Very Long-Period Seismic Signals and Collapse Events at the Kilauea Summit Crater in 2018

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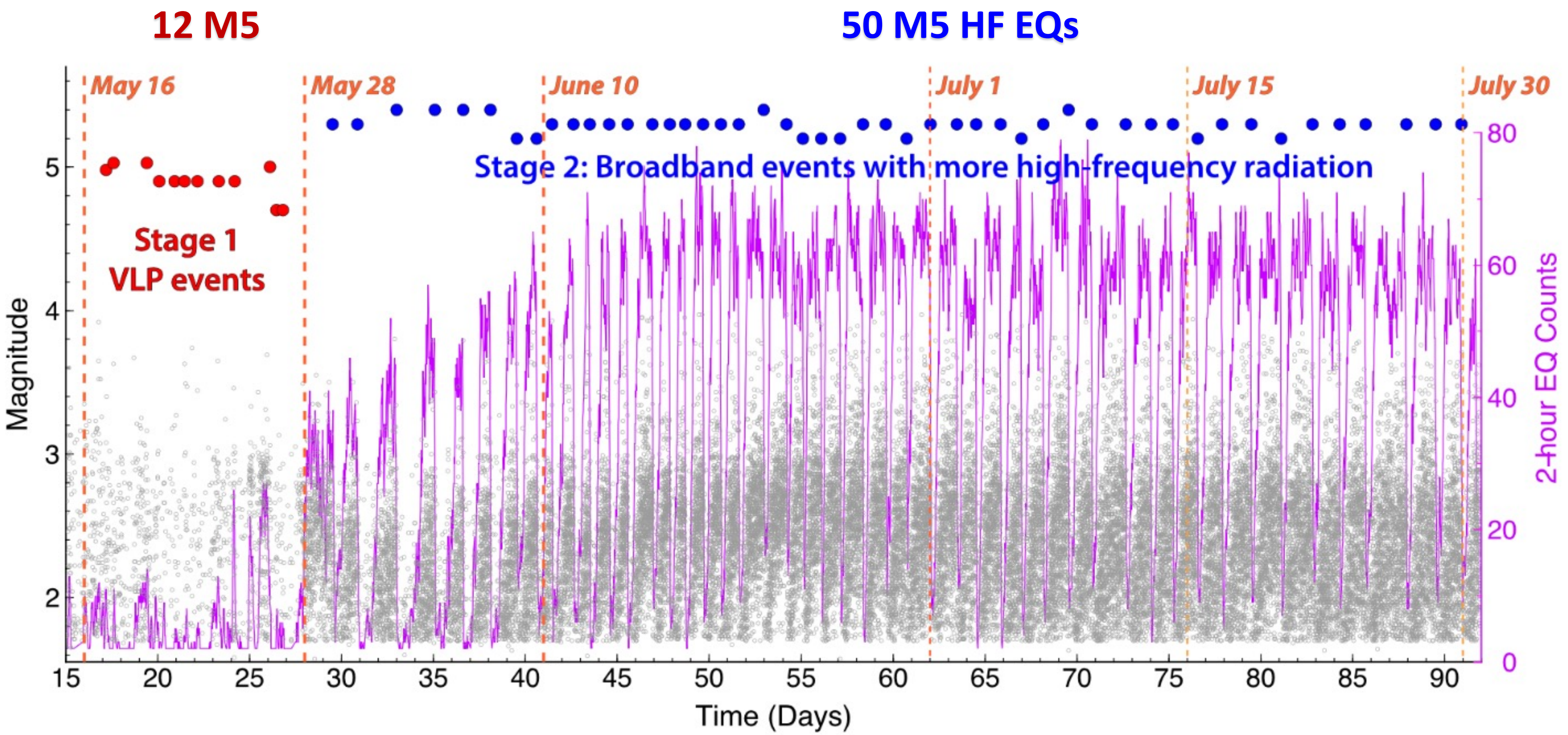
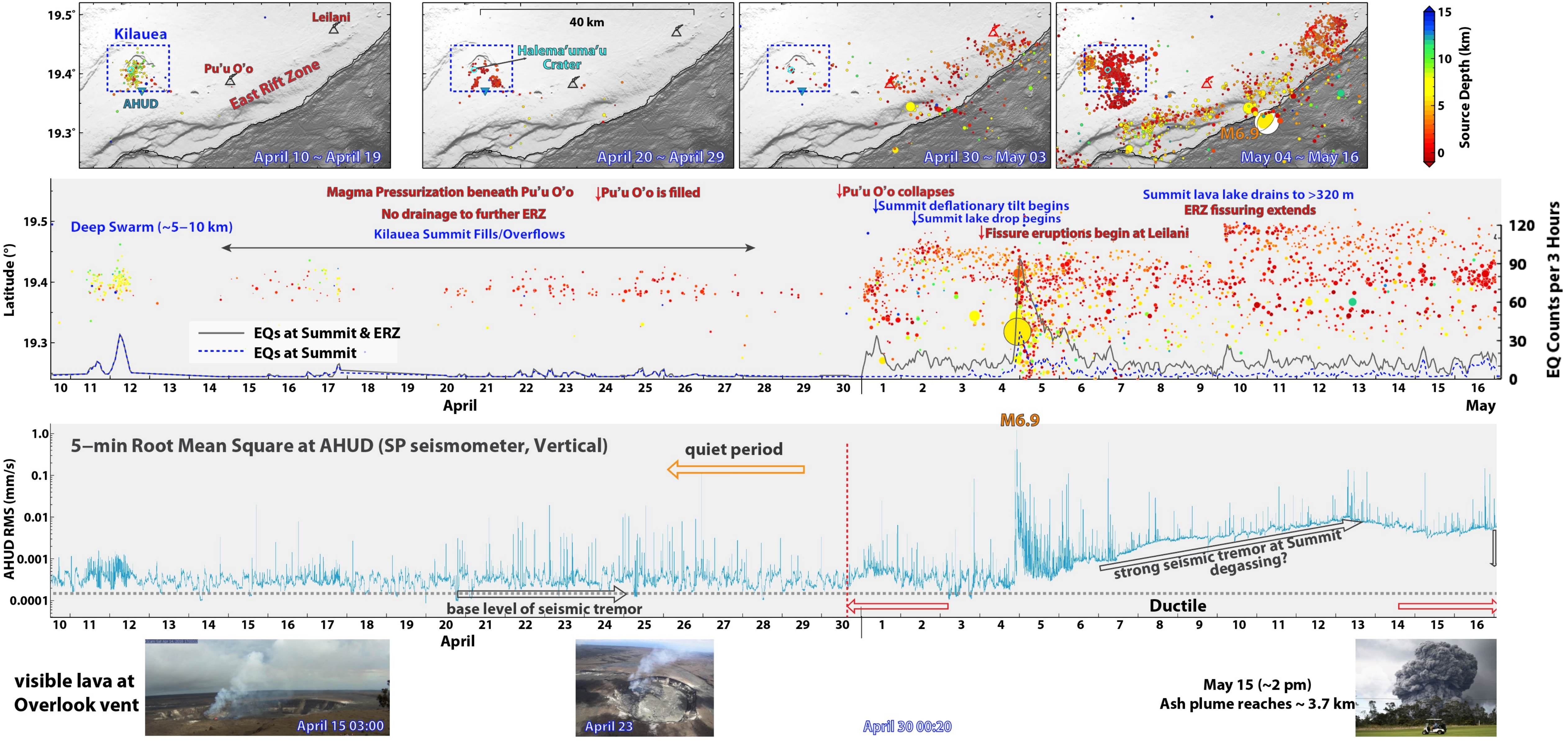


