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How fast do crystals settle in magma chambers? Developing a quantitative understanding of magma chamber processes in the classroom using simple, low-cost experiments

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Experiments in the classroom improve learning in all areas of science teaching. Volcanic and magmatic processes are far removed from everyday experience in terms of the spatial and temporal scales involved, and so the concepts can appear abstract when first introduced. Therefore, education of students in these disciplines requires a rigorous and thorough use of dimensional analysis. Such concepts are perfectly encapsulated in classroom experiments that require scaling to natural phenomena. Here we describe one such experiment in which steel or glass objects are recorded by video or camera as they fall through viscous fluids such as honey or dish soap. These experiments are designed to represent an in-class scaled example exercise that can be conceptually linked to processes in which crystals settle through magmas in the Earth's crust, forming mush layers or layered plutons and segregating eruptible, low-crystallinity melt. We use this set-up to introduce the concepts of (1) transient and steady states, (2) development of theoretical understanding from first principles, (3) data handling and image-based data processing, (4) numerical and code-running techniques using Lattice Boltzmann simulations, and (5) comparison of the physical scales explored in the classroom with those expected to operate in nature. In doing so, we present a range of pedagogic tools that could be used in any of the full range of classroom environments associated with undergraduate or postgraduate geoscience – from mathematics- and numerics-based geophysics classes, to basic introductory classes focussed on phenomenology of magmatism on the terrestrial planets. We briefly explore the effect of such experiments on pedagogic efficiency in developing lasting deep learning.