In situ determination of water-saturated solidus by electrical discontinuity

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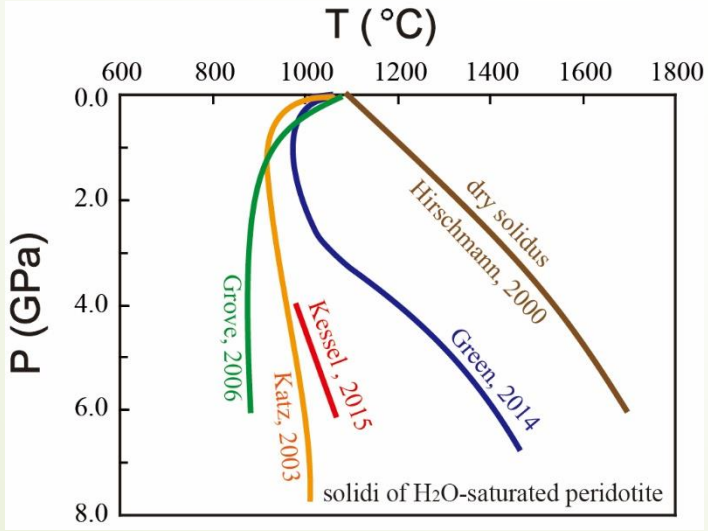
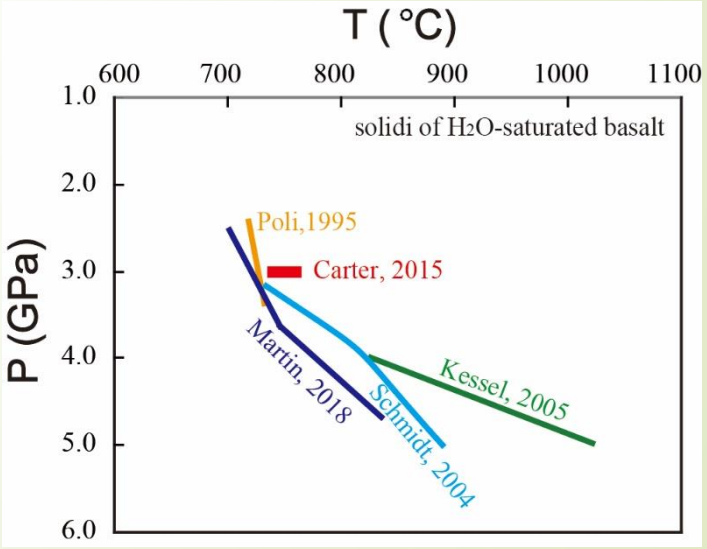
Why do we need to determine the water-saturated solidus?

- Water plays an important role in lowering melting temperature of rocks
- The water-saturated solidus of rock is critical for understanding the magma generation and the dynamics of the Earth
- water-saturated solidi constrained by traditional quench method have obvious discrepancy



melting temperature difference is up to 500° C



up to 150° C at P> 3 GPa

What causes the discrepancy?

- **difference in starting material**
  composition of rock, H_2O content ……
- **disequilibrium between melt and aqueous fluid**
- **lack of criteria to determine the occurrence of melting by quenched product**

