# Ascent timescales at the Onset of the Oruanui, NZ Supereruption

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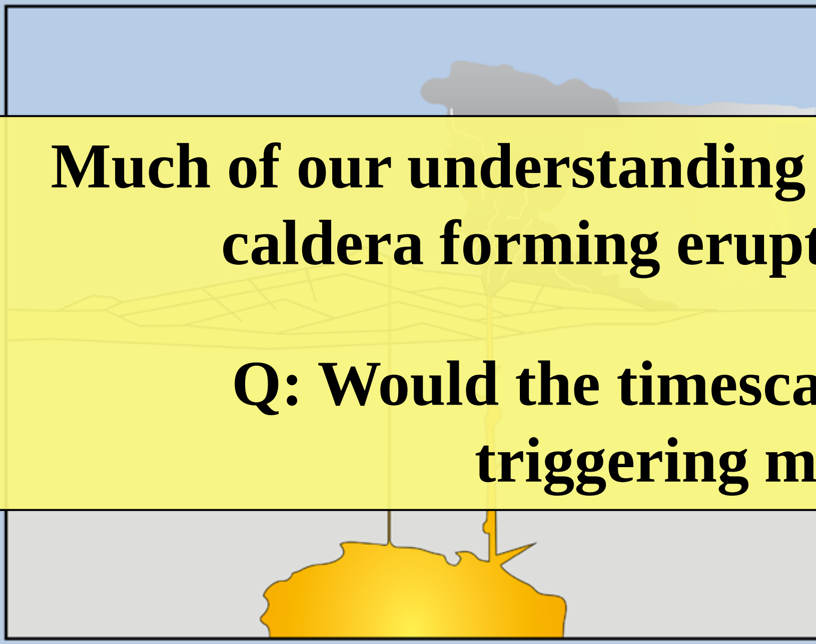
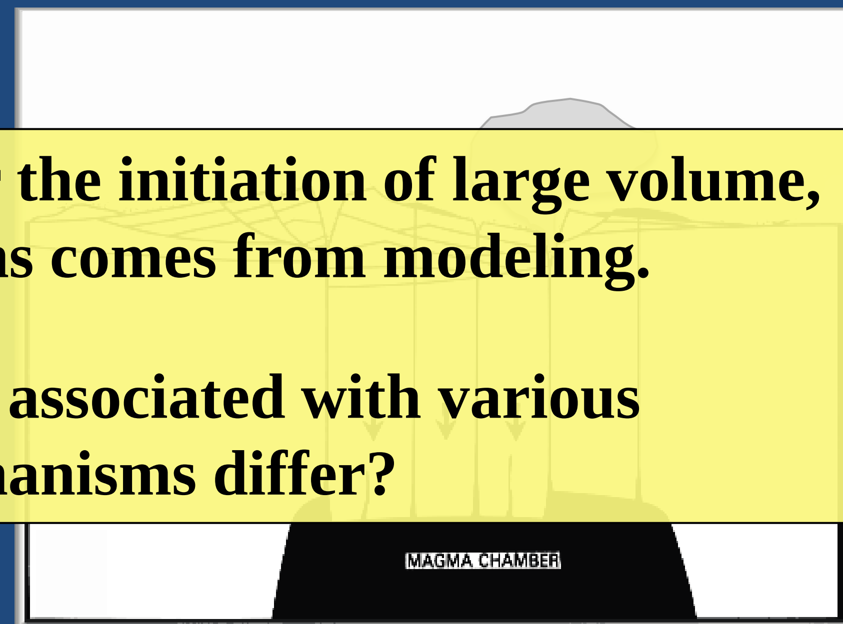
# *How are large volume eruptions triggered?*

## Chamber Triggered



e.g Roche et al., 2000; Roche and Druitt 2001; Carrichi et al. 2014; Malfait et al. 2014

## Externally Triggered

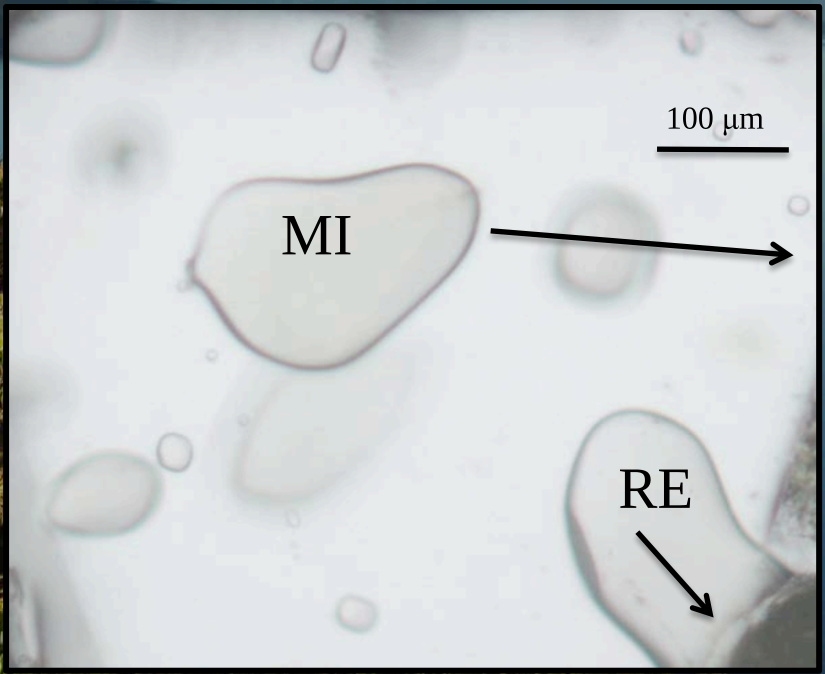



e.g. Allen et al. 2012 ; Gregg et al. 2012, 2015; de Silva and Gregg 2014

**Much of our understanding for the initiation of large volume, caldera forming eruptions comes from modeling.**

**Q: Would the timescales associated with various triggering mechanisms differ?**

# Hypothesis: We can use volatiles concentrations and gradients (namely $H_2O$ and $CO_2$) to quantify the timescales of opening behavior.




