Volcanic particle-ice interaction

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Importance of volcanic particle-ice interaction

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Dispersed particles — Thin layers of particles — Thick layer of particles

Debris-covered glaciers

?

Julio-Miranda et al. (2008)

Important for prediction of future trends of ice loss and subsequent impacts (e.g. water supply, changes to ecosystems, etc.).

Laboratory experiments investigated the behaviour of

- volcanic particles on an ice surface
- volcanic particle movement once within an ice system.

Methods

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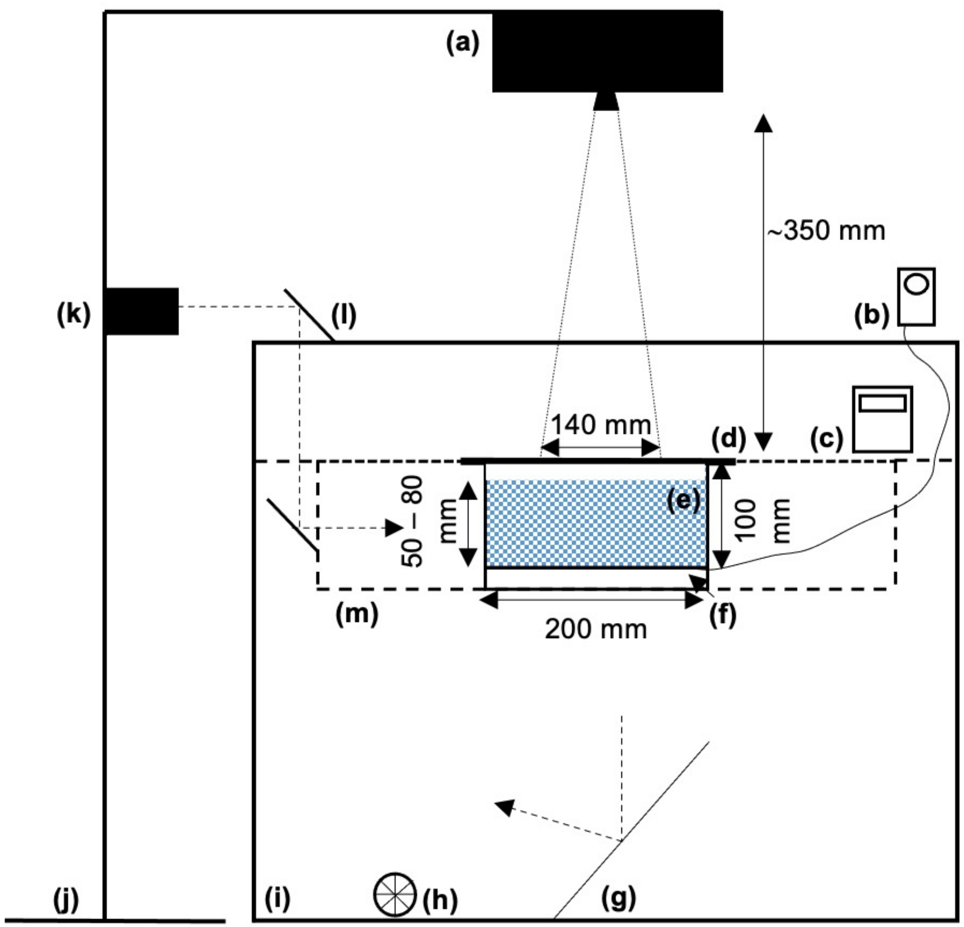


(a) 80 W white LED bulb with projector as artificial radiation source

(b) RS-1316 dual data logger thermometer with type 'K' thermocouple to monitor proxy-ice temperature

(c) Thermo Pro humidity and temperature monitor to measure freezer temperatures

(d) Glass cover to prevent sublimation

(e) Clean ice block suspended approximately 0.5 m above freezer floor

(f) Plastic stand for ice block

(g) Angled mirror to prevent direct reflection off the freezer floor back onto the ice block

