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Supplementary information

Volcanic crisis reveals coupled magma system at Santorini and Kolumbo

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Supplementary Information

Volcanic crisis reveals coupled magma system at Santorini and Kolumbo

Marius Isken[1+*], Jens Karstens[2+*], Paraskevi Nomikou[3], Michelle Maree Parks[4], Vincent Drouin[4], Eleonora Rivalta[1,5], Gareth J. Crutchley[2], Mahmud Haghshenas Haghighi[6], Emilie E.E. Hooft[7], Simone Cesca[1], Thomas R. Walter[1,8], Sebastian Hainzl[1,8], Joachim Saul[1], Dimitris Anastasiou[9], Kostas Raptakis[9], Nikolai M. Shapiro[10], Jannes Münchmeyer[10], Quentin Higueret[10], Jean Soubestre[10], Florent Brenguier[10], Rebeckah S. Hufstetler[7], Kaisa R. Autumn[7], Maria Tsakiri[9], Dietrich Lange[2], Heidrun Kopp[2,11], Morelia Urlaub[2,11], María Blanch Jover[2], Jonas Preine[12], Christian Hübscher[13], Mahdi Motagh[1,10], Daniel Müller[1], Torsten Dahm[1,8], Christian Berndt[2,11]

[1]GFZ Helmholtz Centre for Geosciences, Potsdam, Germany

[2]GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany

[3]Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Athens, Greece

[4]Icelandic Meteorological Office, Reykjavík, Iceland

[5]Section of Geophysics, Department of Physics and Astronomy, Alma Mater Studiorum University of Bologna, Bologna, Italy

[6]Institute of Photogrammetry and GeoInformation, Leibniz University Hannover, Hannover, Germany

[7]Department of Earth Science, University of Oregon, Eugene, OR, USA

[8]Institute of Geosciences, University of Potsdam, Potsdam, Germany

[9]School of Rural, Surveying and Geoinformatics Engineering, National Technical University of Athens, Zographos, Greece

[10]Université Grenoble Alpes, Université Savoie Mont Blanc, CNRS, IRD, Université Gustave Eiffel, ISTerre, Grenoble, France

[11]Institute of Geosciences, Kiel University, Kiel, Germany

[12]Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, USA

[13]Institute of Geophysics, University of Hamburg, Hamburg, Germany

*Corresponding author(s). Email(s): marius.isken@gfz.de; jkarstens@geomar.de

[+]These authors contributed equally to this work.

