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Supporting Information for

Geodetic monitoring at Axial Seamount since its 2015 eruption reveals a waning magma supply and tightly linked rates of deformation and seismicity

William W. Chadwick, Jr.[1], William S. D. Wilcock[2], Scott L. Nooner[3], Jeff W. Beeson[1,4],

Audra M. Sawyer[3], T.-K. Lau[1]

1 – Oregon State University, CIMRS, Hatfield Marine Science Center, Newport, OR, 97365

2 – School of Oceanography, University of Washington, Seattle, WA, 98195

3 – University of North Carolina Wilmington, Wilmington, NC, 28403

4 – NOAA, Pacific Marine Environmental Laboratory, Newport, OR, 97365

Corresponding author: William W. Chadwick (william.w.chadwick@gmail.com)

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Text S1. Supplementary Figures of Deformation and Seismicity During Deflation Events

The paper referenced above describes the identification of eight short-term deflation events during the long-term re-inflation of Axial Seamount since its 2015 eruption. Figure 5 in the paper shows seafloor uplift and a histogram of seismic data from two of the eight short-term deflation events, and Figure 8 in the paper shows earthquake epicenter maps from one of the eight events. This section of the Supporting Information file shows similar uplift and seismic data from all of the eight short-term deflation events for a comprehensive comparison. The figures below include: (1) plots of uncorrected differential uplift from Bottom Pressure Recorder (BPR) data (OOI-BPR-MJ03F minus MJ03E) for each event, (2) histograms of the number of earthquakes per day during each event, and (3) maps of earthquake epicenters before, during, and after each event. The decrease in seismicity during each short-term deflation event is more evident after the beginning of 2018 when the level of seismicity was higher. See the text of the paper for more information.

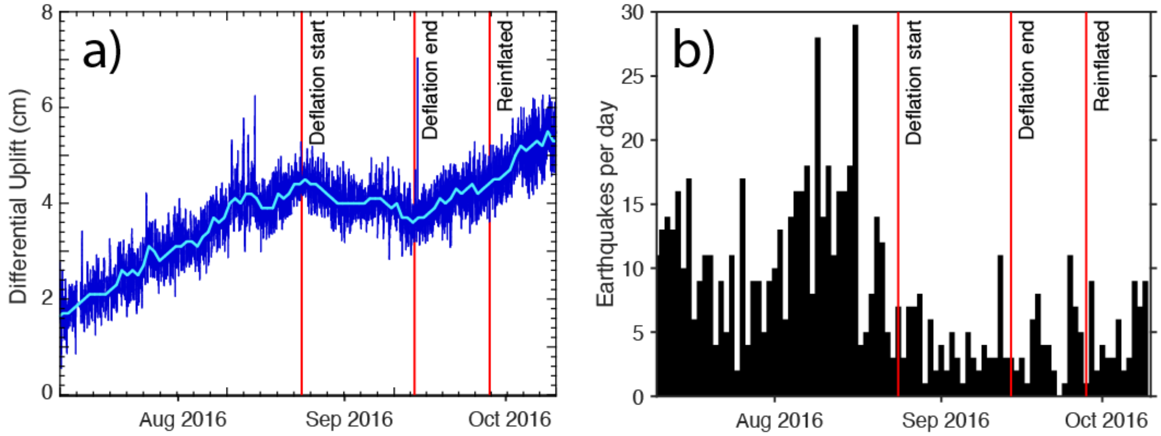


Figure S1. Deformation and seismic data during the **August 2016** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 10 July to 10 October 2016. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level.

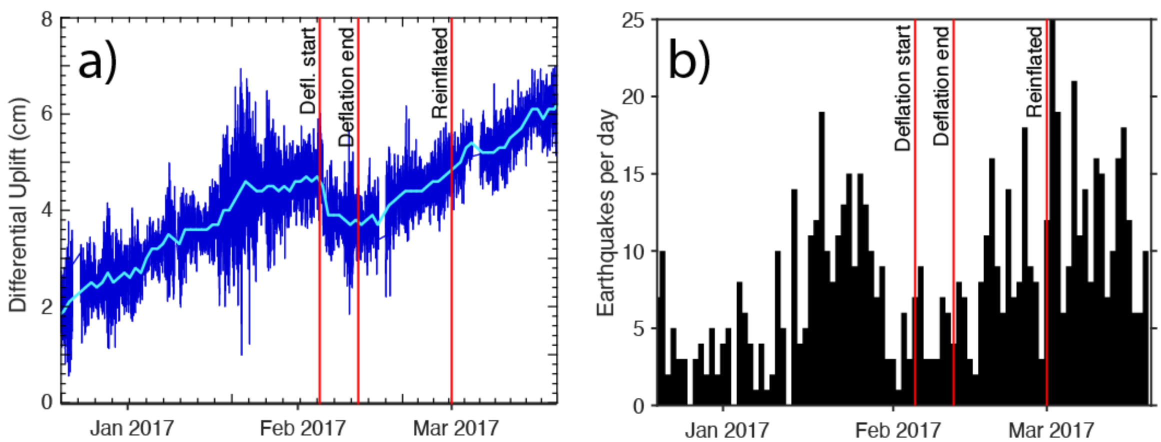


Figure S2. Deformation and seismic data during the **February 2017** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 20 December 2016 to 20 March 2017. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level.

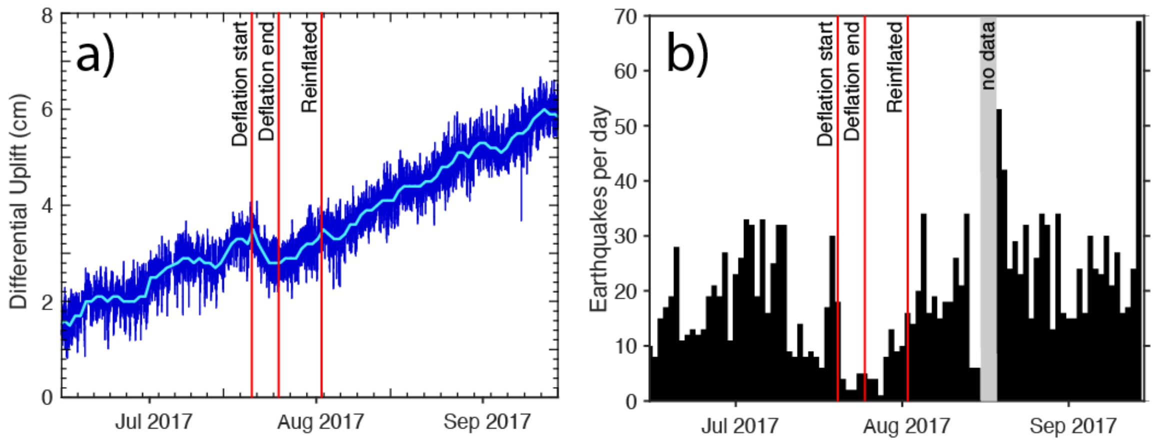


Figure S3. Deformation and seismic data during the **July 2017** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 15 June to 15 September 2017. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level. Grey bar is time period when seismic data are unavailable.

