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Revisiting Earthquake-Triggered Volcanic Eruptions

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Analyses of global volcanic and seismic records since 1500AD have shown that explosive eruptions (VEI 2 or larger) are preceded within days by nearby major earthquakes (M8 or larger) about four times more often than expected due to coincidence, suggesting that earthquakes can trigger eruptions (e.g., Linde and Sacks, 1998; Manga and Brodsky, 2006). The vast majority of these triggered eruptions, however, occur in the 19th century, raising the question of whether 20th century records simply do not capture this phenomenon, or if perhaps these dynamically triggered eruptions are happening less frequently than reported.

We expand the definition of a triggered eruption to include the possibility of M6 or greater earthquakes within five days and 800 km of a VEI 2 or greater eruption. Removing pre-1964 records (to eliminate incomplete seismic data), we find 30 volcanoes that at some point experienced a potentially triggered eruption and define these volcanoes as “sensitive volcanoes”. Within this group of sensitive volcanoes, normalized distributions of volcano-centric factors such as tectonic setting, dominant rock type, and type of volcano are practically indistinguishable from those of “insensitive volcanoes” (ones that have never had a triggered eruption). Additionally, these distributions are almost indistinguishable from those of sensitive volcanoes in which the time of eruption has been randomized. The only notable differences between sensitive volcanoes and insensitive volcanoes are that sensitive volcanoes are slightly more likely to be in subduction zones (which are also regions of high seismicity), and have a shorter time interval between all explosive eruptions (indicating that sensitive volcanoes erupt more frequently). Applying Pearson’s chi-squared test, we find that eruptions are no more likely to happen in the week after than the week before the earthquake. The most statistically robust indication of triggered volcanism is a significantly higher number of explosive eruptions in the two years following major earthquakes than in the two years preceding them, a finding that is consistent with results obtained from previous studies.

We conclude that short-term seismically triggered eruptions occur less frequently than previously inferred.