Clog and Crack: Hidden earthquakes unveil the dynamic evolution of a large-scale explosive eruption

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Okmok Caldera, Aleutian Islands
2008 eruption

Aerial view of Okmok Caldera (10 km wide) looking to the south
(Taken from Larsen et al., 2015; Photograph by C.Read (USGS), June 7 2007.)
Earthquake detection

Supervised

Template Matching

Unsupervised

Fingerprint and Similarity Thresholding (FAST)

Waveform ➔ Binary Fingerprint

(Chamberlain et al., 2017) (Yoon et al., 2015)
Earthquake relocation of templates and FAST events

GrowClust – Hybrid (relocation/clustering) algorithm

Trugman & Shearer (2017)
Development of a local magnitude for Okmok
Local geometric spread/attenuation/station corrections
Calibrated during eruptive period

$$M_L = \log_{10}(A) - \log_{10}(A_{ref}) + 3$$

$$\log_{10}(A_{ref}) = \alpha \left( \frac{R}{17} \right) + K(R - 17) - dM_L$$

Hutton and Boore (1987)
Development of a local magnitude for Okmok
Local geometric spread/attenuation/station corrections
Calibrated during eruptive period
Time series of eruption

End of eruption

[Graph showing earthquake activity and magnitude over time]
Opening
Vent widening (middle of eruption)
End of Eruption
Conclusions

Main bursts of seismicity in the caldera do not correlate in time with plume episodes. This suggests that there is a “clog and crack” process regulating the dynamics of the eruption.

Highlighting of structures
- Ring-fault
- Large NE-SW trending seismicity
- Off-shore NW-SE trending seismicity
- Geothermal field