SILICIC TO BIMODAL OLIGOCENE VOLCANISM IN THE ZIMAPAN AREA, MEXICO: STRATIGRAPHY, AGE AND DEFORMATION

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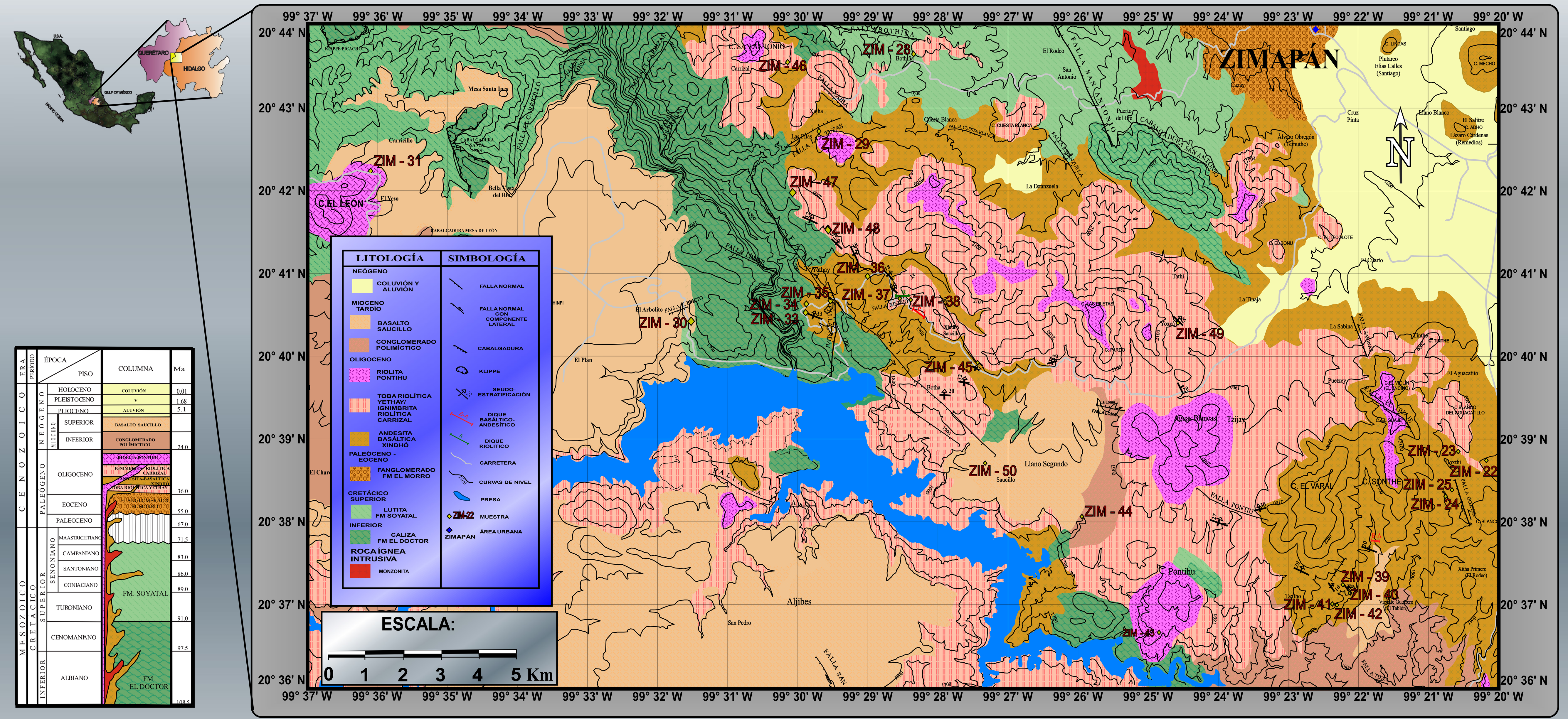
INTRODUCTION

We report new field, petrographic and geochronological data for a voluminous sequence of rhyolitic tuffs and domes associated with basaltic to andesitic lavas exposed southwest of Zimapán, state of Hidalgo. The scare geologic studies in the area assigned this sequence to the initial activity of the Transmexican Volcanic Belt (TMVB) in the late Miocene. Based on this age, normal faults affecting the western part of the study área (Aljibes half-graben) were considered part of the TMVB intra-arc extension (Suter et al., 1995).