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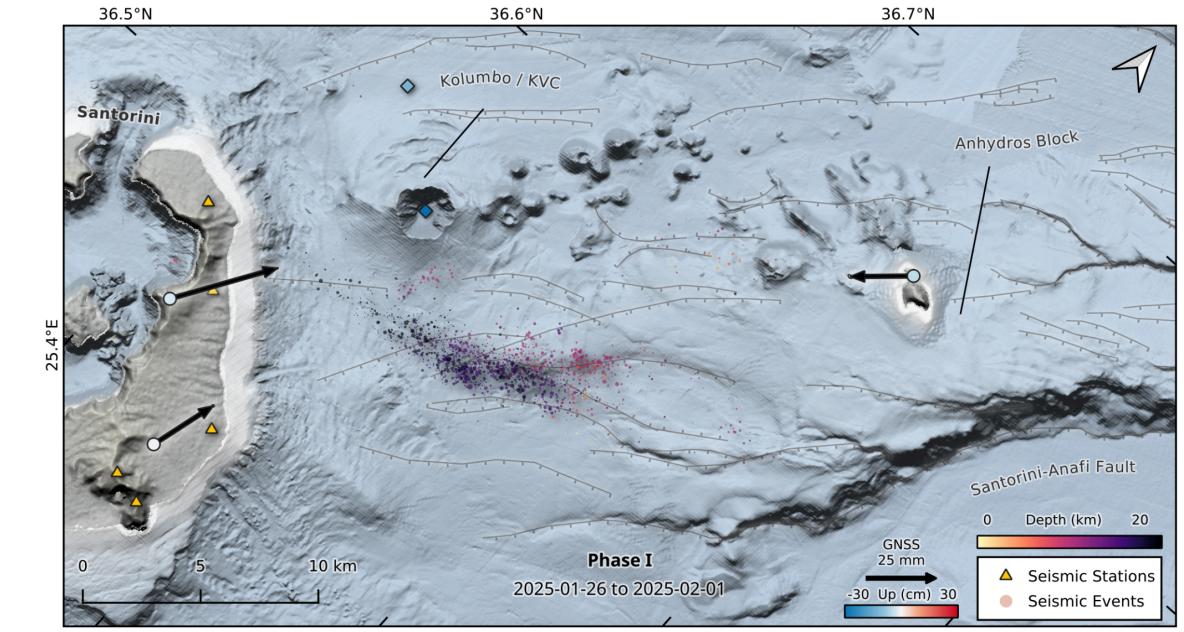
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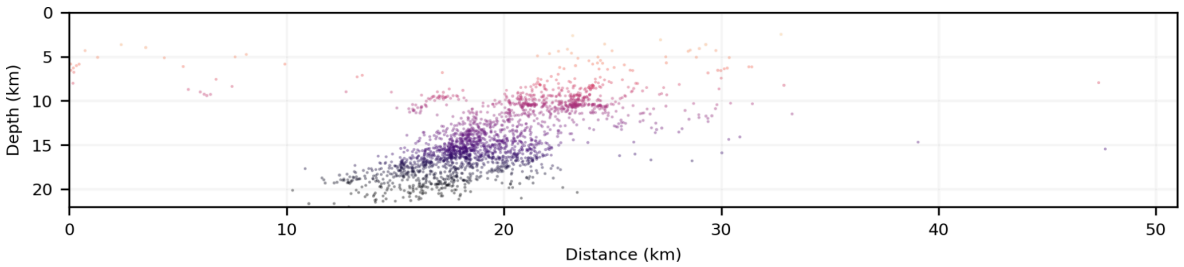
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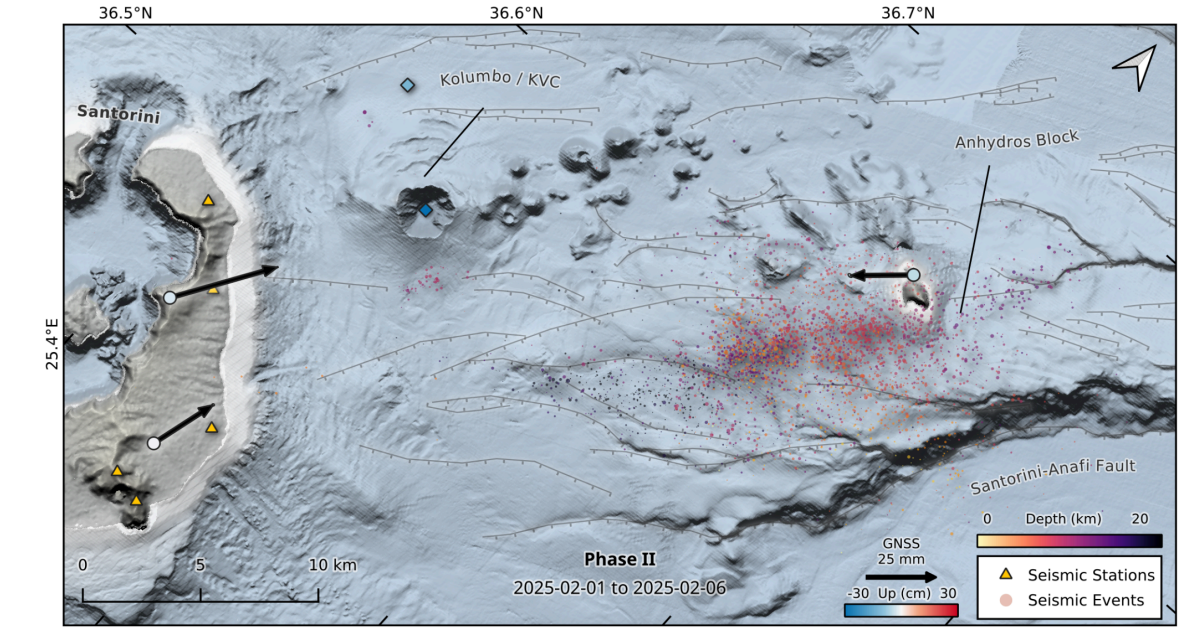