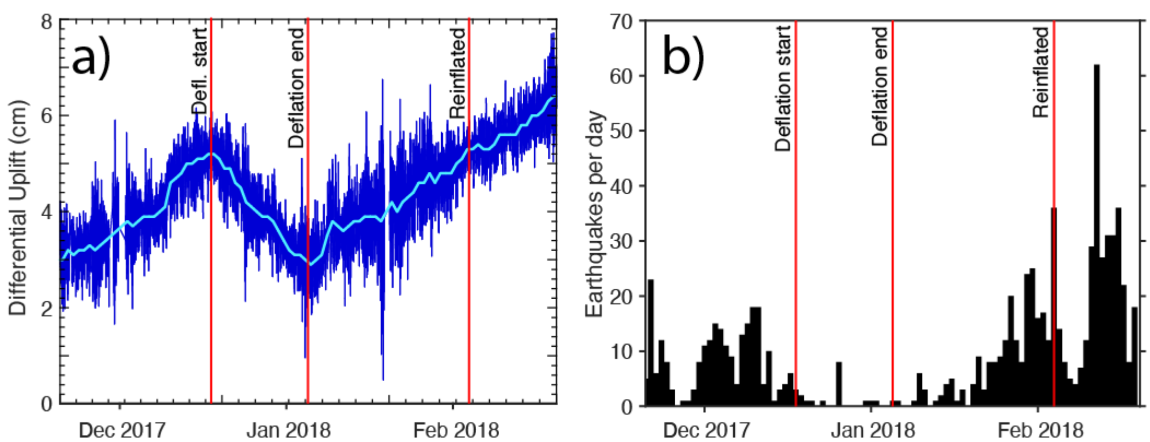


Figure S4. Deformation and seismic data during the **December 2017** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 20 November 2017 to 20 February 2018. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level.

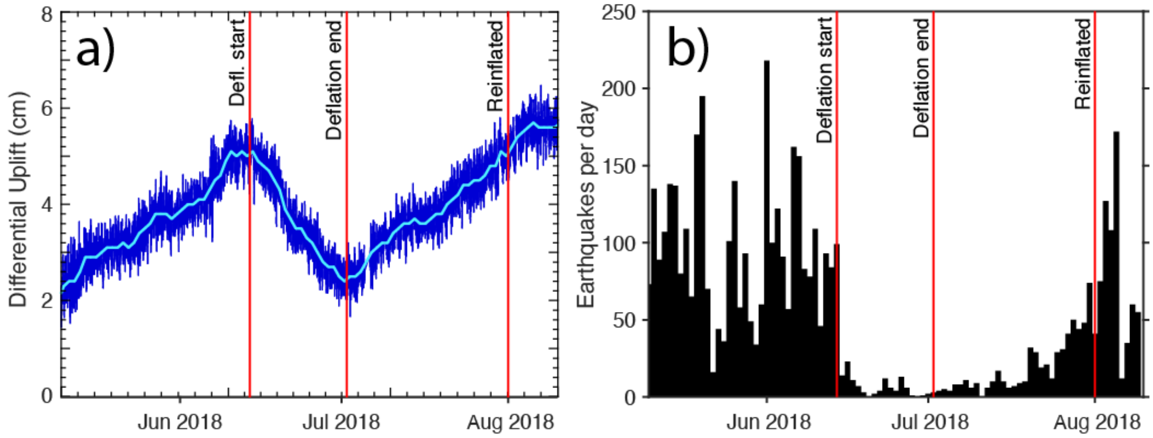


Figure S5. Deformation and seismic data during the **June 2018** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 10 May to 10 August 2018. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level. (Same as Fig. 5a,b in the paper)

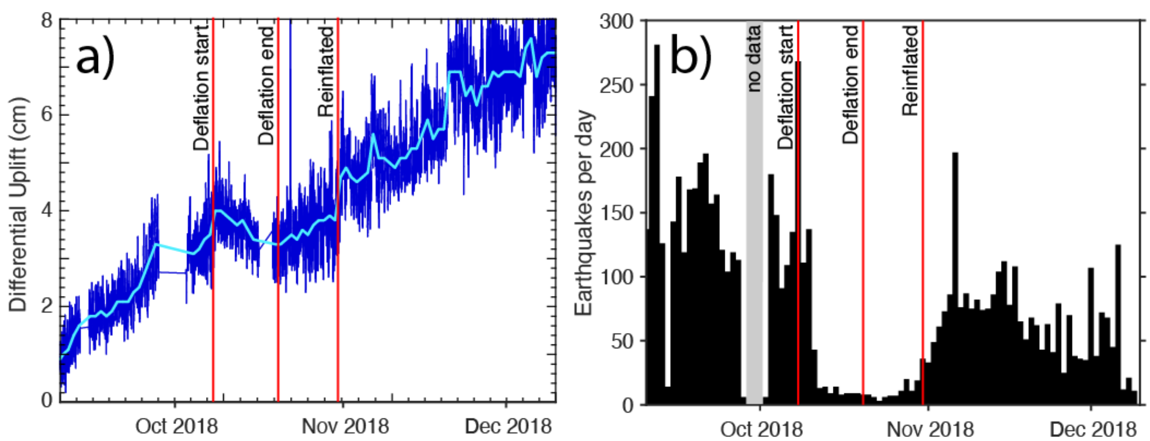


Figure S6. Deformation and seismic data during the **October 2018** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 10 September to 10 December 2018. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level. Grey bar is time period when seismic data are unavailable.

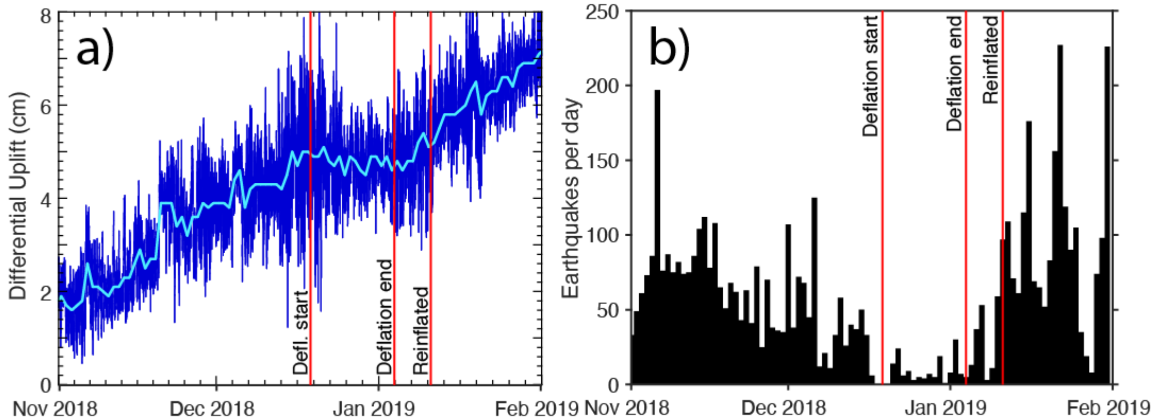


Figure S7. Deformation and seismic data during the **December 2018** short-term deflation event. (a) Uncorrected differential BPR data over 3 months from 1 November 2018 to 1 February 2019. Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level.

