



H₂O-NaCl fluid inclusions in wonderland

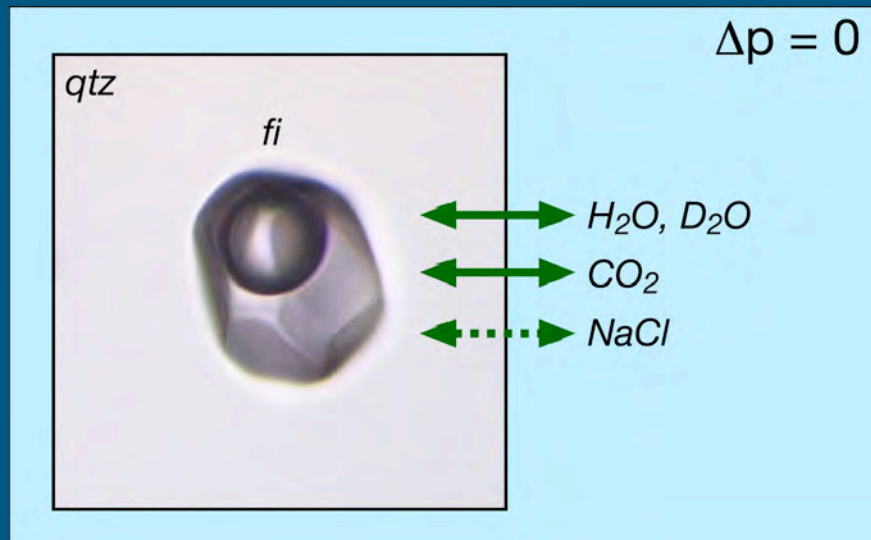
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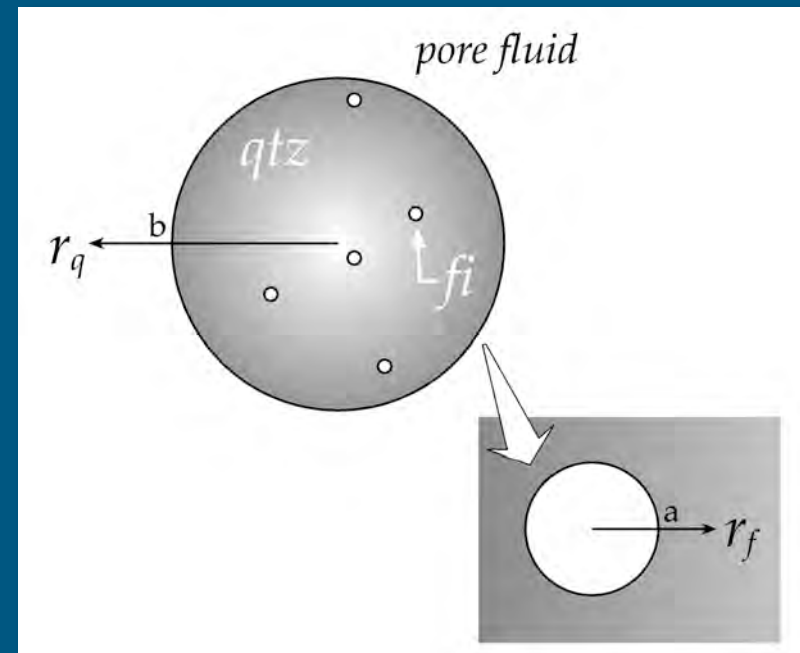
Synthesis and Re-equilibration of Fluid Inclusions

are fluid inclusions able to modify their contents
at constant temperature and pressure conditions?

gradients in fugacity at constant T and P



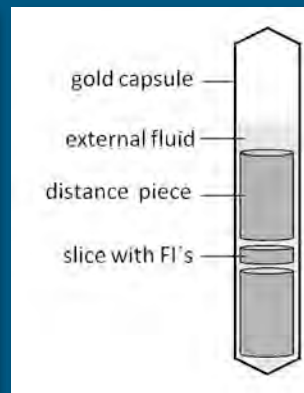
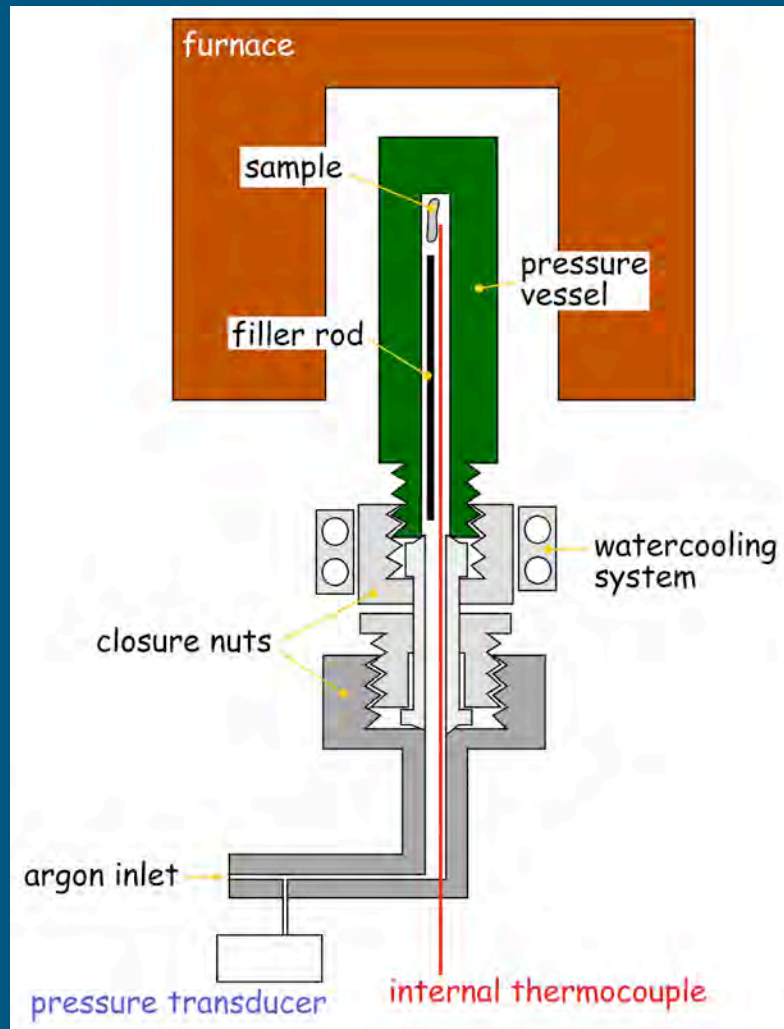
$$P_{fi} = P_{host} = P_{pore}$$



