Defining and delineating Strombolian and Hawaiian volcanism

- boundary conditions
- Intensity/deposit approaches
- Etna
- atypical behaviors at Kilauea
- pulsating behaviors
- questions

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Definitions/boundary conditions

In what parameter-space can we position Strombolian explosions wrt Hawaiian fountaining?

- mass eruption rate (intensity)
- mass (magnitude)
- duration
- steadiness
- gas overpressure
- viscosity
- volatile content
- melt vesicularity
- crystallinity
- VLP seismicity
- infrasound

Pfeiffer 2002

What do we wish to classify?

- well-constrained events at observatory volcanoes in real time
- new observed events at all volcanoes in real time
- (retrospectively) early historical eruptions
- (retrospectively) unobserved eruptions at studied volcanoes
- (retrospectively) to any pyroclastic deposit

Strombolian: Definitions and distinctions:

observational

intensity ↑

paroxysmal

major (small parox.)

normal

Barberi et al. 1993; 2009
Bertagnini et al. 1999
Metrich et al. 2005

Other styles:
puffing
passive degassing
lava effusion

Kilauea: Definitions and distinctions:

observational

intensity ↑

High fountains

Low fountains

Other styles: spattering, gas pistoning, 208-2014 explosions, passive degassing

Time scales

end-members or continuum ?

Yasur 2012

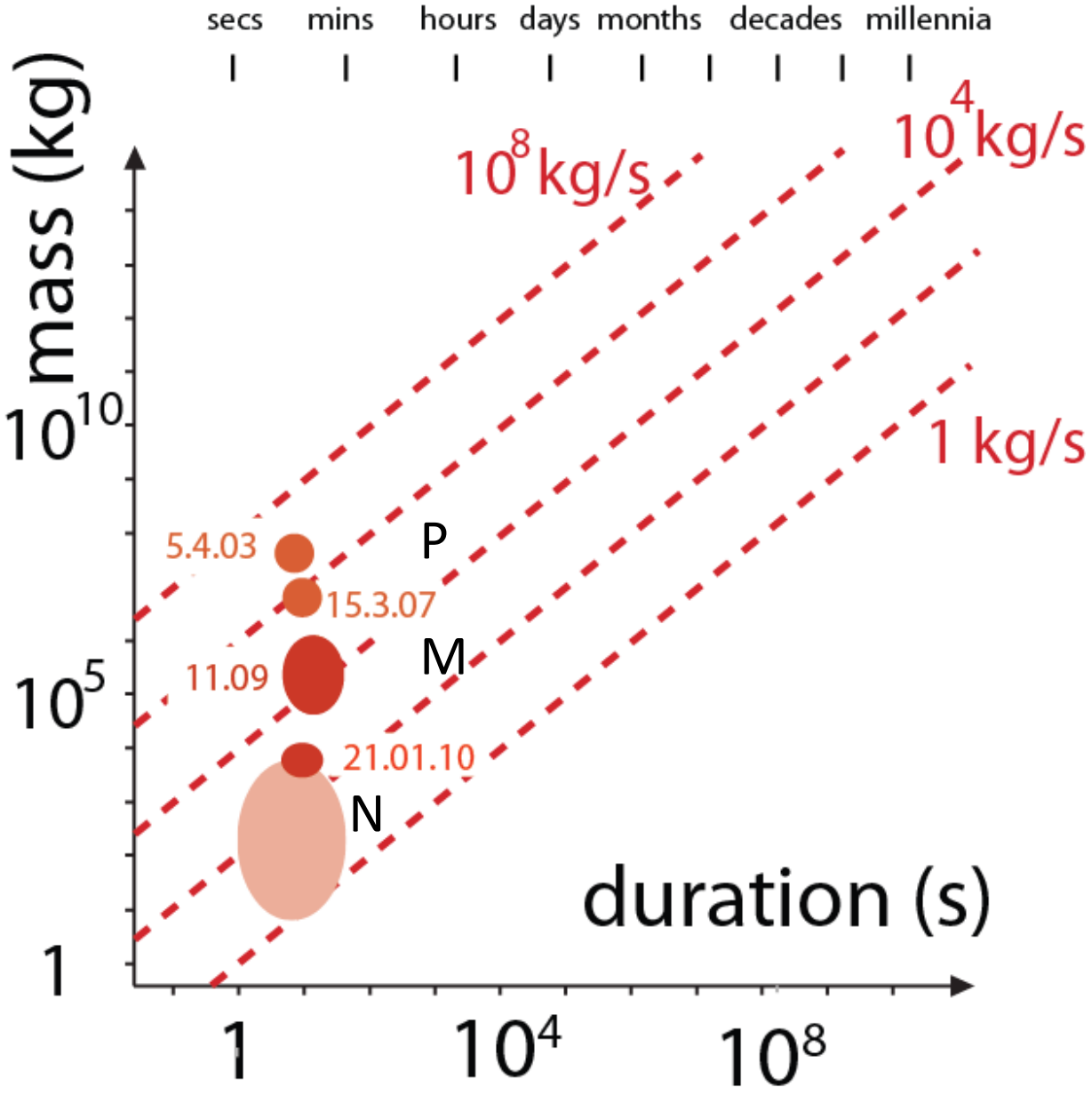
Kīlauea 1959

Characteristic time scales

	(pulses	sec or less)
Stromboli	***explosions***	sec to 10 sec
Kilauea	***episodes***	hrs to days
	eruptions	hrs to ?