The oldest volcanic unit of the Zimapan sequence consists of unconsolidated, partly reworked rhyolitic tuffs dated at 31.5 Ma (U-Pb, zircon; with a significant antecryst population from 37 to 30 Ma). This succession is intruded and partly overlain by mafic laccoliths, sills and dikes that in some places reached the surface forming lava flows that cover both the tuffs and the Cretaceous basement. This mafic unit is undated but can be constrained by the overlying silicic unit. This consists of an ignimbrites succession up to 250 m in thickness, probably emplaced through fissures as indicated by the presence of WNW- ESE striking pyroclastic dikes. A series of partly aligned rhyolitic domes cap the succession. The ignimbrites yielded U-Pb ages of 32.9 and 32.8 Ma (with individual ages ranging from 37 to 28 Ma). Four ages obtained for the rhyolitic domes and dikes range between 28.3 Ma and 31.6 Ma.



STRUCTURAL GEOLOGY

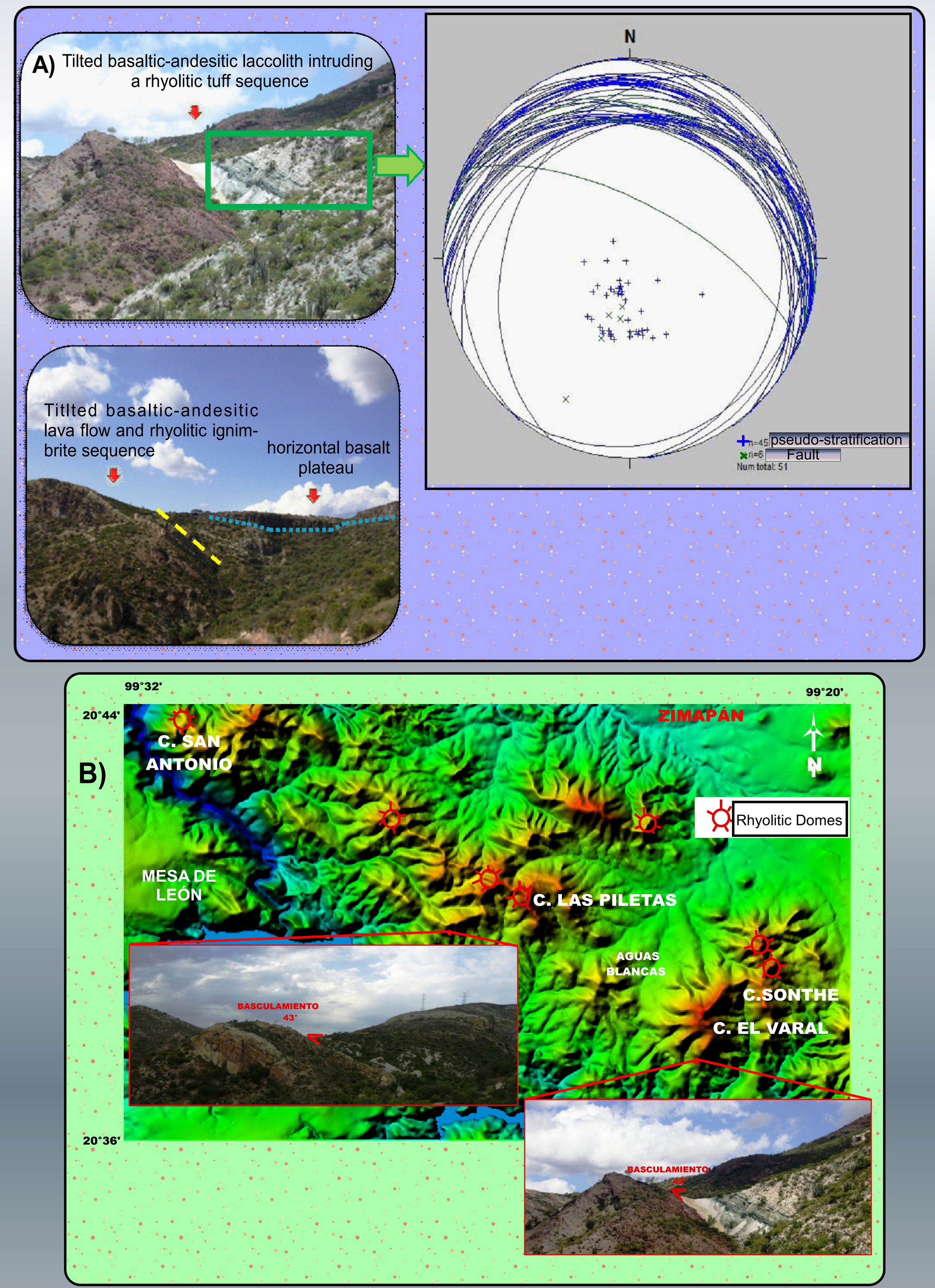
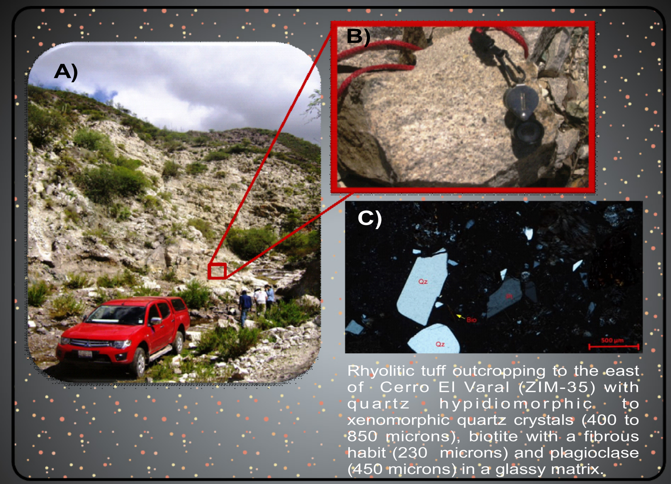