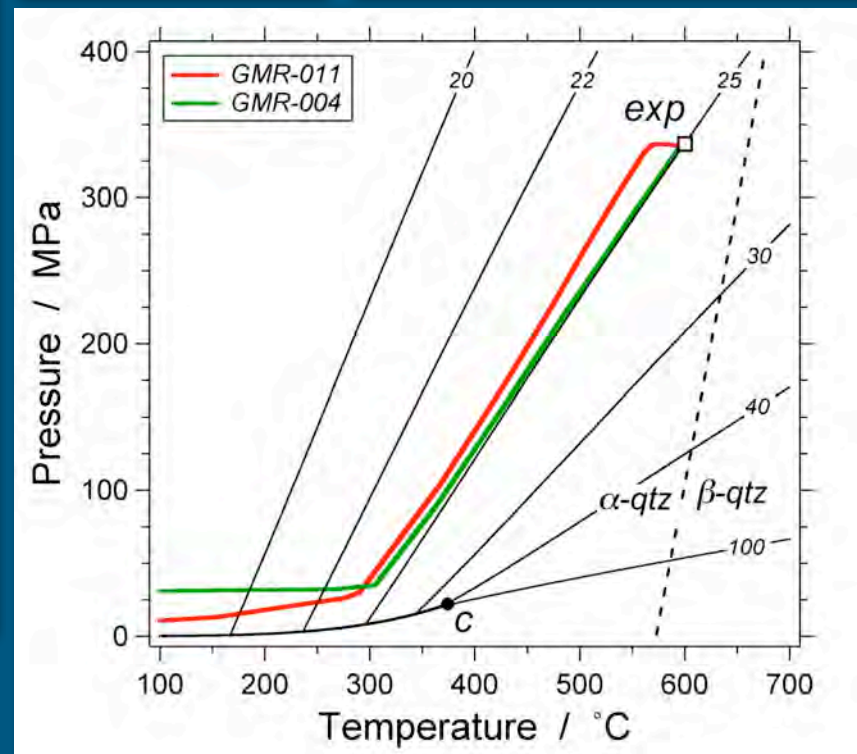
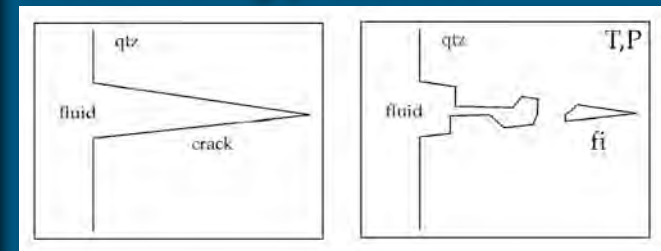
diffusion model

Bakker (2009, Lithos, vol.112, 277-288)

Experimental Setup



crack-healing processes



isochoric loading and unloading of experiments

Quality Experimental Setup

1. experimental conditions

pure H₂O
600.6 ± 0.4 °C
336.3 ± 0.5 MPa
457.4 hours



equation of state

Haar et al. (1984) program "LonerHGK"

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$$V_m(f) = 25.032 \pm 0.022 \text{ cm}^3 \cdot \text{mol}^{-1}$$



3. predicted T_h

correction of quartz molar volume (e.g. Hosieni et al. 1985)

at experimental conditions: $V_m(\text{qtz}) = 23.154 \text{ cm}^3 \cdot \text{mol}^{-1}$

at homogenization conditions: $V_m(\text{qtz}) = 22.927 \text{ cm}^3 \cdot \text{mol}^{-1}$



