Geophysical Research Abstracts
Vol. 15, EGU2013-9313, 2013
EGU General Assembly 2013

Relating dynamic contact angle to wetting front instability

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Dynamic contact angles have been implied as a mechanism for initiating the instability of wetting fronts and the formation of gravity fingers/columns in porous media. To study those dynamic contact angles when gravity effects are present, rectangular capillary tubes are used to facilitate the observation of the complete interface without geometric distortion. Results show that the dynamic contact angle minus the static contact angle has a unique relationship with the capillary number which is function of the velocity of the slug, and surface tension and viscosity of the fluid. Using this relationship and making the assumption that the fluid velocity through the pores is related but not equal to the finger velocity, earlier findings of DiCarlo on the capillary overshoot at the wetting front can be reproduced well. This study confirms that dynamic contact plays a critical role in the formation of unstable finger flow. It also points a way to calculate the capillary pressure at the wetting from as a function of the flux in the finger and the grain size diameter.