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Mushy zones are regions of intermixed liquid and solid which most often result from instability due to the build-up of solute during the solidification of multispecies materials. In a typical experiment, a uniformly mixed solution is placed onto a cold boundary, inducing the growth of a thin solid layer, capped by an initially expanding mushy zone. Growth slows as the solution is depleted of the material forming the dendrites. Common modeling assumptions include an infinite domain and negligible solute diffusion, but restricting the domain and incorporating solute diffusion changes the transient and long-term dynamics of the system. These modified dynamics may be of geological interest. Over long time scales, the mushy zone vanishes, leaving a solid layer in equilibrium with a liquid layer consisting of a uniform solution which differs from the original solution. The transient dynamics in the case of a very cold boundary lead to variations in the amount of solute which is frozen into the solid, which may have consequences for solids such as rock layers formed during the cooling of magma. (Received August 25, 2010)