

Magnetic Resonance Imaging of Structure and Convection in Solidifying Mushy Layers

P. Aussillous⁽¹⁾, A.J. Sederman⁽²⁾, L.F. Gladden⁽²⁾, H.E. Huppert⁽¹⁾, M.G. Worster⁽¹⁾

(1) *Institute of Theoretical Geophysics, Cambridge University, UK*

(2) *Magnetic Resonance Research Center, Cambridge University, UK*

Using a powerful Magnetic Resonance Imaging technique, we present new high-resolution images of structure and convection inside a solidifying mushy layer formed from a binary alloy. We focus especially on systems in which chimneys are observed, which represent an unwanted and financially wasteful phenomenon in industrial casting. The experimental setup consists of a sucrose-water solution in a cylindrical tank, cooled at the top at -20C, well below the liquidus temperature. Once a mushy layer has formed, we observe the appearance of chimneys inside the mushy layer and resolve their internal structures and that of the ice platelets around them. The MRI technique allows us to measure the porosity and follow its evolution as a function of time and position. It also gives a measure of the convection in the chimneys, and we correlate the measured vertical mean fluxes through chimneys with the evolution of the spatial distribution of porosity.

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