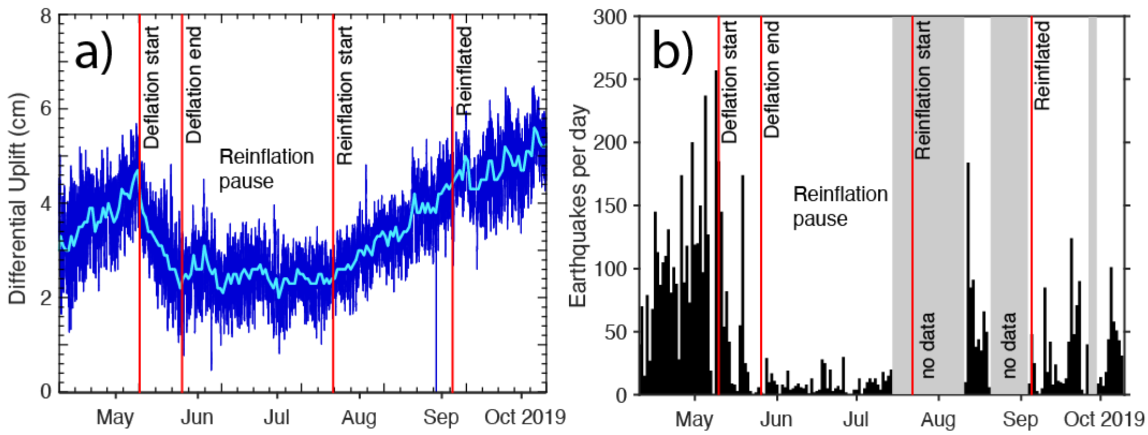


Figure S8. Deformation and seismic data during the **May 2019** short-term deflation event. (a) Uncorrected differential BPR data over 6 months from 10 April to 10 October 2019 (note this is twice as long as the other plots). Dark-blue curve is data sub-sampled to every 15 minutes; light-blue curve is data averaged over 1-day windows. Vertical red lines show the times when deflation started, ended, and when re-inflation reached the previous level. (b) Histogram of the number of earthquakes per day over the same time interval as in (a). Note y-axis for the deformation plots is the same in Figures S1-S8 (8 cm), but the y-axis in the earthquake histograms is different for each figure. Comparing the two plots shows that the seismicity decreased during the short-term deflation event and did not resume until re-inflation reached the previous level. Grey bars are time periods when seismic data are unavailable. (Same as Fig. 5c,d in the paper).

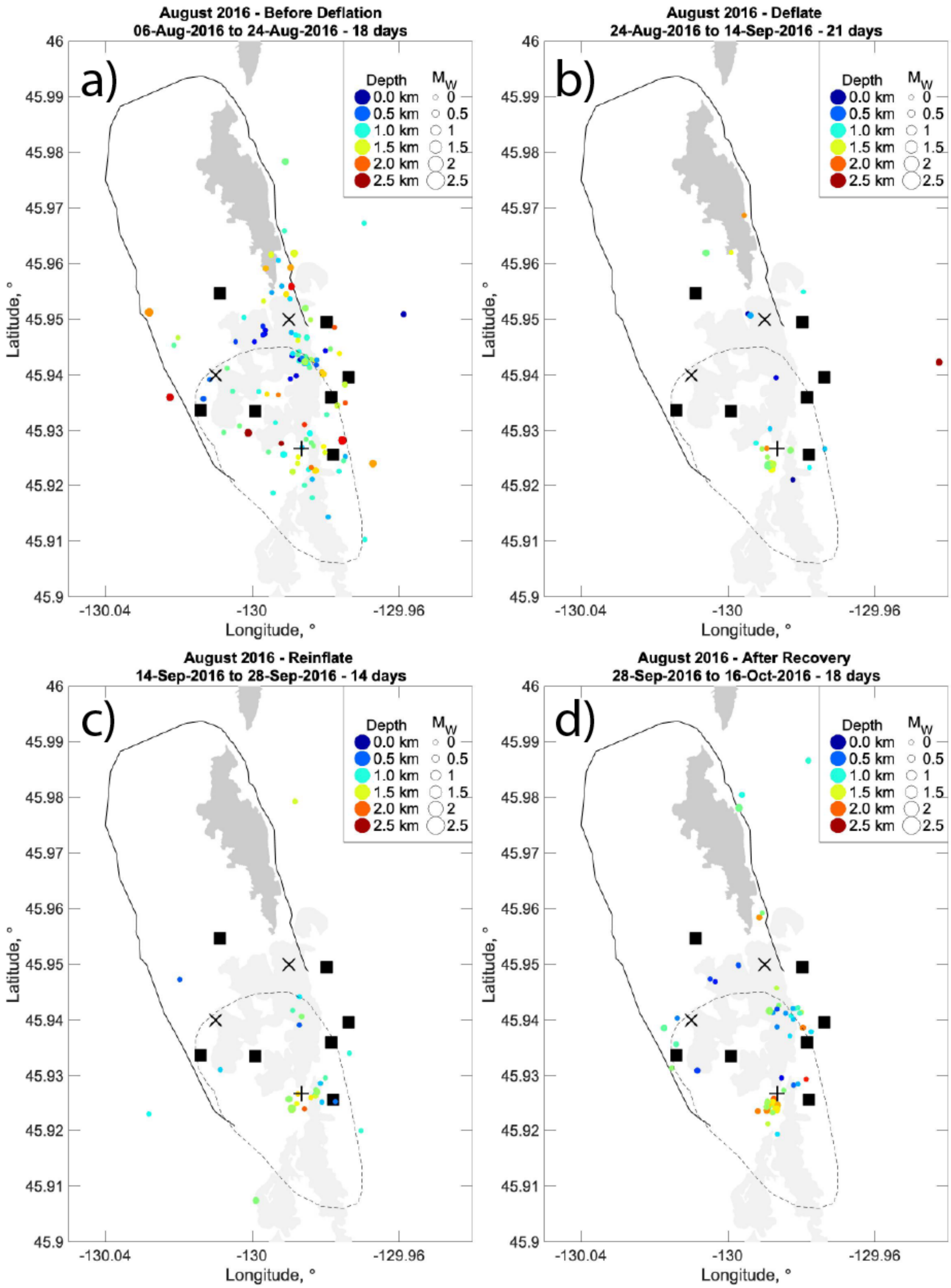


Figure S9. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **August 2016** short-term deflation event. See caption for Fig. 8 in the paper for additional information.

