

Igneous Phase Diagrams: Past, Present, and Future Directions



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EXPERIMENT AS AN AID TO THE UNDERSTANDING OF THE NATURAL WORLD*

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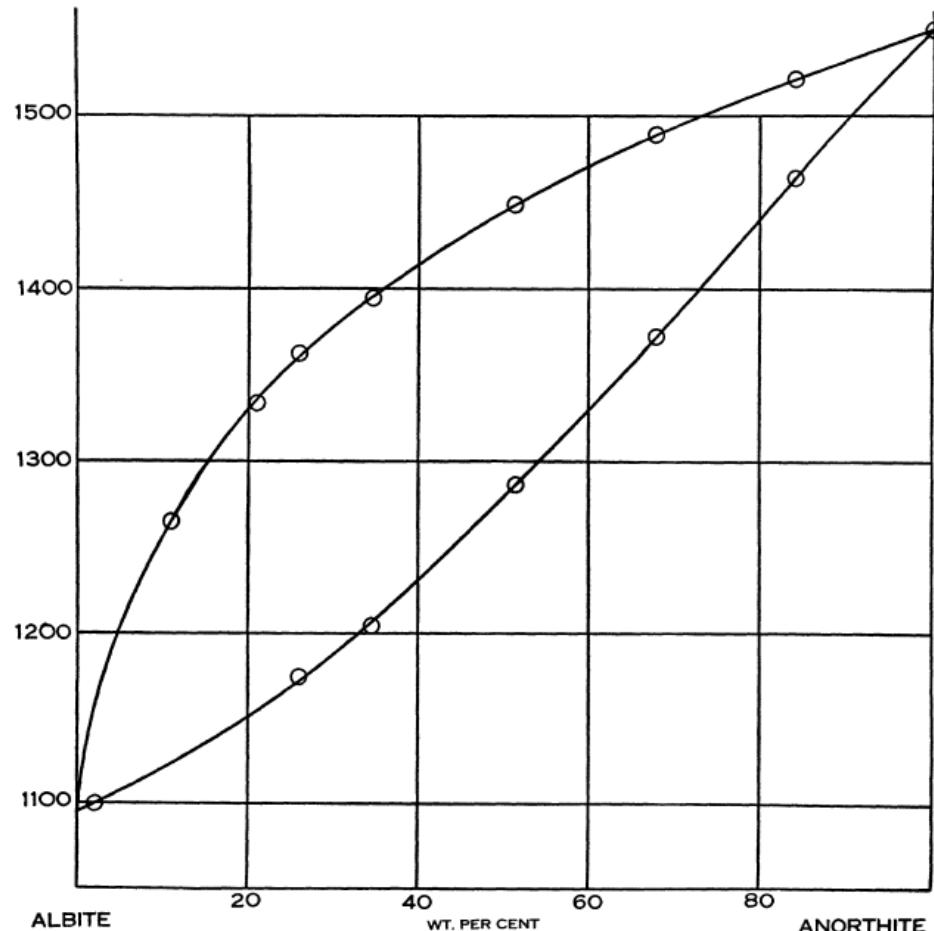


Fig. 1. Melting equilibrium diagram of the plagioclase feldspars.

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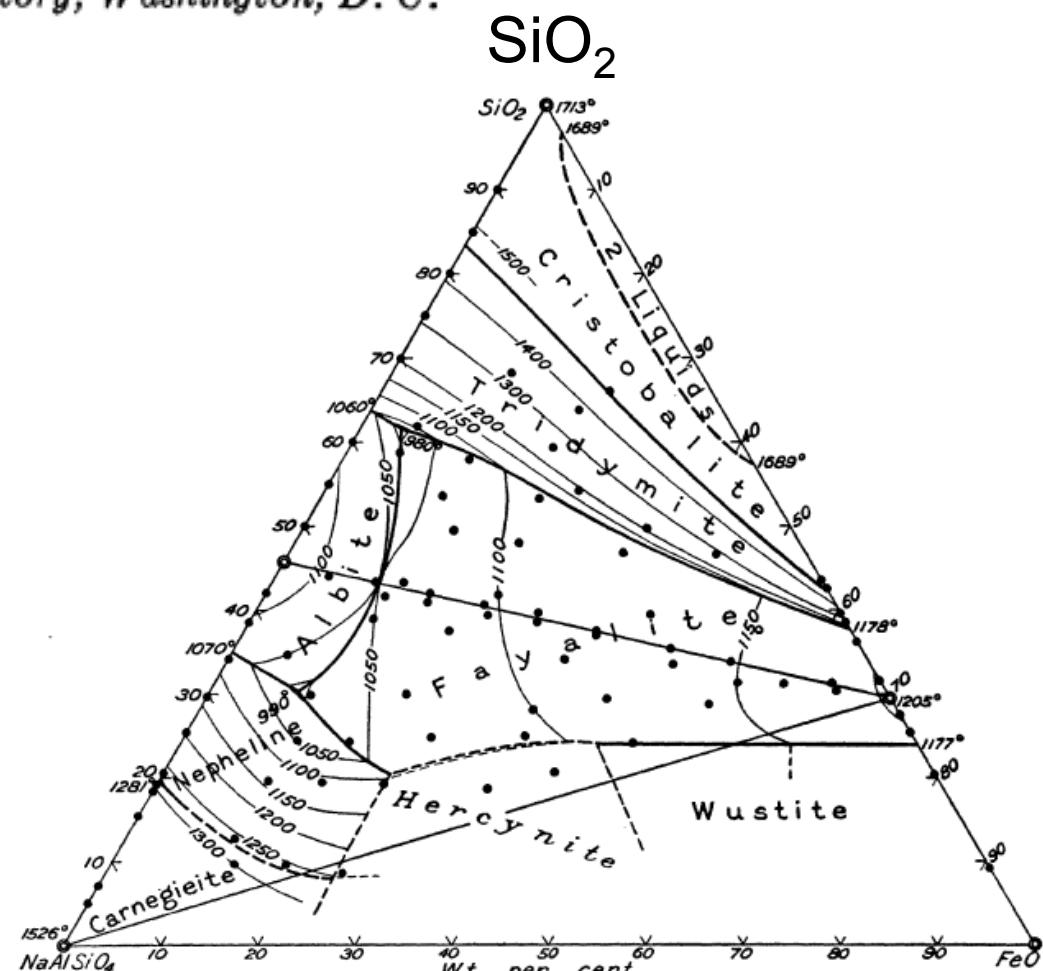


