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HEXAHEDRAL MIXED FINITE ELEMENTS FOR FLOW CALCULATIONS

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In reservoir simulation as well as in many other domains of application, hexahedral grids in combination with locally conservative cell-centered discretization techniques are preferred for modeling flow and transport in porous media. In particular it is easier to follow geological layers with hexahedra than with rectangular solids. In addition, hexahedral grids generally require fewer cells than tetrahedral grids. Numerical models based on mixed finite elements have many properties that make them especially appropriate for flow models: they produce an approximation to the Darcy flux as well as to the pressure and they are locally conservative. However, the classical mixed finite elements of Raviart-Thomas-Nédélec do not give satisfactory results for hexahedral grids. For this reason appropriate composite mixed finite elements have been developed. They are based on subdivisions of the hexahedron into 5 or into 24 tetrahedra.

While a priori error estimates give an indication of the rate of convergence of a method, a posteriori error estimates provide an estimation of the error committed in a particular numerical calculation. These make it possible to know which part of the domain gives rise to the largest part of the error and where further computational effort could be most effectively applied. Many methods have been suggested for calculating a posteriori estimates for mixed methods. In this talk we present a posteriori error estimates for the above hexahedral mixed finite elements. These estimates are based on work of M. Vohralik and emphasize velocity errors.

Finally given a proven a posteriori error estimator we show how to refine the hexahedral mesh locally in order to obtain a uniform distribution of the error. Numerical results will be shown for experiments relevant to flow in porous media.