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Slurry diapirism: an insight into the temperature, duration, and mechanism of granite transport and emplacement

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The mechanism, temperature, and timescale of granite melt transport and pluton emplacement remain controversial, with wide-ranging implications for understanding continental growth, differentiation, rheology, and deformation dynamics. In this presentation we describe a new method for determining pluton emplacement temperature and timescale using the characteristics of the surrounding metamorphic aureole, and apply it to the Skiddaw granite in northern England. The estimated emplacement timescale (0.1-2 Myr) implies magma transport velocities of 1-100 mm/yr. At the thermodynamically-calculated absent or low melt fractions relevant to our estimated emplacement temperature (570-670 ^{o}C), our numerical models show that such velocities are incompatible with pluton formation by successive injections through dykes. Instead, our results indicate the intrusion of a diapir of crystal-rich slurry, solidifying before emplacement, with a rheology governed by the solid crystals. The emplacement depth is likely to be governed by the depth-dependent rheology of the surrounding rocks, occurring close to the brittle-ductile transition. The wider implications of our results relate to (1) an explanation of the difficulty of seismically imaging active plutonium, and (2) the appreciation that much of the chemical and textural characteristics of plutons may relate to pre-emplacement crystallisation at depth, passively transported to higher crustal levels.