Taddeucci et al. (in press)

STROMBOLIAN EXPLOSIONS



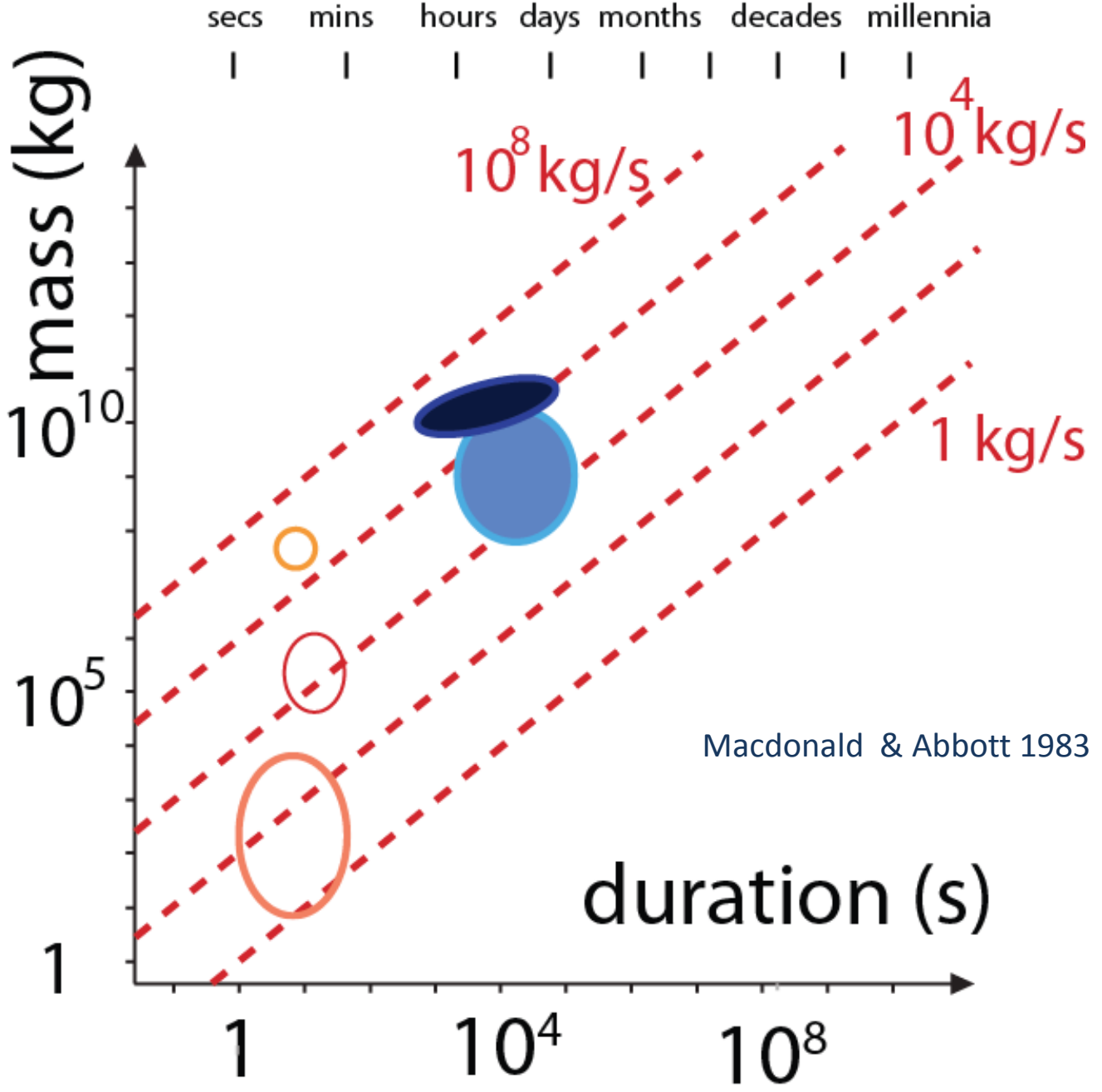
P *Rosi et al. 2006*
Ripepe & Harris 2008
Andronico & Pistoloesi 2010
Pistolesi et al. 2011

