

**Imperial College
London**

Magma chamber imaged beneath an arc volcano

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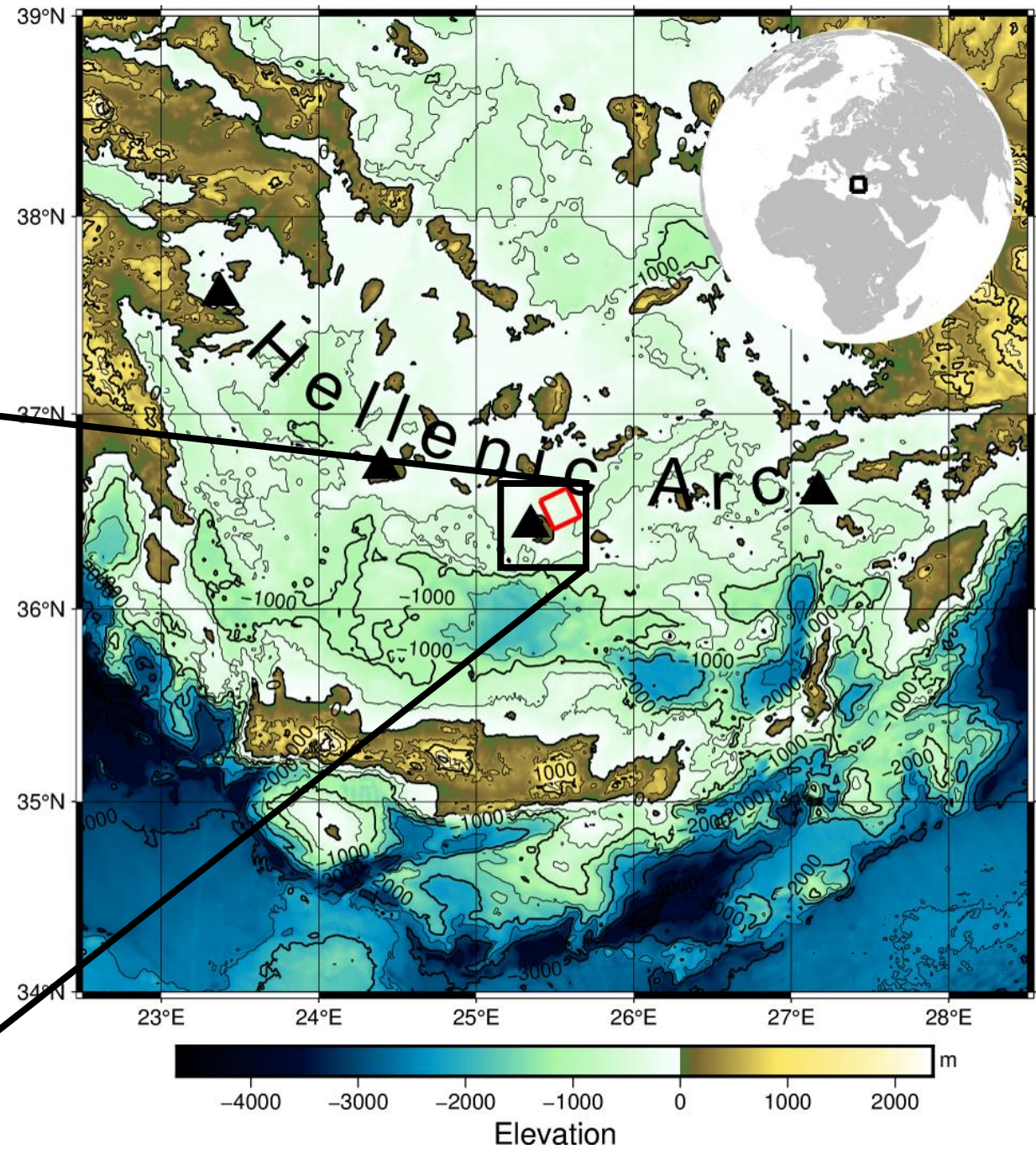
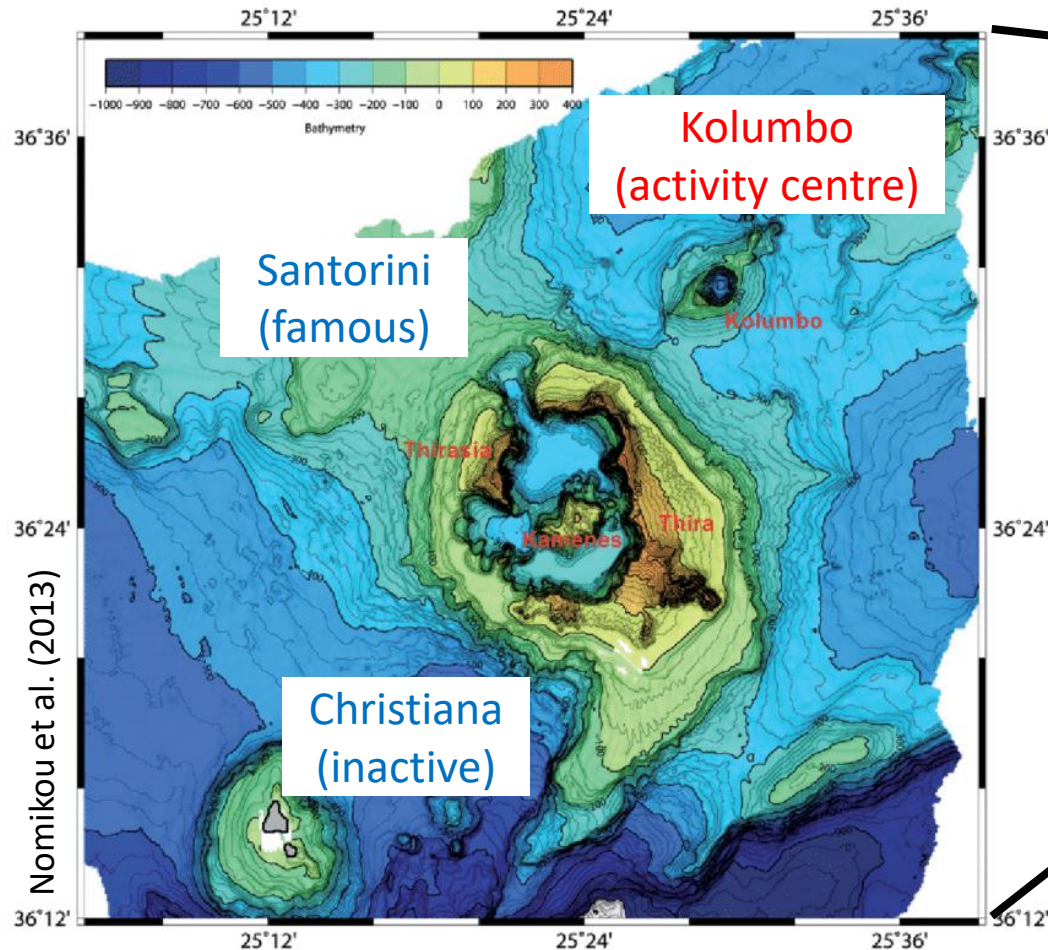
Motivation

