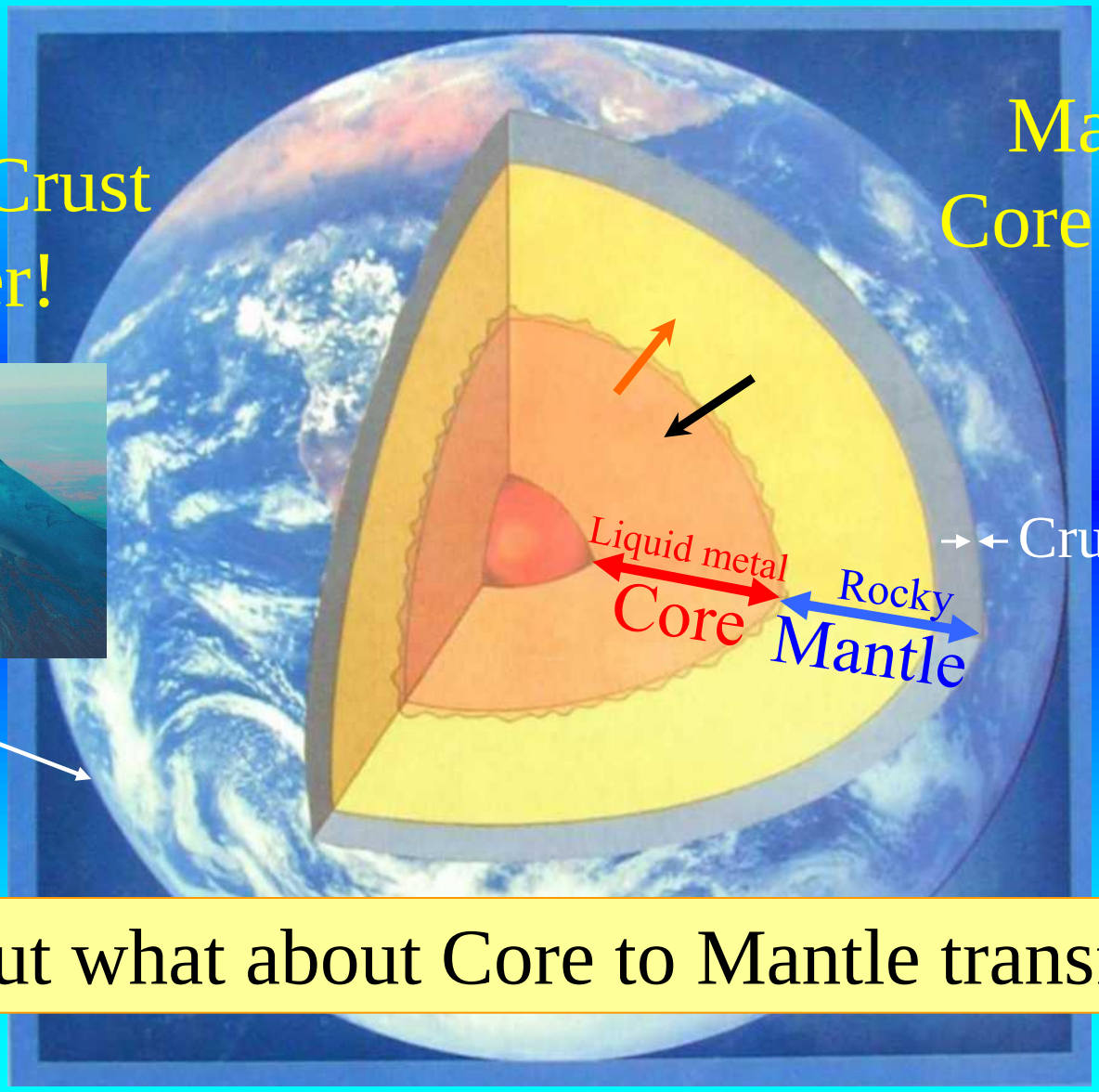
Dave Walker Lamont-Doherty Earth Observatory, Columbia U.

What are some big issues in geochemistry?

Mantle – Crust transfer!

Mantle to Core transfer!



But what about Core to Mantle transfer?

“The core is leaking! The core is leaking!”

What would be an appropriate response?

- Run and find Chicken Little?
- Write NSF or DOE for a grant?
- Call the *National Enquirer*?

Is the core really leaking?

$^{187}\mathbf{Re}$ - $^{187}\mathbf{Os} \rightarrow$ $^{187/188}\mathbf{Os}$ γ_{Os}

$^{190}\mathbf{Pt}$ - $^{186}\mathbf{Os} \rightarrow$ $^{186/188}\mathbf{Os}$ ε_{Os}