M *Gurioli et al. 2013*
Andronico et al. 2013
Rosi et al. in press

N *Chouet et al.1974*
Ripepe et al. 1993

HAWAIIAN FOUNTAINS

overlap in 10^3 to 10^7 kg/s range



Macdonald & Abbott 1983

Distinguished by

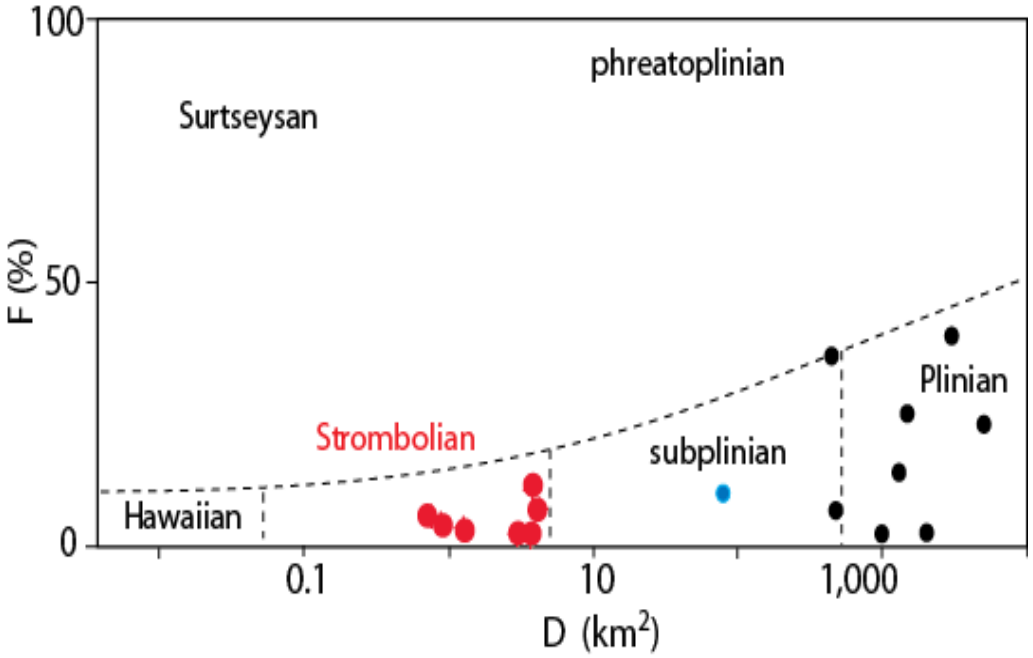
- duration NOT by
- intensity
- (with some caveats)

INTENSITY: Walker approach

measures of:

- fragmentation efficiency
- deposit thinning
- **Strongly driven by dispersal** (as proxy for INTENSITY[Q])
- Dispersal: **magnitude and duration**

Walker 1973



Strengths

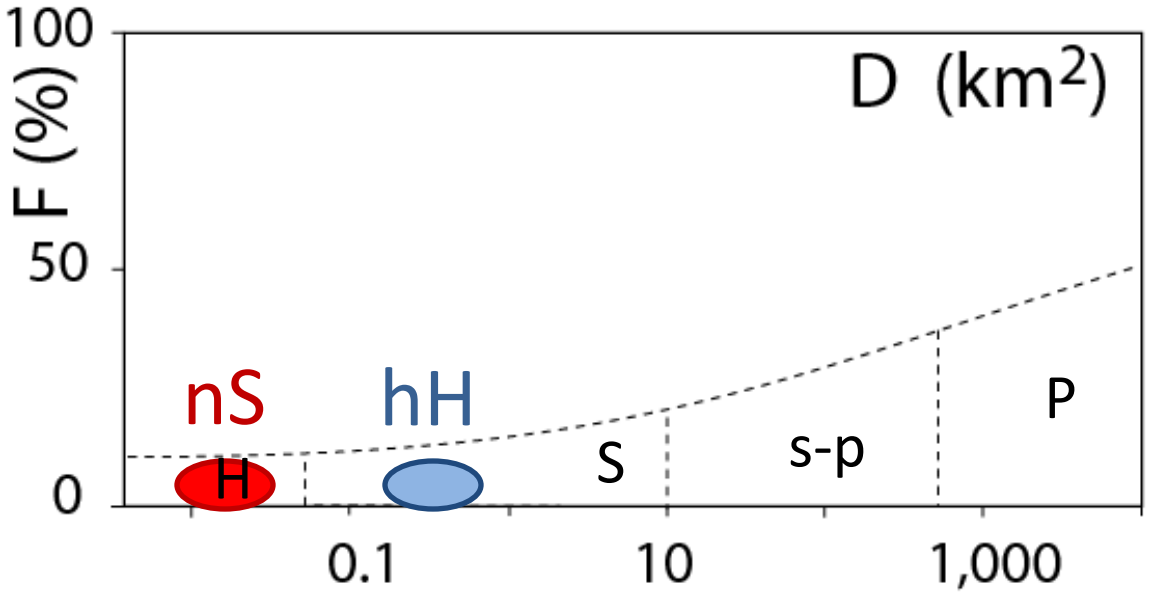
- quantitative
- wide applicability

Concerns

- defined without key data
- Compatibility with measured intensity data
- Time averaged rates

INTENSITY fails because:

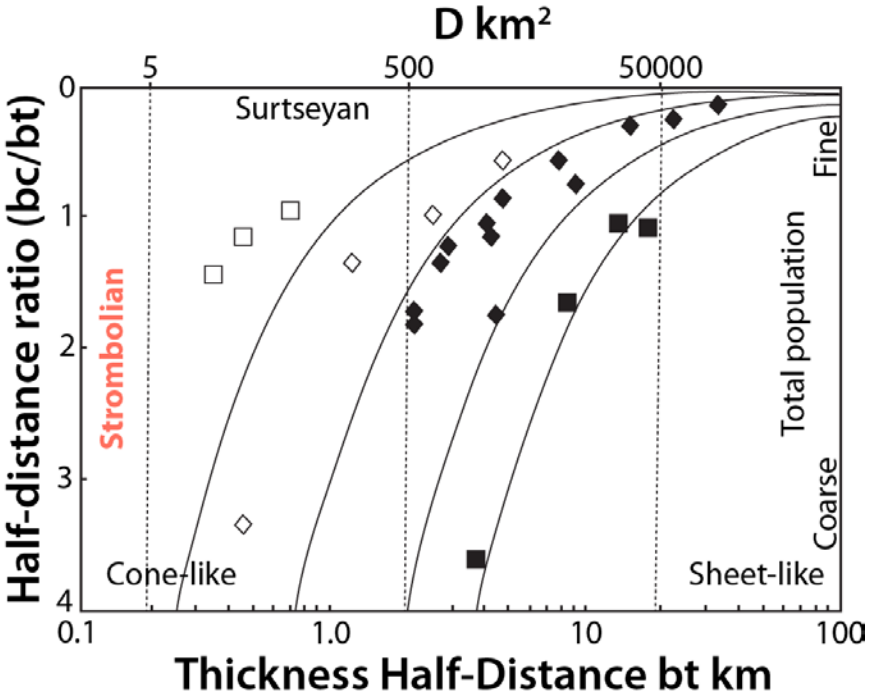
- Cannot distinguish transient versus sustained behaviors (characterizes mass but NOT duration)
- Complete overlap in terms of time averaged Q
- Implication: decouples observed and unobserved events
- Different approaches for different problems



INTENSITY: post-Walker

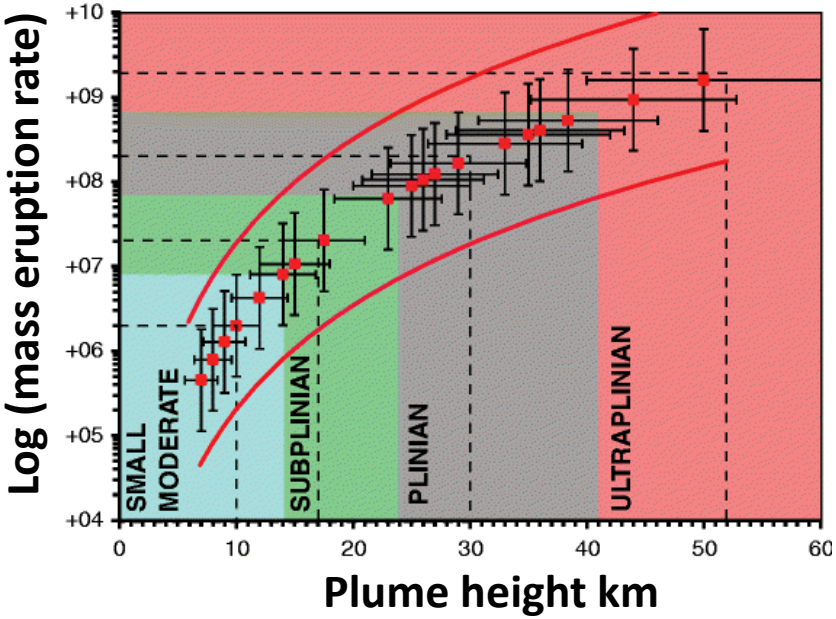
Pyle 1989

- *Strombolian only*



Bonadonna & Costa 2013

- *"Small to moderate"*



OTHER ISSUES 1. styles at Etna

A) Can high fountains at Etna be called ‘Hawaiian’

B) Are the sequences of near-continuous bubble bursts at intervals of seconds ‘Strombolian’.

