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Simulation of CO_2 sequestration in geological formations using mimetic finite difference methods

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The sequestration of carbon dioxide in geological formations is a highly complex process. At least two different phases – a CO_2-rich phase and a water-rich phase – are involved. The geometry of the formations is usually complex and can't be approximated well by structured grids. Material heterogenities complicate further the numerical simulation of the sequestration process.

The numerical methods most commonly used for multiphase flow in porous media – the cell-centered finite volume (FV) method, the vertex-centered finite volume method and the finite element (FE) method – aren't suited particularly well for the simulation of CO_2 sequestration. Cell-centered FV methods only work on structured grids. Vertex-centered FV methods perform poorly on highly heterogeneous materials. Standard FE methods aren't mass conservative.

For diffusion type problems, mimetic finite difference (MFD) methods remedy these shortcomings of the commonly used methods. MFD methods can be considered as a generalization of cell-centered finite volume methods to unstructured grids and have proven highly robust and accurate in applications. Moreover, they are suitable for even more general grids then vertex-centered FV methods.

In our work, mimetic finite difference methods are adpated to the case of multiphase flow in porous media and applied to realistic model problems of CO_2 sequestration. The numerical results are presented and compared to results obtained by other numerical methods.