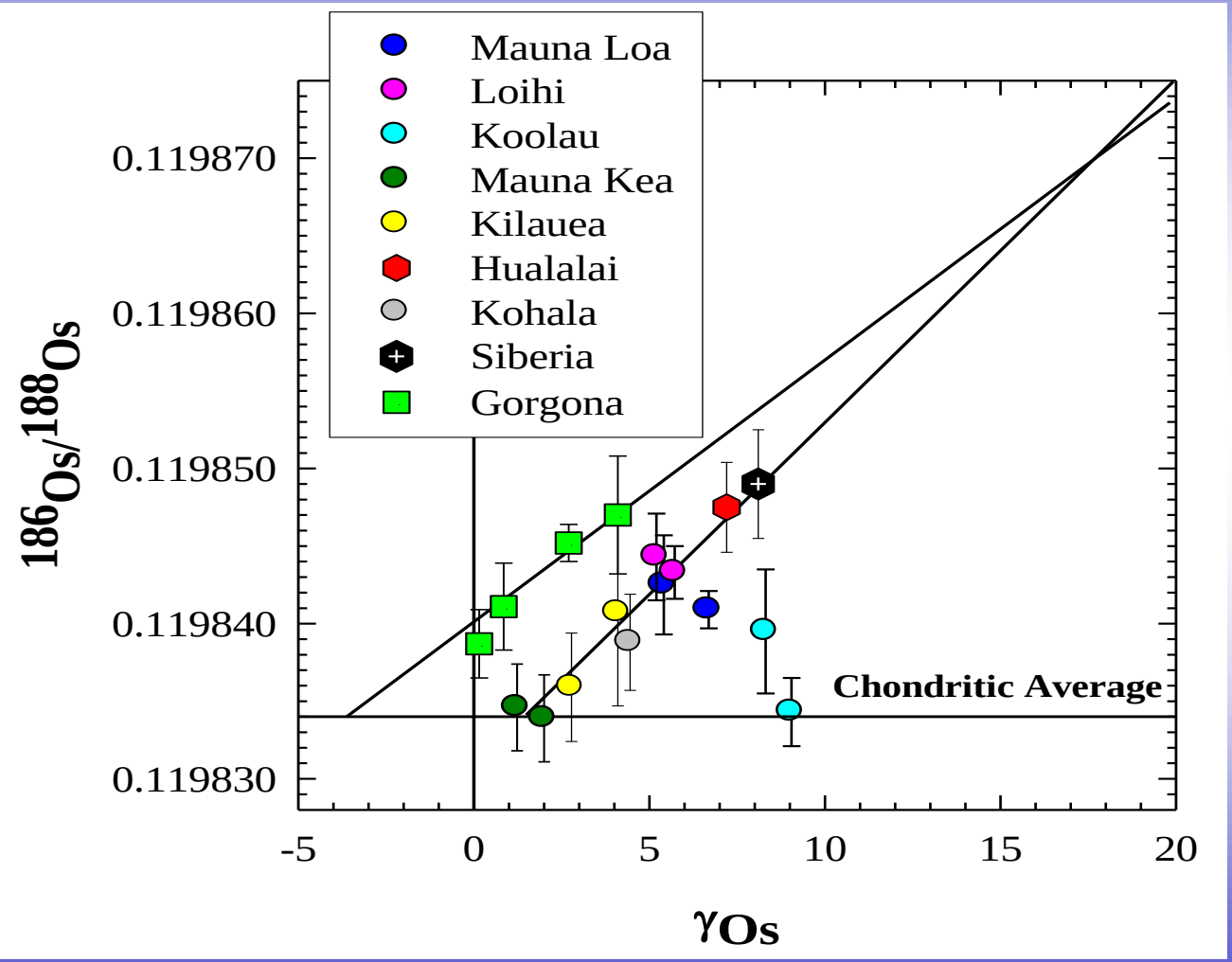
for γ_{Os}- ε_{Os} correlation
need

$D_{Os} > D_{Re} >> D_{Pt}$

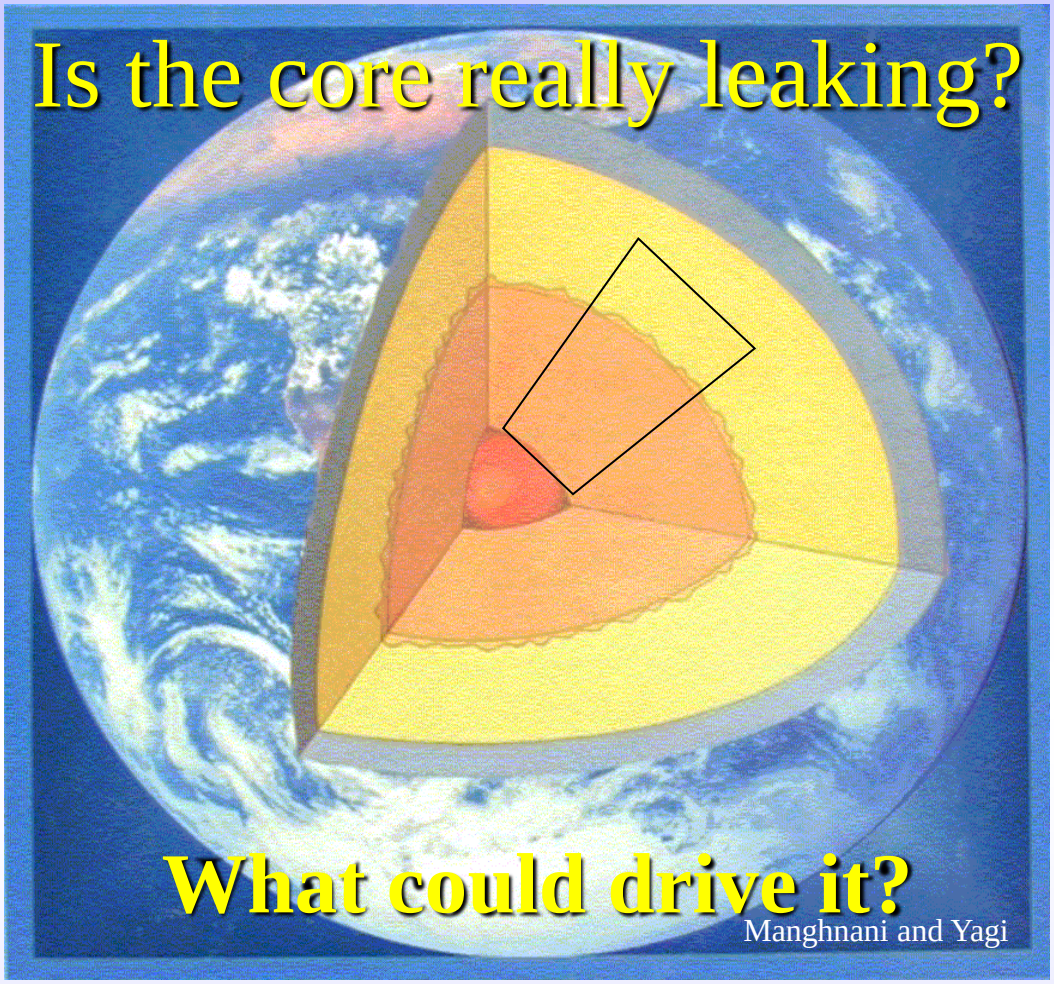
$D_{Os/Re}$ **~1.2-1.4** $D_{Os/Pt}$ **~3-10**

Inner core crystallization would do this!

Some plume basalts do show correlated Os anomalies.



Brandon, Walker et al. (2003)



Yes, perhaps: Os isotopes

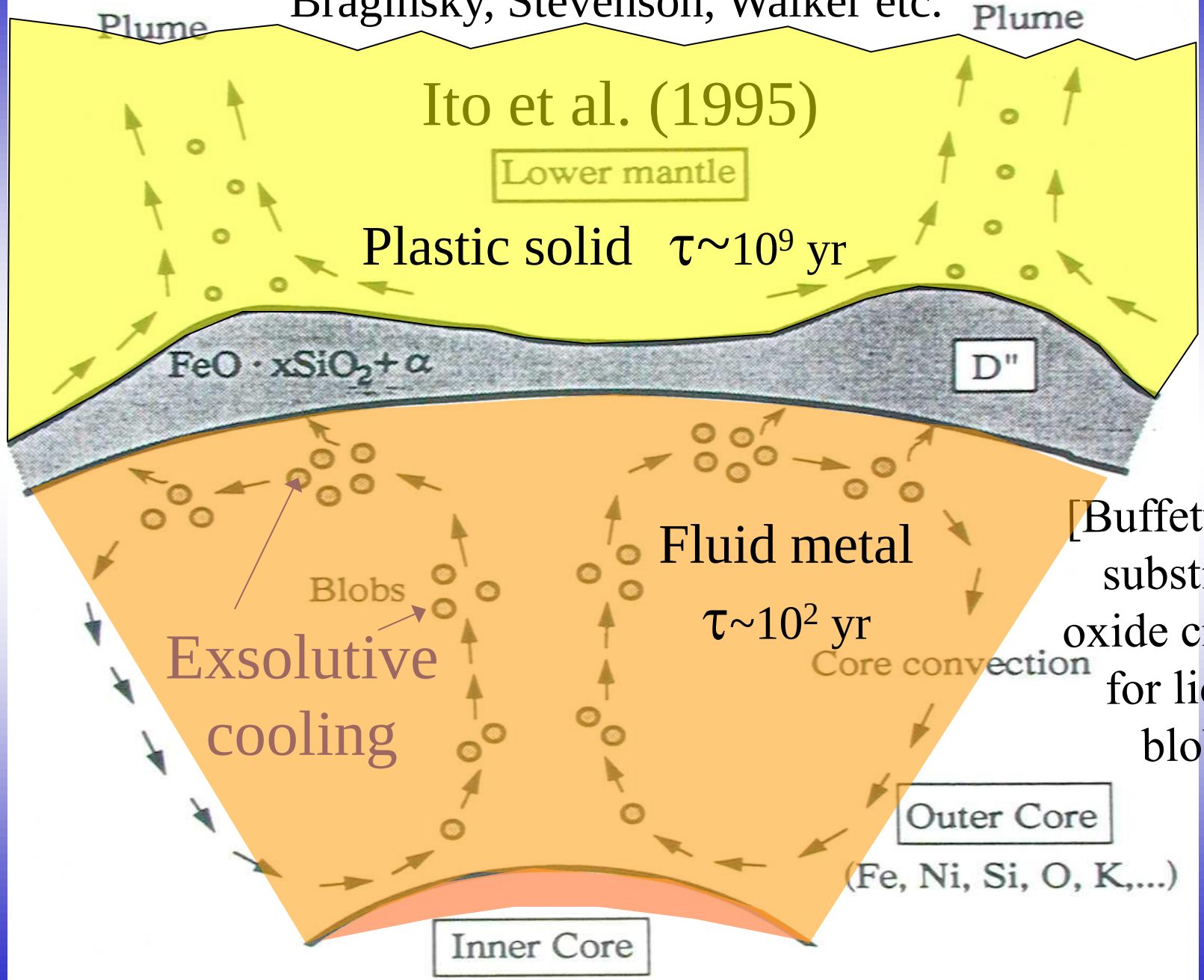
Hawaiian plume Fe/Mn

No: W isotopes & radiogenic Sr/Os correlation

Cooling ΔT drives solubility changes.
Braginsky, Stevenson, Walker etc.

