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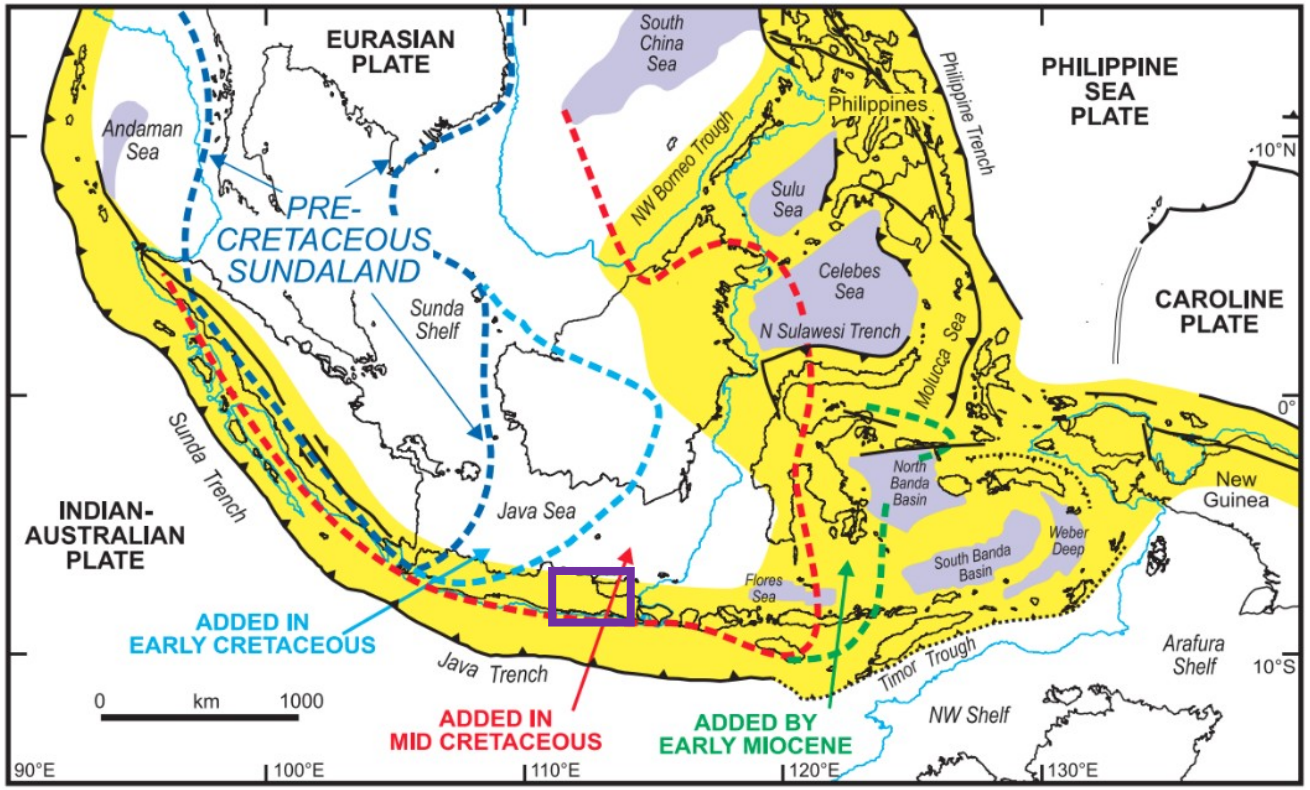
Automatic Detection and Location method of Tremor signals: A case study from East Java, Indonesia.

Sergio Díaz,
Valerie Maupin,
Adriano Mazzini,
Riccardo Minetto,
Matteo Lupi,
Karyono Karyono.

Context

- The case: Mt. Bromo. East Java, Indonesia.
- Main eruption of Mt. Bromo (Strombolian-type) between Nov. 2015 – Jan. 2016.
- Particle emissions. Disruptions in agriculture, tourism, air traffic and others.

Taken from Venzke (2016).



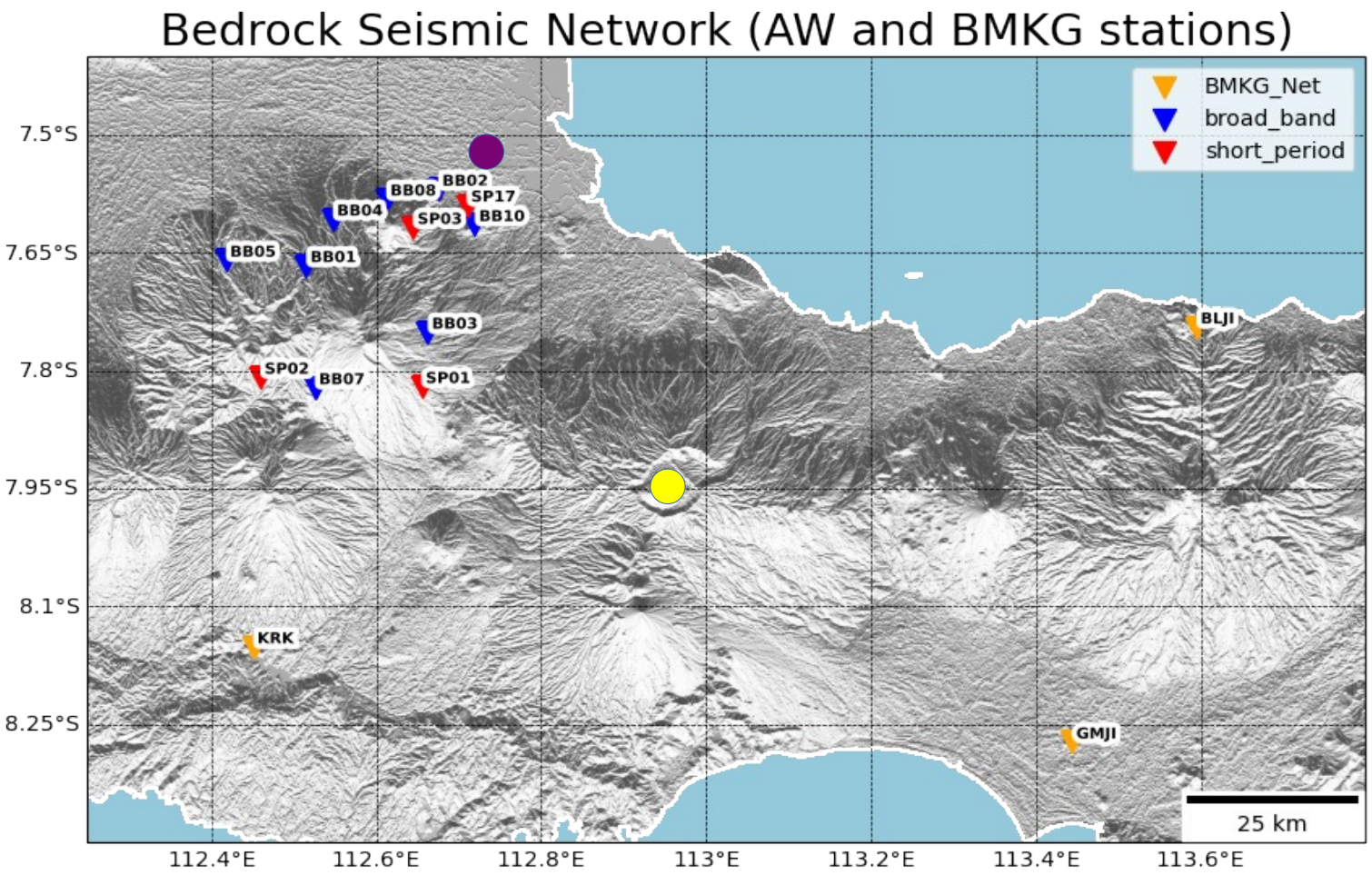
Taken from Hall (2011).

