Day 1: Estimation of primary arc magma composition with petrological models

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Estimation of primary arc magma composition is not an easy task. Olivine maximum fractionation model has been a useful tool but proper application of this was limited only to less-differentiated magmas, such as MgO>~9 wt%. Liquid lines of decent (LLDs) in more evolved magmas vary considerably because of the various source magma composition (e.g., H_2O content), which makes predicted back-calcurations difficult. Moreover, although the source mantle lithology of arc magmas can largely be peridotitic, pyroxene-rich lithologies are also possible. I here present three new approaches using modelled LLDs and various source mantle. First model uses olivine maximum fractionation refined by the latest thermodynamic treatments of Toplis (2005) on olivine-melt equilibrium and Putirka et al. (2007) on olivine thermometry. Effects of H_2O and other major elements are converted empirically to Fe^{2+}-Mg partitioning between melt and olivine. The second model uses template of LLDs with various H_2O contents and back calculate a fractionated magma to a primary basalt. This uses COMAGMAT 3.57 thermodynamic model (Ariskin, 1999) with reporducibility tests of experimental results by Tatsumi & Suzuki (2008), which used a "common" defferentiated arc basalt from IBM arc. The third model uses fractionation corrections of clinopyroxene and olivine with melting phase diagram of pyroxenite sources by Herzberg (2010). The first and second models stop crystal addition at the melt composition equilibrium with Fo90 mantle olivine (peridotite source), whereas the third model stop olivine addition at cotectics of the pyroxinite source. The former two are appropriate for shallow TH/CA basalt magmas from Sp-peridotite whereas the third model would be useful for mafic alkali arc lavas (and may be some HMAs) with Ol+Px+Gar and Cpx+Opx+Gat residual lithology.

Day 2: Open system hydrous adiabatic mantle melting for arc magma genesis

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Arc mantle melts under a hydrous condition and simultaneously undergoes an adiabatic melting because of its upwelling dynamics in the mantle corner flow regime. The sub-arc mantle melting process is thus considerably complex and the mantle would be progressively hydrated as it rise by the addition of slab derived fluid (or melt) from the backarc to the frontal arc. Such the melting conditions should be simulated by an open system melting model including adiabatic melting with progressive addition of slab fluids. Combination of adiabatic melting model (McKenzie, 1984) and hydrus mantle melting model (Katz et al., 2003) allows theoretical basis for the open system adiabatic melting. A prograde water dehydration model of downgoing slab (ABS3 model; Kimura et al. 2009) provides estimates of amount of water being added to the overlying mantle peridotite. By combining the two models, a two box mantle melting model become available. This poster presents the first set of results of this new mantle melting model including (1) dehydration profile of the slab, (2) water addition to the mantle peridotite in adiabat, (3) temperature and degree of partial melting of the open system peridotite, and (4) water contents in the produced basalts. The assumed P-T conditions for the slab are based on Peter van Keken's geodynamic model (unpublished) and the mantle potential temperature is set to Tp = 1450 °C. The results reproduce the cross chain variations of the arc basalts in N-Izu subduction zone in terms of water contents in the basalts and degrees of partial melting of the source.