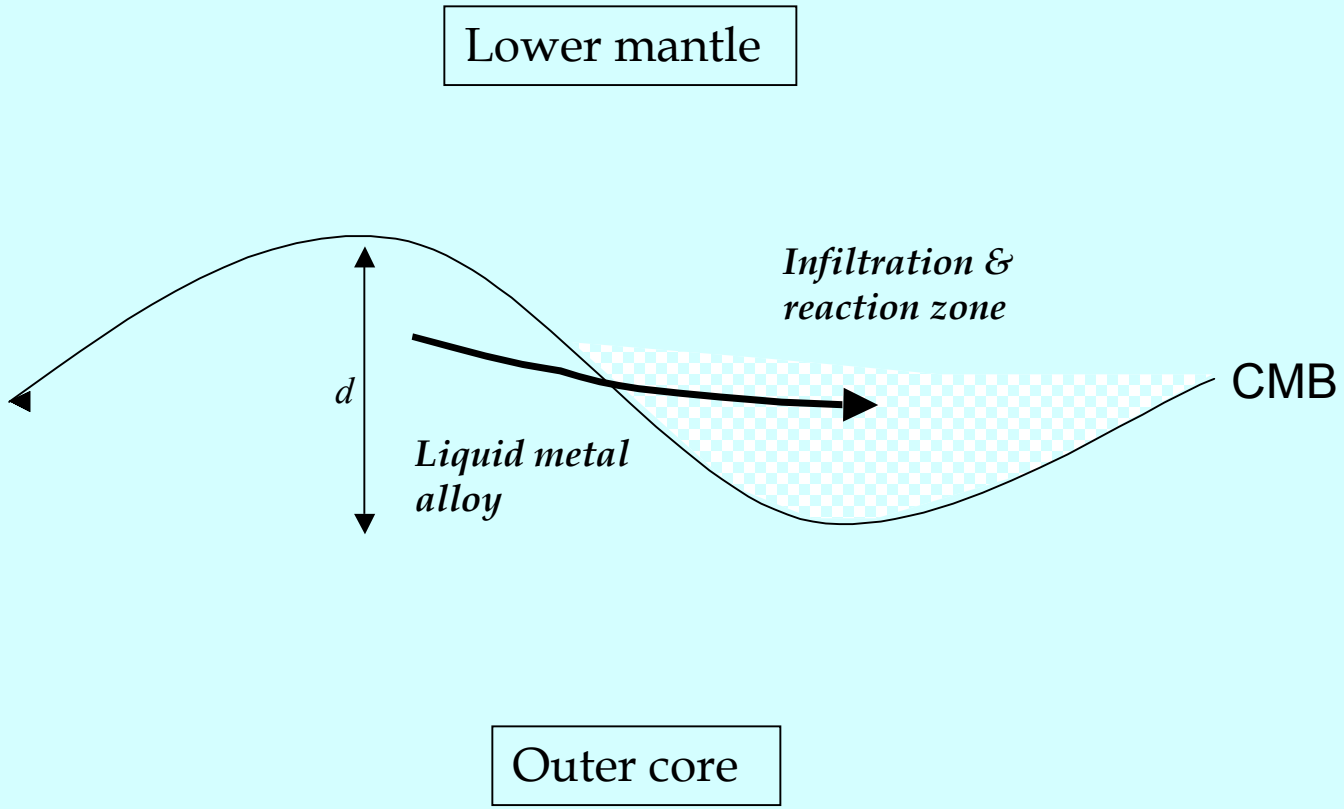
- Fe-depleted silicates & Fe alloys: fast and low seismic velocity, respectively ;
- FeO: non-metallic → metal alloy at deep mantle pressure;

  (O → metal at > 100 GPa)

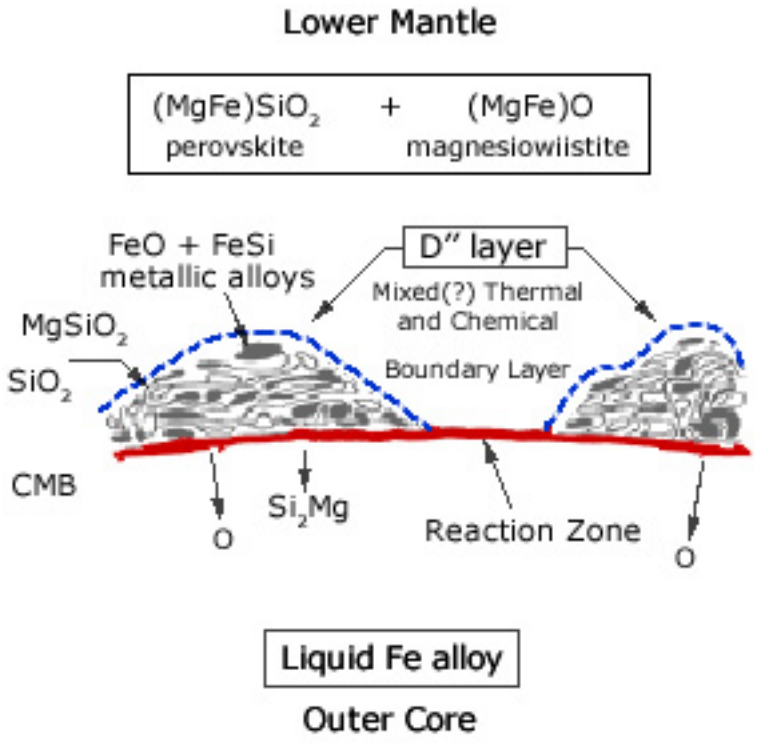
Partial melting

- high T, melting-point depression in metal-silicate system

Igneous & metamorphic processes of CMB



Thermal-chemical boundary layer



[*Knittle & Jeanloz*, 1991]