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Polytopal nonconforming discretization methods for multiple-network poroelasticity and thermo-poroelasticity

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Poromechanical modeling is relevant in several geoscience applications, including waste disposal, injection-production cycles in geothermal fields, and CO_2 storage. In this talk, we focus on the numerical analysis of polytopal discontinuous Galerkin (PolyDG) and Hybrid High-Order (HHO) schemes for poroelasticity problems. In particular, we address the multiple-network poroelasticity model [1] describing seepage through deformable fissured media and the quasi-static thermo-poroelasticity problem [2] modeling the interaction among heat, fluid flow, and elastic deformation. The proposed methods are designed to support polygonal and polyhedral elements. This is a key feature in geological modeling in order to handle fractures and degenerate elements arising in the case of compaction or erosion. As a starting point for the design of the numerical schemes, we adopt a weak formulation with an additional total pressure variable ensuring inf-sup stability. The resulting methods support arbitrary-order approximations on general meshes and deliver error estimates that are robust in the entire range of geophysical parameters and rest on mild regularity assumptions. A wide set of numerical results are presented to validate the error analysis and investigate the robustness of the method.

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REFERENCES

[1] M. Botti, L. Botti, and D.A. Di Pietro, *A Hybrid High-Order method for multiple-network poroelasticity.* in SEMA-SIMAI: Polyhedral Methods in Geosciences, pp. 227–258, Springer, 2021.

[2] M.K. Brun, E. Ahmed, J.M. Nordbotten and F.A. Radu *Well-posedness of the fully coupled quasi-static thermo-poroelastic equations with nonlinear convective transport.* J. Math. Anal. Appl. 471:1, pp. 239-266, 2019.