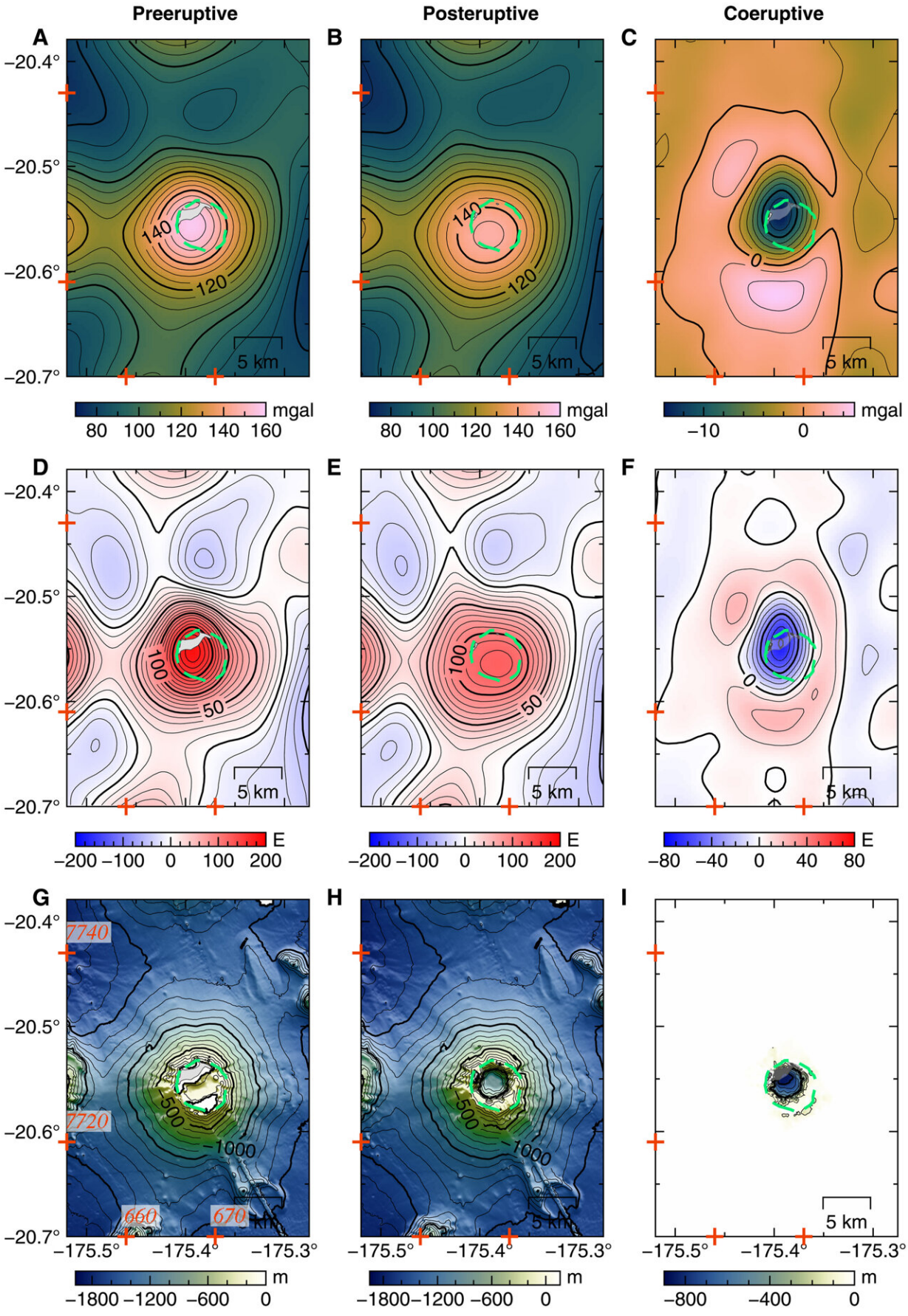
Mapping magma chambers under the Hunga volcano before and after the 2022 eruption

December 22 2023, by Bob Yirka


Preeruptive
Posteruptive
Coeruptive
A
B
C
−20.4°
−20.5°
−20.6°
−20.7°
140
120
0
5 km
mgal
80 100 120 140 160
−10 0
D
E
F
100
50
E
−200 −100 0 100 200
−80 −40 0 40 80
G
H
I
7740
7720
660
670
km
−500
−1000
−175.5°
−175.4°
−175.3°
m
−1800 −1200 −600 0
−800 −400 0

Pre-, post-, and coeruptive datasets. (A and B) Marine gravity anomaly derived from satellite altimetry [V31.1 and V32.1, respectively]. Subaerial island outlines in gray. (C) Change in marine gravity anomaly between (A) and (B). (D and E) Vertical gravity gradient (VGG) data from satellite altimetry [V31.1 and V.32, respectively]. (F) Change in VGG between (D) and (E). (G) Preeruptive bathymetry, (H) Posteruptive bathymetry (see Materials and Methods), and (I) change in bathymetry between (G) and (H) attributed to the January 2022 Hunga eruption. Caldera outline (green dashed line) and Universal Transverse Mercator (UTM) coordinates (zone 1) tick marks (in kilometers) shown for reference in red. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.adh3156

A small team of geologists, volcanologists and Earth scientists from the Carnegie Institution for Science, Earth and Planets Laboratory, in the U.S., the GNS Science, Wairakei Research Center, in New Zealand, Auckland University of Technology, in New Zealand, the University of Auckland, in New Zealand and the Ministry of Lands and Natural Resources, in Tonga, has partially mapped the magmatic system state under the Hunga volcano from both before and after its 2022 eruption.

In their paper published in the journal *Science Advances,* the group describes how they used two types of technology to learn more about the magma reservoirs lying beneath the South Pacific volcano.

In January of 2022, the Hunga volcano experienced a massive eruption—one so strong that its caldera collapsed completely, its plume reached 58 kilometers into the mesosphere and the tsunami it generated reached the shores of both the U.S. and Japan. Study of the volcano and its eruption has proven to be challenging, however, due to its underwater location. In this new effort, the research team has taken a different approach to learning more about the magma chambers that lie beneath

the volcano.

Because it is difficult to deploy conventional sonar equipment to such an undersea environment, the research team instead used data from satellites that are so sensitive that they can measure tiny differences in sea levels across the globe. Slight differences in sea levels above a volcano, due to magma inside chambers, the researchers noted, could be used to measure how much magma is inside such chambers and also to map their size.

To that end, they analyzed data from satellite radar pulses and also from multibeam bathymetry for the region—together the two data sources allowed the researchers to create partial maps of the magma chambers beneath the volcano—one from before the eruption, the other from after—allowing for a comparison.

In studying their maps, the research team found that there exist three pockets of magma beneath the volcano, two that are liquid and a third that is mostly solidifying mush. They also found that the majority of the magma involved in the eruption came from a central chamber and that approximately 30% of its contents were blown out of the volcano during the eruption, leading the caldera to collapse.

The researchers also found evidence of a channel connecting the two liquid-filled chambers, which has allowed much of the magma lost from the central chamber to be replenished. They expect that further study of satellite data will reveal more details of the chambers beneath the volcano.

More information: Hélène Le Mével et al, The magmatic system under Hunga volcano before and after the 15 January 2022 eruption, *Science Advances* (2023). DOI: 10.1126/sciadv.adh3156