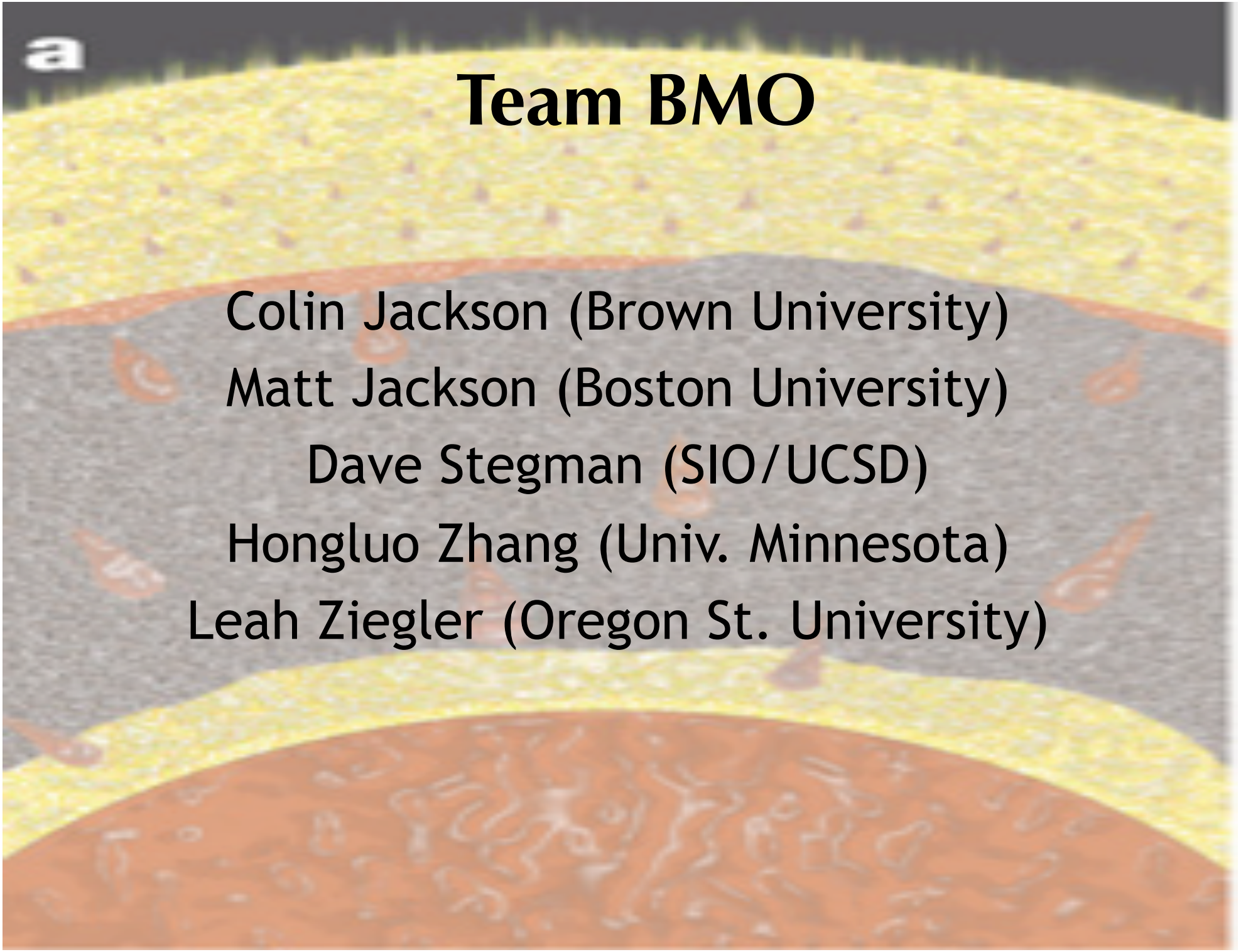


Team BMO

Colin Jackson (Brown University)

Matt Jackson (Boston University)

Dave Stegman (SIO/UCSD)

Hongluo Zhang (Univ. Minnesota)

Leah Ziegler (Oregon St. University)