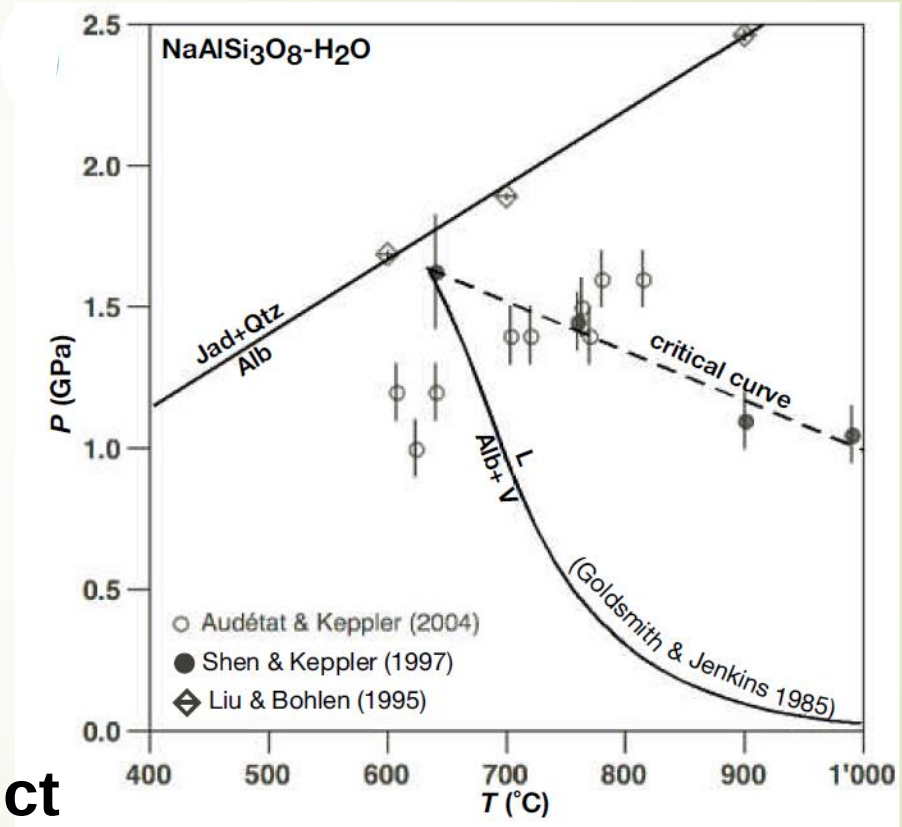
(Stalder, 2012; Till et al., 2012; Green et al., 2014; Kessel et al., 2015)

In situ determination by electrical conductivity can avoid the problem caused by quenching

Electrical conductivity experiment on water-saturated albite

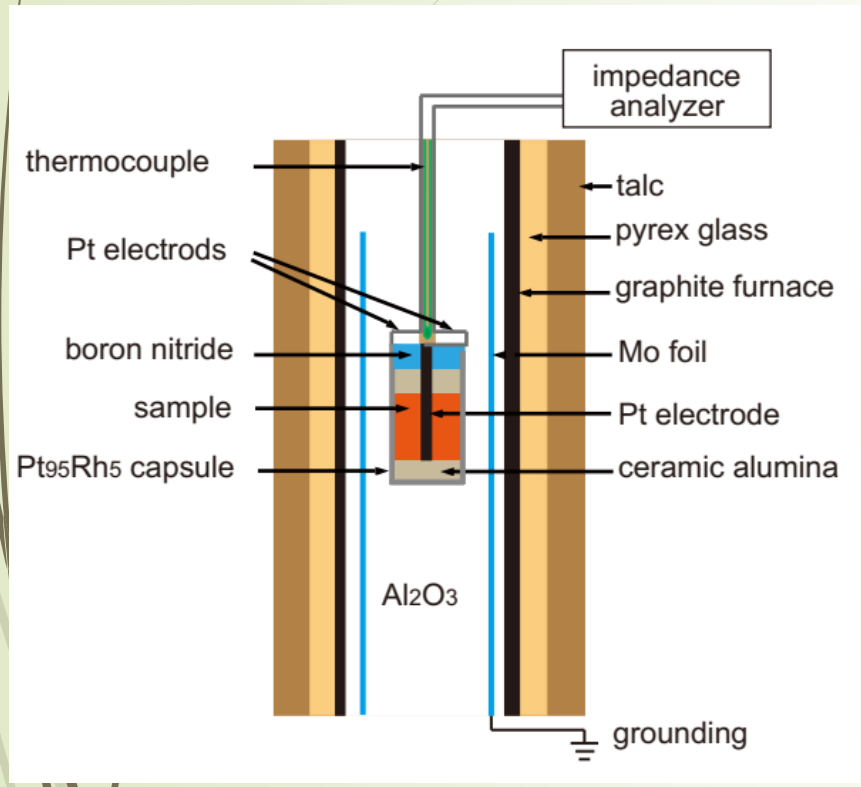
- **Experimental condition**
  - **natural albite powder**
  - **initial H_2O as 10-15 wt%**
  - **pressure ranges 0.35-1.7 GPa**

- **The chosen of H_2O-saturated albite**
  - **the system is simple**
  - **its water-saturated solidus is well known**
  - **little controversy on the quenching product**

