"Resistivity model for the Colima Volcanic Complex from magnetotelluric observations"

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Motivation

No resistivity models are available for the Colima Volcanic Complex which could complement previous geophysical models about its volcanic magmatic system.

Key question

How is magma transported to the surface? Is there a magmatic chamber beneath CVC?

Study area and its dynamic context

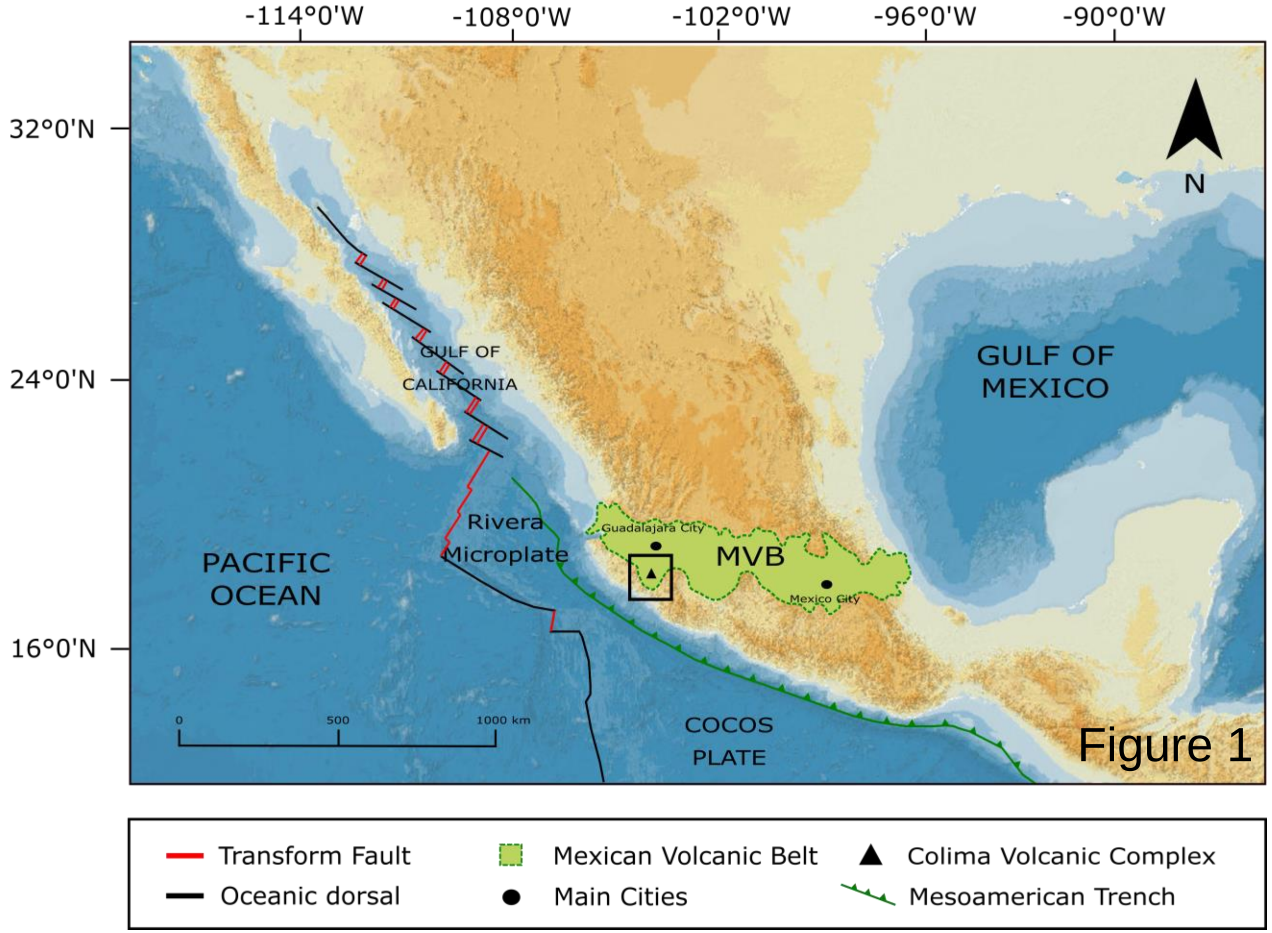
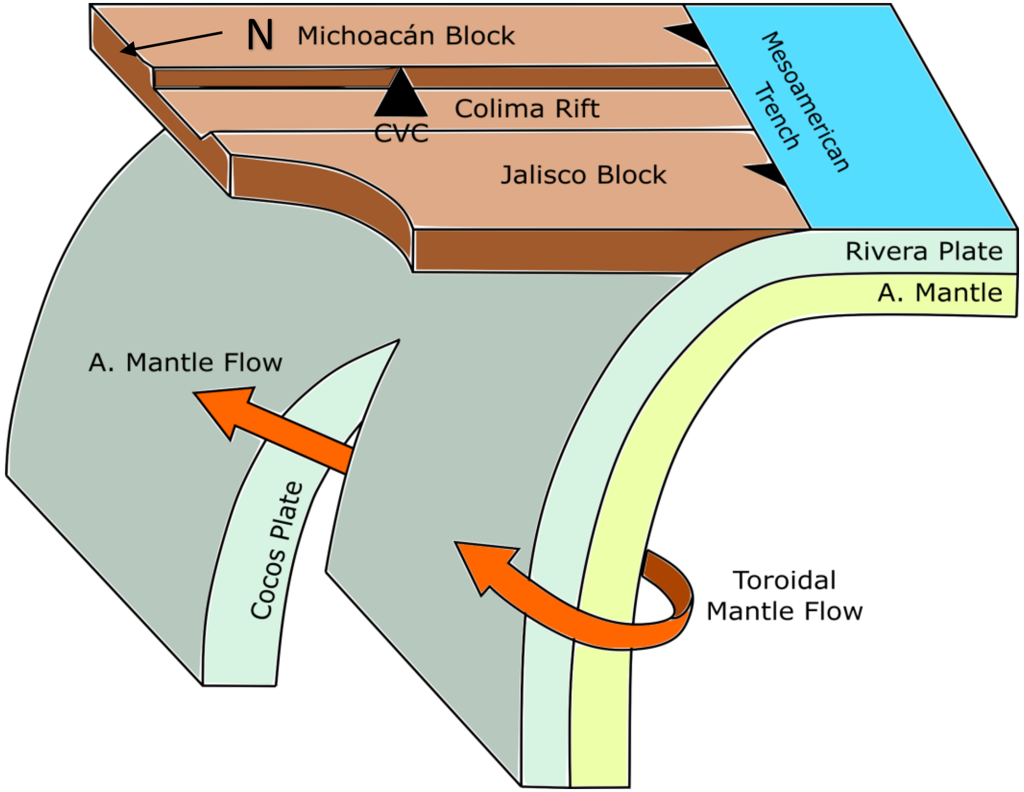