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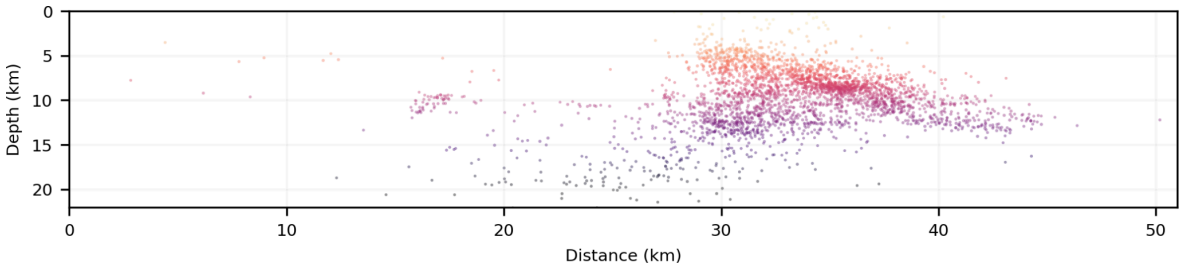
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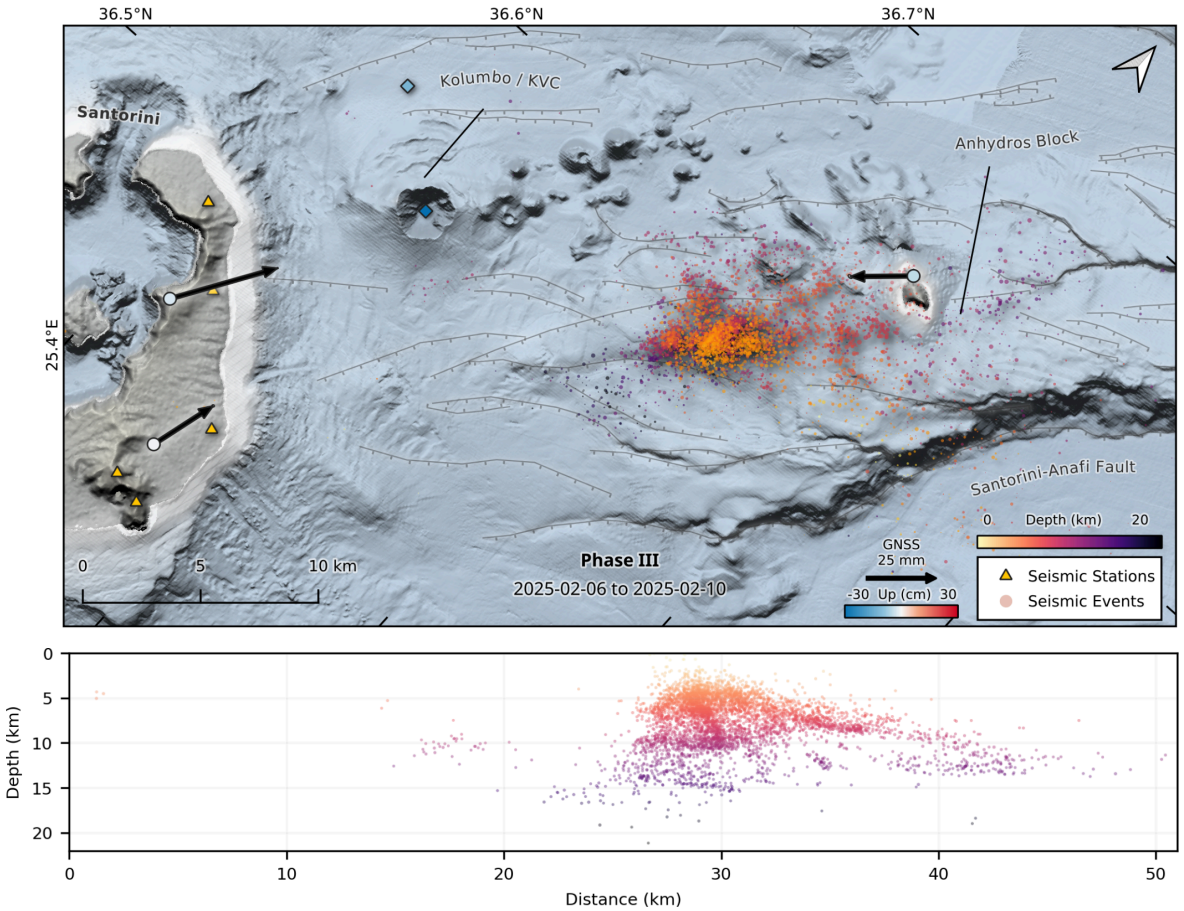
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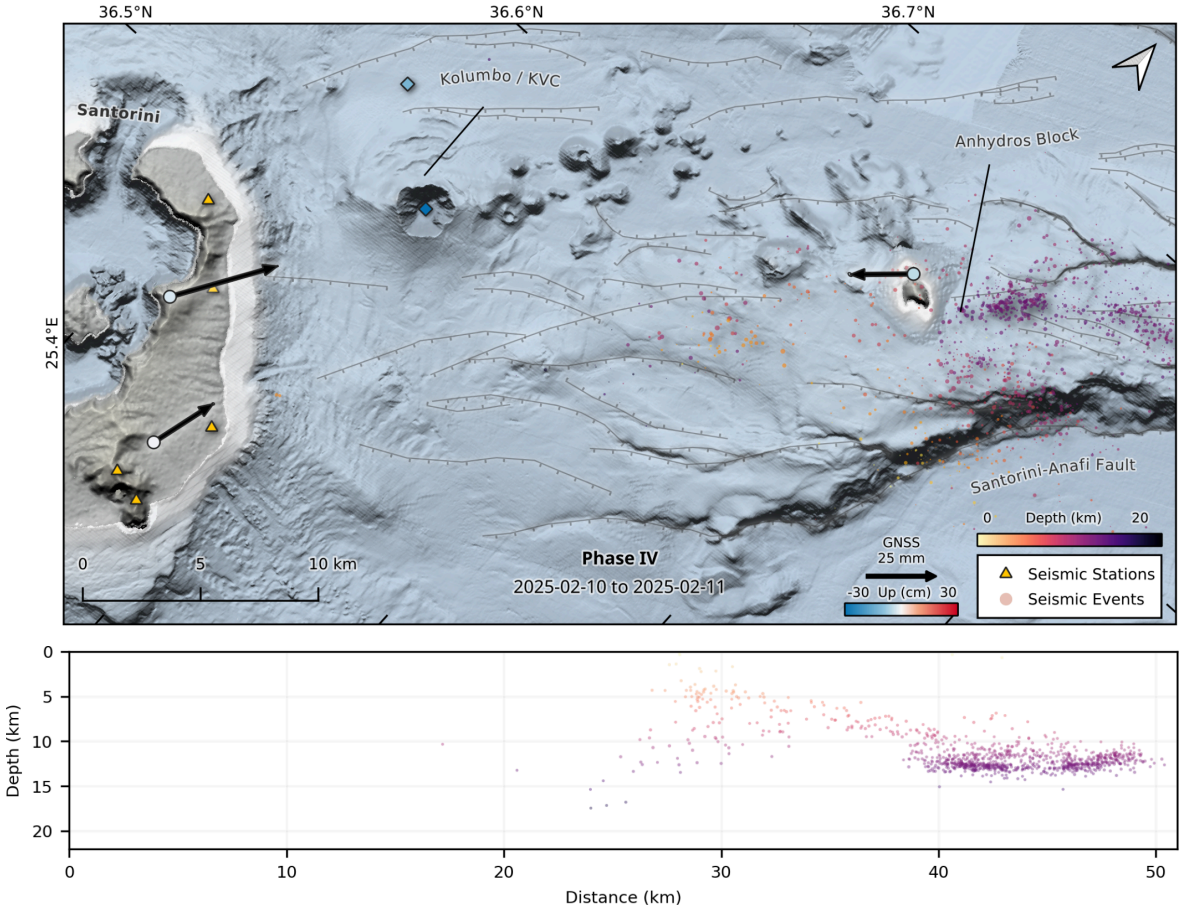

