Lusi: How Long and What Next?

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Outline

1. Introduction to the Geology
2. How long will it last?
3. What next?

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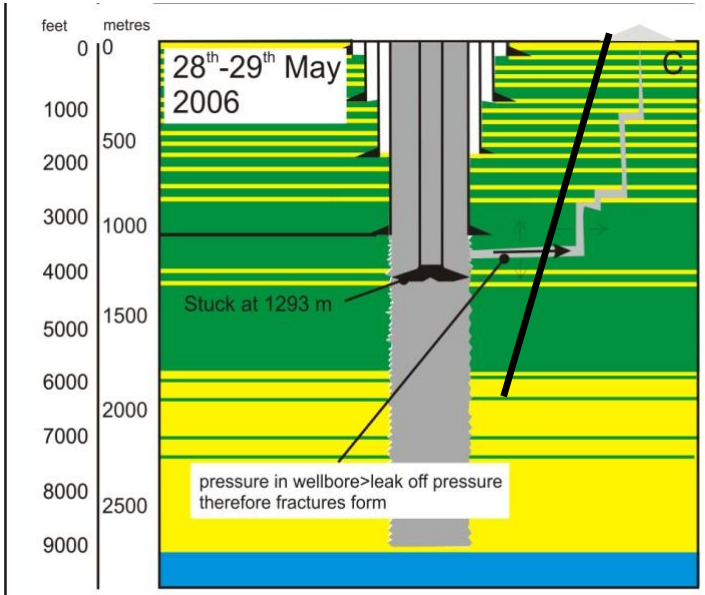
Geology



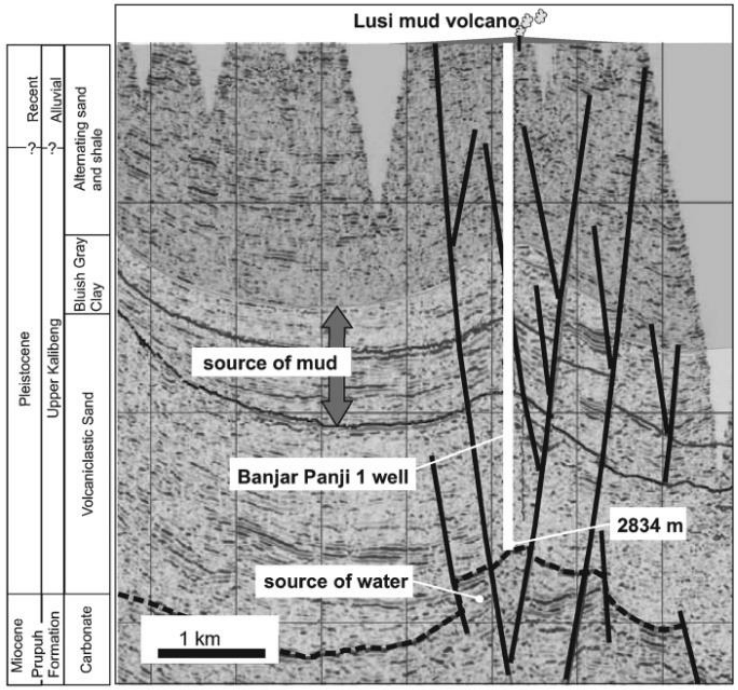


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Table 1. *Ranges for unknown parameters*

Parameter	Minimum	Maximum
Plan area of aquifer, A (km^2)	100	600
Formation thickness, H (km)	0.2	1.0
Porosity, ϕ (–)	0.15	0.25
Initial overpressure ($P_0 - P_w$) (MPa)	13.9	17.6
Permeability, k (m^2)	10^{-14}	10^{-12}
Water fraction of mud, θ (–)	0.50	0.70

