Project ArtFisH: how erupting a ton of wax through an artificial fissure will help us learn about the first phases of Auckland's next eruption

Rosie Cole & James White

M. Hamish Bowman, Tobias Dürig, Brent Pooley, Shane J. Cronin, Magnús T. Guðmundsson, Graham S. Leonard, Greg A. Valentine

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND


Photovolcanica.com

Figure 2. Ubehebe Craters, California, shows a line of craters, one with a cone in it. The biggest crater formed last; the start of the eruption produced high fountains, rather than explosions. At Aljojuca, Mexico, volcanic cones and a large crater are aligned. Underground these were fed molten rock through a single crack, and the lake-filled crater would have formed where the crack extended so that molten rock interacted with groundwater.

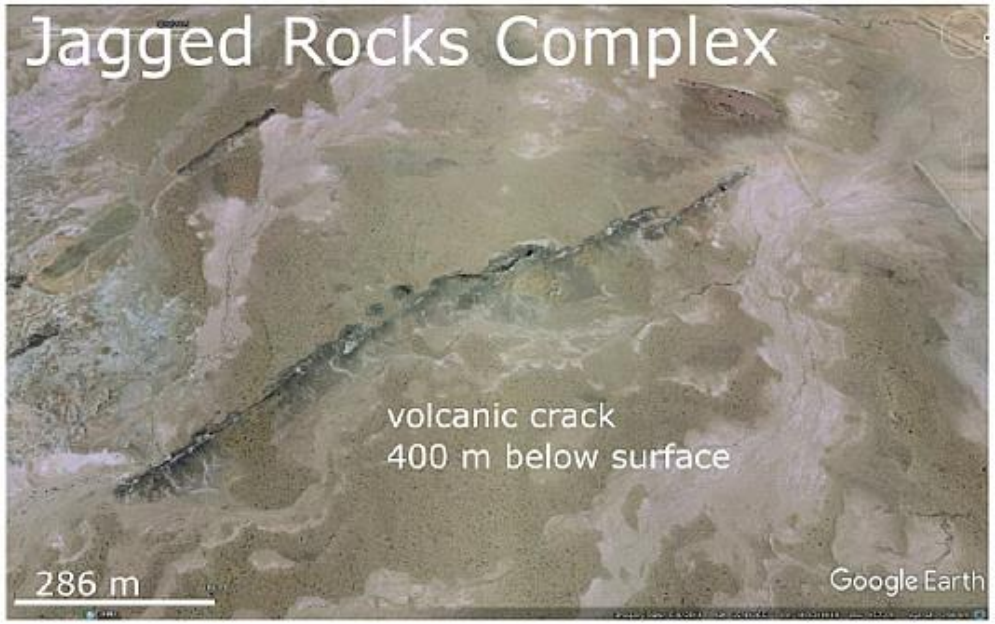
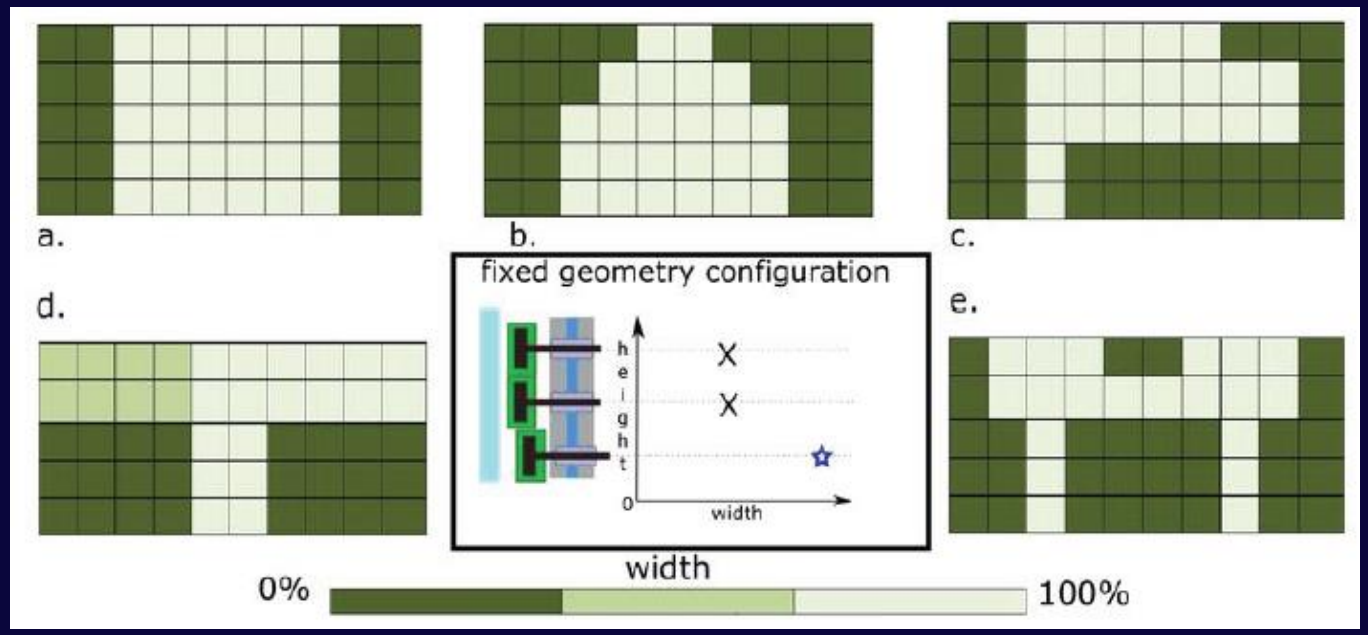
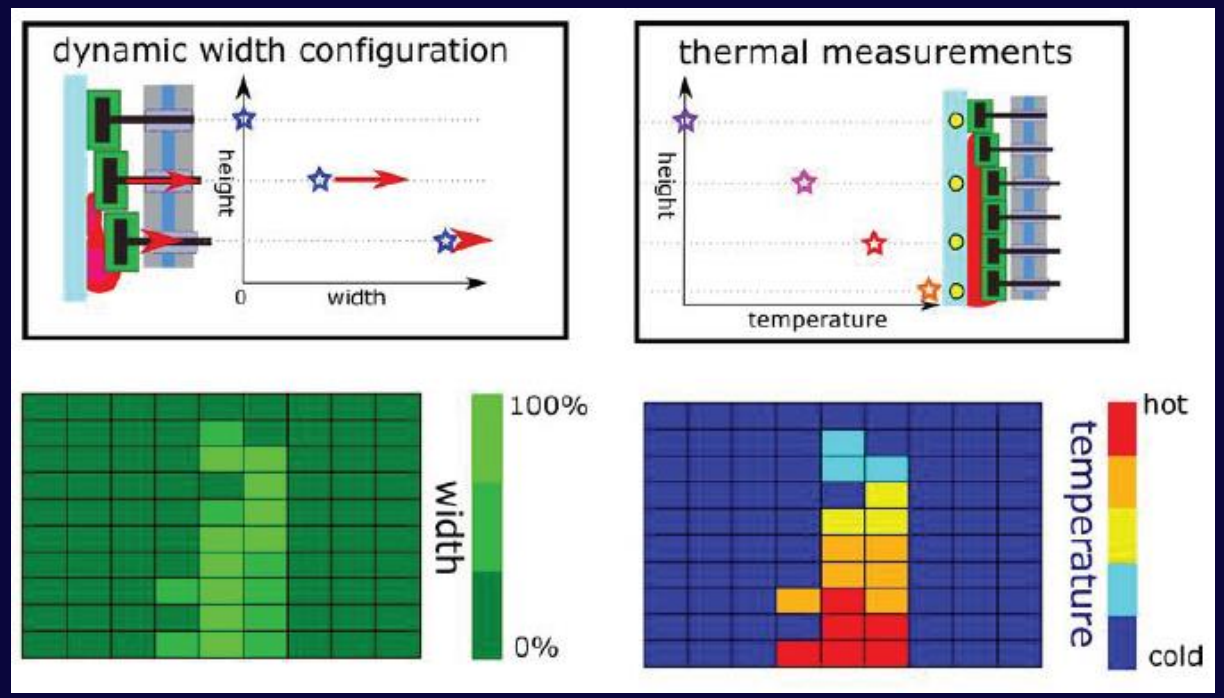