(h) Fan to disrupt the thermal stratification of the freezer

(i) Chest freezer

(j) Stand

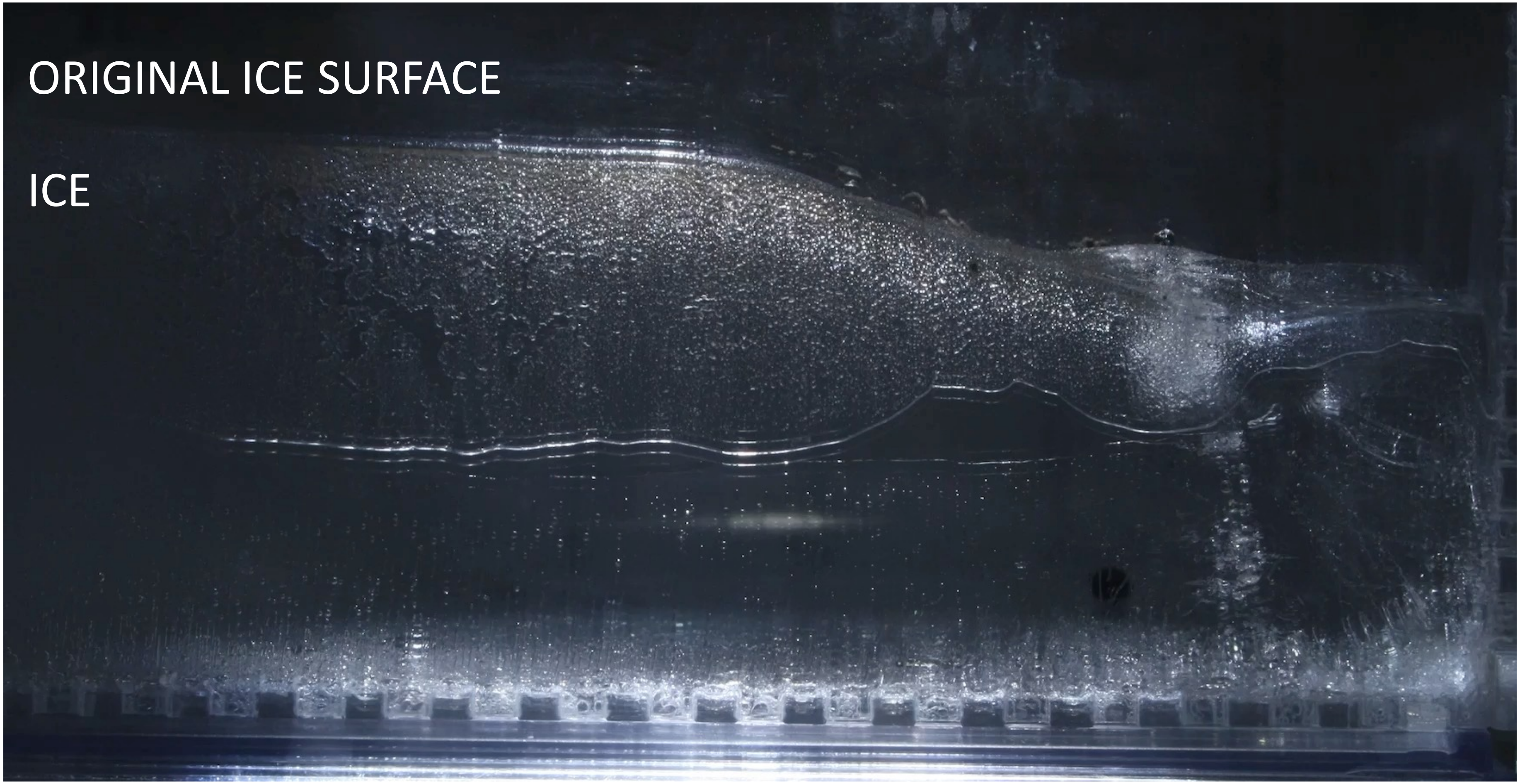
(k) Canon (EOS D50D) camera taking time-lapse imagery (every 5 minutes)

