TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
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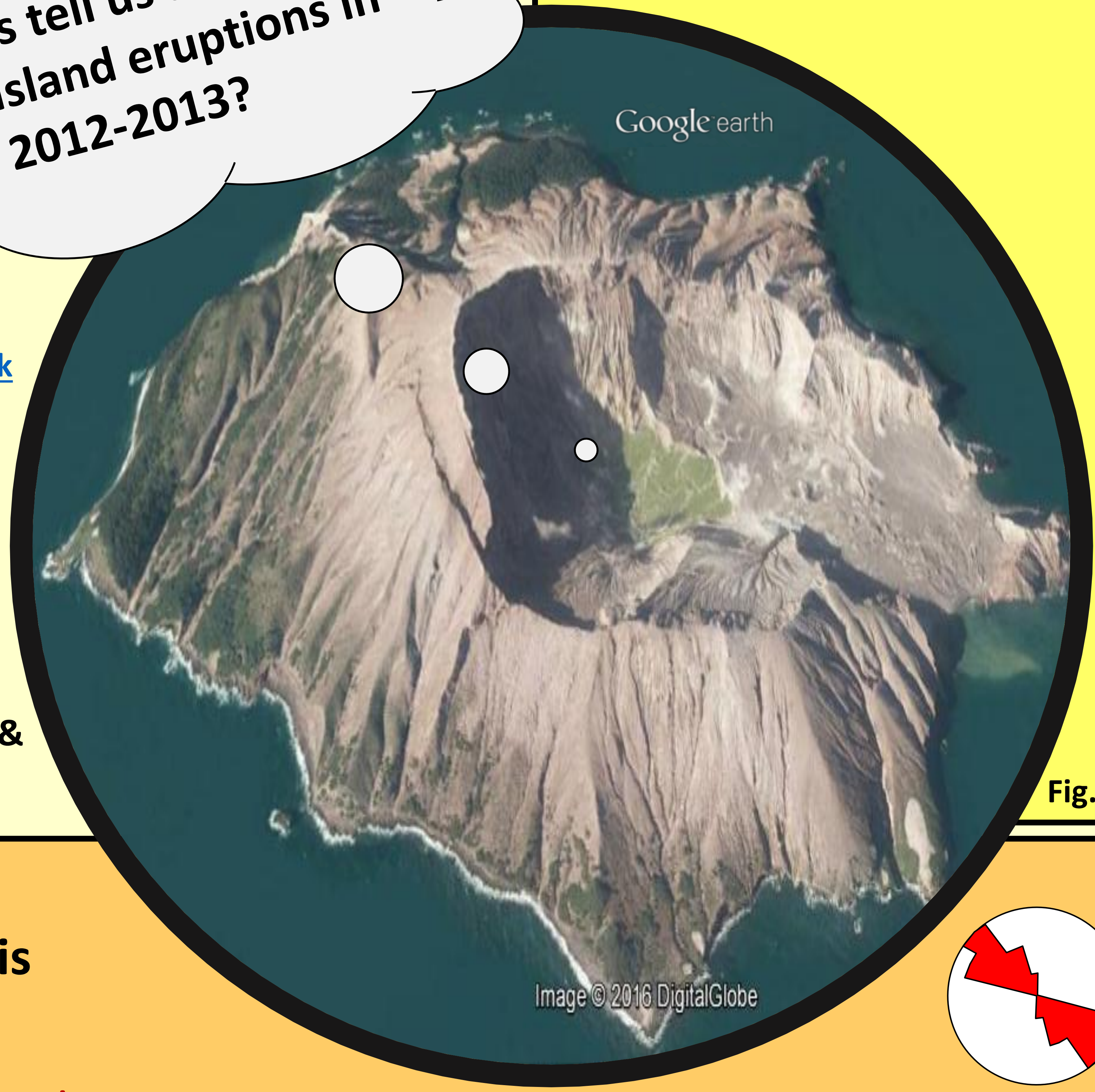
Monitoring Magma Movements underneath New Zealand's most Active Volcano

What can two seismic methods tell us about the White Island eruptions in 2012-2013?



