



Eocene to Quaternary mafic-intermediate volcanism in San Luis Potosí, central Mexico: The transition from Farallon plate subduction to intra-plate continental magmatism



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ABSTRACT

The San Luis Potosí Volcanic Field (SLPVF) of central Mexico includes volcanic sequences of felsic, intermediate and basic compositions that were erupted as discrete episodes from the Eocene to the Pleistocene. Volcanism was dominated by widespread and voluminous rhyolitic ignimbrites of the mid-Tertiary Ignimbrite Flare-up. However, the complete volcanic history must consider basaltic and andesitic Eocene–Pleistocene volcanic successions that provide key evidence for understanding the geochemical evolution of the volcanism in the SLPVF during this time span. Five sequences are recognized according to their geochemical characteristics, each comprising a volcano-tectonic episode. The first episode comprises basaltic andesites and andesites erupted during three intervals, 45–42 Ma, 36–31 Ma, and 31–30 Ma. The oldest was derived from subduction magmatism, whereas the youngest has an intra-plate magmatic signature and this represents the transition from the end of a long lasting subduction regime of the Farallon plate to the initiation of intra-plate continental extension in the North American plate. The second episode, at 29.5–28 Ma, comprises a bimodal succession of high-silica rhyolites and alkaline basalts (hawaiites) that are interpreted as magmatism generated in an intra-plate continental extension regime during the Basin and Range faulting. The third episode, at 21 Ma, is characterized by trachybasalts and trachyandesites that represent mantle basaltic melts that were contaminated through assimilation of the lower crust during advanced stage of intra-plate extension that started at Oligocene. The fourth episode includes 12 Ma alkaline basalts and andesites that were erupted from fissures. These mantle derived magmas evolved to andesites by crustal anatexis and crystal fractionation within a continued, extensional, intra-plate regime. Lastly, the fifth episode comprises 5.0 to 0.6 Ma alkaline basalts (basanites) containing mantle xenoliths, that were erupted from maars and tuff cones, which are the youngest manifestations of mantle-derived intra-plate extensional events. Based upon this volcanic record, the last subduction manifestations of the extinct Farallon plate occurred at about 42 Ma, this was followed by a transition to intra-plate magmatism between 42 and 31 Ma, and an extensional, intra-plate tectonic setting from 31 Ma to almost Present.

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1. Introduction

The San Luis Potosí Volcanic Field (SLPVF), located in the Mesa Central of Mexico (Fig. 1), includes intermediate-mafic volcanism ranging in age from Eocene to Quaternary. The Sierra Madre Occidental (SMO) is an Eocene–Miocene volcanic province, which consists of a

lower sequence of Eocene orogenic-type volcanic rocks dominated by intermediate lavas, a middle sequence of rhyolitic volcanic rocks dominated by Oligo-Miocene ignimbrites, and an upper sequence of mafic lavas, mostly early Miocene in age and dominated by basaltic andesites and alkaline basalts (McDowell and Clabaugh, 1979; Damon et al., 1981; Aguirre-Díaz and McDowell, 1991, 1993; Aguirre-Díaz et al., 2008; Tristán-González et al., 2009a). Volcanism posterior to the SMO, in central-northern Mexico, and particularly in SLPVF, was dominated by basaltic andesites and alkaline basalts widely distributed and preserved as small patches in the region that have ages ranging from middle Miocene to Quaternary (Tristán-González et al., 2009a).

Based upon previous works, the stratigraphy of the SLPVF includes 44 Ma andesites of Casita Blanca Formation, 32–27 Ma rhyolitic and