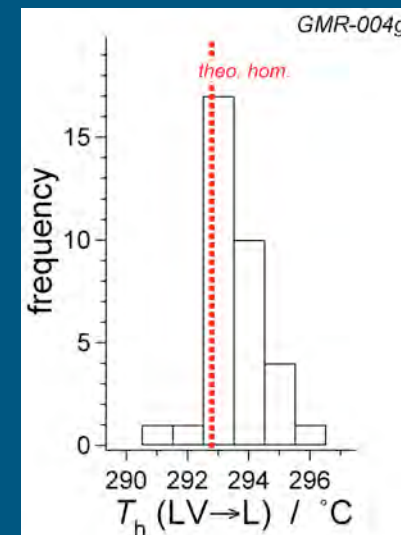
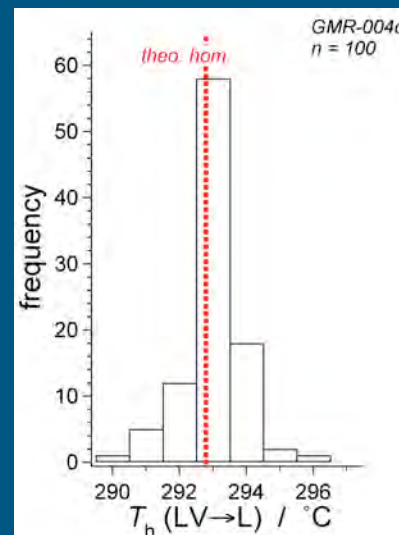
isochore correction: $V_m(f) = 24.79 \pm 0.02 \text{ cm}^3 \cdot \text{mol}^{-1}$



$$T_h = 292.8 \text{ °C}$$

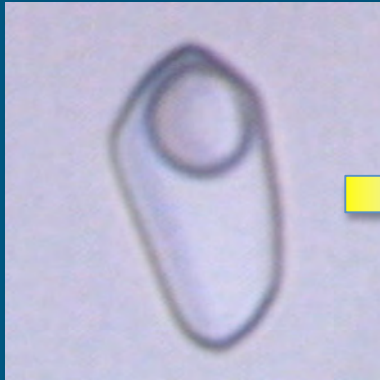
2. homogenization conditions

$$T_h = 292.5 \pm 0.8 \text{ °C}, P_h = 7.7 \pm 0.1 \text{ MPa}$$

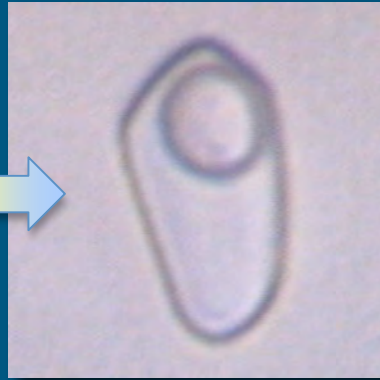


Re-equilibration of pure H₂O fluid inclusions

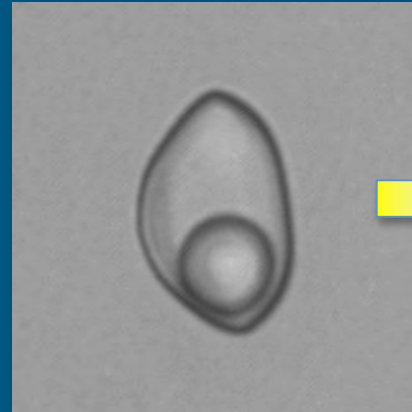
syn. H₂O



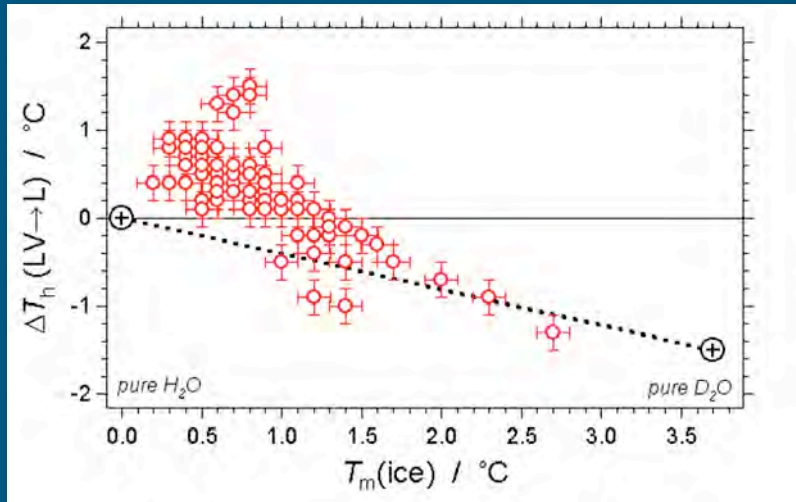
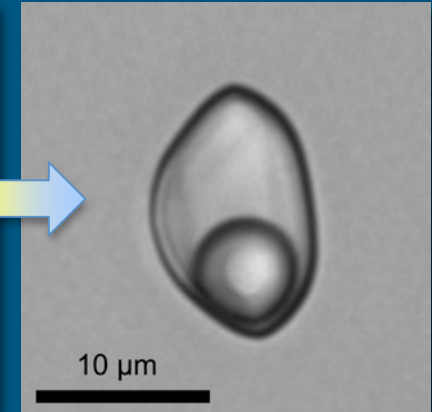
req. D₂O