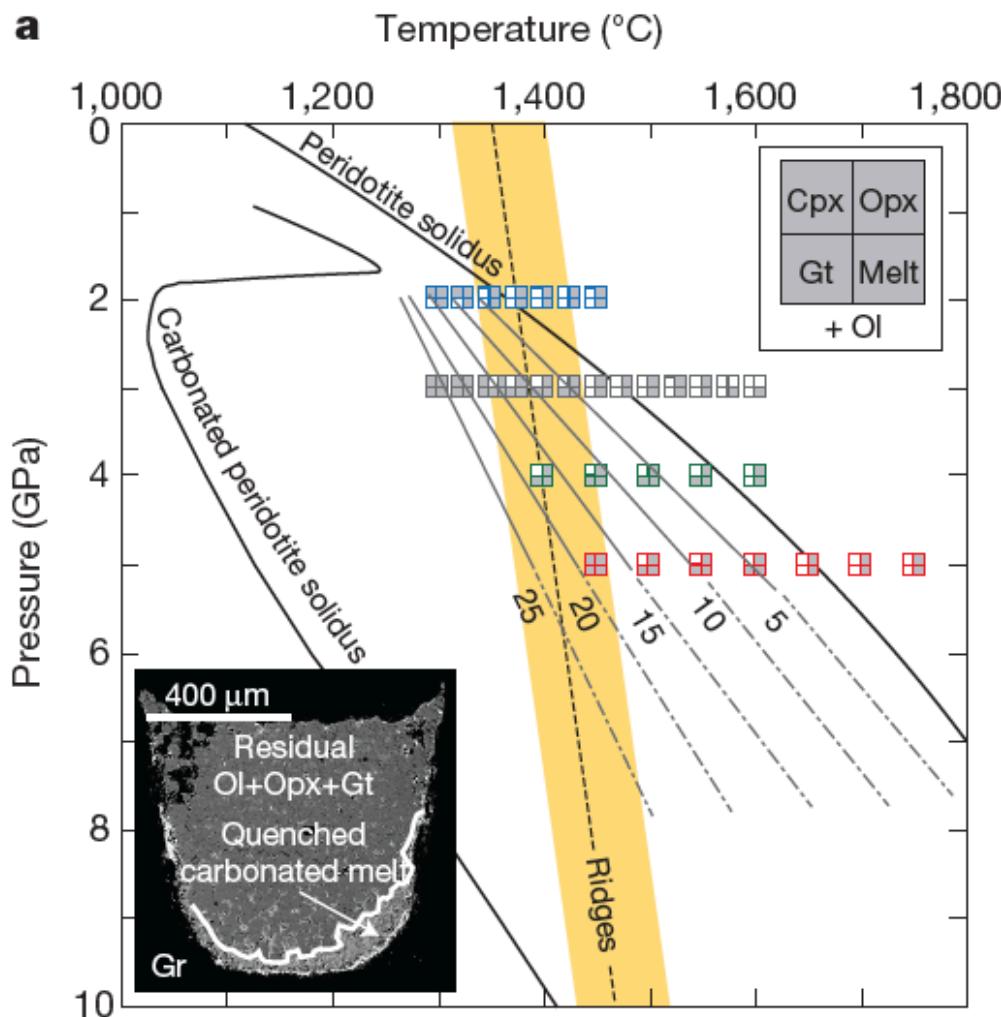
Fig. 5. Equilibrium diagram of the system NaAlSiO_4 - FeO - SiO_2 .

