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Polytopal Discontinuos Galerkin discretization of the fully-coupled thermo-poroelastic problem

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Poroelasticity inspects the interaction among fluid flow and elastic deformations within a porous material. In several applications in the context of environmental sustainability, such as geothermal energy production and CO2 sequestration, temperature plays an important role in the description of the physical phenomena. Therefore, in order to correctly describe these geological processes, the differential problem should also take into account the influence of the temperature, leading to a fully-coupled thermo-poroelastic system of equations.

We present and analyze an arbitrary-order Discontinuous Galerkin method for the numerical modelling of the non-linear thermo-poroelastic problem based on a novel four-field weak formulation. The proposed method is designed to support general 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. To handle the non-linear convective transport term in the energy conservation equation we adopt a fixed-point linearization strategy and different linearizations are examined.

We perform a robust stability analysis for the linearized semi-discrete problem under mild requirements on the problem data. A priori hp-version error estimates in suitable energy norms are also derived. A complete set of numerical simulations is presented in order to validate the theoretical analysis, to inspect numerically the robustness properties, and to test the capability of the proposed method in a practical scenario inspired by a geothermal problem.

Participation

In-Person

References

- P..F. Antonietti, S. Bonetti, M. Botti, Discontinuous Galerkin approximation of the fully-coupled thermo-poroelastic problem, SIAM J. Sci. Comput., 2022, in press [arXiv:2205.04262]

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