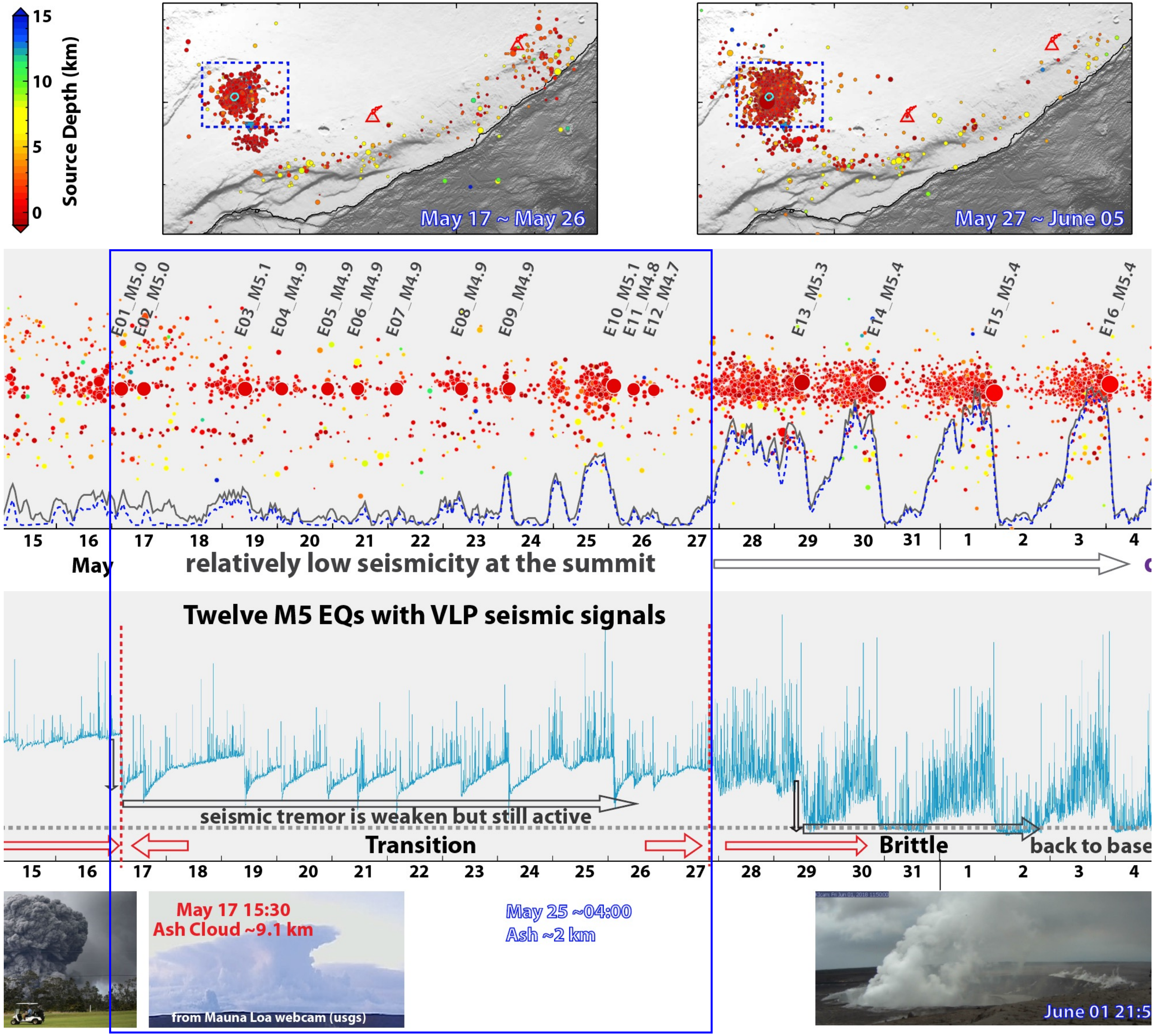
The 2018 Kilauea eruption and ERZ dike intrusion accompanied by 62 M4.7- 5.3 EQs in the Kilauea summit crater

Seismic/Volcanic Activities at Kilauea Summit and East Rift Zone

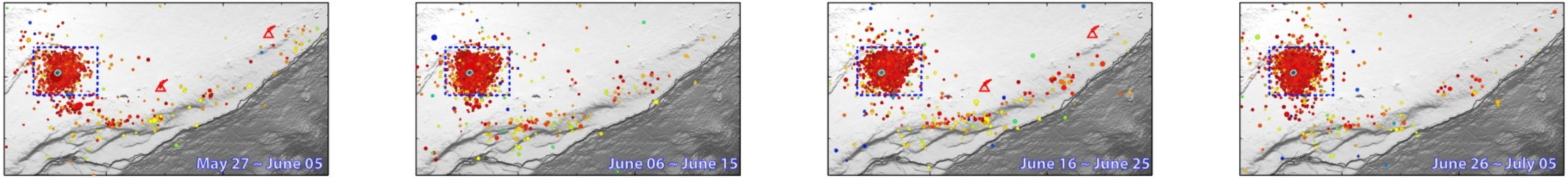


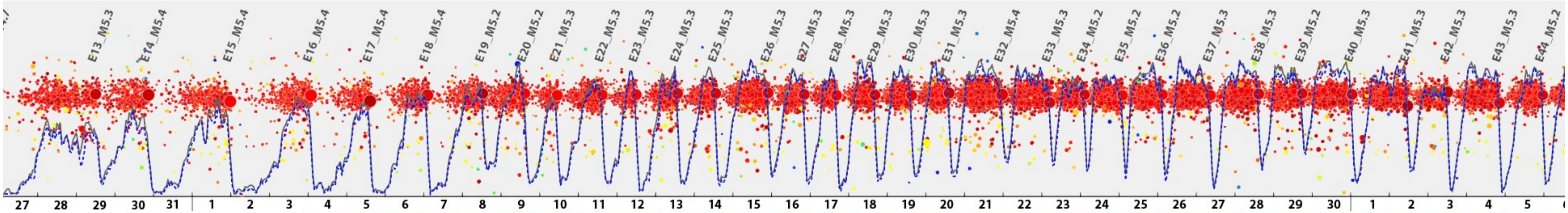
From May 16 to 26, 12 M5 EQs with large eruptive plumes below the SE edge of Halema‘uma’u crater.