Lower Mantle

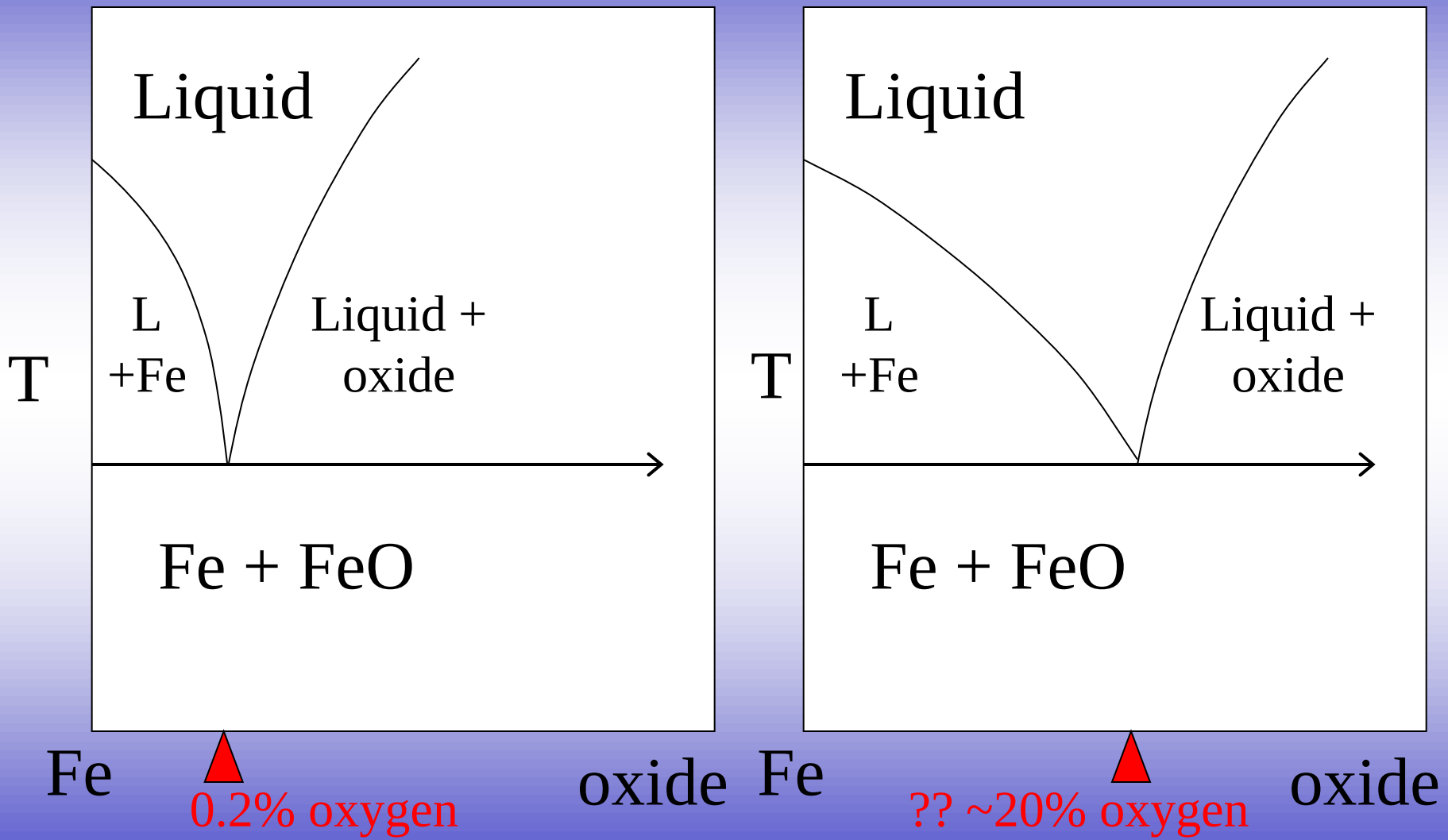
Core



[Buffett et al. substitute oxide crystals for liquid blobs]

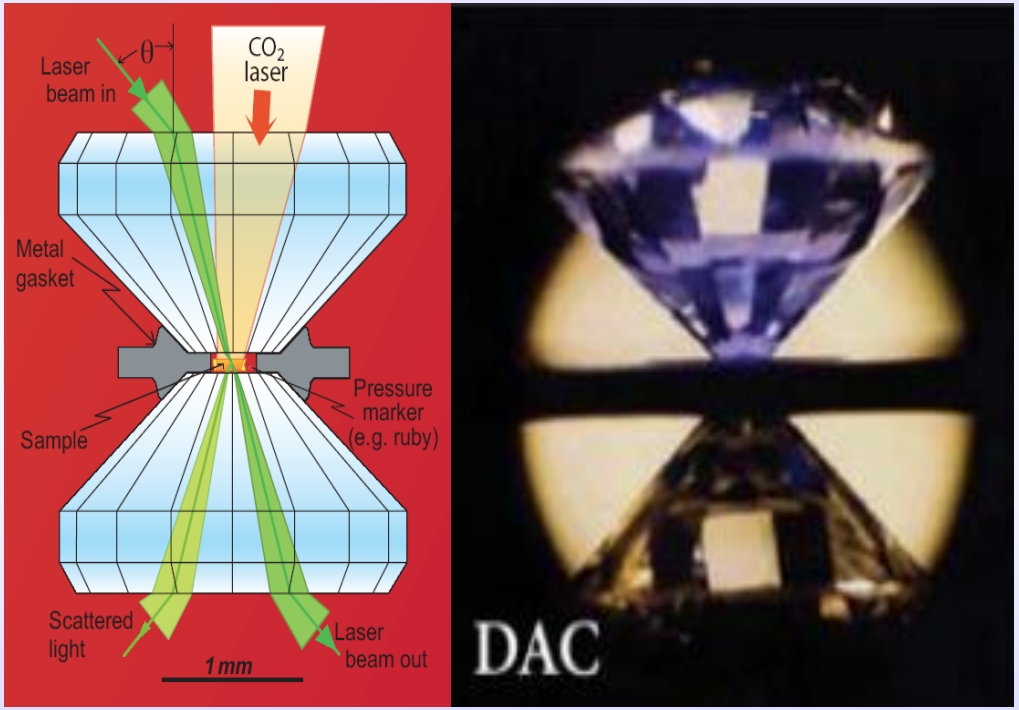
1 atmosphere

?? 1 megabar ??



But what is the solubility of oxygen in liquid Fe?

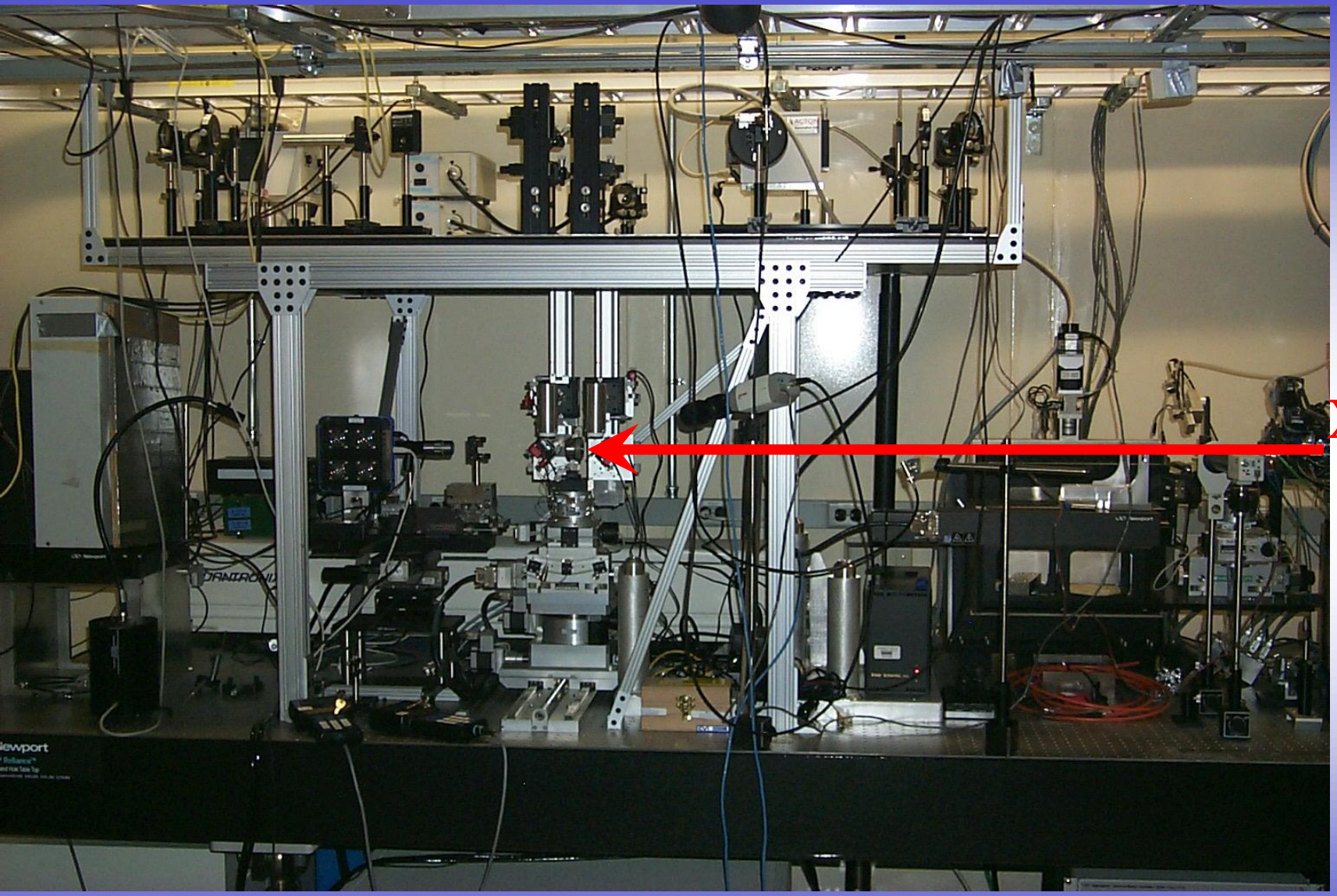
And how could it be measured at a megabar?



Non-divergent synchrotron X-rays for imaging.

