Origin of Bimodal Magmatism in Continental Arcs: The Case of Las Derrumbadas Area, Trans-Mexican Volcanic Belt

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During the last 25,000 yrs, a large variety of monogenetic volcanoes erupted in the center of the Serdán-Oriental basin located in the eastern part of the subduction-related Trans-Mexican Volcanic Belt. We use new cartography, volume estimations, petrography, and whole-rock major and trace-element data to decipher the origin of the notoriously bimodal magmatism in this area. Volcanoes include small (<1 km^3) tuff rings/cones, scoria cones and lavas, a medium-sized shield (3.6 km^3), a tuff ring/dome complex (3.5 km^3), and two twin domes (10 km^3 in total). Magma types vary from basaltic andesites (3.8 km^3) to rhyolites (14.2 km^3), with few andesites (0.4 km^3). Published isotope data indicate that rhyolites are more Sr-radiogenic than the other magma types. All samples display arc-type trace element patterns suggesting an origin by partial melting of a metasomatized mantle source. Basaltic andesites and andesites from different vents show diverse mineralogical assemblages but similar trace element patterns, while rhyolites from distinct centers contain similar assemblages but variable element patterns. Low-MgO basaltic andesites contain xenoliths from the local basement while silicic rocks are typically devoid of them. Rhyolites might have evolved in lower crustal reservoirs as hinted by the occurrence of almandine garnet in the Las Derrumbadas domes. The Cerro Pinto rhyolite may have assimilated additionally shallow hydrothermally altered Tertiary monzonite prior to its eruption. The NW-SE alignment of rhyolite vents along a direction paralleling the fold axes of Creataceous limestone beds deformed during the Laramide orogeny, suggests that these magmas ascended along a major deep-reaching crustal structure, which could explain the large volumes emitted. In contrast, basaltic centers are more scattered and their craters follow variable directions, indicating final magma ascent along shallow faults. The abundance of monogenetic volcanoes in the center of this lacustrine basin (they are notoriously rare within other similar highland basins along the volcanic belt) may be due to the shallowness of the loose sedimentary fill that fails to trap the rising melts.