A facies model of a volcaniclastic apron: The Miocene Tepoztlán Formation (Central Mexico)

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In Miocene times, a major volcano-tectonic change took place in West and Central Mexico due to a reorganization of the tectonic plates in the western Pacific region. Since the mid-Miocene, the Transmexican Volcanic Belt (TMVB) began to form. Until present, few data exist on its initial phase since older volcanic products of the TMVB are widely covered by young volcanic rocks. Furthermore, it is hard to infer the volcano-tectonic history of a region from mostly reworked and redeposited rocks.

The studied lower to mid-Miocene volcaniclastic deposits (Tepoztlan Formation) of the southern edge of the TMVB are covered by Quaternary volcanic rocks. Based on sedimentological, petrographical, palaeomagnetic, and geochemical studies we aim to establish a stratigraphic framework and a palaeoenvironmental interpretation of the Tepoztlan Formation, contributing to the decipherment of the origin of the TMVB.

The 800 m thick Tepoztlan Formation consists of pyroclastic rocks (flow, surge and fall deposits), lahar deposits (debris-flow and hyperconcentrated-flow deposits), fluvial and lacustrine sediments and occasional lava flows. The clastic material is of volcanic origin exclusively, documenting the environmental response and long-term post-eruptive sedimentation effects after initial explosive and effusive eruptions.

Based on K/Ar analyses, the Tepoztlan Formation is preliminary dated between 21.8 ± 0.2 Ma and 19.0 ± 1.2 Ma. Palaeomagnetic data show several pole reversals within the studied sequence, allowing a more precise subdivision of the depositional period and thus a better correlation of the sections.

Principally, the volcanic rocks of the Tepoztlan Formation show andesitic to dacitic composition; basaltic andesite and rhyolite samples are also present. REE patterns are homogenous with enrichment in LREE and no remarkable element anomaly is present, probably indicating a single magmatic origin. This hypothesis is supported by the relatively short period of deposition of the Tepoztlan Formation.

Vertical and lateral distribution of depositional units and stratigraphical data (K/Ar, Ar/Ar of pyroclastic units, palaeomagnetic data) are used to reconstruct the evolution of the depositional environments within time, to detect the volume, type and distribution of the volcanic deposits and thus the type of volcanic eruption.

Different sedimentary environments of the Tepoztlan Formation include proximal-to-vent deposits, braided streams and sandy floodplains. Reworking and resedimentation of pyroclastic debris began immediately after an eruption. The style of this response varied between eruptions and between depositional environments. Initially, depositional processes were dominated by debris- and hyperconcentrated flows. Ephemeral lakes developed in ignimbrite-dammed depressions. Later, braided streams developed, reintegrating primary and secondary pyroclastic material and incising channels and scours.

The volcaniclastics of the Tepoztlan Formation accumulated for the most part in proximal to medial distance to the vent in volcanic flank and apron settings, pointing to several small volcanoes erupting into lowlands.

The integrated sedimentological, geochemical and geophysical study shows that the analysis of autochtonous and reworked volcanic material leads to a better understanding of the processes during initial volcanic arc development.