36.5°N
36.6°N
36.7°N
25.4°E
Santorini
Kolumbo / KVC
Anhydros Block
Santorini-Anafi Fault
0
5
10 km
Phase I
2025-01-26 to 2025-02-01
GNSS
25 mm
-30 Up (cm) 30
0 Depth (km) 20
Seismic Stations
Seismic Events

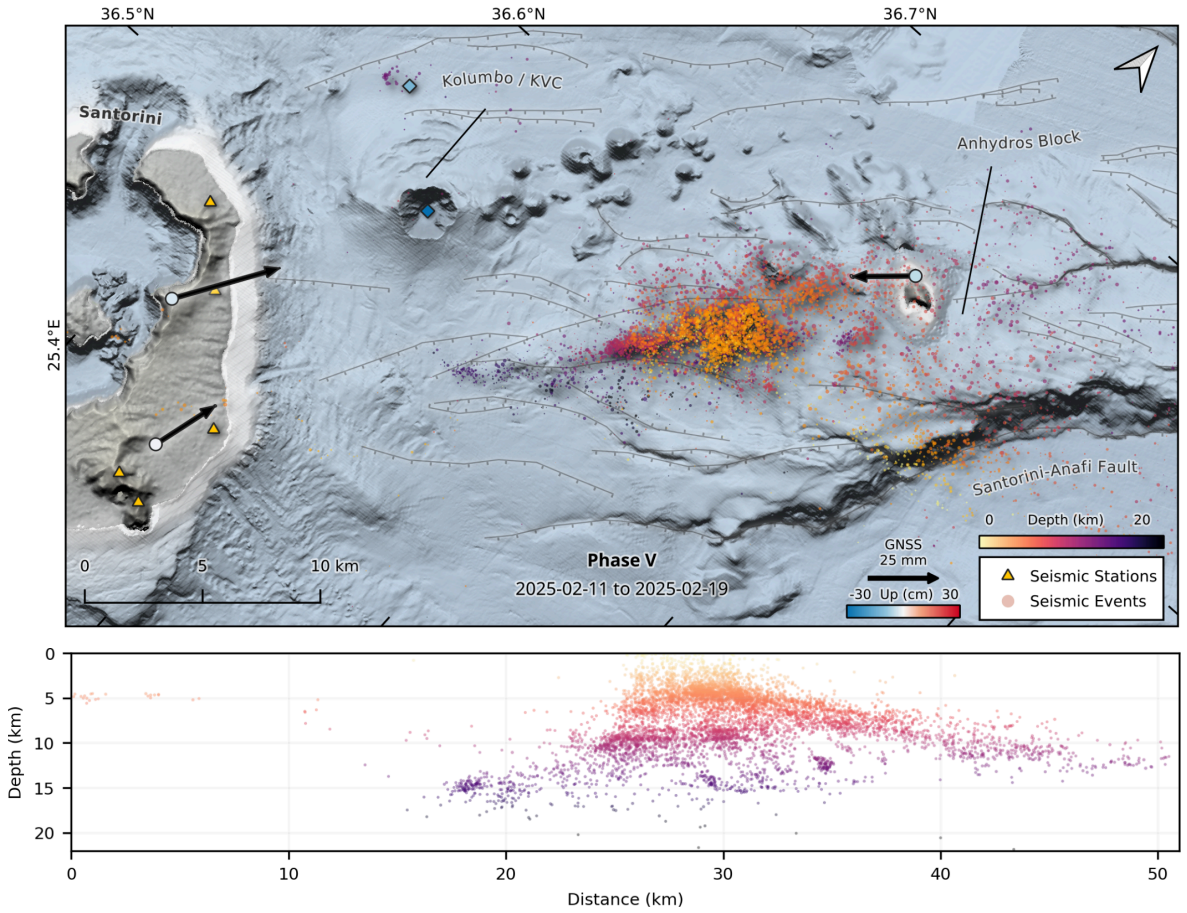

Depth (km)
0
5
10
15
20
0
10
20
30
40
50
Distance (km)


36.5°N
36.6°N
36.7°N
25.4°E
Santorini
Kolumbo / KVC
Anhydros Block
Santorini-Anafi Fault
0
5
10 km
Phase II
2025-02-01 to 2025-02-06
GNSS
25 mm
-30 Up (cm) 30
0 Depth (km) 20
Seismic Stations
Seismic Events

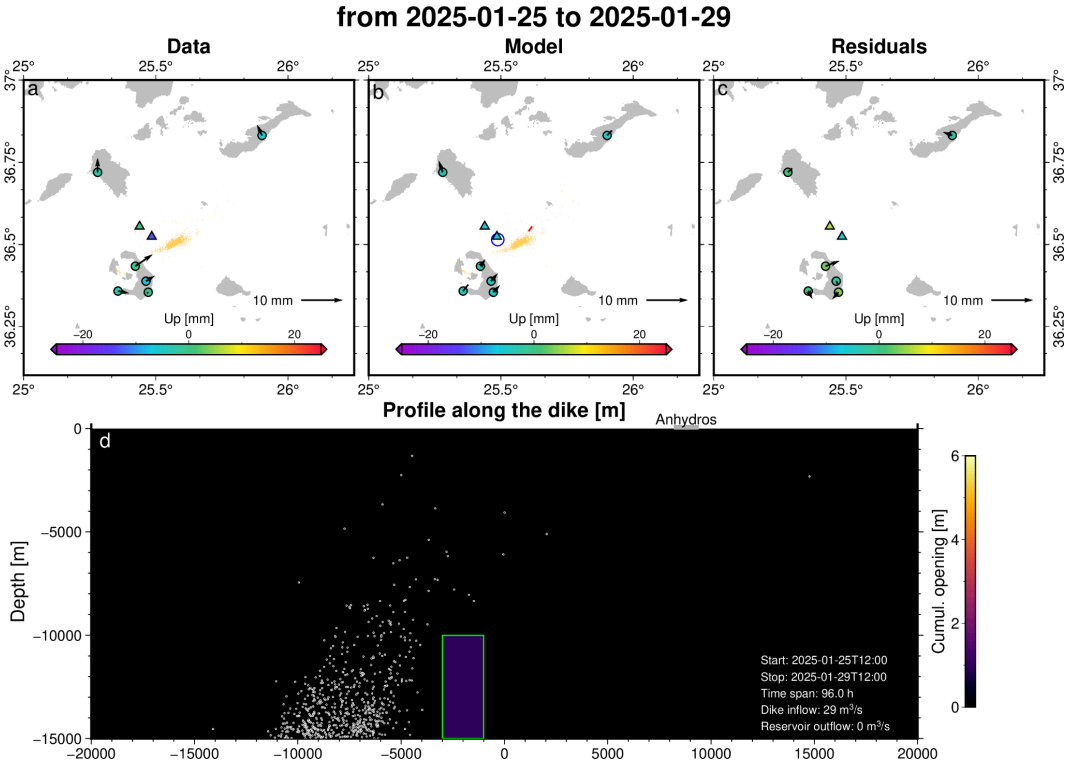

Depth (km)
0
5
10
15
20
0
10
20
30
40
50
Distance (km)

