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A Dual-Continuum Hydromechanical Framework for Modelling Fractured Porous Media

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A general framework for modelling hydromechanically coupled fractured porous media is implemented utilising the dual-continuum concept. Modelling fractured systems explicitly can be impractical at the field scale due to the size of the computational problem. Additionally, fracture properties are often not known unless directly accessed. The dual-continuum approach offers a practical method of gaining insight into the behaviour of fractured porous media over field scales. Previous numerical implementations of coupled dual-continuum models have all been implemented within equal-order mixed finite-element frameworks. Such frameworks are known to suffer instabilities due to failure to satisfy the Ladyshenskaya-Babuška-Brezzi (LBB) stability condition. The current framework makes use of a mimetic-type finite element method called the virtual element method for the mechanical problem, and the finite volume method for the flow problem. Similar approaches to the present have been shown to implicitly satisfy the stability condition, and to honour local mass conservation. Within reservoir engineering, coupled simulation is often done using dedicated software to model each subproblem. Coupling is then achieved by iterating between the mechanical and fluid subproblems. We make use of the iterative coupling approach and show that solving the coupled dual-continuum problem is not limited to the monolithic strategy used in previous implementations. Within the literature, there exist various approaches to formulating hydromechanically coupled dual-continuum models. These approaches can be grouped as phenomenological, thermodynamical, and microporomechanical accordingly. With our general framework we review different hydromechanically coupled dual-continuum models arising from these different methadologies.

References

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