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The rate control of porosity and permeability on melt transport through the crust and mantle

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Batholith or pluton emplacement in the crust has been extensively studied and different general models for the ascent and emplacement of magma have been introduced. Magma ascent is generally considered to begin at some kind of source region (partial melt, deep seated magma chamber etc.) from which magma rises through the crust (e.g. via dykes) to form plutons or batholiths. At the site of emplacement, the addition of considerable amount of material (in the form of melt/crystal mush) produces various structures in the surrounding host rocks that are frequently used to determine the model of emplacement and, to some extend, also the process of magma ascent. However, processes in the magma chamber, the ascent and finally the emplacement of magma/crystal mush have mostly been analyzed as independent processes which they are clearly not. The transport of melt through a porous medium such as rocks is the key to understand the movement of melts through the crust towards their final site of emplacement. This is obvious in case of melt percolating through a rock but it is also the key if melt is supposed to flow through dykes. In this case the influx of melt into one or more dykes is controlled by the porosity and permeability within the source region. Furthermore, if a certain volume of melt has accumulated (e.g. in a melt pocket) and reaches a critical threshold (depending on the density difference under static conditions) it will start to ascent. In case of several melt pockets ascending at the same time they might merge on their way upwards. This process can only work as long as there is enough melt in the source region, if the source region is depleted (or the permeability is to low) no melt can leave the source region until it is replenished (therewith changing the porosity which directly influences the permeability). This gives rise to successive pulses of magma leaving the source region.