

EGU21-14418

<https://doi.org/10.5194/egusphere-egu21-14418>

EGU General Assembly 2021

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



Thermo-mechanical Effects on Fracture Growth and Apertures in Three-Dimensional Subsurface Fractured Rocks

Adriana Paluszny, Robin N. Thomas, M. Cristina Saceanu, and Robert W. Zimmerman
Dept. Earth Science and Engineering, Imperial College, London, United Kingdom (apaluszni@imperial.ac.uk)

A finite-element based, quasi-static growth algorithm models mixed mode concurrent fracture growth in three dimensions, leading to the formation of non-planar arrays and networks. To model the fully coupled THM model, equations describing mechanical deformation as well as heat transfer in the matrix and in the fractures are introduced in the formulation, simultaneously accounting for the effect of fluid flow and stress-strain response. This results in five separate, but two-way coupled model equations: a thermoporoelastic mechanical model; two fluid flow equations, one for the rock matrix and one for the fractures; two heat transfer equations, similarly for both the matrix and fractures. Fractures are represented explicitly as discrete surfaces embedded within a volumetric domain [1]. Growth is computed as a set of vectors that modify the geometry of a fracture by accruing new fracture surfaces in response to brittle deformation. Fracture tip stress intensity factors drive fracture growth. This growth methodology is validated against analytical solutions for fractures under compression and tension [2]. Thermal effects on the apertures and growth patterns will be presented. Isolated fracture geometries are compared with selected experimental results on brittle media. Accurate growth is demonstrated for domains discretised by refined and coarse volumetric meshes. Fracture and volume-based growth rates are shown to modify fracture interaction patterns. Two-dimensional cut-plane views of fracture networks show how fractures would appear on the surface of the studied volume.

REFERENCES

[1] N. Thomas, A. Paluszny and R. W. Zimmerman. Growth of three-dimensional fractures, arrays, and networks in brittle rocks under tension and compression. *Computers and Geotechnics*, 2020. doi: 10.1016/j.compgeo.2020.103447

[2] Paluszny and R. W. Zimmerman. Numerical fracture growth modeling using smooth surface geometric deformation. *Eng. Fract. Mech.*, 108, 19-36, 2013. doi: 10.1016/j.engfracmech.2013.04.012