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Petrology and pre-eruptive conditions of the 2010 Merapi magma

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In an attempt to understand why the 2010 eruption of Merapi was larger and more explosive that the many dome forming eruptions of the past century, we have investigated the geochemistry, petrology and pre-eruptive conditions of the magma. Bulk-rock analyses of bread-crusted bombs and columnar jointed blocks of the November 5th pyroclastic eruption show that the magma is basaltic andesite (57% SiO2) of a very similar composition to dome rocks erupted in 2006. The rock samples show a seriate texture with phenocryts of mainly clinopyroxene and plagioclase followed by orthopyroxene and minor amounts of amphibole. Microlites are mainly plagioclase and clinopyroxene.

Glomerocrysts of pyroxenes and apatite are common. There are two types of amphiboles: large crystals with reaction rims (probably xenocrysts), and smaller crystals with no reaction rims. The latter are magnesiohastingites with high Al2O3 contents (about 13 wt%) indicating high temperature and pressure crystallization. Plagioclase phenocrysts show sieved textures and resorbtion zones, with compositions ranging from An90 to An45, and microlites are at about An35. Clinopyroxene (mg# of 70-75) is occasionally found surrounding resorbed orthopyroxene (mg# of _70). Two-pyroxene geothermometry gives pre-eruptive temperatures of about 1000oC (+/- 20o). Glass inclusions in clinopyroxene and amphibole have totals that vary between 92 and 96 wt %, SiO2 contents between 63 and 68 wt %, and total alkalis between 9 and 12 wt% (normalized to 100% anhydrous), and thus are trachytic. SO3 contents of glass inclusions vary between 0.1 and 0.6 wt %. Plagioclase-melt equilibria indicate pre-eruptive water contents of about 5.0 (+/- 0.5) wt %. The phenocryst mineral assemblage and textures of this 2010 magma are similar to those of recent and less explosive eruptions of Merapi (e.g., 2006, 1994), except for presence of black hornblende microlites in matrix of the 2006 and 1994 products. In addition, the rate of magma extrusion was as much as 17-21 times higher from the 2006 eruption and the distance of pyroclastic flows in the same drainage (Gendol River) reached 15 km in 2010 and only 7 km in 2006. The explosive character could be due to a higher than normal volatile content, as suggested by the plagioclase-melt equilibria and sulfur contents of glass inclusions, and consistent with pre-eruption large increases in CO2 emissions, as recorded by BPPTK.