An assessment of the capability of finite element solvers in simulating saltwater intrusion

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Saltwater intrusion is a naturally occurring phenomenon involving the permanent influx of saline water from the sea into the freshwater of an aquifer, and thus represents a significant threat to fresh groundwater resources. Mathematical modelling of saltwater intrusion involves two contrasting physical approaches. One approach treats saltwater and freshwater as distinct fluid entities, separated by a sharp interface. The diffuse interface approach takes into account mixing between saltwater and freshwater, leading to a zone of mixed water quality separating the two fluids.

The diffuse interface approach leads to the formulation of a system of non-linear partial differential equations that require solution. A number of finite element solvers are available for simulating saltwater intrusion; however, there is a lack of information advising one on selecting a package for a particular problem.

A critical review of three finite element solvers (SALTFLOW, PDE2D, and SUTRA) will be presented. The famous Henry, and modified Henry problems will be solved by each package, enabling an assessment of the performance for each solver to be made. Both problems have a known solution, making them a valuable benchmark for testing the worth of a numerical solver. Preliminary results suggest that the SALTFLOW solver is capable of reproducing the solution to both of these problems with a high degree of accuracy.

For each package, a range of other attributes will be assessed, such as the ease of use for the user interface, preparation of initial conditions and boundary conditions, and production of solution graphics. The production of suitable graphics following a SALTFLOW simulation requires extra work, since this package does not have inbuilt graphics capabilities.

This work will assist others in making a more judicious choice of package for simulating saltwater intrusion, by investigating the strengths and weaknesses of each package.