Figure 6. a) Stereographic projection showing NW-SE pseudo-stratification of a tilted ignimbrite sequence dipping 15°- 35°, with the same orientation measured normal faults, b) Digital elevation model of the study area showing the alignment of rhyolite domes related to its emplacement through listric normal growth faults.

LOCAL GEOLOGY

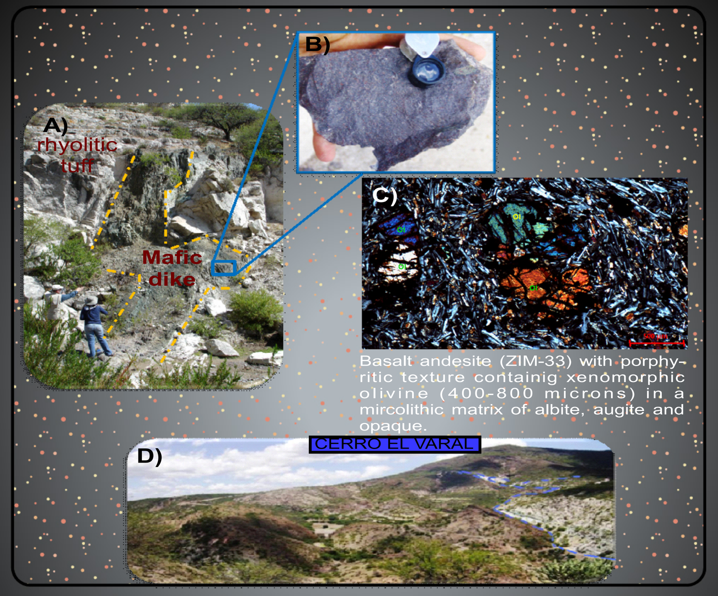
RHYOLITIC TUFFS



Rhyolitic tuff outcropping to the east of Cerro El Varal (ZIM-35) with quartz hypidiomorphic to xenomorphic quartz crystals (400 to 850 microns), biotite with a fibrous habit (230 microns) and plagioclase (450 microns) in a glassy matrix.