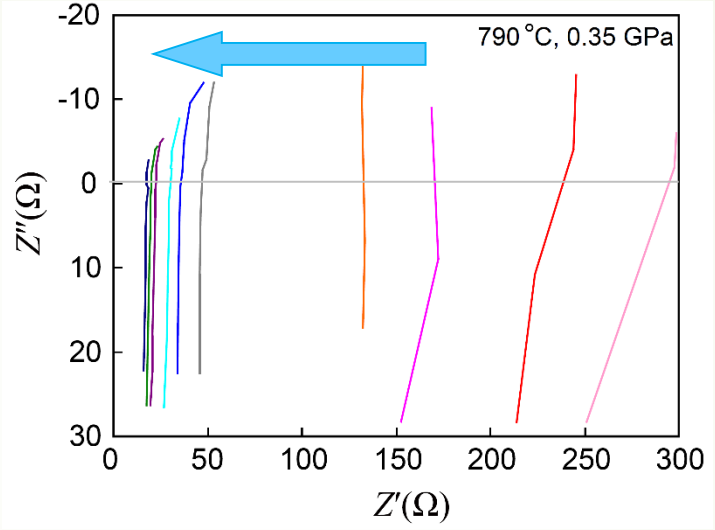


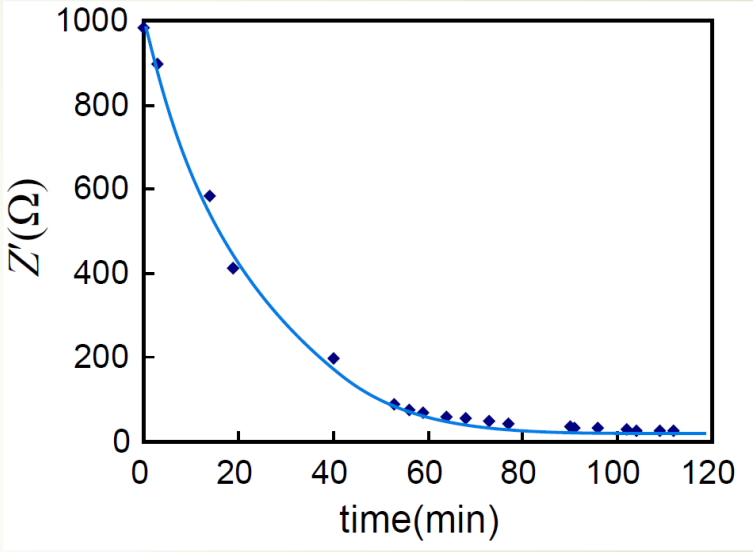
(Hack et al., 2007)

