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Buoyancy-driven magma-dikes ascent in proximity of layer interfaces and the free surface: inversion of dynamic parameters

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Laboratory experiments on air-filled fracture ascent in solidified gelatine have evidenced that the vicinity of the free surface and of layer interfaces controls the dynamics of the process.
Some field observations have shown a comparable behaviour for magma-filled dikes beneath volcanoes, where dike movement can located by dike-induced earthquakes.
We present a simple theoretical model to explain the change in dike ascent velocity at the free surface and at layer interfaces. The theory is based on a fracture mechanical approach of buoyancy-driven cracks with constant fluid volume. The ascent velocity of the crack is controlled by the fracture toughness at the crack tip and the dynamic pressure drop within the crack resulting from viscous fluid flow.

The acceleration in the neighbourhood of the free surface and velocity changes near layer interfaces can be explained by introducing a distance-dependent effective fracture toughness.
We present an inversion approach to obtain dike and rock parameters from velocity changes. The inversion method is tested with the results of laboratory experiments in gelatine and applied to field examples.