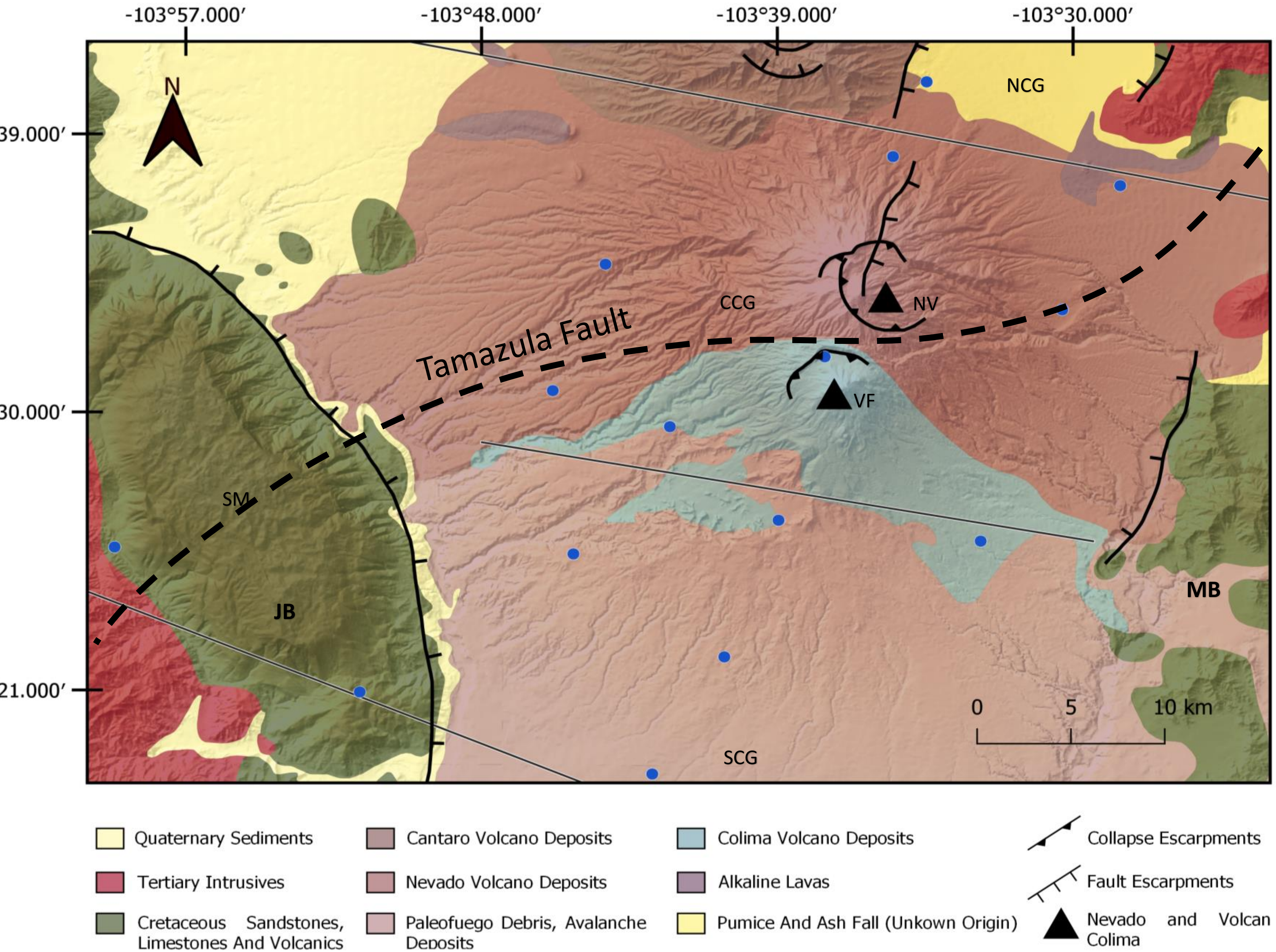
Figure 1

The Colima Volcanic Complex (CVC) is located in the occidental part of Mexico, within the westernmost side of the so called Trans-Mexican Volcanic Belt (TMVB). The CVC structure is 120 km far from the Mesoamerican Trench, 80 km from the Pacific Coast and 100 km south of Guadalajara City.

Figure 2



Two oceanic plates; Rivera and Cocos, converge obliquely and with different slab angles to the North American continental plate. From seismic tomography (Yang et al. 2009) has been inferred that a slab window ocurrs at 150 km depth, just beneath north and central Colima Rift, that allows a flow of asthenospheric mantle to the mantle wedge enabling the crust to melt. This coincides with the volcanism in the CVC, which is north-south migrating/old-young aging.



Geology

The CVC lies in the westernmost part of the TMVB which is the largest neogene volcanic arc in North America with an area of 160,000 km2 (Ferrari et al. 2017) and a basement composed mainly volcanic deposits and marine sedimentary rocks. Particularly for the CVC, the basement consists of carbonated rocks and volcanic intrusives which are overlain by Colima rift's sedimentary infill sequences and the volcanic products of the Volcan Cántaro, Nevado de Colima and Volcan de Fuego, which form the CVC.