Electrical conductivity measurement on water-saturated albite



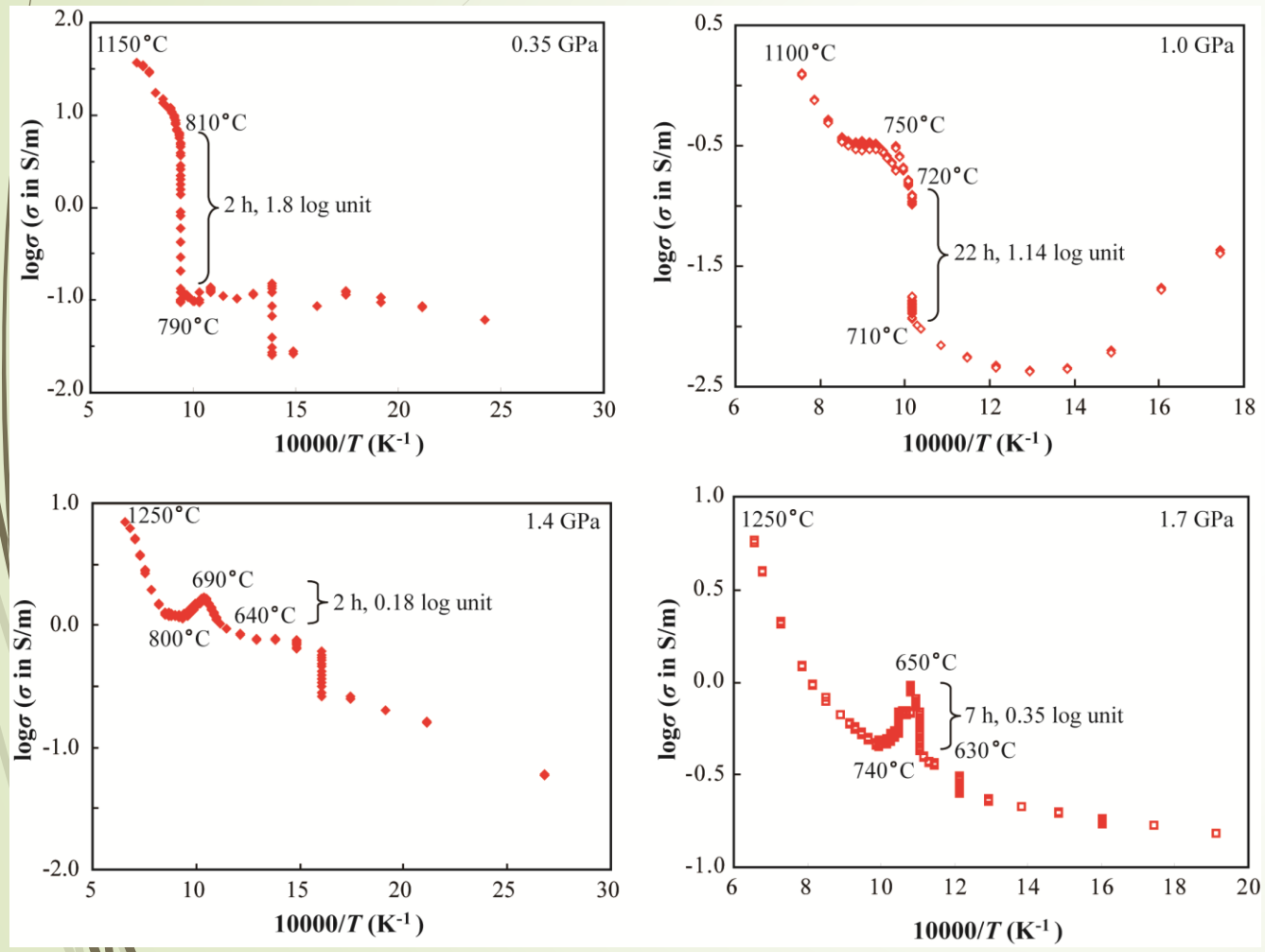
sample assembly design

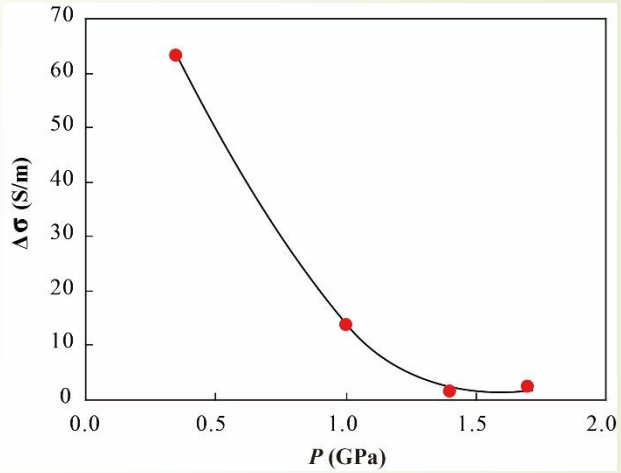




- resistance at melting temperature reduces with time
- when the resistance no longer changed, it was taken as reaching equilibrium