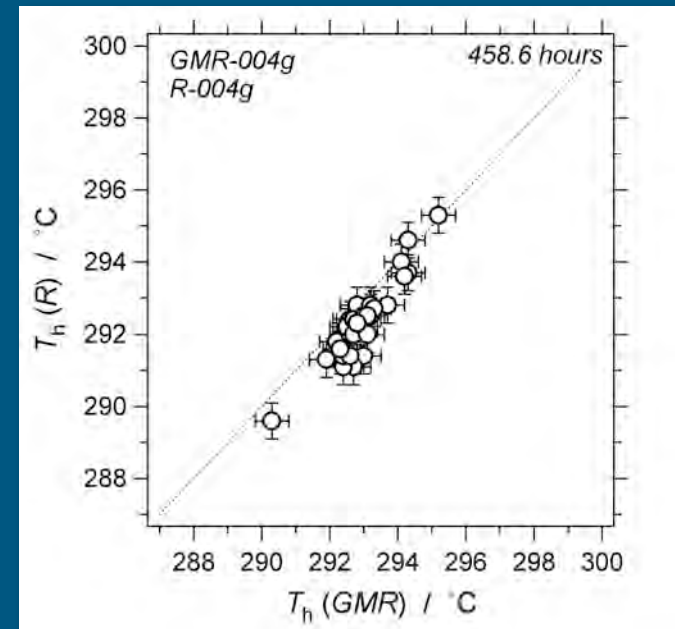
syn. H₂O



req. H₂O



Doppler et al. (2013, *Contrib. Mineral. Petrol.*, vol.165, 1259-1274)



Synthesis H₂O-NaCl fluid inclusions

Experimental conditions

10, 16.3, 19.8 mass % NaCl
600.6 ± 0.4 °C
336.3 ± 0.5 MPa
457.4 hours



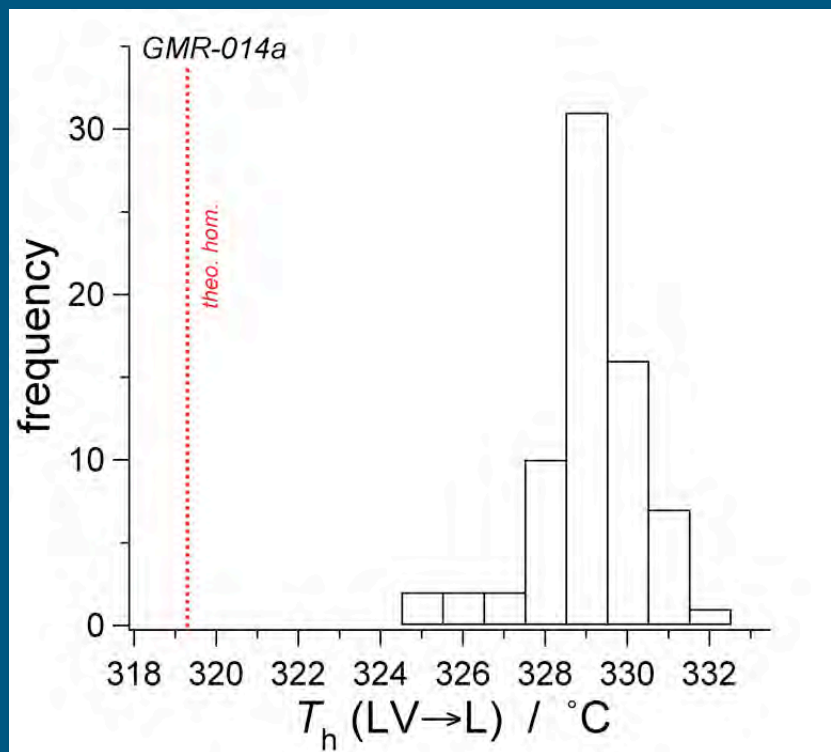
equation of state

Driesner (2007) program "AqSo DH"
www.fluids.unileoben.ac.at



Predicted $T_h = 319.3$ °C

H₂O-NaCl fluid inclusions in wonderland: part 1



Re-equilibration of H₂O-NaCl synthetic fluid inclusions

constant temperature and pressure:

pure H₂O environment

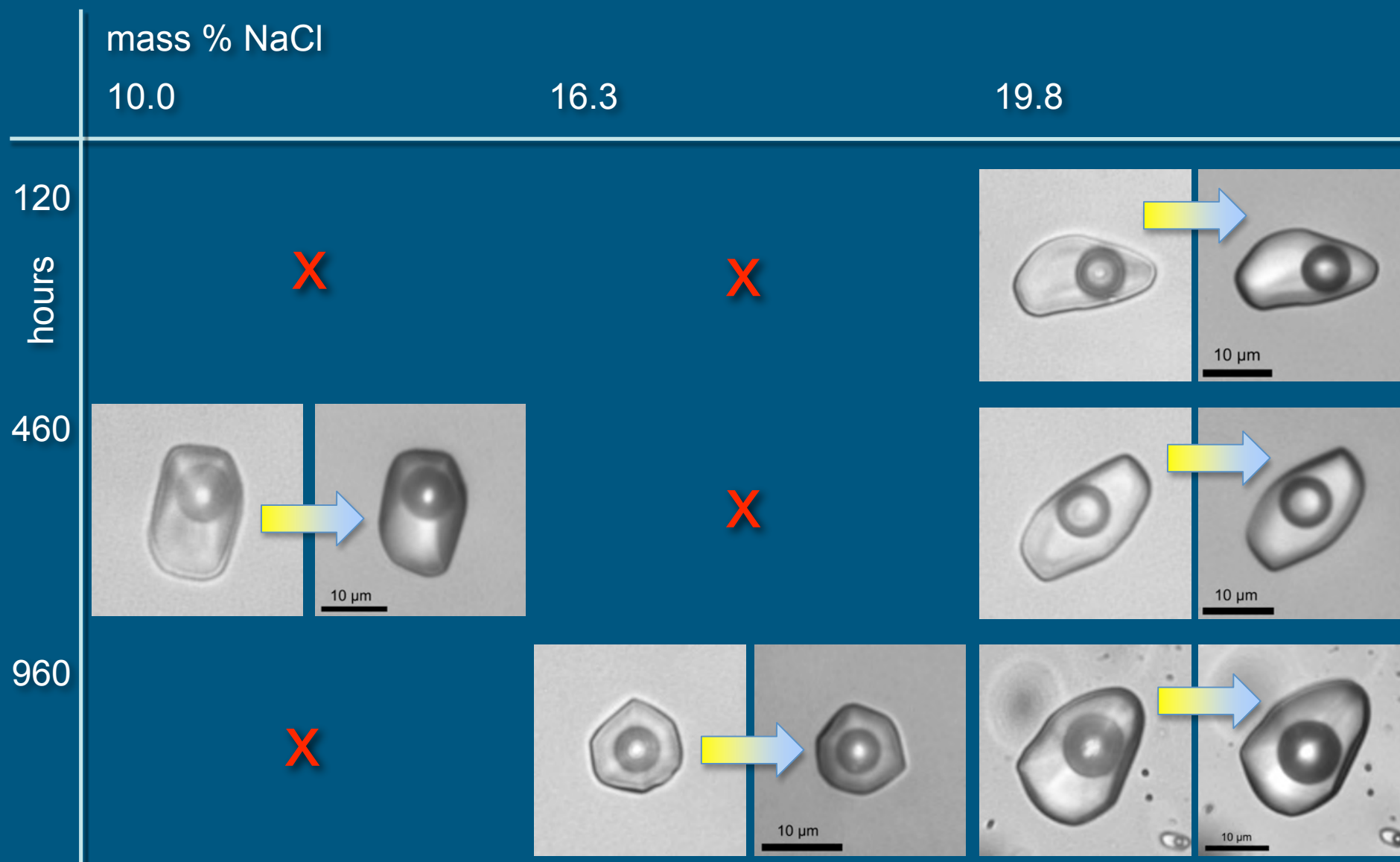
600 °C

337 MPa

gradients in water fugacity, $\Delta f(\text{H}_2\text{O})$

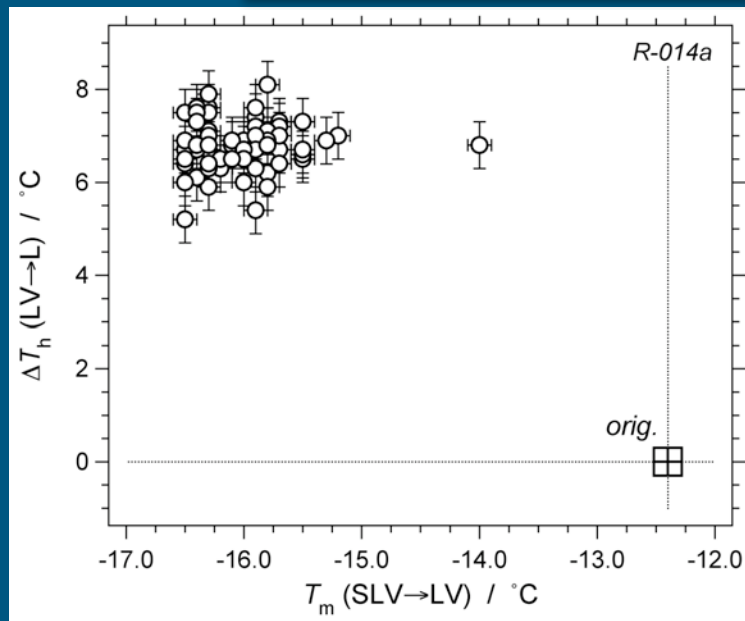
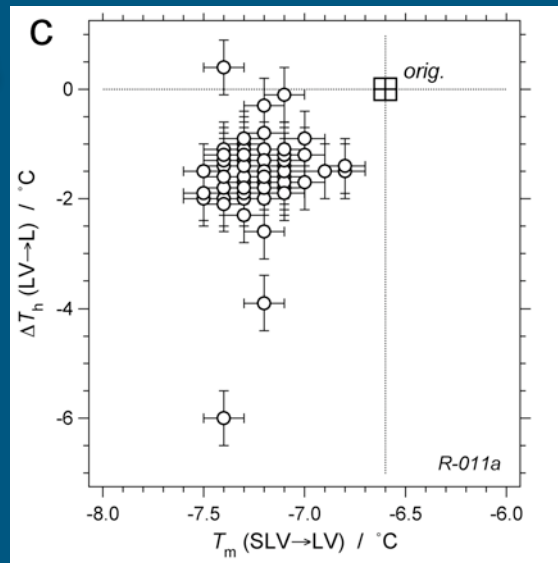
| | | mass % NaCl | | |
|-------|-----|--------------------|---------------------|---------------------|
| | | 10.0 | 16.3 | 19.8 |
| hours | 120 | X | X | R-005c -10.6 MPa |
| | 460 | R-011a -6.4 MPa | X | R-005a -12.6 MPa |
| | 960 | X | R-014a -10.7 MPa | R-005b -13.2 MPa |

