EGU21-16252, updated on 25 May 2022
https://doi.org/10.5194/egusphere-egu21-16252
EGU General Assembly 2021

Complex magmatic-tectonic interactions during the 2020 Makushin Volcano, Alaska, earthquake swarm

Diana Roman[1], **Federica Lanza**[2], John Power[3], Cliff Thurber[4], and Thomas Hudson[5]
[1]Carnegie Institution for Science, Earth and Planets Laboratory, Washington, United States of America (droman@carnegiescience.edu)
[2]Schweizerischer Erdbebendienst (SED), ETH Zürich
[3]United States Geological Survey, Alaska Volcano Observatory
[4]Department of Geoscience, University of Wisconsin-Madison
[5]Department of Earth Sciences, Oxford University

We investigate the processes driving a significant earthquake swarm that occurred between June and December 2020 on Unalaska Island, Alaska, ~12 km southeast of the summit of Makushin Volcano. The swarm was energetic, with two M>4 events that were widely felt by the population in Dutch Harbor, ~ 15 km west of the epicenters. This is the strongest seismic activity ever recorded at Makushin since instrumental monitoring began in 1996. To date, no eruptive activity or other surface changes have been observed at the volcano in satellite views, webcam images, GPS or InSAR. Seismic swarms close to volcanoes are often associated with the onset of unrest that can lead to eruption. However, determining whether they reflect magmatic rather than tectonic stresses is challenging. Here, we integrate information from space-time patterns of the hypocenters of the swarm earthquakes with their double-couple fault-plane solutions (FPS). We relocate swarm events using double-difference relocation techniques and a 3D velocity model. We find that most of the events cluster into two perpendicular lineaments with NW-SE and SW-NE orientations, but no apparent migration in time towards a preferred fault. On the one hand, the lack of temporal migration (with both faults slipping concurrently), and FPS for M3+ events consistent with regional stresses, seem to indicate a tectonic driving process. On the other hand, FPS for the lower-magnitude earthquakes have 90°-rotated P-axes perpendicular to the regional principal stress orientation, providing strong evidence for dike inflation/magma intrusion. Coulomb stress modeling indicates that the rotated FPS are best explained by an inflating dike to the SW of the swarm epicenters, in a zone of long-term elevated seismicity. This complex overlapping of regional and magmatic stresses is also evident in the statistical analysis of the sequence, which started as a main-shock/aftershock sequence with the first event having the largest magnitude, and evolved into a swarm sequence indicative of a more pronounced role of magmatic processes.