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Magma transport in the shallow crust – the dykes of the Chachahuén volcanic complex (Argentina)

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Recent eruptions such as the Kilauea 2018 (fissure) eruption on Hawaii are the result of magma intruding into Earth's crust and ascending towards the surface. Magma is dominantly transported, through the shallow crust in form of vertical sheet intrusions (dykes). Even though dyke propagation and emplacement has been monitored with geodetic and geophysical methods, direct observations of subsurface intrusion processes remain inaccessible due to the hazardous nature of active volcanic and igneous systems. Therefore, we studied the extinct and eroded volcanic system of the Chachahuén volcanic complex (CVC) in Argentina to investigate the scale and physical mechanisms of magma transport in volcanic and igneous plumbing systems.

The Chachahuén volcanic complex is located in the northern part of the Neuquén Basin, east of the southern volcanic zone (SVZ) of the Andes. A decline in volcanic activity during the Quaternary and erosion have exposed the shallow part of the Miocene CVC's plumbing system, including two major vertical sheet intrusions: (1) the Great Dyke and (2) the Sosa Dyke.

The objective of this ongoing study is to characterize the mechanisms of magma transport within the two exposed dykes to better understand the physical processes during their emplacement. We apply a multiscale approach combining field work and state-of-the-art analytical techniques, i.e., drone/ground-based photogrammetry, Fourier Transform Infrared Spectroscopy (FTIR), Electron Backscatter Diffraction (EBSD) and Anisotropy of Magnetic Susceptibility (AMS), with traditional geological methods, i.e., microstructural analysis and igneous petrology. Thus, we can investigate the effect of magma rheology (small-scale) on the outer shape and morphology of the dykes (large-scale).

Our results using high-resolution 3D outcrop models show a segmentation of the investigated dykes. Each of these dyke segments shows blunt ends. This suggests either the emplacement of a highly viscous magma or a weak brittle host rock. Flow features identified with AMS analysis indicate a dominantly lateral magma transport within the dykes. To estimate the magma viscosity

during emplacement FTIR (H_2O content of the initial melt), and microstructural analysis (for crystallinity) are performed at the moment. These analyses in combination with a map of the host rock and, the dyke morphologies, will help to characterize the dominantly controlling mechanism(s) of magma emplacements in the CVC. Finally, the new findings from this project will contribute to the general understanding on how the physical properties of the magma affect the shape of magma bodies and magma flow in the Earth's shallow crust.