* All inclusions are crystal & bubble-free

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Shea et al. 2015

- $H_2O$ + $CO_2$: FTIR, University of Oregon

# Three supereruptions with different characteristics

**Bishop Tuff**
760 ka, 650 km$^3$

No significant time breaks observed; entire eruption inferred to have taken ~6 days

Wilson and Hildreth 1997

**Huckleberry Ridge**
2.08 Ma, 2500 km$^3$

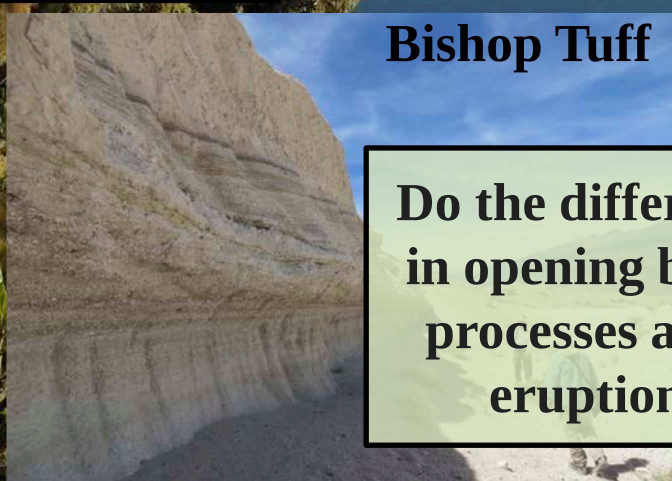
Subtle reworking in the fall deposit indicates multiple short time breaks

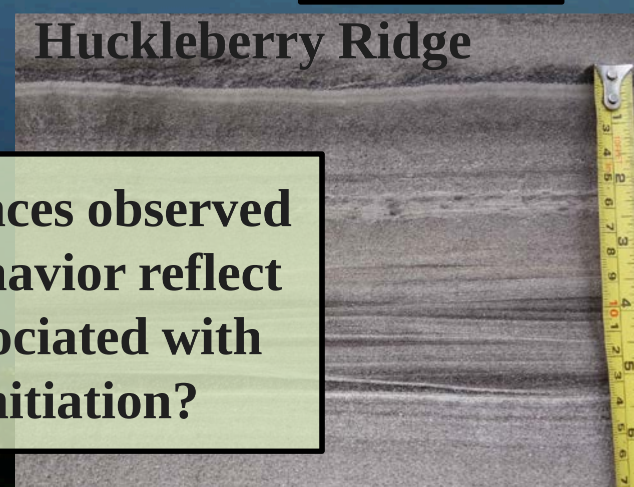
Wilson 2009

**Oruanui, NZ**
25.4 ka, 530 km$^3$

Significant time breaks between fall layers, the longest on the order of weeks to months

Wilson 2001

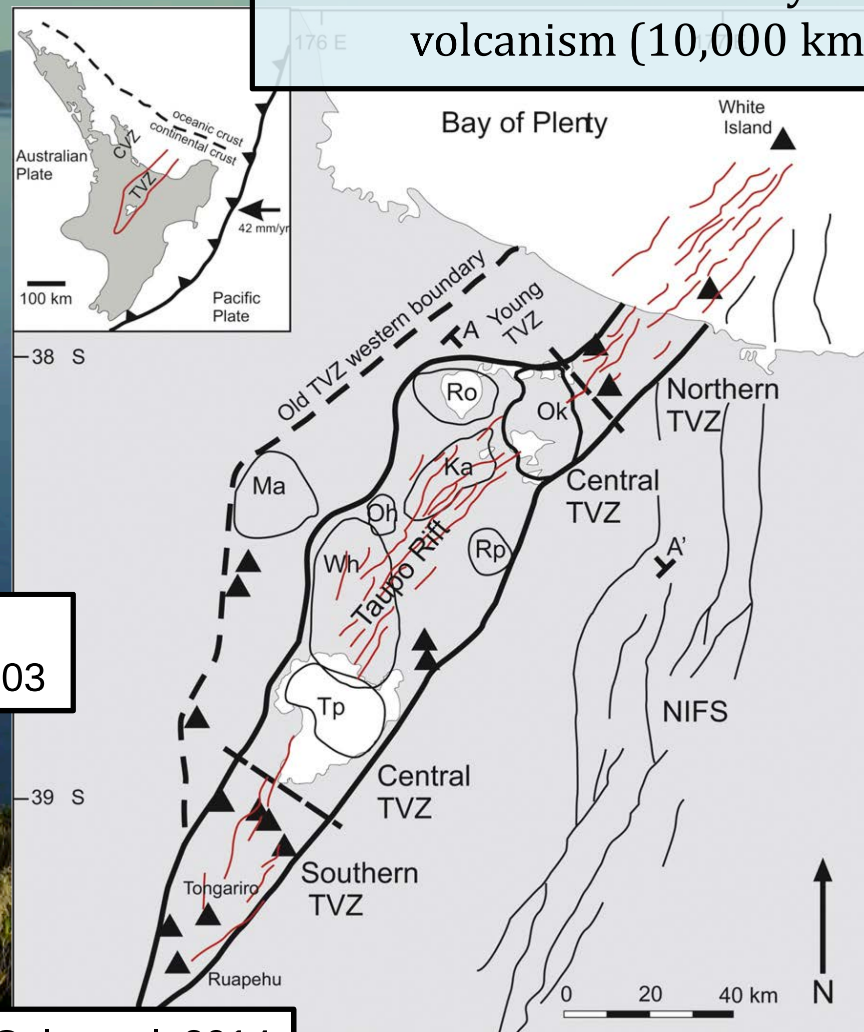



**Do the differences observed in opening behavior reflect processes associated with eruption initiation?**

# Taupo Volcanic Zone (TVZ)

Modern TVZ began around 2 Ma; predominantly andesite. At 1.6 Ma switched to dominantly rhyolitic volcanism (10,000 $km^3$).



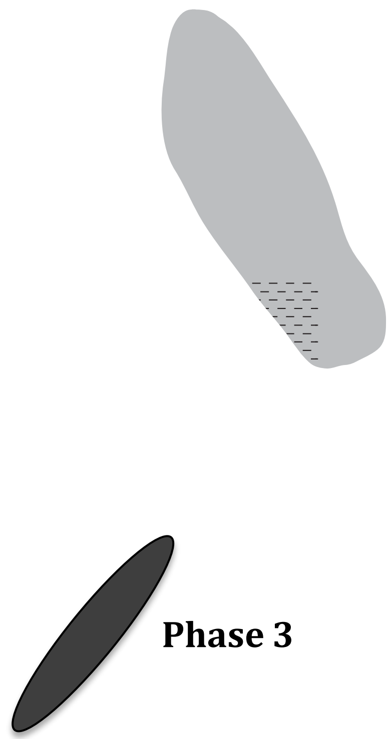

Cole et al. 2014

~7 mm year, Acocella et al. 2003

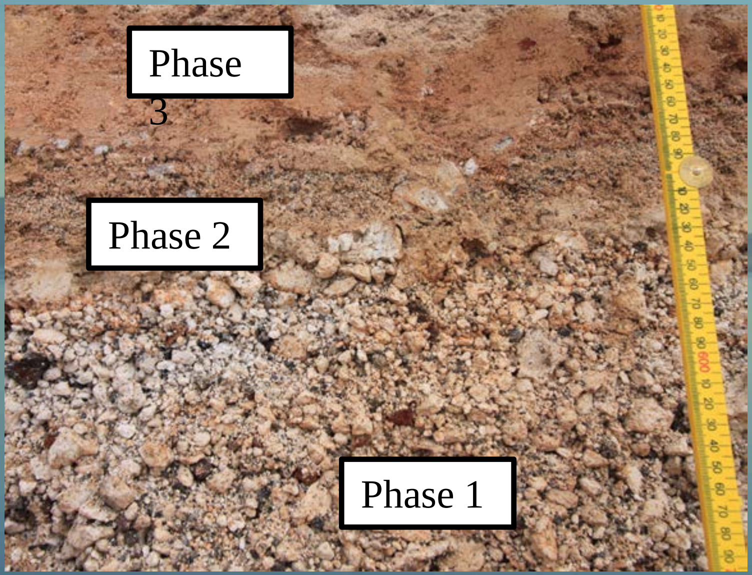
Hamling et al. 2016

Southern extent of the Tonga-Kermadec arc.

