Petrogenesis and geodynamic significance of silicic volcanism in the western Trans-Mexican Volcanic Belt: the role of gabbroic cumulates.

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Large volumes of silicic volcanism are frequently explained by the two end-members of crustal melting and fractional crystallization from basalt. Both models present critical issues particularly in arc setting where extensive crustal melting is not always tectonically favoured and extensive basalt fractionation requires unrealistically large volume of cumulates.

In the western Trans-Mexican Volcanic Belt voluminous silicic volcanism has been associated to the rifting of the Jalisco block from mainland Mexico since the Pliocene. Based on new and published geochronologic, geochemical, and isotope data we revise this interpretation and propose a new petrogenetic model. Silicic volcanism began in Late Miocene after a major pulse of basaltic lavas dated 11 to 9 Ma. The first group of rhyolitic domes was emplaced north of Guadalajara with a volume of around 370 km3 and ages of 7.5 to 5 Ma. This was followed between 4.9 and 2.9 Ma by rhyolites (around 500 km3) emplaced between Guadalajara and Compostela. The youngest episode consist of around 430 km3 of rhyolites of Pleistocene age emplaced between Tequila and Guadalajara, with La Primavera caldera (around 35 km3) as the sole explosive volcanic episode.

Rhyolites and basalts have distinct compositional trends and the large silica gap suggests that rhyolites are not fractionating from basalts. At the same time the low Ba and Sr contents of rhyolites suggest extensive fractional crystallization. Rhyolite Sr isotope values are only slightly more radiogenic than the 11-8 basalts, whereas Nd isotope ratios are indistinguishable.

The similarity in Nd isotope compositions between basalt and rhyolites strongly argues for a mantle-origin of the rhyolites. Nevertheless, a problem posed by any basalt-origin model lies in the large (2:1) volume of intermediate cumulates that should be associated to the final silicic magmas. We propose an alternative model in which the production of the 7.5-3 Ma silicic magmatism is the result of partial melting of crustal gabbroic complexes underplated at the base of the crust during the Late Miocene pulse of volcanism. Subsequent basalt intrusion in the lower crust heated and melted these gabbroic complexes forming silicic magmas, which subsequently underwent AFC differentiation processes. Geochemical and isotope data of rhyolites can be successfully modelled by low degree of melting of the Late Miocene gabbroic complexes leaving a residue dominated by plagioclase and clinopyroxene. These melts are subsequently modified via AFC processes en-route to the surface. Late Miocene slab detachment and subsequent slab rollback produced pulses of mafic magma that decrease in volume with time, forming gabbroic cumulates. Melting of this newly formed gabbroic crust originate the first episode of silicic magma during a period of low tectonic activity. Extensional faulting since the Pliocene favours the eruption of both silicic magma and lesser amount of mafic lavas.