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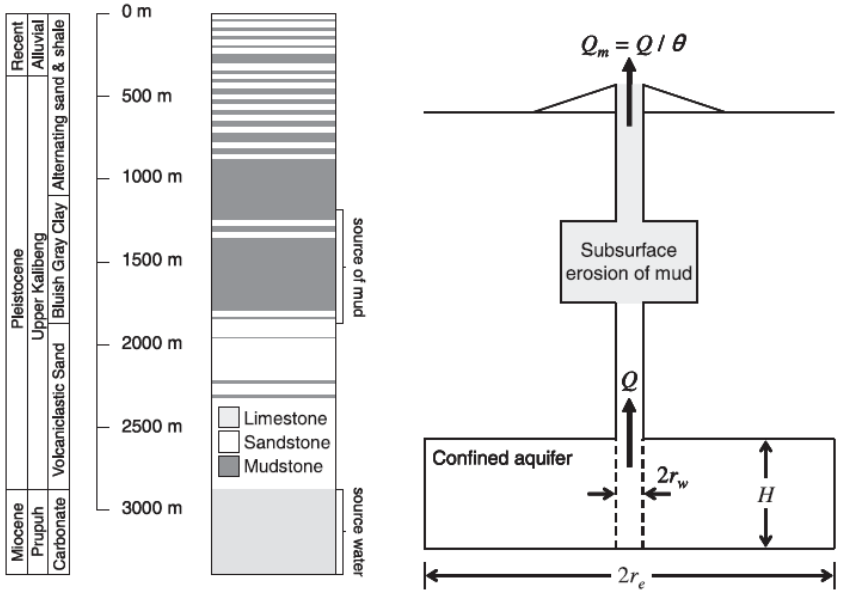
Method and Input

1. Its based upon a model using input such as Darcies Law, 1D radial-flow, reservoir engineering approach (e.g. a water well)
2. Probabilistic , range of inputs
3. Source of water are carbonates at 2500 – 3500 m depth
4. Estimated area 100-600 km^2
5. Thickness 0.2-1 km
6. Porosity 0.15-0.25%
7. Pressure 13.9-17.6 MPa
8. Separate source of mud 1200-1800 m

- Carbonates 'not penetrated', but only formation with sufficient permeability
- Break up of Upper Kalibeng would contribute water



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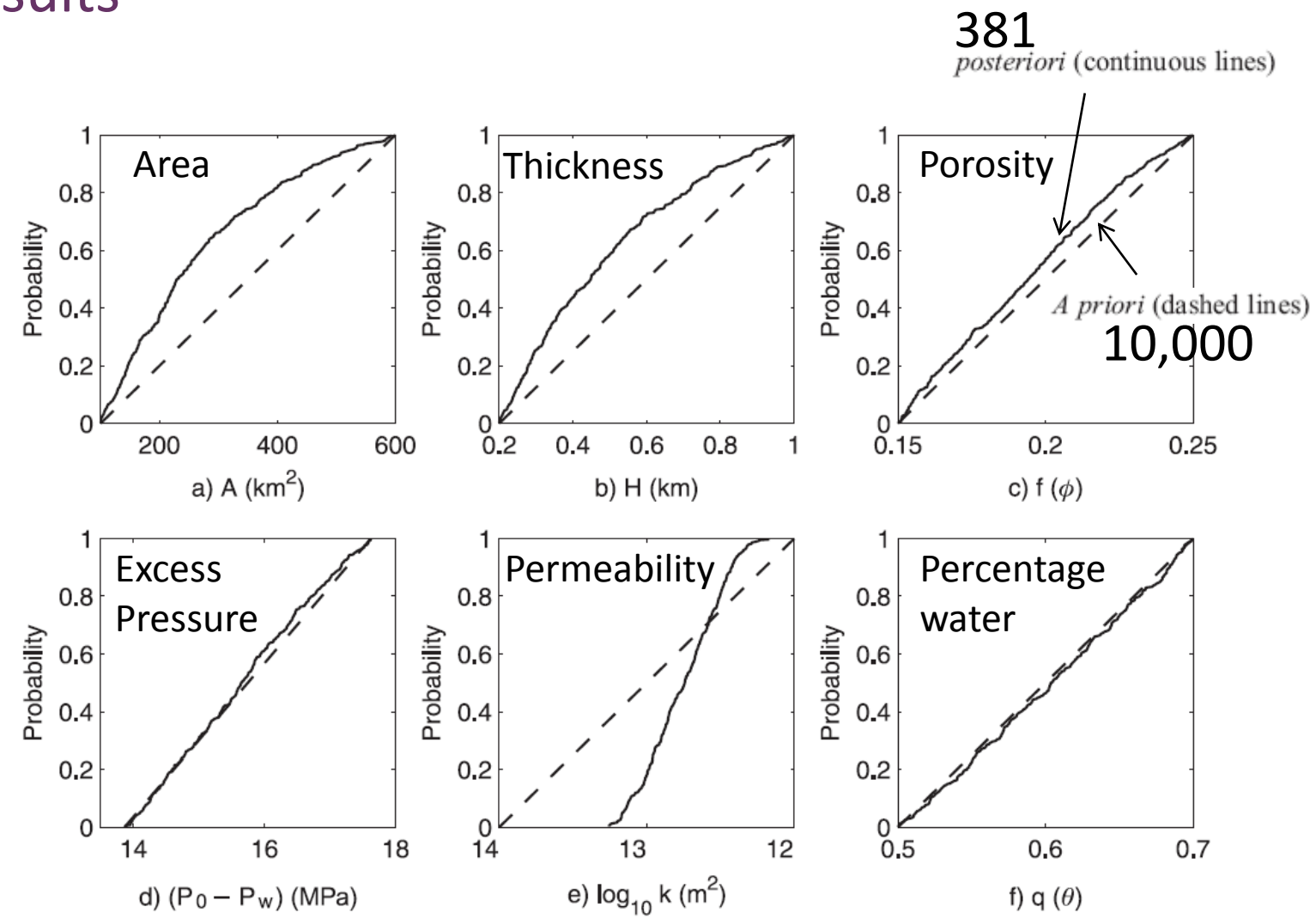
Results