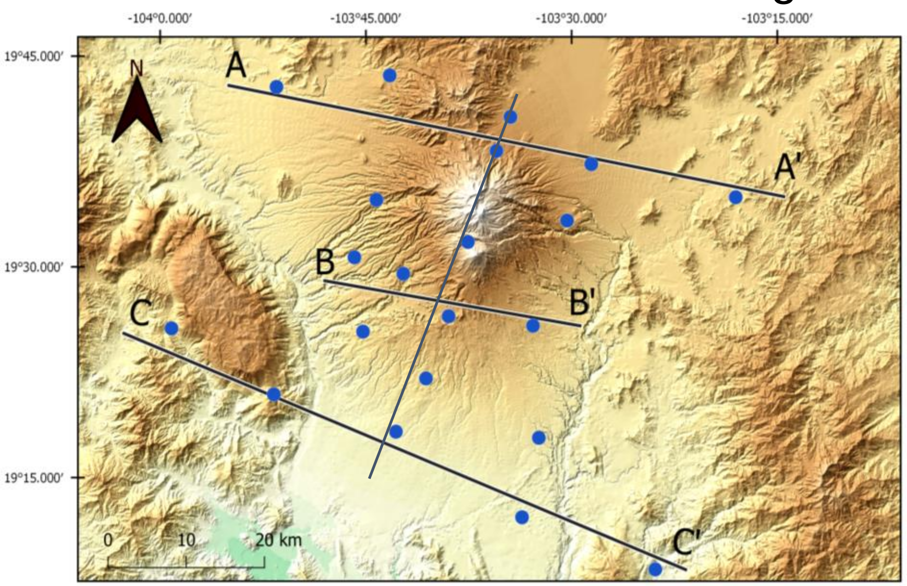
Two main structural features can be evidenced; a north-south normal faulting that delineates the north part of the rift, which continuation along the central and south parts it is not so clear, and an almost east-west structure called Alseseca graben, inferred to be constructed by the active Tamazula fault, which played an important role in the gravitational collapses of the CVC to the south (Norini et al. 2010).

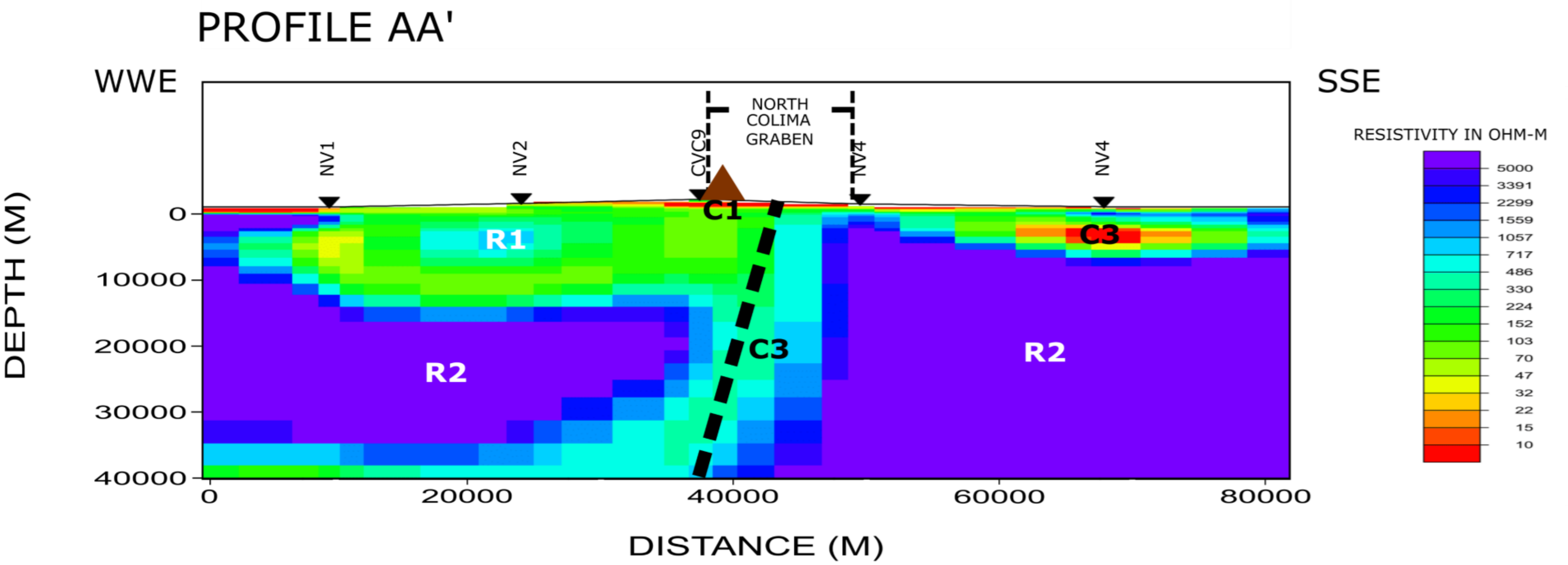
Figure 3. Geologic map taken and edited from the recapitulation made by Crummy (2013) after the works of Rodríguez-Elizarrarás (1995), Cortés (2002,2005 and 2010) and Ferrari et al. (2017). NCG: North Colima Graben, CCG: Central Colima Graben, SCG: South Colima Graben, RA: Armería River, NR: Naranjo River, SM: Manantlan Mountain Range, JB: Jalisco Block, MB: Michoacán Block, VF: Volcan de Fuego, NC: Nevado de Colima, Blue dots are MT soundings and thin blue lines are MT profiles.

