Temporal changes in seismic anisotropy near the times of the 2012 Tongariro Volcano eruptions, New Zealand

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On 6 August 2012 Tongariro Volcano erupted for the first time in over 100 years. The eruption was not specifically predicted, but pre-eruption signals of volcanic unrest had caused GNS Science to lift the alert levels for possible volcanic activity. Some of those signals included a swarm of earthquakes just north of Ngaruhoe Volcano. About two weeks before the eruption GNS deployed a set of four seismometers to record the swarms; one of the seismometers was located directly on top of, and was destroyed by, the future eruption. A second, smaller eruption occurred on 21 November. Combined with data from the existing GeoNet permanent seismic network sites, there will be an excellent dataset to test methods of monitoring volcanic activity. Here we examine changes in shear wave splitting, or seismic birefringence on the permanent network. We used the same objective shear wave splitting code on all volcanoes to measure time delays (dt), and fast polarisation directions (phi). If anisotropy is caused by stress-aligned, fluid-filled cracks, then the dt depends on the numbers and aspect ratios of cracks, while phi depends on their orientation; phi is expected to be parallel to the cracks and to the maximum principal stress.

Preliminary results from the GeoNet permanent stations suggest that there may be a general increase in shallow seismicity at the beginning of July. The increase is accompanied by rotations in statistically significant changes of average phi of between 30 and 90 degrees at the five stations examined so far. Average delay times also change significantly at three of the stations, some of which may be affected by cycle skipping. Scatter in phi and dt also changes with time. The changes are not apparent for earthquakes deeper than 50 km but are present at earthquakes both above and below 15 km in the crust. Further breakdown for earthquakes at different azimuths and examination of the portable data will help to determine if the earthquakes are responding to temporal variations in anisotropy or spatial variations in anisotropy coupled with changes in earthquake source locations.