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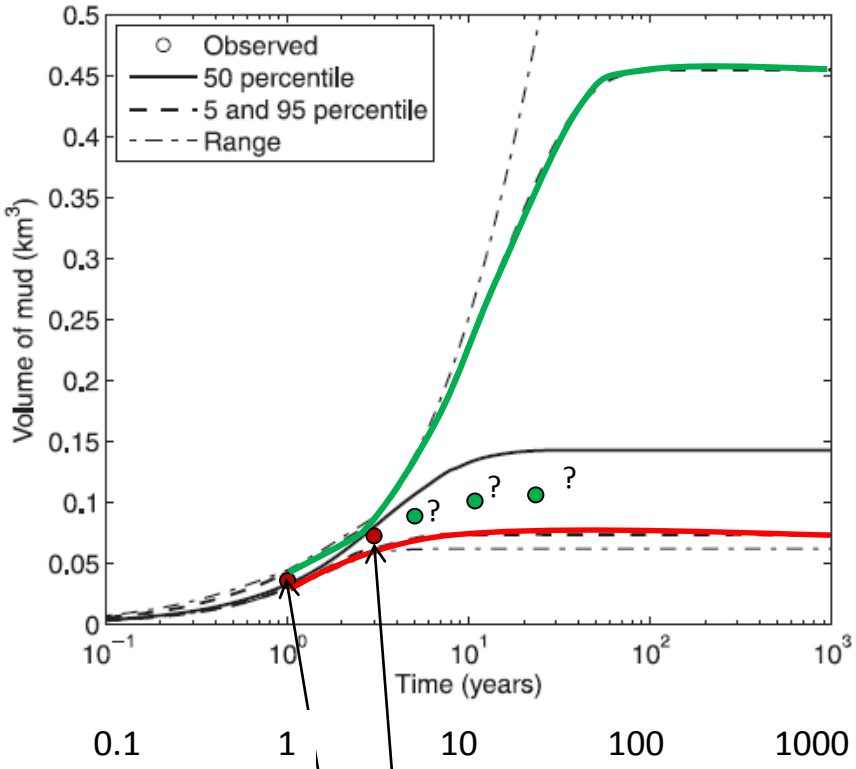
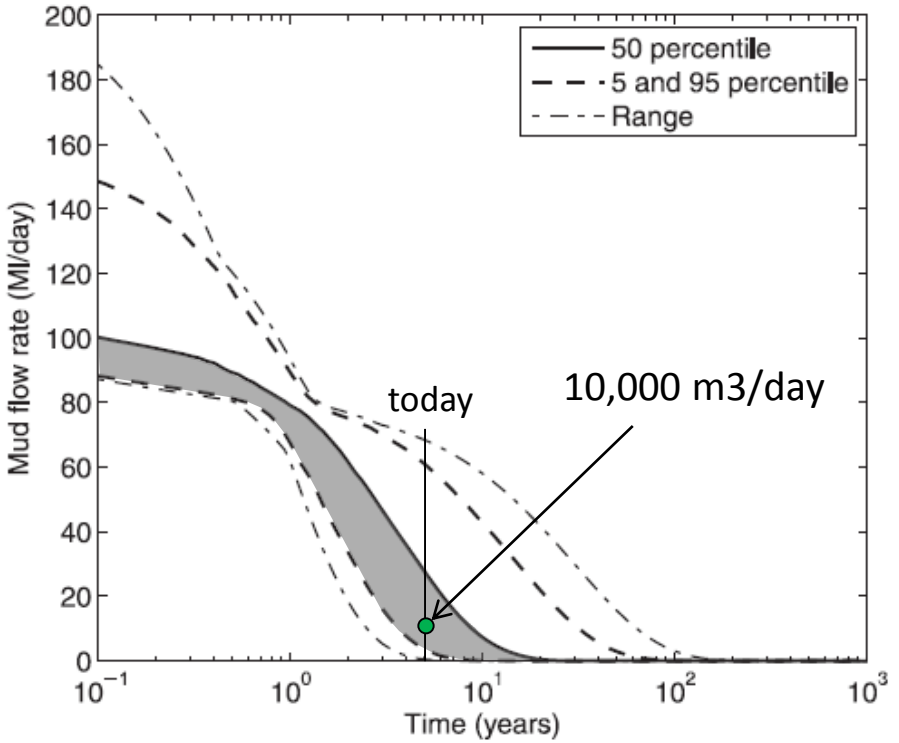
Results