# Oruanui Supereruption, NZ (25.4 ka, 530 km$^3$)



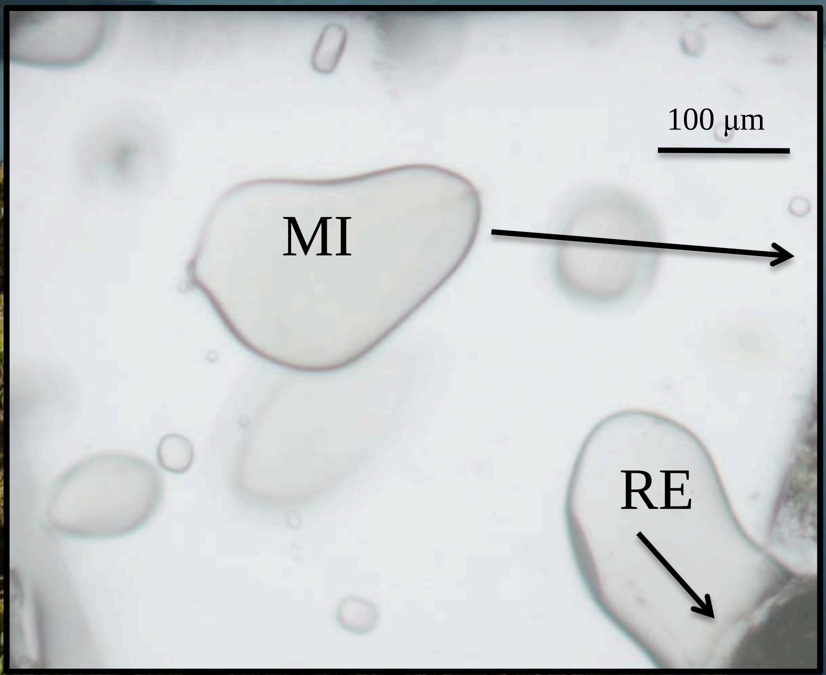

Allan et al. 2012




**Lateral injection of a foreign magma body**

The longest time gap is between phase 1 and phase 2, estimated to be on the order of several weeks.

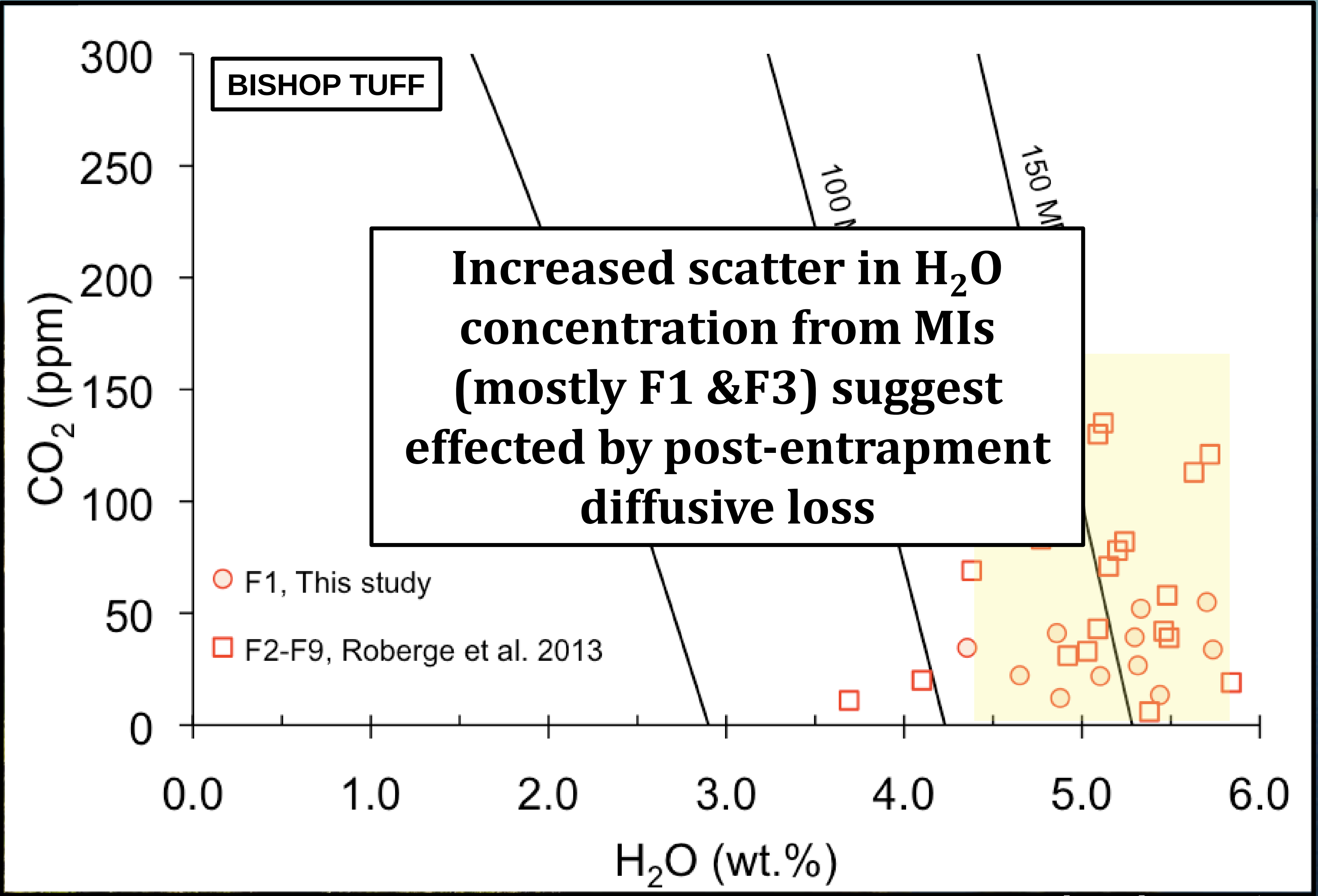
# Are there timescale indications associated with the initial fall deposits of the Oruanui eruption, where rifting facilitated its initiation?