Low seismicity during the VLP EQs, but increased to have 20-40 events per hour before later M5 events followed by several hours of reduced activity

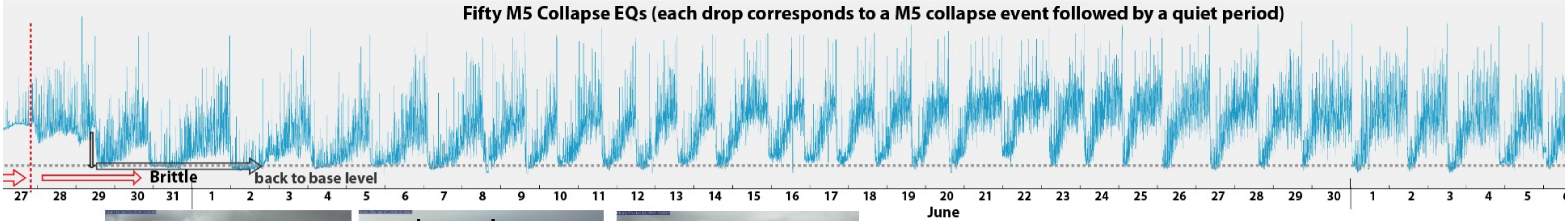


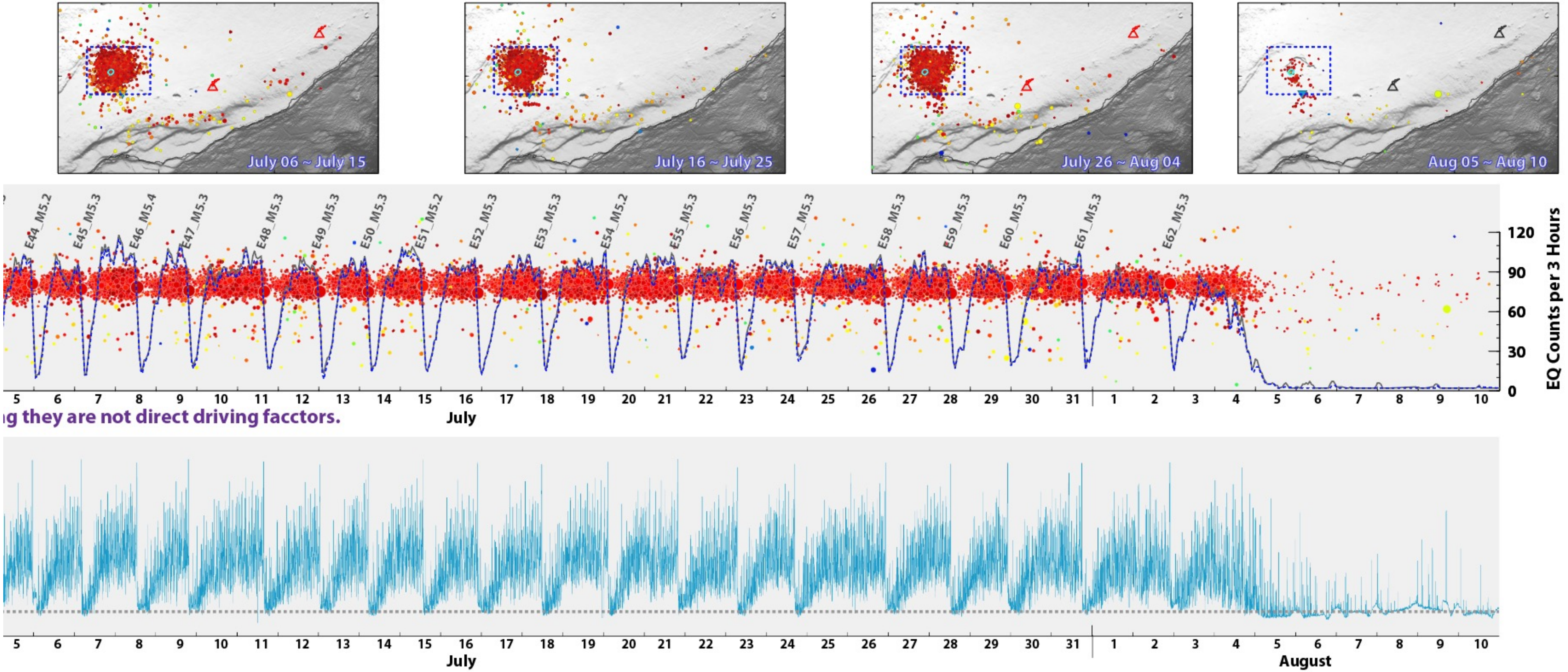
After May 28, seismicity has been quasi-periodic, with intervals from ~2 to ~1 day





