Maturation of incipient island arcs: New insights from the southern Mariana arc

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Despite being defining features of the solid Earth, how juvenile island arcs evolve into thicker-crust, mature stratovolcanoes remains poorly understood. What is the composition of nascent island arc magmas and how do they evolve over time? The Southern Mariana arc is an incipient island arc, which possesses irregularly emplaced submarine volcanoes,that progressively evolves into stable, thicker-crust stratovolcanoes to the north.The juvenile Mariana arc magmas are progressively enriched in K_2O and in slab-fluid proxies (Ba/Th, Ba/Nb, Th/Yb) during arc maturation. This compositional evolution is associated with a change in the type of melting (i.e., from decompression to fluid-assisted mantle melting) and to a deepening in arc magma generation, which is accompanied by a retreat of the volcanic arc front. The more mature arc magmas thus progressively capture the deeply-sourced, slab fluids, as they overlie deeper portions of the subducted slab over time. We further propose that the steadiness and the location of the volcanic arc front is modulated by the growth of the serpentinized fore-arc mantle since arc inception. Arc stabilization promotes, in return, melt focusing, magma differentiation and crustal assimilation, which result in crustal thickening. The development of a serpentinized fore-arc mantle is thus essential to arc maturation, as it contributes to the growth of the arc crust, and as to the arc volcanoes maintain their location for millions of years.

Keywords: subduction infancy, Izu-Bonin-Mariana, arc maturation

