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When Air is Injected into Mobile Liquid-saturated Porous Medium

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The study of gas movement following injection into liquid saturated porous media is an active area of exploration for theoretical and practical reasons, e.g., in air-sparging, oil recovery, and bio-filter. Here, we report a set of two-dimensional laboratory visualization experiments by injecting air into a vertically placed granular medium. The medium is made of crushed fused silica glass and saturated with a glycerine-water solution for refractive-index-matching. We learn that: i) A previously unrecognized gas-flow instability was observed. The interaction of the injected air flow and the medium structure leads to mobilization of the medium and an instability, which causes the air channel to migrate. This instability is dominated by a dimensionless number , which can be interpreted as a normalization of a critical velocity with a dipole velocity for saturated conditions. The channel migration appears as a sequence of previous channels collapsing and new channels opening. ii) The channel migration comes to a stop after some time, leaving one stable preferential channel for air flow. Furthermore, the grains' packing is compacted due to a rearrangement process. The compacted process is indicated by a set of tracing experiments. iii) Due to a mobilization of the granular medium, segregation on grain size occurs depending on a critical grain size, below which the coarser grains tend to accumulate at the downstream end of the preferred air pathway, and above which the finer grains tend to accumulate there.