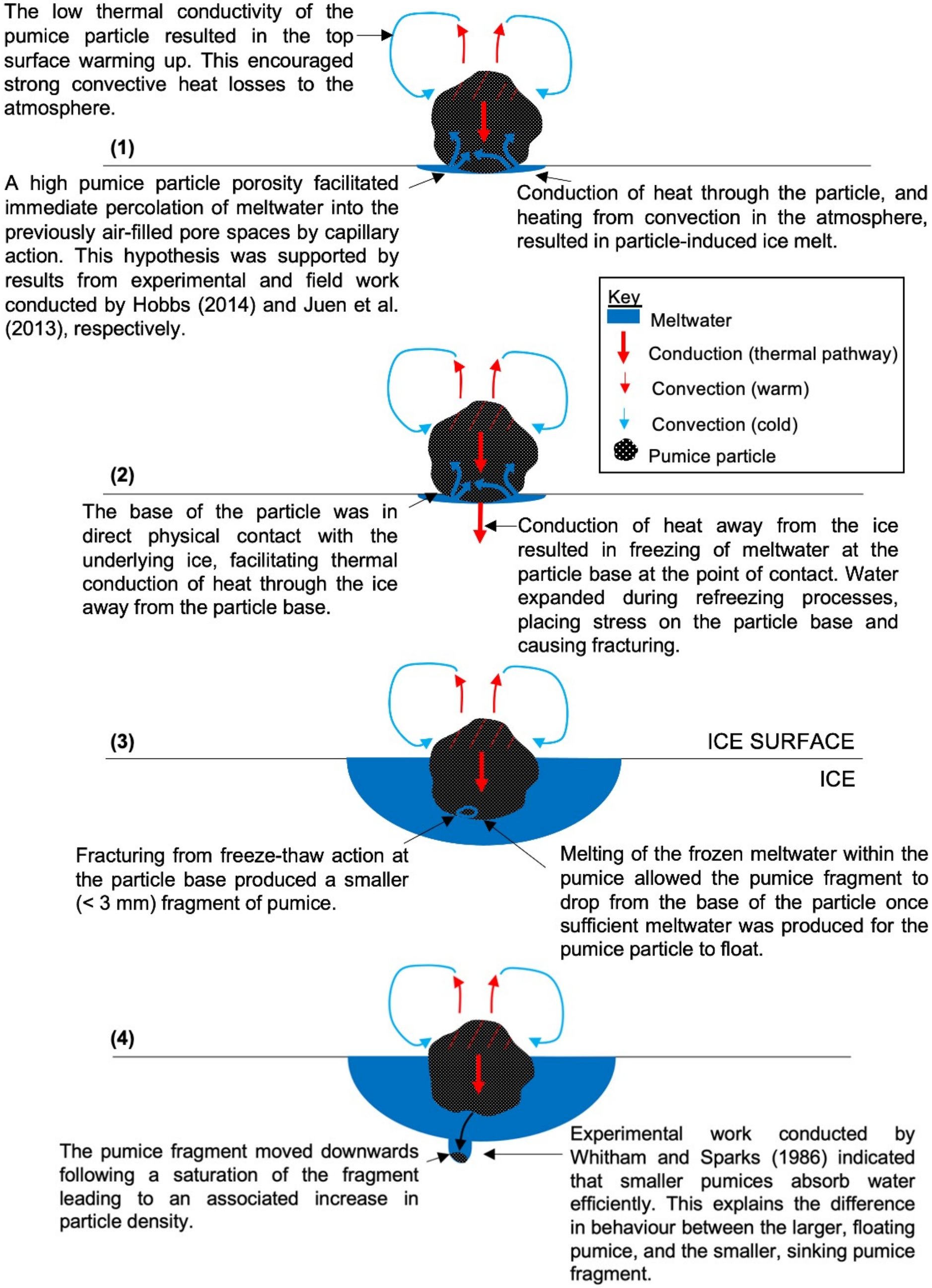
(l) Mirrors to act as a periscope system so that the cross-section of the ice block can be captured

(m) Wire shelf

Figure 1. Diagram indicating the experimental set up, where 'LED' is light-emitting diode, and 'W' is Watts.

