Geophysical Research Abstracts
Vol. 21, EGU2019-8171, 2019
EGU General Assembly 2019
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The interplay between Transverse Faults and Pleistocene-Holocene Dyke Systems in the Southern Volcanic Zone of Chile

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Networks of fractures in the upper crust can act as pathways for fluids when they are optimally oriented. In some circumstances the coalescence and dilation of fractures in and around faults can play a key role in the transport, emplacement, and eventual eruption of magma at the surface. It is then relevant to assess the extent to which pre-existing fractures play a role in the formation of dykes and the transport of magma through dykes. Fracture dilation by fluid pressure depends partly on the amount of fluid pressure and on the fracture's orientation to the prevailing bulk regional stress field. Moreover, local variations in stress field influence the amount of fracture dilation and the path of a fluid driven fracture.

The Southern Volcanic Zone (SVZ) of Chile is an ideal place to study the interplay between tectonic related fractures and magma transport in an active subduction zone, because segmentation of the SVZ by crustal thickness and basement cover, among other factors, may result in differences in the mechanism of dyke formation and propagation. Dyke propagation can be further enhanced by crustal discontinuities (ie. fault-fracture networks) which are ubiquitous in the area of study. The NE-aligned Tatara – San Pedro – Pellado volcanic complex (TSPP), which comprises part of the study area, is a segment of the volcanic arc characterized by NE trending extensional faults. These faults are kinematically consistent with the prevailing Quaternary orogen-scale shortening and spatially associated to parallel NE trending mafic dyke swarms.

To understand the role of pre-existing structures and regional stress fields on magma transport, we performed detailed structural mapping and fault-slip analysis of the region between the Maule and Botacura rivers (35º48' – 36º00'S). The field data was used as input to a series of FEM numerical models designed to understand the distribution and evolution of stresses during dyke emplacement. Here we present preliminary field and numerical results which highlight a regional NE-striking and steeply dipping right-lateral transtensional fault system parallel to the alignment of the TSPP. The fault cuts both Oligo-Miocene folded volcanoclastic rocks and Mid Pleistocene lavas, dominantly basaltic andesites, and pyroclastic deposits. Near San Pedro Volcano the transtensional faults have right lateral displacements and orientations ranging between NE-SW to E-W. The western termination of the NE transtensional system consists of steeply dipping normal faults which strike E-W and the N-S striking Melado Valley fault, which is kinematically consistent with a 2012 6.0Mw earthquake with right lateral displacement. Second order NW to WNW striking left lateral, steeply dipping faults are observed in the east of the study area, where the structures cut a Late Cretaceous granodiorite intrusion. Our results are important for understanding the effect of crustal discontinuities and complex regional stress fields on magma propagation.

This work is a contribution to FONDAP-CONICYT project 15090013(CEGA) and FONDECYT project 1141139.