Objective

LUSI-site (s.h.g.s.): multi-c short-period and broadband station.

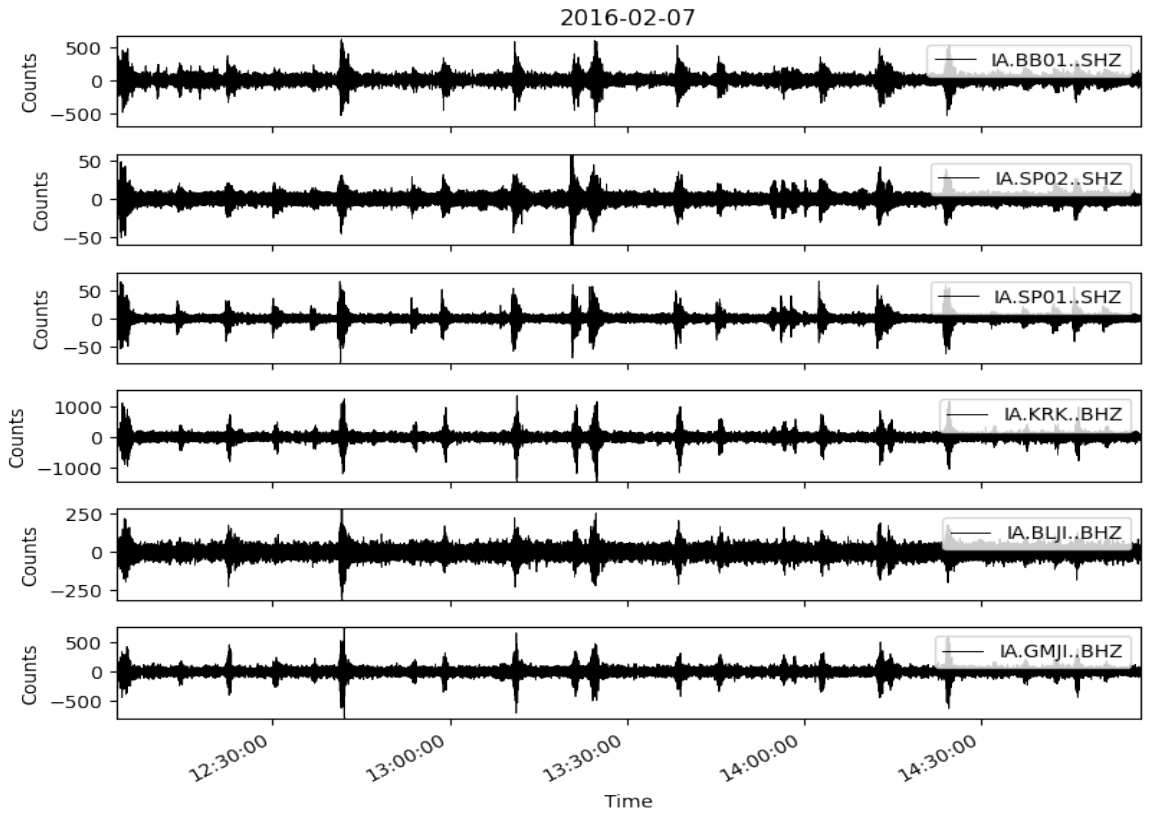
Advantage to study Mt. Bromo: + permanent stations (national observatory).

- Investigate the origin and characteristics of the signals recorded by a designed automatic processing routine.
- data: continuous 2 years of records (2015-2016), including the eruption period.



Method

- Found coherent signals (0.3 – 1.5 Hz).
- Detection by using a MCCT:
- Recursive STA/LTA trigger method in individual components per station.
- Creates a signal window (Start-End). Then evaluating the overlap across components (2 out of 3).
- Associate (20 sec window). All picks falling in a windows are associated to the same event.



Method

- First-arrival pick problems since they are Tremor signals (no clear onset).
- Polarization Analysis from particle trajectory around the first-arrival picks to rectify.

2 sec window around arrival-pick.

Covariance Matrix; Eigenvalues and Eigenvectors.

Rectilinearity and Planarity. We can classify P and R picks.

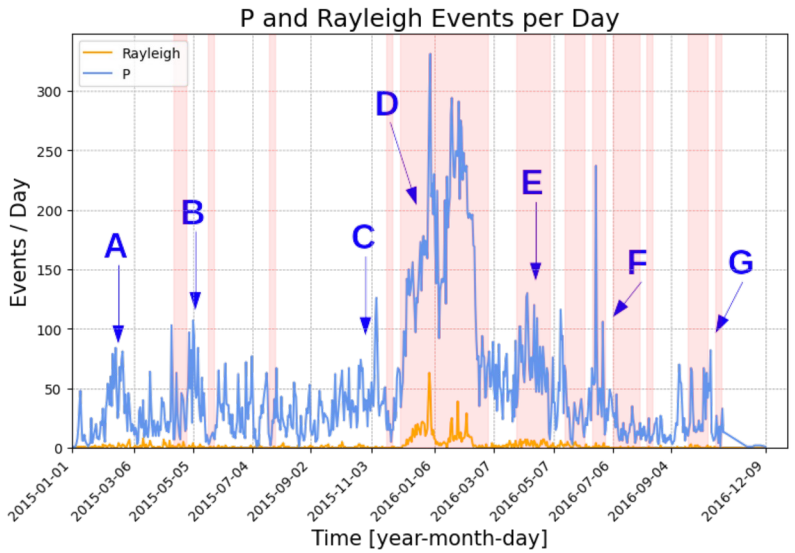
- P wave: Rect & Plan >= 0.9 λ_2/λ_1 & λ_3/λ_1 <= 0.2
- Based on experiments with tectonic events (clear P and R wave arrivals).