E.g. a scattering of basaltic-andesitic scoria particles (< 3 mm)





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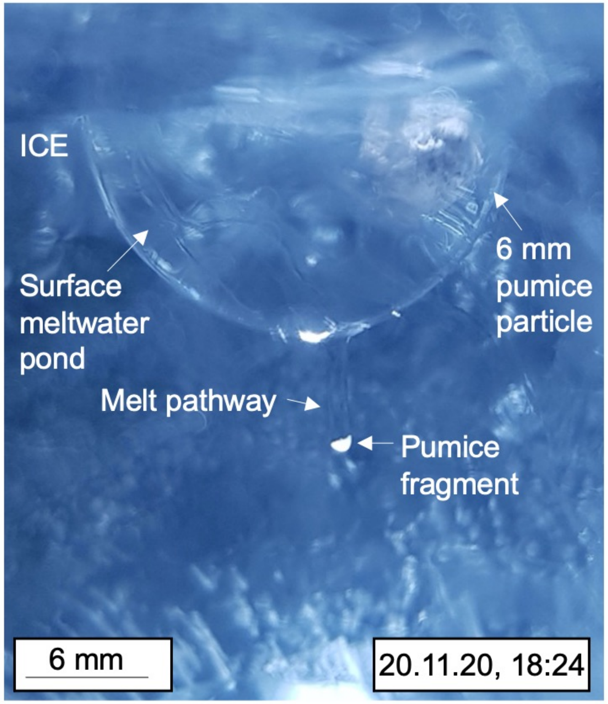


Conclusions

- Strong convection systems associated with embedded volcanic particles with a low thermal conductivity
- Multiple focal points of melting
- Fragmentation of particles is common
- A single volcanic particle is rarely a 'single' particle
- Volcanic material can effectively melt an ice system

Thank you for attending, any questions?

Results: (1) melt pathway

- A particle absorbs incoming radiation and transfers heat into the ice to cause ice melt. A high density particle moves downwards in meltwater to create a ‘melt pathway’ (Fig. 2).