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Ambient Noise Cross-correlation

Hypothesis

Small perturbations in the Earth's elastic properties can be detected through the **cross-correlation of ambient noise**. We use this to investigate small **velocity variations** in the medium around White Island, where magma pressurization, and their effect on cracks, acts as a plausible mechanism for such change.

Method

Seismic waveforms are cross-correlated to detect **coherent noise**, travelling directly between stations. Examining how the **wave velocity varies over time** provides information on seismic properties. We considered two pathways connecting the mainland station with both Island stations.

Results

The medium velocity along the path investigated is observed to drop by **~0.2% pre-eruption in August 2012** (Figure 1), whereas a decrease of the same magnitude is observed **post-eruption in August 2013**. Such velocity variations are **not unique** however, with fluctuations equally occurring without event.

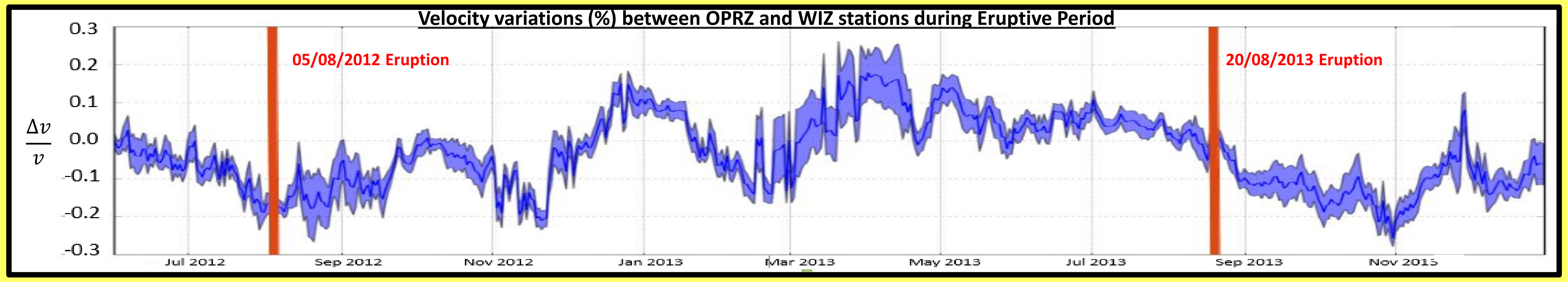


Fig. 1

Shear-wave Splitting Analysis

Hypothesis

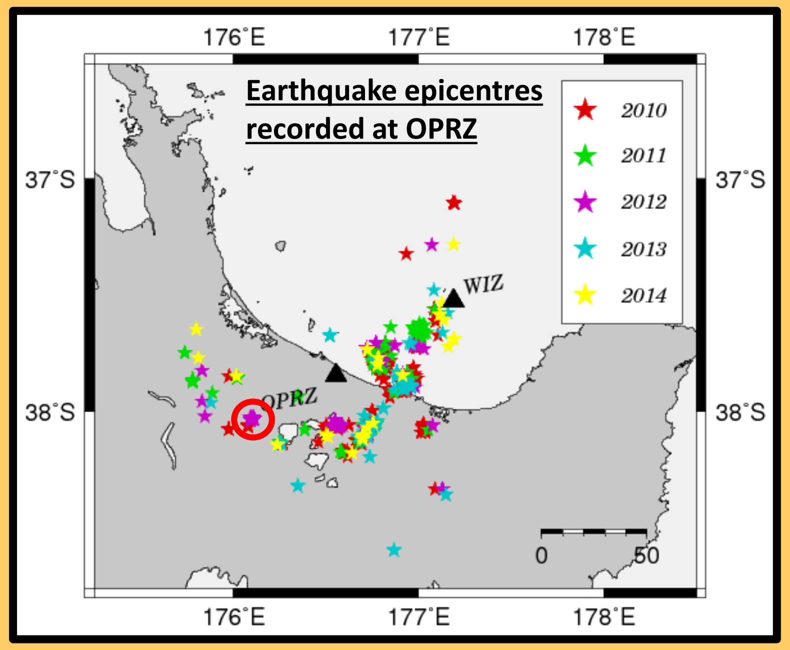
It has been suggested that **micro-cracks** in the region around volcanoes can **reorient prior to volcanic eruptions**, as a result of stress changes related to magma movements.