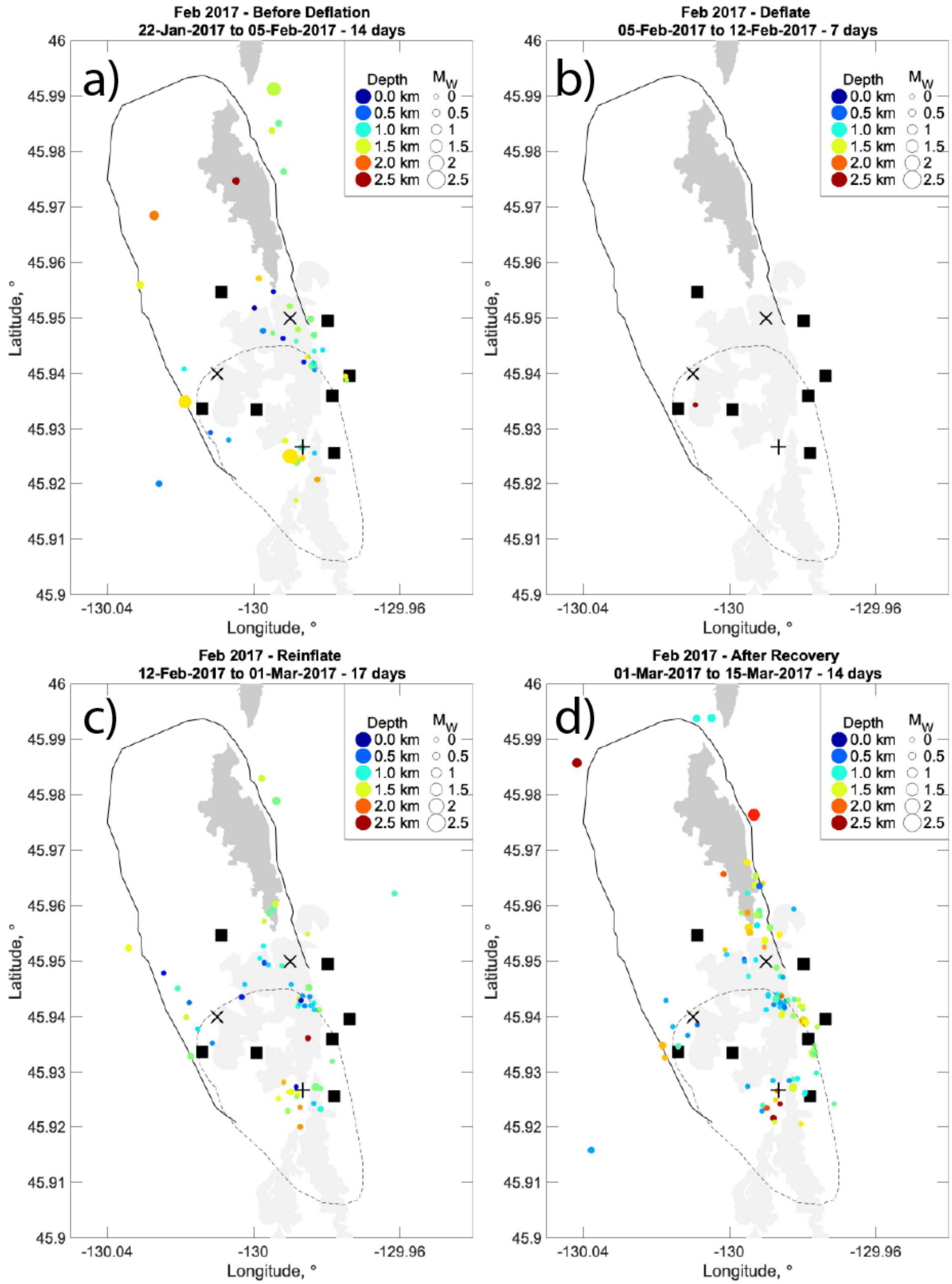


Figure S10. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **February 2017** short-term deflation event. See caption for Fig. 8 in the paper for additional information.

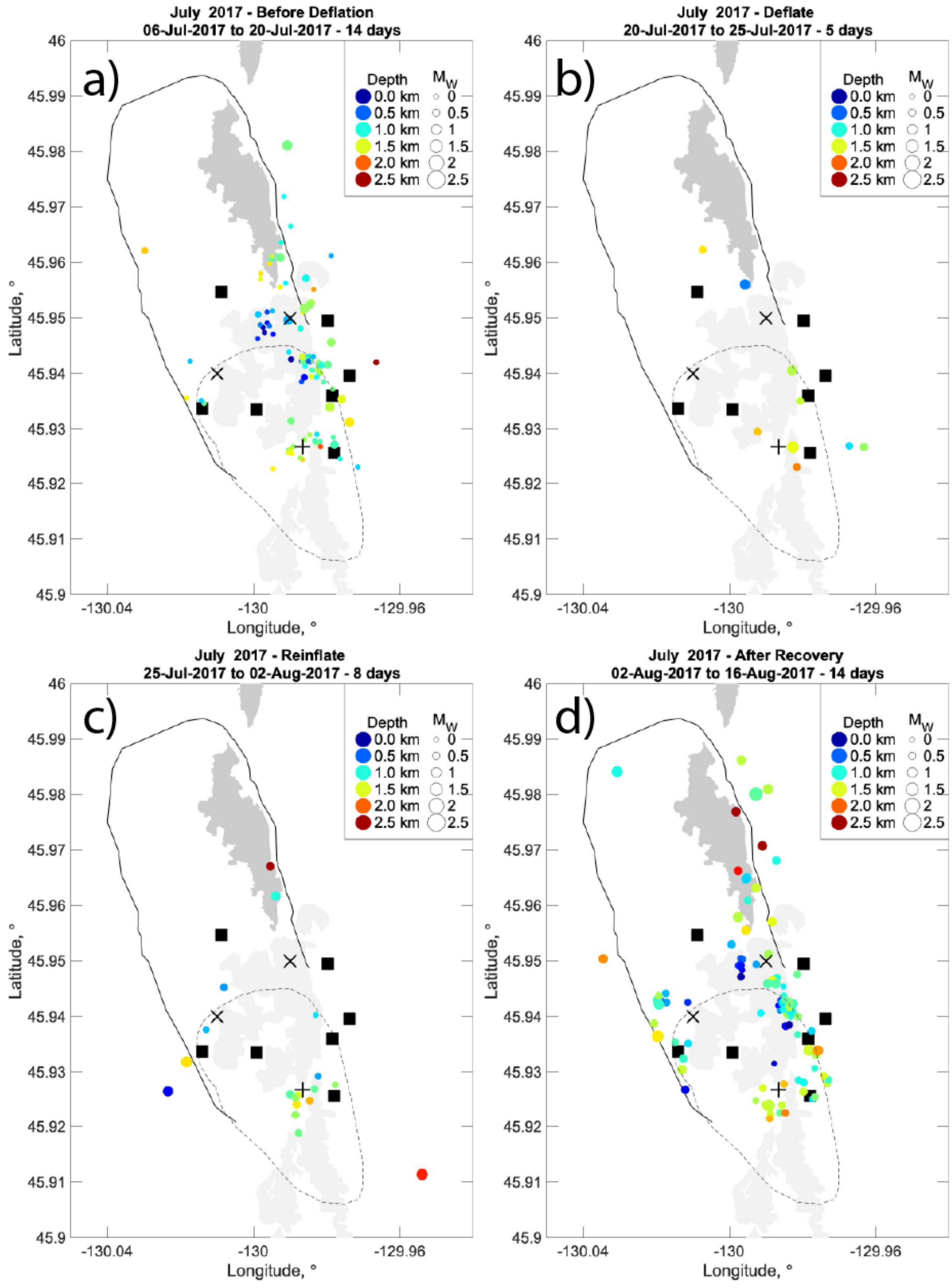


Figure S11. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **July 2017** short-term deflation event. See caption for Fig. 8 in the paper for additional information.

