

The initiation of crustal recycling processes in island arcs: insights from the Soufriere Volcanic Centre, Saint Lucia

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Extensive intermediate pyroclastic flow deposits, lava flows, domes and block-and-ash-flow deposits from the Soufriere Volcanic Complex (SVC), Saint Lucia, collectively represent a conspicuous shift in composition and eruption style for this island arc segment. Compositionally, these dominantly silicic (61.6 to 67.7 wt. percent SiO₂) SVC deposits are distinct from older more mafic deposits in Saint Lucia. They contain accessory zircons, and many of the most recent rocks have phenocrystic quartz. SVC deposits occur in and around the Qualibou Depression, a c. 10 km diameter wide sector collapse structure of poorly constrained age. Here, we re-investigate the onset of silicic volcanism in Saint Lucia, and the relationship between individual SVC pyroclastic flows and the sector collapse through (U-Th)/He, U-Th and U-Pb zircon chronostratigraphy, aided by mineralogical and geochemical correlation.

The oldest SVC units comprise pyroclastic deposits at Micoud (640±8 ka), Bellevue (264±8 ka), Anse John (104±4 ka) and La Pointe (59.8±2.1 ka), and at Anse Noir and Piaye (undated). These were all previously grouped with or associated with the so-called Choiseul tuff, whereas our chronology demonstrates that the units represent individual periods of activity spanning a range of ages. Choiseul pumice at the type locality has yielded a (U-Th)/He zircon age of 515±61 ka, overlapping with the age for Morne Tabac (532±42 ka), a dome truncated by the depression escarpment. Younger SVC units comprise Morne Bonin (273±15 ka), Gros Piton and Petit Piton (71±3 ka and 109±4 ka, resp.), Belfond (13.6±0.4 ka) and Terre Blanche (15.3±0.4 ka). The younger units are clearly domes within the Qualibou Depression whereas the nature of Morne Bonin (dome or mega-block) remains poorly constrained. Belfond and Terre Blanche have whole rock geochemistry and mineral assemblages similar to the Belfond pyroclastic flow deposit, the most recent widespread pyroclastic flow with nearly-concordant (U-Th)/He and ¹⁴C ages of 20 ka. The Belfond and Terre Blanche domes possibly represent late-erupted degassed portions of the magma that produced the Belfond pyroclastic flow.

The geochemical characteristics and similar zircon age distributions of the silicic lava domes and pyroclastic flows of the SVC suggest that these share a common magma source beneath the Qualibou depression. The onset of activity from this proto-Qualibou centre occurred much earlier than previously thought (by c. 500 k.a.), and marks a change from largely quartz- and zircon-free andesitic magmatism to more evolved magma compositions. We interpret crystal recycling in SVC magmas, and the presence of co-genetic plutonic enclaves, to indicate the progressive build-up of a mid-crustal batholith, and thus a major change in the crustal structure of this island arc segment.