FeO

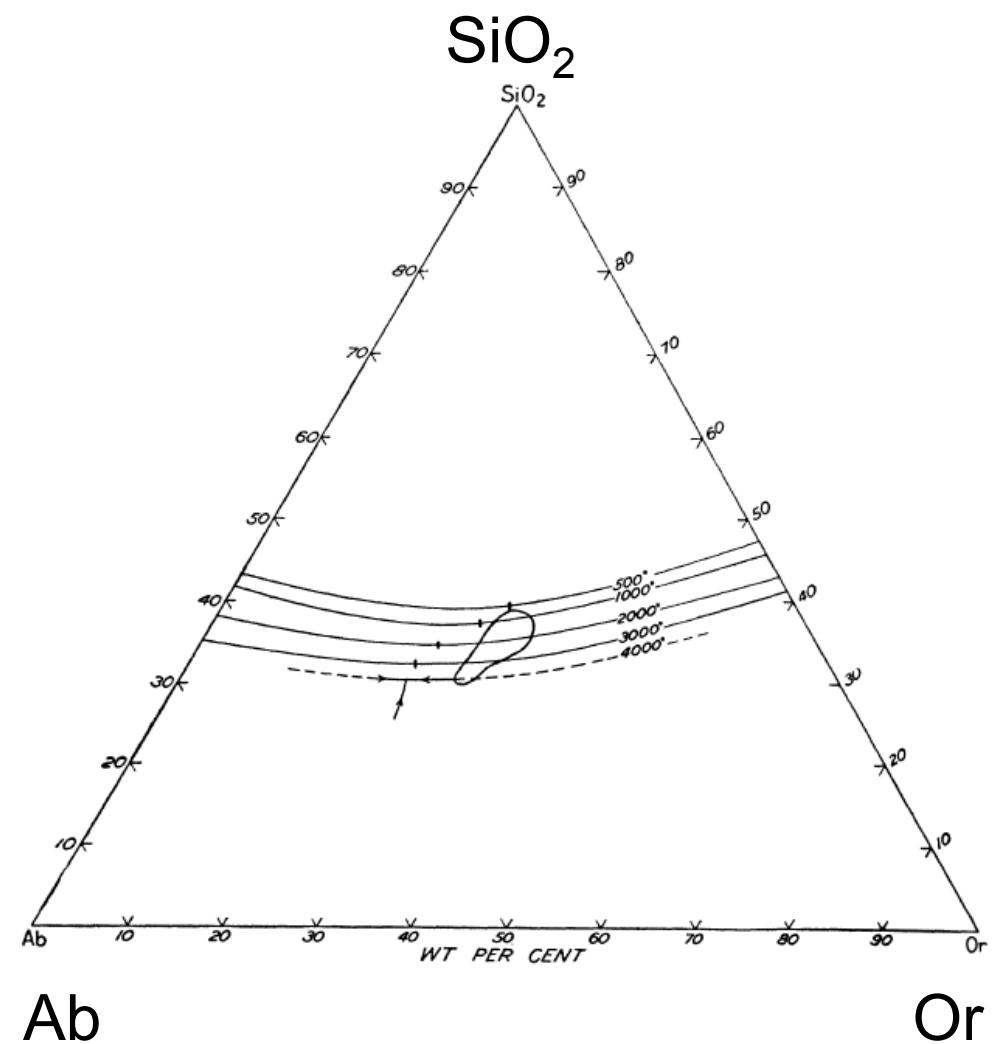
The importance of volatiles

carbonated peridotite

a

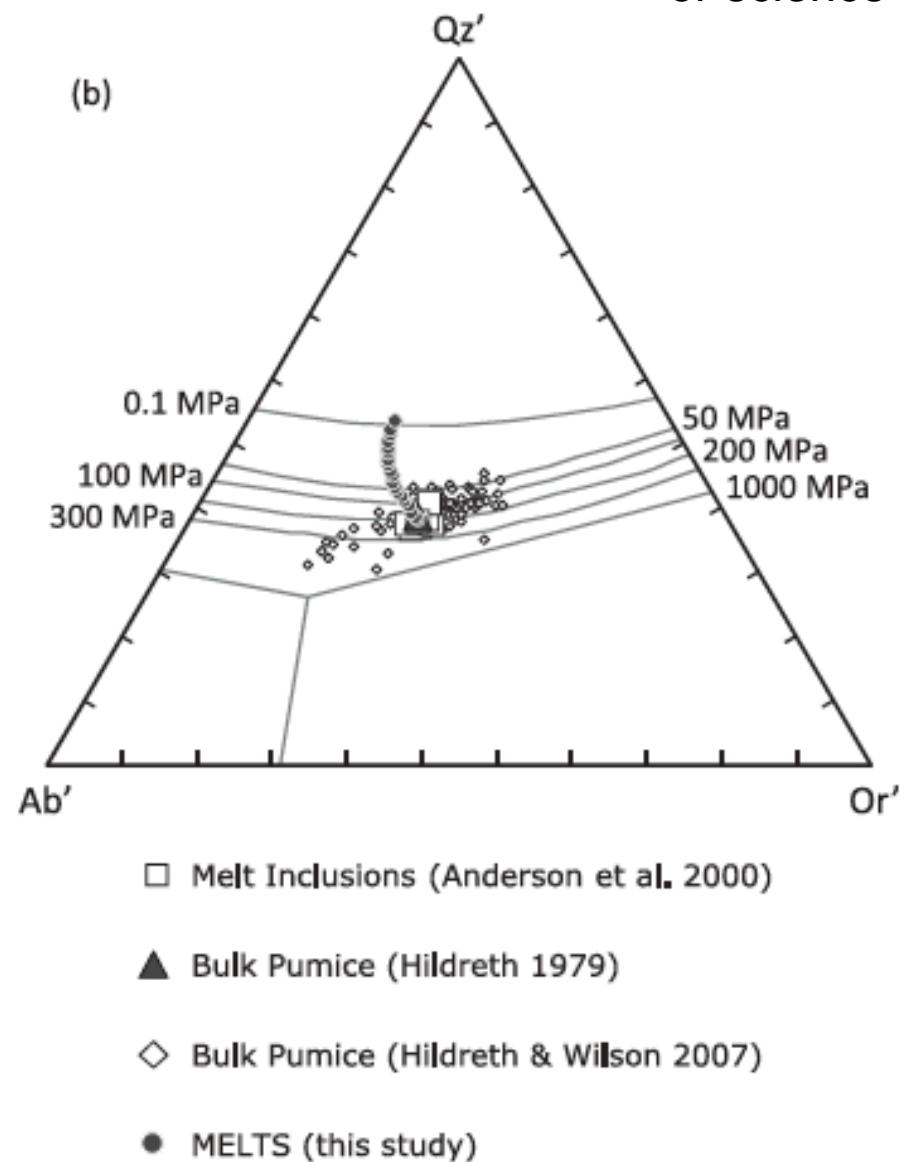
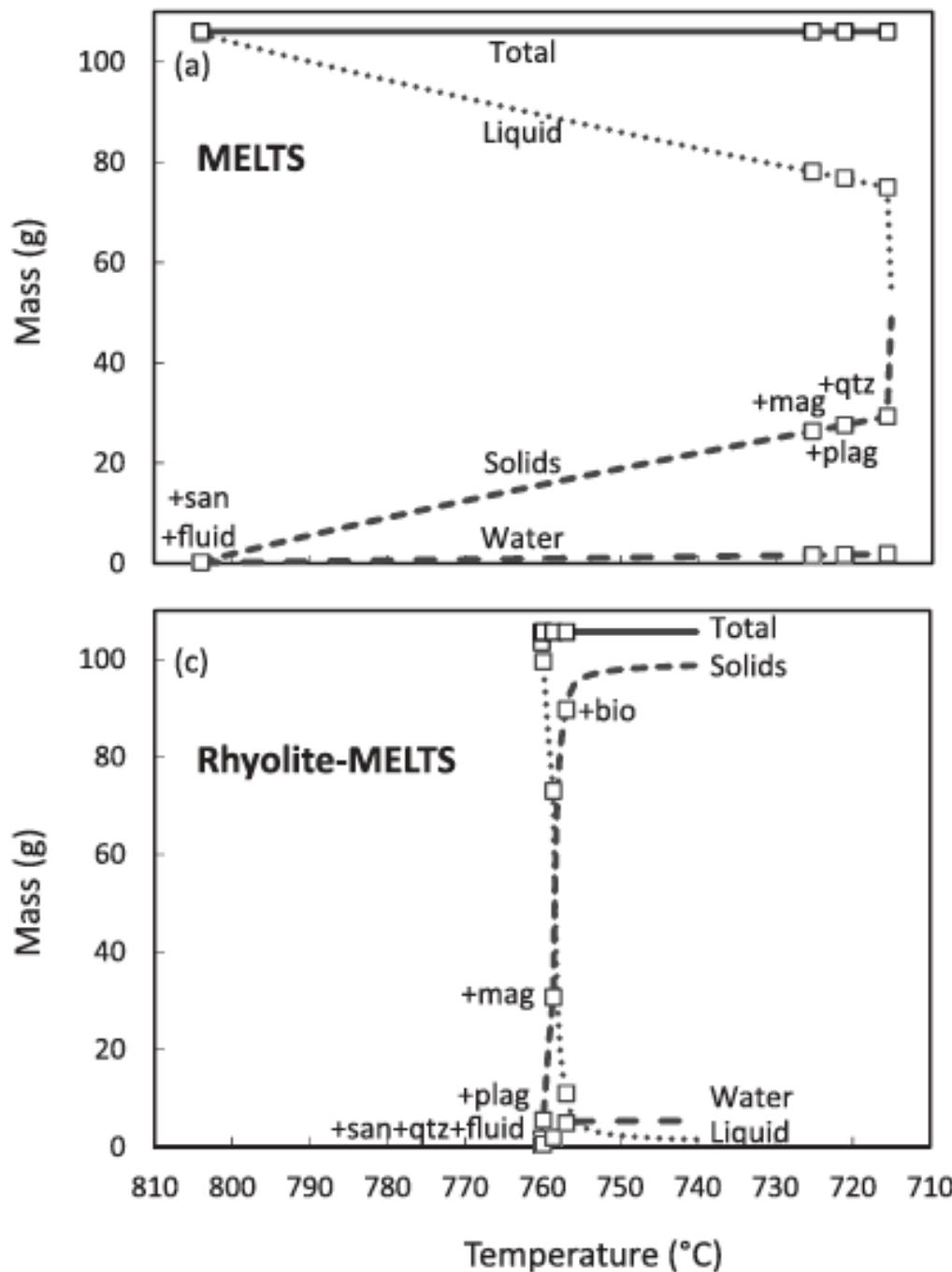