2. Two of the things at Kīlauea that are definitely not Hawaiian

A. Gas pistoning
B. Collapse-triggered explosions

A

B

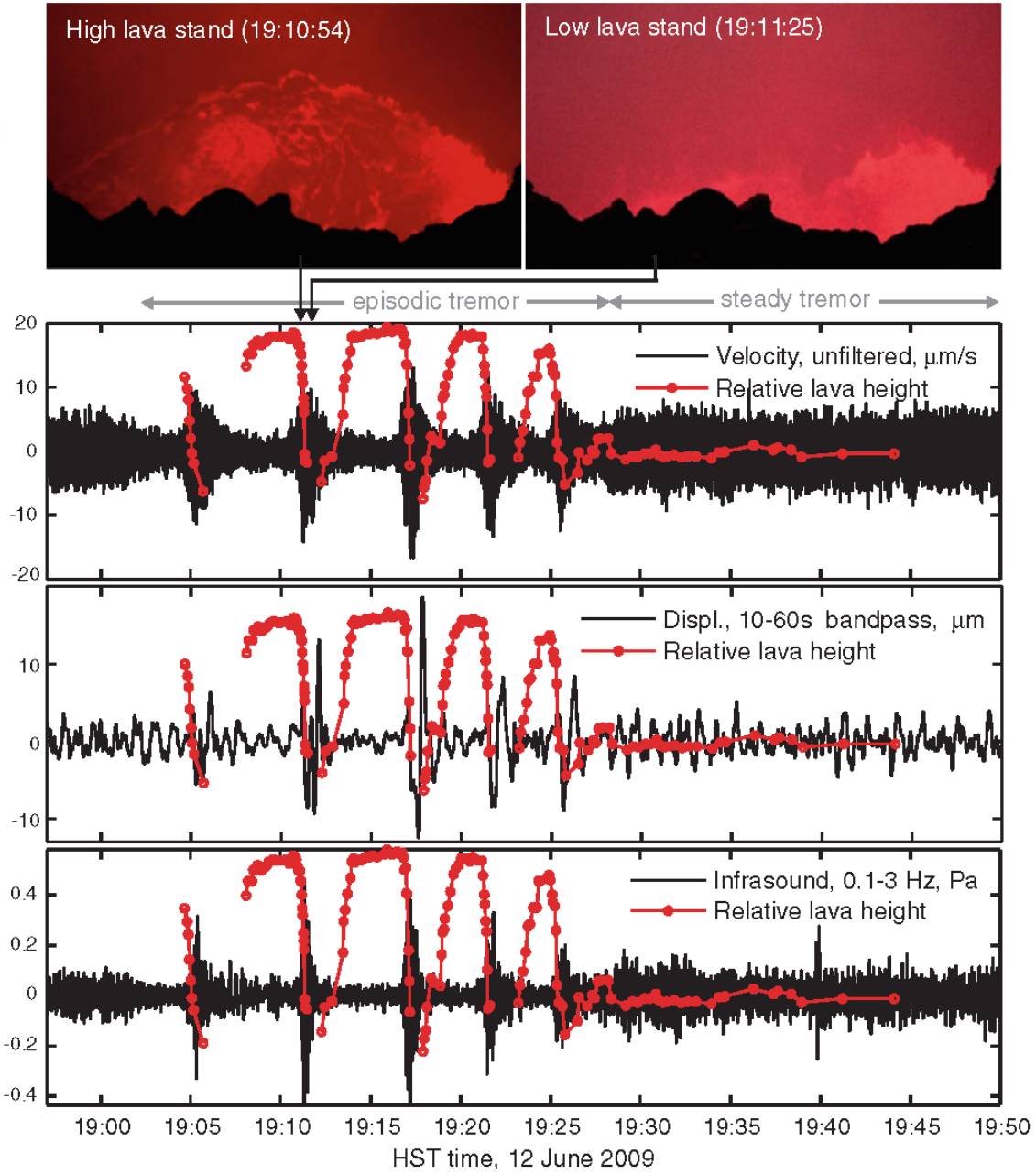
Patrick et al. 2011

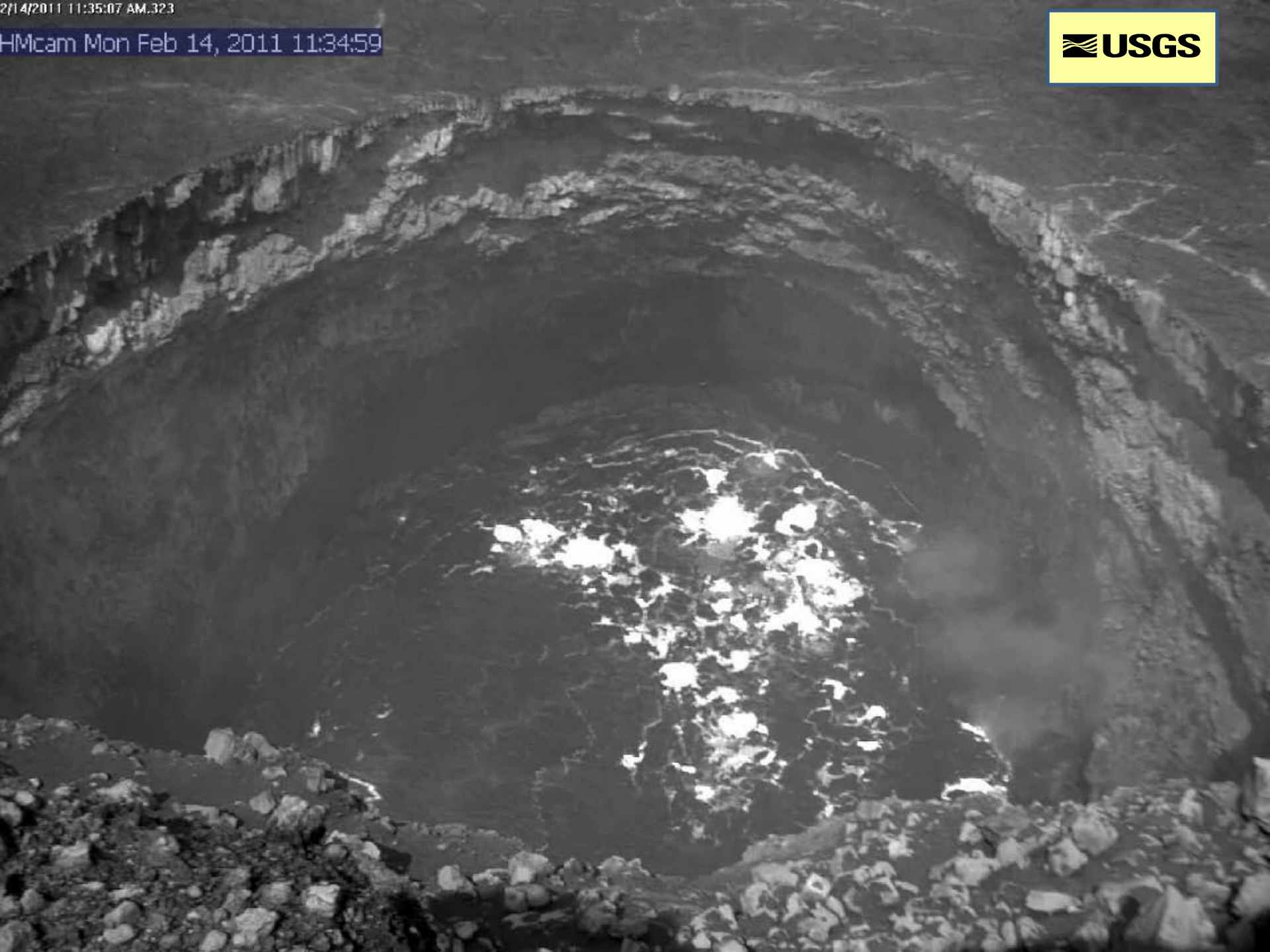
ORIGIN OF EPISODIC TREMOR