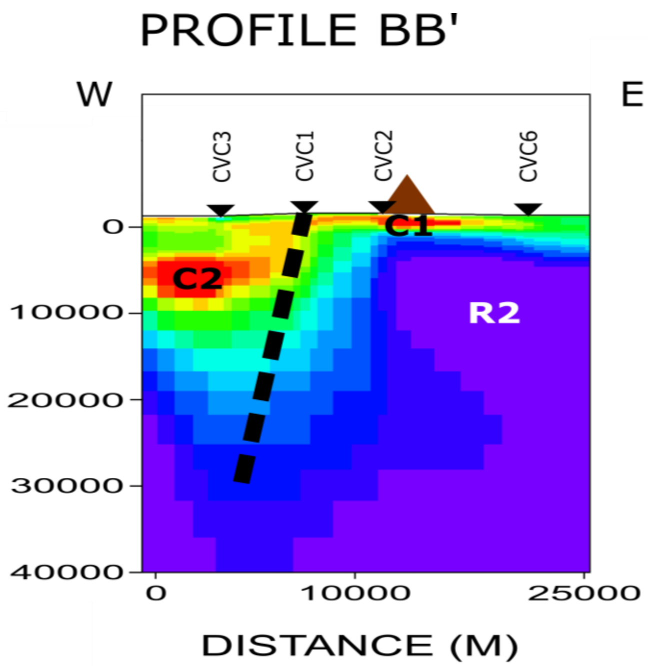
Figure 4

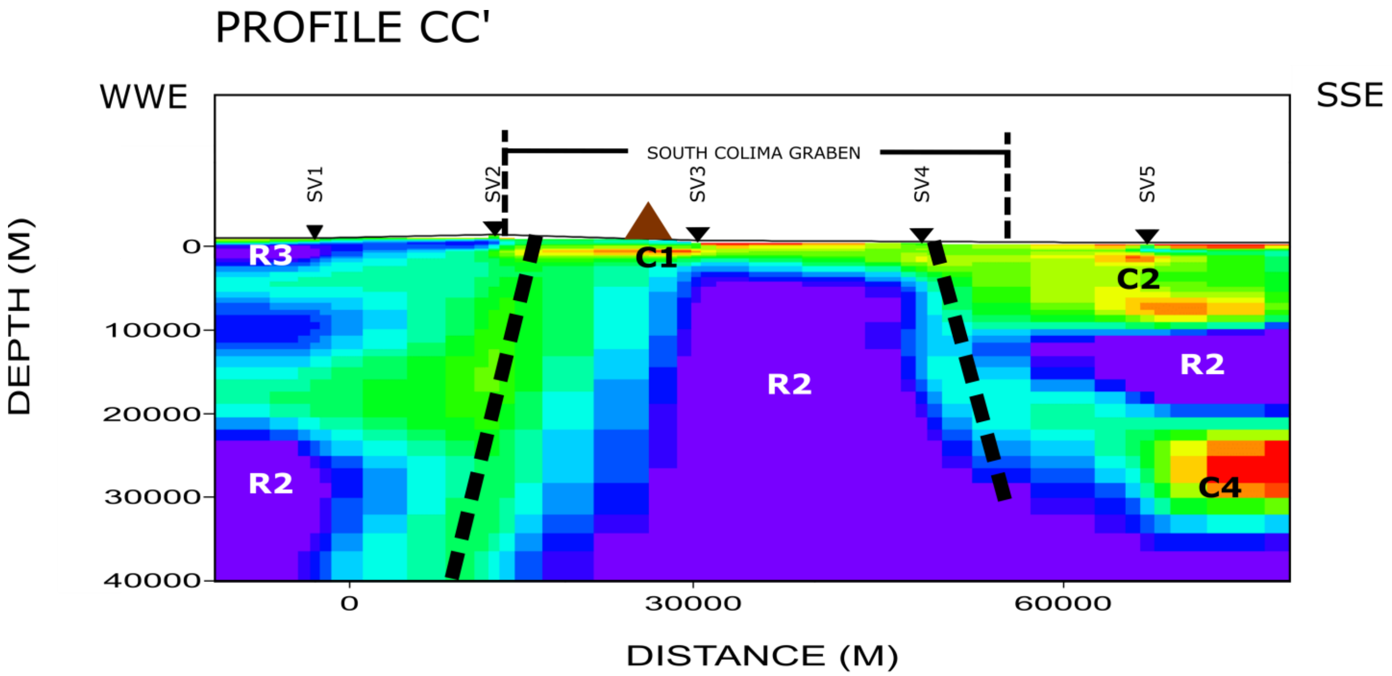
Resistivity models

From resistivity models we conclude a good correlation with superficial geology and with the normal faults that delineate the northern and central part of the Colima rift. A homogenous basament goes along all the structure where no avidence for