- arc volcanoes are hazardous (viscosity, volatiles, human population)
- especially if submarine - Tonga!
- key for hazard assessment: magma or mush?
- very few magma chambers imaged so far...
- how common are long-lived pockets of mobile melt (magma)?



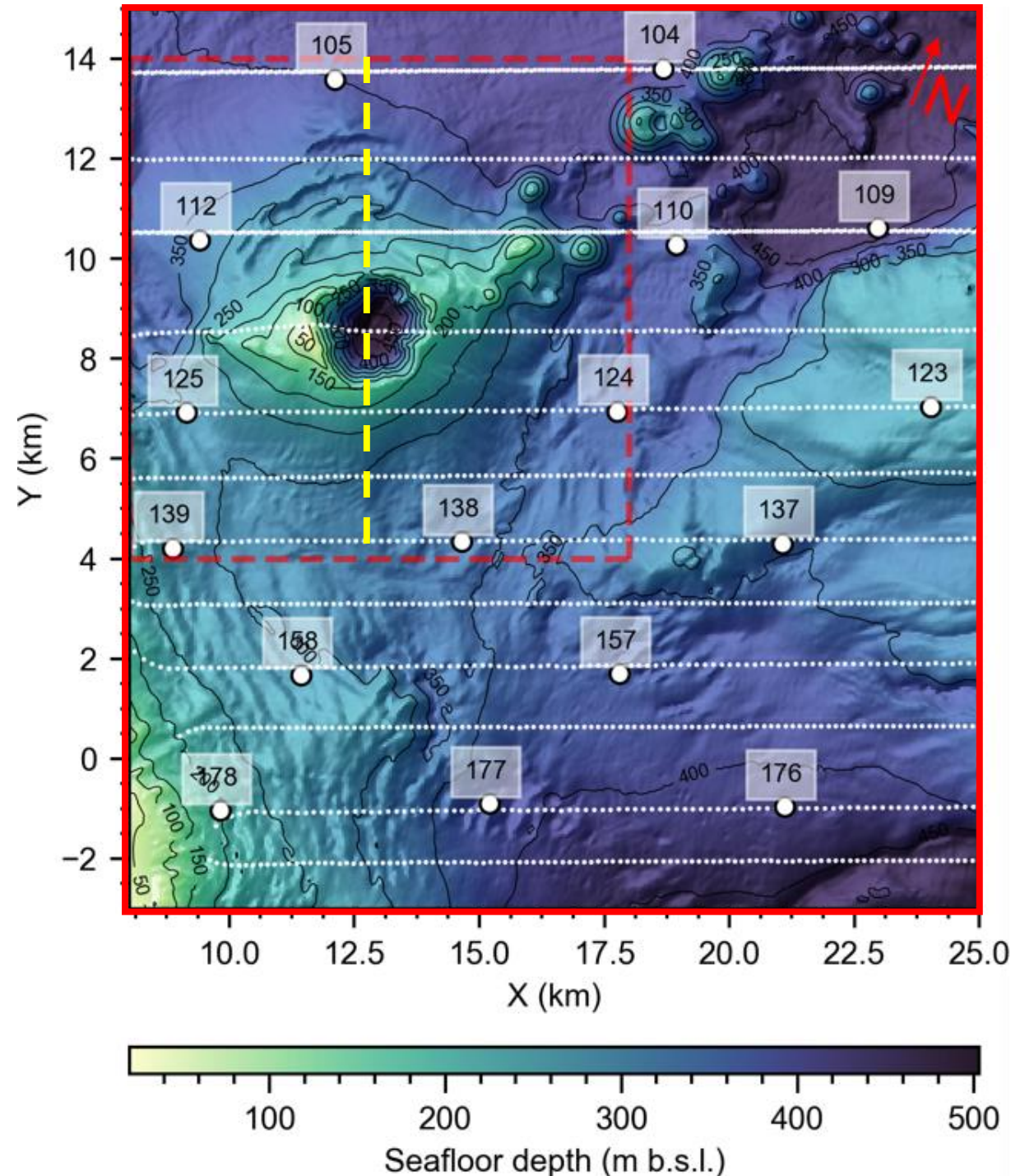
Christiana-Santorini-Kolumbo volcanic field

