Geophysical Research Abstracts
Vol. 18, EGU2016-10063, 2016
EGU General Assembly 2016

Thermal crack damage is dominated by cooling

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Most studies of thermally-induced cracking to date have focused on the generation of cracks formed during heating and thermal expansion. Both the nature and mechanism of crack formation during cooling are hypothesised to be different from those formed during heating. We present in-situ acoustic emission data recorded as a proxy for crack damage evolution throughout a series of heating and cooling experiments on samples of basalt and dacite. The results show that both the rate and energy of acoustic emission are consistently much higher during cooling than during heating. When comparing the AE during the heating phase with the AE during the cooling phase of a comparable duration heating and cooling cycle; we find that there are $\sim$ 150 times as many hits during cooling. Furthermore, the average energy of those AE are more than 3 times greater, resulting in a total AE energy that is almost 500 times higher during cooling than during heating. Seismic velocity comparisons and crack morphology analysis of our heated and cooled samples support the contemporaneous acoustic emission data and also indicate that thermal cracking is largely isotropic. These new data are important for assessing the contribution of cooling-induced damage within volcanic structures and layers such as dikes, sills and lava flows.