5 episodic tremor bursts in 19 m
lava height (red trace) v
- broadband seismicity
- VLP displacement
- infrasonic pressure

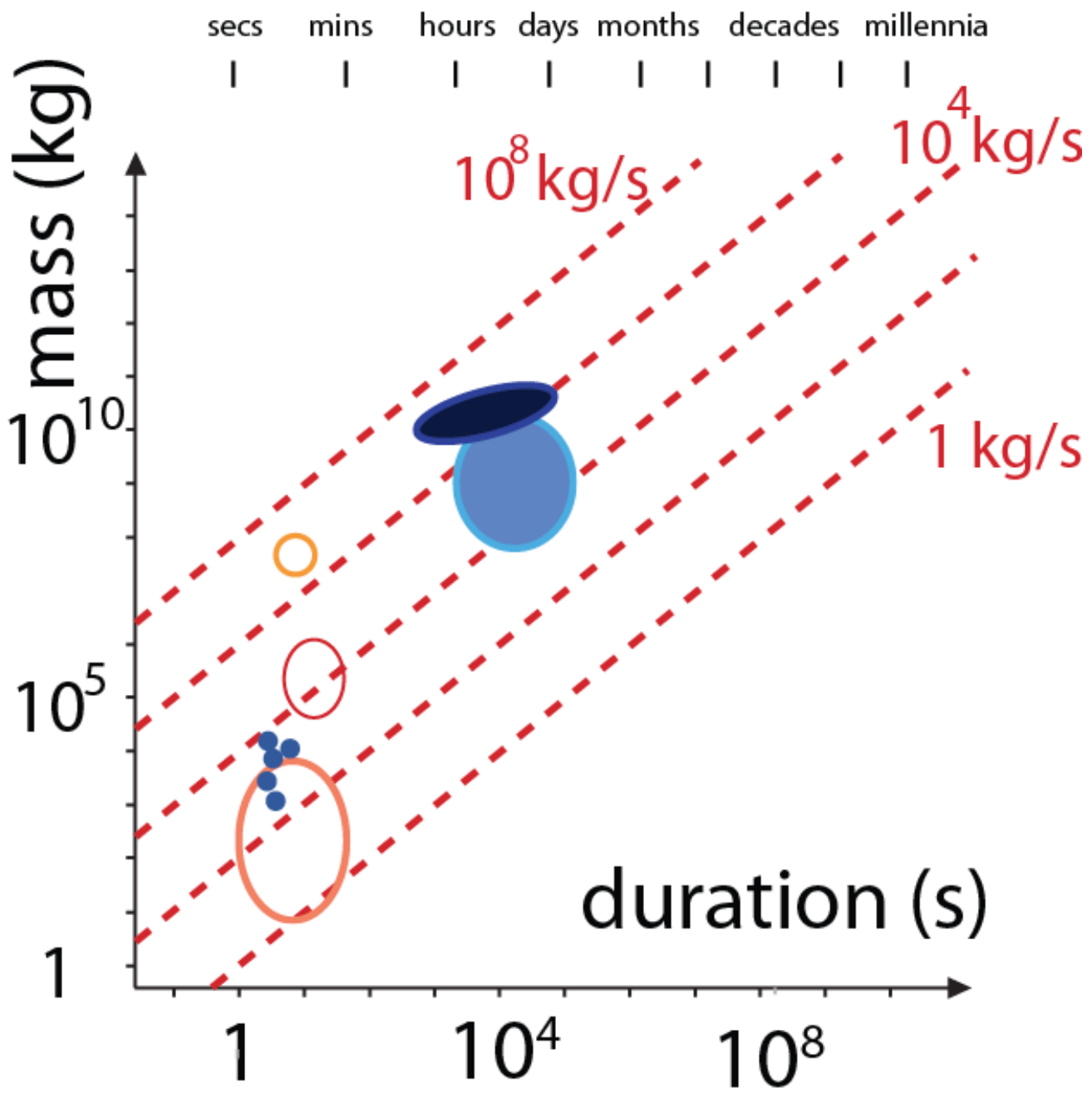
Lava drainage coincides with
- onset of tremor burst
- spattering
- VLP events
- infrasound spikes