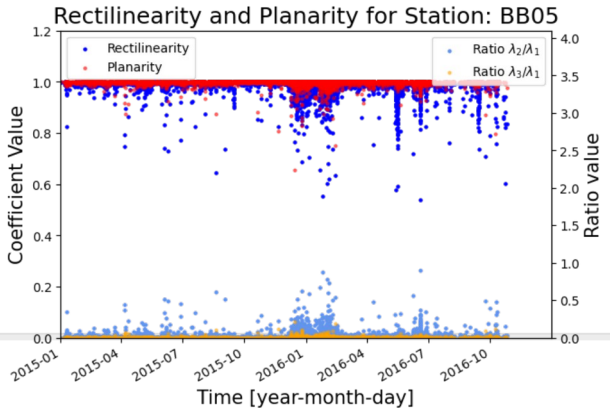
$$Rectilinearity = 1 - \frac{\lambda_2 + \lambda_3}{2\lambda_1} \qquad Planarity = 1 - \frac{2\lambda_3}{\lambda_1 + \lambda_2}$$

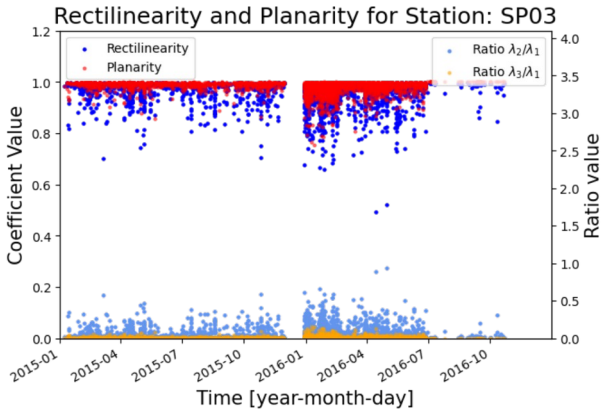
Results

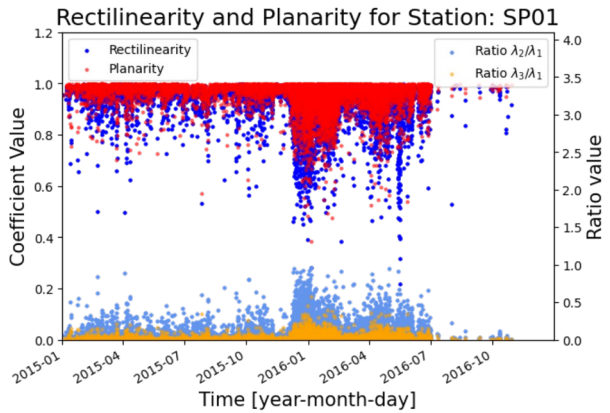
- Seven Peaks identified.
- (D,E,F and G from eruption periods).
- Increase in number of R waves (Rect.Plan).

Only P wave events were located (Non Lin Loc; Lomax, 2004).