Research Questions

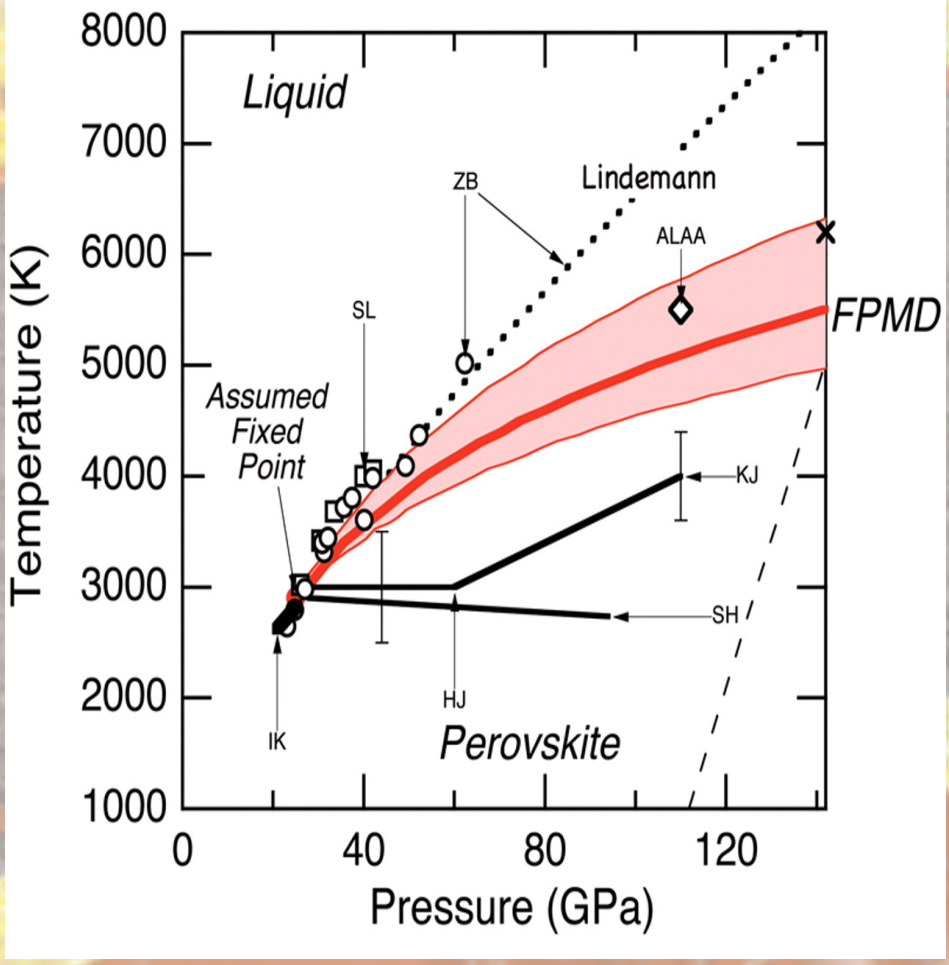
- What is the range of plausible scenarios for solidification and stability of a BMO?
- What are the expected geochemical signatures for BMO products?
- How sensitive are these signatures to the solidification sequence?
- Can these signatures be related to observed geochemical reservoirs and/or linked to structures of the deep mantle?

Past Work

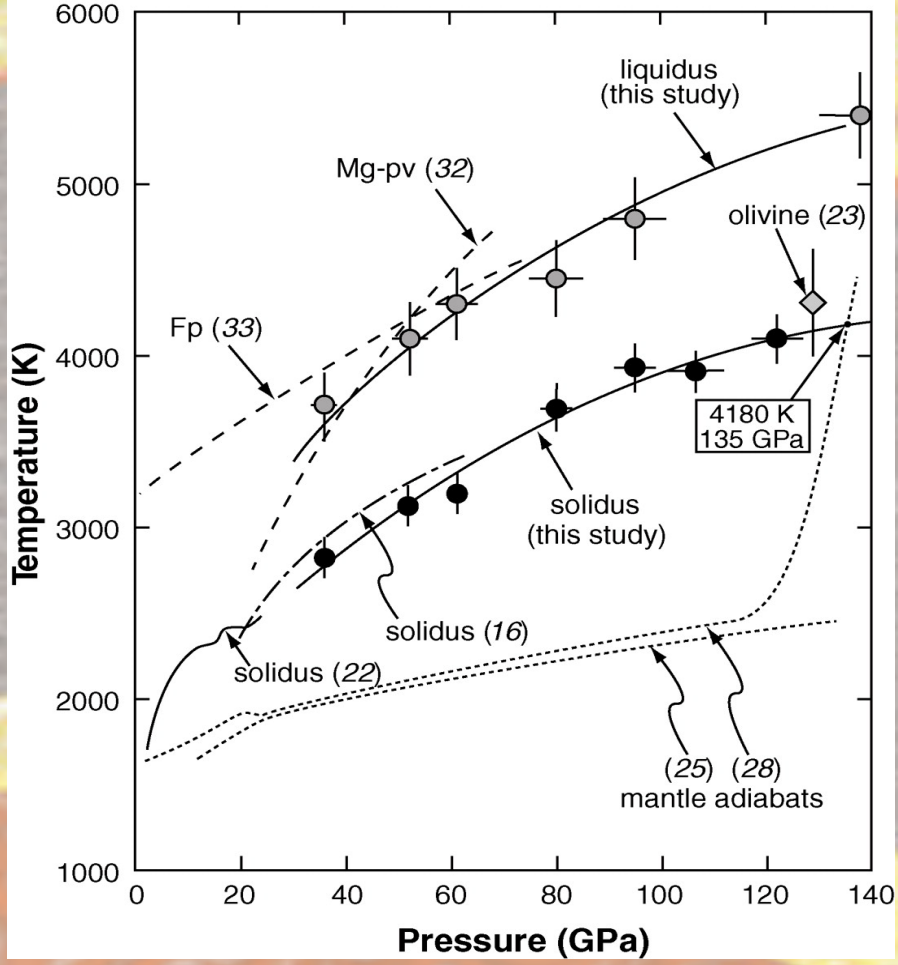
Caro et al., 2005; Labrosse et al, 2007

- Assumed **constant** partition coefficients
- Did not consider influence of minor elements (Ca, Al)
- Explored a very limited range of solidification scenarios (initial depth, starting composition, duration)

