Geophysical Research Abstracts
Vol. 16, EGU2014-3226, 2014
EGU General Assembly 2014

Field study and three-dimensional reconstruction of thrusts and strike-slip faults in the Central Andes: implications for deep-seated geothermal circulation and ore deposits exploration

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The Puna plateau (NW Argentina), located in the back-arc of the Central Andes, is a plateau characterized by both orogen-parallel and orogen-oblique deformation styles, extensive magmatic and geothermal activity, and the broad occurrence of igneous and hydrothermal ore-forming minerals. In this area, like in other convergent margins, the behaviour of the magma-tectonics interplay can affect the circulation of hydrothermal fluids, so that the full comprehension of the tectonic control on the magmas and fluids paths in the continental crust is crucial to plan the geothermal and ore exploration.

In this study, we present a structural analysis of the back-arc portion of the orogen-oblique Calama-Olacapato-El Toro fault system and the surrounding orogen-parallel thrust faults in the central-eastern Puna Plateau, comprising the Cerro Tuzgle-Tocomar geothermal volcanic area, with high geothermal potential, and silicic calderas and domes associated with epithermal ore deposits. We also focused on the tectonic and volcanotectonic structures of the Chimpa and Tuzgle stratovolcanoes, two of the most important polygenetic volcanic centres of the plateau.

Morphostructural analysis and field mapping reveal the geometry, kinematics and dynamics of the tectonic structures of the studied area. These data and the available stratigraphic and geophysical data have been integrated with the software MOVE and PETREL in a three-dimensional reconstruction of the main fault planes, showing their attitude and intersections at depth.

As a result of our study, we show that despite different geometry and kinematics of the Calama-Olacapato-El Toro fault system and the thrust faults, they formed and evolved under the same progressive evolving dynamic state, forming a single tectonic system and accommodating crustal shortening of a thickened crust. In this frame, the crust underwent simultaneous deformation along both the low-angle thrust faults and the vertical transcurrent strike-slip faults, with the latter developed as transfer zones among the main thrusts. Both reverse and transcurrent displacements resulted from the interplay between the compressive regime of the plateau, with horizontal maximum principal stress, and the vertical thickening of the upper crust.

The study suggests that the tectonic control on the magma and fluid circulation in the crust is mainly related to the geometry of the fault planes and the orientation of the stress field, with an important role played by the orogen-parallel thrust faults and horizontal maximum principal stress in determining the secondary permeability, the arrangement at depth of potential cap rocks and reservoir units, the structure and location of monogenetic and polygenetic volcanoes and the geometry of mineral veins.