Figure 3. Top, a set of elongate craters, aligned, with small subcraters, in Australia. These formed where molten rock rose through a crack, and rock cooled in a similar crack, illustrated at the same scale, preserves crack details at Jagged Rocks (bottom)

See any potential fissure-aligned vents? Some are known to be single eruptions, others reliably distinct age, others unknown



Experimental Series 2. Fissure operated in fixed-geometry configurations. Before wax injection the fissure-wall segments are set for parts of the fissure to be open, closed, or intermediate. In panel (a), for example, wax will rise up a parallel-sided vertical slot; in (d), up a narrow slot where it has a narrow slot to the left, and a full-width one to the right. Only examples shown – many configurations possible.



Operation of fissure in dynamic-width mode; may be combined with a partial fixed-geometry configuration, e.g. to deliver wax at centre base. Before wax injection the dynamic segments are closed, then entering wax exerts pressure against the walls to force them apart as wax flows between. Changing wax flow alters pressure, and walls forced apart may either remain in place (inelastic opening), or move back inward as pressure falls (elastic opening; see Figure 5). At right the acquisition of thermal data is shown, for the same time as represented for width.

ArtFisH

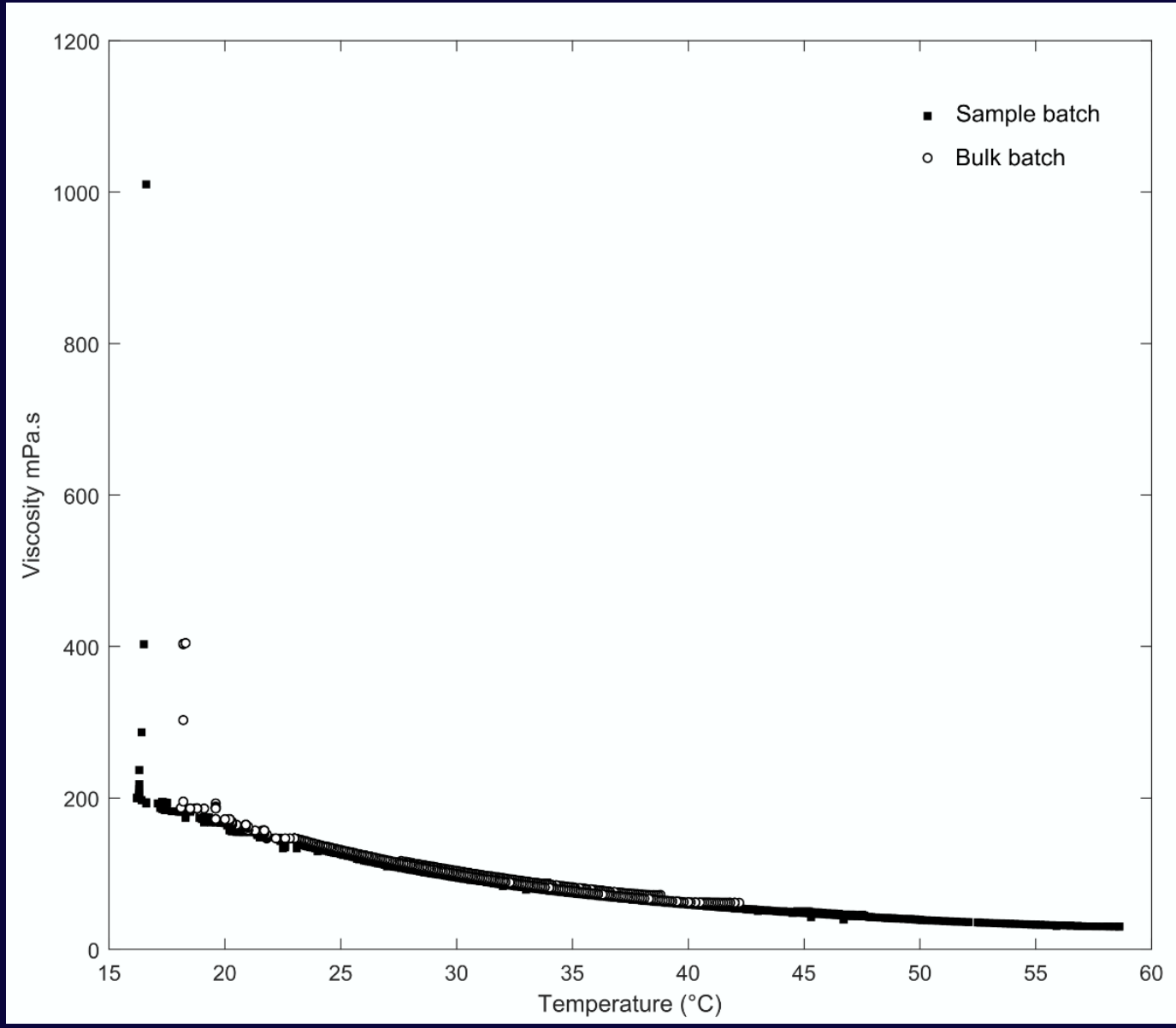
Artificial Volcanic **Fis**sure for **H**ot-wax Analysis of Thermal Feedback and Conduit Initiation