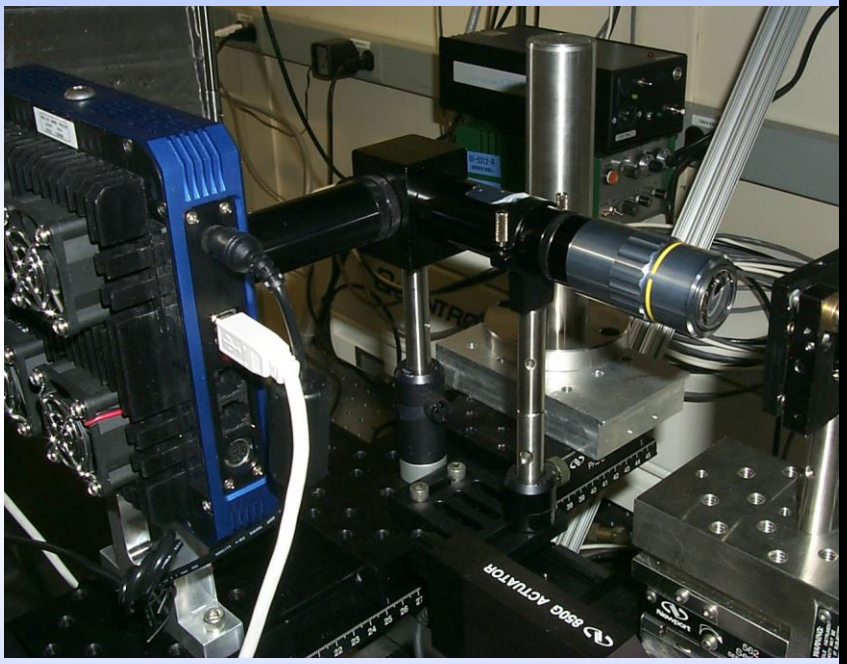
http://xraysweb.lbl.gov/bl1222/home.htm

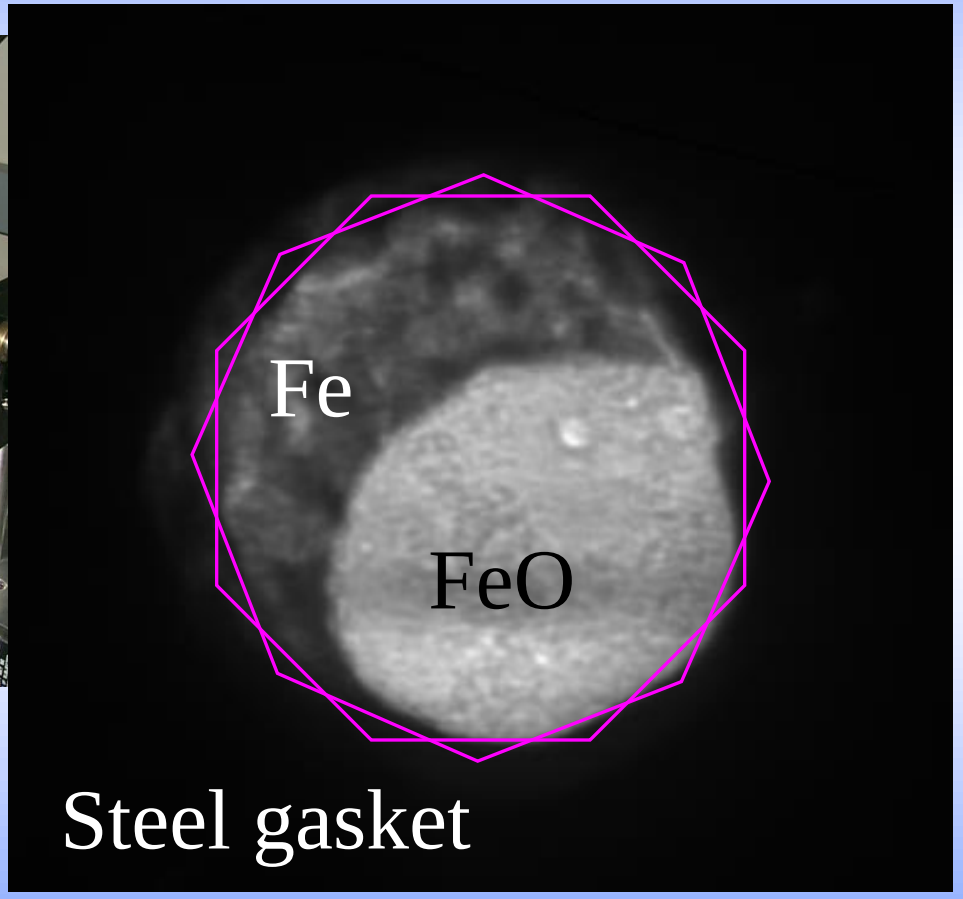
Experiments at ALS/LBL
With Mike Walter*, Simon Clark, Martin Kunz, and many others



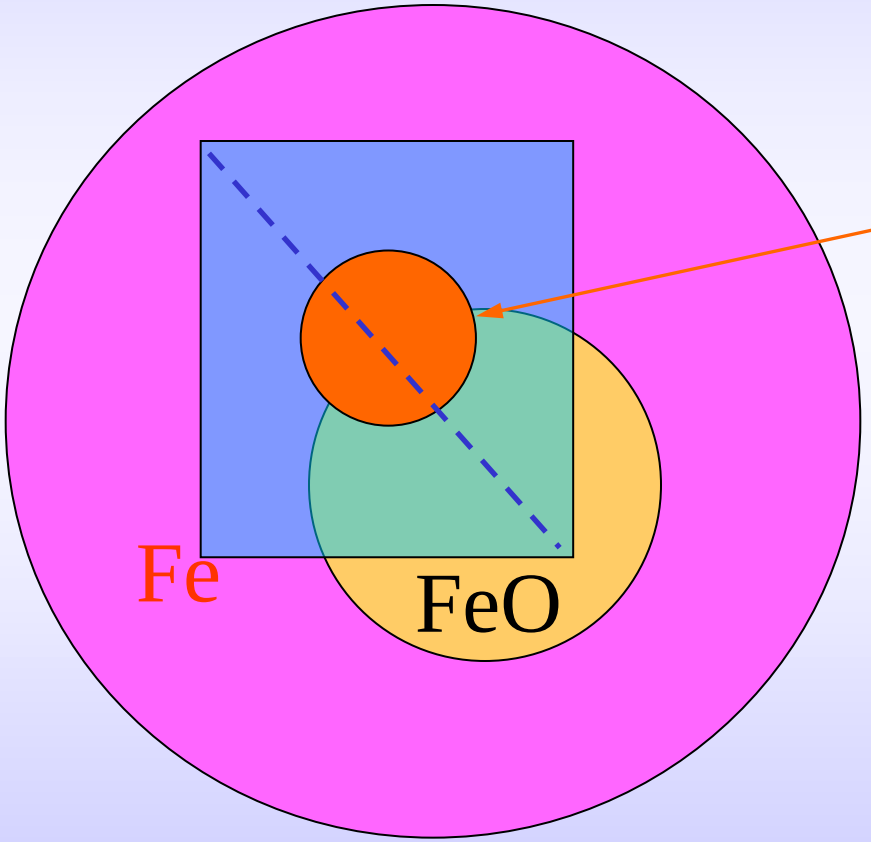
LBL ALS Station 12.2.2

X-ray density for chemical analysis!

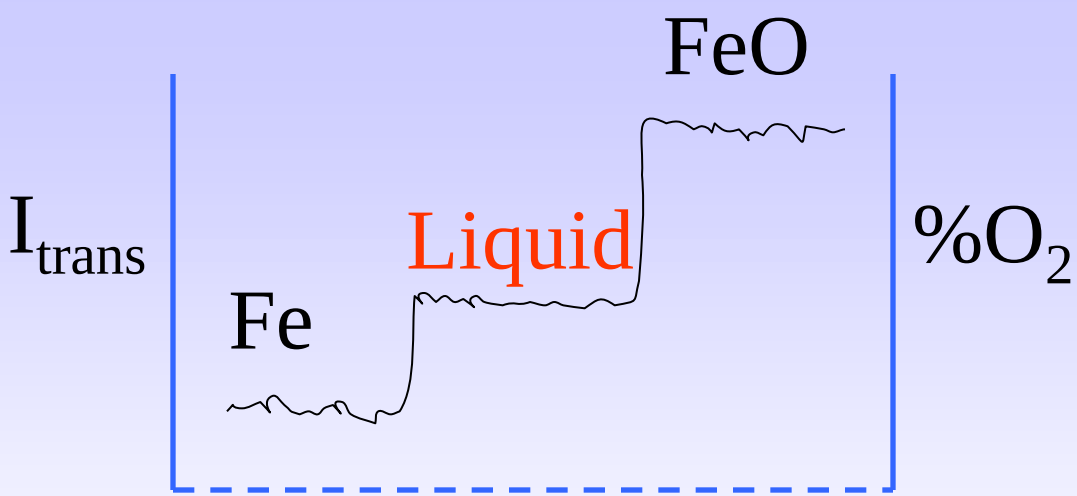




In situ DAC X-Radiographic Imaging (XRI)