Figure 1. a) Outcrop of tilted rhyolitic ignimbrite (40°) at the base of Cerro El Varal with aphanitic fine volcanic lithic and sediment to the ground of Varal Hill (ZIM-40, 20° 37. 268' N / 99° 21,963' W), b) Rhyolitic tuff hand sample from same outcrop, c) Thin section of rhyolitic tuff .

BASALTIC TO ANDESITIC LAVAS



Basalt andesite (ZIM-33) with porphyritic texture containig xenomorphic olivine (400-800 microns) in a mircolithic matrix of albite, augite and opaque.

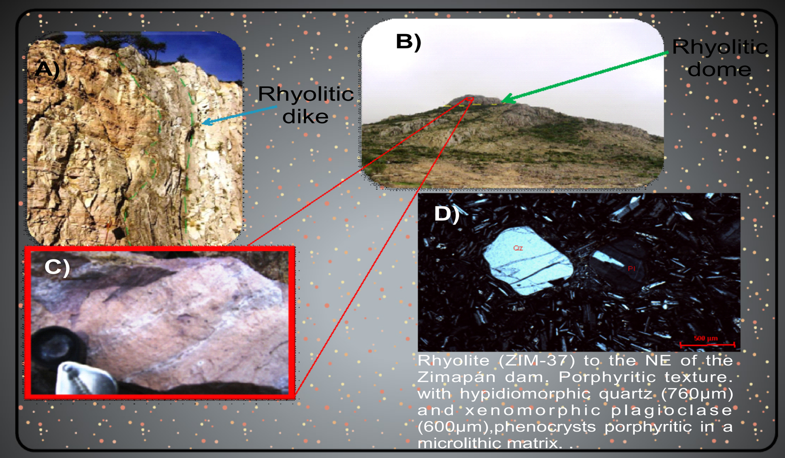
Figure 2. a) The tuffs are cut by mafic dikes of basaltic-andesitic composition, which in part conducted the magma to the surface to from lava flow sequences like that found at the top of Cerro El Varal (Fig. 2d), c)Hand sample showing aphanitic texture, and the presence altered olivine crystals. d) Cerro El Varal is formed by massive tilted basaltic-andesitic laccoliths, wish intrude greenish rhyolitic tuffs that are seen at the bottom right of the image.

RHYOLITIC IGNIMBRITE SEQUENCE

Rhyolitic ignimbrite (ZIM-33) to the NE of Zimapán dam. Contain xenomorphic quartz (50 to 460microns),xenomorphic albite with polysynthetic twinning(820 microns) and biotite with fibrous habit (320 to 580 microns) in a glassy matrix.

Figure 3. a) Ignimbrite, b) Hand sample of a rhyolitic ignimbrite, c) Thin section of cristal-rich rhyolitic ignimbrite.

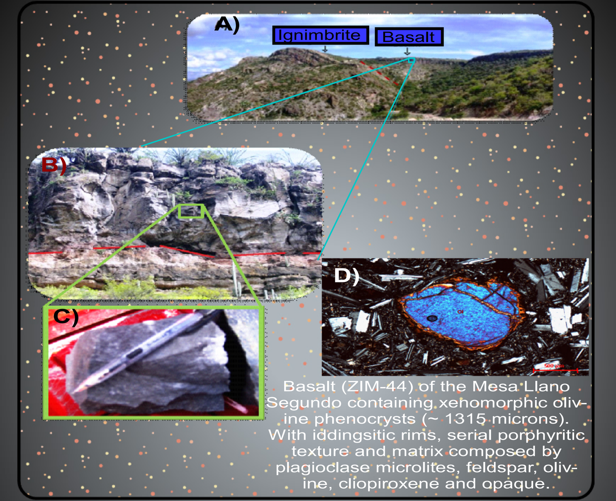
RHYOLITIC DOMES



Rhyolite (ZIM-37) to the NE of the Zimapán dam. Porphyritic texture with hypidiomorphic quartz (760µm) and xenomorphic plagioclase (600µm),phenocrysts porphyritic in a microlithic matrix.