10,000 Realizations but those that failed to reproduce these two data points within 20% were rejected

Reducing to 381 realisations





0.1 1 10 100 1000 0.1 1 10 100 1000

$73 \times 10^6\ m^3$ of mud after 3 years (Tingay 2010). Realizations

$37.3 \times 10^6\ m^3$ of mud after 1 year (Istadi *et al.* 2009)

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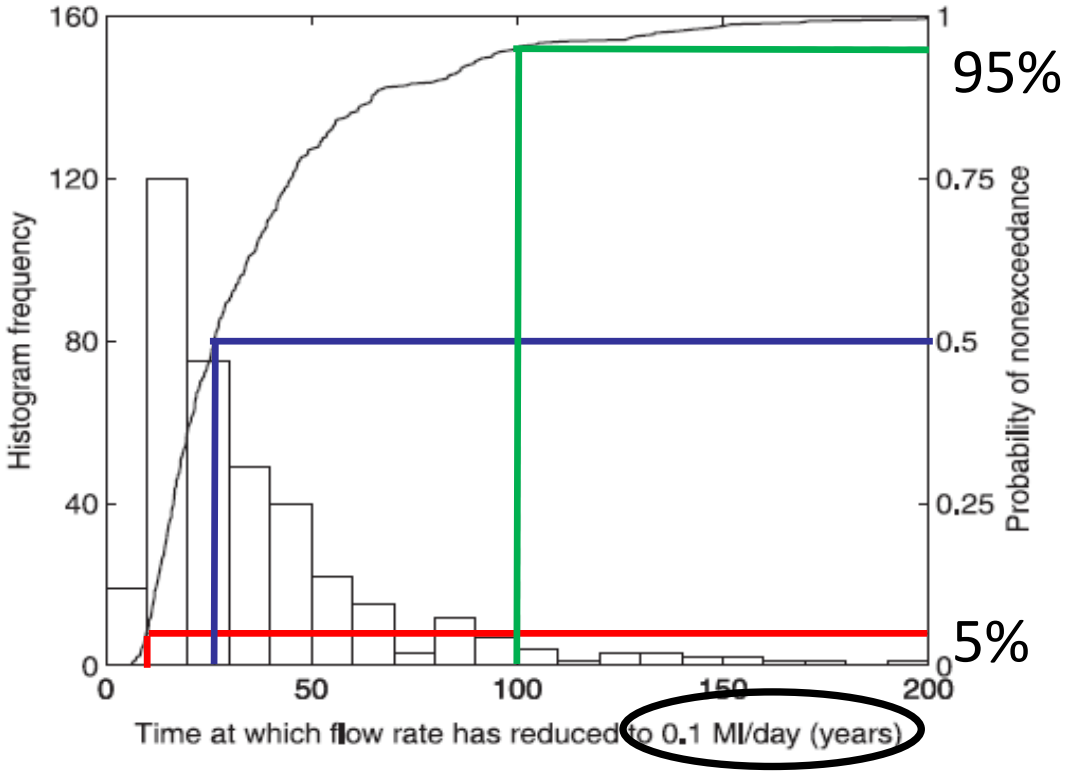
Results



Assumes no recharge of pressure (no evidence for this)

Ignores gas – would increase longevity (provides another lift mechanism)

Ignores role of ‘secondary vents’

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Longevity one of the most important results of our research efforts.