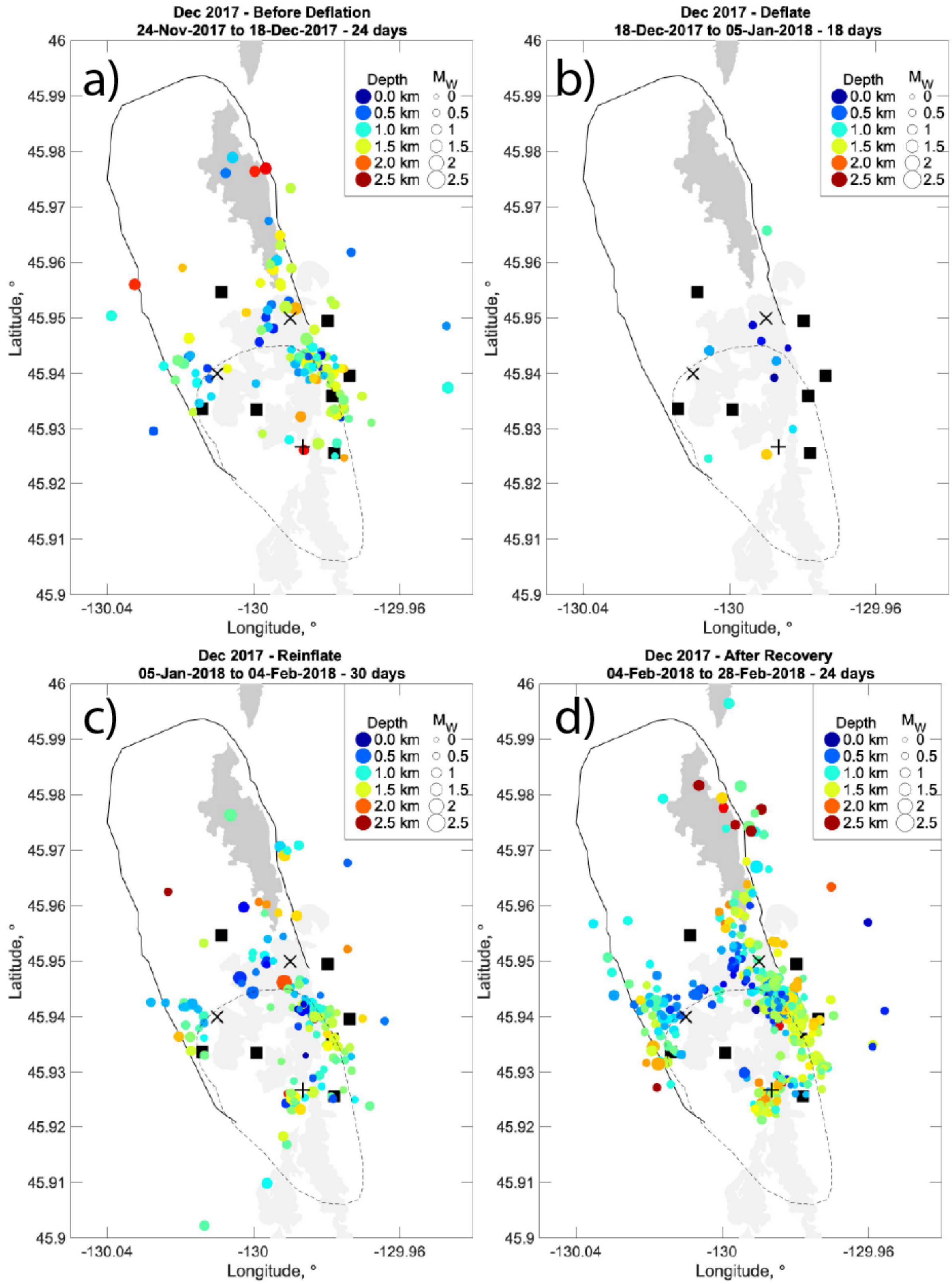


Figure S12. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **Dec. 2017** short-term deflation event. See caption for Fig. 8 in the paper for additional information.