Figure 4. a) Rhyolitic dike intruding the ignimbrite sequence, and are considered as feeders of rhyolitic domes (ZIM 38, 20. 67729 N/99. 47381 W), b) rhyolite dome to the west of Coaxithi village (20° 40.406' N / 99° 24.523' W), c) rhyolitic rock sample with flow banding taken from Cerro San Antonio (20° 43.237' N / 99° 30.873' W),d) Thin section of a rhyolitic lava sample with phenocrysts of quartz and plagioclase.

OL-BASALT LAVA FLOWS



Basalt (ZIM-44) of the Mesa Llano Segundo containing xehomorphic olivine phenocrysts (~ 1315 microns). With iddingsitic rims, serial porphyritic texture and matrix composed by plagioclase microlites, feldspar, olivine, cliopiroxene and opaque.

Figure 5. a) Tilted ignimbrite package discordantly covered by a horizontal basalt plateau, b) light gray basalt with aphanitic texture and fresh olivine, plagioclase and pyroxene (20° 38.580' N / 99° 27.442' W), overlying lacustrine tuffaceous deposits c) Hand sample of ol-basalt,d)Thin section of ol-basalt lava with aphanitic texture abd fresh olivine, plagioclase and pyroxene.

GEOCHEMISTRY

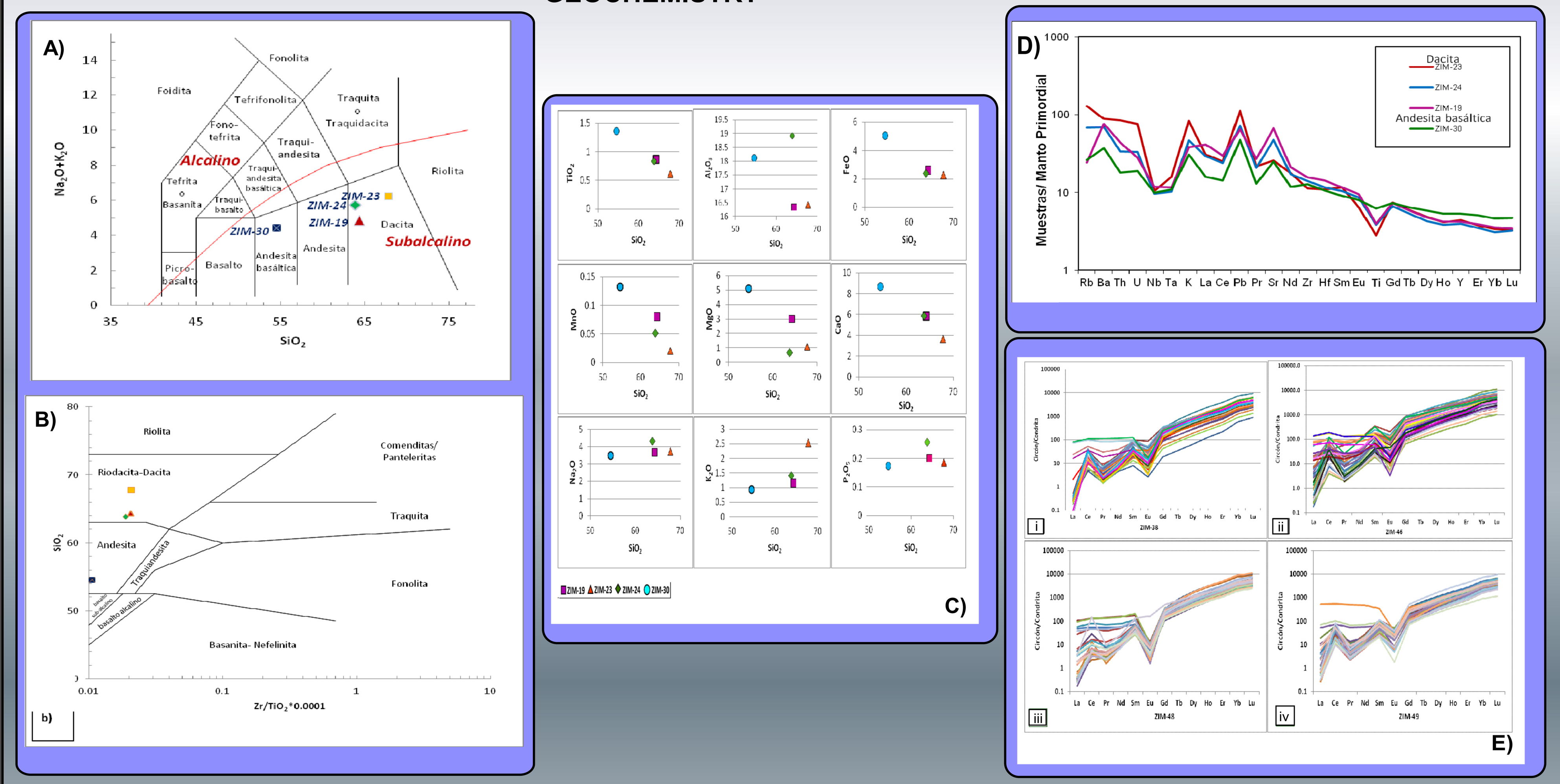


Figure 7. a) TAS classification diagram $Na_2O + K_2O$ vs SiO_2 (Le Bas et al., 1986), which includes the line between alkaline and subalkaline fields of Irvine and Baragar (1971), b) classification diagram based on altered rocks Zr/TiO_2 vs SiO_2 (Winchester and Floyd, 1977), c) Harker diagrams for major elements, e) REE patterns normalized to chondrites (Anders and Grevesse, 1989) for zircons analyzed by LA-ICP-MS, d) multi-element diagram normalized to primitive mantle (Sun & McDonough, 1989).