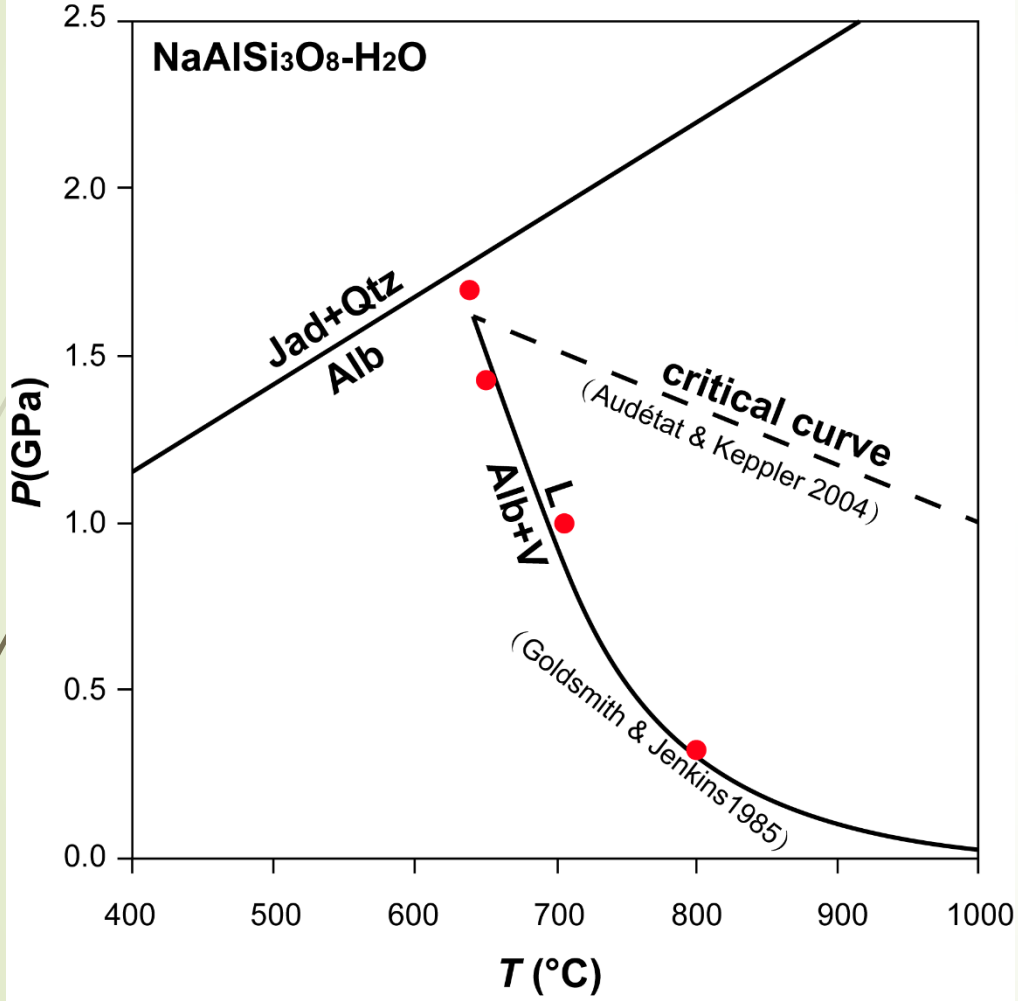
Electrical conductivity discontinuity at melting temperature



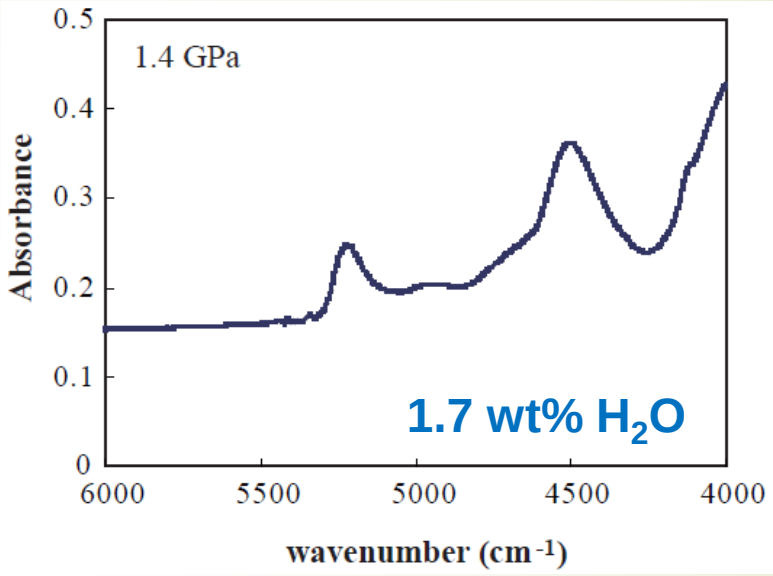


- obvious change of electrical conductivity was observed at solidus temperature
- a stronger increase of conductivity at lower pressures