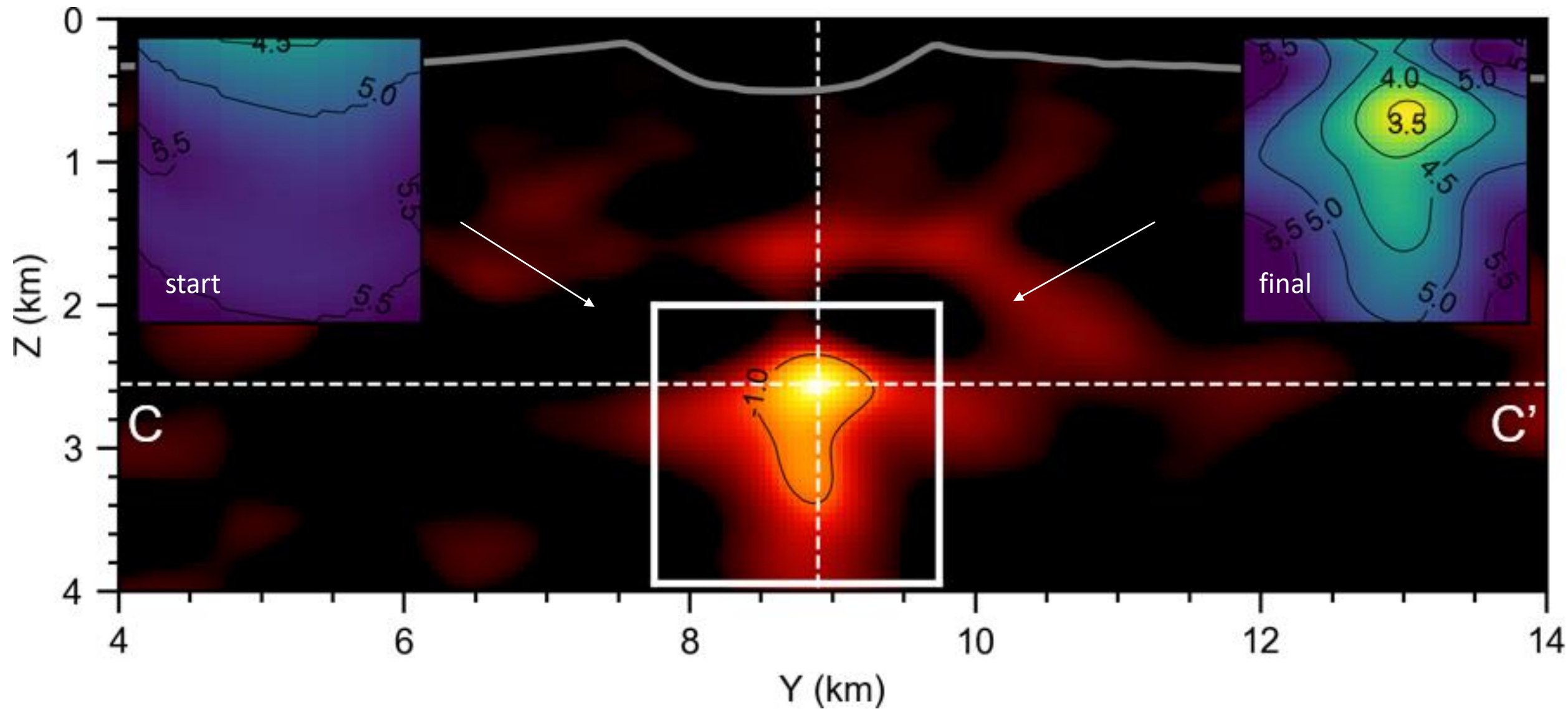
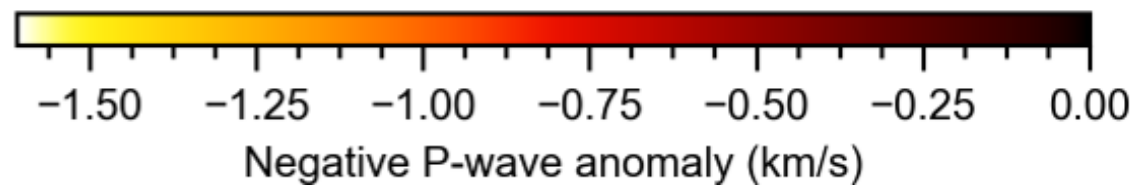
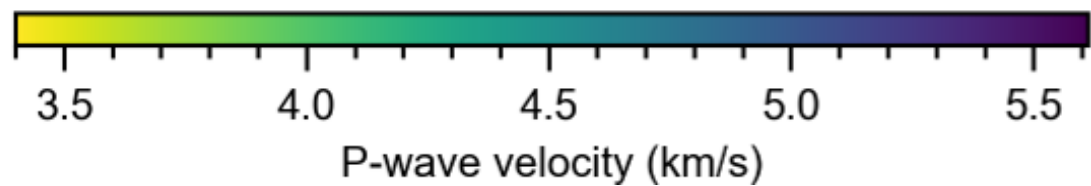
- very active (volcanically & seismically)
- accessible to 3D marine acquisition