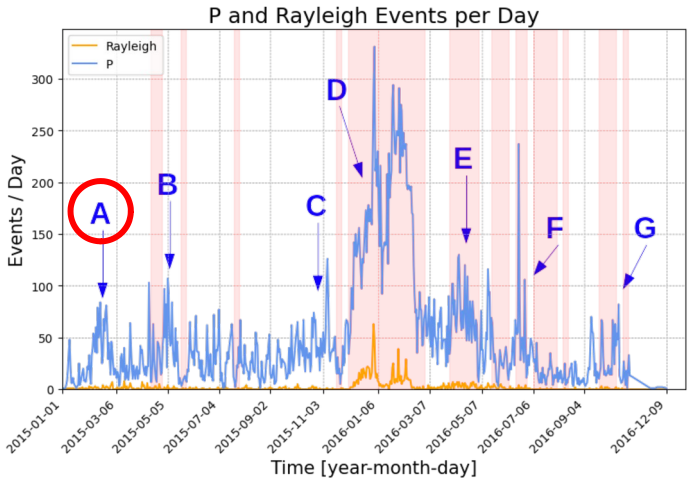


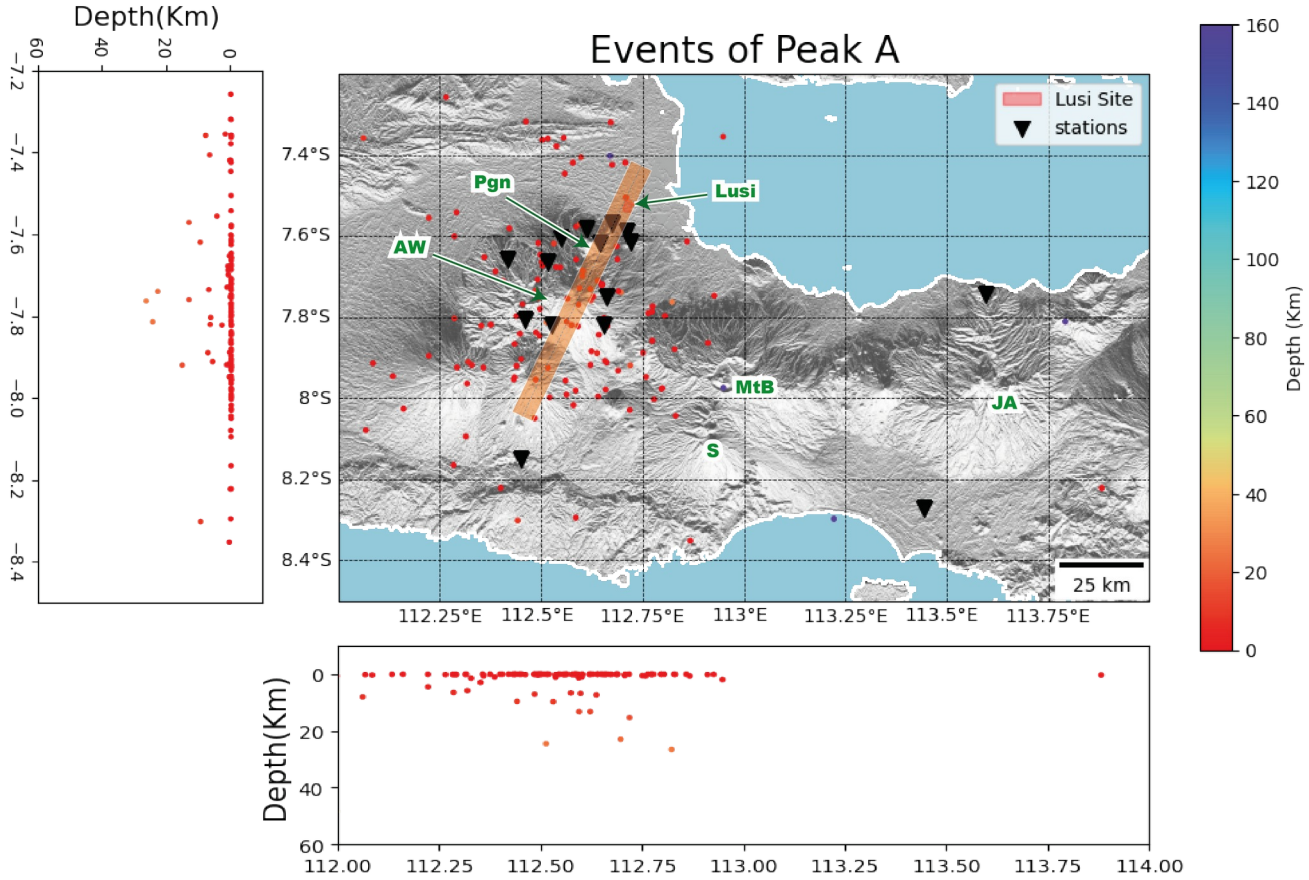




Peak A

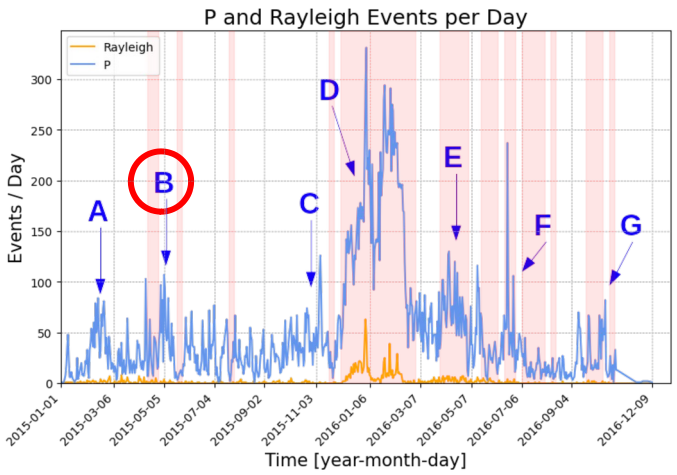
- No associated with eruption.
- Sources from AW and local events.
- Moho at 35-50 Km depth (Wölbern & Rümpker, 2016; Rosid & Ramadhanti, 2019).
- Connections with Mt. Bromo at depth.

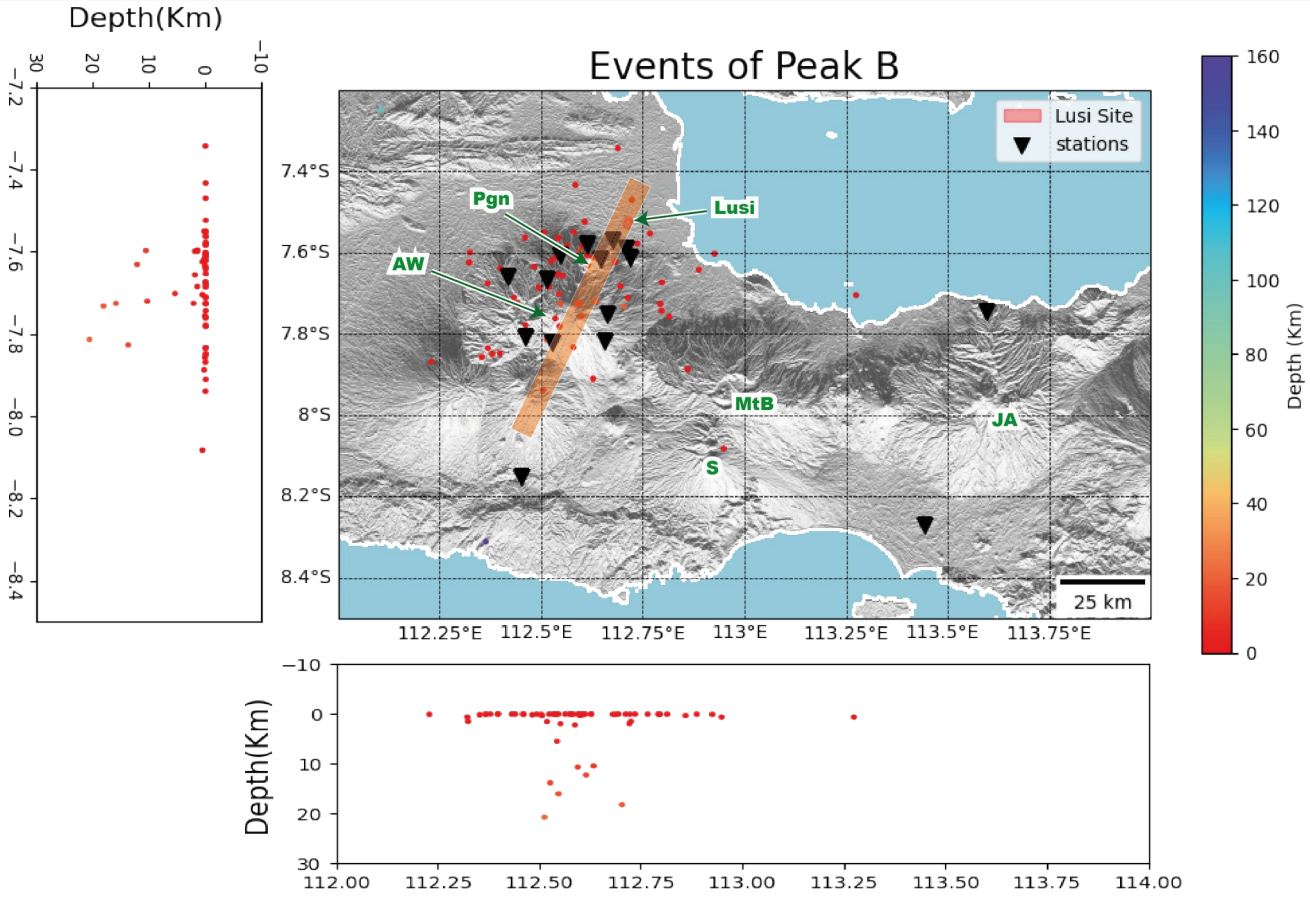




Peak B

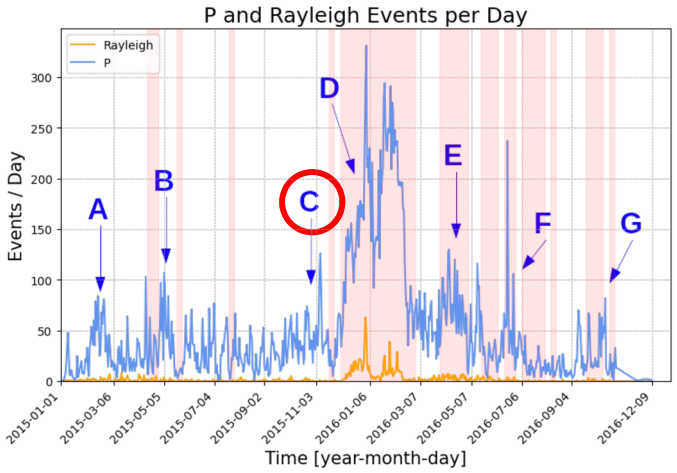
- No associated with eruption.
- Same AW sources.
- Possibly no locations elsewhere due to gaps in the permanent stations.

