Seismic anisotropy on active volcanoes

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We summarize measurements of seismic anisotropy and its relation to other geophysical measurements of stress and cracks on eleven active volcanoes; Unzen, Sakurajima, Aso, Kirishima and Asama in Japan; Okmok in Alaska, Ruapehu and Tongariro in New Zealand, Soufriere Hills in Montserrat, Kilauea in Hawaii and Piton de la Fournaise in La Reunion. We used the same objective shear wave splitting code on all volcanoes to measure time delays (dt) and fast polarisation directions (phi). Where possible we used S waves from deep earthquakes to ensure that the movement of the earthquakes was not correlated with the volcanic activity. At some volcanoes we used families of repeating events with similar waveforms and at most volcanoes we also computed splitting at earthquakes local to the volcano. We compared the shear wave splitting measurements variation in time to eruption occurrences and to other available parameters including seismicity rate, b-values, focal mechanisms, isotropic velocity changes from noise cross-correlation, Vp/Vs ratios, Geodetic measurements such as GPS and tilt, and gas flux.

All volcanoes had some stations with excellent shear wave arrivals that yielded measureable splitting. Individual measurements showed scatter in most areas, but at most of the volcanoes, moving averages of phi or dt (or both) yielded time variations that correlated with other measurements related to volcanic activity or to stress changes or changes in crack-filling material such as gas flux. The multiplet studies did not yield slowly varying splitting but instead showed distinct jumps in splitting parameters at various times, which appears to be caused in part by cycle skipping.