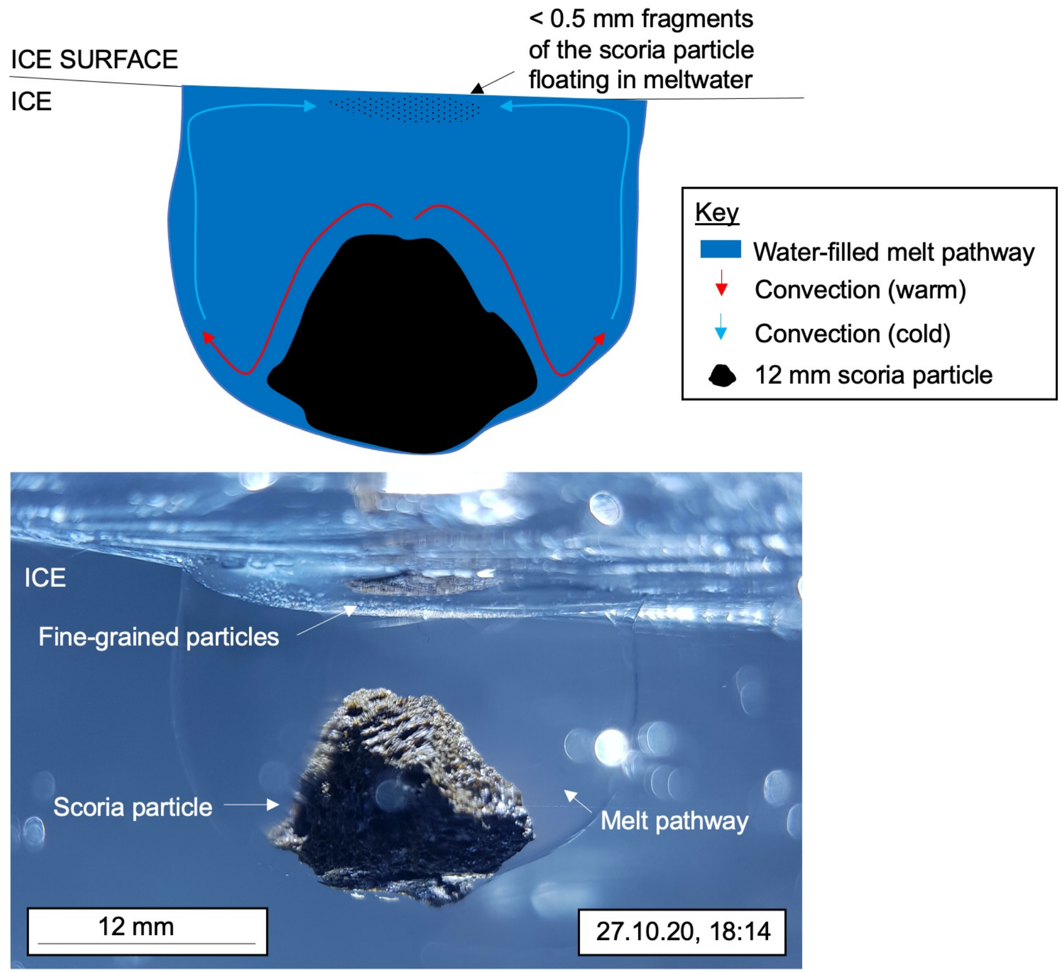
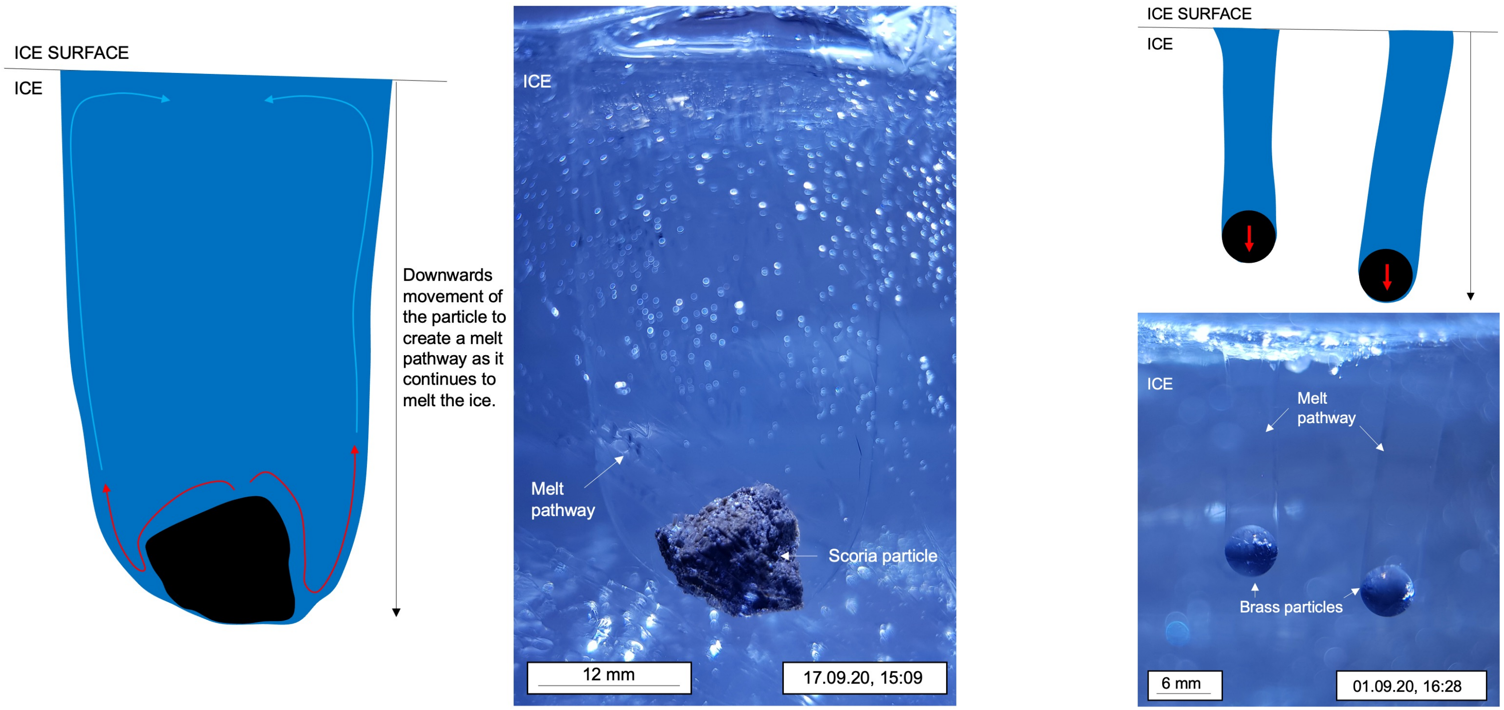


Figure 2. Line drawing and photograph of 12 mm scoria particle moving downwards into the ice and associated melt pathway.