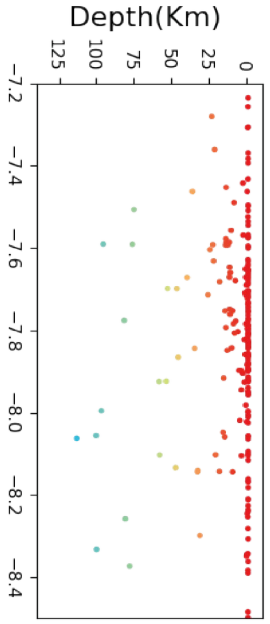


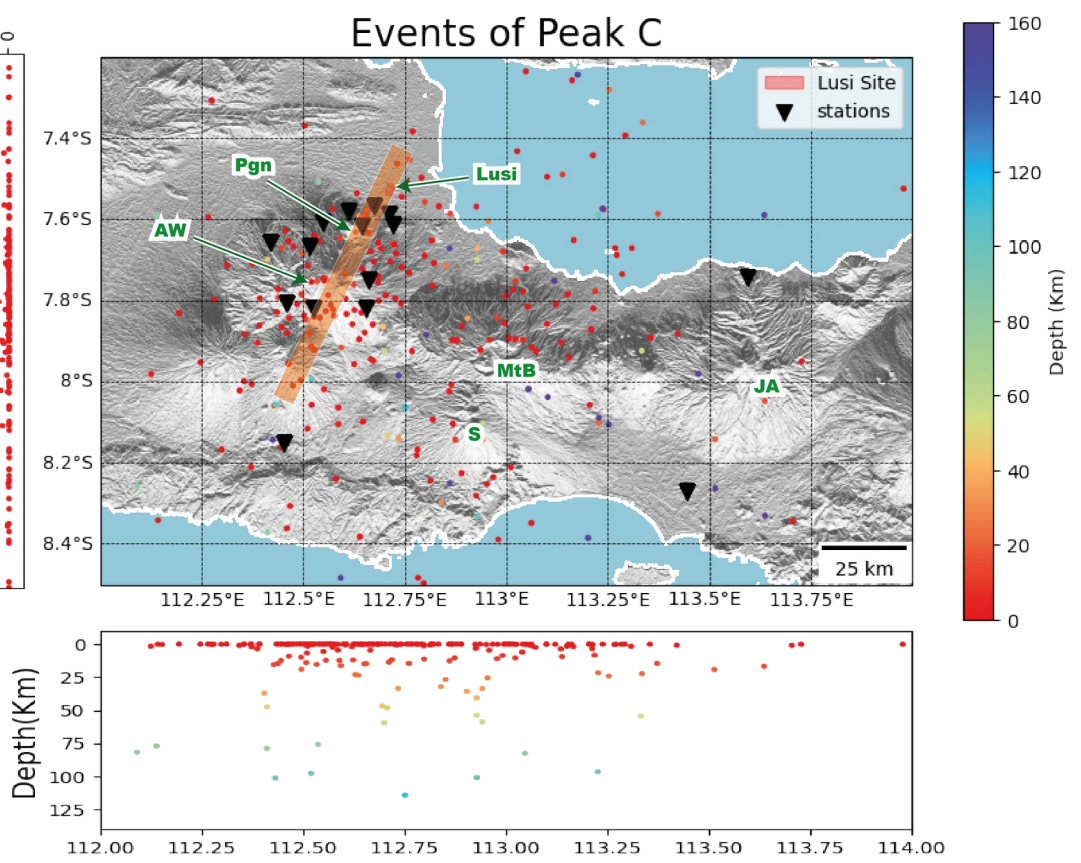


Peak C

- Sources from AW and Mt. Bromo.
- 1-6 min of duration.
- Some are following lineaments (crater, southern uplift).
- Several VT (clear P onset, lack of R).
- Precursor to main eruption. Also seen in Strombo-type volcanoes (Java).

