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Long- and short-term tectono-magmatic role of transverse fault systems in the Andes: A combined geological and numerical approach

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The present contribution combines field work, mechanical modelling and published data to provide an updated synthesis of the geological and physical nature of the regional-scale NW- and NE-striking transverse fault systems of the Central and Southern Andes (ATF). Mechanical modelling places some first-order constraints on the underlying physics governing tectonic processes and are then confronted with regional scale geological data to assess two specific questions: (1) What is the precise role of ATF on the long- and short term magma/geofluid transport through the lithosphere and (2) What is their relevance on the short-term seismotectonic segmentation of the margin within the framework of the subduction zone seismic cycle?

Regional field data documents that the ten-to-hundred-kilometer long ATF have total accumulated displacements between a few tens of meters to a few kilometers. ENE-striking faults are mostly dextral strike-slip, whereas WNW-striking faults are sinistral; however, local switches in the sense of slip are also documented. ATF are spatially associated with Cretaceous to Miocene ore deposits and to Pliocene-Holocene volcanic centers and geothermal reservoirs, suggesting they have acted as episodic pathways for magma/fluid migration through the lithosphere.

Ongoing Boundary Element and Finite Element modelling show that the tectono-magmatic role of ATF can vary significantly on different time scales. The long-term mechanical and geofluid transport role of ATF responds to the low strain rate loading scenario of the interseismic period of the subduction seismic cycle (SSC), whereas transient transport of geofluid and opposite kinematics can be expected during the transient, high strain rate coseismic period of the SSC. Furthermore, some ATF may represent rheological boundaries between adjacent lithospheric scale blocks that have undergone differential long-term shortening and are currently associated with distinctive short-term earthquake rupture zones. This hypothesis is tested here by using Finite Element models.

We conclude that transverse fault systems in the Andes play a much more significant role than previously recognized and that they should be taken into account when trying to unravel key fundamental questions regarding the evolution of mountain belts, such as along-strike tectonic segmentation, natural resource exploration and seismic/volcanic hazard.