granites

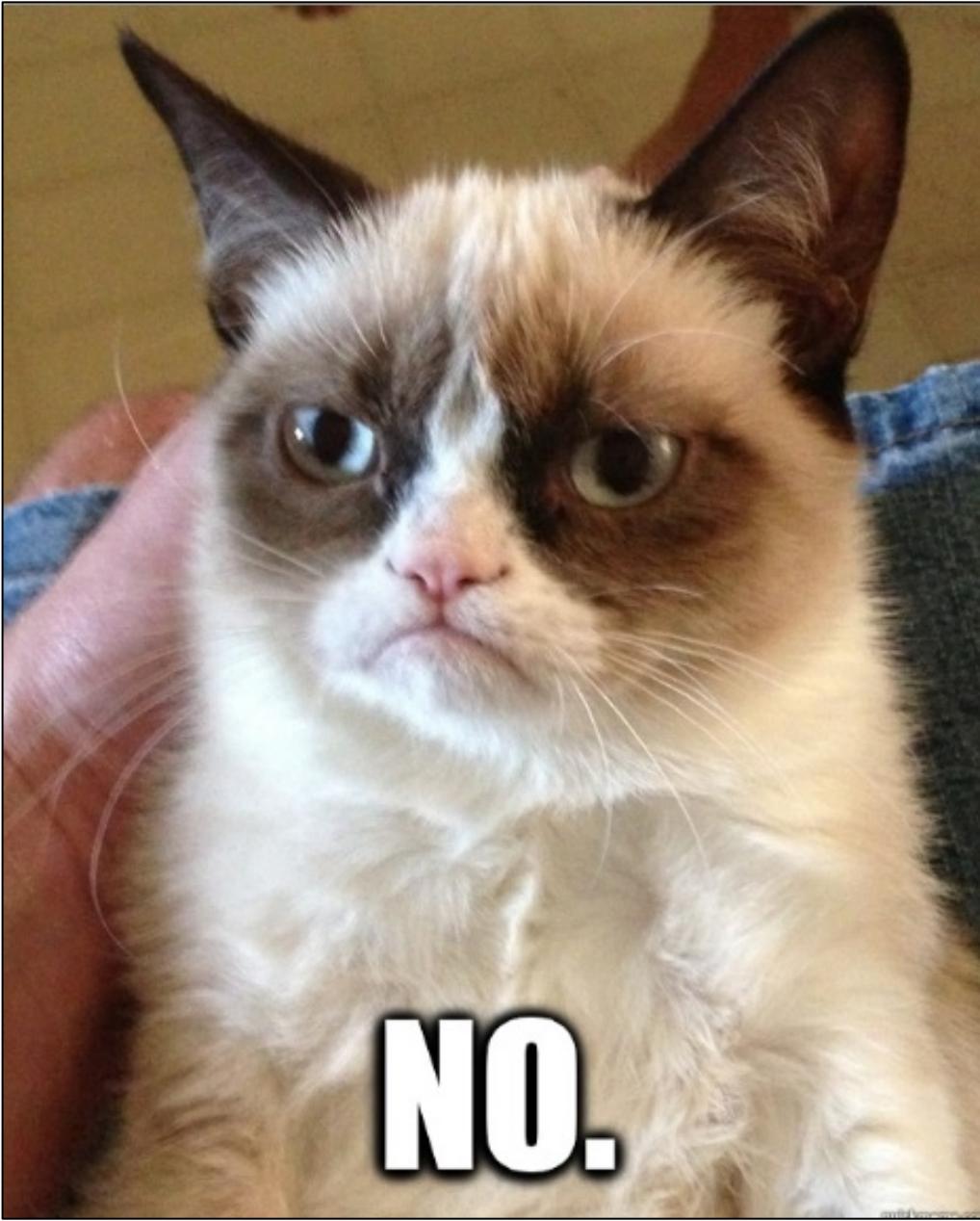


Igneous Phase Diagrams: state of the art*

* or science



So are we done?



Textures of granitic rocks



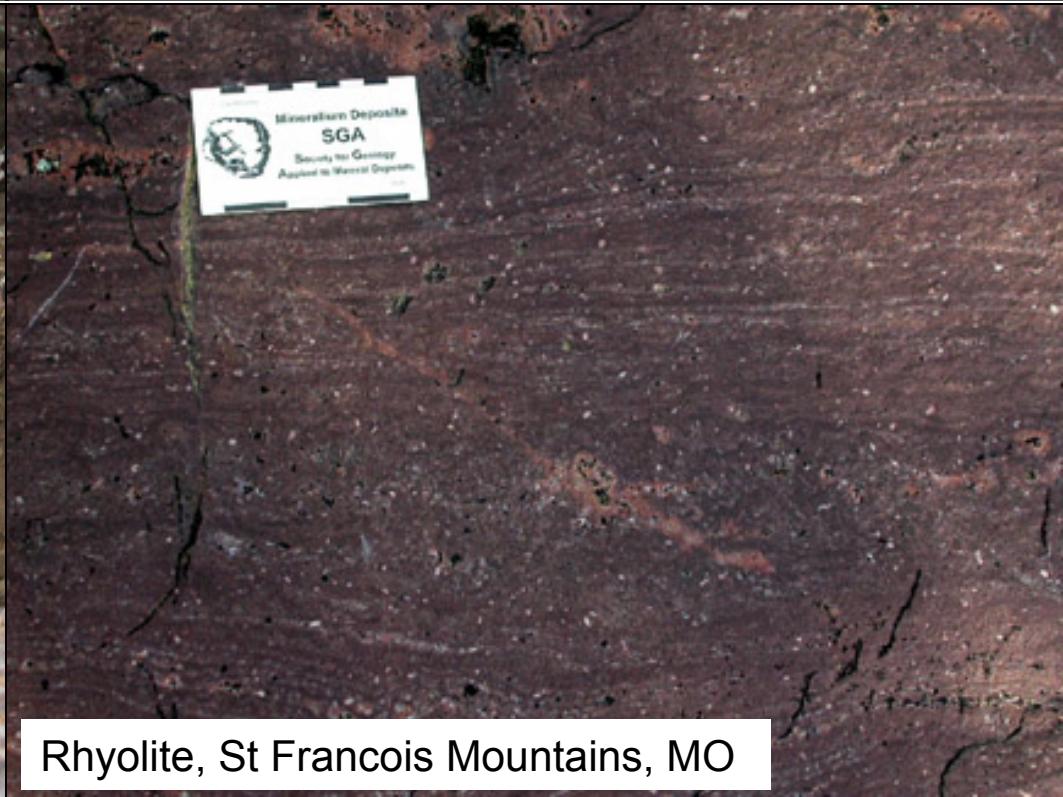
Pegmatite, Minas Gerais, Brazil



Granite, Nanga Parbat, Pakistan

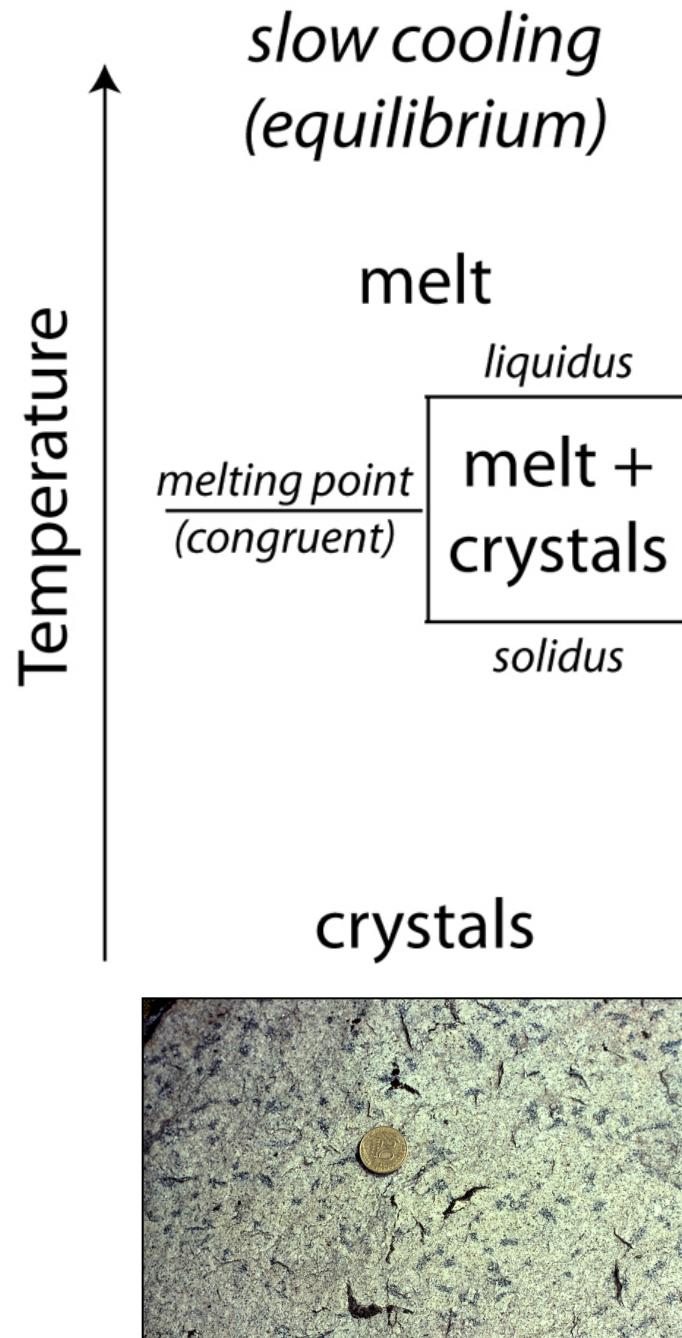


Obsidian, Landmannalaugar, Iceland



Rhyolite, St Francois Mountains, MO

“Disequilibrium” phase diagrams



fast cooling
(disequilibrium)