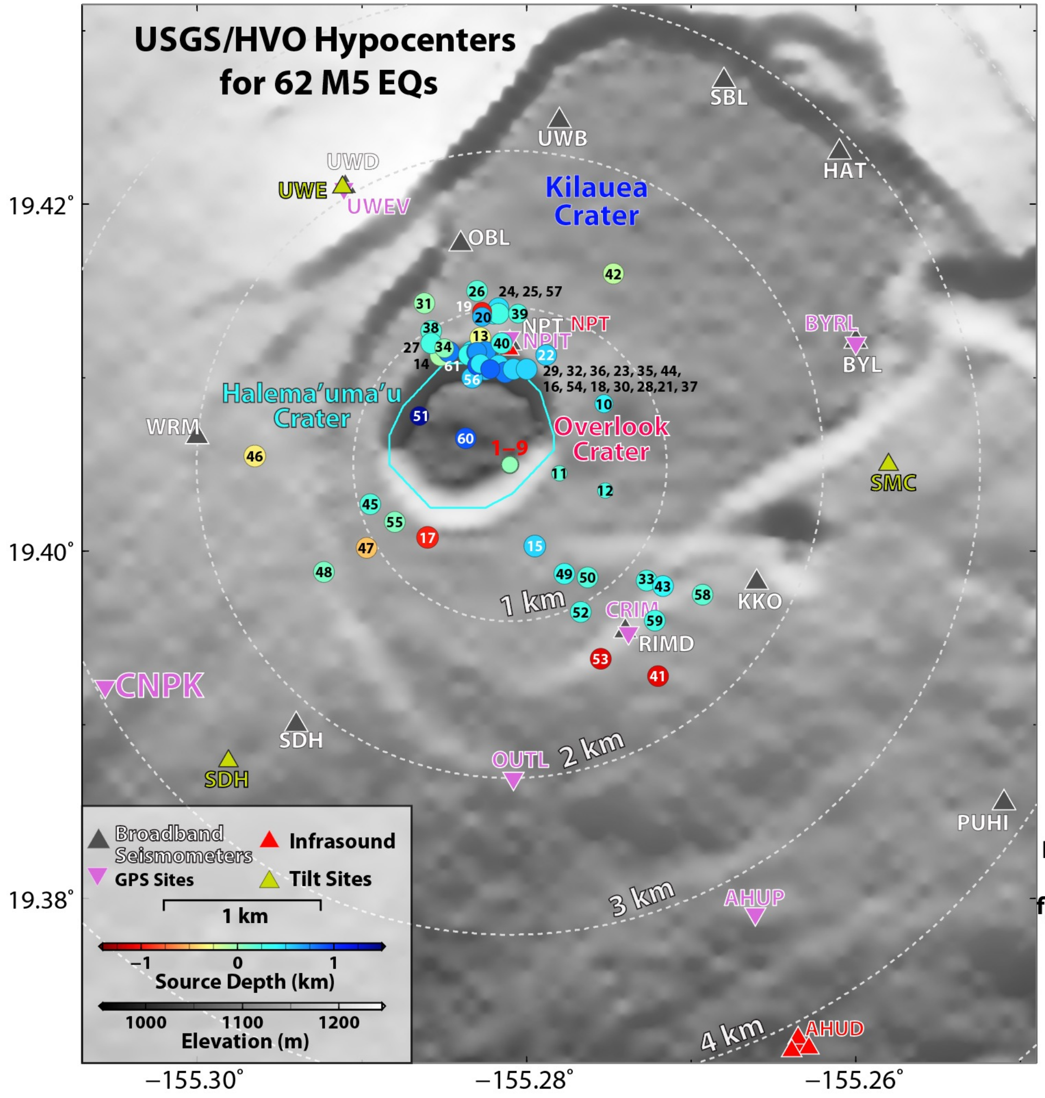
quasi-periodic seismicity with intervals from ~2 to ~1 day; no clear correlation with solid earth tides or volume strain variations, suggesting they

