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Two-Way Coupling in Reservoir-Geomechanical Models: Vertex-Centered Galerkin Geomechanical model Cell-Centered and Vertex-Centered Finite Volume Reservoir Models

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Procedures to couple reservoir and geomechanical models are reviewed. The focus is on immiscible compressible non-compositional reservoir – geomechanical models. Such models require the solution to: coupled stress, pressure, saturation and temperature equations. Although the couplings between saturation and temperature with stress and fluid pressure are "weak" and can be adequately captured thru staggered (fixed point) iterations, the couplings between stress and pressure equations are "strong" and require special procedures for accurate integration. As shown and discussed in detail in (Prevost, 2013), two-way coupling (i.e., simultaneous integration) of pressure and stress equations is required if poromechanical effects are to be captured accurately. In our previous work a Galerkin implementation of both pressure and stress equations was used with equal order interpolant for both pressure and solid displacements.

However, most (if not all) reservoir simulators use a finite volume implementation of the pressure equation. Therefore there remain important unanswered issues related to the interface between a Galerkin vertex-centered Geomechanical model with a Reservoir finite volume implementation of the pressure equation. We address those issues in the following by studying the interface with both a cell-centered and a vertex-centered (often referred to as CVFEM in the Petroleum Engineering literature) finite volume implementation of the pressure equation. The elemental contribution to the Jacobian matrix is computed through numerical finite differencing of the residuals. The procedure is detailed herein. In the following, in order to attempt to clear confusion, the simplest case of an isothermal fully saturated, slightly compressible system is presented in detail, and the various solution strategies, simplifications and shortcomings are identified.

REFERENCES

Prevost, J.H. (2013), "One-Way versus Two-Way Coupling in Reservoir-Geomechanical Models". in Poromechanics V: *Proceedings of the Fifth Biot Conference on Poromechanics*, Vienna, Austria, July 10-12, 2013. C. Hellmich, B. Pichler and D. Adam, Editors, American Society of Civil Engineers, 517-526