Patrick et al. 2012




2/14/2011 11:35:07 AM.323
HMcam Mon Feb 14, 2011 11:34:59
USGS

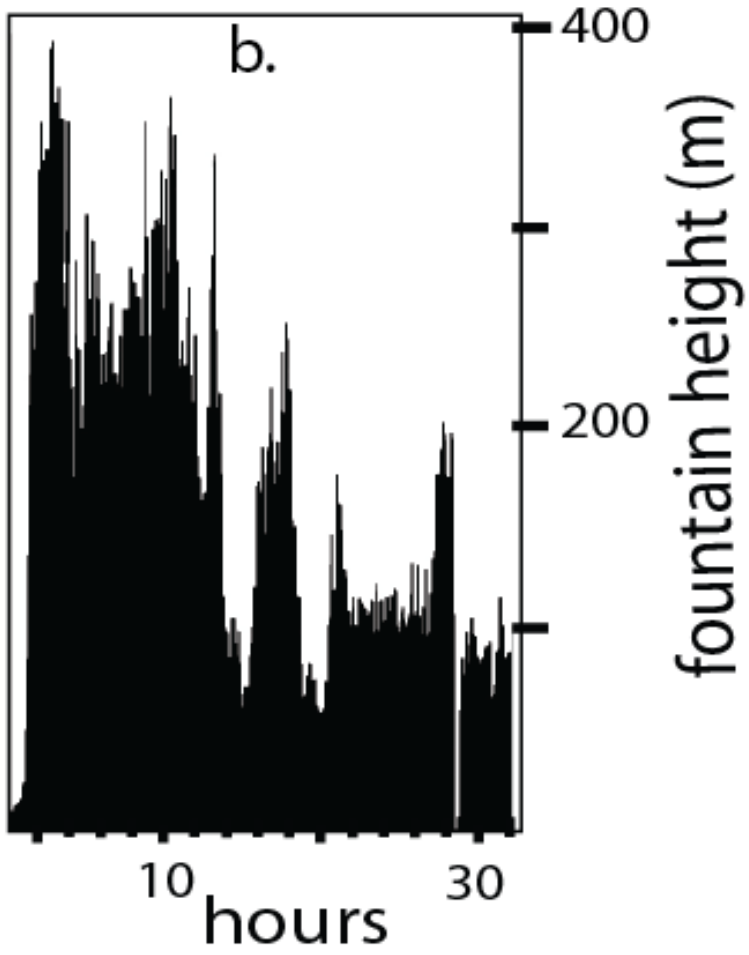
2008 explosions



3. Pulses: Hawaiian

KILAUEA

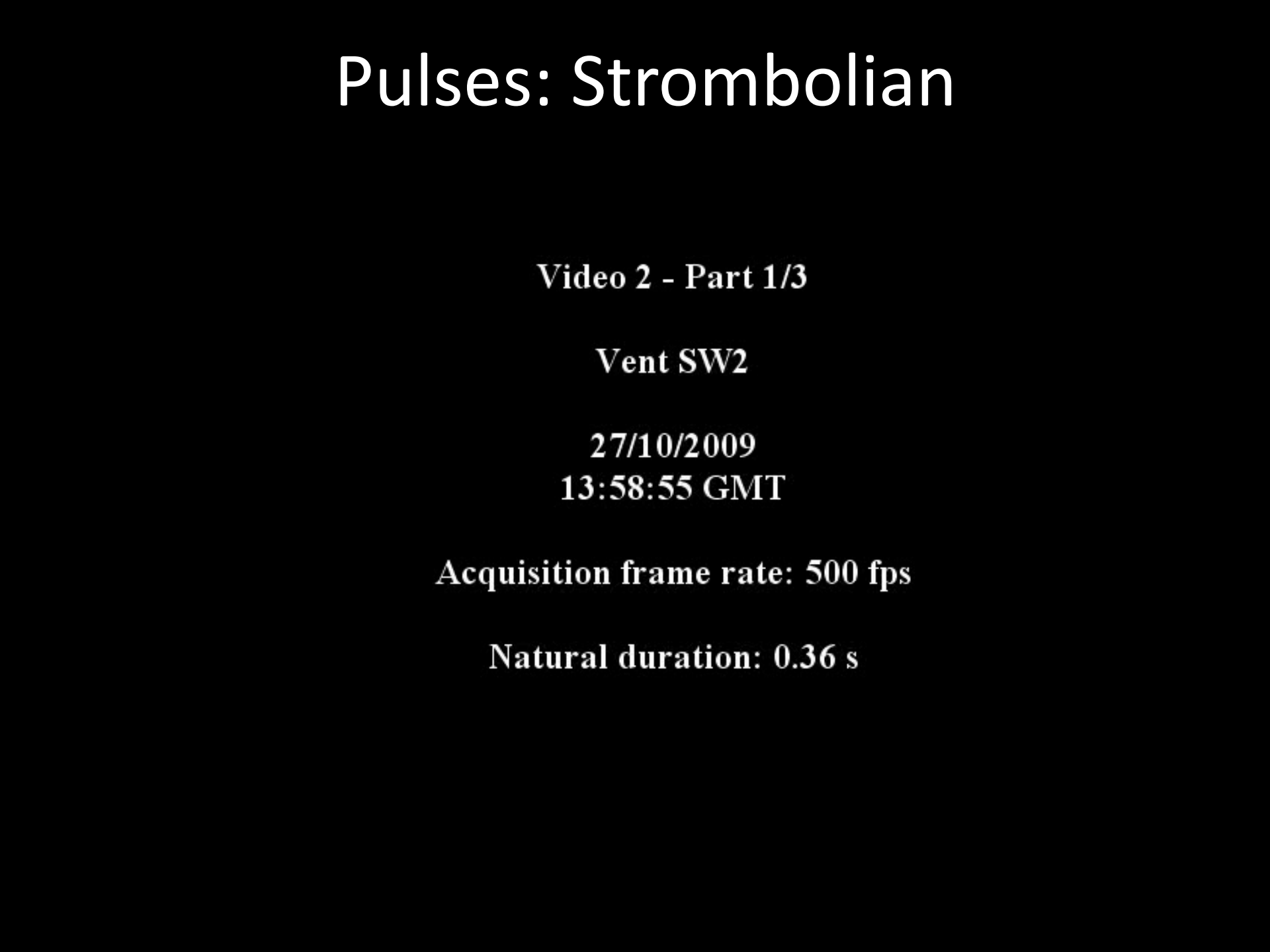
- visually single fountain (32 hours)
- numerous pulses
- non-linear decay of fountain height