The wax: Polyethylene glycol (PEG) 600

Melting temperature ~ 22 °C

Temperature-dependent viscosity

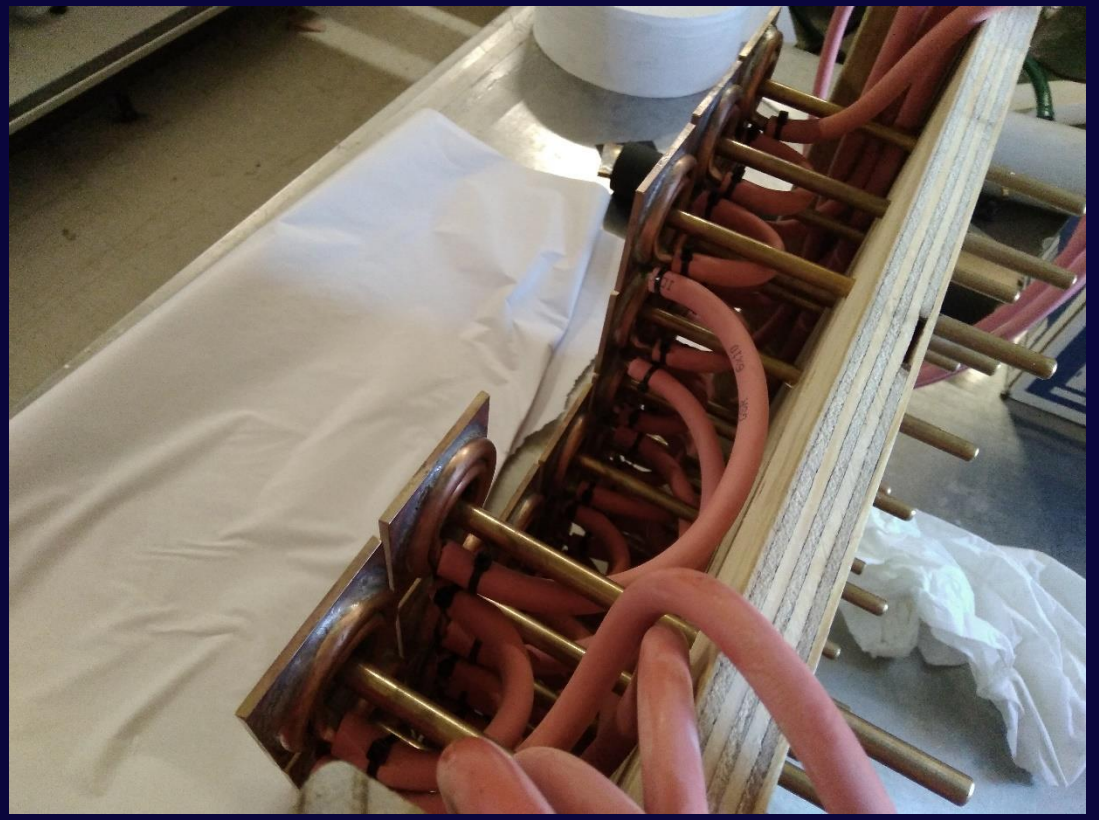
Common lava/magma analogue fluid



Prototype - smArtFish