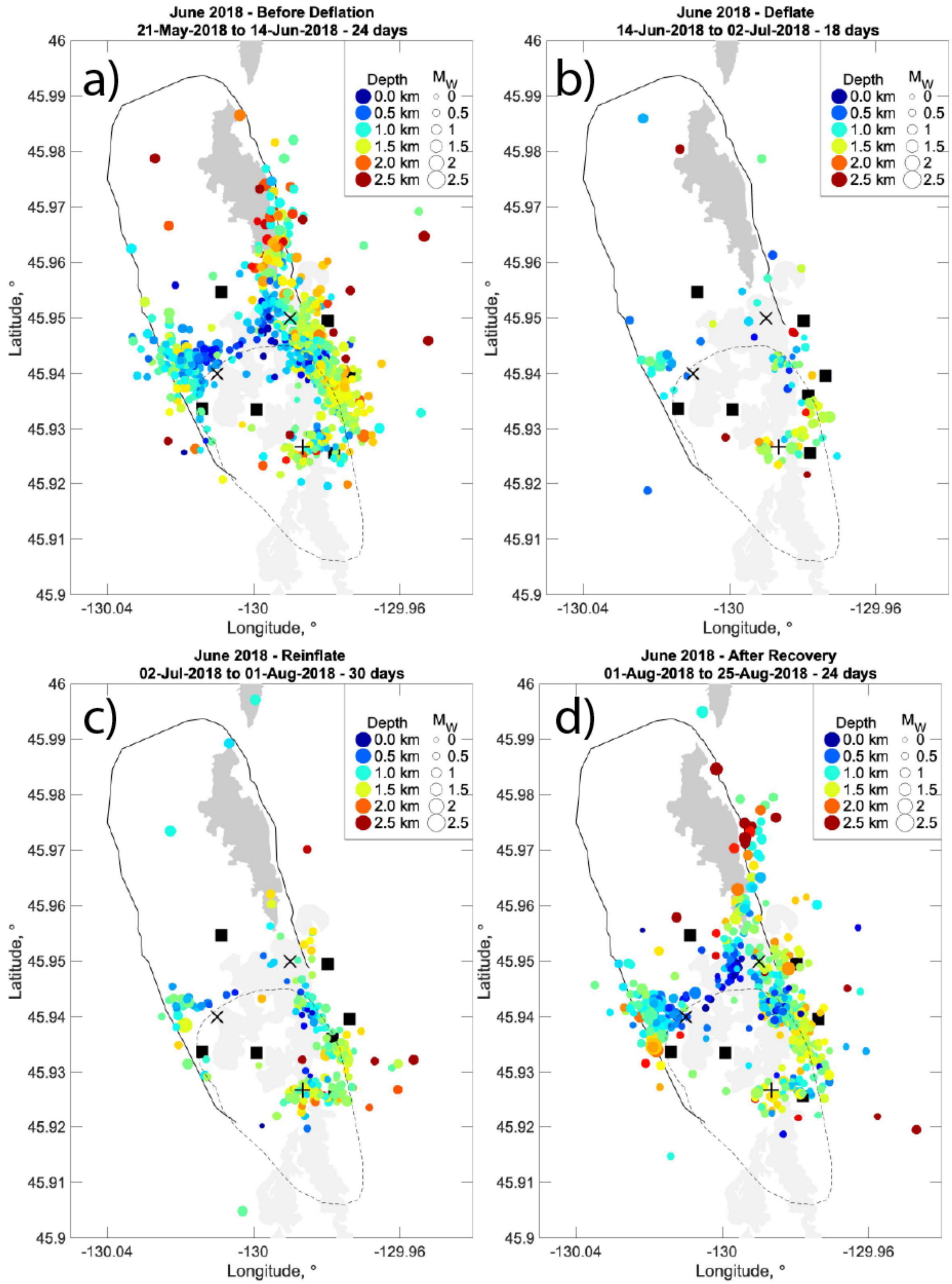


Figure S13. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **June 2018** short-term deflation event. See caption for Fig. 8 in the paper for additional information.

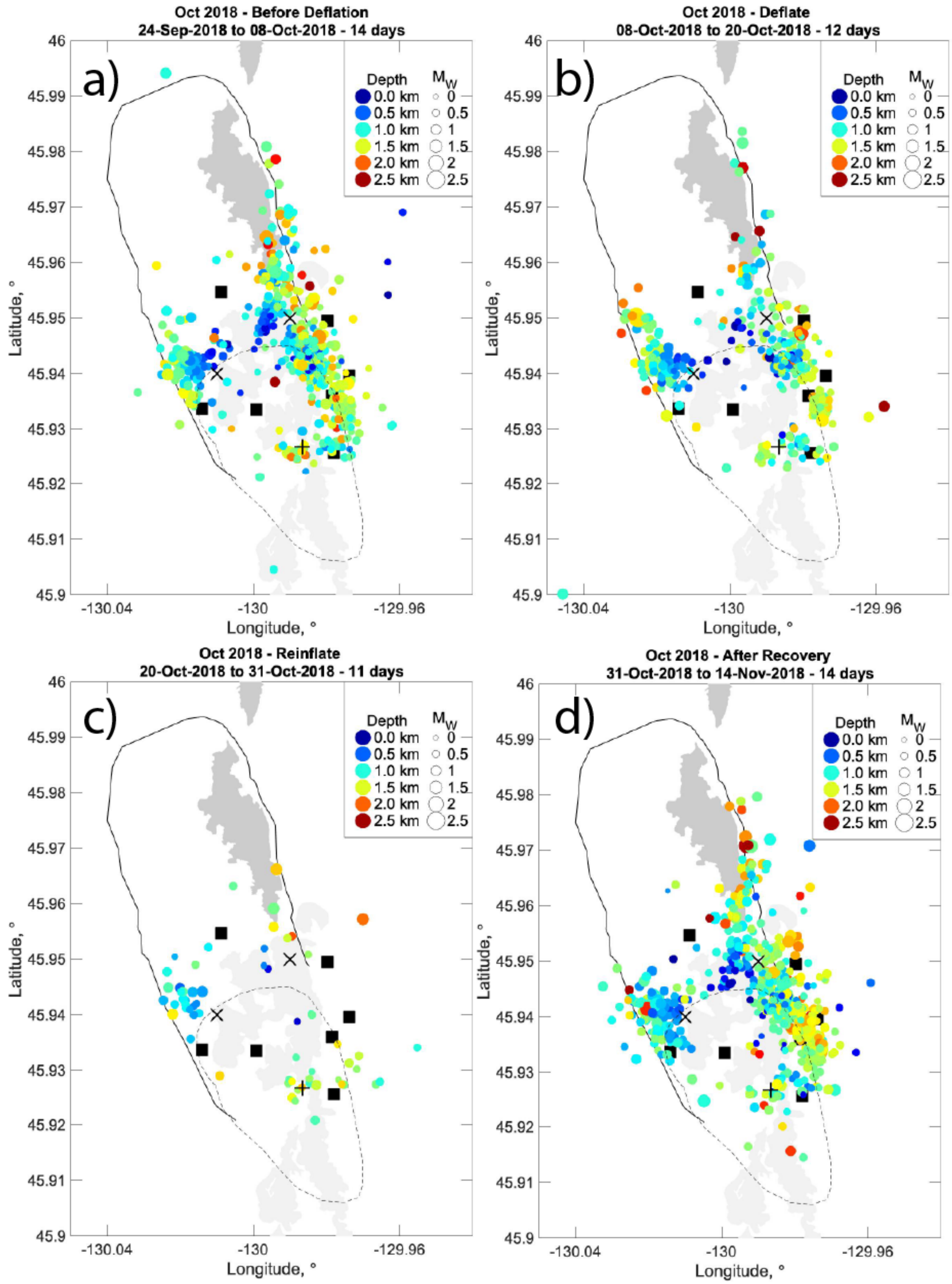


Figure S14. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **October 2018** short-term deflation event. See caption for Fig. 8 in the paper for additional information.