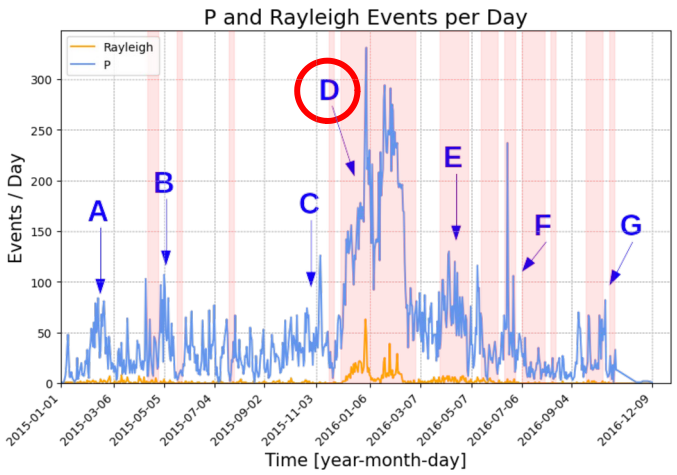


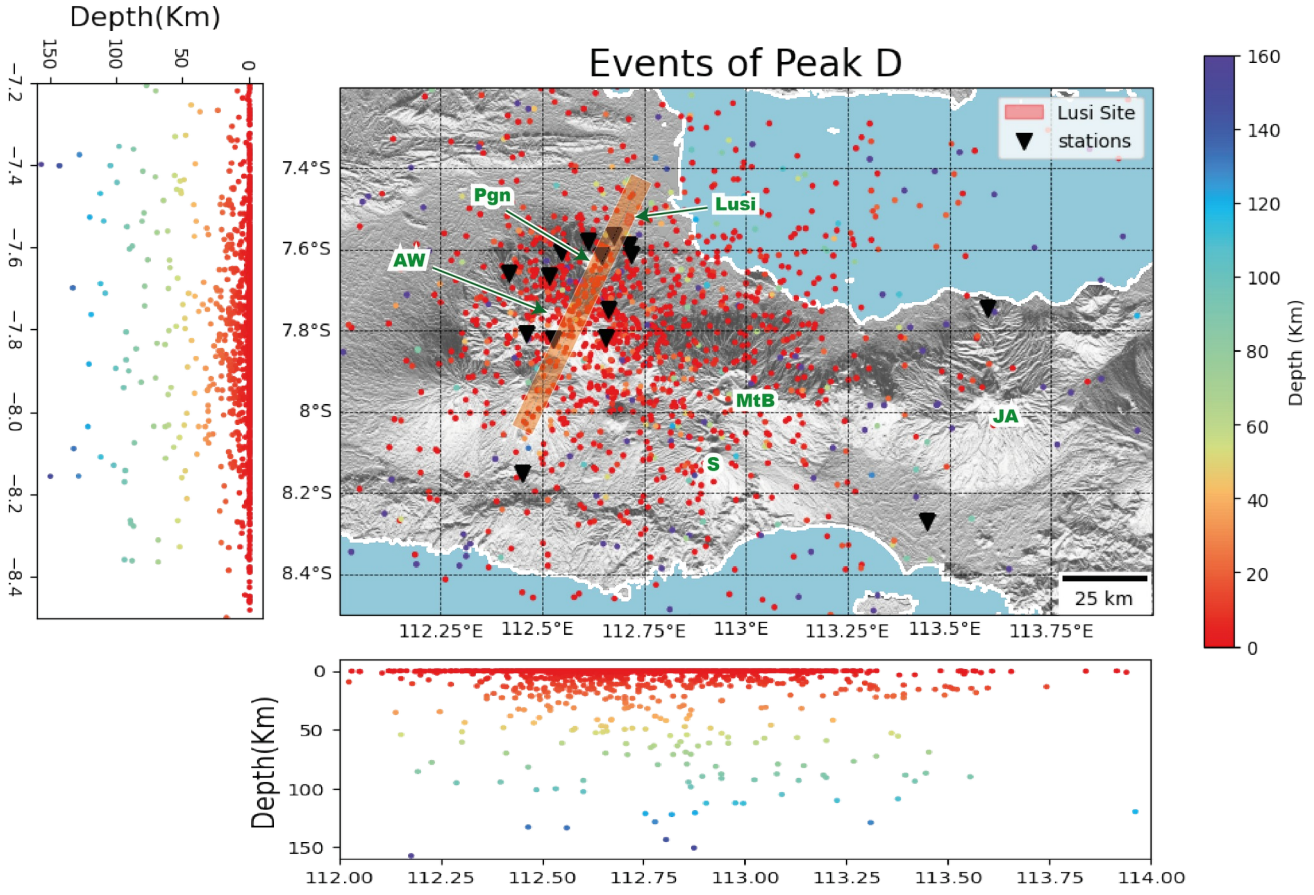




Peak D

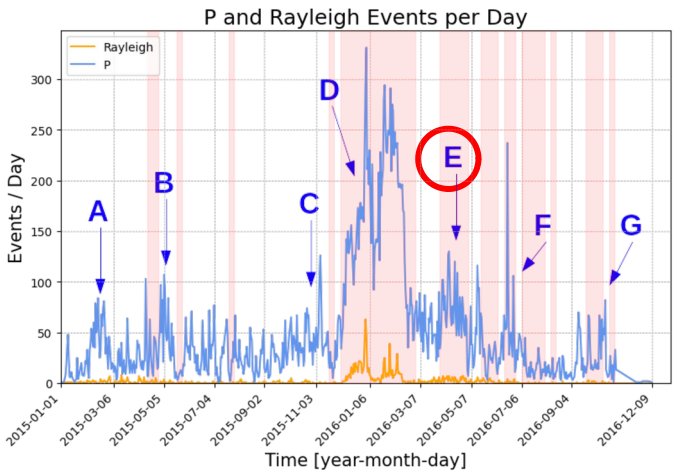
- Main Event.
- Some VT, but mostly fragmented tremors (no clear P-wave onset, polarization analysis, 2-4 min of duration).
- Multiphase-events (Hybrids). Explosion and particle emission.