Full-waveform inversion

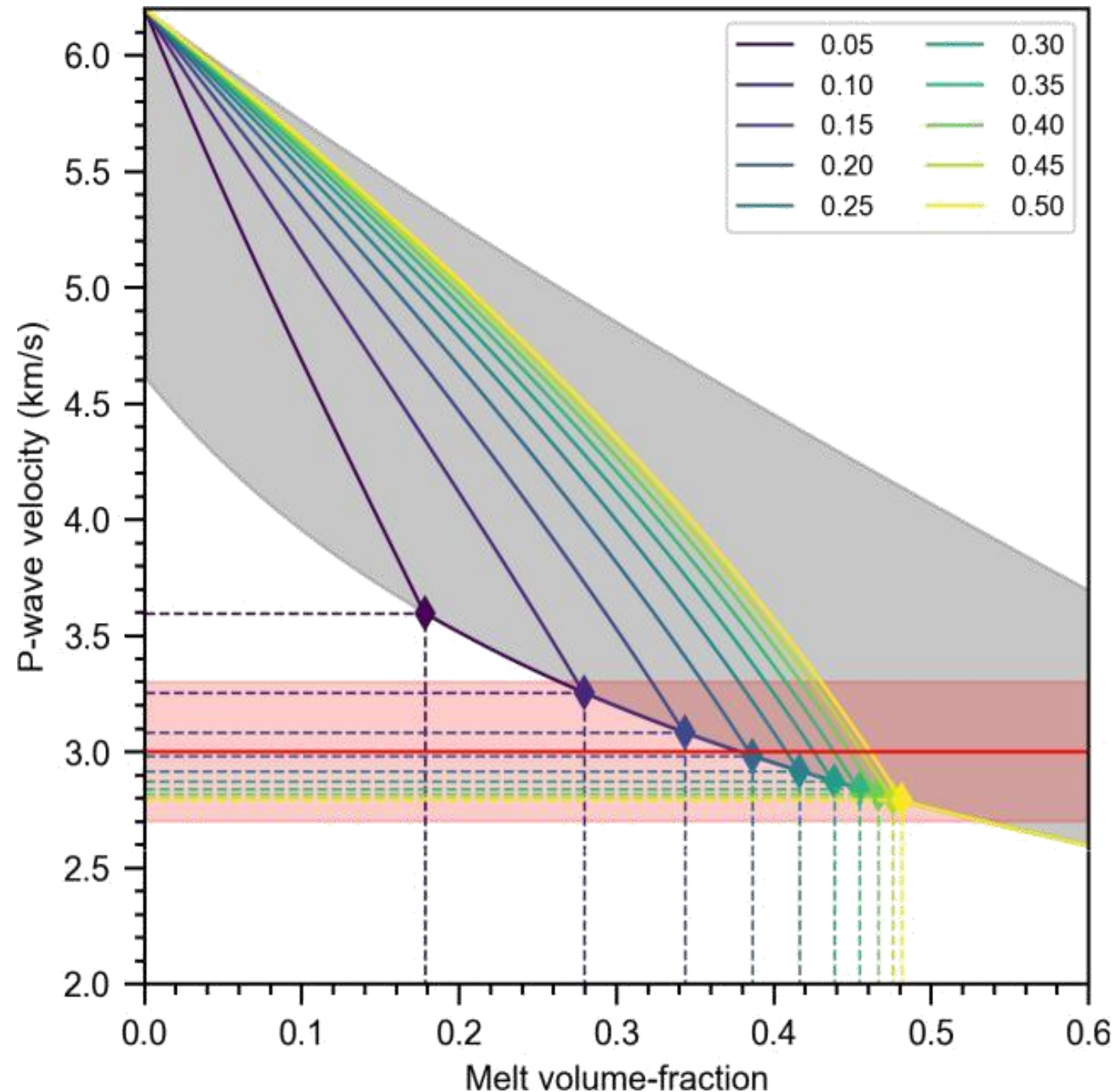
- 16 ocean-bottom hydrophones
- 1500 air-gun shots
- starting model from travel-time tomography (Heath et al., 2018)
- acoustic, isotropic wave equation
- careful quality control of data-fit
- error - from jackknife resampling
- resolution - from spike recovery tests