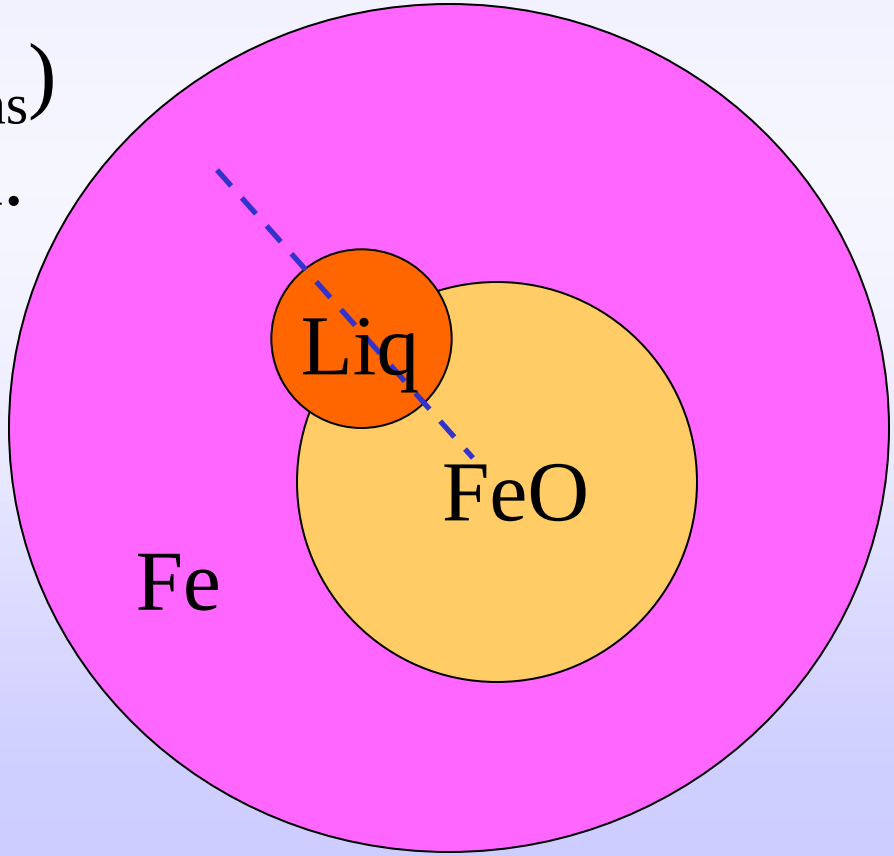


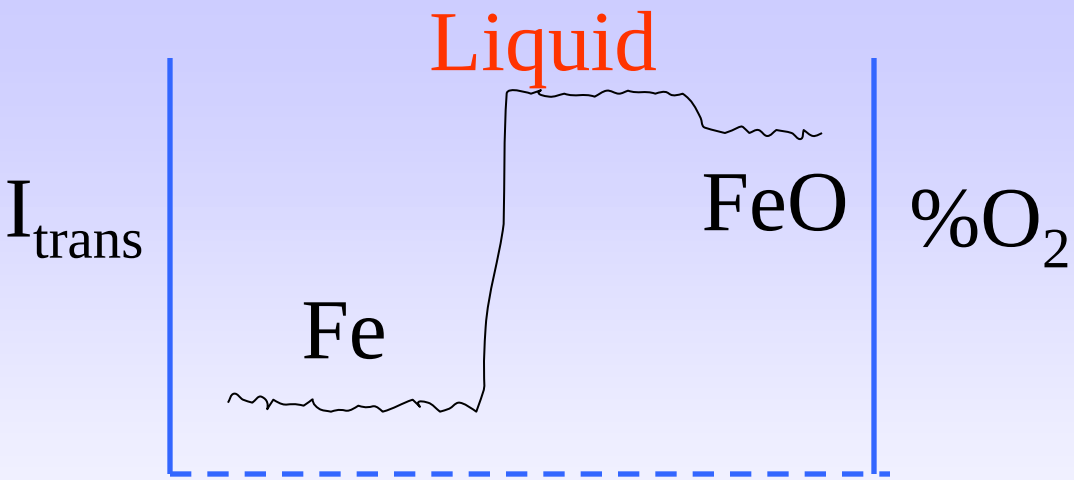
Transmission
imaging *in situ*



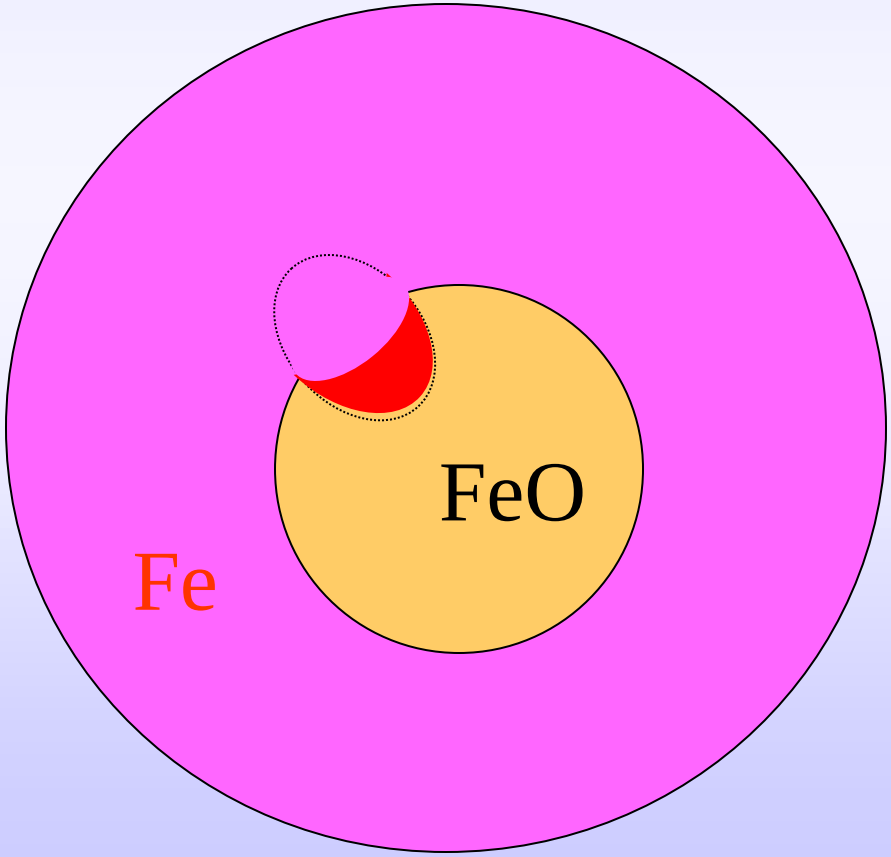
Single *in situ* property (I_{trans}) to characterize binary join.

