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The impact of coupled flow and geomechanics on fault stability: a numerical study with XFEM

Anna Scotti[1], Luca Formaggia[2], Luigi Vadacca[3] and Daqing Liu[4]

Politecnico di Milano, p.za Leonardo Da Vinci 32, 20133 Milano (Italy)
[1] anna.scotti@polimi.it, [2] luca.formaggia@polimi.it, [3] luigi.vadacca@polimi.it,
[4]daqing.liu@polimi.it

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The effect of human activities (oil production, geothermal reservoirs exploitation and waste water disposal) on the risk of seismicity is a highly debated topic. In particular the injection/production of fluid from the subsurface has been linked to an increase in the occurrence of small to moderate earthquakes. Indeed, fluid pressure can change the effective normal stress acting on preexisting fault surfaces and even lead to fault slip if the tangential-to-normal stress ratio exceeds the friction coefficient. A numerical study of this phenomenon poses some challenges. First of all the problem exhibits a two-ways coupling: fluid pressure affects stress and deformation, and conversely deformations can change the medium and fault permeability. An unconditionally stable iterative splitting between fluid and geomechanics is used to avoid the solution of a single large nonlinear system. Moreover, an initially stuck fault surface can present a slipping region that evolves in time, where different interface conditions should be prescribed. In literature Lagrange multipliers are often employed to enforce interface conditions on the fault. In this work however we use the Nitsche consistent penalization method, thus avoiding additional unknowns and changes in the number of unknowns in time. Finally, both subproblems are approximated with the eXtended Finite Element Method with suitable enrichments on the fault, regarded as a lower dimensional interface in the model. This choice allows the fault to cut the mesh elements, alleviating the problem of mesh generation in complex configurations and in the case of uncertainty on the geometry.

REFERENCES

[1] B. Jha, and R. Juanes, Coupled multiphase flow and poromechanics: A computational model of pore pressure effects on fault slip and earthquake triggering. *Water Resour.Res.*, Vol. **50**, pp.3776–3808, 2014.

[2] F. Cappa, J. Rutqvist, Modeling of coupled deformation and permeability evolution during fault reactivation induced by deep underground injection of CO2, *nternational Journal of Greenhouse Gas Control*, Vol. **5(2)**, pp. 336–346, 2011.