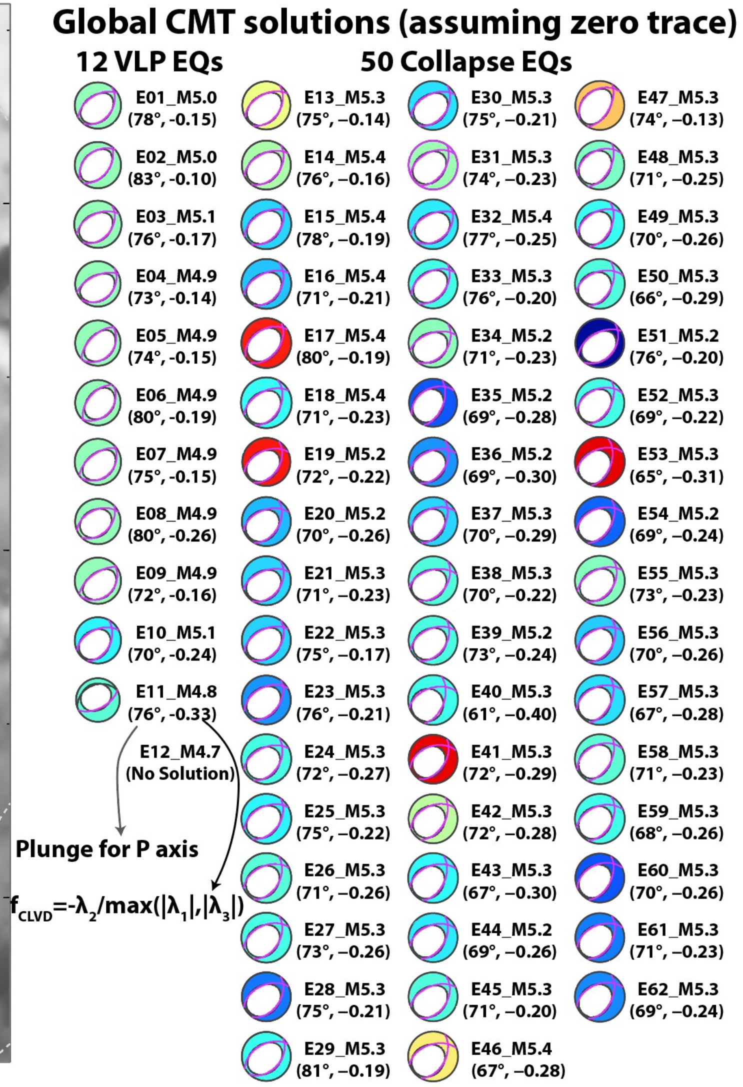




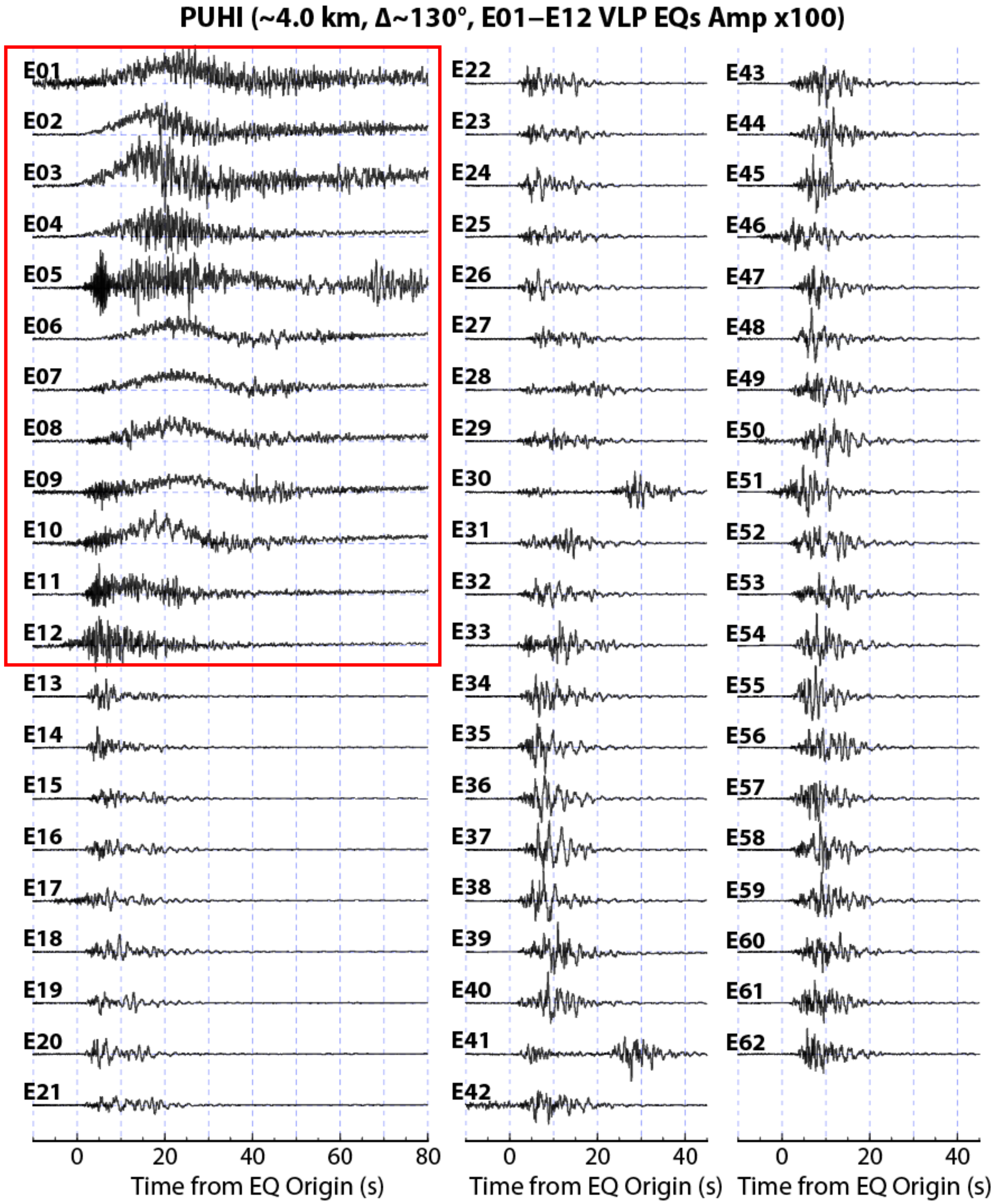
The main seismicity sequence is from May 17 to August 4.
The volume change at Kilauea from mid-May to August is over 82.5 km^3.
The largest total vertical collapse is >500 m.

Long-period GCMT solutions have nearly vertical P-axes with moderate to large non-double-couple components (~30%-70%)