Estimates of Pv Liquidus

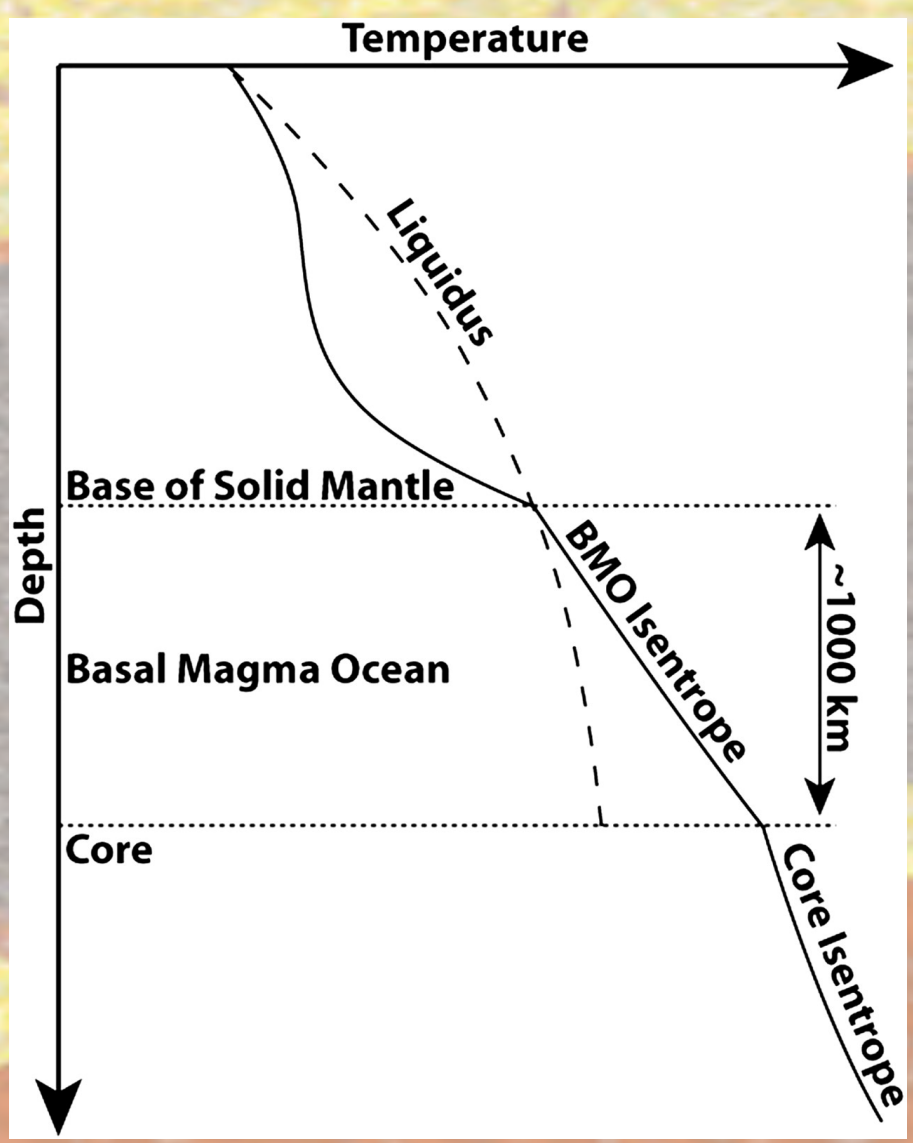


Stixrude and Karki, 2005



Fiquet et al., 2010

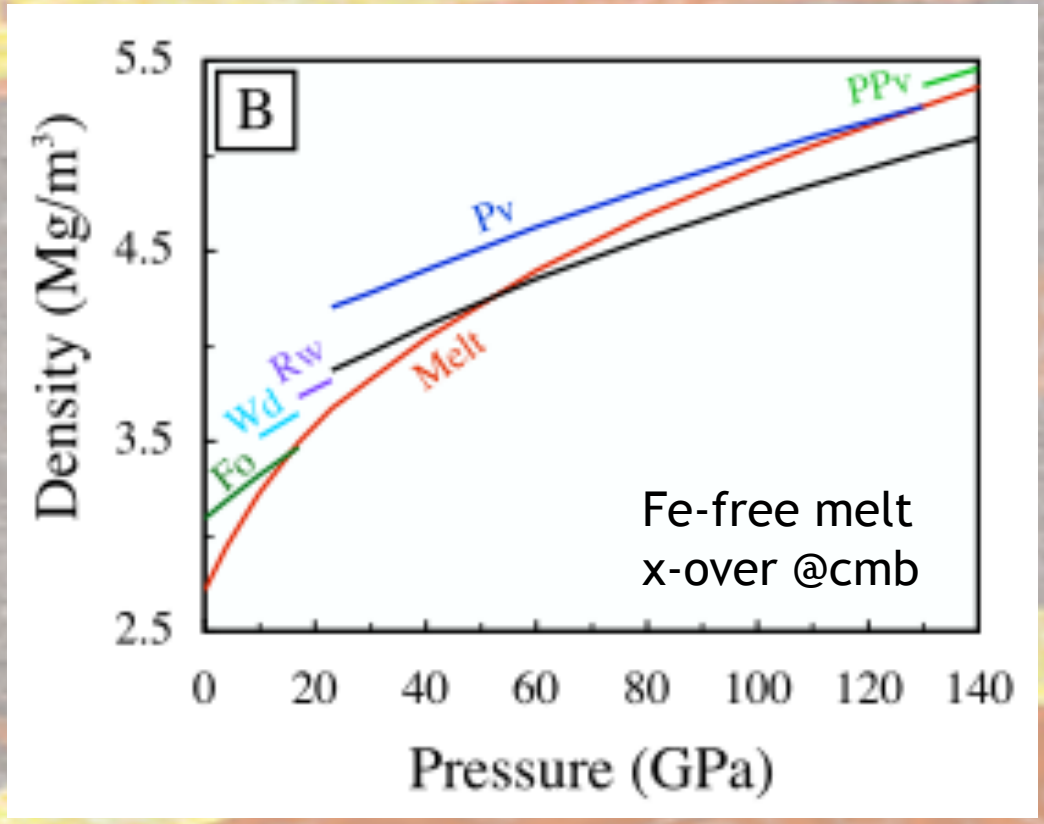
Liquidus vs Adiabat



Coltice et al, 2011

- At which P-T conditions does the liquidus intercept the adiabat of magma ocean?
- What depth does the magma ocean start crystalizing?
- Will the crystals sink or float?

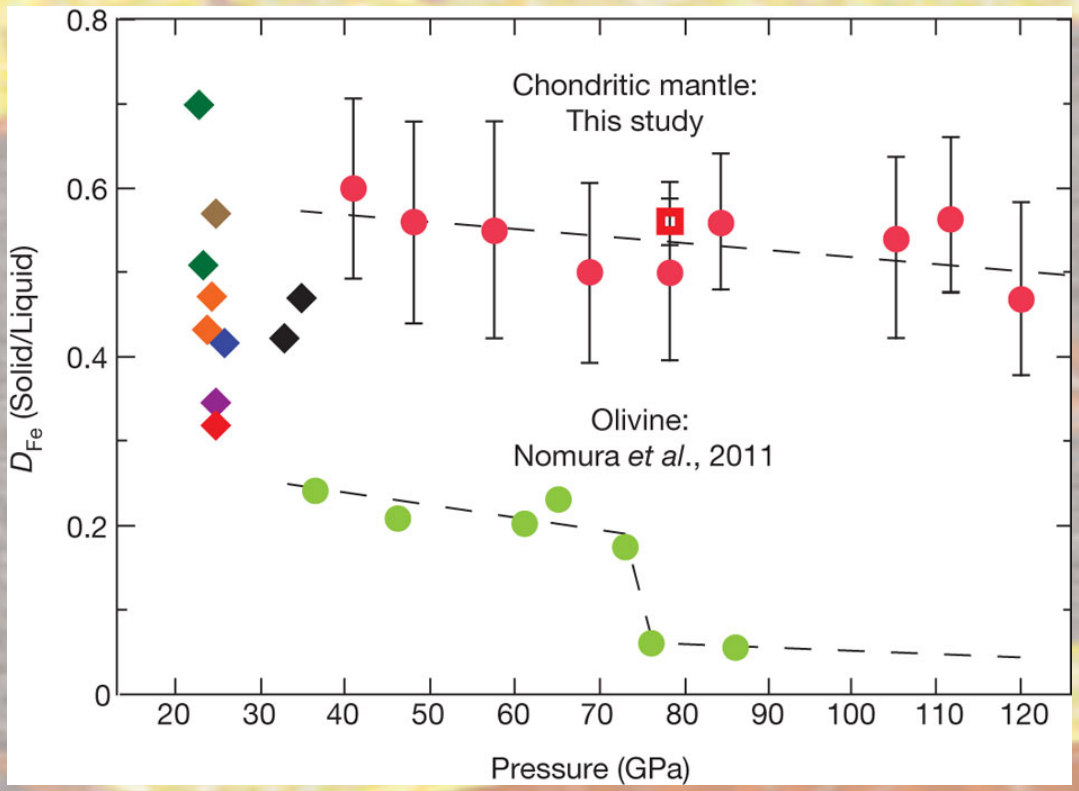
Density of melt vs solid



Mosenfelder, 2009

- How dense is the melt compared to solid?
- Added Fe to system suggests density cross-over in lower mantle
- Amount of Fe in liquid is critical to density of silicate melt and BMO depth

Behavior of Iron



Andrault et al, 2012

- Fe-partitioning seems dependent on aluminum content
- Need to understand systematics of Al in order to predict Fe

Research Aims of Project

Step I: Develop framework to model solidification of basal magma ocean (code named BMO2XL)