* All inclusions are crystal & bubble-free

- METHOD 1: H diffusion through quartz on timescales of days
- METHOD 2: $H_2O$ and $CO_2$ gradients formed in REs during final ascent; timescales of hours

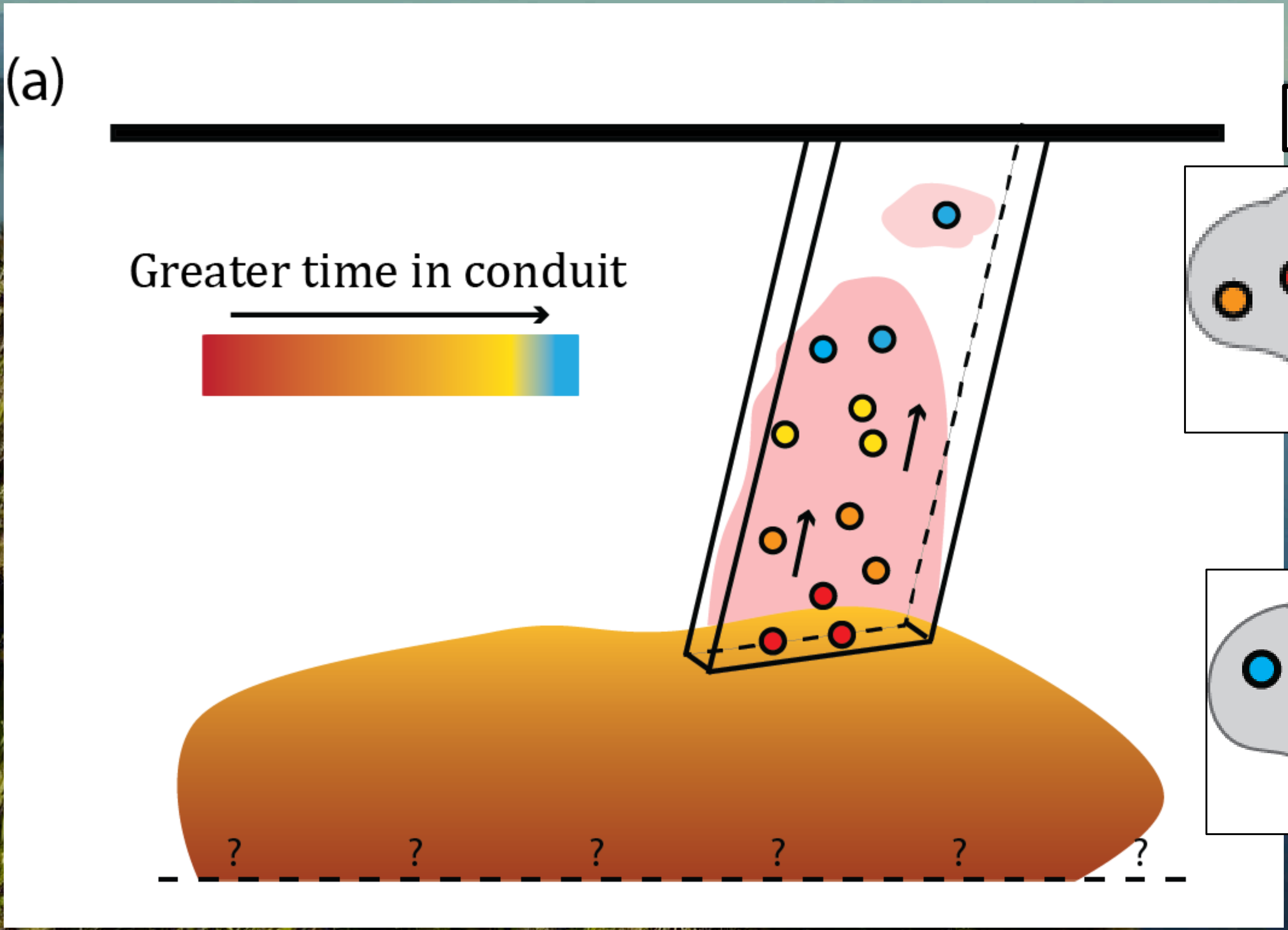
# $H_2O$ and $CO_2$ Concentrations for Melt Inclusions



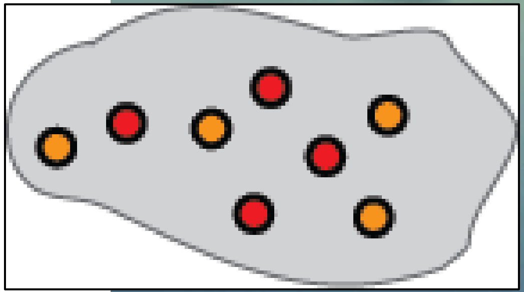

**Increased scatter in $H_2O$ concentration from MIs (mostly F1 &F3) suggest effected by post-entrapment diffusive loss**

Melt Inclusions (n=95)

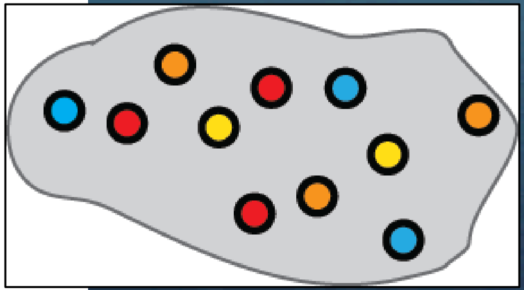
# *Diffusive Loss of $H_2O$ from entrapped MIs during magma ascent*




