



Fluid mass balance inconsistency in density-dependent flow

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The flow equation expresses conservation of the mass of fluid. In groundwater variable density problems, the fluid may be viewed as consisting of two components: water and salt. The flow equation must be complemented with the transport equation, which express solute mass conservation. Most of the density-dependent flow simulation codes neglect pure salt sources when establishing the fluid mass balance. In this work, salt sources are considered in fluid balance and it is shown that the resulting flow regime and concentration distribution is dramatically affected. Two test cases are used to illustrate the role of salt sources. First, the salt water bucket problem which consists of adding salt to a close domain. It shows that neglecting salt sources in the flow equation causes heads to fall and the fluid to flow towards the source, which is erroneous. Second, the Elder problem shows that acknowledging the presence of salt sources reduces fingering but increases substantially overall salt transport. One conclusion of this work is that prescribed concentration boundaries and thermal analogies should be carefully scrutinized when used to analyze salt or brine transport.