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Flow patterns and rheology of confined granular media during fluid injection

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We characterize the deformations of a dry granular medium confined inside a horizontal Hele-Shaw cell where air is injected at a constant overpressure. The overpressure is systematically varied, and we show a range of flow regimes where for example the injected fluid form channel structures similar to viscous fingers in a porous medium. By combining experimental deformation data and numerical simulations of the pore fluid pressure in the same system, we are able to analyze the rheology of the granular medium, and show that it follows a behavior similar to a yield-stress fluid. This behavior could explain the formation process of the dendritic patterns of channels empty of beads, which produces patterns in the universality class of the Dielectric Breakdown Model to the power of 2 (fractal dimensions from 1.5 to 1.6). Further, in the jammed state of the medium, we observe a stick-slip behavior where a localized region of beads suddenly rearrange and compacts, such that we have a compaction pulse moving against the pore fluid flow direction. We characterize this pulse with high speed optical imaging and acoustic measurements.

References

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