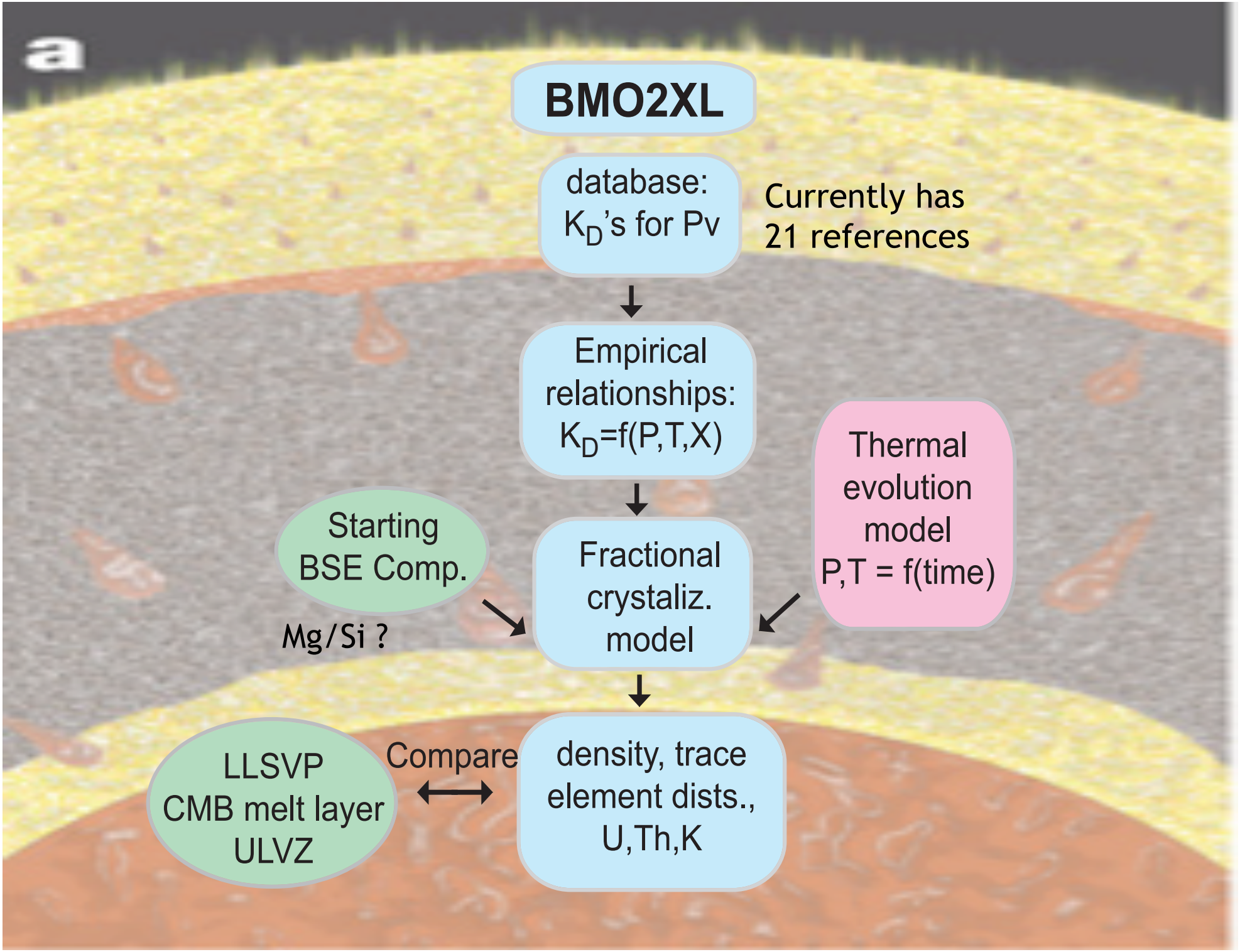
A. compile database of solid Pv-melt partition coefficients for major, minor, and trace elements

B. investigate dependence of coefficients on P-T-X; describe empirical relationships

C. apply empirical relationships to solidification sequence of basal magma ocean

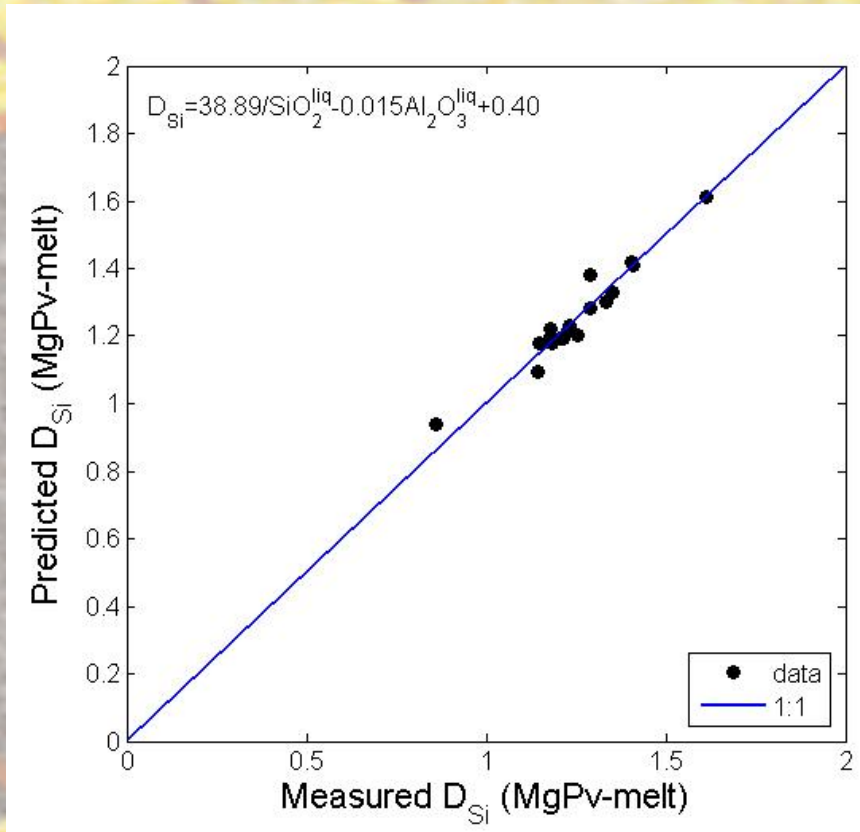
Step II: Compare predicted geochemical signatures

