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# Gas Segregation in Dykes and Sills

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Many basaltic volcanoes emit a substantial amount of gas over long periods of time while erupting relatively little degassed lava, implying that gas segregation must have occurred in the magmatic system. The geometry and degree of connectivity of the plumbing system of a volcano control the movement of magma in that system and could therefore provide an important control on gas segregation in basaltic magmas. We investigate gas segregation in a simple geometry consisting of a vertical conduit connected to a horizontal intrusion by means of analogue experiments. Degassing is simulated by electrolysis, producing micrometric bubbles in viscous mixtures of water and golden syrup. The presence of exsolved bubbles induces a buoyancy-driven exchange flow between the conduit and the intrusion that leads to gas segregation. Bubbles segregate from the fluid by rising and accumulating as a foam at the top of the intrusion, coupled with the accumulation of denser degassed fluid at the base of the intrusion. Steady-state influx of bubbly fluid from the conduit into the intrusion is balanced by outward flux of lighter foam and denser degassed fluid. The length and time scales of this gas segregation are controlled by the rise of bubbles in the horizontal intrusion. Comparison of the gas segregation time scales with that of the cooling and solidification of the intrusion suggests that segregation is more efficient in sills than in horizontally-propagating dikes, and that this process could be efficient in intermediate as well as basaltic magmas. Our investigation shows that non-vertical elements of the plumbing systems act as strong gas segregators. Gas segregation has also implications for the generation of gas-rich and gas-poor magmas at persistently active basaltic volcanoes. For low magma supply rates, very efficient gas segregation is expected, which induces episodic degassing activity that erupts relatively gas-poor magmas. For higher magma supply rates gas segregation is expected to be less effective, which leads to stronger explosions that erupt gas-rich as well as gas-poor magmas. These general physical principles can be applied to Stromboli volcano and are shown to be consistent with independent field data. Gas segregation at Stromboli is thought likely to occur in a shallow reservoir of sill-like geometry at 3.5 km depth with exsolved gas bubbles 0.1–1 mm in diameter. Transition between eruptions of gas-poor, high crystallinity magmas and violent explosions that erupt gas-rich, low crystallinity magmas are calculated to occur at a critical magma supply rate of 0.1–1 $m^3$ $s^{-1}$.