BISHOP TUFF

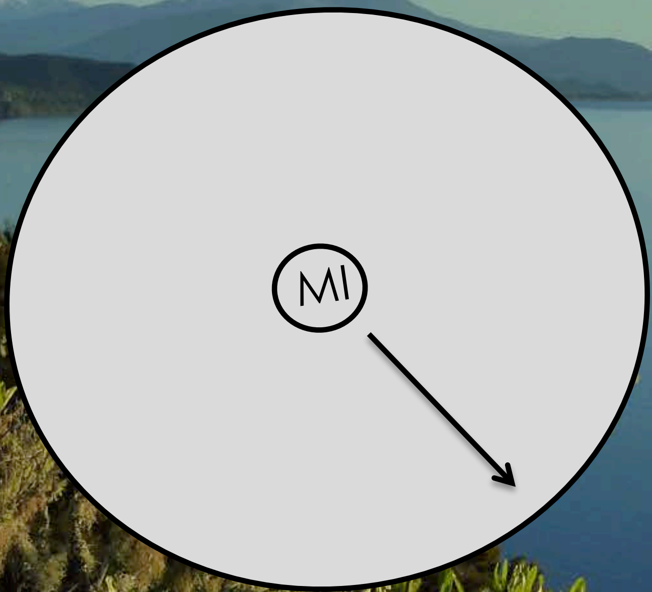


Oruanui



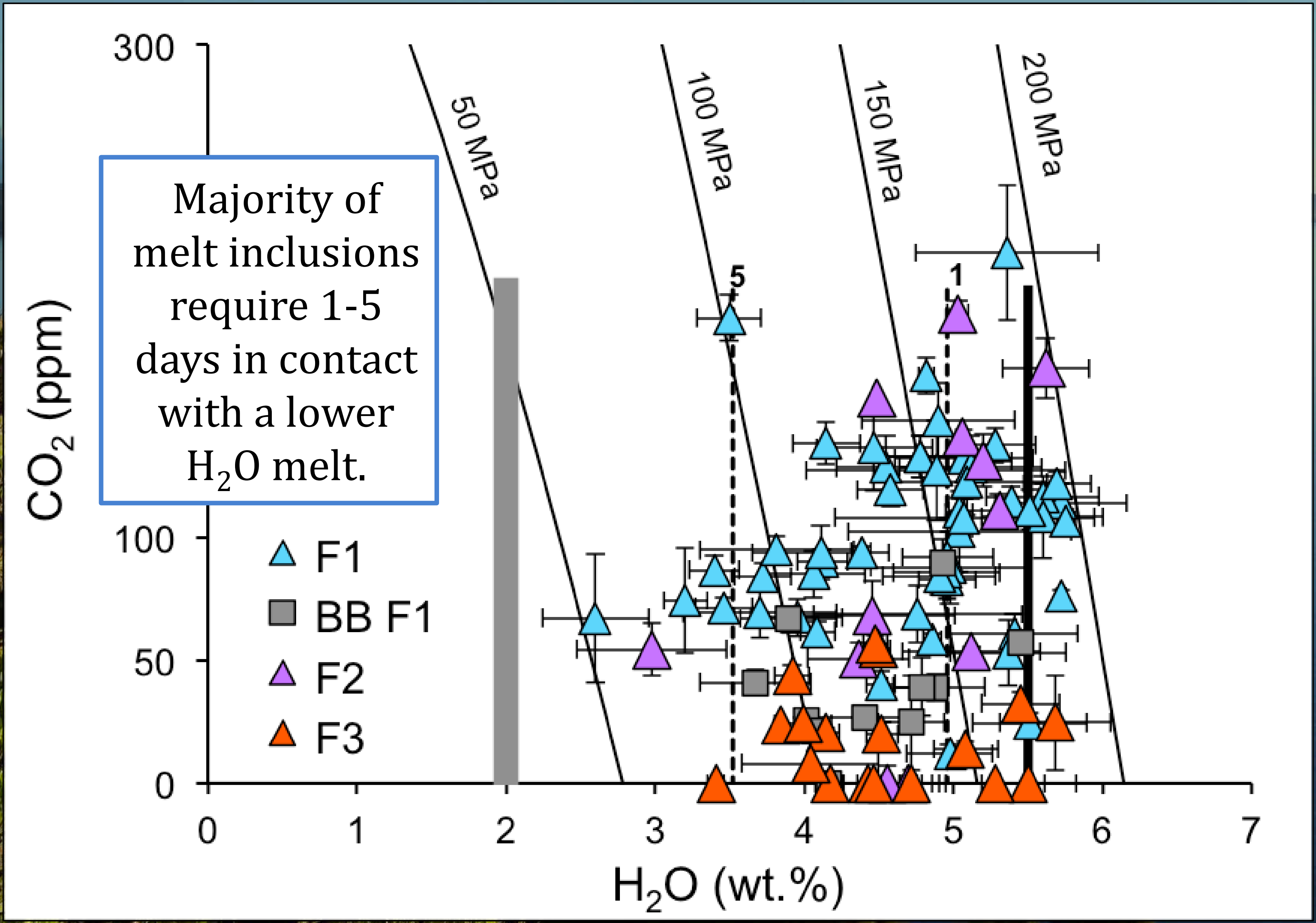
# Method I: Diffusion of H through Quartz

- Initial $H_2O$ Concentration –Highest melt inclusion values
- External $H_2O$ Concentration – Reentrant interior value

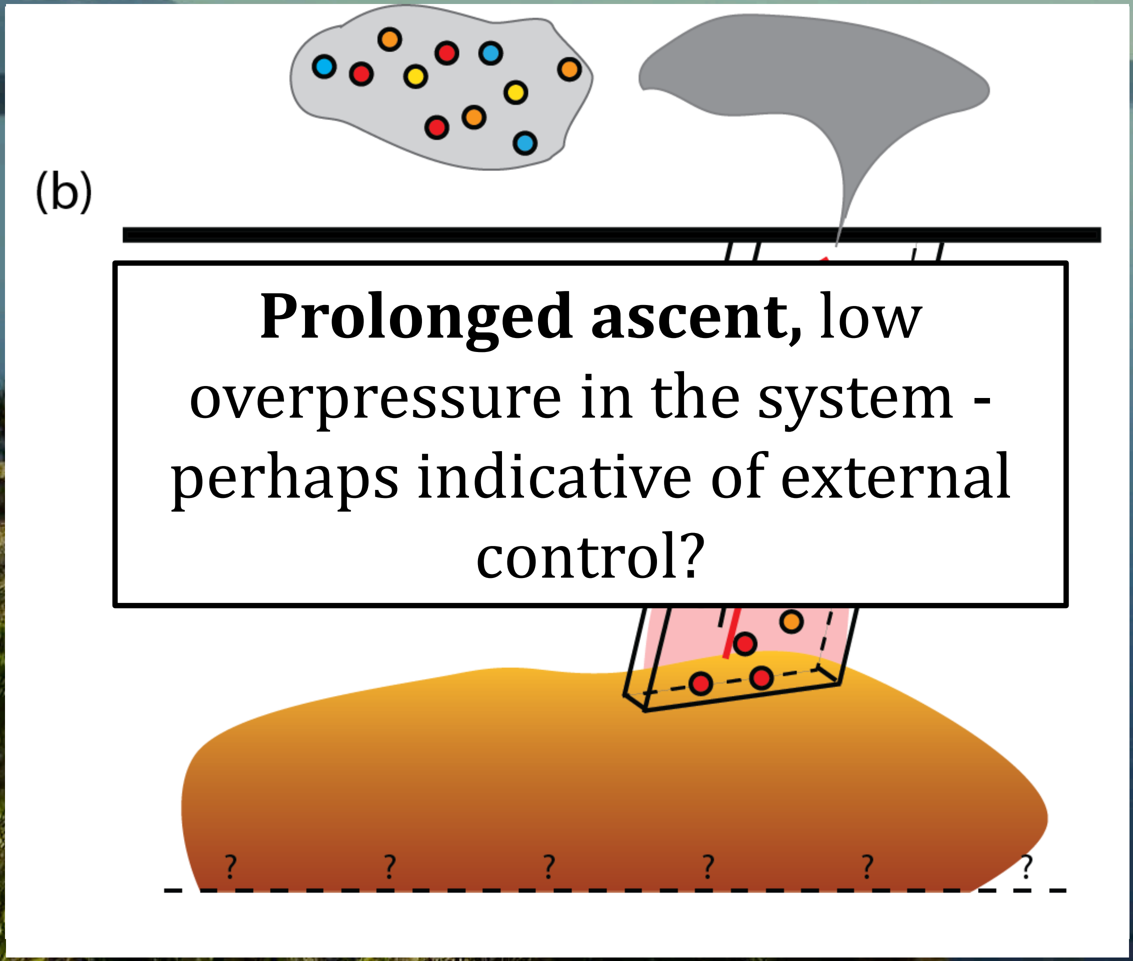



- Diffusion model (Qin et al. 1992, Cottrell et al. 2005)
- Diffusion Coefficient (Severs et al. 2007)
- Partition Coefficient (Qin et al. 1992)
- Size of inclusion and distance to rim