Eutectic

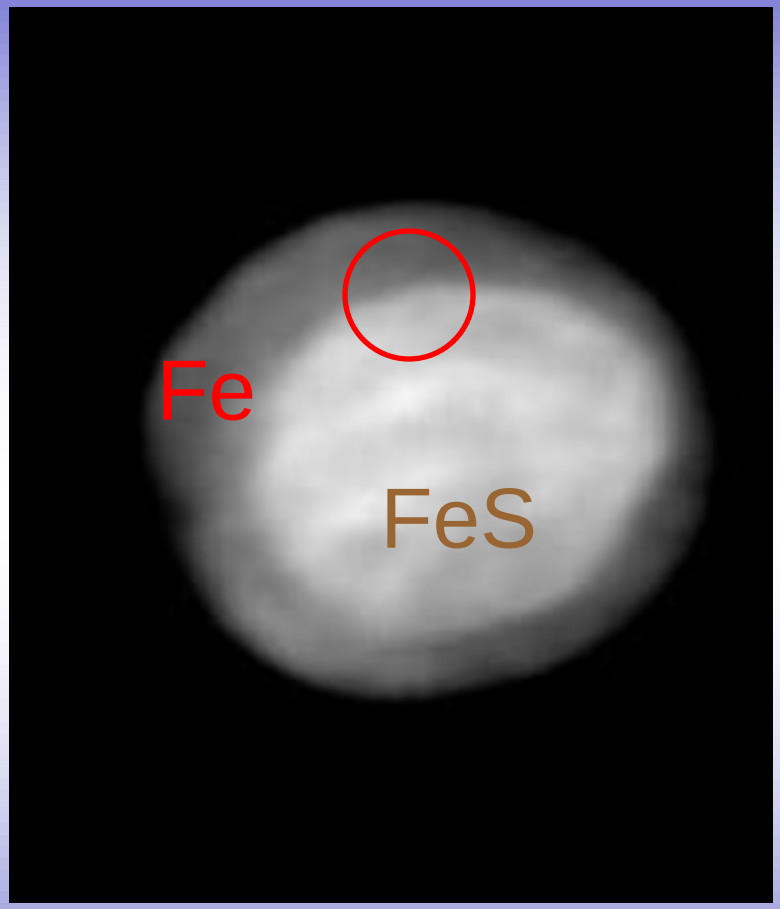


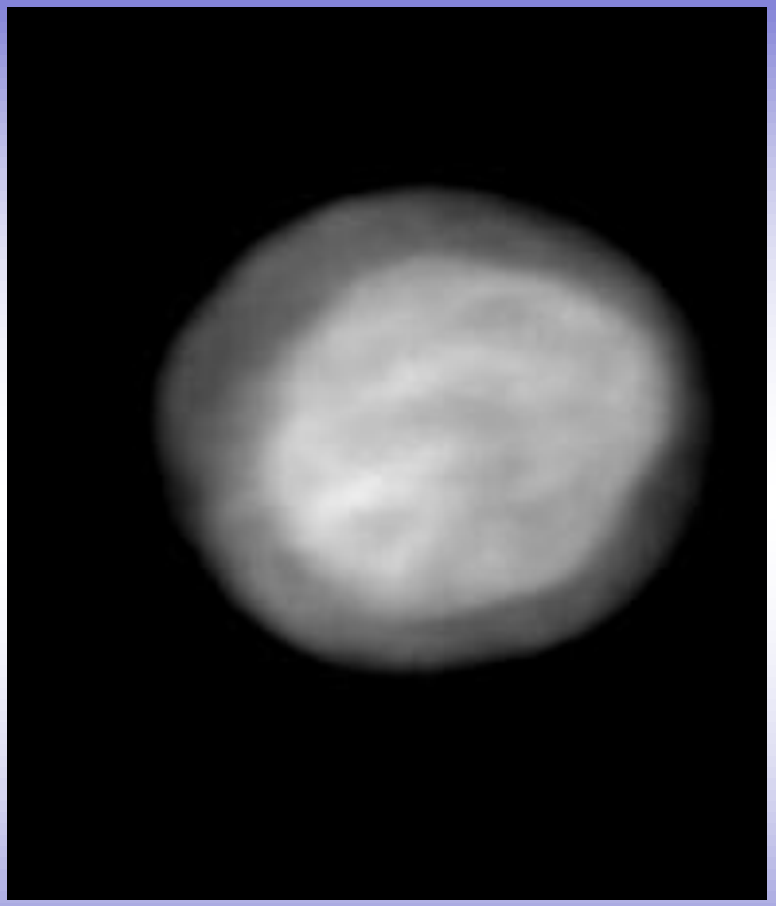


Peritectic
possible
to recognize



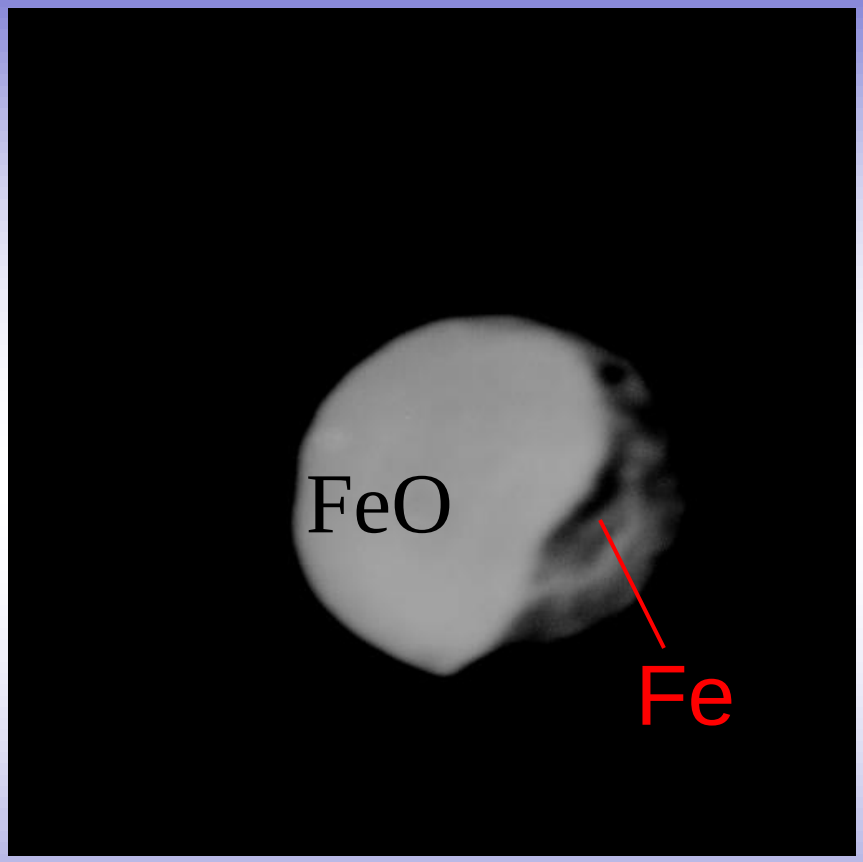
50 kilobars

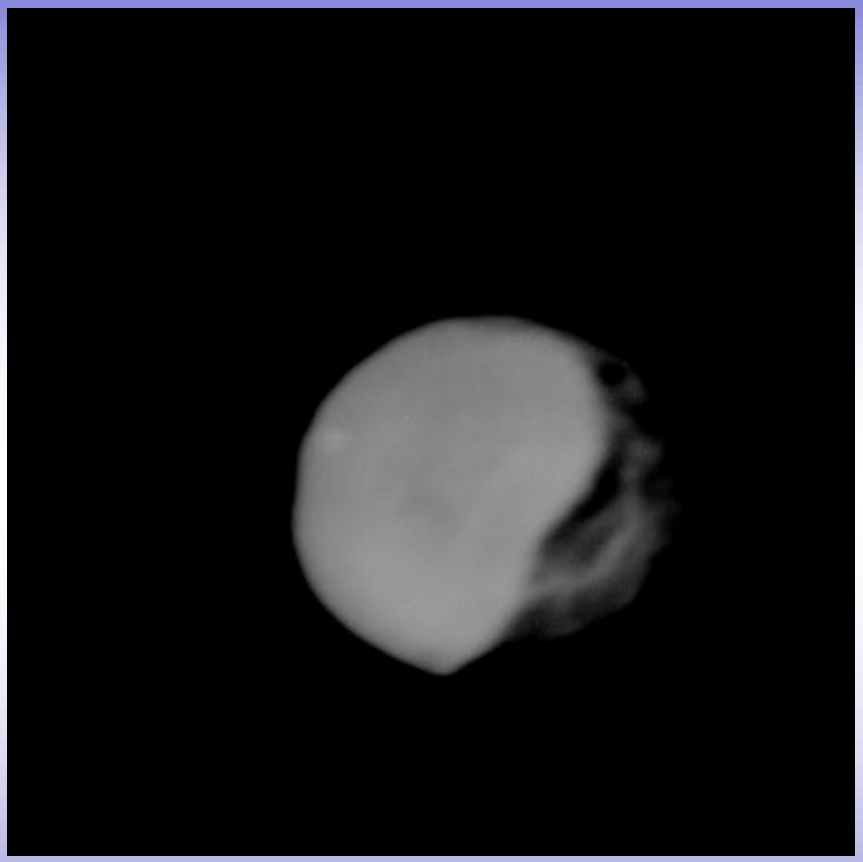




Melting shows erosion

550 kilobars

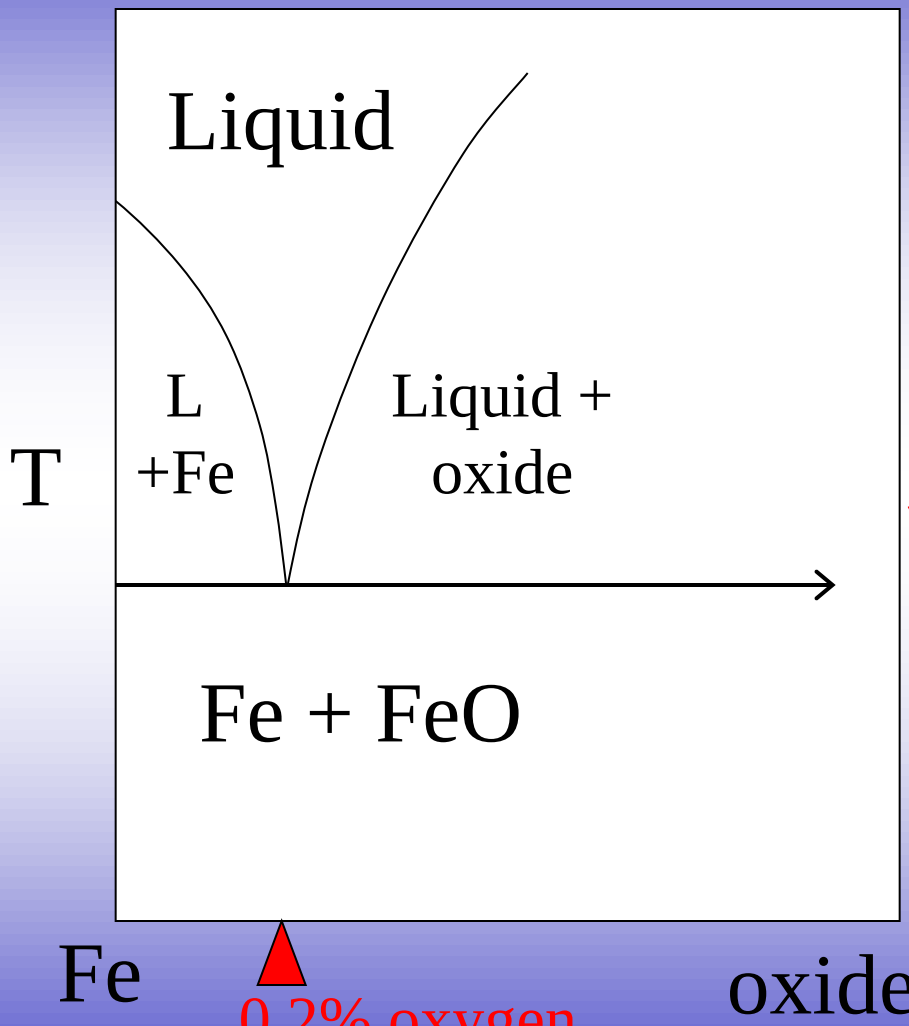


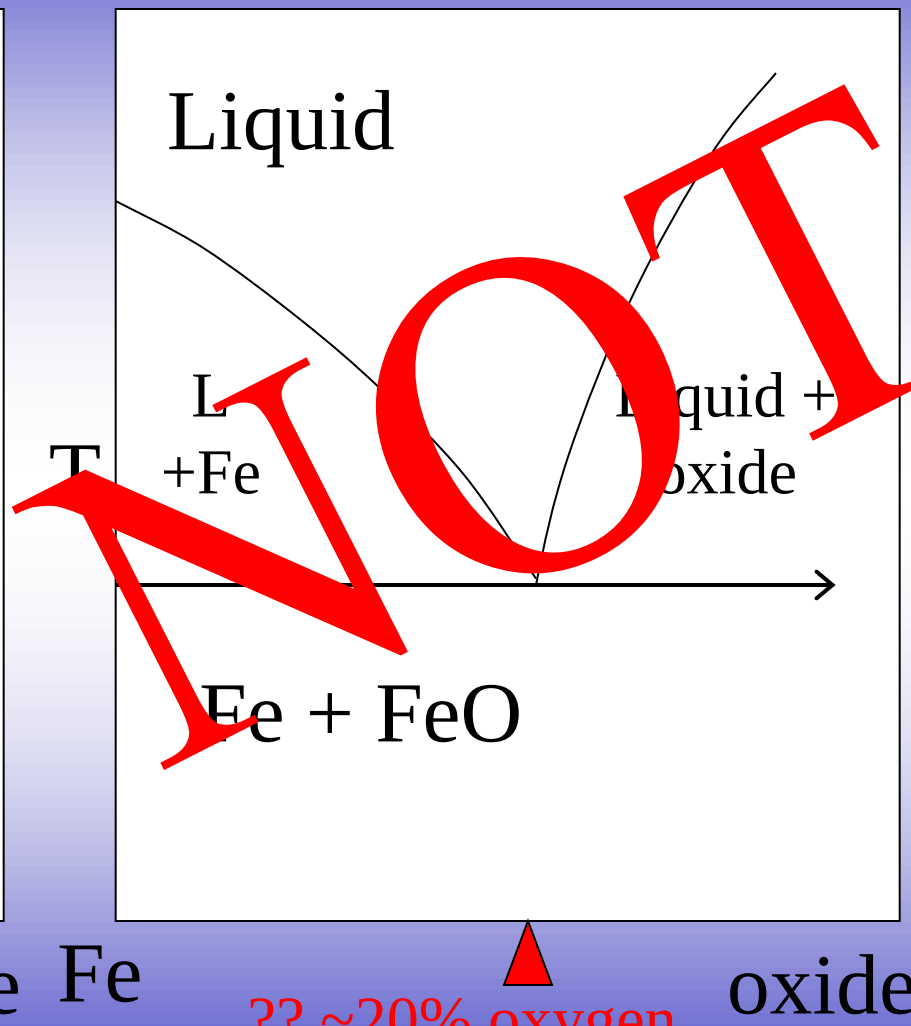