Step III: Couple solidification history to thermal evolution model

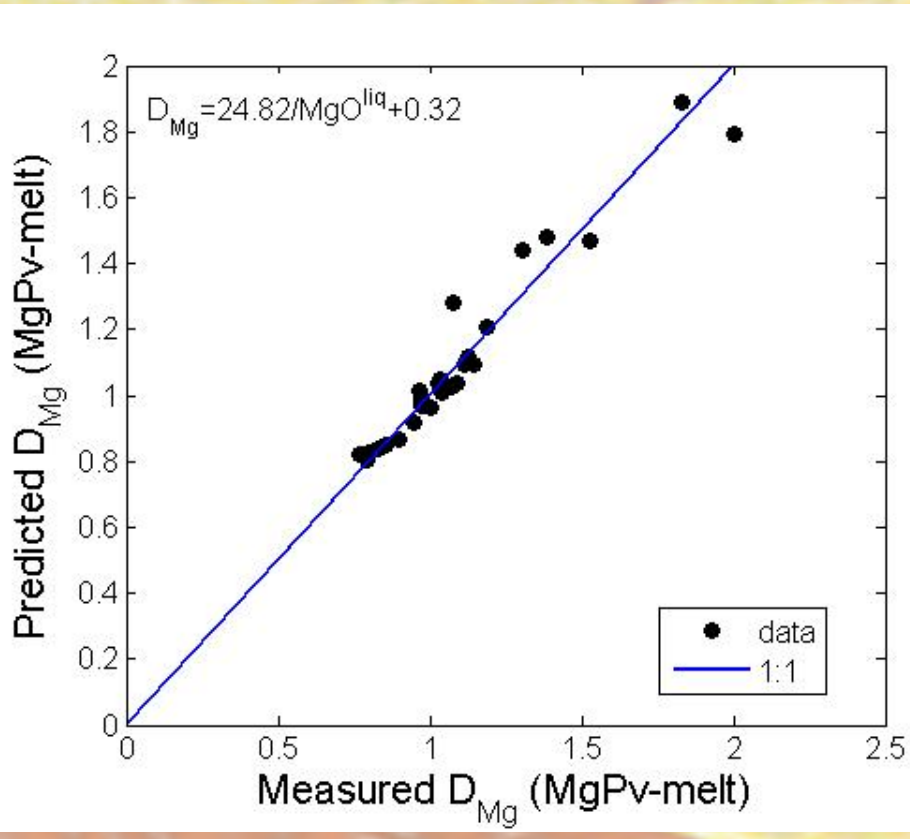

a
BMO2XL
database:
K_D's for Pv
Currently has
21 references
Empirical
relationships:
K_D=f(P,T,X)
Starting
BSE Comp.
Mg/Si ?
Fractional
crystaliz.
model
Thermal
evolution
model
P,T = f(time)
LLSVP
CMB melt layer
ULVZ
Compare
density, trace
element dists.,
U,Th,K

Results: major elements (Si, Mg)

D_Si = fn(Si, Al)

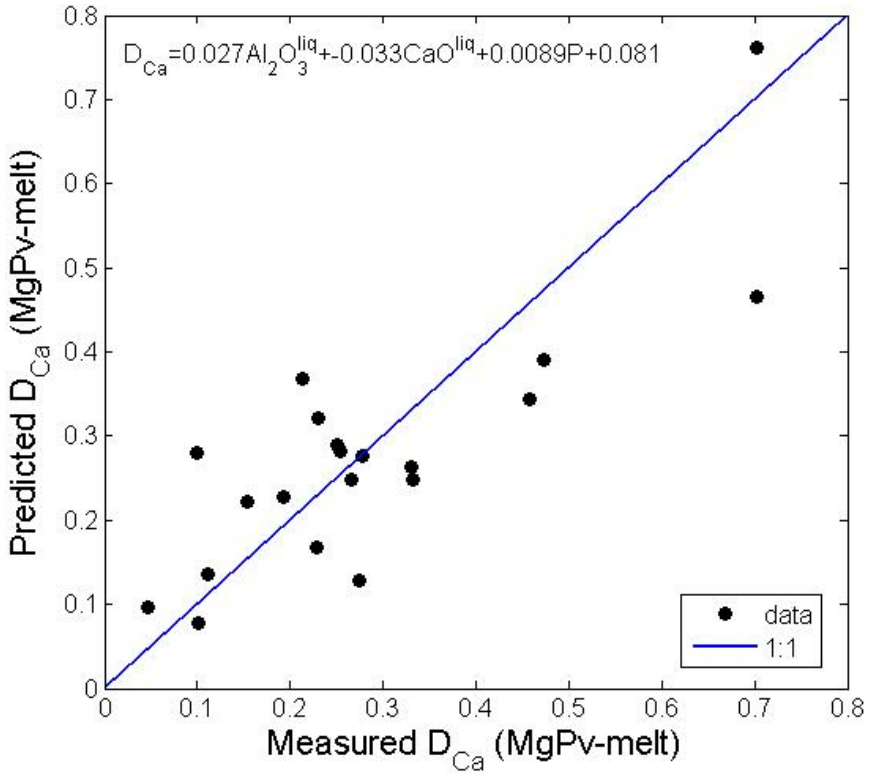


D_Mg = fn(Mg)

