Petrology and geochemistry of the large-magnitude 2010 eruption of Merapi volcano, Central Java, Indonesia: insights into magma dynamics

Ralf Gertisser[1], Katie Preece[2], Heather Handley[3], Mark Reagan[4], Kim Berlo[5], Jenni Barclay[2], Richard Herd[2]

[1]School of Physical and Geographical Sciences, Keele University, Keele, ST5 5BG, UK, [2]School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, UK, [3]GEMOC, Department of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia, [4]Department of Geoscience, The University of Iowa, Iowa City, IA 52242, USA, [5]Department of Earth Sciences, University of Oxford, Oxford, OX1 3AN, UK

E-mail: r.gertisser@keele.ac.uk

The devastating eruption of Merapi that started on 26 October 2010 was the volcano's largest since 1872 and the deadliest event since 1930. The eruption was unusual in many respects: (1) it started, after nearly two months of increased seismicity and summit deformation, with an explosive phase that was not preceded by lava dome extrusion at the summit; (2) between 30 October and 4 November, a lava dome appeared and grew rapidly within the newly formed summit crater, exceeding growth rates observed at the peak of the penultimate eruption in 2006 by a factor of 7.5 [1]; (3) during the paroxysmal eruption phase on 5 November, high-energy PDCs were generated and at least one PDC travelled more than 15 km (more than twice the distance of the largest flows in 2006) beyond the summit along the Gendol river valley, causing widespread devastation on Merapi's south flank [2, 3]; (4) in a later phase on 5 November, PDCs were produced that incorporated conspicuous light-coloured pumice clasts; (5) ash emissions from sustained eruption columns resulted in ash fall tens of kilometres from the volcano, affecting, amongst other areas, the city of Yogyakarta 25 km to the south of Merapi; and (6) the total non-DRE volume in 2010 is thought to have been at least 4 times higher than that of the preceding 2006 eruption [3, 4]. Despite the unusual eruptive behaviour of Merapi in 2010, whole-rock major and trace element compositions, Sr-Nd-O isotopic data, pre-eruptive melt volatile concentrations, as determined by electron and ion microprobe analysis of pyroxene-hosted melt inclusions, for the eruptive products from the various stages of the 2010 eruption are remarkably similar to other recent and historical eruptions, which were predominantly characterised by periods of slow lava dome extrusion punctuated by gravitational dome failures. By contrast, notable petrographical differences are the presence of unaltered amphibole phenocrysts and microphenocrysts without reaction (breakdown) rims as well as variations in groundmass textures in the juvenile component(s) of the 2010 eruption, which, in combination with short-lived U-series isotope systematics (^{210}Po-^{210}Pb-^{226}Ra), provide a detailed picture of pre-eruptive magma dynamics characterized by fast ascent and temporary shallow stalling of magma (or batches of magma) that fed the eruption.

References: [1] Pallister et al. (2013). J. Volcanol. Geotherm. Res., doi:10.1016/j.jvolgeores.2012.07.012. [2] Komorowski et al. (2013). J. Volcanol. Geotherm. Res., doi: 10.1016/j.jvolgeores.2013.01.007. [3] Charbonnier et al. (2013). J. Volcanol. Geotherm. Res., doi:10.1016/j.jvolgeores.2012.12.021. [4] Charbonnier and Gertisser (2011). Sedimentology, 58, 1573-1612.