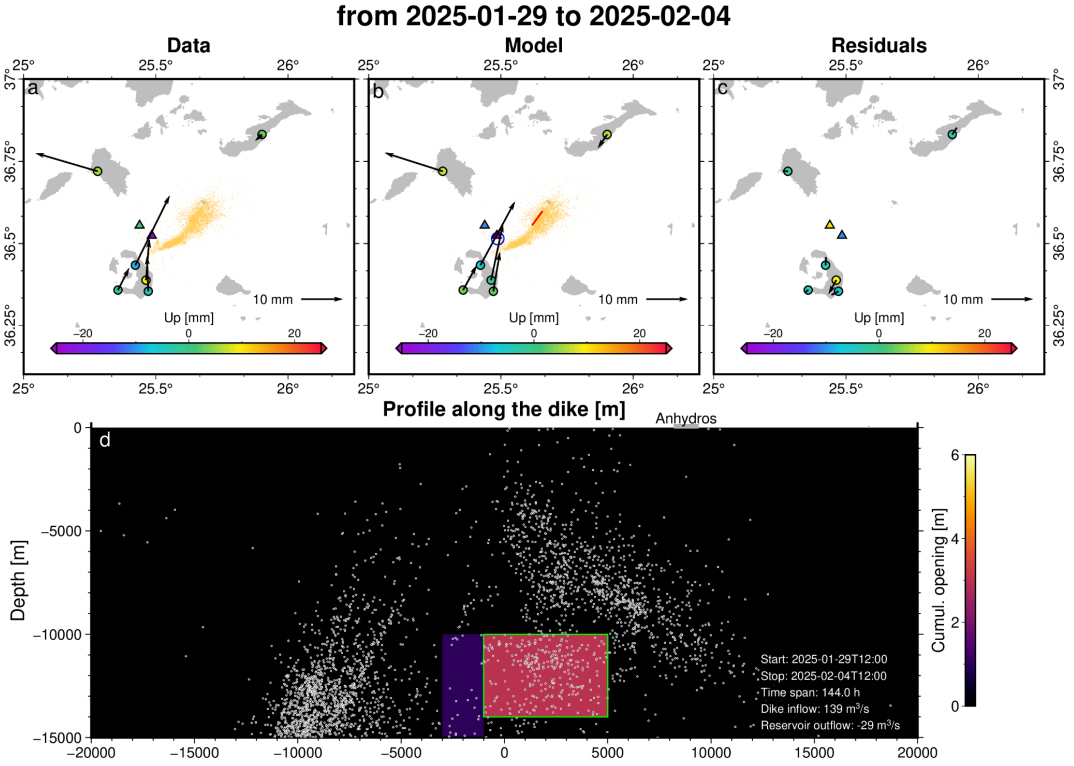

36.5°N
36.6°N
36.7°N
25.4°E
Santorini
Kolumbo / KVC
Anhydros Block
Santorini-Anafi Fault
0
5
10 km
Phase III
2025-02-06 to 2025-02-10
GNSS
25 mm
-30 Up (cm) 30
0 Depth (km) 20
Seismic Stations
Seismic Events
Depth (km)
Distance (km)

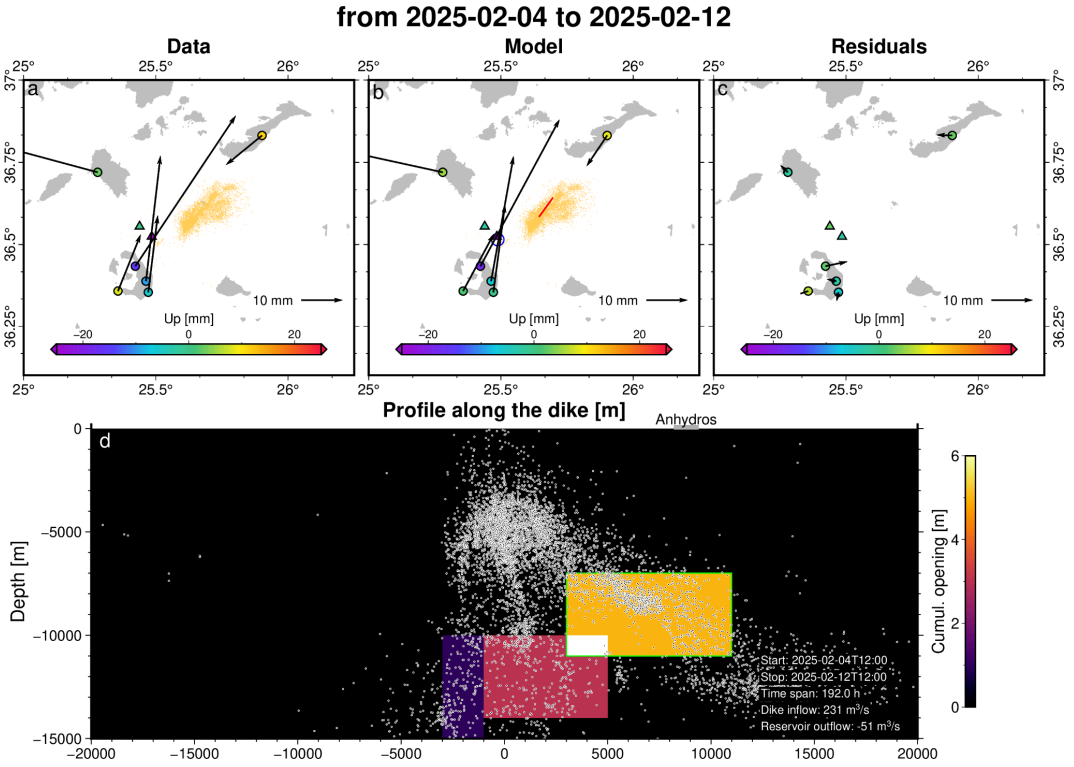

36.5°N
36.6°N
36.7°N
25.4°E
Santorini
Kolumbo / KVC
Anhydros Block
Santorini-Anafi Fault
0
5
10 km
Phase IV
2025-02-10 to 2025-02-11
GNSS
25 mm
-30 Up (cm) 30
0 Depth (km) 20
Seismic Stations
Seismic Events
Depth (km)
Distance (km)