GEOCHRONOLOGY

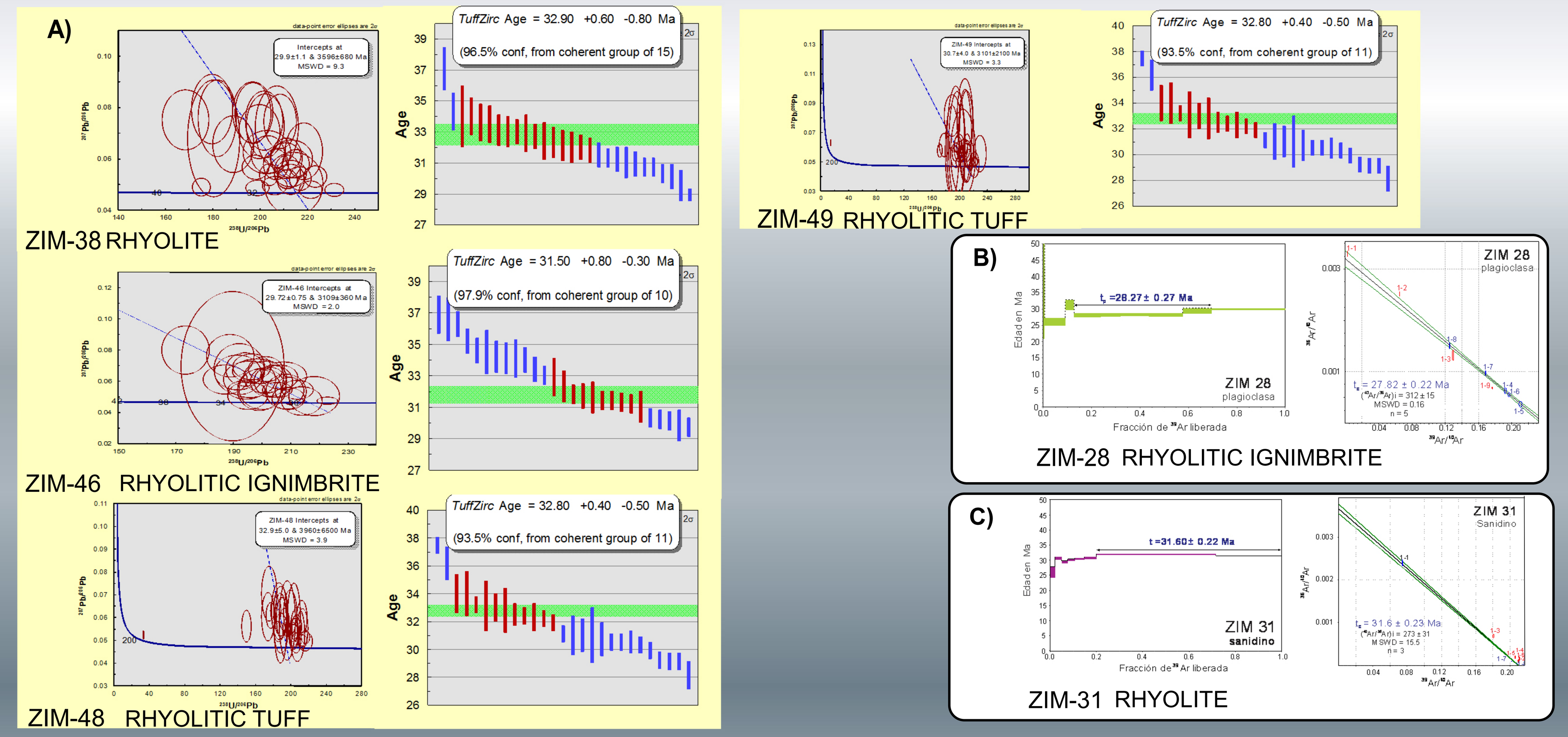


Figure 8. a) U / Pb dating of samples ZIM-38, ZIM-46, ZIM-48 and ZIM-49 plotted in Tera-Wasserburg concordia diagram and $^{206}Pb/^{238}U$ weighted average diagram, b) results of Ar / Ar analysis of plagioclase from sample ZIM-28 age spectra with plateau age of 28.27 ± 0.27Ma and isochron diagram with an isochron age of 27.82 ± 0.22Ma, c) results of Ar / Ar analysis of sanidine from sample ZIM-31: sanidine age spectra with a plateau age 31.60 ± 0.22Ma and to ZIM-31sample: sanidine age spectra with a plateau age 31.60 ± 0.22Ma and isochron diagram yielding an isochron age of 31.6 ± 0.23Ma isochronous (Tp = plateau age, Tc= isochron age . The numbers close to the ellipses in the diagrams correspond to each measured fraction).

CONCLUSIONS

The Oligocene succession exposed southwest of Zimapán, state of Hidalgo is affected by WNW striking, SSE-dipping normal faults, with displacements up to 150 m and up to 40° tilting. Rhyolitic domes and dikes are also aligned in a WNW direction, suggesting a common extensional regime.

Growth faults and decreasing tilting upsection indicate that faulting was synchronous with volcanism and entirely bracketed within the Oligocene. The youngest unit in the area are untilted Ol-basaltic lava flows of Late Miocene age, affected by small extensional faults with less than 50 m of displacement.

Our new data show that the volcanic sequence in the area was emplaced in a short time span during the Oligocene as a part of the Sierra Madre Occidental volcanism. Although small E-W striking faults do affect late Miocene and younger rocks, most of the deformation previously ascribed to the Aljibes half-graben is older and cannot be part of the TMVB intra-arc extension.

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