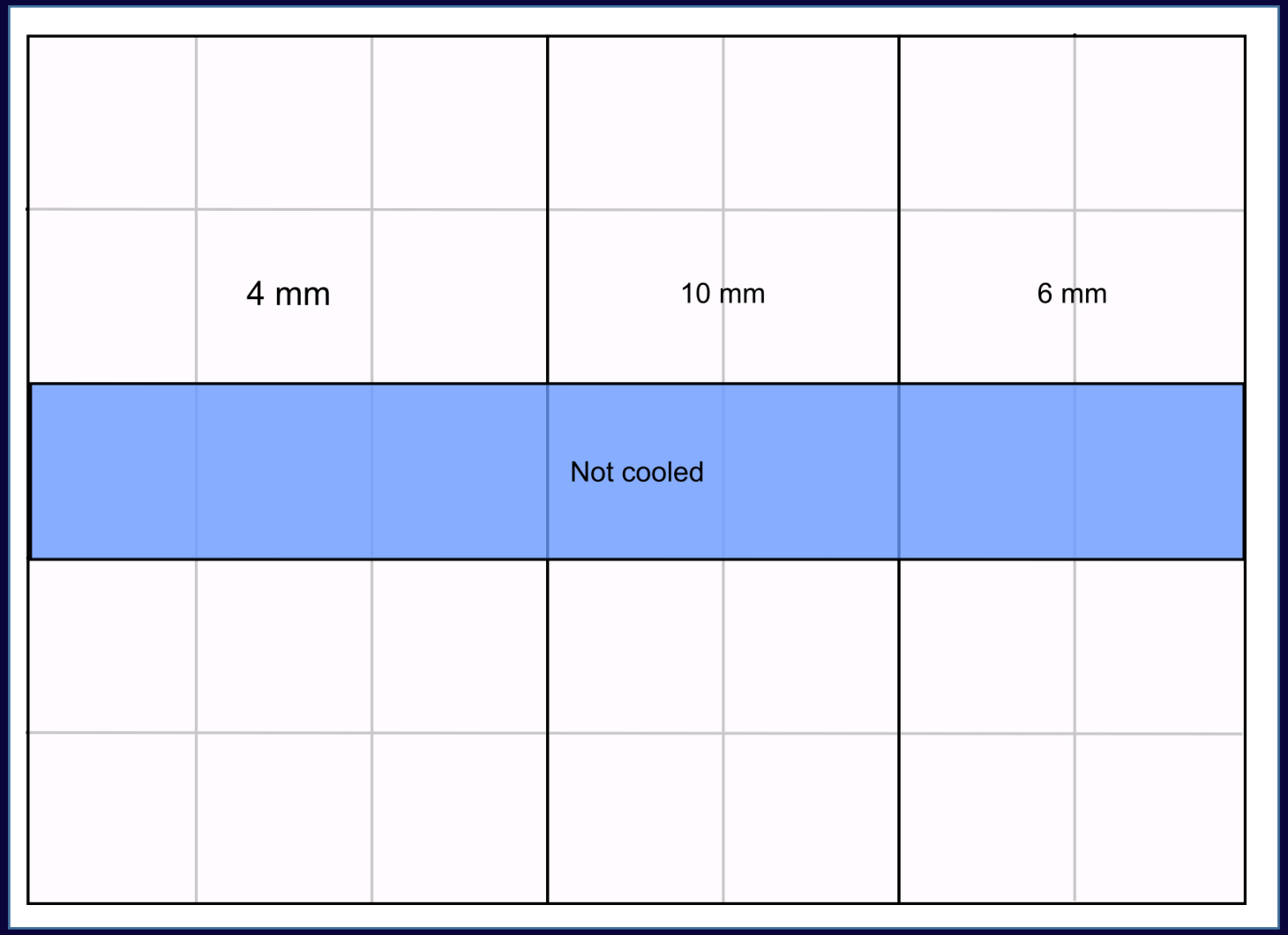
Adjustable fissure width and shape

Adjustable wall temperature

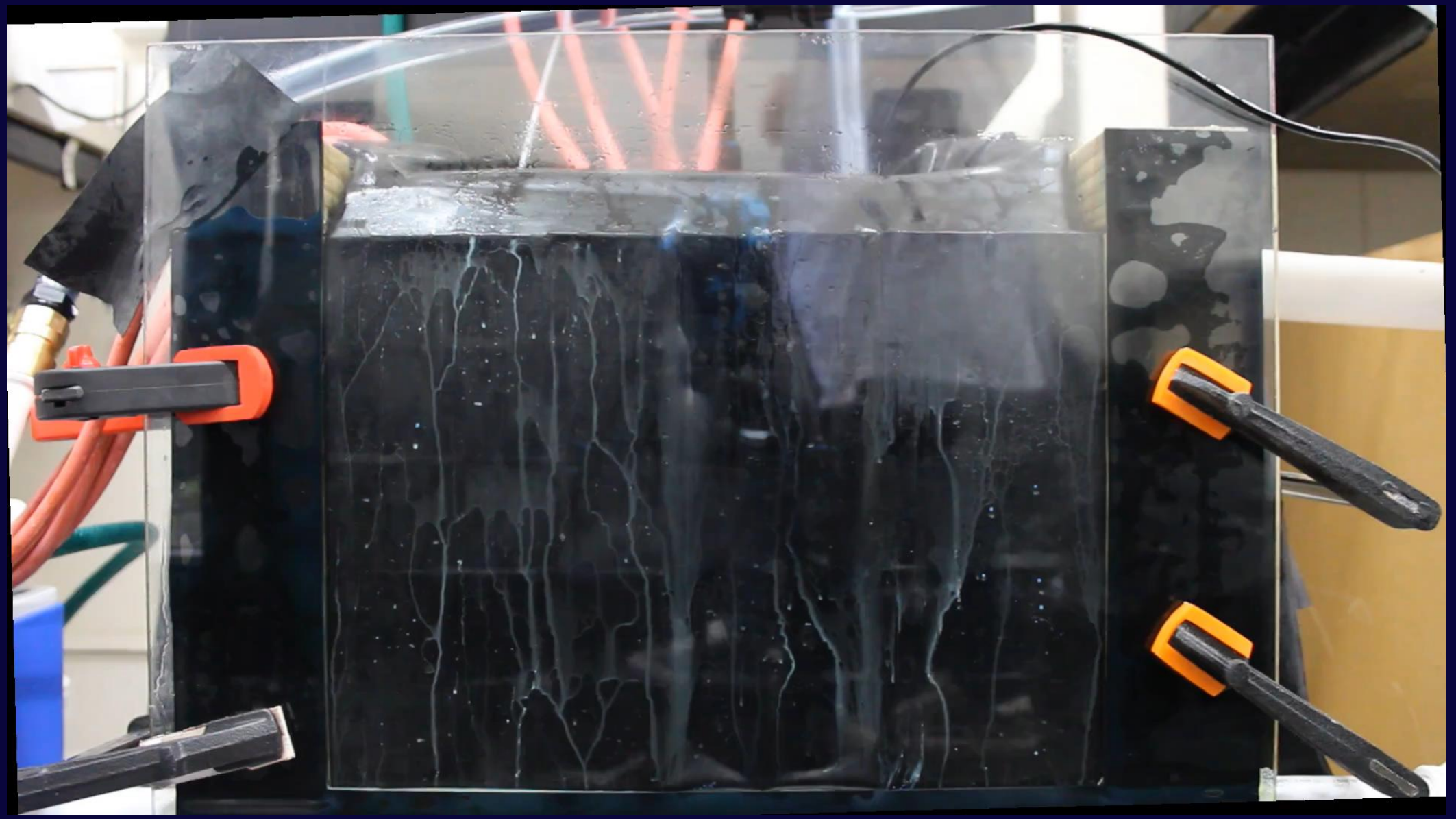


Initial tests: variable temperatures