Results: (1) melt pathway

(a) **Wide melt pathway associated with low thermal conductivity.**

(b) **Narrow melt pathway associated with high thermal conductivity.**



Key

- Water-filled melt pathway
- Conduction (thermal pathway)
- Convection (warm)
- Convection (cold)
- 12 mm scoria particle
- 6 mm brass particle

Figure 3. Line drawing and photograph of (a) a 12 mm scoria particle and (b) a 6 mm brass particle and the associated melt pathways.

Results: (2) a multiple particle system

- Downwards moving particle creates a melt pathway and basal meltwater pond – embedded particles moving through ice system.
- Fine-grained (e.g. <0.5 mm) volcanic particles shed from the ’large’ particle to float in meltwater and create a surface meltwater pond – surface particles, melting → runoff.

= large volume of melt, despite refreezing conditions

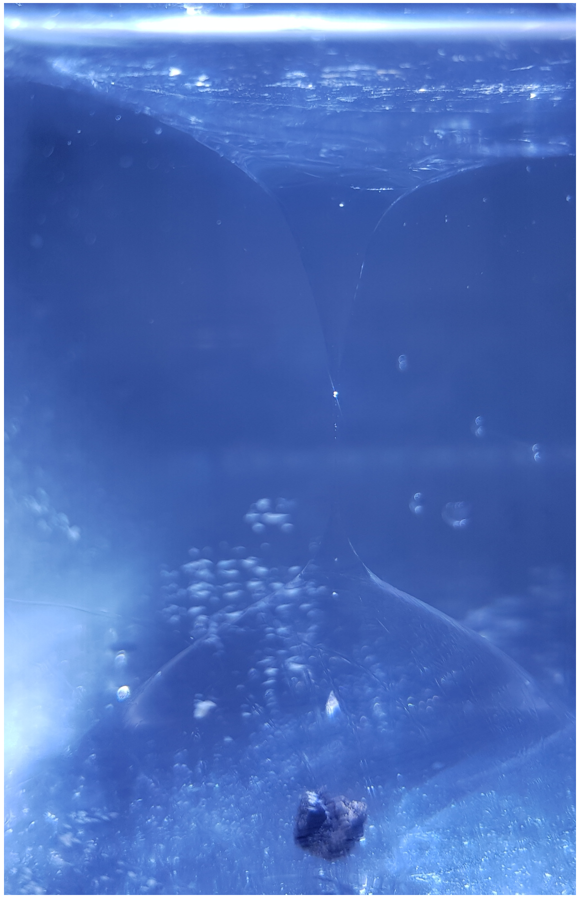


Figure 5. Photograph of 6 mm scoria particle and fine-grained material. Refreezing of melt pathway is noted.

Results: (3) particle fragmentation

- Observed with cemented ash clusters from Eyjafjallajökull, Iceland (Fig. 6).