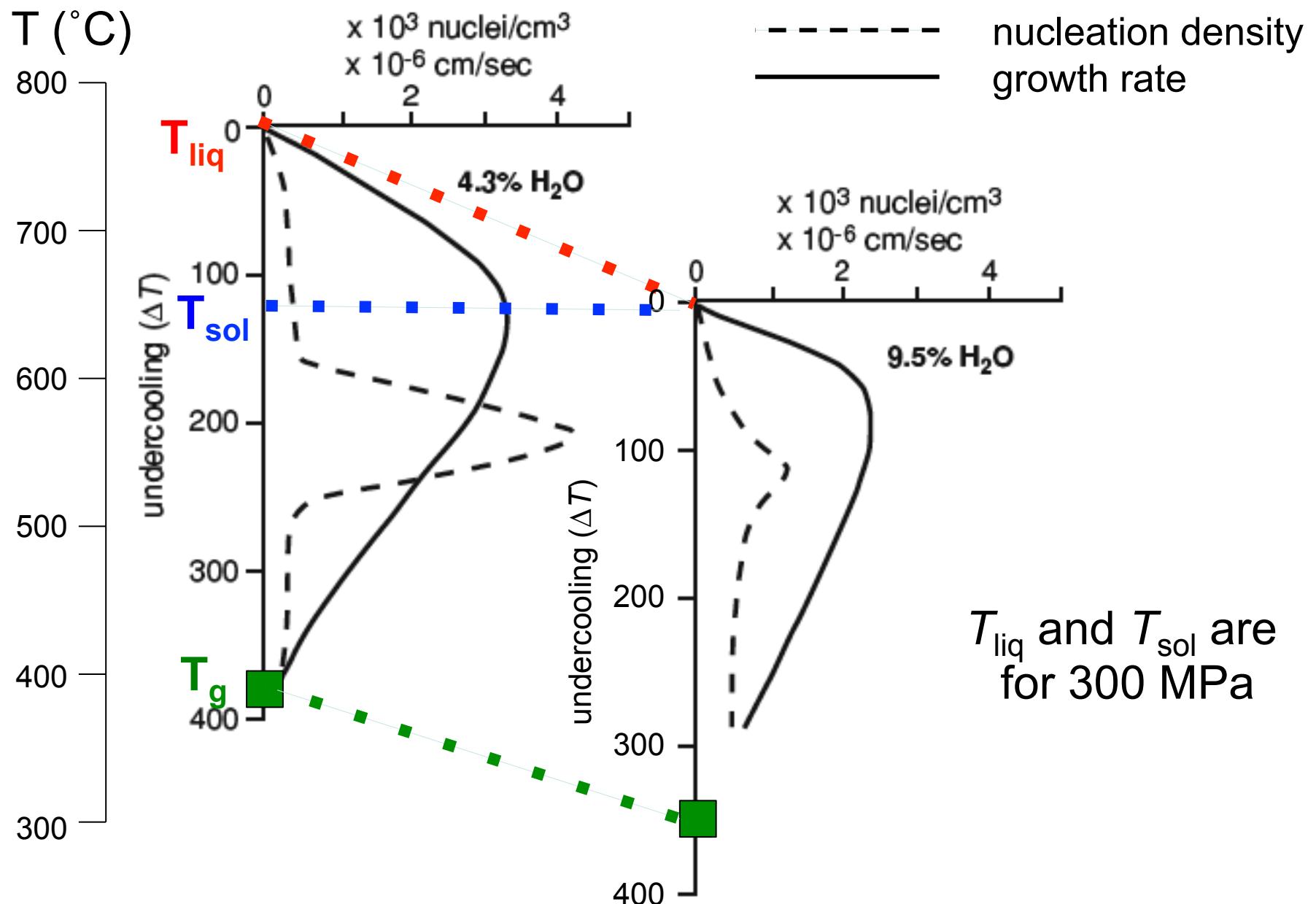
melt

glass transition
(faster cooling = higher Tg)