Initial tests: variable widths



Initial tests: variable widths



Scaling up and scaling to nature

Aspect ratio: $\frac{H}{w}$

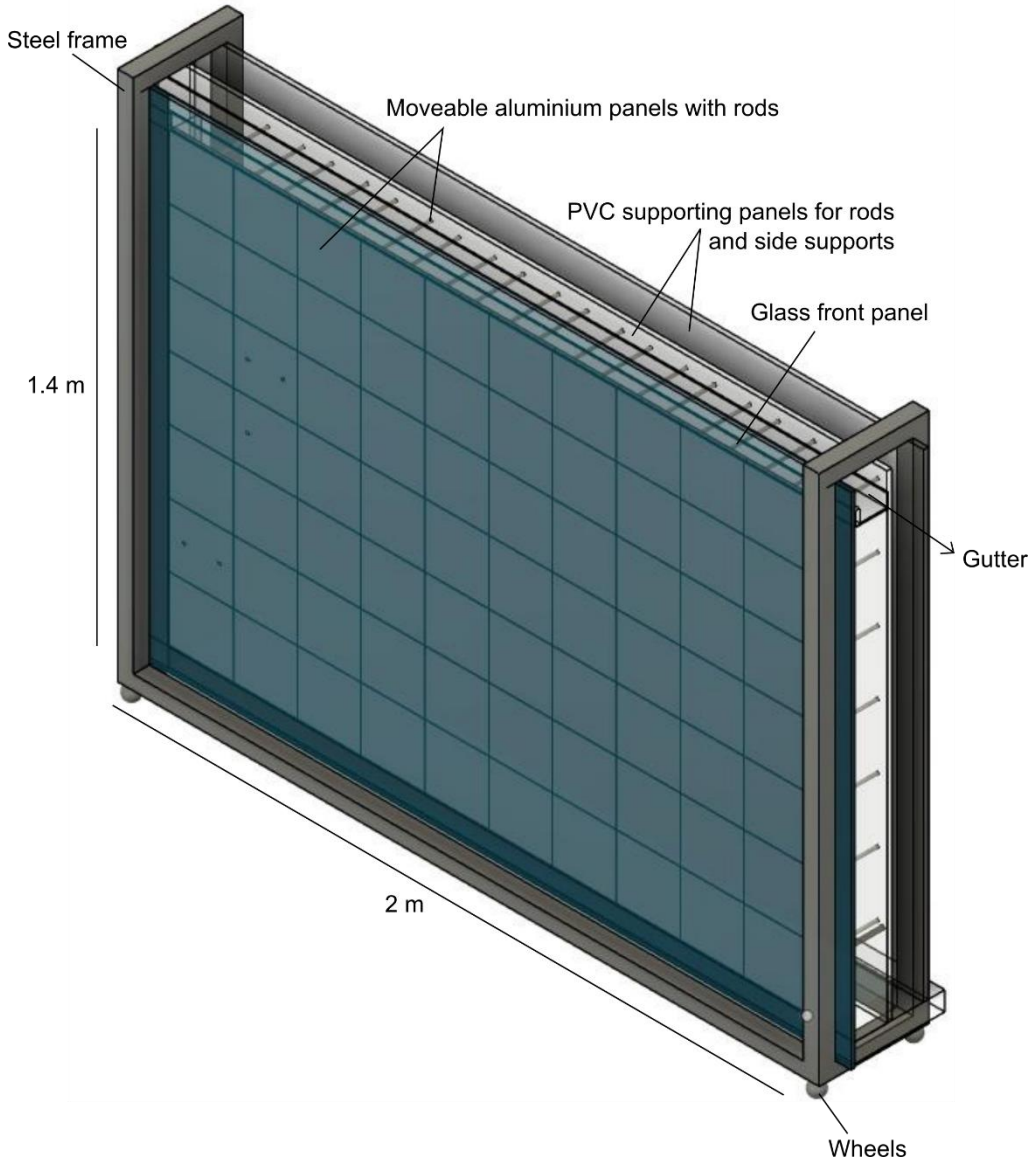
Dimensionless T: $\frac{Ts - Tw}{Tm - Tw}$