Re-equilibration of H₂O-NaCl synthetic fluid inclusions

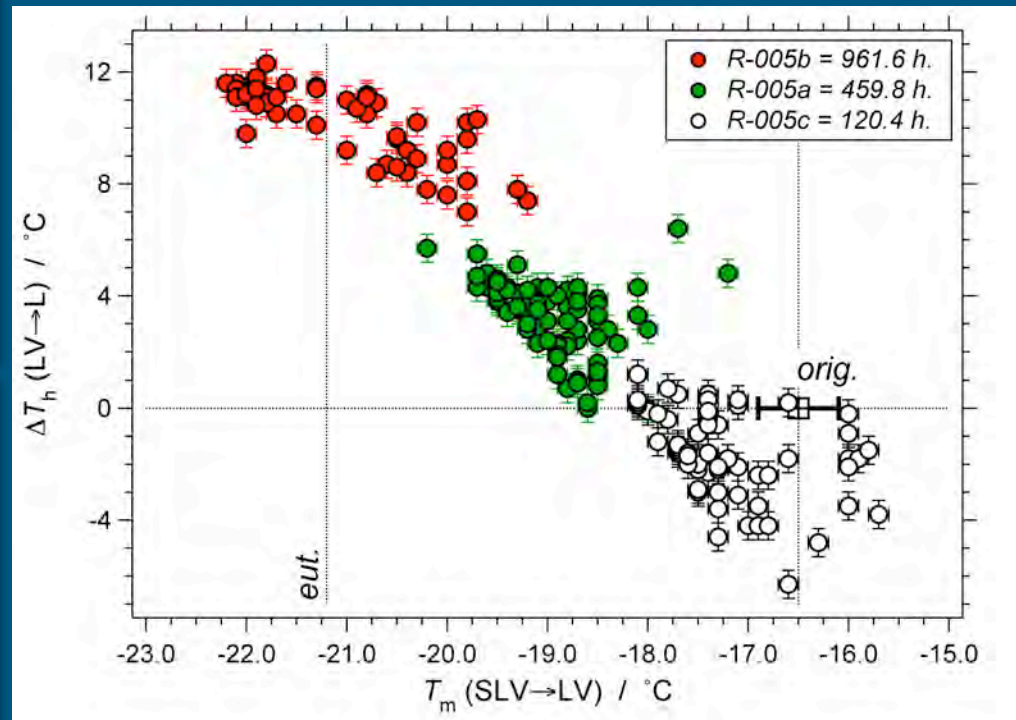


Re-equilibration of H₂O-NaCl synthetic fluid inclusions

10 mass%



microthermometrical modifications



19.8 mass%

16.3 mass%

Re-equilibration of H₂O-NaCl synthetic fluid inclusions

diffusion model

calculated with program "ReqDif" (Bakker, 2009)

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$$\Delta f = 0.0 \text{ MPa}$$



19.58 mass% NaCl

$$\Delta P = +23.5 \text{ MPa}$$

$$\Delta V_m = -1.3\%$$



$$T_m (\text{ice}) = -16.2 \text{ }^\circ\text{C}$$

$$T_h (\text{LV} \rightarrow \text{L}) = 315.6 \text{ }^\circ\text{C}$$

$$\Delta T_h = -8.7 \text{ }^\circ\text{C}$$

preferential H₂O leakage model

calculated with program "AqSo DH"

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| loss% | x(NaCl) | mass% | V_m | T_m | T_h |
|-------|---------|-------|--------|-------|-------|
| 0 | 0.07072 | 19.80 | 23.733 | -16.5 | 329.7 |
| 5 | 0.07417 | 20.63 | 24.890 | -17.6 | 361.5 |
| 10 | 0.07800 | 21.53 | 26.164 | -18.8 | 393.6 |
| 15 | 0.08218 | 22.51 | 27.577 | -20.2 | 427.9 |

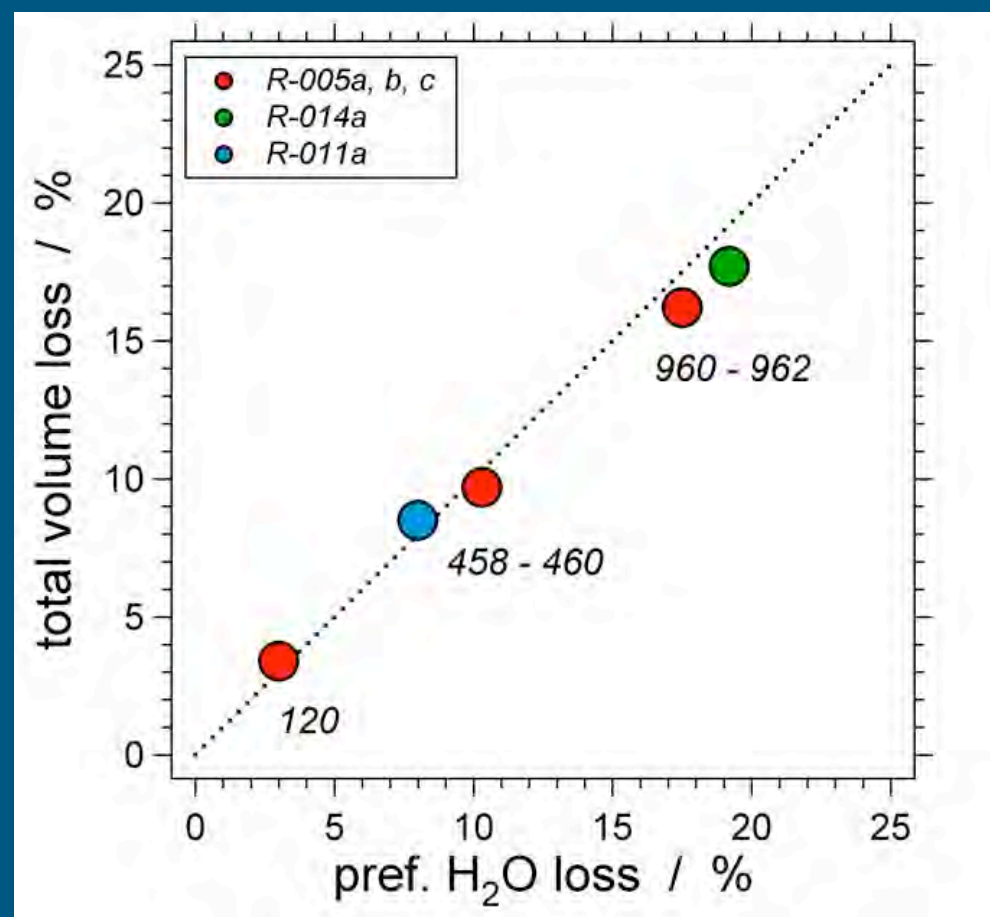
*H₂O-NaCl synthetic fluid inclusions
in wonderland part 2*