glass

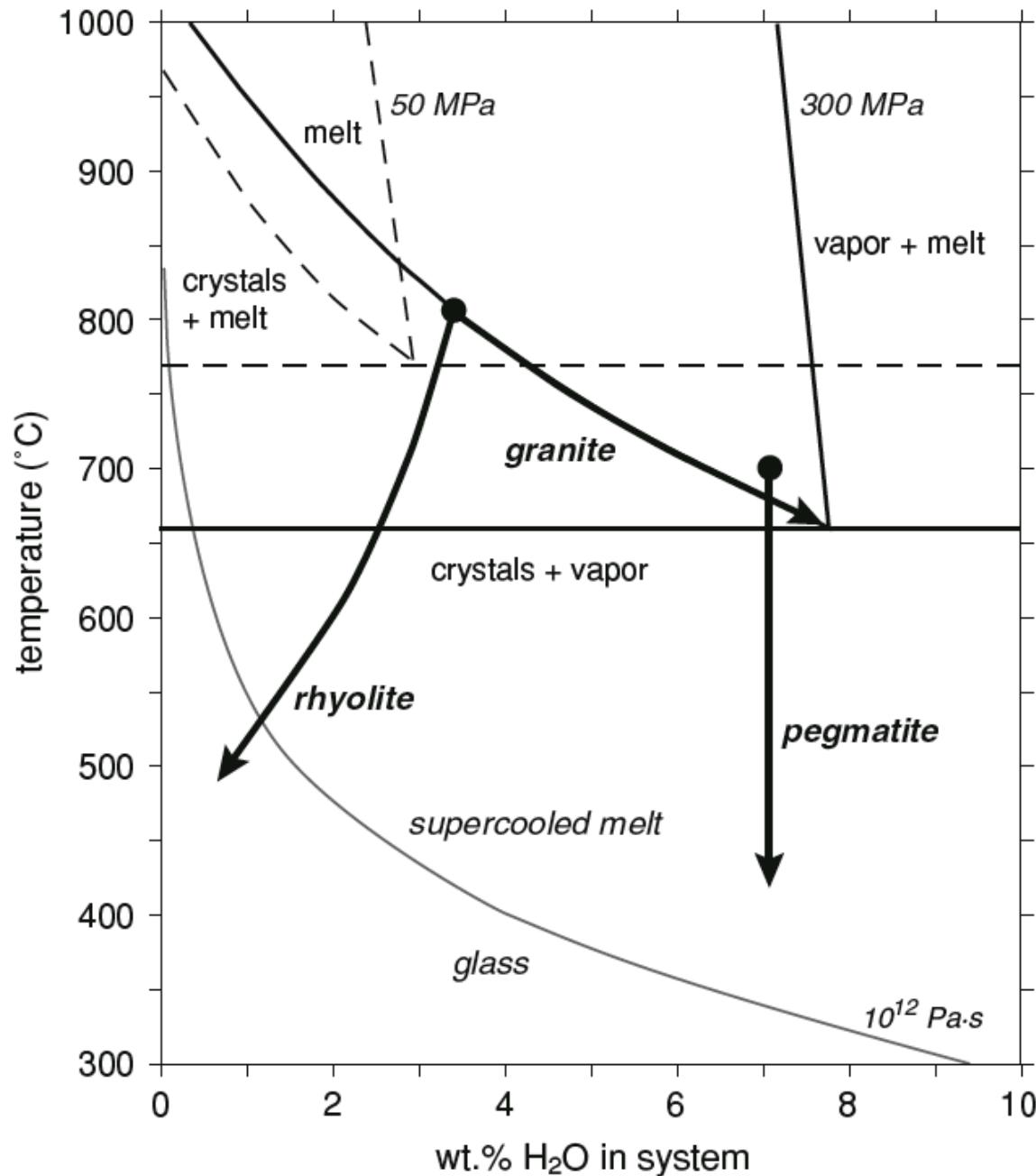


Crystal nucleation and growth



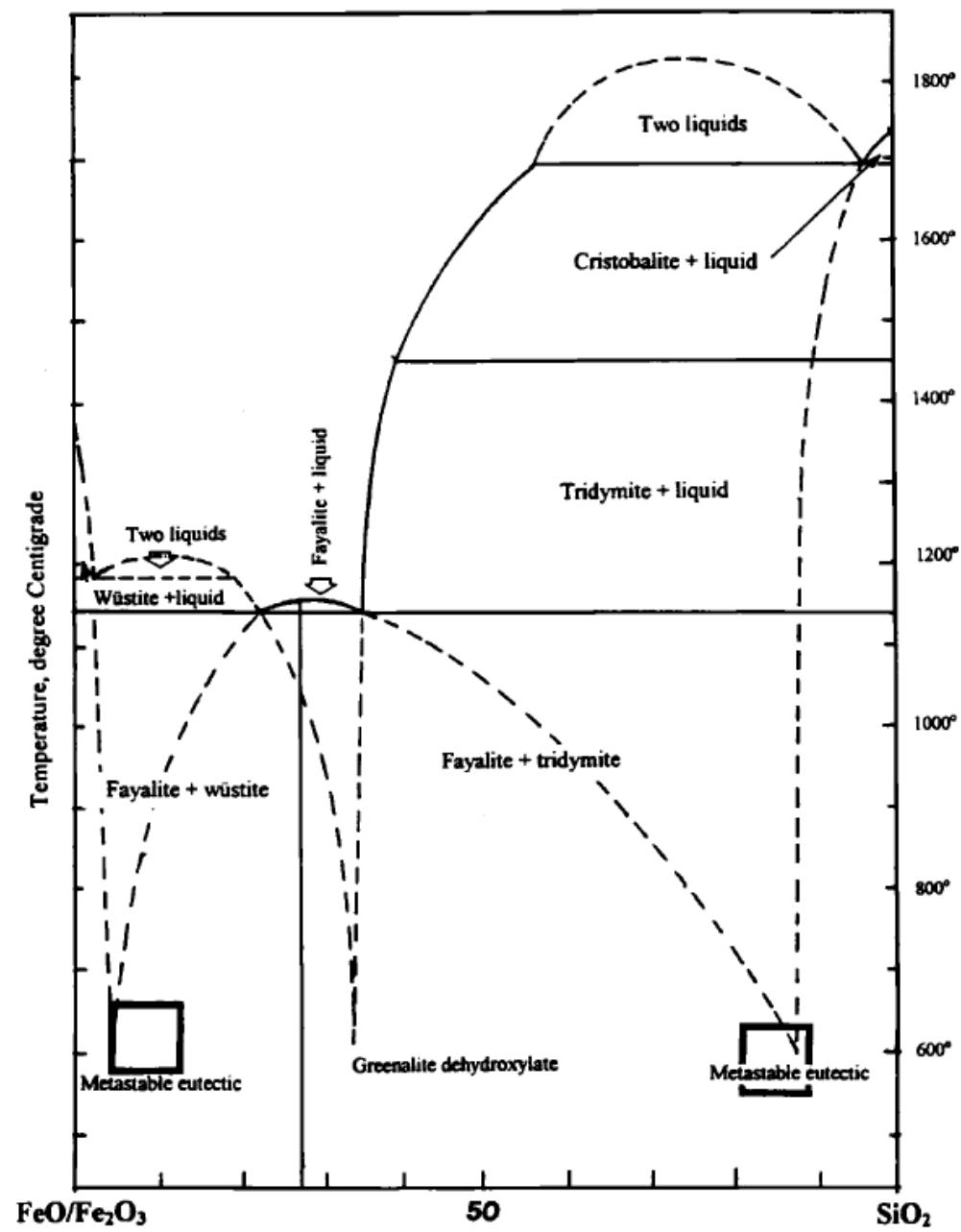
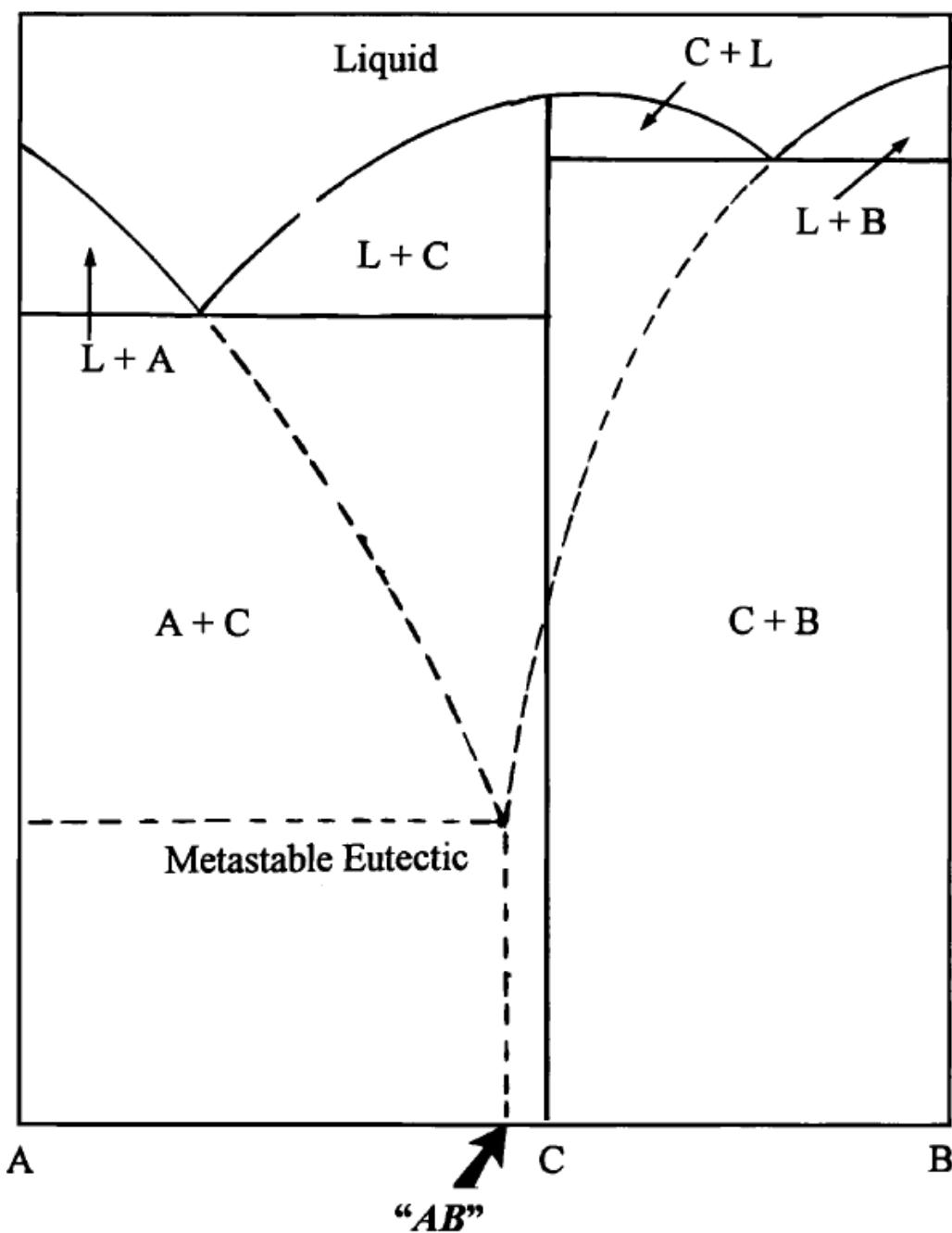
Data of Fenn (1977) *Canadian Mineralogist*, figure modified from Nabelek et al. (2010) *Contributions to Mineralogy and Petrology*