Method

To investigate this, we examine **shear waves** produced by local earthquakes at three seismic stations, two on White Island and one inland. On entering an anisotropic medium, shear waves **split into two components**; one fast and one slow. The particle motion of the fast is said to move in the direction of the cracks (often referred to as the **fast direction**).

A **rose diagram** is commonly used to display the measured fast direction. We indicate unreliable results, where the number of usable events is too few, by colouring the wedges black.

Fig. 3



Results

We observe an additional fast direction (Figure 2). measured at both stations from 2011 to 2012. Figure 3 however reveals the earthquakes yielding the new direction originated from a new location (circled), making it plausible the new measurements are a result of sampling a different pathway of shear-waves.

Any further variations cannot be distinguished from **sample size issues**, resulting from **noisy data**. This led to the exclusion of one island station entirely.

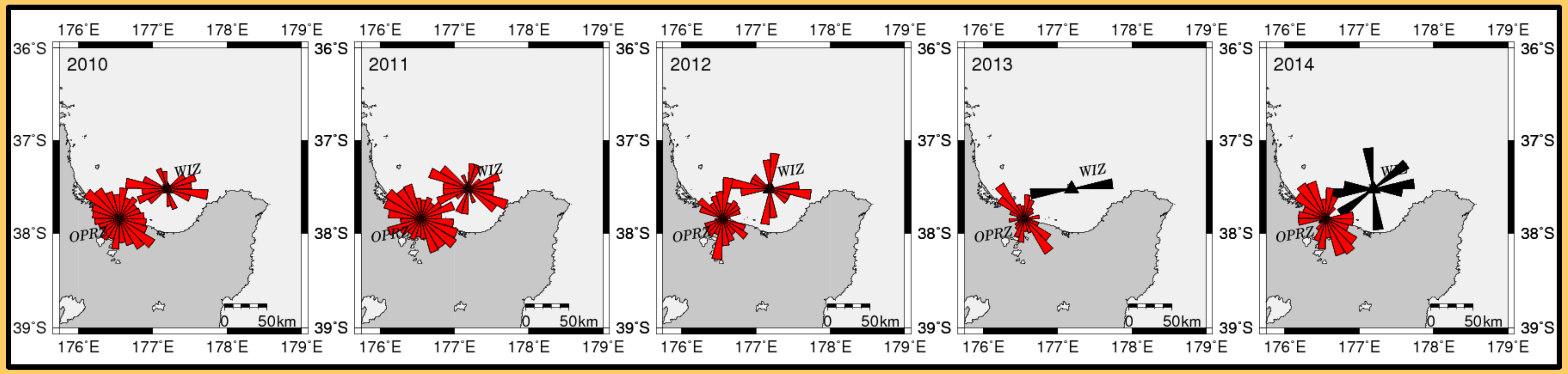


Fig. 2

Conclusions / Further Work

Both methodologies hint at the detection of stress changes during White Island's eruptive period; however we cannot conclusively link the findings to the eruptions themselves without further information.

To better understand our observations, focus should be on retrieving a greater number of usable events for shear-wave splitting analysis, where noisy data vastly limited interpretation. For ambient noise cross-correlation, analysis of further station pairs would improve coverage and a longer pre-eruption time period should be considered to develop understanding of how the velocity fluctuates while activity is low.

Key References

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