shallow or medium crust depth reservoirs are present. Anomaly C2 and C3 are of interest because of the agreement with the subsurface prolongation of the main faults. From this, we can hyphotesize a tectonic-structural control for magma ascend, along fault planes.









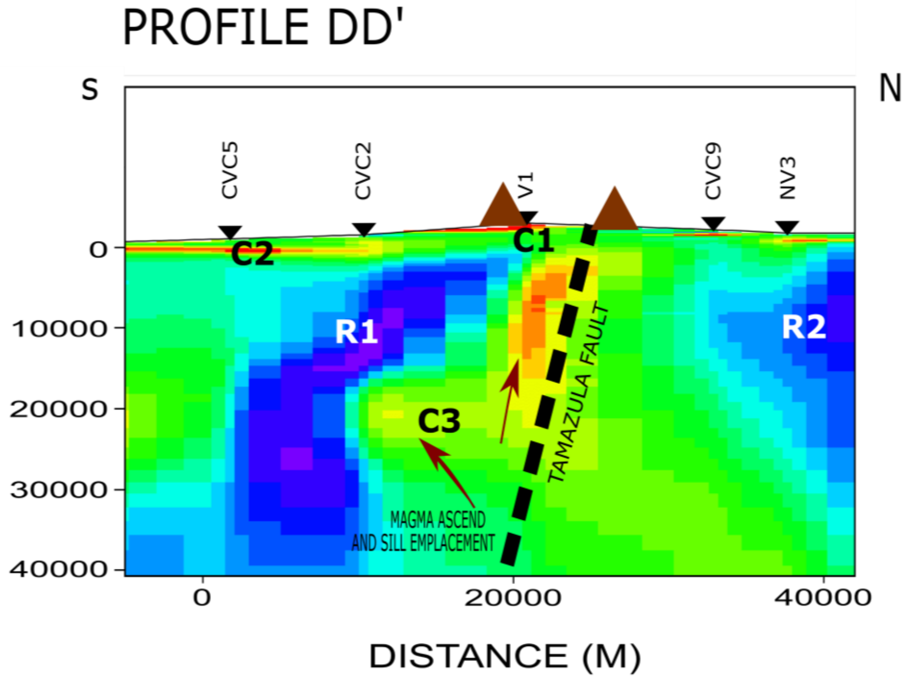
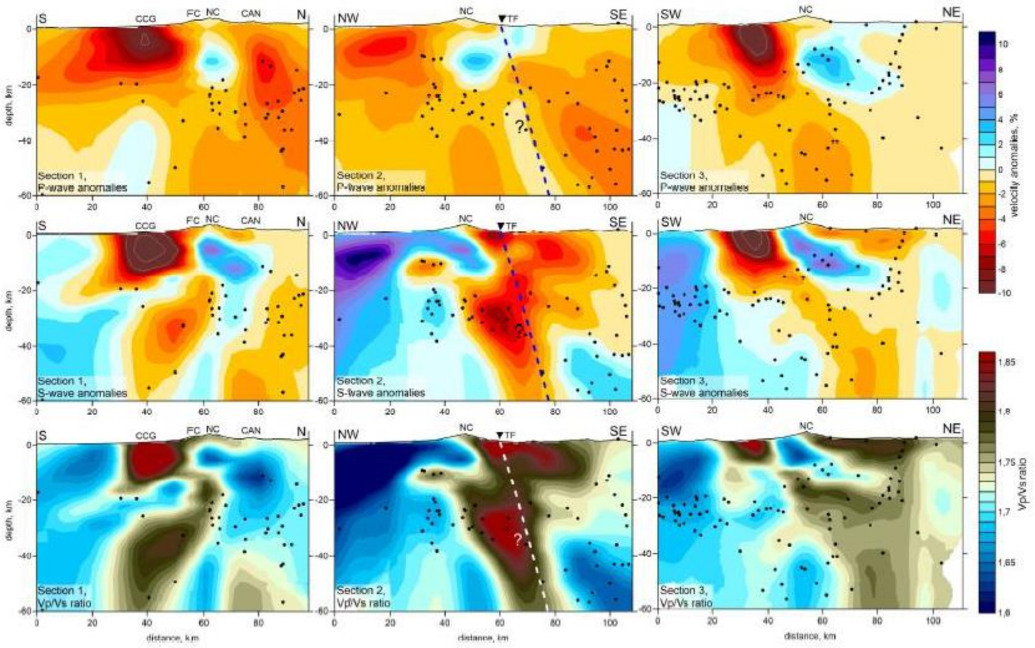


