Petrological and Geochemical Study of Sundoro Volcano, Central Java, Indonesia: Temporal Variations in Differentiation and Source Processes in the Growth of an Individual Arc Volcano

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We reported new Sr-Nd-Pb radiogenic isotope ratios in addition to the complementing whole rock geochemistry and trace elements combined with mineral chemistry of representative rocks of Sundoro volcano, central part of Java sector of Sunda arc. Collected samples represent stratigraphically well-constrained volcanic products from 34 to 1 ka activities. The rocks of the volcano span from basalt (SiO_2 51.5 wt. %) to andesite (62.9 wt.%) and are dominated by basaltic andesite. Least evolved rocks contain MgO less than 6 wt.% and are considered as evolved basalt. The rocks can be grouped into three magma types on the basis of isotopic compositions. The three magma types are named A-, B-, and C-type and characterized by low, medium, and high Sr-Pb isotopic compositions, respectively, which are in tune with variations of Ba/Zr, La/Yb, and Th/Yb ratios.
Against progressive silica content, evolution trend of the three magma types are separated: relatively parallel to each other in $^{87}Sr/^{86}Sr$, ratios of Ba/Zr, and La/Yb, diverge in ratios of Th/Yb, and discretely varied in Pb-isotope. Combination of these discrete geochemical evolution trends with petrographic disequilibrium features and wide-range bimodal compositions of plagioclase crystal core (An46-94) suggest that 1) magma mixing is dominant process in intra-crustal level. 2) The three magma types correspond to mixing of three distinct couples of mafic- and felsic-end member magmas. 3) The felsic end-member magma cannot be produced from fractionation of corresponding mafic end-member magma and might come from different melt source. 4) The three mafic-end member magmas are not related co-genetically, thus relative correlation of their mafic rocks might represent magma source characteristics. Trace elements as proxies of slab contributions (e.g. Ba/Zr, Th/Yb, La/Yb) of the representative mafic rocks of the three magma types show positive correlation to Sr- and Pb-isotopic compositions but negative to Nd-isotopic ratios. We proposed that magma of A-, B-, and C-type corresponds to three distinct slab-derived fluxes containing sediment-derived melt contributions approximately 50%, 55%, and 60%, respectively, which were added to the mantle wedge in a rates of ~1%, ~1.5%, and ~2%, respectively. Temporal variations of the magma type shows the existence of A-type in 20-9 ka, co-existence of A- and B-type in 14-17 ka, and abrupt change from A- to C-type after 9 ka. Reconstruction of the supply magma system in these periods indicate that time interval between the three slab-derived fluxes is about 3-8 ky and shows increasing portion of sediment contribution and rate of slab-fluxes through time. Further application of these approaches to dataset of Merapi volcano revealed increasing rate of slab-derived flux to the magma genesis beneath volcanic front region of central part of Java through time.

Keywords: Sunda arc, Temporal variation, Multiple magmas, Slab contribution, Sundoro volcano