# Timing of opening behavior: evidence for sluggish start

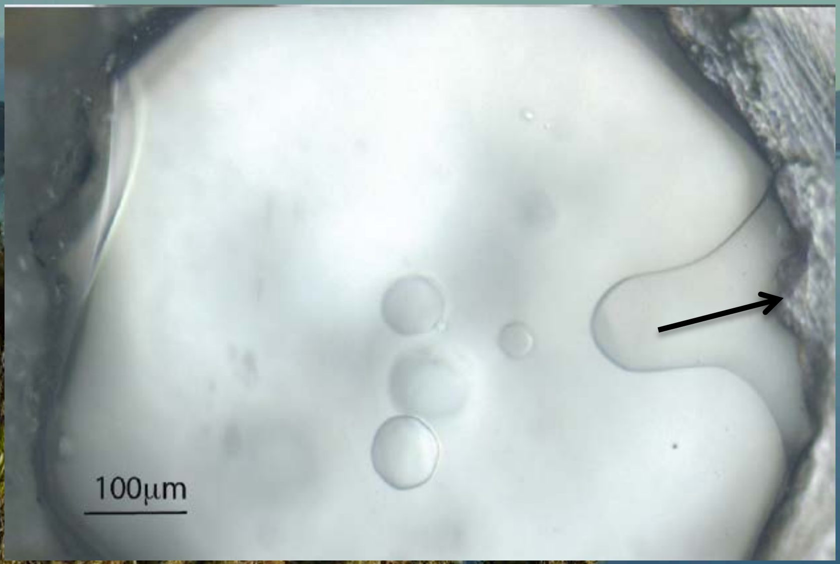


# *Different decompression histories into a single clast?*

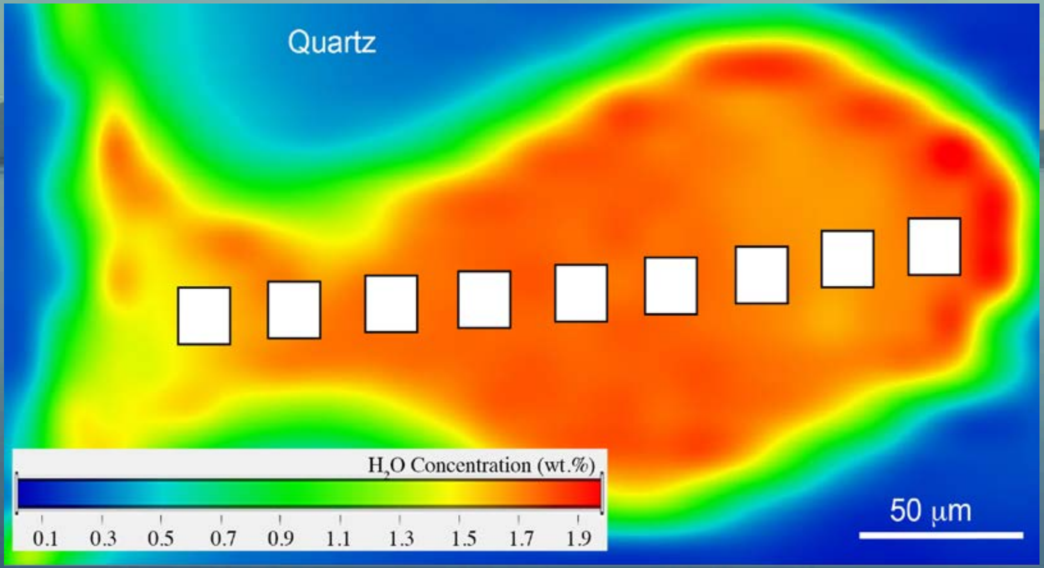



**Prolonged ascent,** low overpressure in the system - perhaps indicative of external control?

# Reentrants to calculate final ascent ($H_2O$ & $CO_2$)

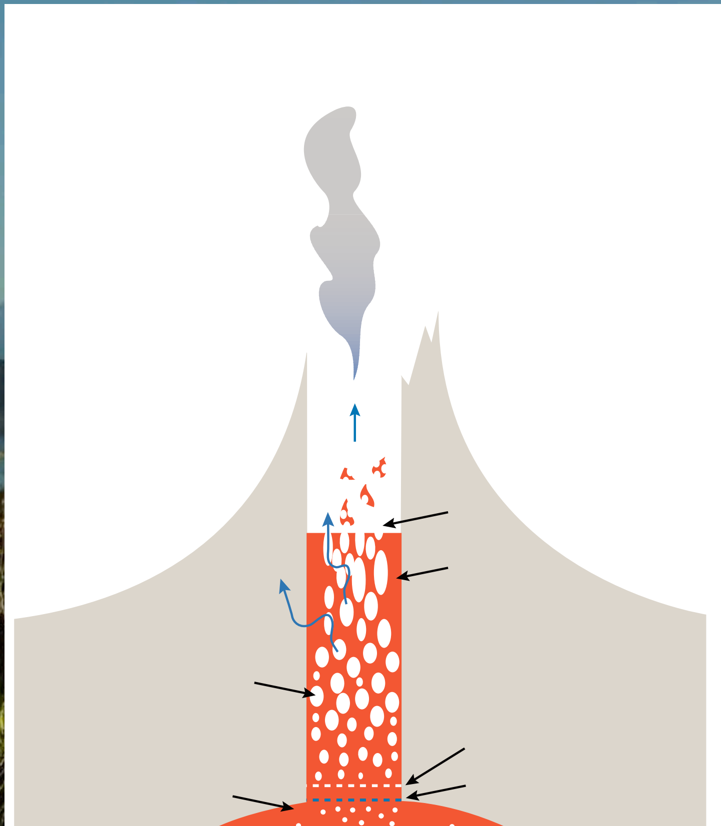



Quartz grains picked and intersected to expose reentrant

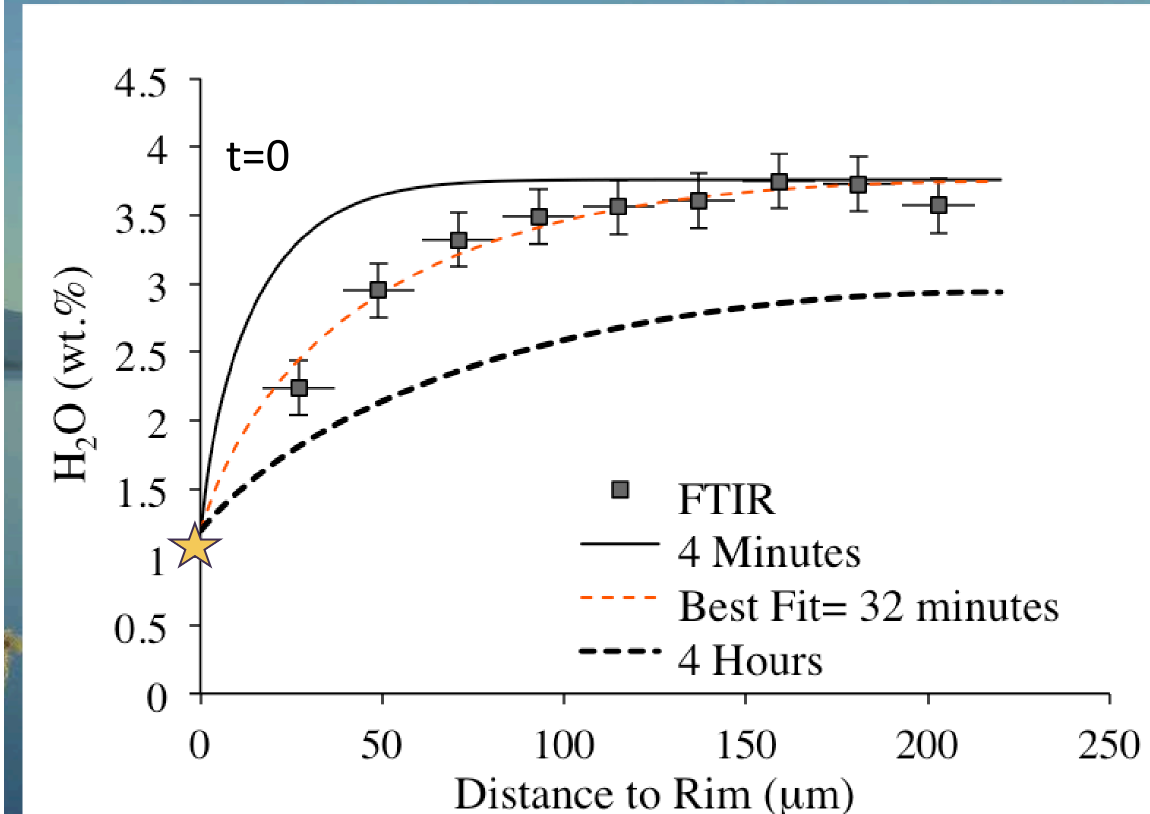



Area map made using the FTIR.

During decompression, gas exsolves into bubbles. This drives $H_2O$ & $CO_2$ gradients in enclosed melt pockets (reentrants) that can be modeled to estimate decompression rate.