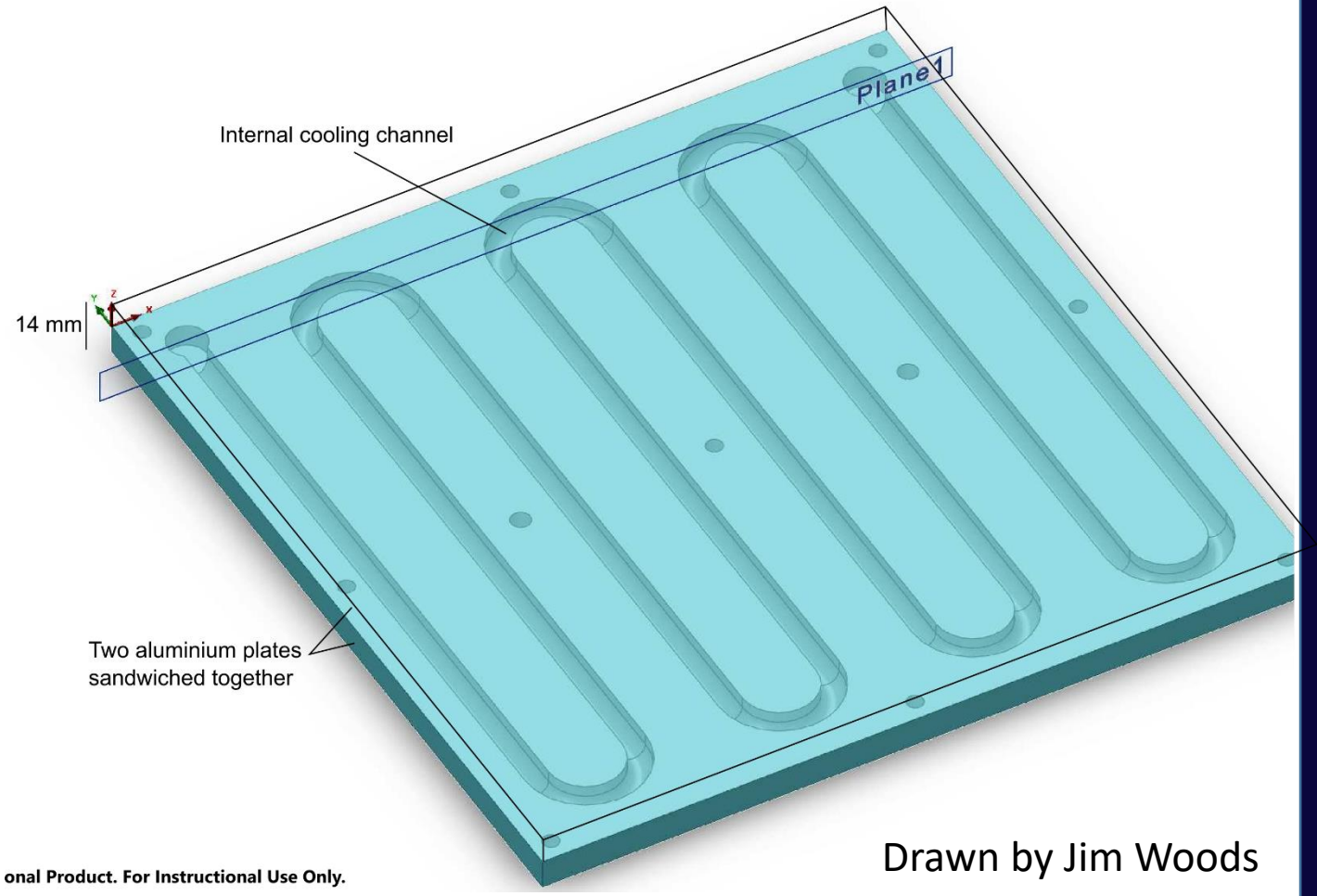
Peclet number: $\frac{v\rho Cw}{k}$

Reynolds number: $\frac{v\rho w}{\mu}$

Dimensionless parameters	**Nature**	**Experiment**
Peclet number Pe	2.4 x10^4 - 9.8 x10^6	0.6 - 460
Reynolds number Re	2.6 - 1620	0.6 - 11
Dimensionless temperature T*	0.7 - 1.2	0.7 - 0.8
Aspect ratio	300 - 20000	150 - 300