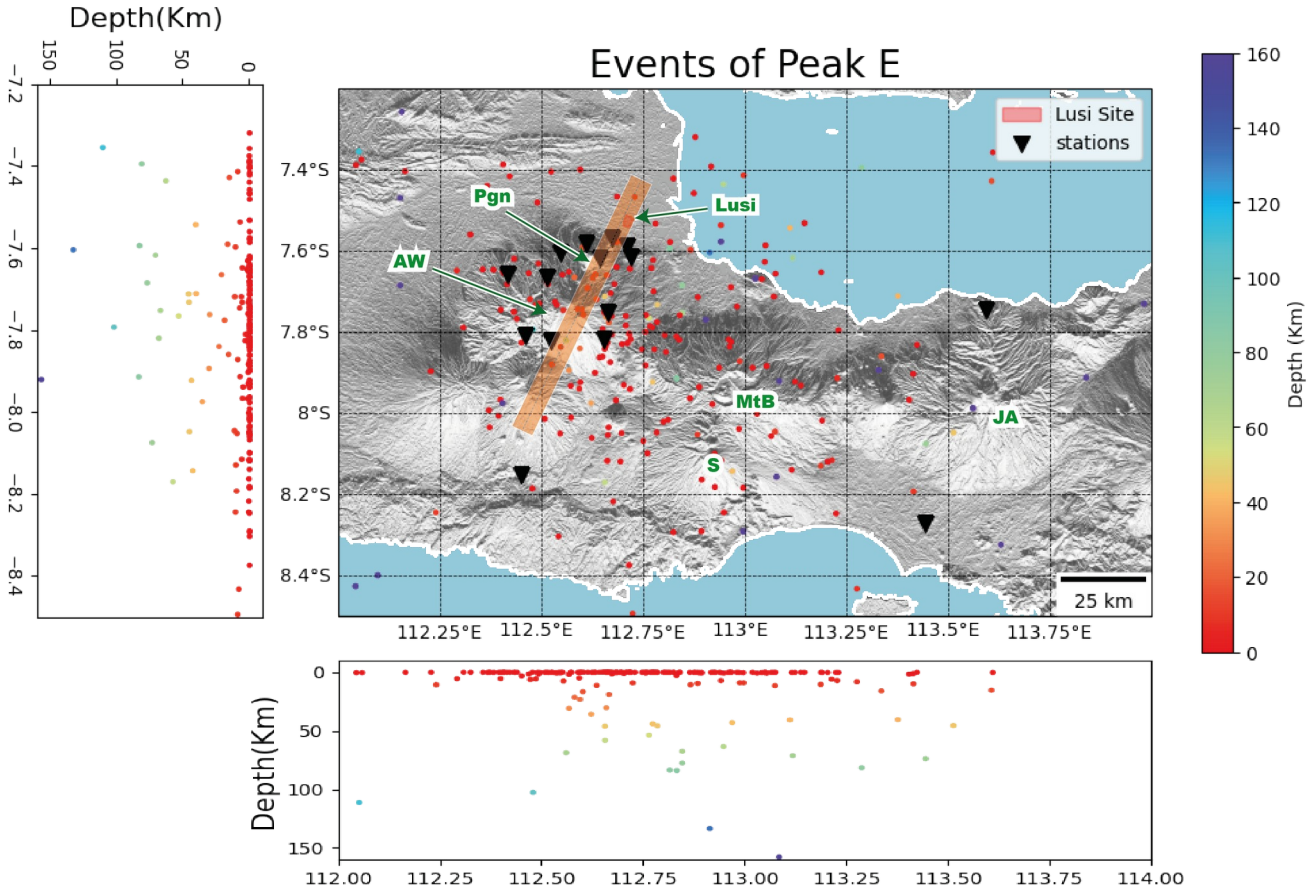




Peak E

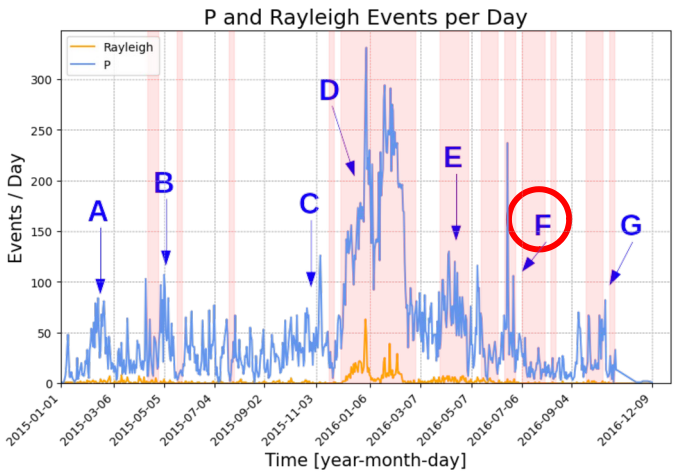
- Continuation of eruption.
- Same as Peak D but with less amplitude.

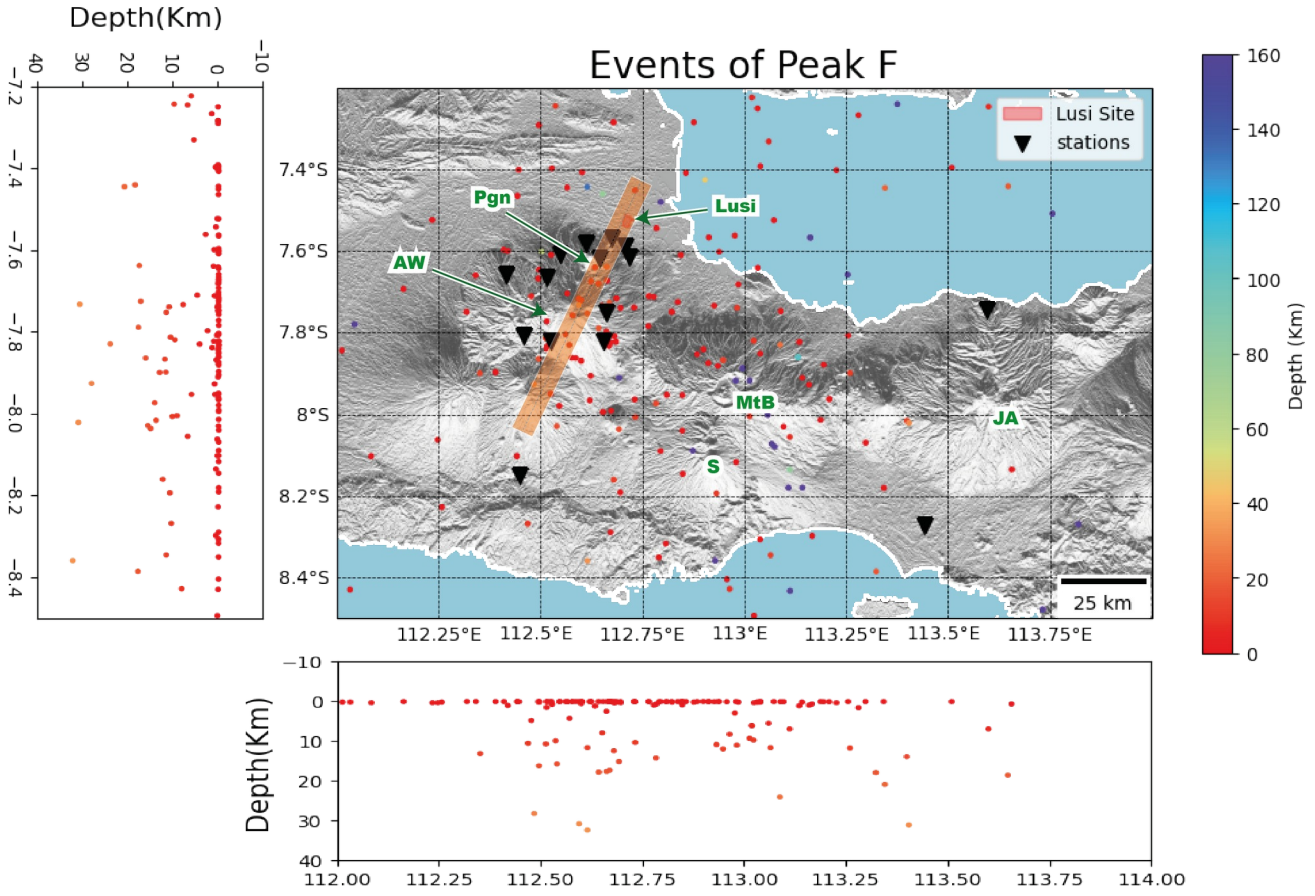




Peak F

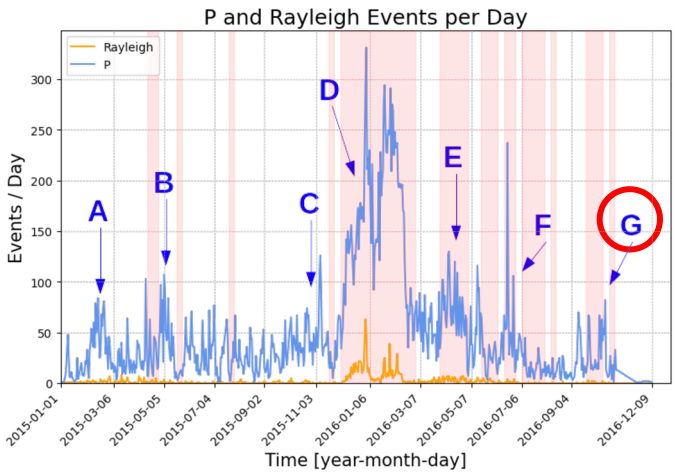
- Sources extent to the East.

