Another 2D code for modeling of two-phase flow: A benchmark and an application in geodynamics

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It has long been recognized that the arc volcanism is directly related to the slab dehydration and water is necessary to explain the low temperature melting of the mantle wedge and possibly of the subducting oceanic crust and the composition of arc magma. To better understand the dynamics of geophysical fluid viz. water, melts in the mantle wedge related to subduction zone, we have developed a numerical model for two-phase flow which takes into account the effects of compaction of the matrix.

In this numerical model, we solve mass and momentum conservation equations of matrix and of fluid following the formulation of Bercovici et al. (2001) using potential formulation of velocities of matrix and fluid. We use several numerical schemes like Finite Difference (FD) method, Successive Over Relaxation (SOR) method to solve potential equations, Multidimensional Positive Definite Advection Transport Algorithm (MPDATA) scheme [Smolarkiewicz et al. (1998)] to solve advection equation i.e. mass conservation equation.

To benchmark our code, we have looked for a solitary wave solution and derived analytical solutions assuming a porosity dependent effective viscosity for the one-dimensional problem along with a method to compute their shapes [Richard et al. (2010)]. Implementing this solution as an initial condition allows us to test our numerical code.

Here we present a formulation of our code and also the results obtained from it.

References:

Bercovici, D., Ricard, Y., and Schubert, G. (2001). A two-phase model of compaction and damage, 1. general theory. J. Geophys. Res., 106(B5):8887-8906.

Smolarkiewicz, P. K. and Margolin, L. G. (1998). Mpdata: a finite-difference solver for geophysical flows. J. Comput. Phys., 140(2):459-480.

Richard, G., Kanjilal, S. and Schmeling, H. (2010). Solitary-wave in geophysical two-phase media : a pseudo-analytical solution, submitted to Journal of Fluid mechanics