But if the dynamics have changed from overpressure driven, to gas slug driven, then the whole basis for estimating both future eruptive activity and eruption longevity has changed. Experience on igneous volcanoes like Stromboli could be used

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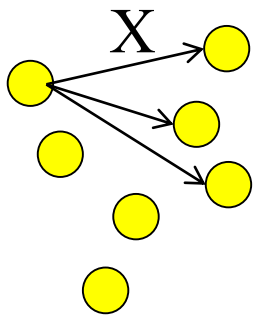
Approach

5-12 m (Lusi data, courtesy of Badan Penanggulangan Lumpur Sidoarjo (BPLS);

Nearest neighbour technique tests randomness in spatial distributions by calculating the ratio of the observed mean distance to the expected mean distance for a hypothetical random distribution to determine whether the points are clustered.

The 2-point azimuth technique was used as a measure of the significance of alignments between vents.



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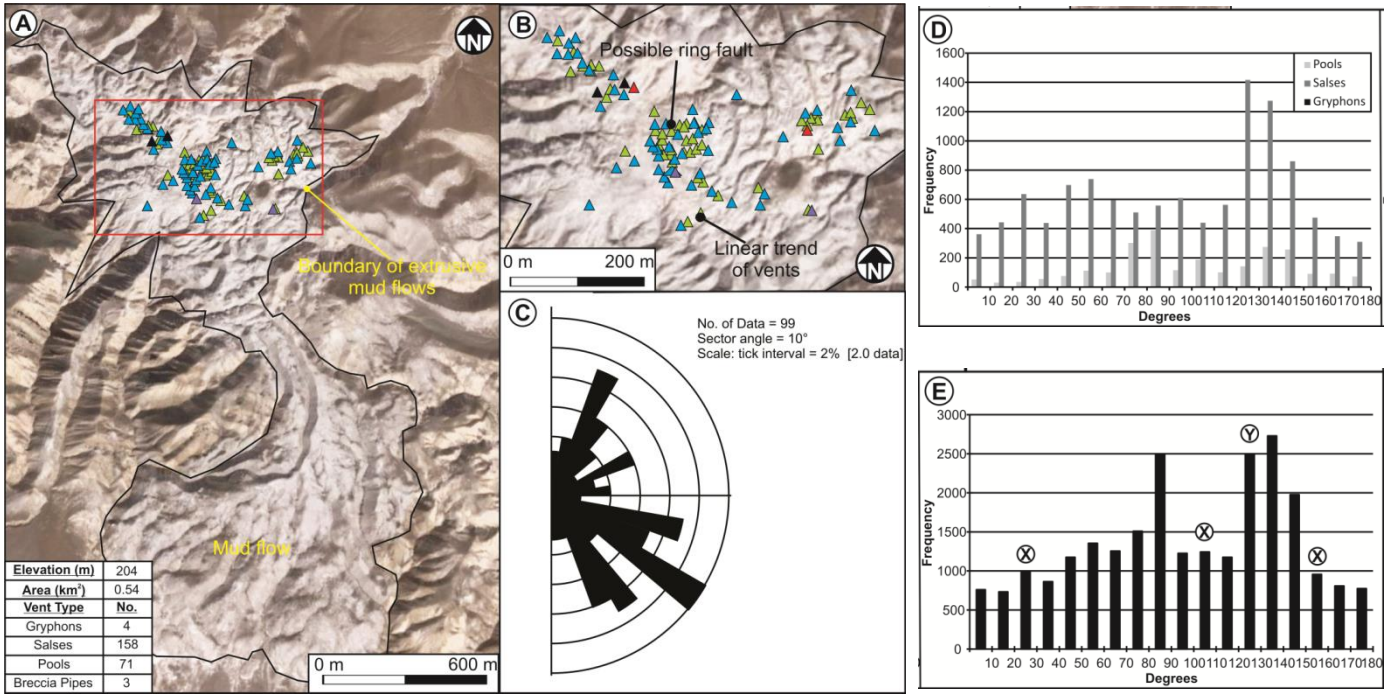
Example from Azerbaijan