Phase diagrams and textures



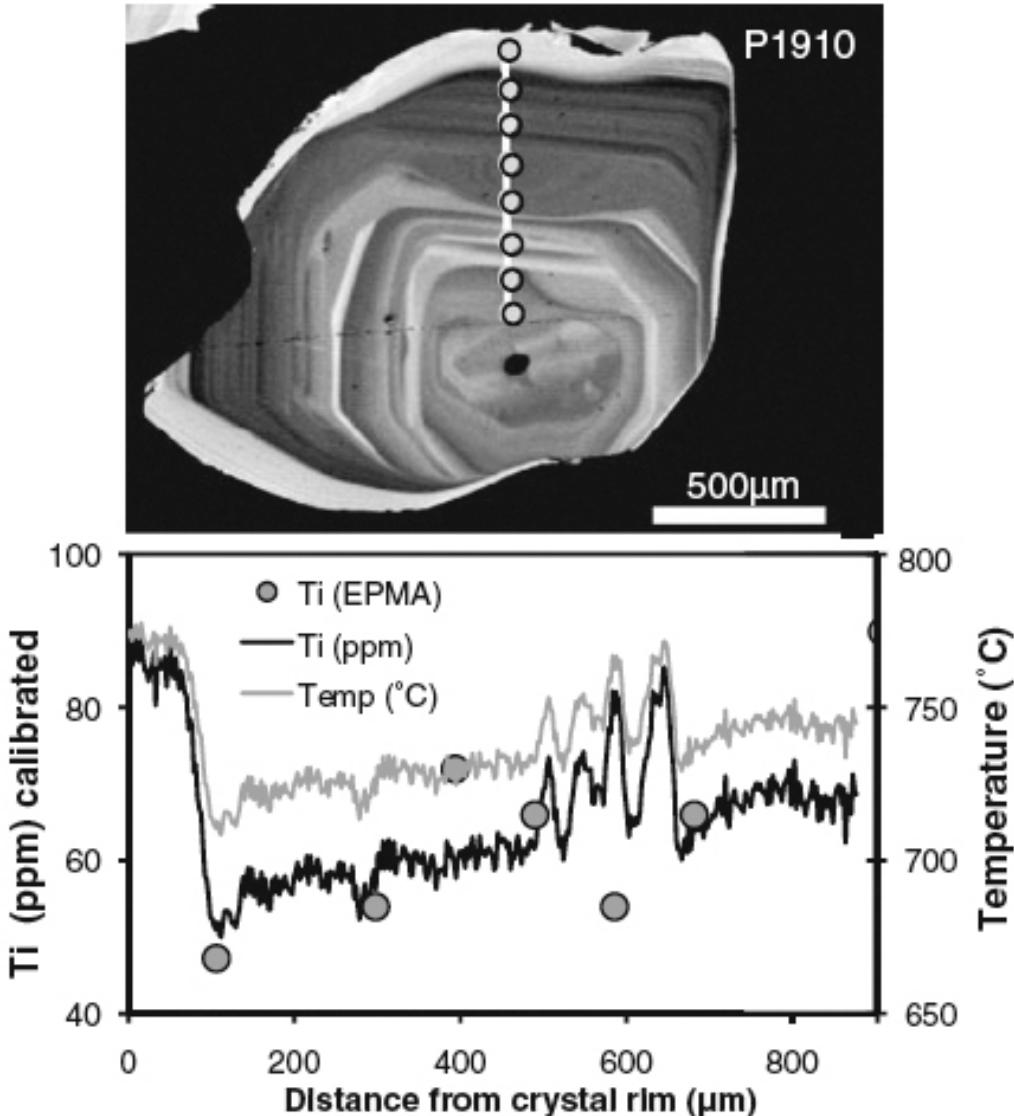
Metastable eutectics

Eos, Vol. 81, No. 36, September 5, 2000



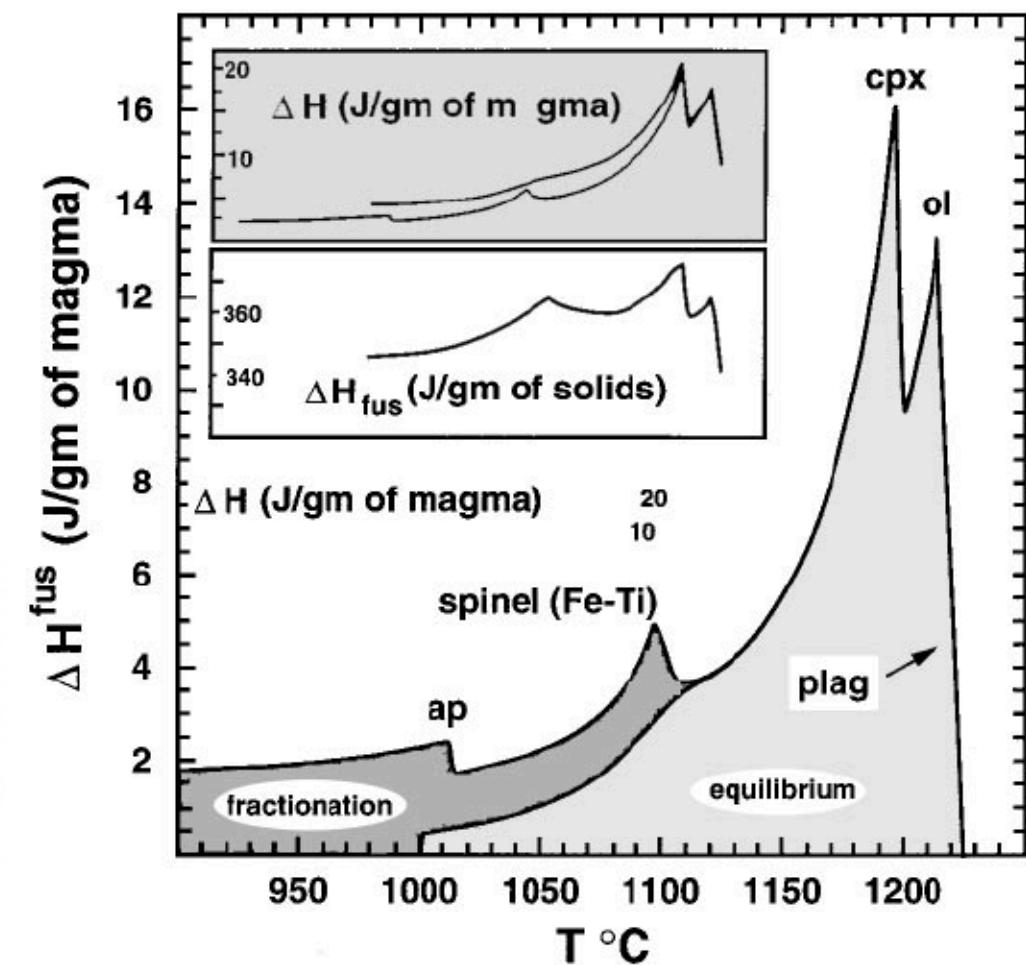
Are cooling histories linear?

External factors (recharge?)