No erosion on melting!

1 atmosphere

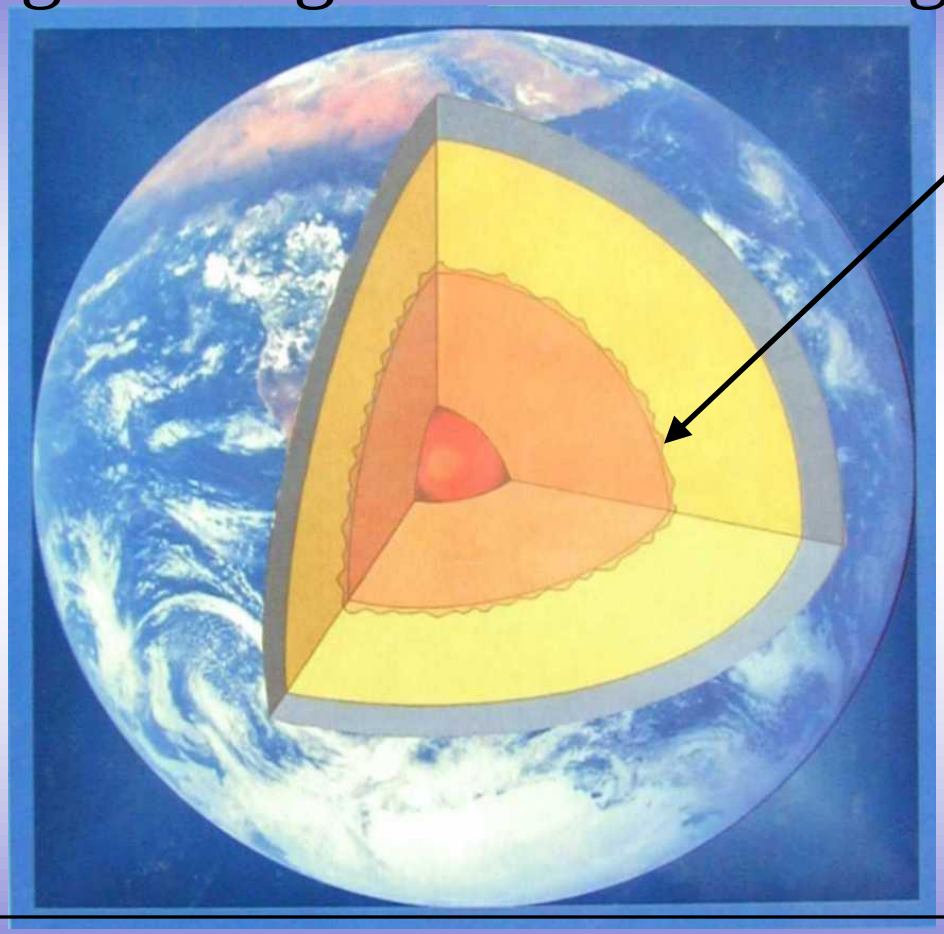
?? 1 megabar ??





NOT

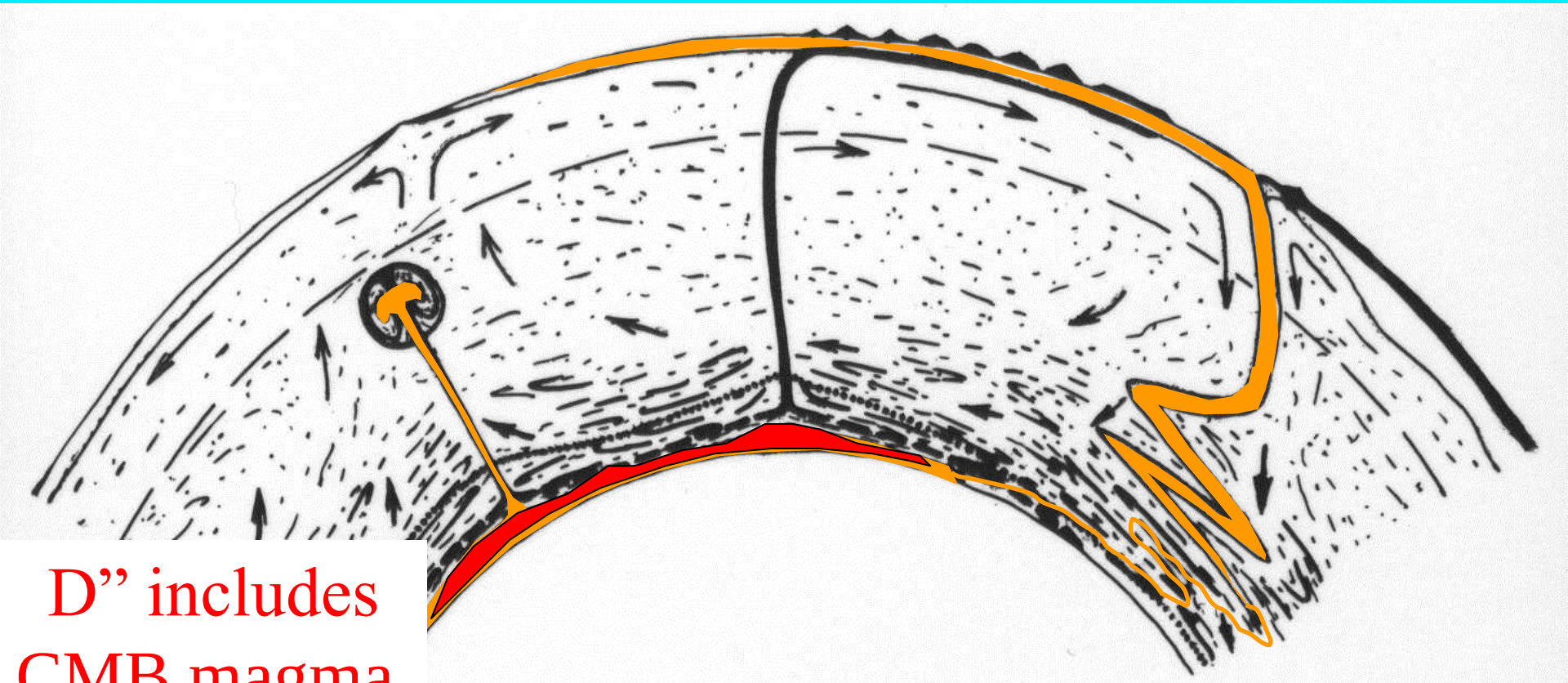
Oxygen solubility does not appear to be high enough to be interesting.



Lumpy D″ probably not exsolved, floating slag on molten Fe of the outer core

Are there other solutions to the problem?

