The hazards and driving processes of lava dome collapse: insight from the eruption of Sinabung Volcano (Indonesia)

Brett B Carr
University of Arizona
United States

Effusive eruptions of more viscous intermediate-to-silicic lava often build lava domes above the vent. Lava domes are inherently unstable structures prone to collapses that form block-and-ash style pyroclastic flows. Multiple different processes can cause instabilities to develop in lava domes and affect the size and frequency of dome collapses. This can make dome collapse hazards during an eruption difficult to assess. Dome-forming eruptions can also last years or even decades, creating a persistent hazard to those living in vicinity to these volcanoes.

The recent eruption of Sinabung Volcano (Indonesia) included lava dome and flow emplacement and numerous processes driving thousands of dome collapses that occurred over more than a decade of activity. Our investigations of this eruption have provided numerous insights on the hazards and driving processes of dome collapse. While collapse frequency often correlated with the effusion rate, collapse size did not. Large collapses remained possible throughout the eruption and thus the range of the pyroclastic flow hazard never decreased even as eruption rate waned. In one case, the volcano's topography controlled the development of a large instability that collapsed and led to both a change in effusive style (endogenous to exogenous) and an increase in collapse activity, all while effusion rate continued to decline. We developed a new method using photogrammetry and a slope stability model to assess the collapse hazard of dome instabilities which develop independent of the eruption rate, including after an eruption has ended. This work helps contribute to a more complete understanding of dome stability and assessment of collapse hazards at volcanoes with lava domes.