



## **Crustal fault systems and geothermal fluid flow in the Andean Southern Volcanic Zone: New magnetotelluric and seismic evidence**

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At convergent plate boundaries, the nature and spatial distribution of volcanism is largely controlled by major, margin-parallel and transverse fault systems that act as magmatic and hydrothermal fluid conduits through the crust. In the south-central Chilean Andes, the volcanically and seismically active Tinguiririca and Planchon-Peteroa volcanoes are considered to be tectonically related to the major Miocene-Pliocene El Fierro thrust fault system due to their alignment along strike of the fault trace. This large scale reverse fault system is characterized by hydrothermally altered fault cores, which exhibit signatures of copper-porphyry mineral haloes within the fracture damage zone, and geothermally heated springs that occur along the outcropping fault traces. These surficial features support the hypothesis that hydrothermal fluid propagates up to the surface in the hanging wall damage zone, below an impermeable fault core. This study aims to constrain the 3D architecture of these tectono-magmatic features and their interaction with the active geothermal system. This was achieved by combining a 24 station Metronix magnetotelluric and 12 station ESPD and 6TD seismic network in a 40 x 40km grid within the selected study area. Data from the magnetotelluric survey were processed with robust remote referencing techniques with BIRRP to produce reliable impedance values, followed by a 3D inversion to produce the presented regional subsurface conductivity signatures. The local seismic hypocentres picked from SAC from the first six months are also presented here, together with the magnetotelluric results. The combined results show a distinct coherence of high conductivity regions and seismic clusters in the top 10km of the crust. These conductors show a westward dipping trend in the region of the El Fierro fault, and also occur as large conductive regions beneath the Planchon-Peteroa volcanic complex. As the seismic clusters occur on the eastern edge of their correlating conductors, it is also interpreted that the ambient tectonic stresses are causing the seismic events to occur on the footwall of the large-scale reverse fault systems. As the hydrothermal system in this region is still volcanically active, evident from the minor strato-volcanic eruption that occurred in November 2018 within the duration of the seismometer deployment, the results from this study provide evidence of how lithospheric weakening from the circulation of meteoric and magmatic fluids within the crust promote tectonic rupture. The fluids are attributed to meteoric and magmatic sources in circulation within the active hydrothermal system, the composition and temperature gradients of which will be constrained with finalised 3D inversions. We also show strong evidence of a north-west oriented seismic cluster that may indicate the presence of a margin-oblique second-order NW fault, commonly known as Andean Transverse faults (ATF), which can also be correlated with NW lineaments shown in preliminary resistivity maps. This study will ultimately provide insight into the interaction of geothermal fluids with concealed/blind fault systems, and their influence on orogenic evolution of this region of the South Central Andes