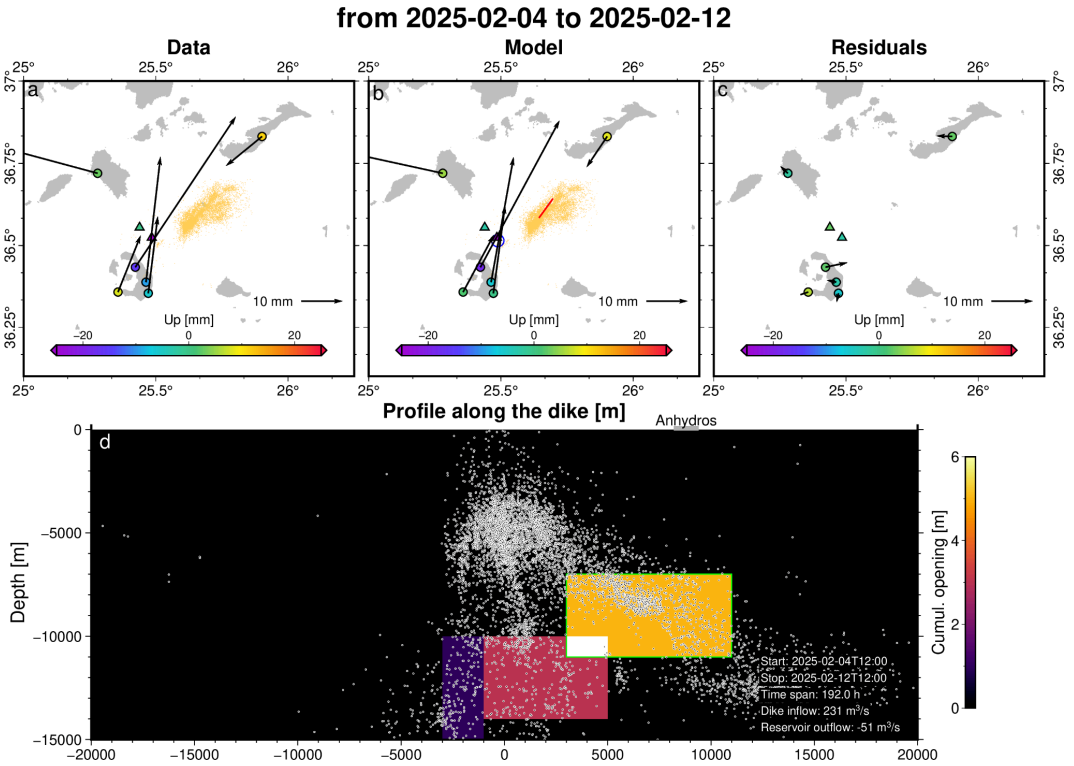


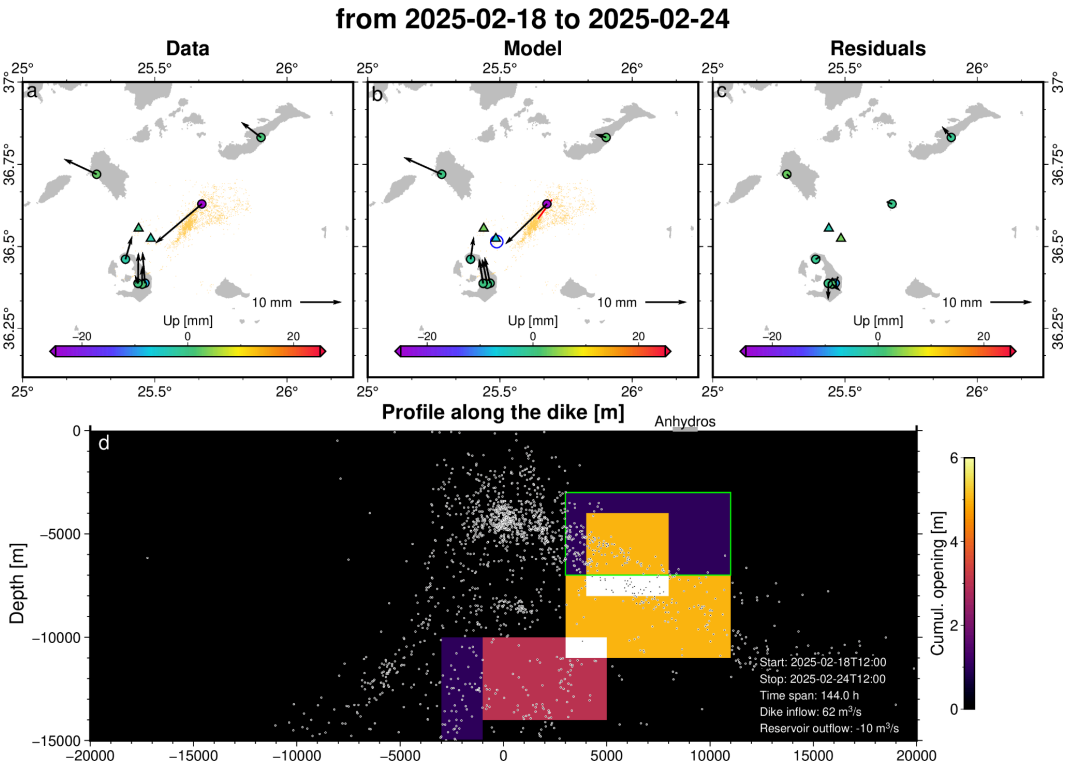
Supplementary Fig. 1 | Spatiotemporal migration of seismicity. *Maps and cross-sections illustrating the spatial migration of seismicity within phases I to V, between 24 January and 23 February 2025.*


from 2025-01-25 to 2025-01-29
Data
Model
Residuals
a
b
c
10 mm
Up [mm]
Profile along the dike [m]
Anhydros
d
Depth [m]
Cumul. opening [m]
Start: 2025-01-25T12:00
Stop: 2025-01-29T12:00
Time span: 96.0 h
Dike inflow: 29 m3/s
Reservoir outflow: 0 m3/s