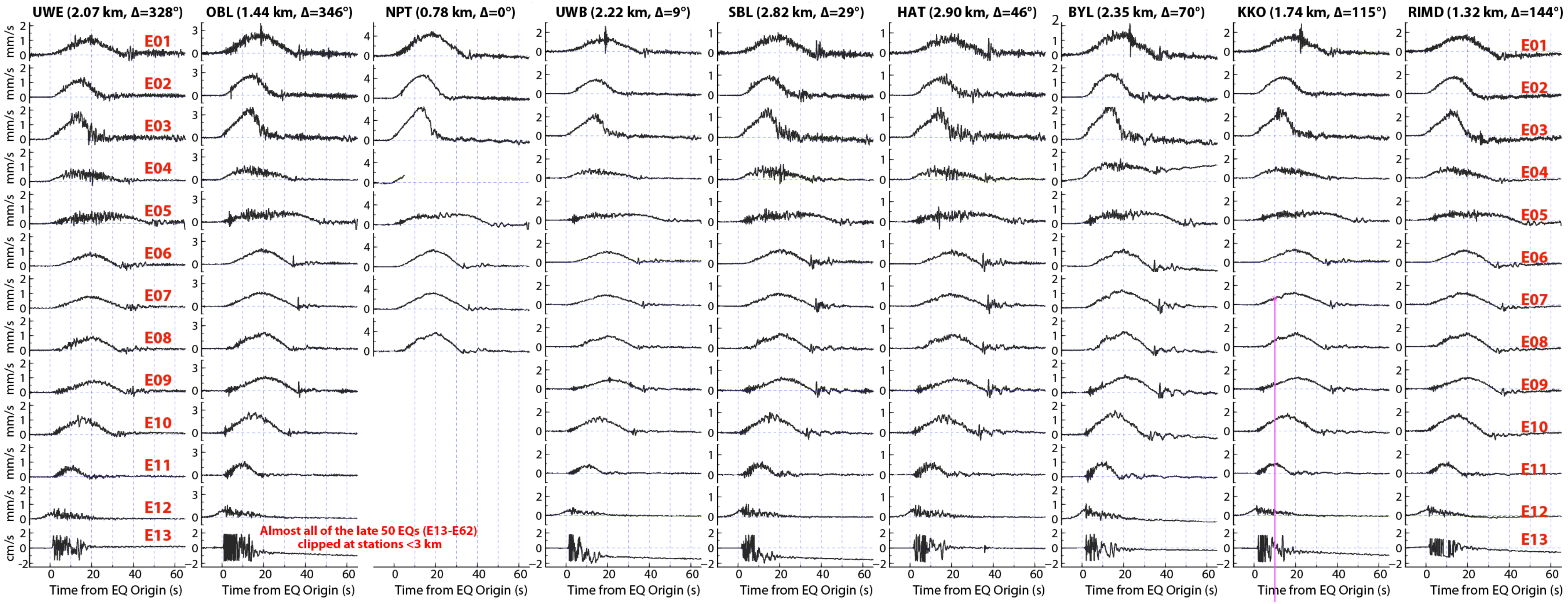


compensated linear vector dipole
f_{CLVD}~-0.15 to -0.35



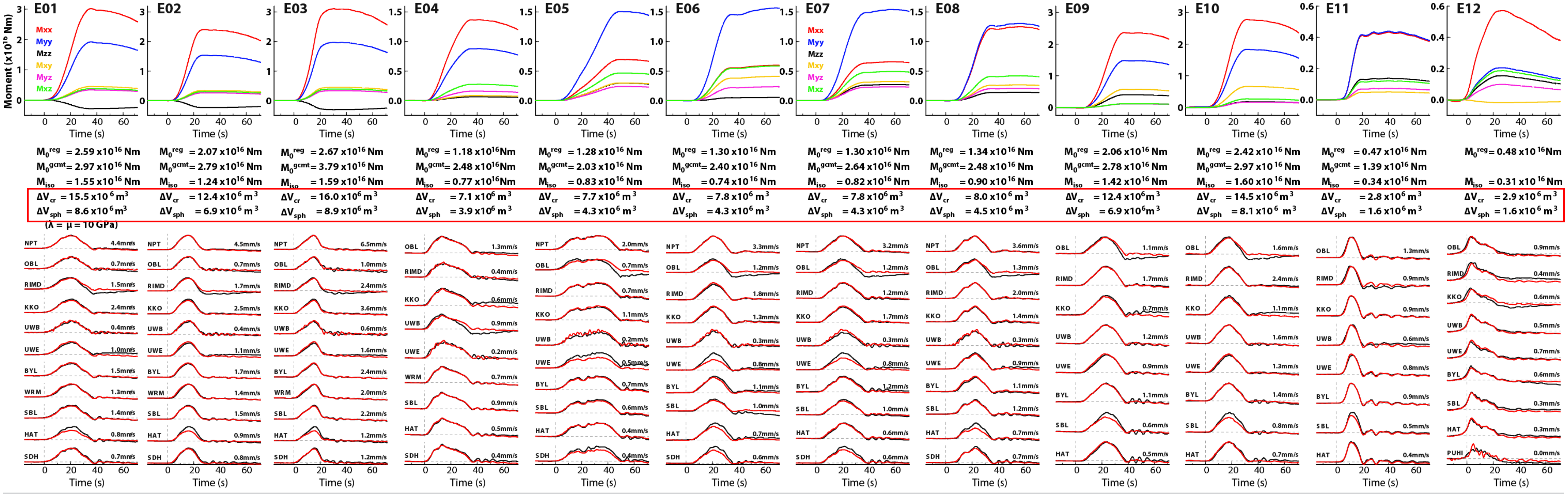
Vertical ground velocities recorded by local broadband seismic station (PUHI, ~4 km from the crater) indicate distinct behavior between the first 12 VLPs and late 50 collapse (E12-E62) events.

Vertical ground velocity signals along the edge of the crater from the for the 12 VLP events



- ✓ Very long-period seismic pulses with durations of about 20-50 s at all azimuths, suggesting distinct static outward displacements (either isotropic or CLVD source)
- ✓ Almost all VLP pulses ended with sharp arrivals that are likely from small collapses

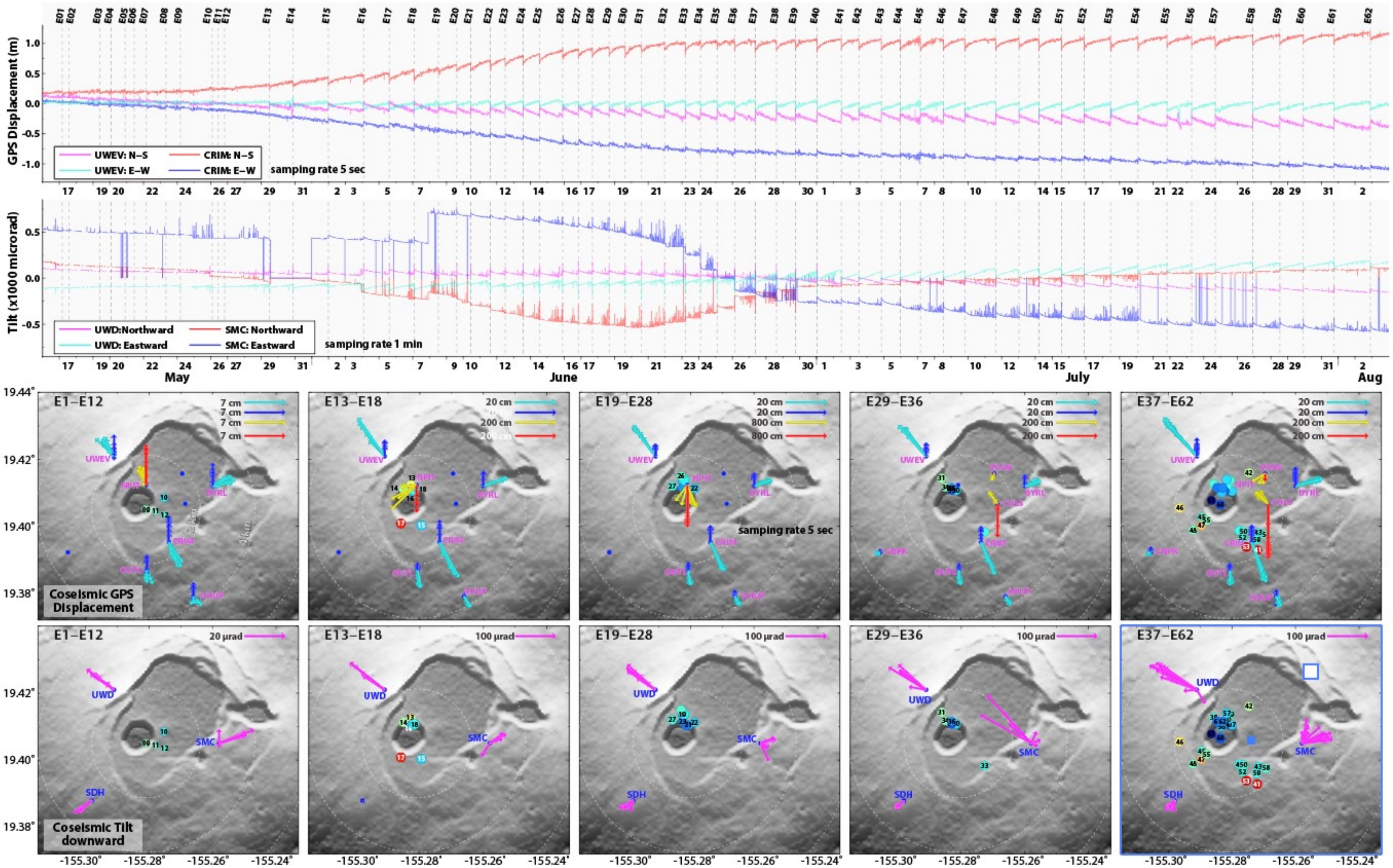
Inverting Source time history of 6 moment-tensor components simultaneously



- ✓ Volume change with the model of a crack: $V_{cr} = M_{\text{iso}}/(\lambda + 2\mu/3)$
- ✓ Spherical volume of the explosion or implosion model (Muller, 2001, BSSA):

$$V_{sph} = M_{\text{iso}}/(\lambda + 2\mu)$$

GPS and Tilt Signals indicate distinct static outward displacements



III. Infrasound Signals and Sources

Azimuth Estimates from a Small Aperture (100 m) Infrasonic 4-station Array at AHUD