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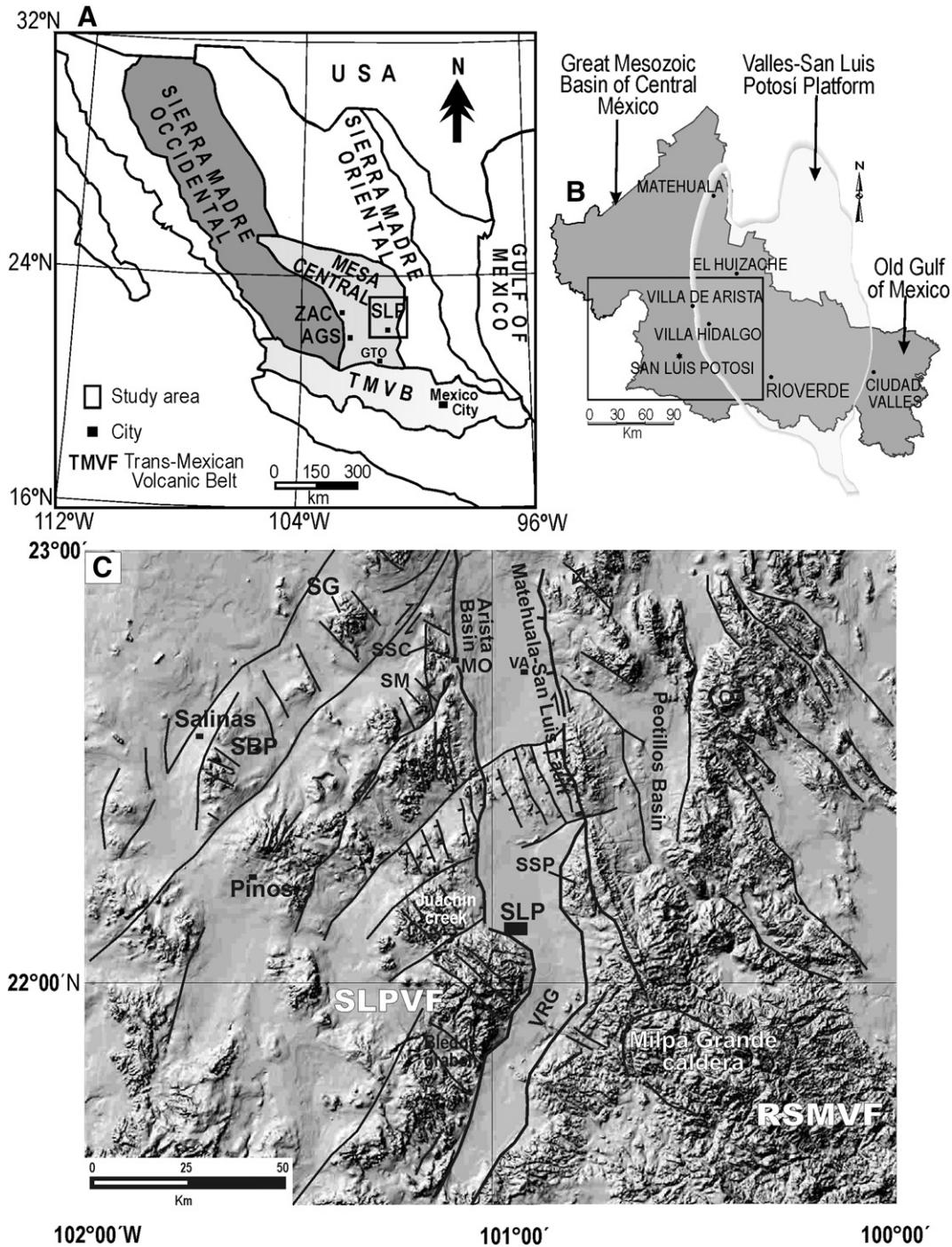


Fig. 1. Location of San Luis Potosí (SLPVF) and Río Santa María volcanic fields (RSMVF). A) Spatial relationship with the main geological provinces of northern Mexico; ZAC, Zacatecas city; AGS, Aguascalientes city; GTO, Guanajuato city; SLP, San Luis Potosí, city (modified after [Tristán-González et al., 2009b](#)). B) Location of the main volcano-tectonic features of the San Luis Potosí State. C) Digital elevation model showing the main tectonic structures in the SLPVF and surrounding area. RSMVF, Río Santa María Volcanic Field; SG, Sierra Guanamé; SSC, Sierra Santa Catarina; SM, Sierra Las Minas; SBP, Sierra La Ballena–Peñón Blanco; SSP, Sierra San Pedro, MO, Moctezuma; VA, Villa Arista; VRG, Villa de Reyes Graben.

dacitic ignimbrites and lava domes with sparse 30 Ma andesites, and a bimodal, 28 Ma succession represented by the widespread Panalillo rhyolitic ignimbrite and La Placa basalt ([Labarthe-Hernández et al., 1982](#); [Idier, 2003](#); [Rodríguez-Ríos and Torres-Aguilera, 2009](#); [Tristán-González et al., 2009a](#)). The last volcanic stages in the SLPVF consists of Middle Miocene and Plio-Pleistocene alkaline basalts including basanites and trachybasalts ([Lühr et al., 1995](#); [Martínez-Esparza, 2004](#)). Eocene–Oligocene volcanism in the Mesa Central was mostly controlled by NW–SE normal faults, whereas Quaternary volcanism was

controlled by E–W and N–S normal faults ([Tristán-González, 2008](#); [Tristán-González et al., 2009b](#)).

It is well documented that felsic volcanism predominates in the SLPVF, where it is represented by mid-Tertiary dacitic-rhyolitic lavas and high-silica rhyolitic ignimbrites ([Labarthe-Hernández et al., 1982](#); [Aguirre-Díaz et al., 2008](#); [Aguillón-Robles et al., 2009](#)). In contrast, the intermediate-mafic volcanic rocks are less well known and less studied than the voluminous felsic volcanic rocks. However, despite its relatively smaller volume, the intermediate-mafic volcanic rocks are

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