Automated Grading Analysis for Shear Wave Splitting

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Shear wave splitting is a useful tool for determining anisotropy in the Earth using seismograms of earthquakes. The measured anisotropy can in turn be related to mineral orientation and deformation or cracks and stress. Changes in anisotropy as monitored via shear wave splitting have been proposed as eruption precursors. However, it is important to ensure the results are reliable through a grading of the quality of the observations. We developed a method to automate the manual grading process in the Silver and Chan (1991) method of estimating shear wave splitting delay times and fast directions, which usually involves visual inspection of adjusted waveforms, and other graphical diagnostics. The grading process is time consuming and conclusions may differ between different graders, and a grader may also find it difficult to grade a large number of events consistently. Therefore, we automated grading first by manually grading 146 nearly identical events obtained from station BOR on Piton de la Fournaise volcano on Reunion Island hotspot. We then developed a set of numerical criteria that as far as possible characterised the features that the manual grader used to classify the events. Finally we performed a multiple linear regression analysis on the set of numerical criteria as predictors of the manual grade. A stepwise model selection procedure was used to select the most important of the numerical criteria.

The automated method produced grades that roughly match the manual grades and the method can clearly distinguish between good results and bad results. The most strongly predictive of the numerical criteria are related to the contour map of the eigenvalues and the corrected polarisation waveform. The process of automation led us to review some of the manual grades, which were discordant with the predicted grades from the automated system, confirming the inconsistencies that can occur with manual grading. We also plan to test our regression model using another, more diverse, dataset from stations situated near Mount Ruapehu.