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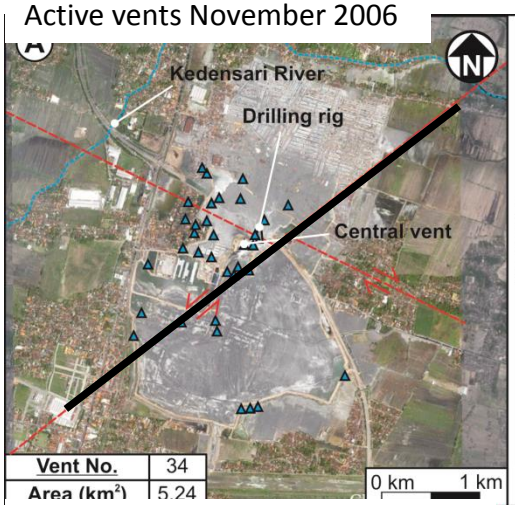
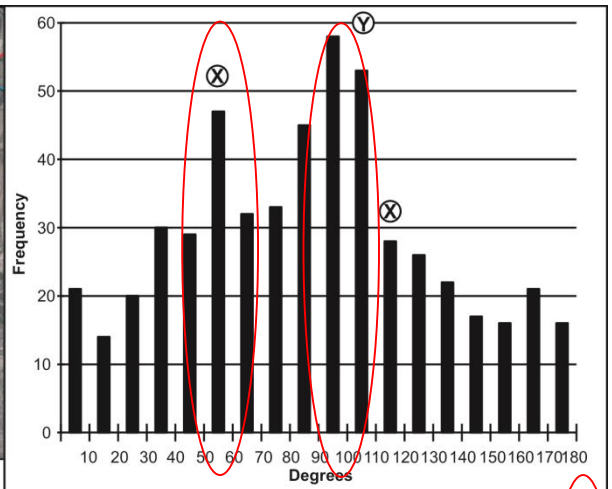
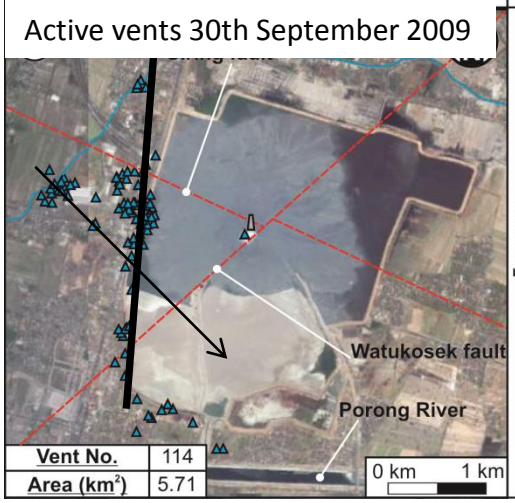
Lusi 2006-2010