?

Re-equilibration of H₂O-NaCl synthetic fluid inclusions

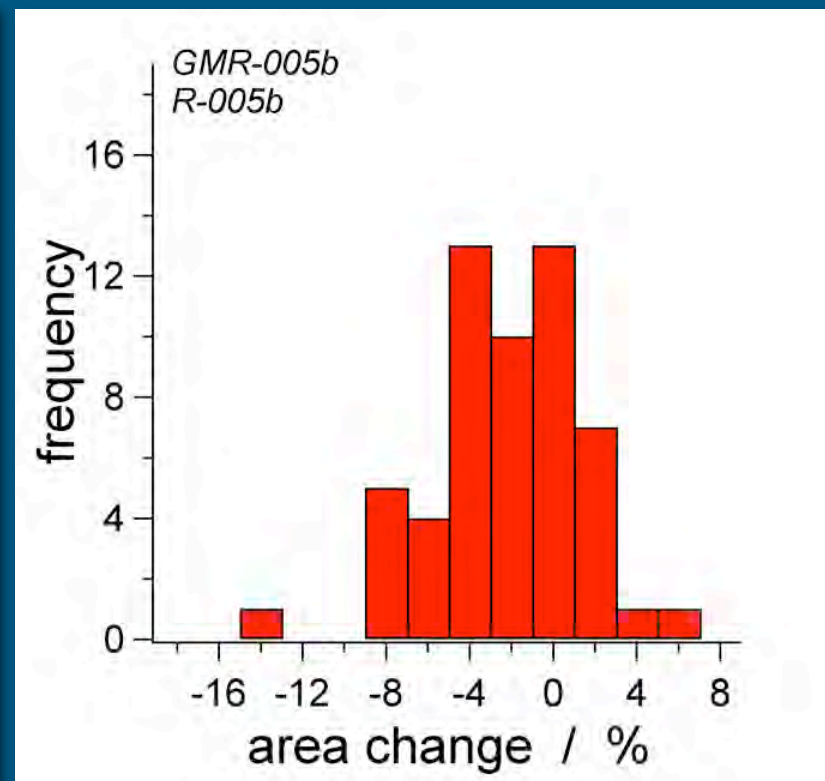
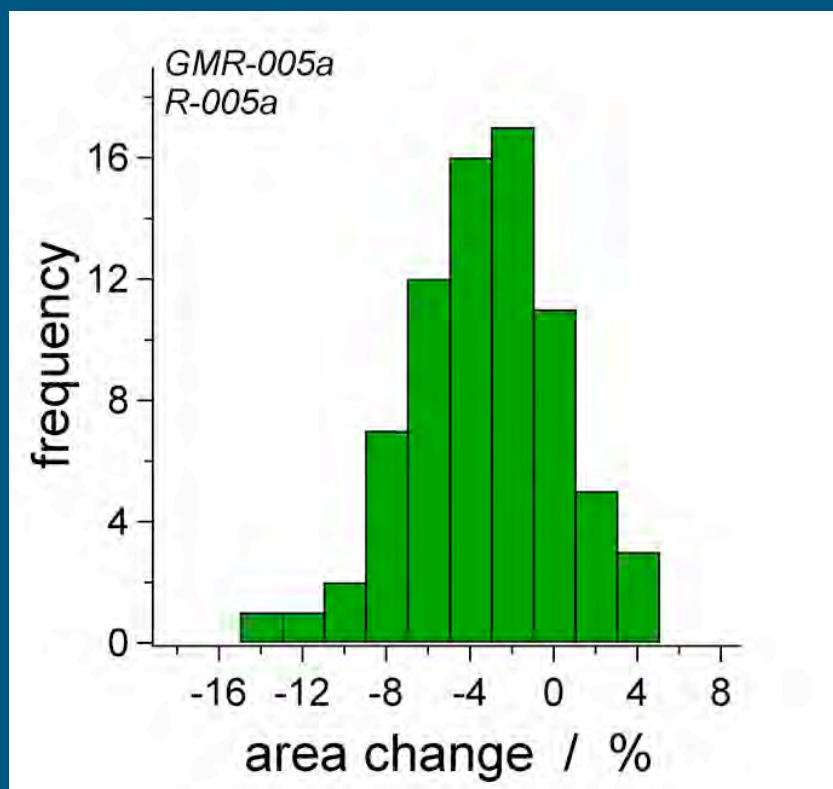
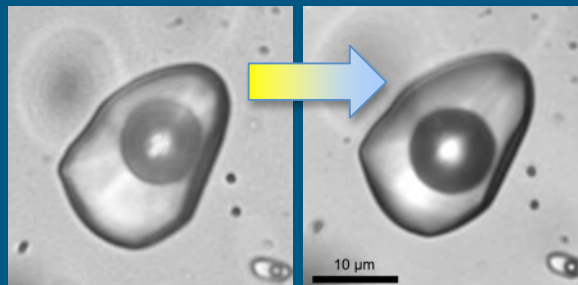
Are the observed T_m and corresponding T_h values consistent?

