Spatial and temporal evolution of the Trans-Mexican Volcanic Belt

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The evaluation of a geochemical data base (~3,000 samples), constrained by geological and geochronological information, allowed establishing patterns of spatial and temporal geochemical variability in the Trans-Mexican Volcanic Belt, and their relation to changes in the subduction dynamics. Volcanism began in middle Miocene (19 to 11 Ma) forming a broad arc of central vents in central and eastern Mexico, with calcalkaline, intermediate composition (SiO_2: 61.8±5.8), subduction related rocks [e.g., low Nb (<13), relatively high Ba/Nb (24–131), and low TiO_2/K_2O (<1.0)]. The adakitic character and inland migration of the arc at the end of this episode suggests a flat subduction geometry. Between ~11.5 to 6.5 Ma (locally until 3 Ma), an eastward migrating pulse of mainly fissural mafic volcanism (SiO_2: 50.2±4.0) generated calcalkaline and Na-alkaline magmas; this pulse has been related to the eastward propagation of a slab detachment episode that allowed the infiltration of asthenospheric material into the mantle wedge. Most samples have a subduction signature, but east of Long 99°W they display much lower to none influence of subducted components [e.g., high Nb (>20), high TiO_2/K_2O (>1.5), and low Ba/Nb (<15)]; this geochemical boundary divides the region affected by Oligocene-Miocene subduction magmatism of the Sierra Madre Occidental (to the west) from the region unaffected by subduction since the Permian. From 7.5 to ~3.0 Ma, large calderas and dome complexes of silicic composition (SiO_2: 70.3±6.0) were emplaced just to the south of the previous episode. We relate this episode to the slowing down of subduction because of the loss of slab pull after the detachment episode, which produced a reduced mantle flux, lower magma production and/or slab rollback and, possibly, melting of lithospheric mantle. In Pliocene-Holocene times, the arc migrated toward the trench and magmas displays a strong compositional variability. Calcalkaline rocks with high Ba/Nb (<415) are common throughout the arc; K-alkaline magmas (shoshonitic, lamprophyric) dominate in the arc front; mafic OIB-type volcanism appear in the rear part of the western sector since early Pliocene (~4.5 Ma) and occurs in several arc localities in the Quternary, sometimes associated to peralkaline rhyolites. Mg# and Ba/Nb ratios disminish with distance to trench, and crustal contributions match the wide range of variation in crustal thickness of the region (15 to 47 km).