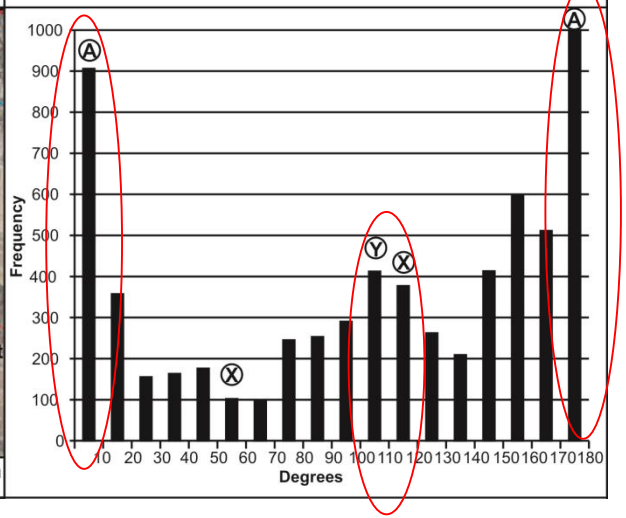
Active vents November 2006



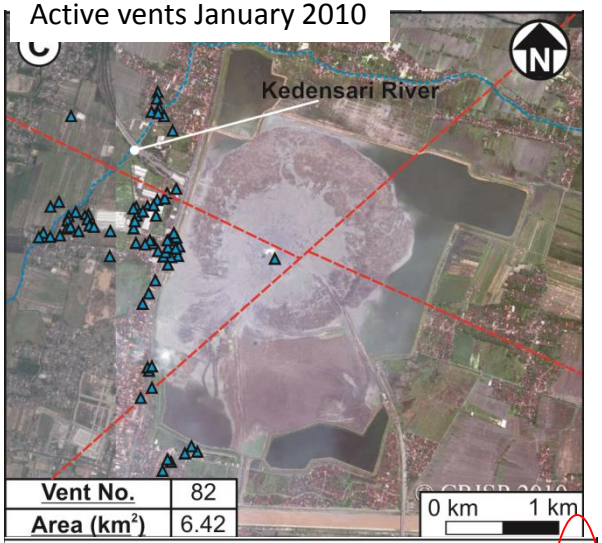


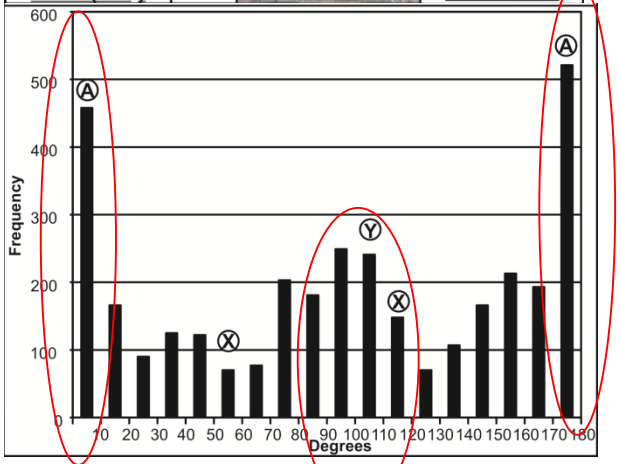
Active vents 30th September 2009





Active vents January 2010





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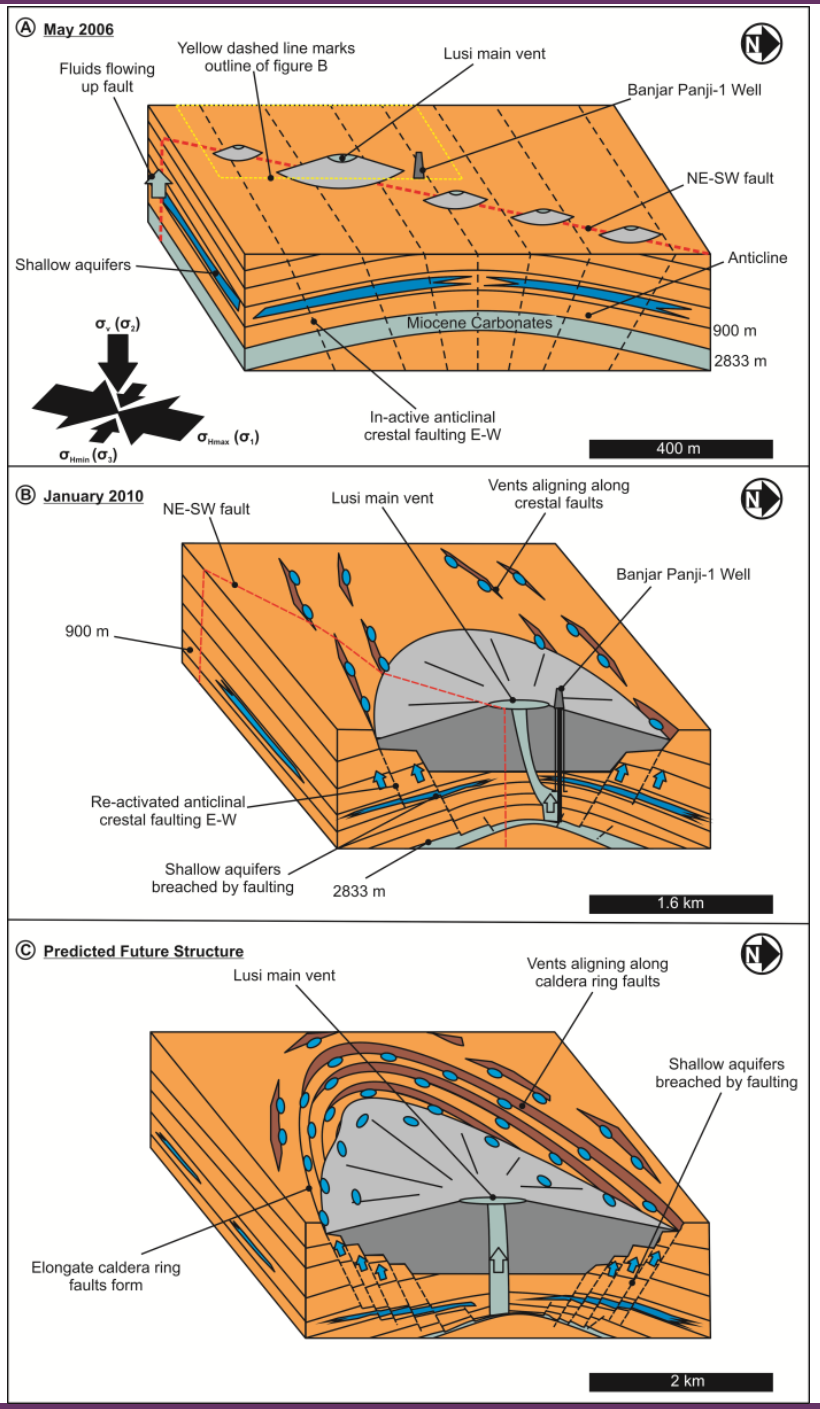
Structural Model

