# THE MODELLING OF THE FLOW OF A BINGHAM FLUID IN A POROUS MEDIUM WITH APPLICATION TO CONVECTION IN A SIDEWALL-HEATED CAVITY

Sarah Nash, D. Andrew S. Rees*
Department of Mechanical Engineering
University of Bath, Bath BA2 7AY, UK
* Corresponding author

Tel : +44 1225 386775 Fax: +44 1225 386928 Email: D.A.S.Rees@bath.ac.uk

Keywords
Bingham fluid, unidirectional flow, phenomenological anisotropy, cavity convection

Section: Advanced mathematical approaches to the modeling of porous media.

## ABSTRACT

The aim of this paper is to model the flow of a Bingham fluid in a porous medium by considering a porous medium as being composed, in turn, of (i) identical one-dimensional channels, (ii) a random set of one-dimensional channels, and (iii) a 2D network of uniform channels. It is found that flow doesn't arise until the driving pressure gradient exceeds a threshold value, which confirms the assumptions made in the analysis of Pascal (1981). But unlike Pascal's model, the flow/pressure-gradient relationship at higher pressure gradients is not linear because of the changing location of the yield surface within each channel. The flow/pressure gradient relationship can take more exotic shapes when the porous medium is composed of channels of different diameters, and much of this paper concentrates on this aspect.

Our model is applied to two-dimensional convection in a sidewall-heated porous cavity as an example of how the flow of a yield stress fluid causes strong modifications to the induced flow. For example, the presence of a pressure gradient threshold means that there is an inherent anisotropy within what appears to be an isotropic medium for cases where the porous medium is composed of a square network of identical channels.

**H. Pascal** (1981) Nonsteady flow through porous media in the presence of a threshold gradient. *Acta Mechanica* **39,** 207-224.