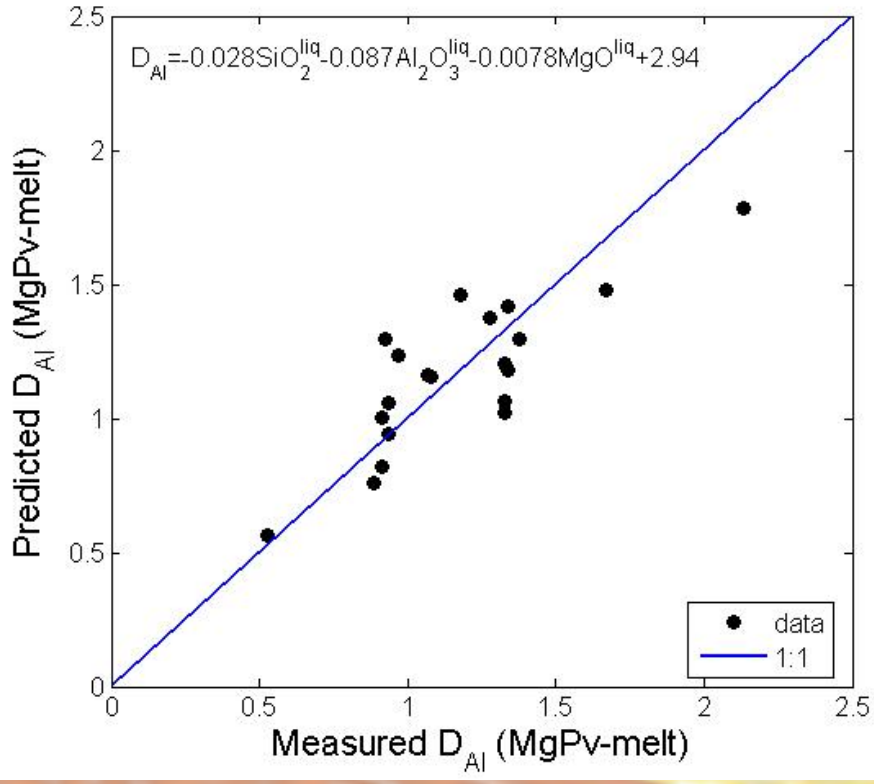


Results: major elements (Ca, Al)

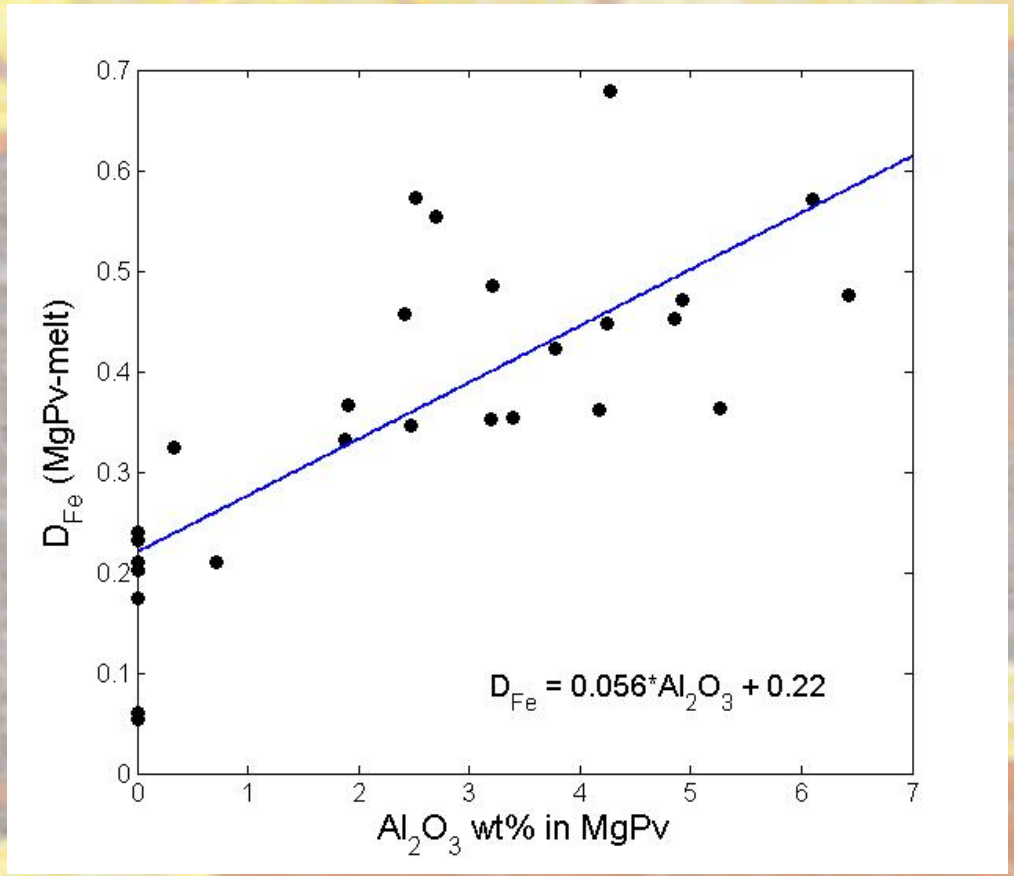
D_Ca = fn(Al, Ca, pressure)



D_Al = fn(Si, Al, Mg)

