Supplementary information for Seismic characteristics of the 2022-2023 unrest episode at Taupō volcano, New Zealand

<u>SEIS</u>

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Figure S1 Comparison of locations and depths for automatically detected GeoNet earthquakes (left) and relocated earthquakes (right).



Figure S2 Map showing location of GeoNet seismometers across the North Island of New Zealand. Dark and white triangles are for broadband and short-period sensors, respectively.



Figure S3 Histograms of (left) Distance of event to nearest seismometer (kms), (centre) Azimuthal gap (degrees), with a median azimuthal gap of 71 degrees and standard deviation of 36 degrees. (right) root mean squared (rms) of the travel-time residuals for each event



Figure S4 Histograms of (left) minimum horizontal uncertainty, in kms, (centre) maximum horizontal uncertainty, and (right) depth uncertainty, in km, estimated using the projection of 68% confidence ellipsoids derived using NLLoc software (NonLinloc from Lomax et al, 2000). The median depth uncertainty is 2.1 km



Figure S5 Progression of earthquake locations and depths during the unrest. Each panel details relocated earthquakes with each phase of the unrest period, coloured by cluster number. (See Fig. 4 in main text for key on cluster colour allocation.)



Figure S6 (a) Map of felt reports across the North Island submitted to GeoNet after the $M_L 5.7$ on 30 November 2022. The location of the earthquake is noted with a green star. (b) Macroseismic ground shaking intensity map for the $M_L 5.7$ event on 30 November 2022 (located with black star).



Figure S7 Deviatoric moment tensor solution for M5.7 event. Top right panel shows location of event and stations used for the moment tensor inversion. Top right panel shows variance reduction for different depths, with best solution highlighted. Middle panel shows comparison between observed and synthetic waveforms for various stations. Moment tensors are shown at the bottom, shown as lower hemisphere projections.



Figure S8 Full moment tensor solution for M5.7 event. Top right panel shows location of event and stations used for the moment tensor inversion. Top right panel shows variance reduction for different depths, with best solution highlighted. Middle panel shows comparison between observed and synthetic waveforms for various stations. Moment tensors are shown at the bottom, shown as lower hemisphere projections.



Figure S9 Time series of GNSS data recorded at TGHO during the 2022-23 unrest at Taupō.



Figure S10 Seismic activity detected by GeoNet during two previous unrest episodes at Taupō. The two time periods are (a) 30/03/2008 - 9/02/2009, and (b) 01/01/2019 - 31/12/2019.



Figure S11 Analysis of time intervals between earthquakes under Lake Taupō. (a) Map of Lake Taupō showing various structural features, as well as search area used for earthquakes in this figure (pink line). (b) Empirical cumulative distribution functions for earthquake inter-event times for different time periods since 2013. (c) Inter-event times for earthquakes within search area in panel A, since 2013. (d) Similar to panel (c), but for earthquakes since August 2020.



Figure S12 3D view of earthquake relocations for the 2022-23 unrest episode at Taupō volcano, plotted beneath the lake bathymetric data. Each panel provides a view looking north (A), west (B), east (C) and south (D). Each earthquake is coloured by the k-means spatial clustering (see Fig. 4 in main text for key). Plots were generated using Geoscience ANALYST software.