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Faults and magma reservoirs along the Southern Andes Volcanic zone (SAVZ): linking oservations and numerical models of stress change controlling magmatic and hydrothermal fluid flow

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The Chilean margin is amongst the most active seismic and volcanic areas on Earth. It hosts active and fossil geothermal and mineralized systems of economic interest documenting significant geofluid migration through the crust. By comparing numerical models with field and geophysical data, we aim at pinning when and where fluid migration occurs through porous domains, fault zone conduits, or remains stored at depth awaiting a more appropriate stress field. Dyking and volcanic activity occur within fault zones along the SAVZ, linked with stress field variations in spatial and temporal association with –short therm- seismicity and -long term- oblique plate convergence. Volcanoes and geothermal domains are mostly located along or at the intersection of margin-oblique fault zones (Andean Transverse Faults), and along margin-parallel strike slip zones, some which may cut the entire lithosphere (Liquiñe-Ofqui fault system). Whereas the big picture displays fluid flow straight to the surface, at close look significant offsets between crustal structures occur. 3D numerical models using conventional elasto-plastic rheology provide insights on the interaction of (i) an inflating magmatic cavity, (ii) a slipping fault zone, and (iii) regional tectonic stresses. Applying either (i) a magmatic overpressure or (ii) a given fault slip can trigger failure of the intervening rock, and generate either i) fault motion or ii) magmatic reservoir failure, respectively, but only for distances less than the structures' breadth even at low rock strength. However, at greater inter-distances the bedrock domain in between the fault zone and the magmatic cavity undergoes dilatational strain of the order of 1-5x10-5. This dilation opens the bedrock's pore space and forms «pocket domains» that may store up-flowing over-pressurized fluids, which may then further chemically interact with the bedrock, for the length of time that these pockets remain open. These porous pockets can reach kilometric size, questioning their parental link with outcropping plutons along the margin. Moreover, bedrock permeability may also increase as fluid flow diminishes effective bedrock friction and cohesion. Comparison with rock experiments indicates that such stress and fluid pressure changes may eventually trigger failure at the intermediate timescale (repeated slip or repeated inflation). Finally, incorporating far field compression (iii) loads the bedrock to a state of stress at the verge of failure. Then, failure around

the magmatic reservoir or at the fault zone occurs for lower loading. Permanent tectonic loading on the one hand, far field episodic seismic inversion of the stress field on the other, and localized failure all together promote a transient stress field, thus explaining the occurrence of transient fluid pathways on seemingly independent timescales. These synthetic models are then discussed with regards to specific cases along the SVZ, particularly the Tatara-San Pedro area (~36°S), where magnetotelluric profiles document conductive volumes at different depths underneath active faults, volcanic edifices and geothermal vents. We discuss the mechanical link between these deep sources and surface structures.