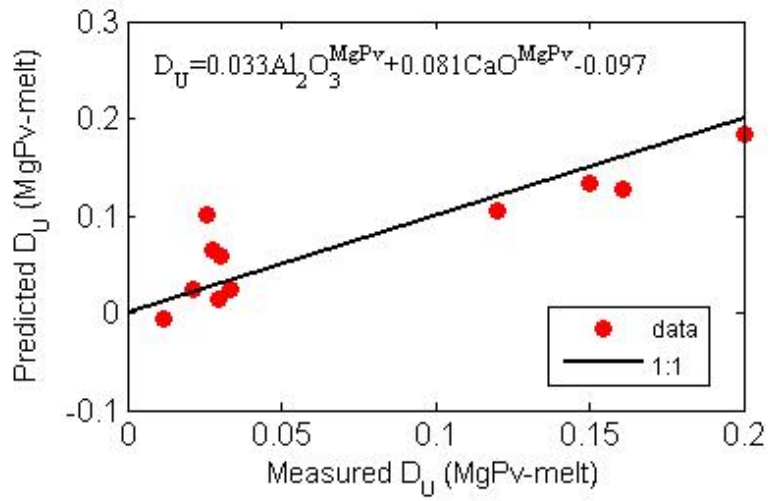


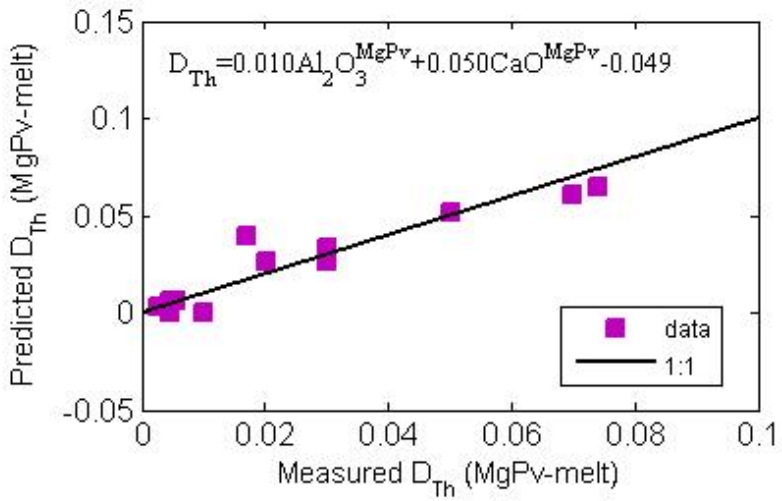
Results: behavior of Iron

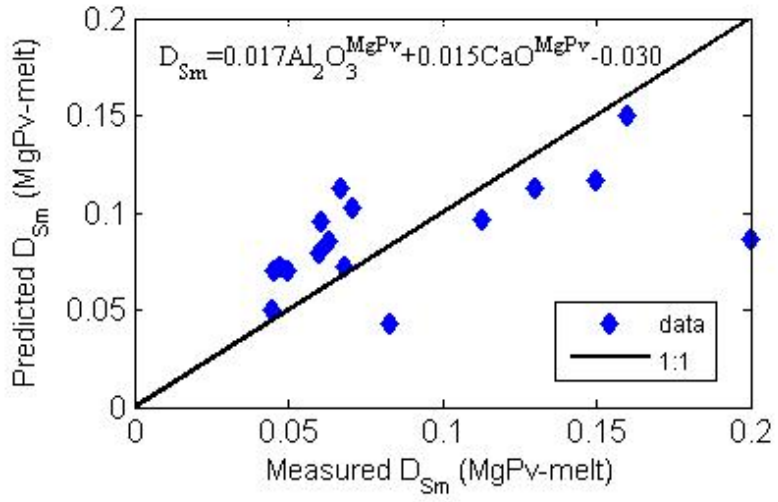


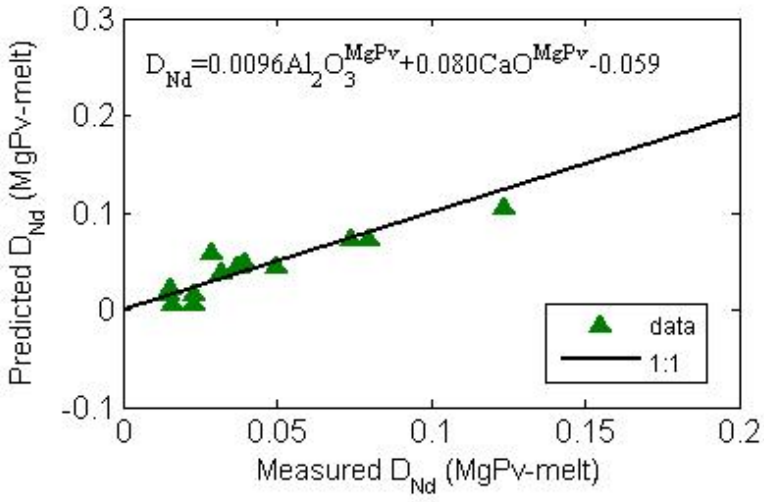
- Fe-partitioning *does* depend on Al content *but* Al content depends on Si, Al, and Mg
- Fe content in melt evolves non-linearly

Results: trace elements









Conclusions

- Empirically found Al and Ca influence Fe partitioning
- Amount of Fe enrichment in silicate melt depends on solidification history
- Evolving melt composition is non-linear
- Solidification scenarios will be more complex than previous models have assumed
- Many interesting scenarios yet to be explored
- Profound implications for Earth's thermal evolution