ArtFisH





Drawn by Jim Woods

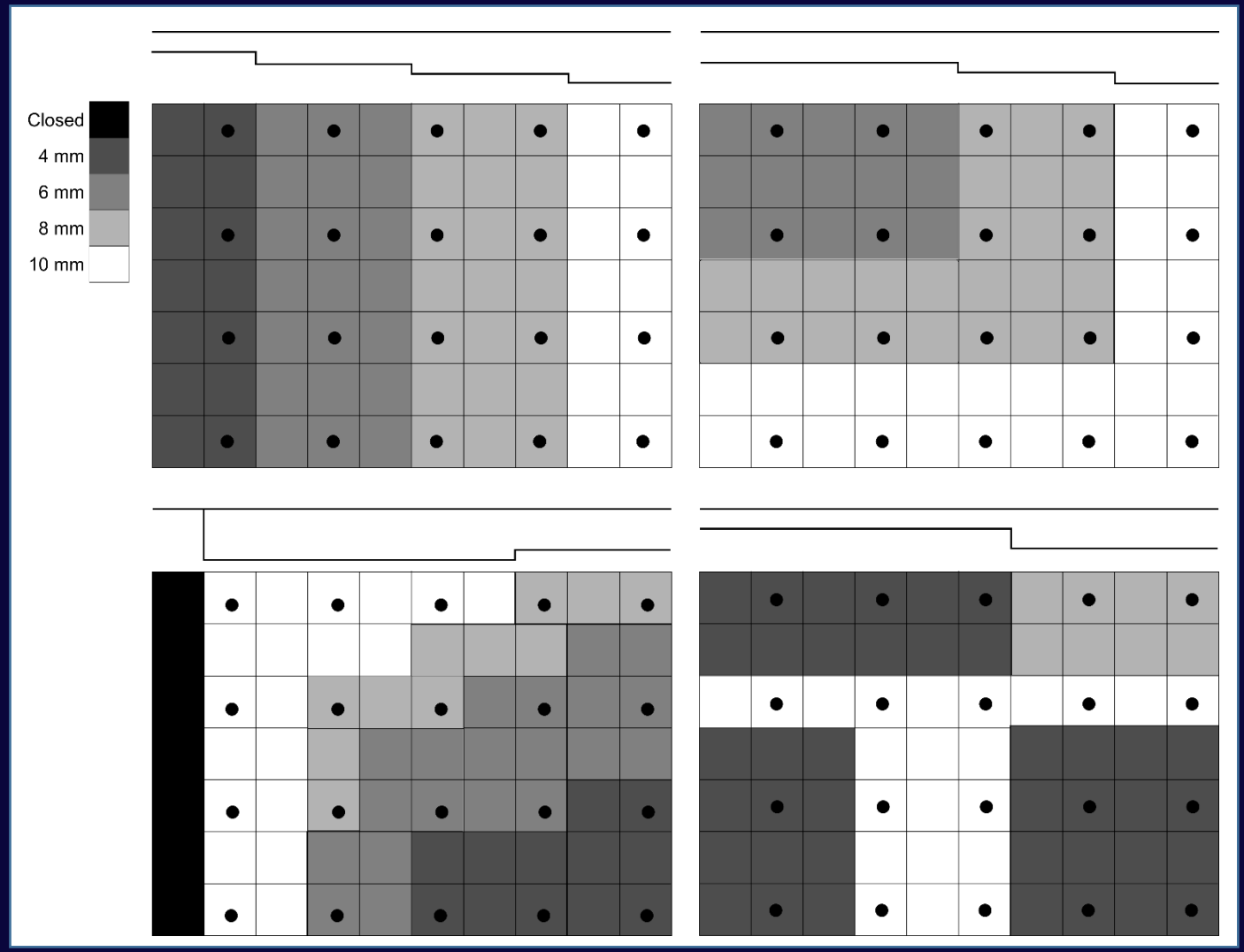
Experiment configurations: width/shape

e.g. lateral narrowing

lateral and vertical narrowing

…. and opening

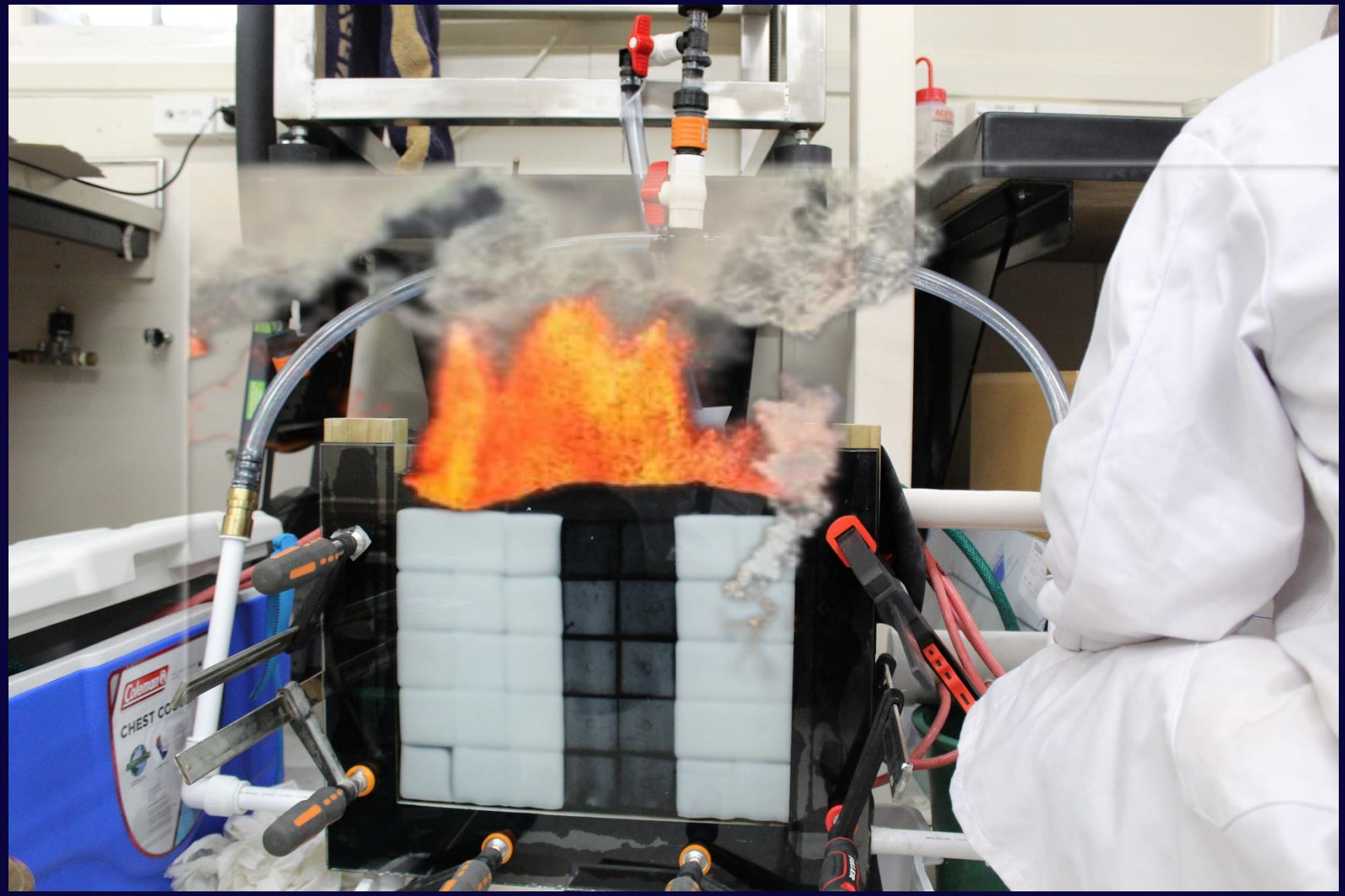
excavation of softer layers



Combined tests: Which property has the greater influence?

Instrumentation

- Videos
- Thermal sensors
- Thermal cameras?
- Particle Image Velocimetry (PIV)


Coleman