

GSA Data Repository 2013

Table DR1. Sample major element composition

Sample	Etna E09.2
SiO ₂	47.52
TiO ₂	1.72
Al ₂ O ₃	17.77
Fe ₂ O ₃	10.95
MnO	0.18
MgO	4.96
CaO	10.21
Na ₂ O	3.93
K ₂ O	2.10
P ₂ O ₅	0.59
SO ₃	<0.002
LOI	-0.47
Total	99.46

The whole-rock magma element composition of Etna sample E09.2 was determined using XRF analysis at the University of Leicester using a PANalytical Axios Advanced XRF spectrometer. Major elements were determined on fused glass beads prepared from ignited powders, with a sample to flux ratio of 1:5 and a 80% Li metaborate: 20% Li tetraborate flux. Negative LOI indicates weight gain on ignition.

Thermogravimetric Analysis-Differential Scanning Calorimetry (TGA-DSC) Method

The total volatile content and thermal transformations within bulk samples were characterised using a TA Instruments SDT Q600 simultaneous differential scanning calorimetry–thermal gravimetric analyser (TGA-DSC) instrument at Lancaster University. The TGA-DSC instrument consists of two balance beams within a furnace. A powdered sample (125-500 µm grainsize, ~50 mg) is placed in a pan on the sample beam, and an empty pan is placed on the reference beam. During a heating programme, the sample weight is continually measured, and output as a percentage of its initial weight (TGA curve, Fig. DR1). The differential heat flow to the thermocouples in the two beams is also measured, giving the DSC signal. Melting is an endothermic process, during which the sample absorbs heat and the heat flow to the sample is lower than the reference. Crystallisation is exothermic, meaning heat is released and the sample heat flow exceeds the reference heat flow. In the resultant DSC curve shows melting events as troughs and crystallisation events as peaks (Fig. DR1). The system was purged with oxygen-free nitrogen for 12 hours prior to each measurement to minimise atmospheric contamination, with the sample maintained at 150 °C, and the sample was then heated to 1250 °C at 20 °C/min and cooled at 20 °C/min to 150 °C; the heating-cooling cycle was then repeated. The weight signal was calibrated using Al₂O₃ to correct for drift associated with beam growth and buoyancy; the thermal signal was calibrated using sapphire and zinc standards. The furnace temperature was calibrated to better than ±3 °C using six

nickel-cobalt alloy Curie point standards. Between 7 and 11 repeated measurements were conducted for each sample, the water contents given here are mean values and have been corrected for sample crystallinity (Etna 46 vol %, Kilauea 10 vol %).

Heated Stage Microscopy Method

The stage contains a ceramic furnace (7 mm diameter) with a basal aperture (0.8 mm diameter) that allows light transmission (Fig. DR2). Wafers are placed on a 0.3 mm-thick sapphire slide close to a S-type thermocouple. Melting of indium, silver and gold wire was used to calibrate furnace temperatures to ± 2 °C over 157–1064 °C.

