The effect of axial stress in maximum sustainable fluid pressure in Andersonian and non-Andersonian crust: A field-based numerical study from the Southern Andes (39 degrees S)

By: Roquer, T (Roquer, Tomas)[1,2]; Arancibia, G (Arancibia, Gloria)[1,2]; Rowland, J (Rowland, Julie)[3]; Veloso, EA (Veloso, Eugenio A.)[1,2]; Molina, E (Molina, Eduardo)[2,4]; Crempien, JGF (Crempien, Jorge G. F.)[1,2]; Morata, D (Morata, Diego)[2,5]
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Abstract

Fracture opening at low differential stress controls maximum sustainable fluid pressure (lambda) within cohesive brittle crust. Standard Andersonian stress states occur when two conditions are met: (1) one of the principal stresses sigma(1)>=sigma(2)>=sigma(3) is vertical, and (2) failure occurs at optimal orientations so that the stress tensor shape ratio phi=(sigma(2)-sigma(3))/(sigma(1)-sigma(3)) is irrelevant. Here we explore the role of phi-values (axial compression, triaxial stress and axial tension) on sustainable fluid pressure driving rock failure under general stress states. We analyzed two exposures representing tectonics of the Southern Andes. Calculated failure curves in lambda-depth space indicate that the hydrostructural behavior of general stress states is governed by the steepest of the principal stresses and the phi-value. Generally, hydrostructural behavior falls within standard Andersonian lambda-depth conditions. However, field examples suggest that non-Andersonian axial stresses may sustain fluid pressures that depart from the standard Andersonian condition: the lowest fluid pressures occur under subvertical axial compression and subhorizontal axial tension; and the highest fluid pressures occur under subvertical axial tension and sub -horizontal axial compression. Since around 15% of global stress compilations correspond to one of these categories, it follows that a significant portion of tectonic regimes potentially define a hydrostructural infrastructure different from standard Andersonian crust.

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Author Information

Reprint Address:
Pontificia Universidad Catolica de Chile Pontificia Univ Catolica Chile, Dept Struct & Geotech Engn, 4860 Vicuna Mackenna, Santiago, Chile.
Corresponding Address: Roquer, T (corresponding author)

+ Pontificia Univ Catolica Chile, Dept Struct & Geotech Engn, 4860 Vicuna Mackenna, Santiago, Chile.

Addresses:

+ [1] Pontificia Univ Catolica Chile, Dept Struct & Geotech Engn, 4860 Vicuna Mackenna, Santiago, Chile
+ [2] Univ Chile, Andean Geothermal Ctr Excellence, 803 Plaza Ercilla, Santiago, Chile
+ [3] Univ Auckland, Sch Environm, 23 Symonds, Auckland, New Zealand
+ [4] Univ Cadiz, Dept Earth Sci, 11519 Puerto Real, Puerto Real, Spain
+ [5] Univ Chile, Dept Geol, 803 Plaza Ercilla, Santiago, Chile

E-mail Addresses:teroquer@uc.cl

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