May 2006

Jan 2010

2011 onwards



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What next - ideas

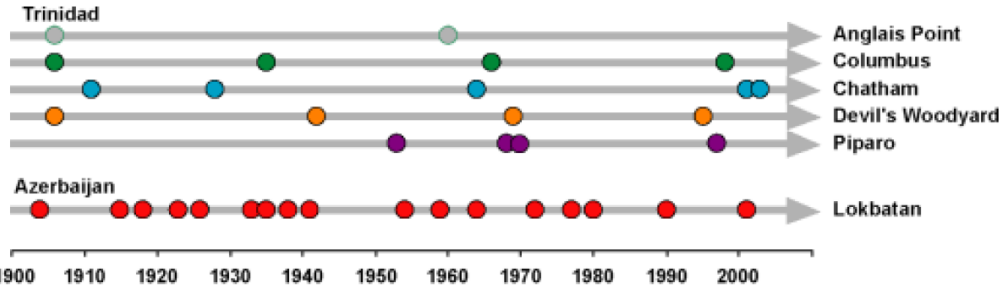
Within the next few years Lusi could slow to very low eruption rates (as predicted)

But natural mud volcanoes go through phases of short duration violent eruption (pressure release).

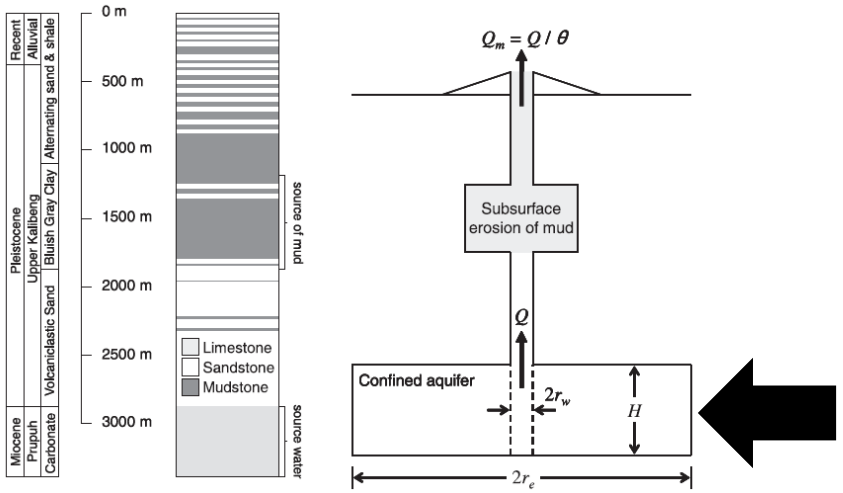
Could Lusi develop clearer phases of activity and dormancy on similar timescales to natural mud volcanoes?

Pressure re-charge?

Dissolved gas may keep very low levels of activity going for several decades



Deville et al 2010, Basin Research



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Idea for more joined-up research approach

Set up ‘Lusi research network (LRN) including people researching Lusi (overseas and Indonesian academics) and key stakeholders. Meet once per annum in Surabaya.

1. Discuss ideas and ensure research impact (we’re working on questions with relevance)
2. Discuss sources of new data
3. New research avenues and potential funding streams
4. Requires fund of $25k(?) per annum and some adminstration

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Thank You

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