Method: multiple signal classification (MUSIC) (details in Yamakawa et al., 2018, GRL)

Assumption

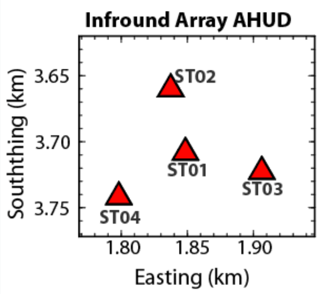
- Plain wave
- Only one signal is within one time window

Input

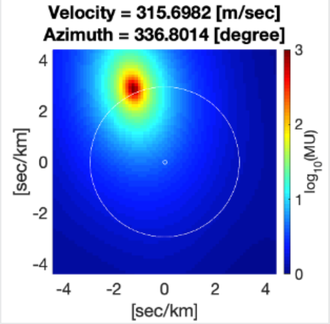
- Time window: 10 sec
- Frequency band: 0.8 - 1.2 Hz
- Back azimuths of 1°, 2°, … , 360°
- Slowness values of 0.05, 0.1, … , 5 [s/km]

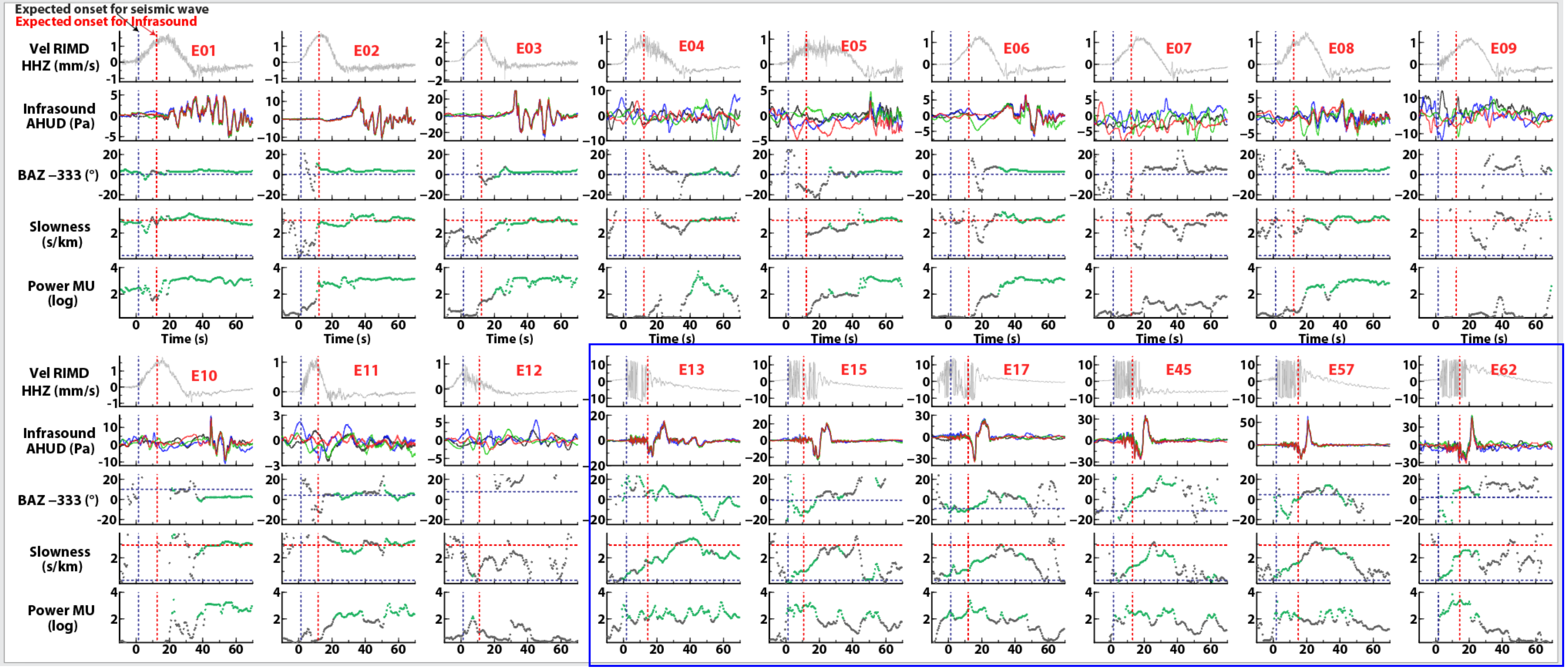
Output

- Peak value of MUSIC Spectrum (MU) and corresponding azimuth and slowness

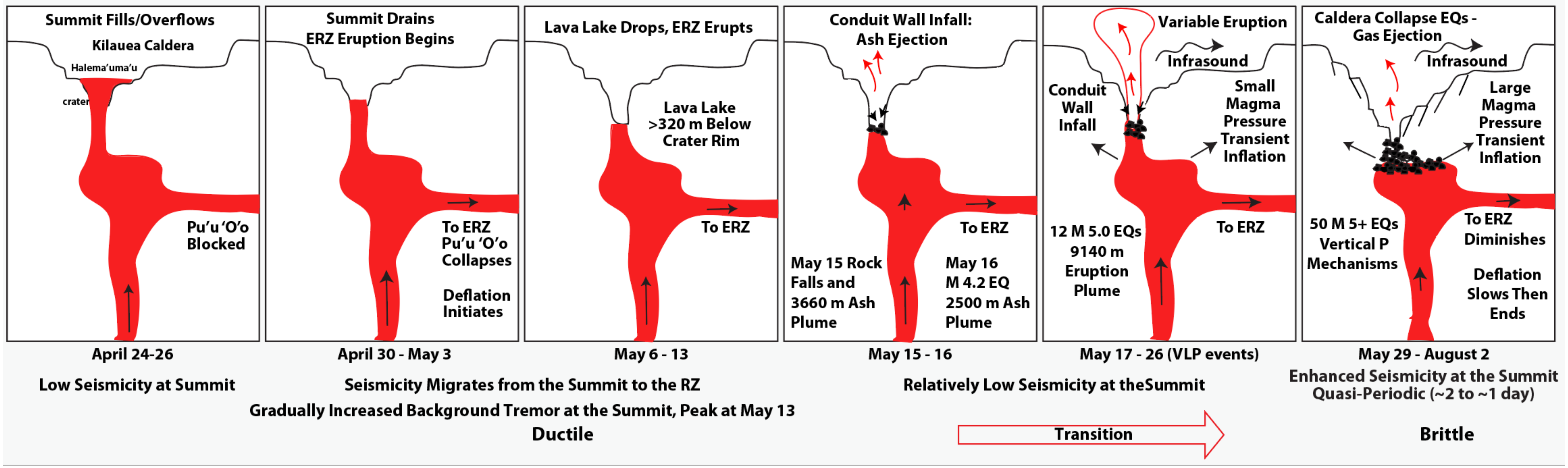


MUSIC Image for E01 (example)