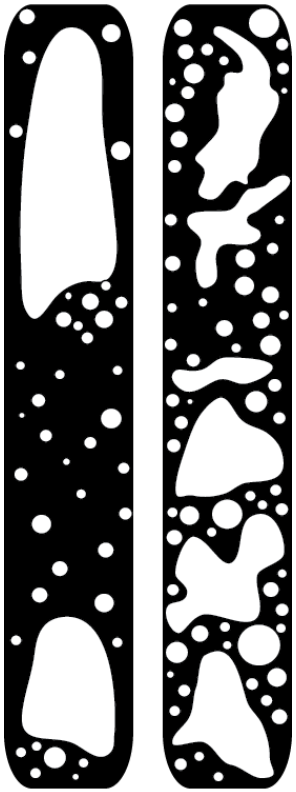
Wolfe et al. 1998

Halema‘uma‘u 5 December 2013

Pulses: Strombolian

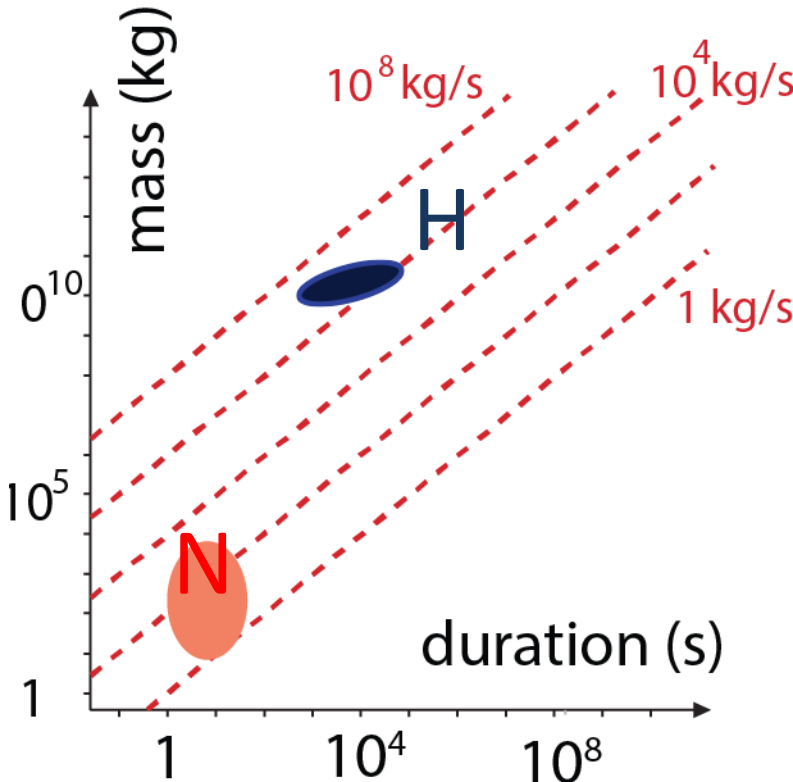


CONCLUSIONS: Very tentative thoughts



- these styles are driven and distinguished not by discharge rate but by patterns of rise and outgassing of gas pockets on second to sub-second time scales
- an intensity approach could only be applied to deposits of normal Strombolian explosions versus high Hawaiian fountains

- Alternatives
  - B& C (2013) “small to moderate” subdivided via a further criteria (like duration)
  - A clean start?



Thank you

M. Alatorre-Ibarguengoitia, M. Burton, A. Capponi, R. Carey , C. Cimarelli, E. del Bello, M. Edmonds, K. Kosinski, U. Kueppers, E. Llewllin, T. Orr, M. Patrick, P. Scarlato, J. Sutton