Figure 5

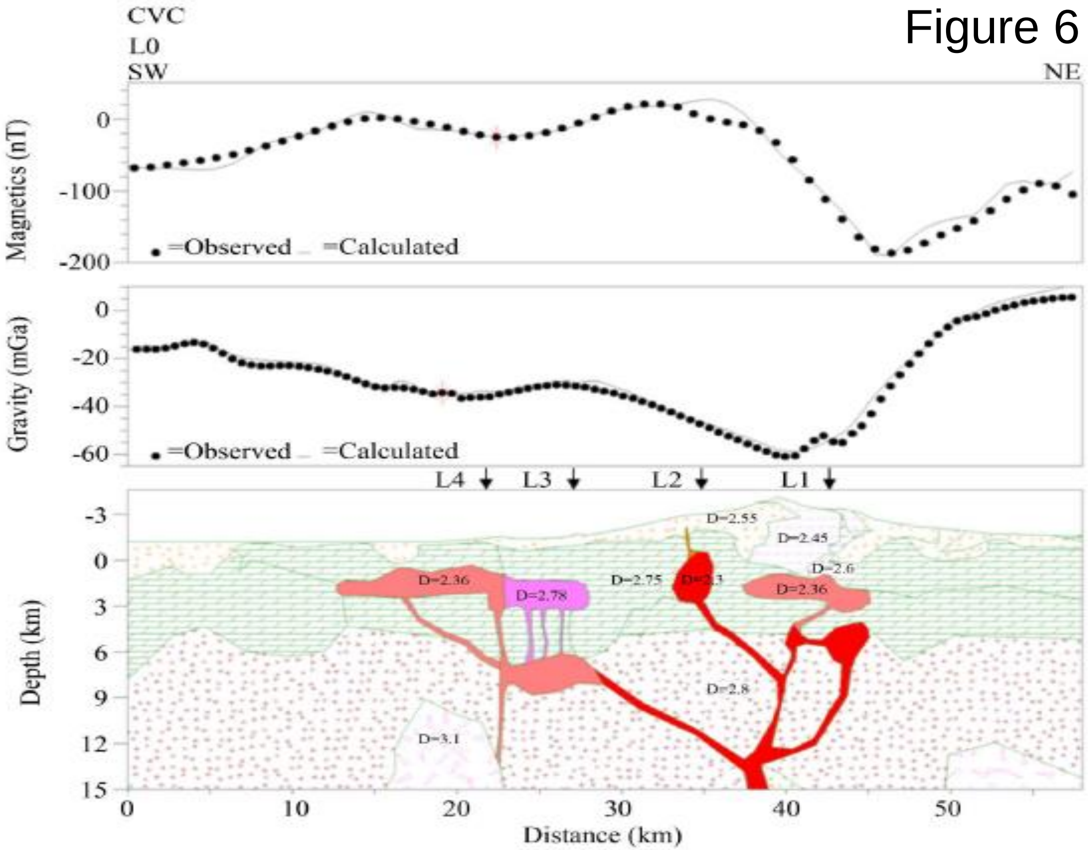
Seismic models correlation with resistivity models

Profile DD’ resistivity model show a conductive anomaly vertically extensive parallel to Tamazula fault plane and an horizontal extensive sill complex around 20 km depth. Velocity model from Sychev et al. (2019) elucidates an anomaly. Low velocity zones correlate with our conductive body.