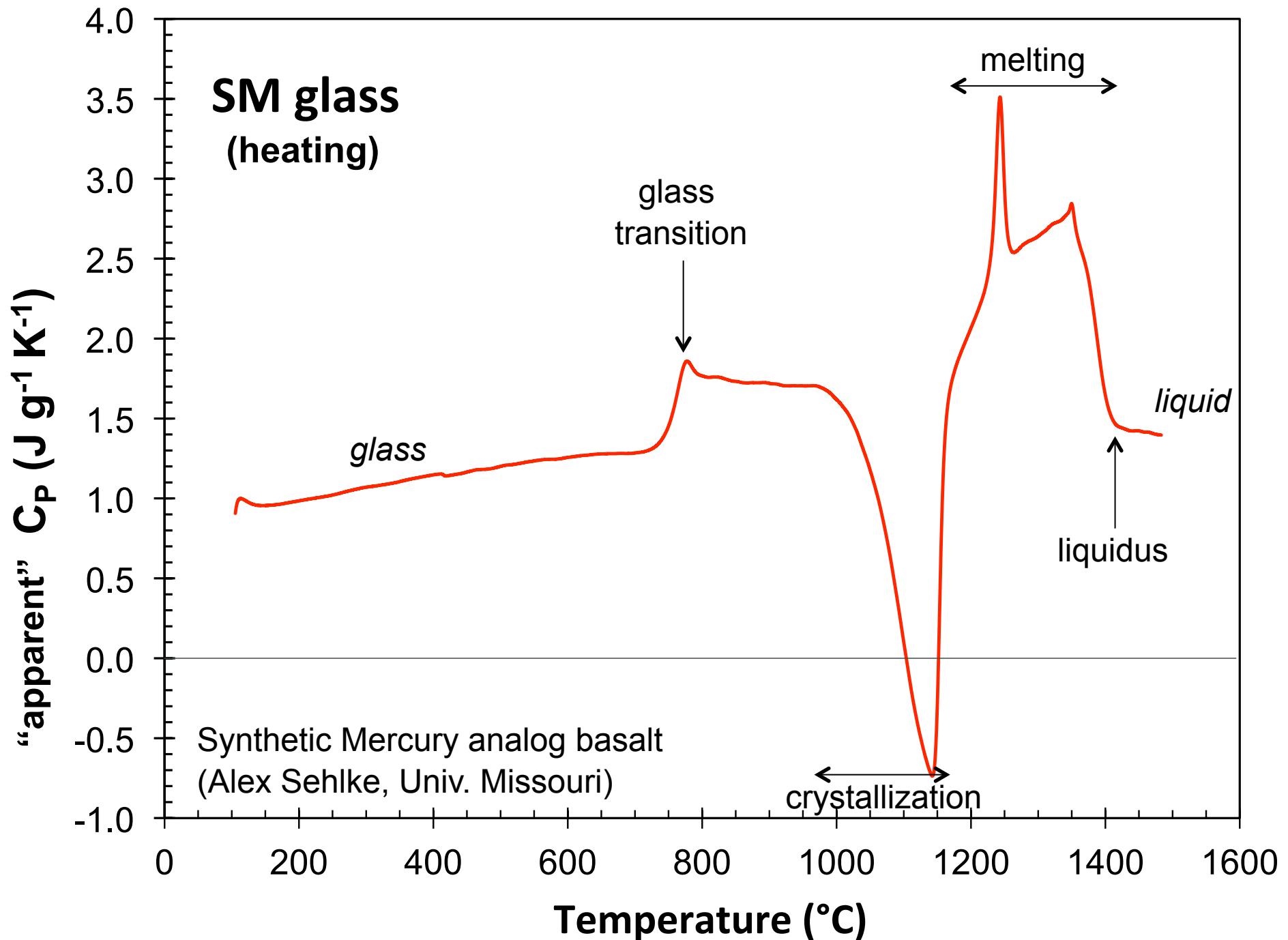
Matthews et al. (2012)
Contributions to Mineralogy and Petrology

Internal factors (latent heat)

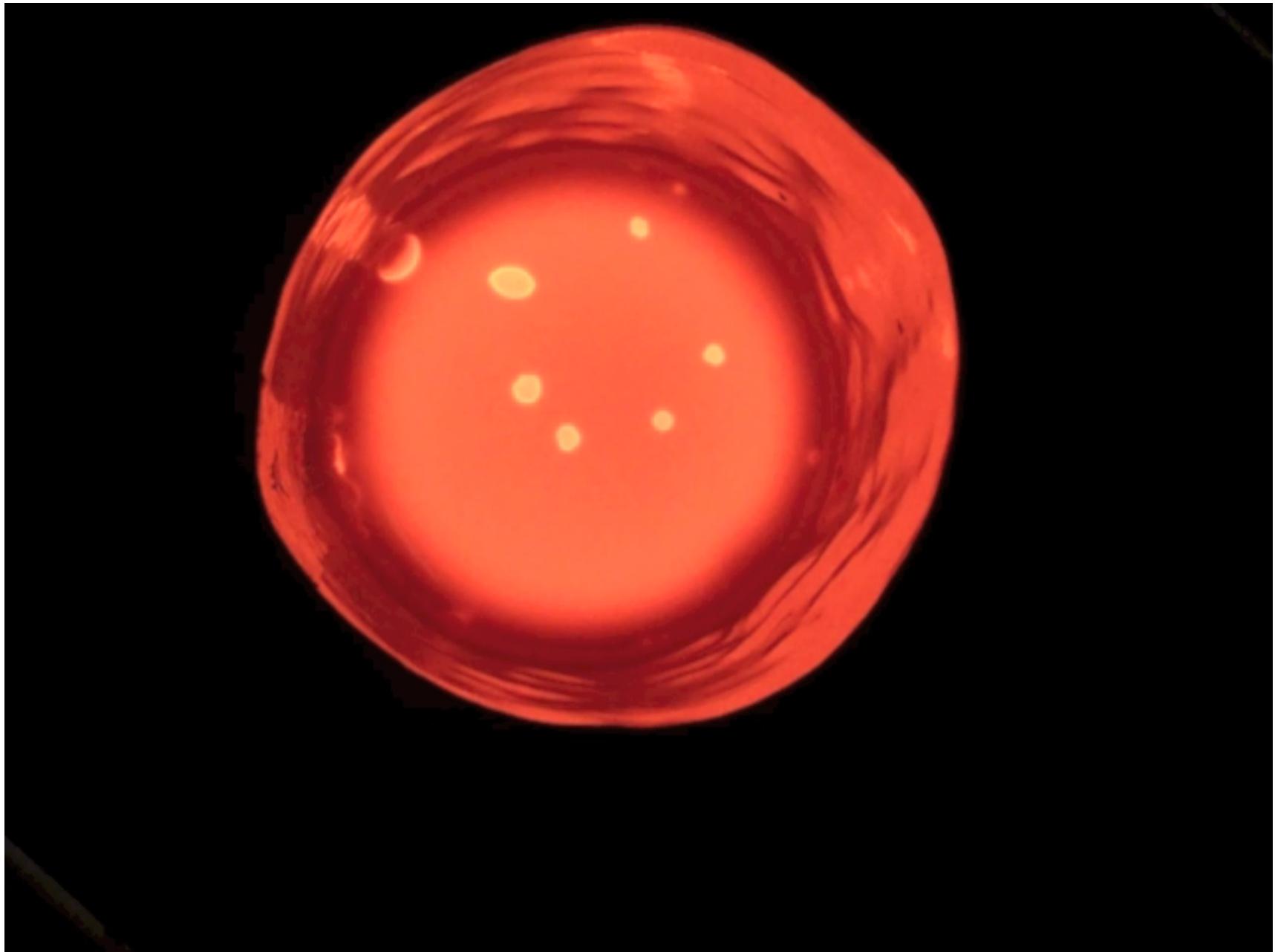


Ghiorso (1997) *Annual Reviews of Earth and Planetary Sciences*

Latent heat vs sensible heat



Recalescence in $(\text{Fe},\text{Mg})\text{SiO}_3$ melt



Video by Alex Sehlke, Univ. Missouri

Conclusions

- equilibrium model:
 - Phase equilibrium experiments \Leftrightarrow thermo measurements
 - Internally consistent databases (ig-met convergence)
 - Volatiles (CO_2 , mixtures, ...)
- disequilibrium phenomena:
 - Metastability (the vitreous phase, eutectics, ...)
 - Cyclic thermal histories (recalcescence, shear heating, ...)
 - Forward models must integrate P - T - t - X information and feedbacks (ig-met convergence)



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