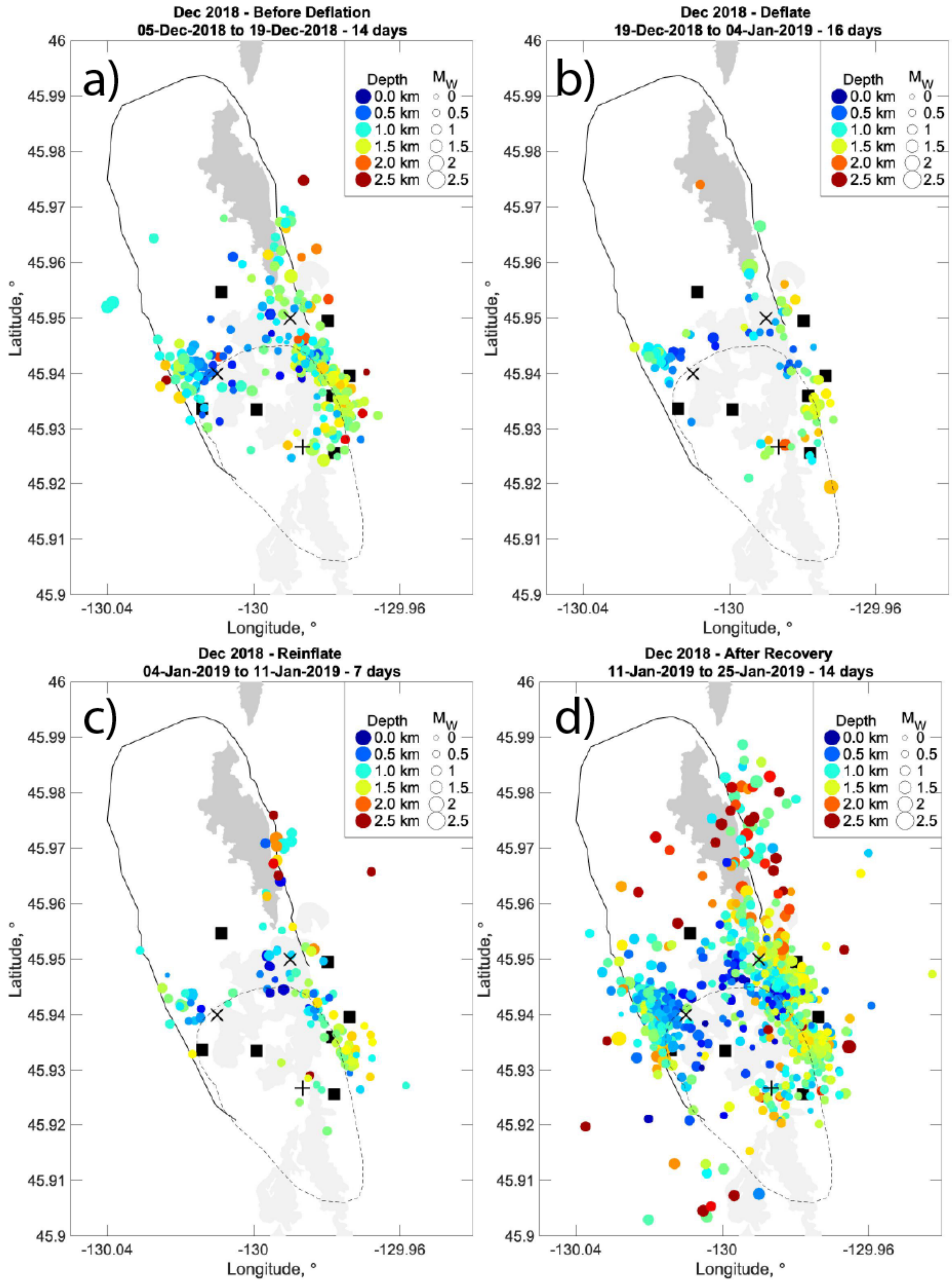
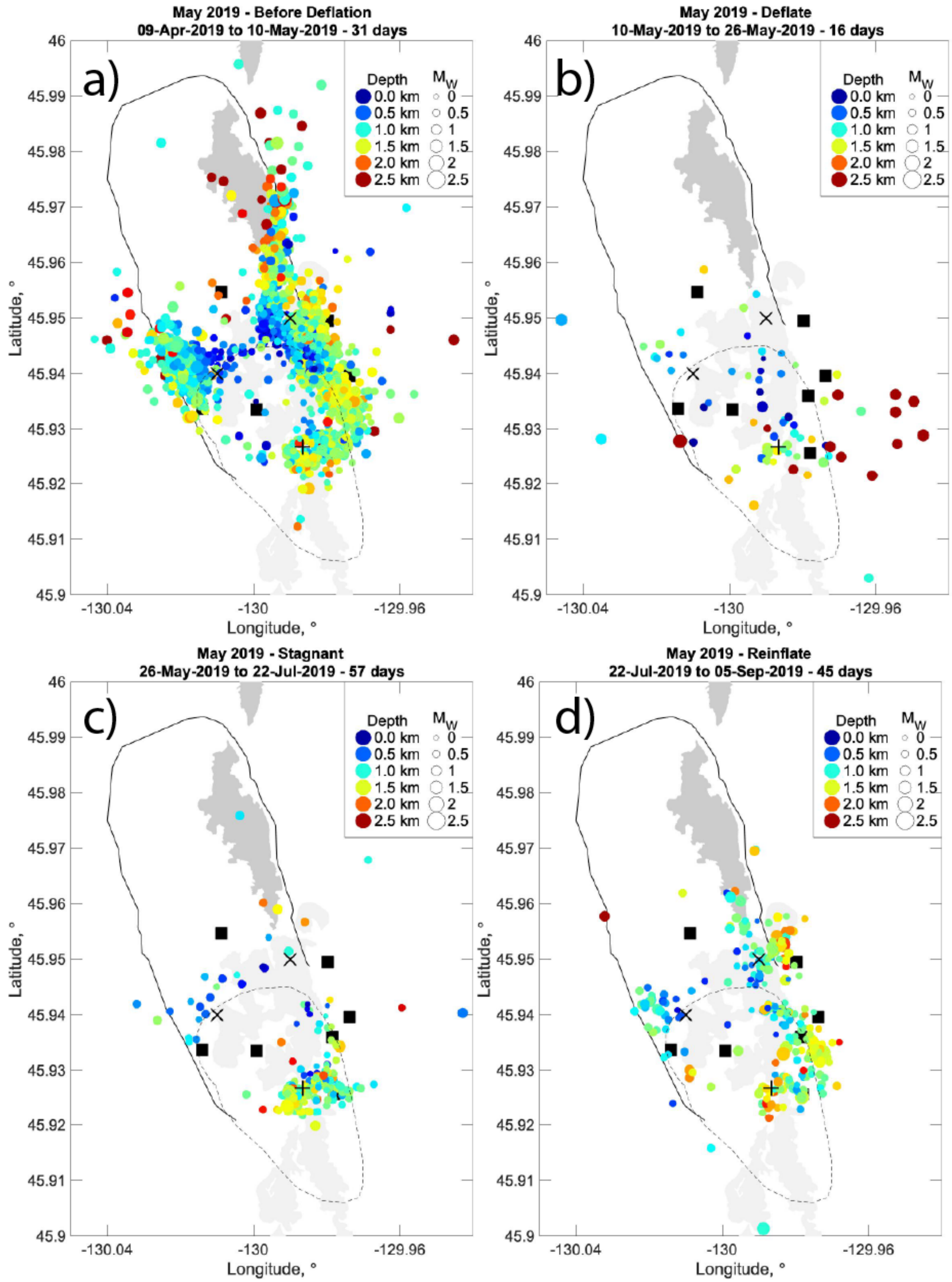


Figure S15. Maps of earthquake epicenters before (a), during (b), and after (c&d) the **Dec. 2018** short-term deflation event. See caption for Fig. 8 in the paper for additional information.