What does the presence of life do for us?



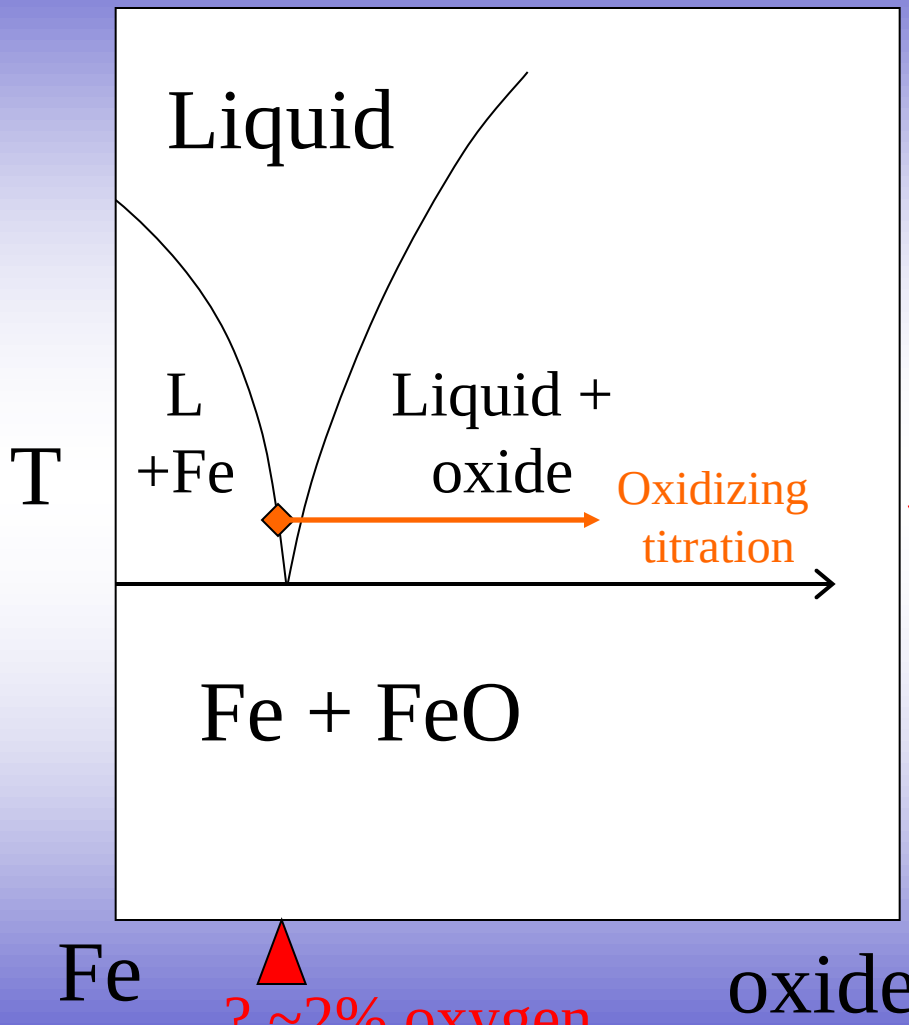
D” includes CMB magma chambers

Oxidative titration of core→mantle

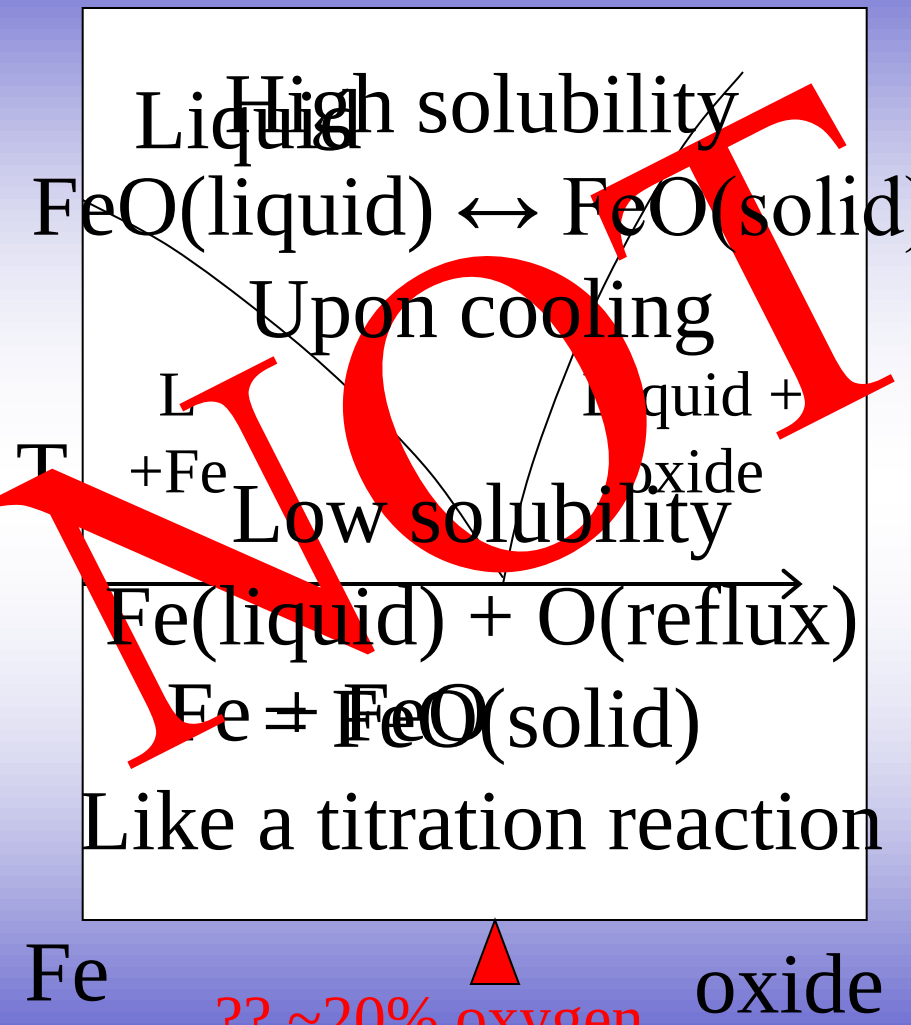
Contaminated plume source

Core signal generated by recycled oxidized crust.

1 megabar



?? 1 megabar ??



NOT

Remaining questions:

Is the core really leaking?

What are crustal digestion processes at the CMB?

Does the biosphere corrode the core?

Activities/questions

- Would you expect gravitational acceleration to vary as you go from crust to core?
- It doesn't vary much. Why not?
- What is average density of the mantle if pressure at the CMB is 1.3 megabar?
- How much force must a DAC use to hit a megabar?
- Give an example of exsolution with a pressure change or with a temperature change. [See E2C from October 2002.]
- Give an example of a precipitation or titration reaction.

Do the melting relations work?

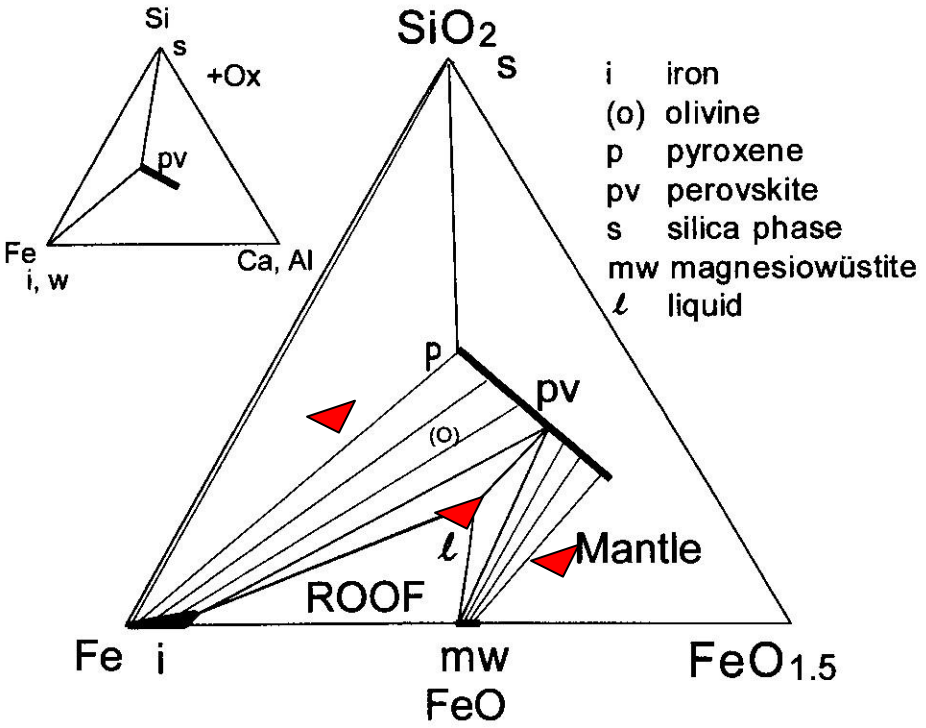


FIGURE 1. Assumed phase relations in the vicinity of the core-mantle boundary (CMB) projected from Mg. The mantle assemblage

Morse (2000)

Guess what, we have no idea!

Two *in situ* properties needed to characterize ternary liquid composition.