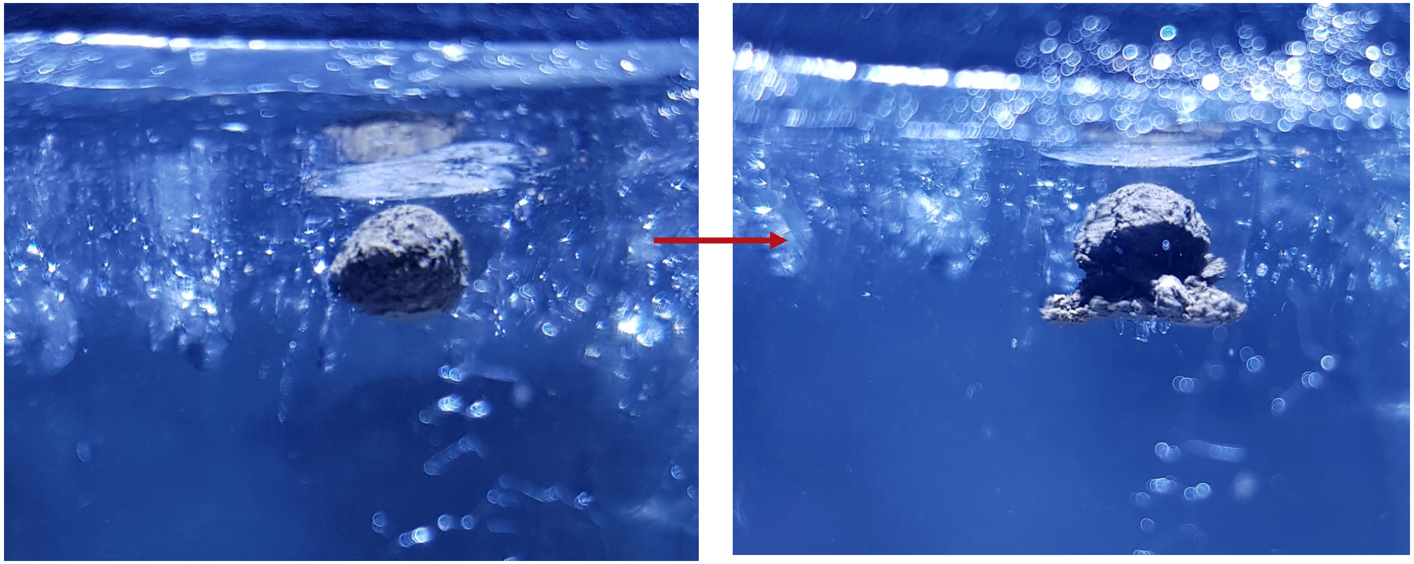


Figure 6. Photographs of disintegration of a 6 mm cemented ash cluster, where (a) is prior to disintegration and (b) is during disintegration.

Results: (3) particle fragmentation

- Observed with pumice from Mt. St. Helens, USA (Fig. 7).