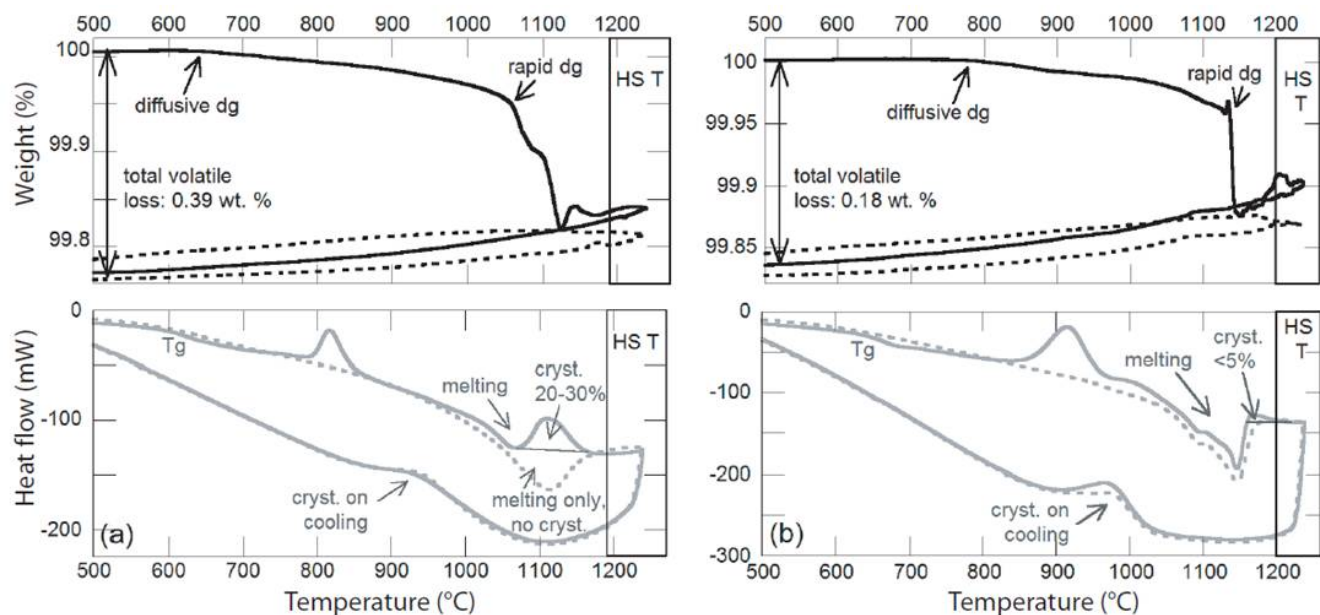


Figure DR1. TGA (black) and DSC (grey) curves for (a) the Etna and (b) the Kilauea samples examined in this study. The samples were subjected to 2 cycles of heating from 150 to 1250 to 120 °C. The range of temperatures studied in the heated stage is shown by the black box (HS T). The solid line shows the 1st cycle, and the dashed line the 2nd cycle. On 1st heating, diffusive degassing (dg) is followed by rapid degassing at high temperature. Events in the DSC curves are labelled. On the 1st heat, a peak interpreted as crystallisation occurs after the rapid degassing event. On 2nd heating (dashed lines) neither degassing nor crystallisation occur, suggesting a causative relationship. Integrating the crystallisation peak above the fine black line gives an estimate of the extent of crystallisation, and suggests that the extent of degassing determines the extent of crystallisation.

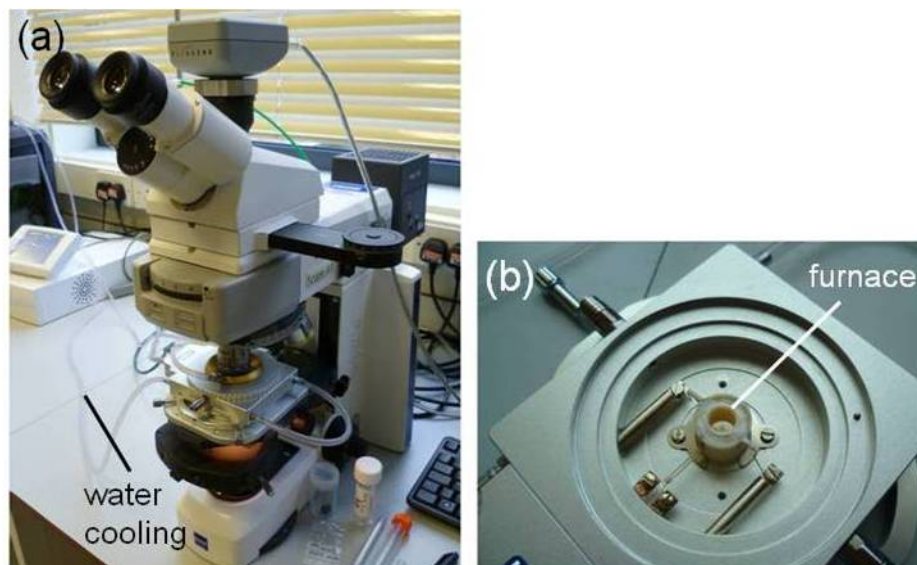


Figure DR2. (a) The experimental setup, showing the water-cooled Linkam TS1500 heated stage mounted on a Zeiss Axioscope. (b) Inside the stage, showing the ceramic furnace. The thermocouple enters the furnace adjacent to the basal aperture (visible in the centre of the furnace). Setting up an experiment takes less than 30 minutes.

MOVIES

Movie DR1. Movie showing the behaviour of the Etna sample in experiment 4 (Table 1). On heating above 1100 °C, the sample melts. Degassing-driven crystallisation of plagioclase is seen during a 30 minute isothermal at 1250 °C, and the growth of dendritic pyroxene is seen during cooling.

Movie DR2. Movie showing the behaviour of the Kilauea sample in experiment 9 (Table 1). On heating above 1135 °C, the sample melts. No degassing-driven crystallisation is observed during the 30 minute isothermal at 1250 °C and, during cooling, the growth of plagioclase-pyroxene laths is followed by dendritic pyroxene.