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A petrogenetic approach on the St. Martin/Maarten granitoids (Lesser Antilles Arc) and associated mantle processes

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In St. Martin, the Oligocene granitoids comprise granodiorites, leucotonalites, melatonalites and Qz-monzodiorites. Tonalites are low-K, whereas granodiorites and Qz-monzodiorites are related with calc-alkaline suites. Mineralogical, geochemical and Sr-Nd isotopic data denote that most rocks are I-type calc-alkaline, except for the melatonalites that seemingly resemble peraluminous S-type granitoids. The melatonalites display the lowest Al_2O_3/TiO_2 and highest CaO/Na_2O ratios, pointing to high temperature conditions. Various geothermometry applications, which include Ti-in-zircon thermometry reveal high generated temperatures for the melatonalites, exceeding by ~100 °C those calculated for the other granitoids. Regarding the granodiorites (Type-I low REE; Type-II high REE), Type-II are associated with higher temperature conditions by ~70 °C. Zircon saturation thermometry also show higher crystallization temperatures for the melatonalites and Type-II granodiorites. Thermobarometric results elucidated from mineral chemistry and bulk-rock geochemical point to higher temperature and pressure crystallization conditions for the melatonalites compared to the leucotonalites and granodiorites. The granitoids were affected by extensive differentiation processes; plagioclase preferably fractionated in the Type-I granodiorites; Type-II mainly involved K-feldspar removal. Fluctuation of hydrous and slab-derived fluid fluxes contributed to magma differentiation as inferred by the Th/Nb and Ba/La ratios, with hydrous-saturated conditions favouring formation of granodiorites rather than leucotonalites.

Melatonalites and Type-II granodiorites likely formed at proto-arc settings, with melting of a fertile mantle during subduction initiation. Melatonalites may have involved magma mixing via interaction of a hotspot plume within the forearc mantle, as denoted by geochemical and geothermometry results. The geochemical features of the Type-II granodiorites likely reflect formation at the early subduction stages, associated with a fertile source.

Reference: Koutsovitis et al. 2024. Granitoids from St. Martin/Maarten Island, Caribbean: Insights

on the role of Mantle processes in the Lesser Antilles Arc. Lithos (Under Review).