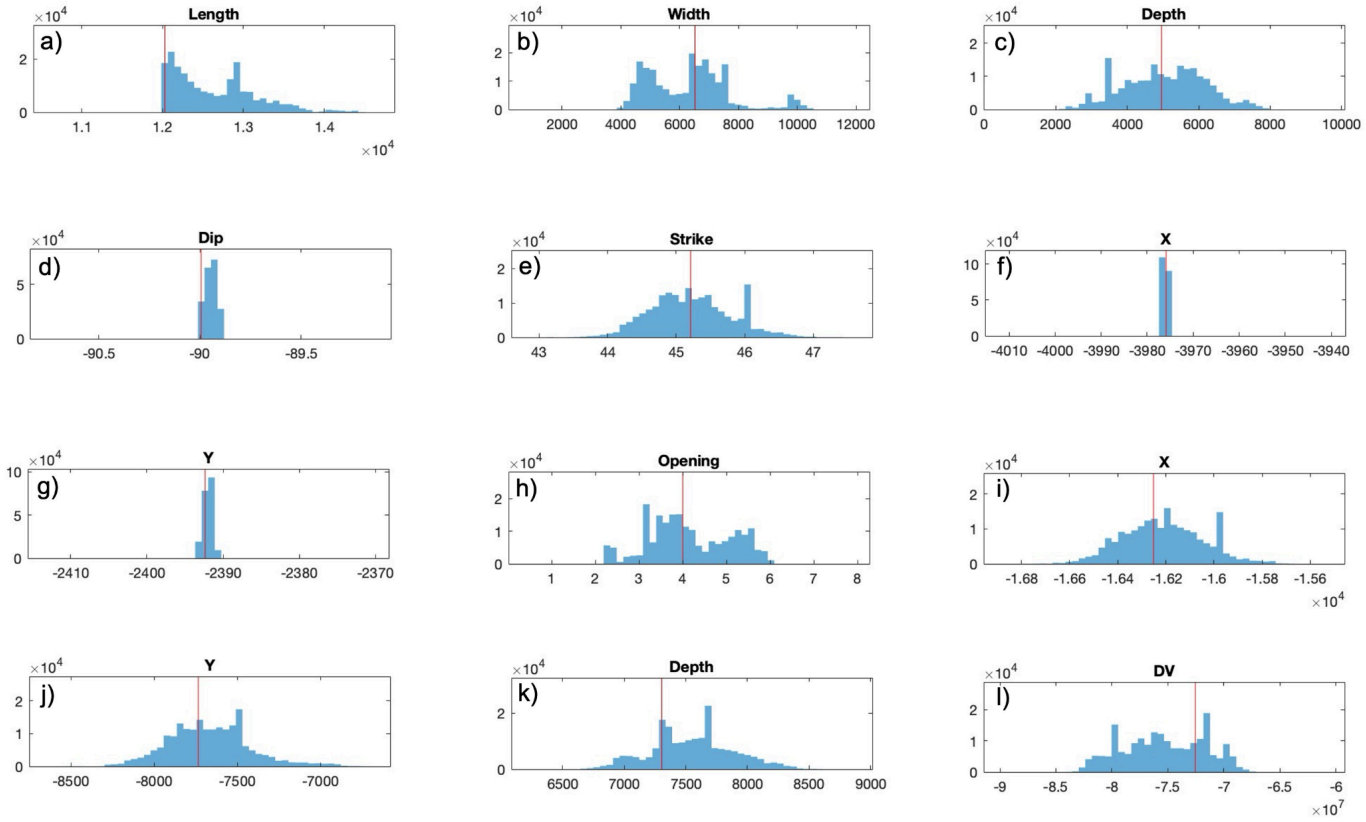

from 2025-01-29 to 2025-02-04
Data
Model
Residuals
a
b
c
10 mm
Up [mm]
Profile along the dike [m]
Anhydros
d
Depth [m]
Cumul. opening [m]
Start: 2025-01-29T12:00
Stop: 2025-02-04T12:00
Time span: 144.0 h
Dike inflow: 139 m3/s
Reservoir outflow: -29 m3/s


from 2025-02-04 to 2025-02-12
Data
Model
Residuals
a
b
c
10 mm
Up [mm]
−20
0
20
25°
25.5°
26°
37°
36.75°
36.5°
36.25°
Profile along the dike [m]
Anhydros
d
Depth [m]
0
−5000
−10000
−15000
−20000
−15000
−10000
−5000
0
5000
10000
15000
20000
Cumul. opening [m]
6
4
2
0
Start: 2025-02-04T12:00
Stop: 2025-02-12T12:00
Time span: 192.0 h
Dike inflow: 231 m³/s
Reservoir outflow: -51 m³/s

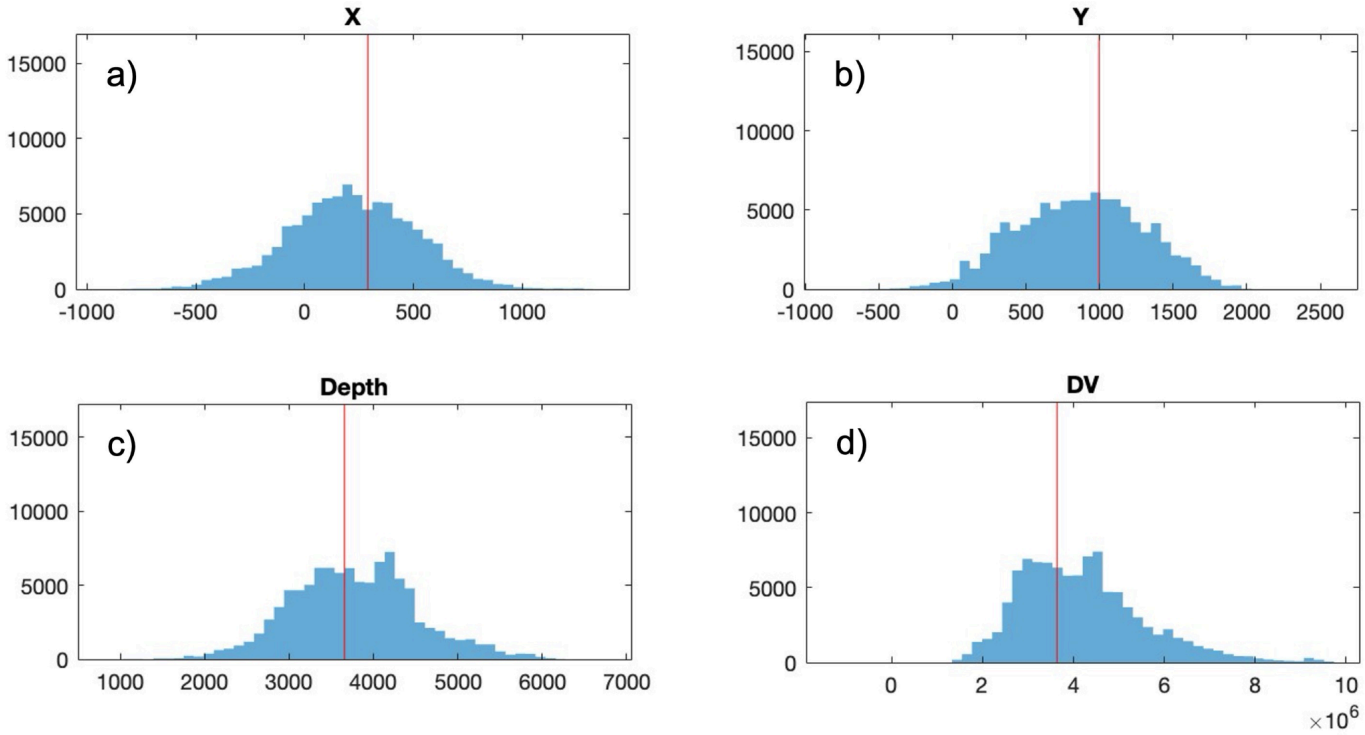

from 2025-02-04 to 2025-02-12
Data
Model
Residuals
a
b
c
10 mm
Up [mm]
−20
0
20
25°
25.5°
26°
37°
36.75°
36.5°
36.25°
Profile along the dike [m]
Anhydros
d
Depth [m]
0
−5000
−10000
−15000
−20000
−15000
−10000
−5000
0
5000
10000
15000
20000
Cumul. opening [m]
6
4
2
0
Start: 2025-02-04T12:00
Stop: 2025-02-12T12:00
Time span: 192.0 h
Dike inflow: 231 m³/s
Reservoir outflow: -51 m³/s