preferential leakage of H₂O
+
total volume decrease



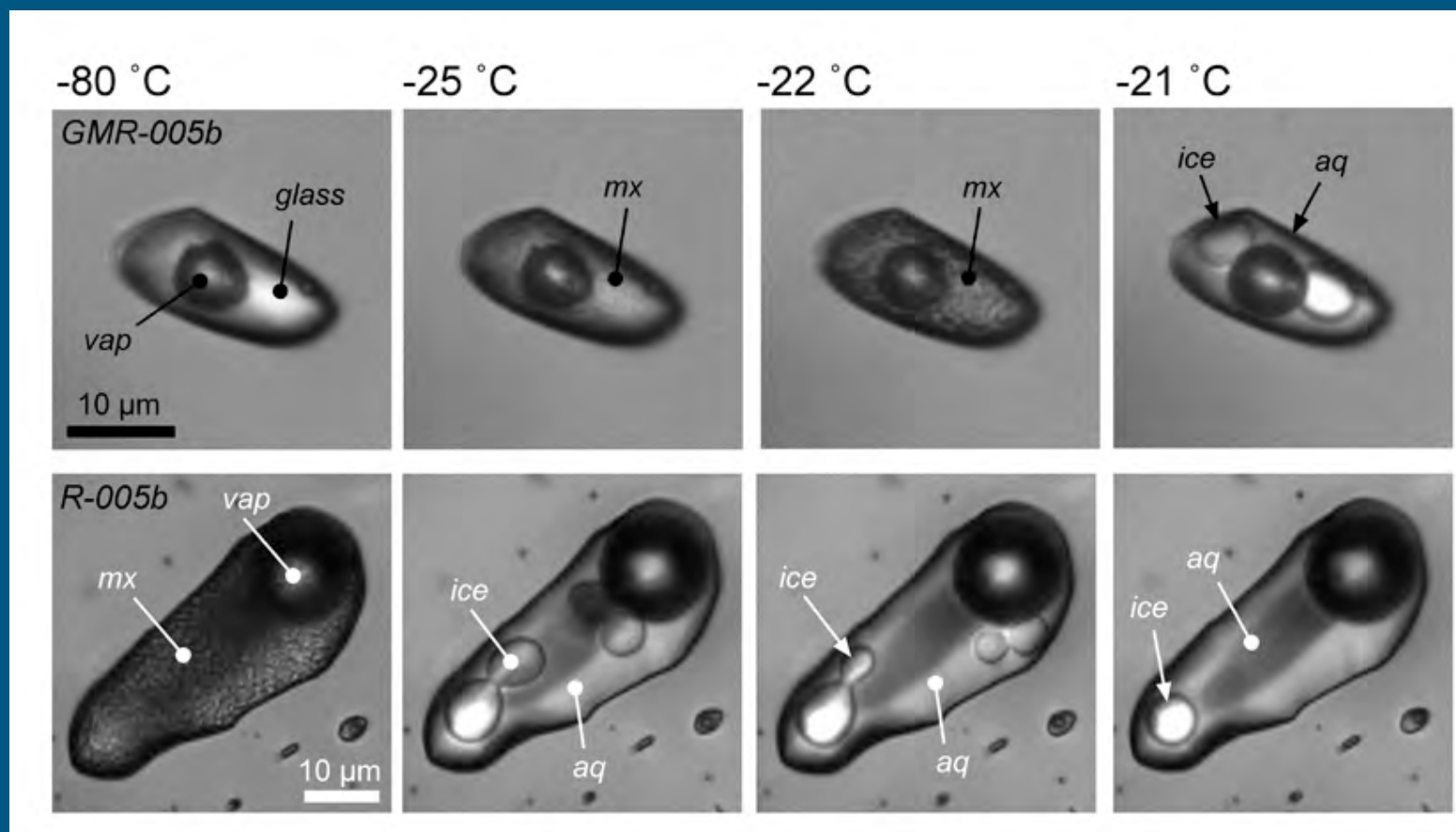
Re-equilibration of H₂O-NaCl synthetic fluid inclusions

total volume decrease?



Re-equilibration of H₂O-NaCl synthetic fluid inclusions

modified microthermometrical behaviour



H₂O-NaCl synthetic fluid inclusions in wonderland part 3

Conclusions

if diffusion leads to larger pressure gradients:
fugacity gradients are not the major driving force
in fluid inclusion modification

preferential H₂O-loss is the major process
for any modification scenario,
triggered by pressure gradients

H₂O-loss is combined with quartz (host material) „flow“
towards inclusions
(time dependent process)