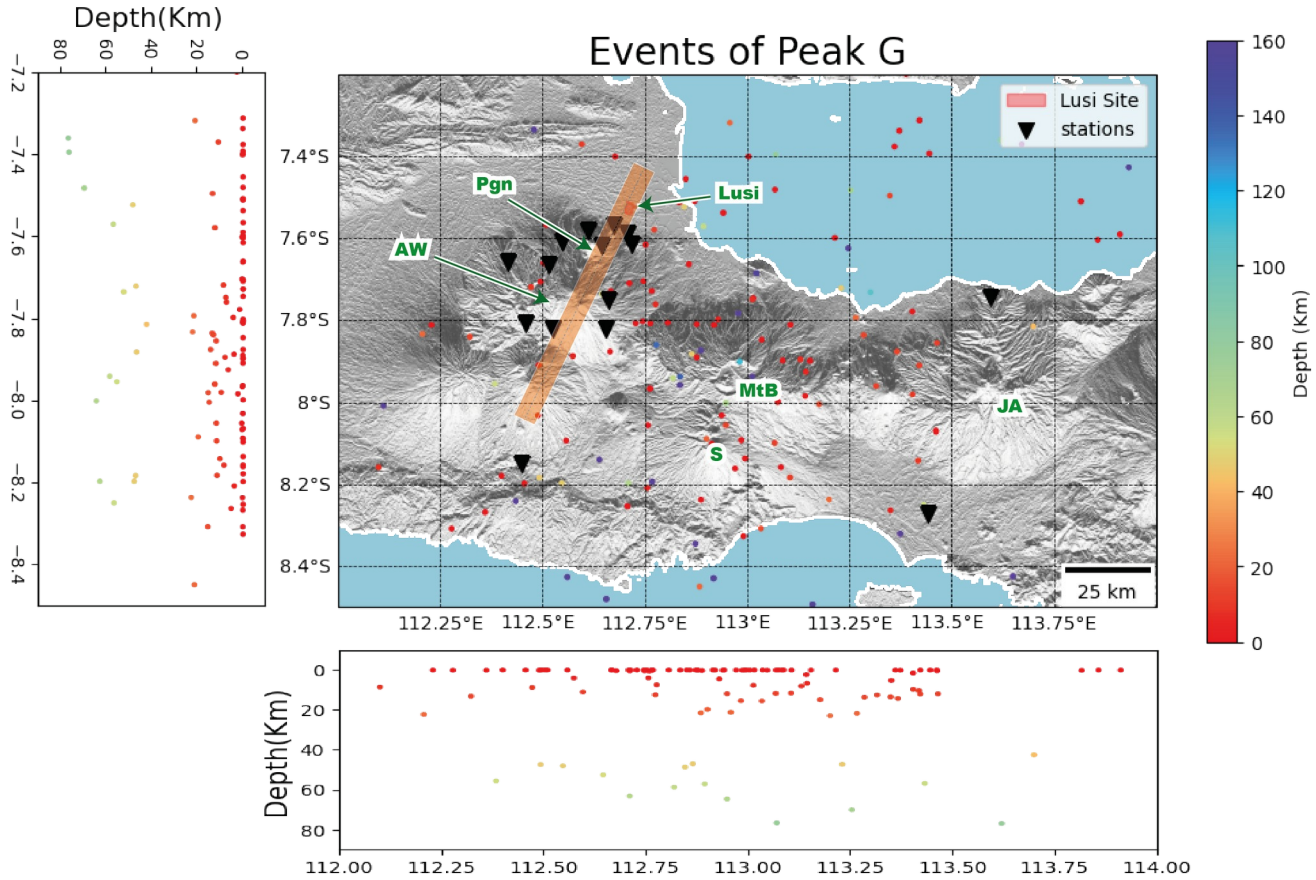




Peak G

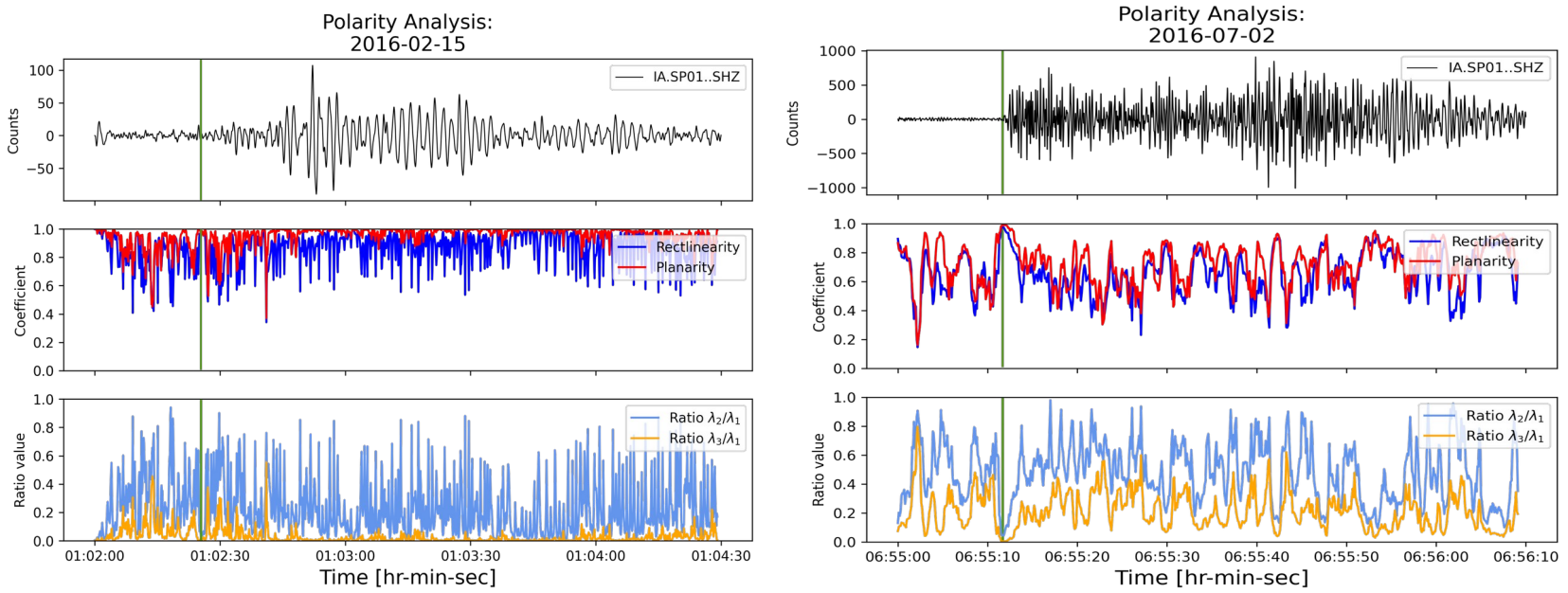
- Sources beneath Mt. Bromo.
- Effectively, activity is migrating to the East, beneath JA.
- Chambers might be connected, so the is a dynamic between the 3 volcanoes.





Further Work

- Decrease STA/LTA trigger sensitivity. To avoid noise picking.
- Use the idea of the MCCT (overlap) as association method.
- Use polarization window to re-pick P waves, instead of rectify.



Conclusions

- 2-years of data were processed automatically (0.3-1.7 Hz).
- 7 main peaks. Some related to eruption periods.
- Precursor to eruption – VT events and lineaments.
- In-depth dynamic between the 3 volcanic buildings. Migration of activity in West-East direction.
- Superficial events have mayor errors, however our proposals for further work might improve the steps that introduced most of the error.

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