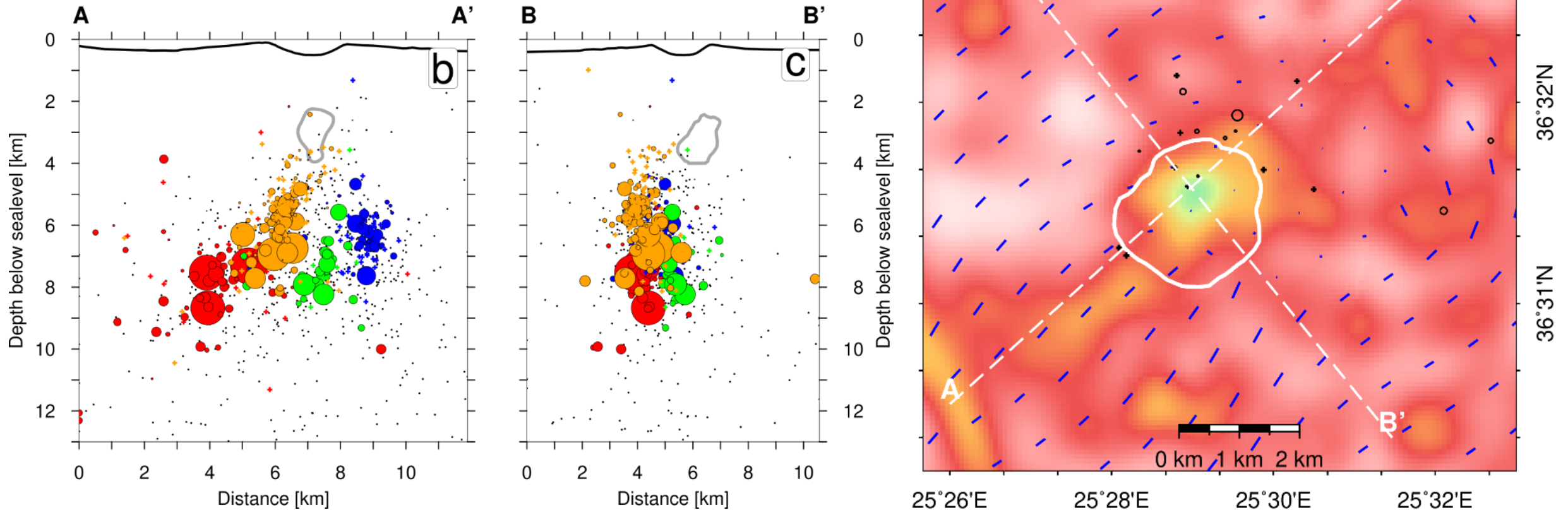
Melt fraction estimation

- calculated effective P-wave velocity of a partially molten granitic intrusion,
- 26-53% melt fraction explains the observed seismic anomaly