Electrical conductivity discontinuity at melting temperature



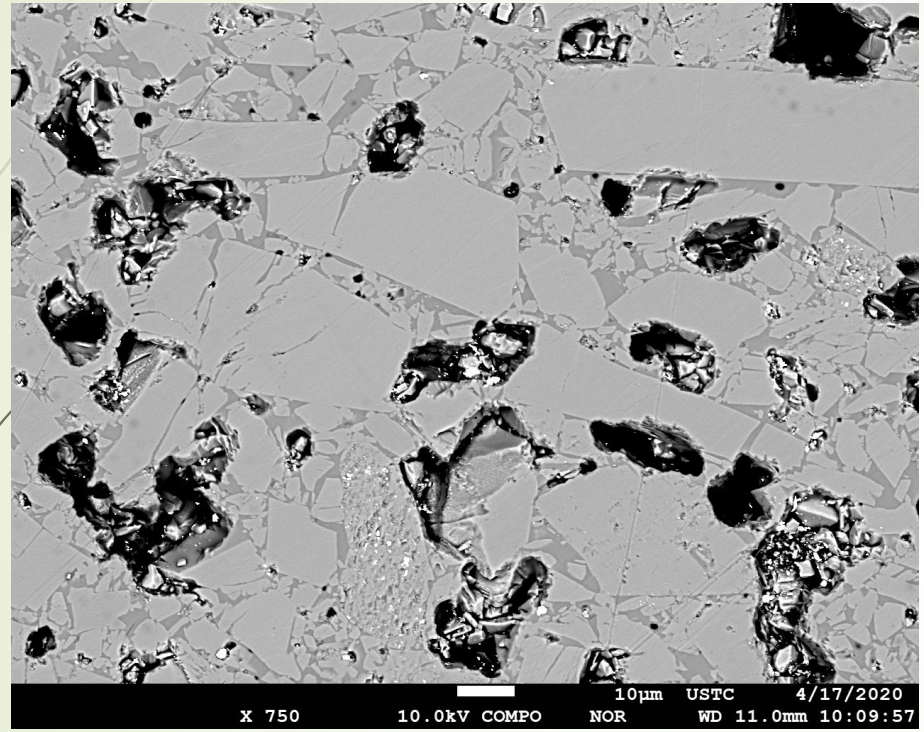
(Hack et al., 2007)

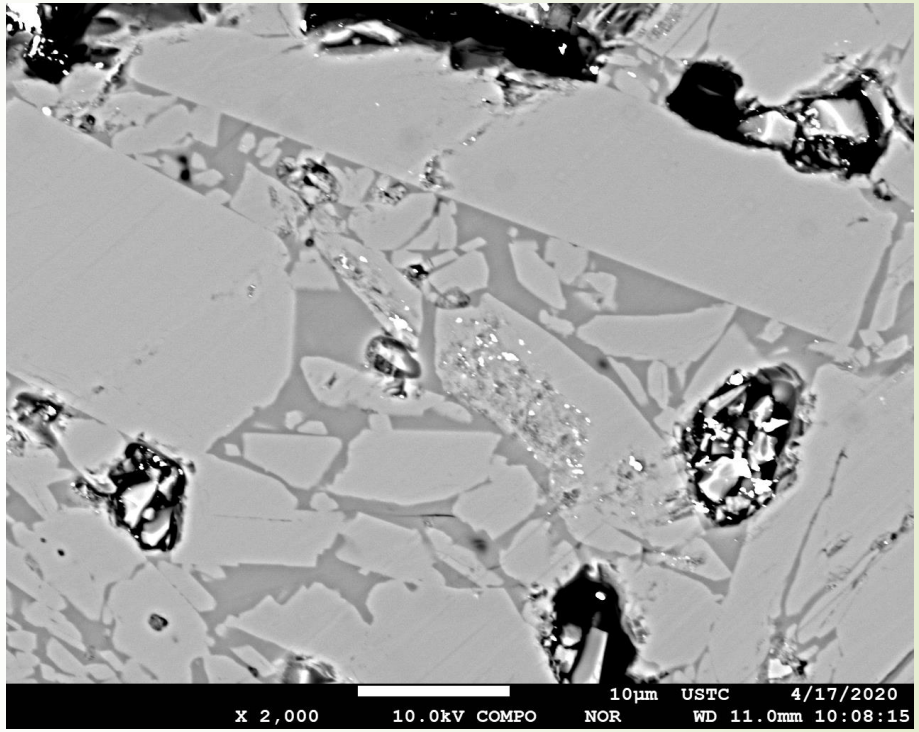


- Melting temperatures determined by conductivity discontinuity are consistent with previous H_2O-saturated albite solidus
- One defect of this method is the loss of water during experiment
- But the system is still water-saturated

equilibrium experiment at melting temperature

hydrous melt is interconnected in the system





730°C, 1.0 GPa BSE

fluid～16 vol%, melt~14 vol%

EMPA (wt%)	SiO_2	Al_2O_3	CaO	Na_2O	K_2O	Total
melt	60.27	18.56	0.19	8.44	0.51	87.97
Ab	67.49	20.00	0.40	11.45	0.17	99.52

Summary

- Electrical conductivity discontinuity occurs at melting temperature for H_2O-saturated albite, the results of which are consistent with previous solidus
- A stronger increase of conductivity was observed at lower pressure
- Significant loss of water happened during the experiment, which requires improvement of the assembly design
- This method may be applied to other rocks to better constrain the water-saturated solidi in the future.