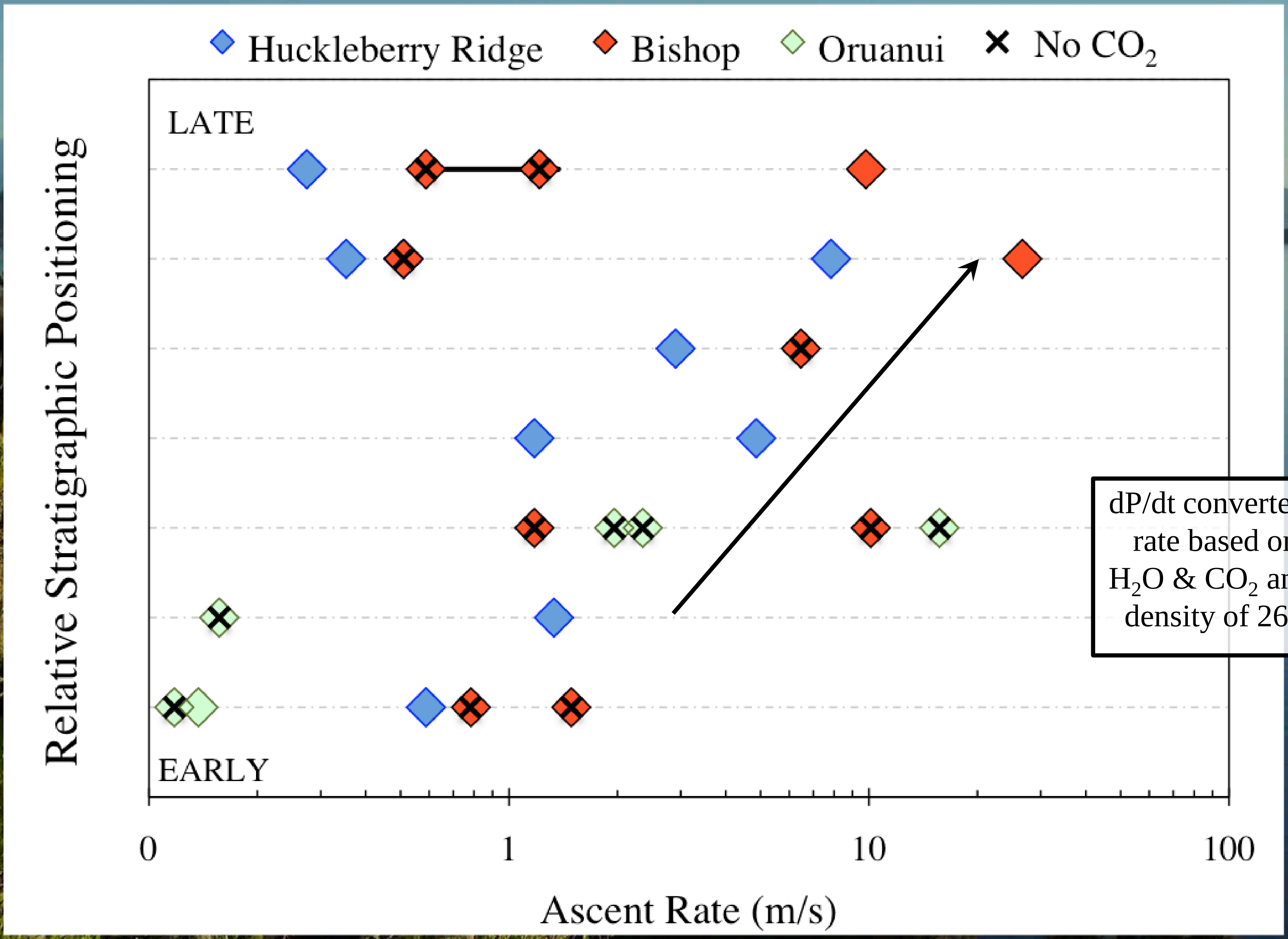
Gonnermann and Manga 2007



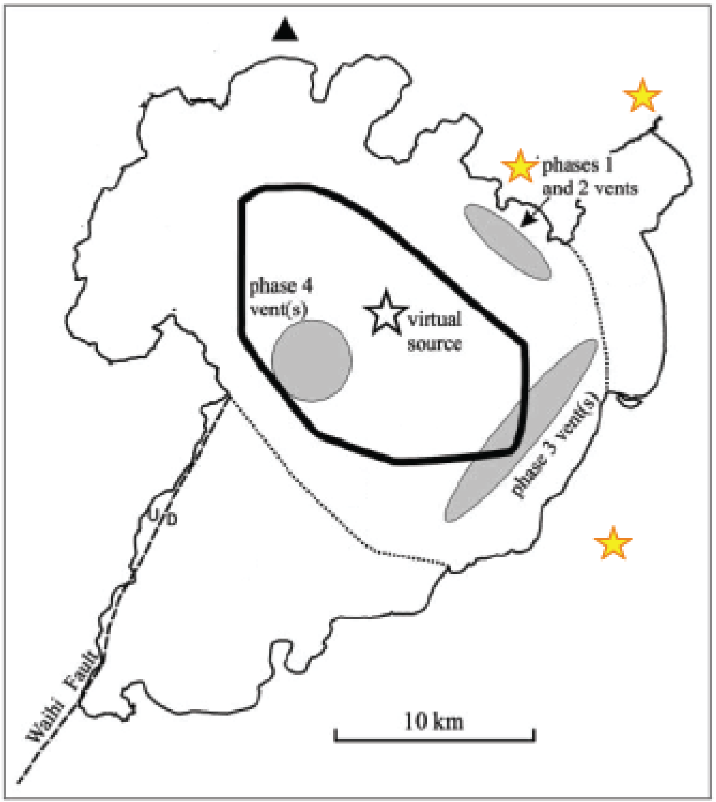

Assumptions input into the Liu et al. 2007 model:

1. Initial Conditions (Based on Melt Inclusion values or *Innermost Reentrant Concentration*)
2. Initial exsolved gas
3. Fragmentation Threshold = 10 MPa (when quenching is assumed to have occurred)
4. Constant Decompression
5. Isothermal

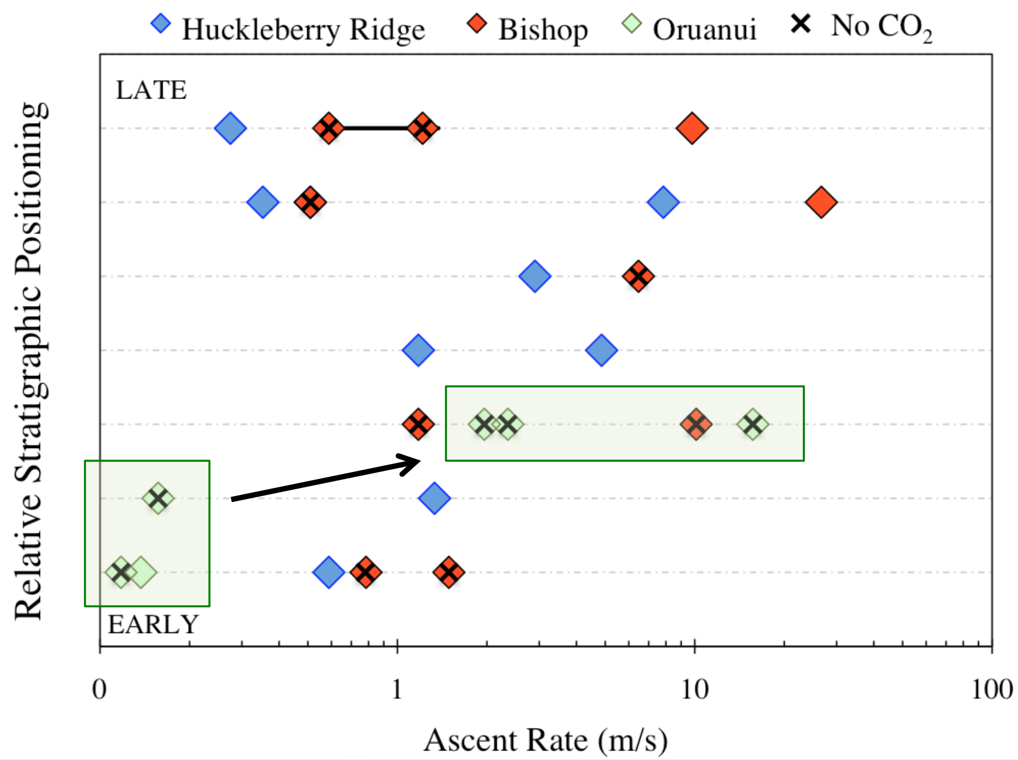
# Modeled $H_2O$ and $CO_2$ (when present) gradients from 26 reentrants



# Oruanui (530km$^3$, 25.4ka)




Sample Locations

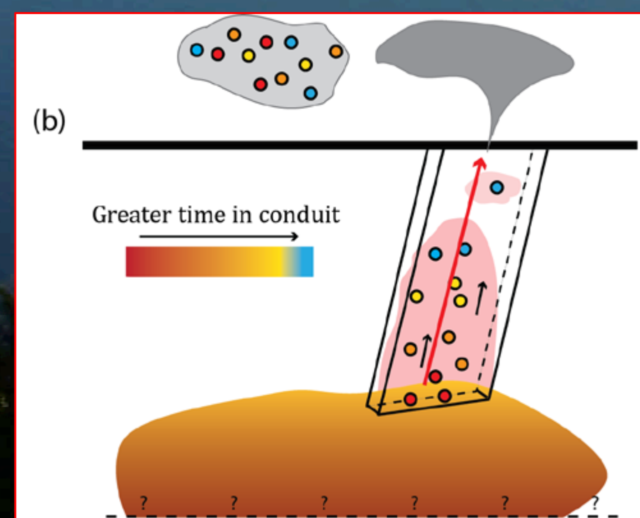



Ascent rate seems to increase most significantly in the Oruanui between Phase 1/Phase 2 (central vent) to Phase 3 (elongated source, higher eruptive volume)

# Evidence that rifting strongly influenced the Oruanui initiation

Allan et al. 2012

- ✧ Time breaks in deposition.
- ✧ Foreign magma body laterally injected, facilitated through rifting
- ✧ $H_2O$ scatter in MIs- prolonged ascent, potentially low overpressure
- ✧ Slow final ascent rates for Phase 1 & 2, with increased rates associated with Phase 3



*THANK YOU*

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