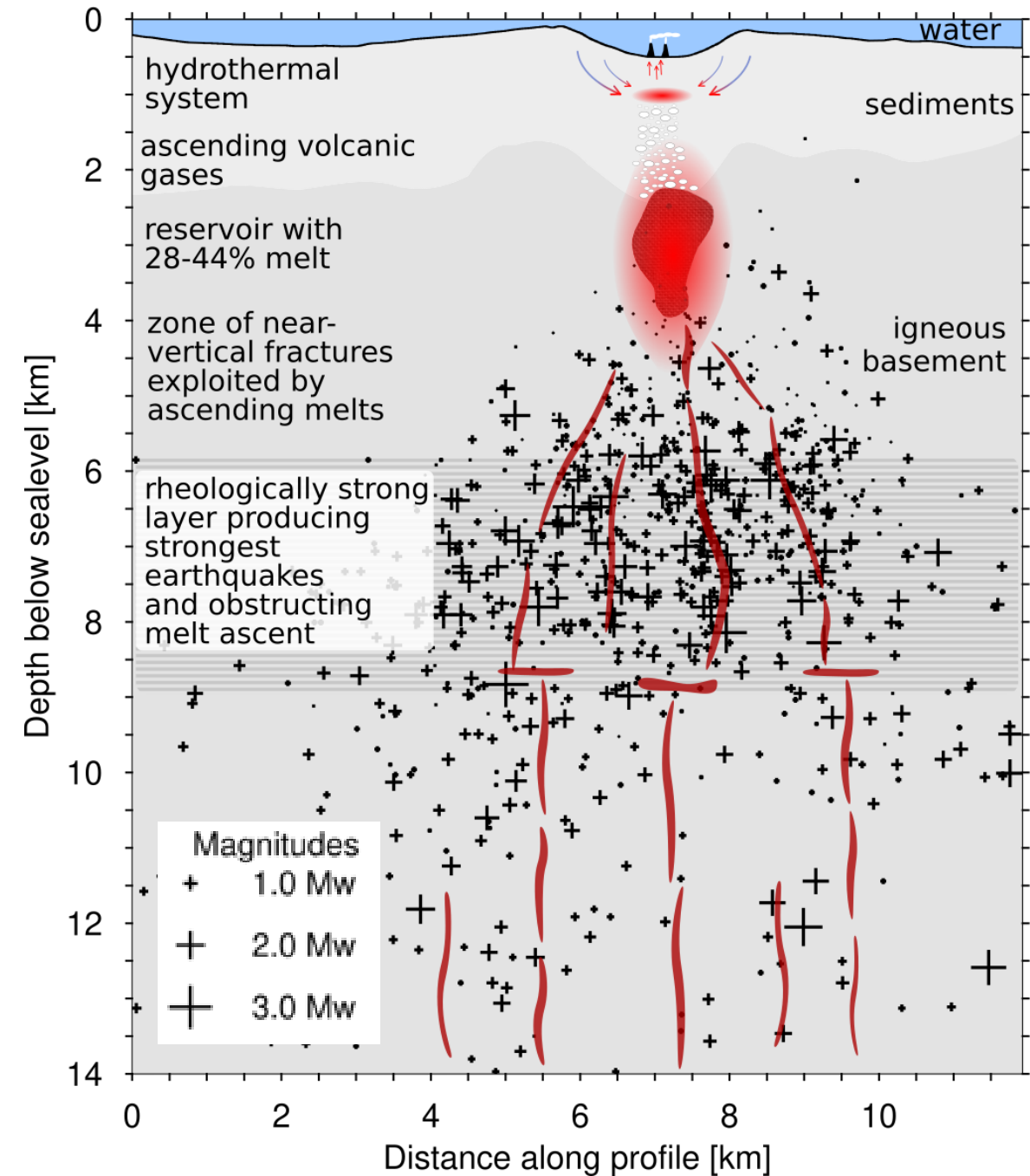
Microseismicity

The chamber coincides with the termination point of the recent earthquake swarms.