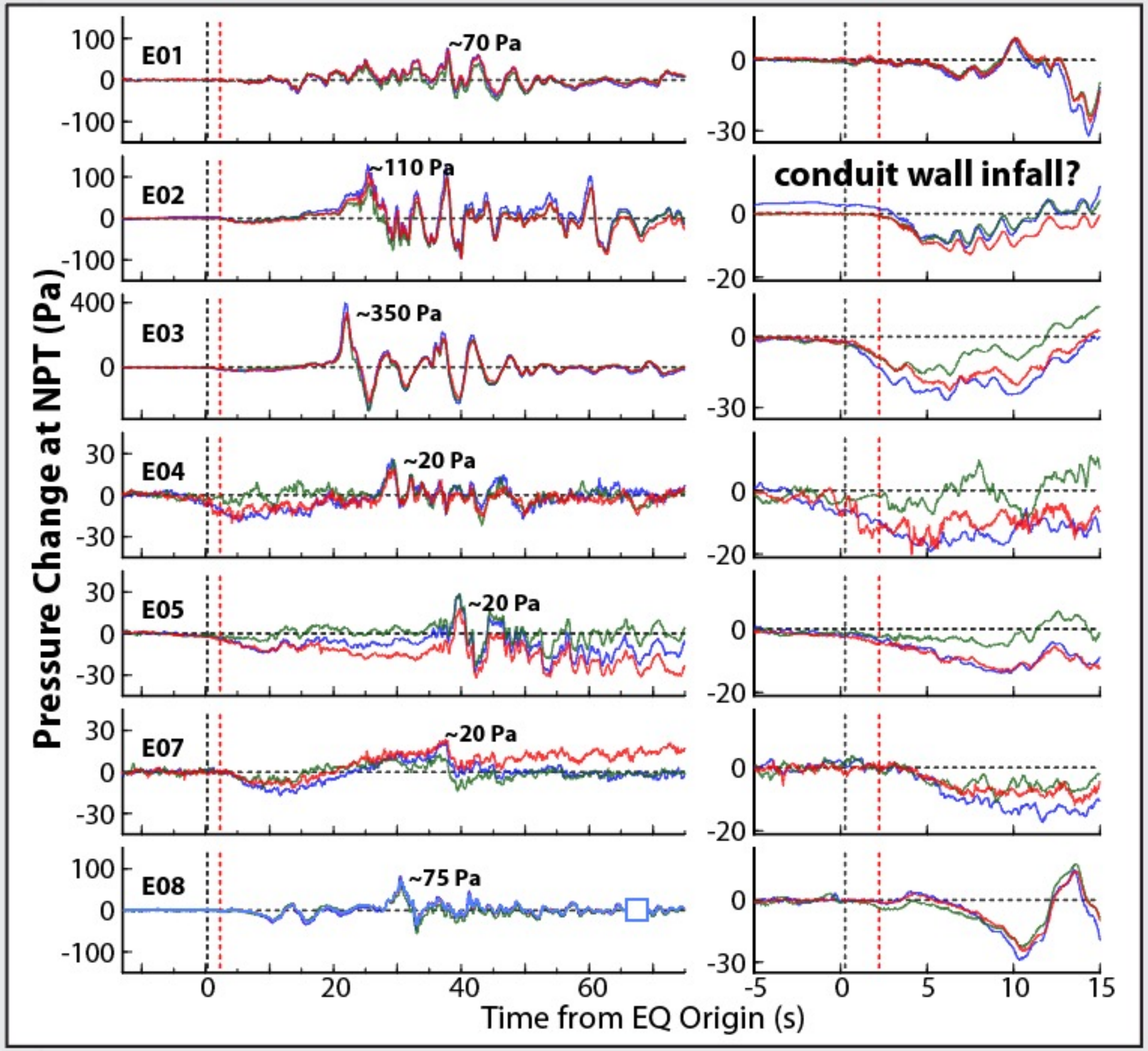
A Cartoon Model of Kilauea and East Rift Zone Activities in 2018
Two-stage Seismicity behavior



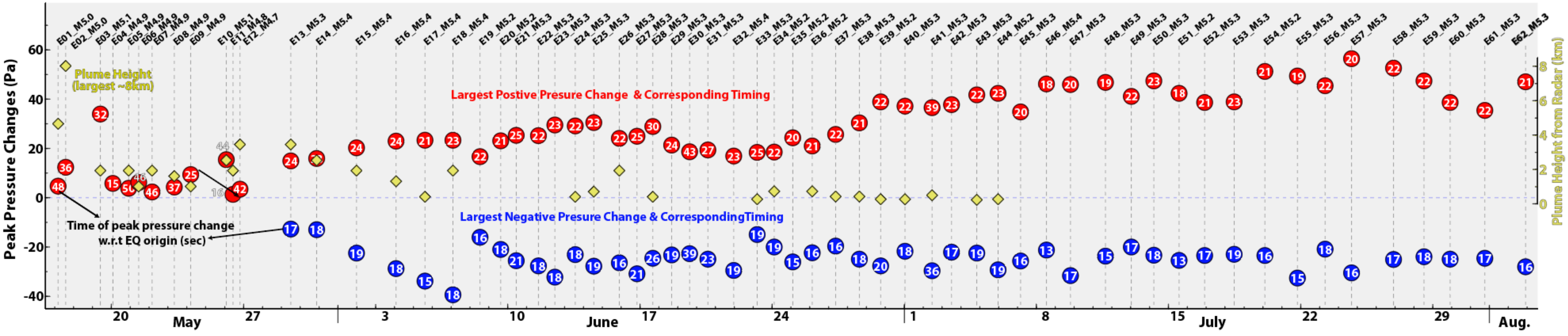
Stage 1 (May 16 to 26): inflation transients that causes VLP events with large ash/gas explosion

Stage 2 (May 29 – Aug. 2): collapse with extensive shallow fracturing and weaker gas explosions

Infrasound at NPT for VLP EQs



Eruption plumes heights vs peak pressure change



- VLP EQs: no clear correlation between peak positive pressure vs plume height

- **Collapse EQs:**

✓ infrasound is more stable than the plume height;

✓ a lack of correlation => ground-motion controlled sounds rather than eruption sounds.