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Convective chimney formation in a mushy layer: experiments, simulations and theory[1] RICHARD KATZ, GRAE WORSTER, University of Cambridge — Laboratory experiments on directional solidification of aqueous ammonium chloride in a Hele-Shaw cell produce a convectively unstable, partially crystalline mushy layer. Within this layer, reactive flow of buoyant fluid creates chimneys of zero solid fraction. We have investigated the development of chimneys with new, time-dependent, computational simulations of directional solidification. These simulations employ the Enthalpy method coupled with Darcy's law to describe the thermodynamics and fluid mechanics of the system. A comparison between simulations and experimental results raises questions about the mode of instability that leads to chimney formation: do chimneys originate from disturbances at the mush-liquid interface and grow downwards or are they the product of an instability within the mushy layer? Is there a clear distinction between these two modes? To address this question we consider a hydrodynamic stability analysis of the system, substituting the Darcy-Brinkman equation for Darcy's law. This allows for a flexible choice of permeability functions.

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