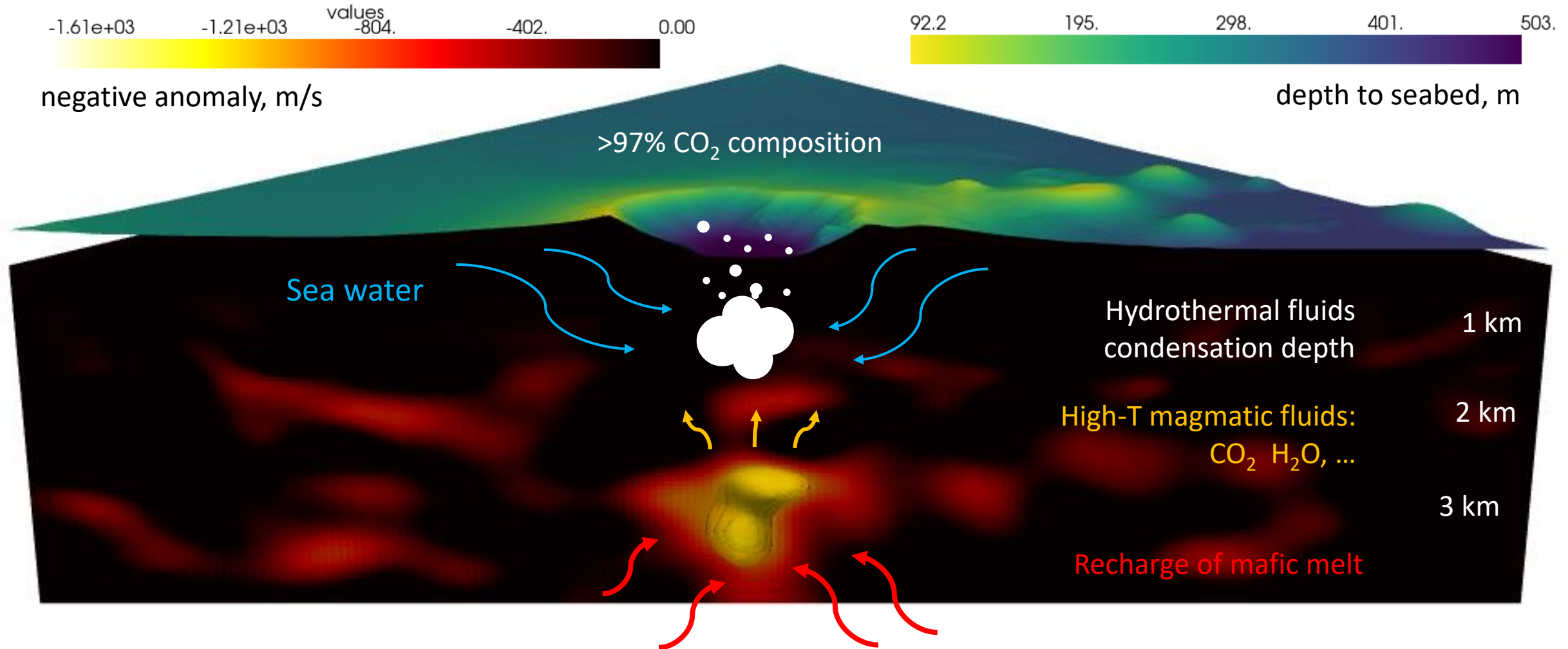


Interpretation

Near-vertical fractures through rheologically strong layer exploited by ascending melt.



Shallow part of the magmatic system



Conclusions

- new class of melt reservoirs that can be imaged seismically,
- travel-time tomography and similar methods have too low resolution, even with dense active-source data,
- similar reservoirs may have gone undetected at other volcanoes,
- Kolumbo is smaller than Tonga, but more people live nearby,
- seafloor observatory advisable even if melt fraction is overestimated.

Thanks for your attention!

Geochemistry,
Geophysics,
Geosystems

Find out more about data acquisition, processing and imaging methods in:

Magma chamber detected beneath an arc volcano with **full-waveform inversion** of active-source seismic data

K. Chrapkiewicz, M. Paulatto, B. Heath, E. Hooft, P. Nomikou, C. Papazachos, F. Schmid, D. Toomey, M. Warner, and J. Morgan

Heralds of future volcanism: swarms of **microseismicity** beneath the submarine Kolumbo volcano indicate opening of near-vertical fractures exploited by ascending melts

F. Schmid, G. Petersen, E. Hooft, M. Paulatto, K. Chrapkiewicz, M. Hensch, T. Dahm



As well as the state of the art in seismic imaging beneath volcanoes in:

Advances in seismic imaging of magma and crystal mush

Michele Paulatto, Emilie E E Hooft², Kajetan Chrapkiewicz¹, Benjamin Heath³,
Douglas R. Toomey², Joanna V. Morgan¹