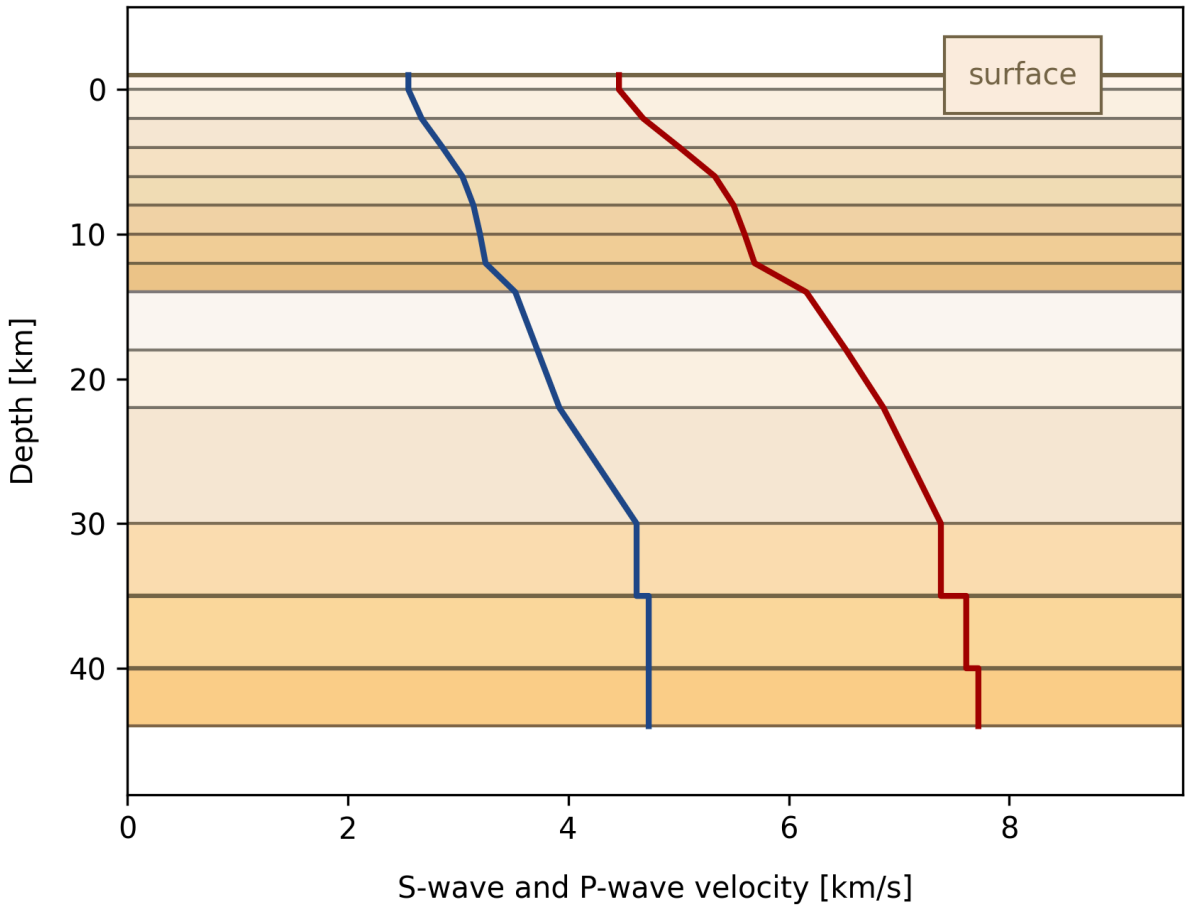
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Supplementary Fig. 3 | Co-diking geodetic modelling posterior probability density distributions. *Geodetic model parameters for Kolumbo deflation and diking event spanning 18 January to 23 February 2025 using a point source of pressure (Mogi, 1958) and Okada dislocation (Okada, 1992).* ***a-h****, Probability density functions for the dike (Okada dislocation) parameters.* ***a****, length (m),* ***b****, width (m),* ***c****, top depth (m),* ***d****, dip (°),* ***e****, strike (°),* ***f****, center point x-location (m),* ***g****, center point y-location (m),* ***h****, opening (m). Dip and central X, Y coordinates of the dike were fixed. Lower bound on length was set to 12 km.* ***i-l****, Probability density functions for the deflating source (Mogi) parameters.* ***i****, x-location (m),* ***j****, y-location (m),* ***k****, depth of source (m),* ***l****, volume change (m^3). The georeference point for the model is 25.669°E, 36.584°N.*



Supplementary Fig. 4 | Santorini inflation pre-diking geodetic modelling posterior probability density distributions. *Spanning 10 July 2024 to 18 January 2025 using a point source of pressure (Mogi, 1958). (a-d) Probability density functions for the source parameters.* ***a****, x-location (m),* ***b****, y-location (m),* ***c****, depth of source (m),* ***d****, volume change (m^3). The georeference point for the model is 25.387°E, 36.424°N.*



Supplementary Fig. 5 | Seismic velocity model used for detection and localisation of seismicity. *Local subsurface seismic velocity P- (red) and S-wave (blue) model used for earthquake detection and localisation. From Papadimitriou et al (2015).*



Supplementary Fig. 6 | Seismic stations used for moment tensor inversion. *The probabilistic moment tensors were inverted from a set of regional seismic stations with a maximum distance of 700 km to Santorini using the AK135 velocity model.*

References

Papadimitriou, P. et al. The Santorini Volcanic Complex: A detailed multi-parameter seismological approach with emphasis on the 2011–2012 unrest period. Journal of Geodynamics 85, 32–57 (2015).