May 2019 - Before Deflation
09-Apr-2019 to 10-May-2019 - 31 days
a)
May 2019 - Deflate
10-May-2019 to 26-May-2019 - 16 days
b)
May 2019 - Stagnant
26-May-2019 to 22-Jul-2019 - 57 days
c)
May 2019 - Reinflate
22-Jul-2019 to 05-Sep-2019 - 45 days
d)
Depth
0.0 km
0.5 km
1.0 km
1.5 km
2.0 km
2.5 km
M_W
0
0.5
1
1.5
2
2.5
Latitude, °
Longitude, °

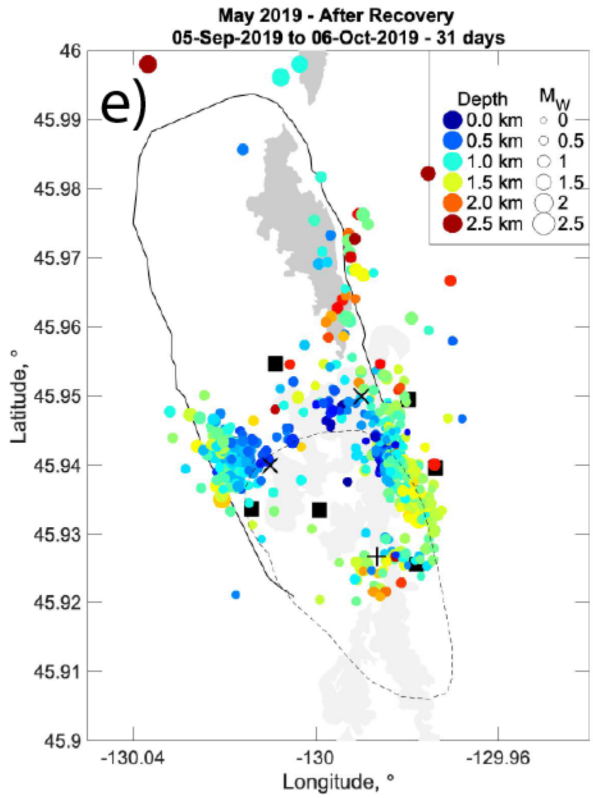


Figure S16. Maps of earthquake epicenters before (a) and during (b) the **May 2019** short-term deflation event, followed by the 2-month stagnant pause (c) when neither inflation nor deflation was occurring, then the interval of reinflation (d), and finally a month-long time period after the previous level of inflation was recovered (e). See caption for Fig. 8 in the paper for additional information.

Text S2. Relationship Between Rate of Uplift and Magma Supply

Here, we show how we relate the rate of seafloor uplift (or inflation) observed at the center of the caldera at Axial Seamount (for example, at MPR seafloor benchmark AX-101, or at OOI-BPR-MJ03F, or the corrected differential uplift of MJ03F minus MJ03E) to an estimate of the associated magma supply rate (or volume change) in the shallow sub-caldera magma reservoir that caused that uplift. The plot below shows a linear relationship of 1.3 x 10^6 m^3/yr in volume change per 1 cm/yr of observed uplift, and is based on the best-fit deformation model previously published in Nooner and Chadwick (2016). That model is a steeply-dipping prolate spheroid with the major axis dipping at 77° in the direction of 286°, with major and minor axes of 2.2 km and 0.38 km, respectively, a depth to center of 3.81 km, and a centroid located beneath the eastern caldera rim at 45° 56.880'N latitude and 129° 59.088'W longitude. To relate uplift to volume change, we keep most of the parameters of the prolate spheroid model fixed, and allow the major and minor axes to vary while keeping the ratio of the two axes fixed. This allows the volume of the spheroid to change and causes the uplift of the seafloor above it to vary in a linear relationship. This relation is very model-dependent, but it provides a quantitative example to illustrate how much the magma supply rate at Axial Seamount has varied over the last few decades.

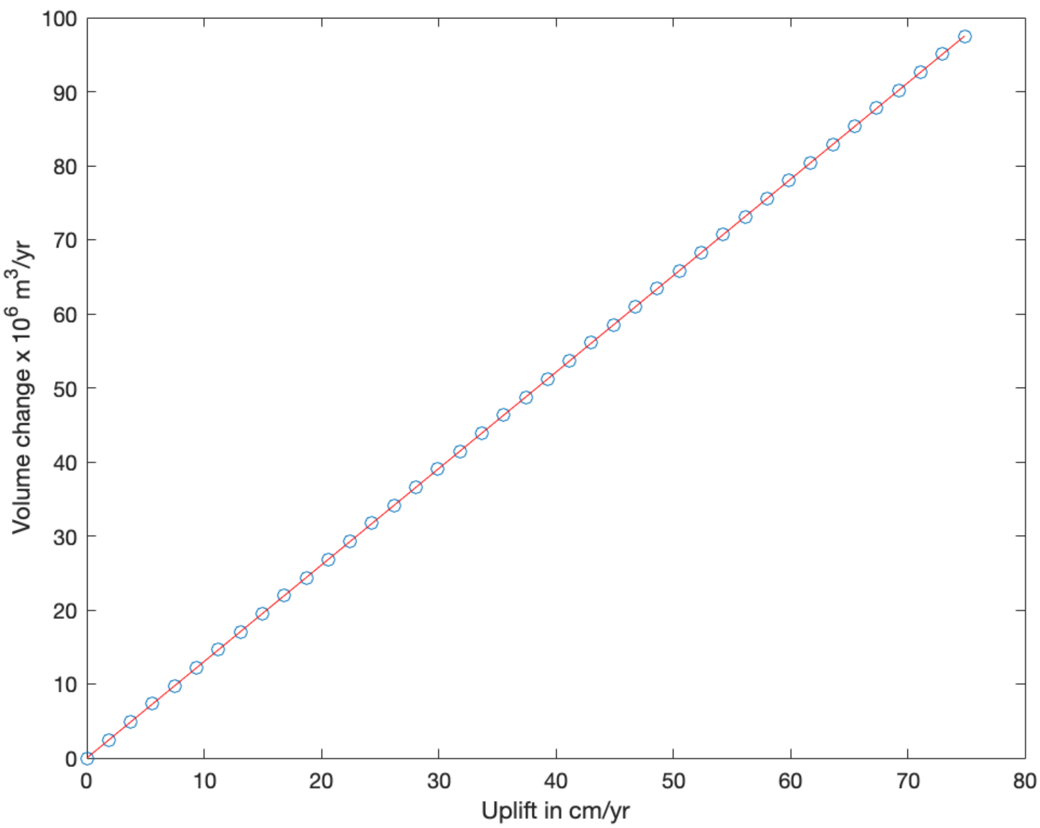


Figure S17. Plot of the relationship between rate of seafloor uplift (or inflation) at the center of the caldera at Axial Seamount vs. the associated magma supply rate (or volume change).