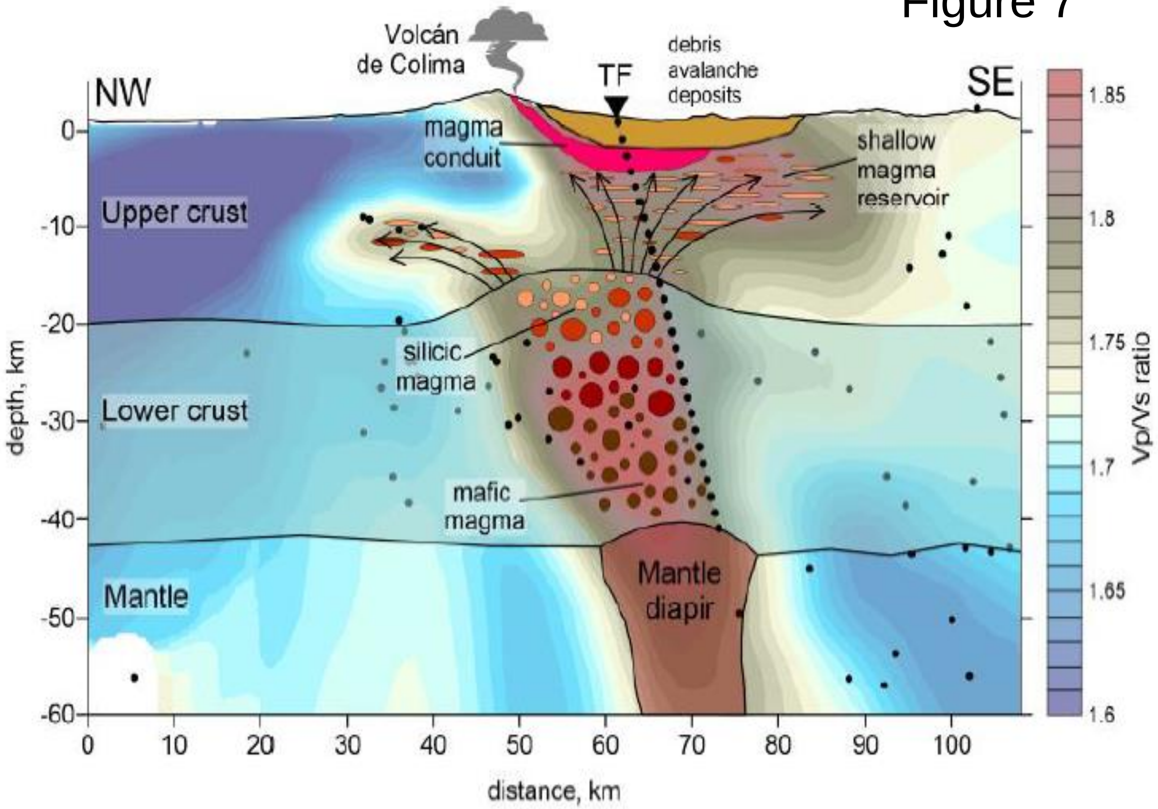
Below, seismic models from Sychev et al. (2019) showing in the first and second row velocity anomalies and the third row the Vp/Vs ratio. Above, north-south MT resistivity model

Figure 6



Gravimetric and magnetic model from Alvarez & Yutsis (2015) show several magmatic chambers interconnected with dykes. Low magnetic and gravimetric anomalies correlate with our profile DD' anomaly. No resistivity model evidence stands for the magma chambers south the CVC.

Figure 7



Our results support Sychev et al. (2019) schematic model for the CVC magmatic system, where a mafic magma intrudes and then evolves to a more silisic magma during its ascend through weakness planes.

Conclusions

- Resistivity models obtained from magnetotelluric data inversion depicts a good correlation with actual structural and geological information for the Central Colima Graben but new insights for new structures can be established from resistivity models.

- No shallow magma chamber seems to be south the CVC as inferred in seismic models. Apparently conductive anomalies west of Profile BB’, vertical conductive body west of Profile CC’ and the evidence of Tamazula fault in the NS profile show a main tectonic-structural control for magma or hydrothermal fluids ascend.

- Further work must consider a denser MT soundings array to constrain geological structures smaller than 5 km and the comparison of 3D models resistivity models (in process).