Geophysical Research Abstracts
Vol. 20, EGU2018-8080, 2018
EGU General Assembly 2018

Mineralogical control on thermal damage and the presence of a thermal Kaiser effect during temperature-cycling experiments

Ali Daoud, John Browning, Philip Meredith, and Thomas Mitchell
University College London, Earth Sciences, London, United Kingdom (j.browning@ucl.ac.uk)

Volcanic and geothermal systems are in part controlled by the mechanical and thermal stresses acting on them and so it is important to understand the response of volcanic rocks to thermo-mechanical loading. One such response is the well-known 'Kaiser stress-memory' effect observed under cyclic mechanical loading. By contrast, the presence of an analogous 'Kaiser temperature-memory effect' during cyclic thermal loading has received little attention. We have therefore explored the possibility of a Kaiser temperature-memory effect using three igneous rocks of different composition, grain size and origin; Slaufrudalur Granophyre (SGP), Nea Kameni Andesite (NKA) and Seljadalur Basalt (SB). We present results from a series of thermal stressing experiments in which acoustic emissions (AE) were recorded contemporaneously with changing temperature. Samples of each rock were subjected to both a single heating and cooling cycle to a maximum temperature of 900 C and multiple heating/cooling cycles to peak temperatures of 350C, 500C, 700C and 900 C (all at a constant rate of 1C/min on heating and a natural cooling rate of <1C/min). Porosity, permeability and P-wave velocity measurements were made on each sample both before and after thermal treatment. We use the onset of AEs as a proxy for the onset of thermal cracking. This clearly demonstrates the presence of a Kaiser temperature-memory effect in SGP, but not in either NKA and SB. We further find that the vast majority of thermal crack damage is generated upon cooling in the finer grained materials (NKA and SB), but that substantial thermal crack damage is generated during heating in the coarser grained SGP. The total amount of crack damage generated due to heating or cooling is dependent on the mineral composition and, most importantly, the grain size and arrangement, as well as the maximum temperature to which the rock is exposed. Knowledge of thermal stress history and the presence of a Kaiser temperature-memory effect is potentially important in understanding magma chamber dynamics, where the cyclic nature of mechanical and thermal inflation and deflation can lead to sequential accumulation of damage, potentially leading to critical rupture.