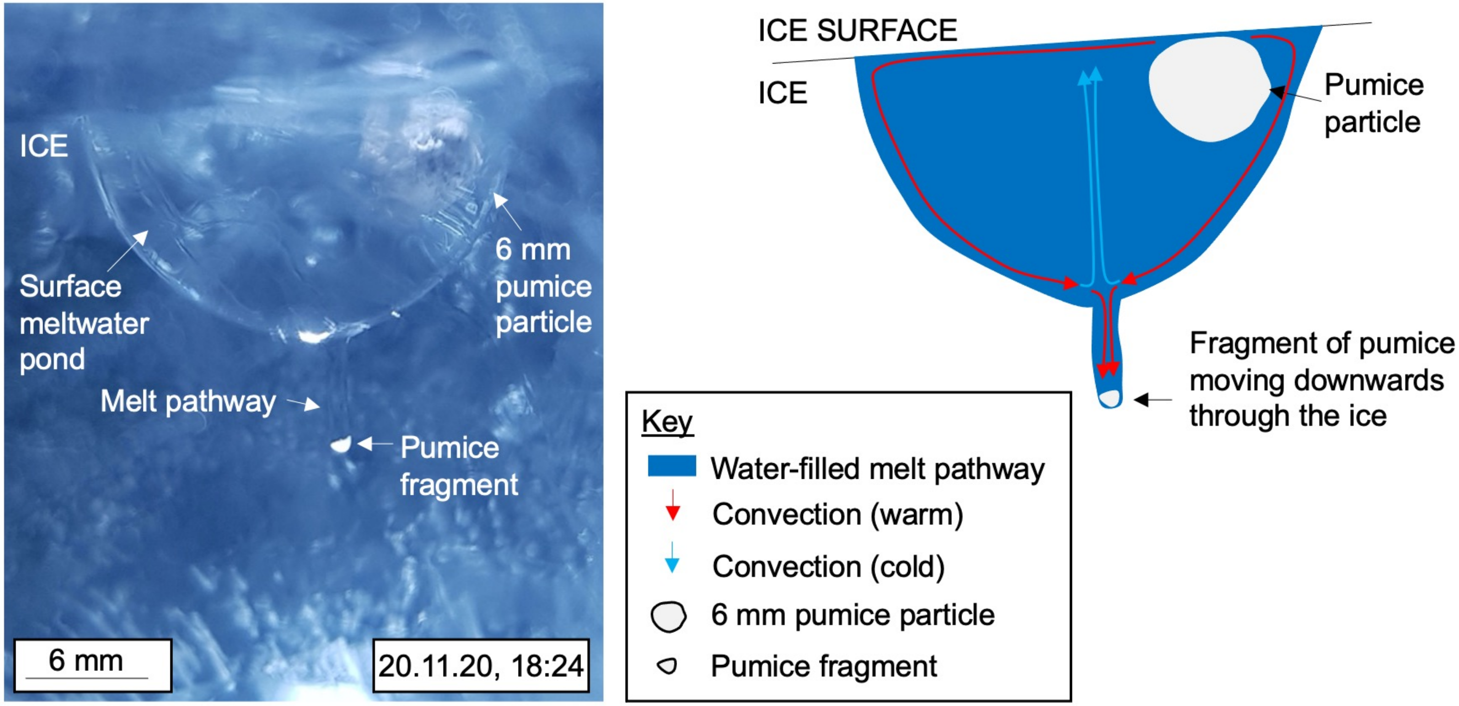


Figure 7. Photograph and line drawing of the fragmentation of a 6 mm pumice particle floating in a surface meltwater pond.

Results: (3) particle fragmentation

- Observed with scoria from Sollipulli, Chile (Fig. 8).

Figure 8. Photograph of fragmentation of a 12 mm scoria particle.

Results: (4) particle interception with ice vein network

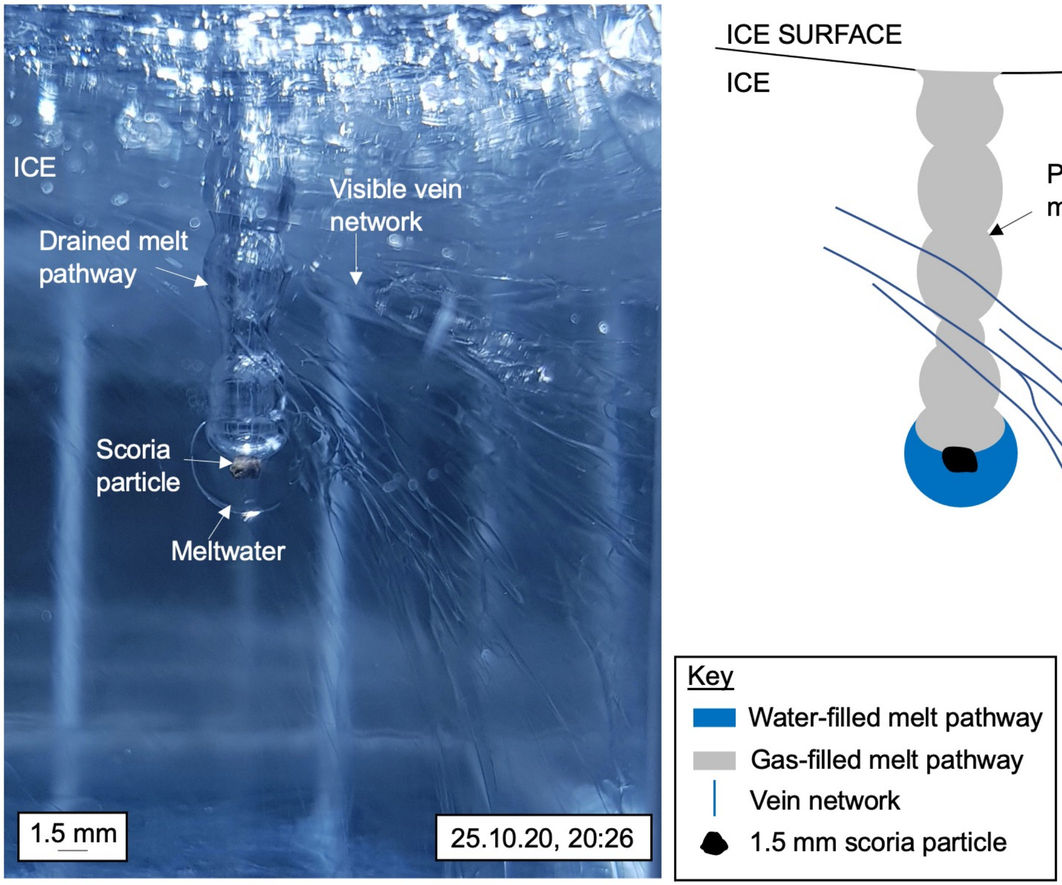


Figure 4. Photograph and line drawing of a 1.5 mm scoria particle within a drained melt pathway.