Fluid migration and fluid-rock interaction during metamorphism

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A crucial aspect for the generation of ore deposits is an effective mass transfer through solid rocks in the deeper Earth. Element transport is most effective in a liquid phase along pathways that enable mass transfer through a solid material. Thus, quantification of fluid-mediated element transport requires knowledge about the formation of permeability, constraints on the amount of percolating fluids as well as on the extent of fluid-rock interaction. In this contribution we give an overview about the theoretical considerations of fluid migration in metamorphic rocks, show natural examples of permeability development during metamorphism and present an approach to quantify fluid-rock interaction utilising combined thermodynamic-geochemical models. Transient fluid pathways generated by metamorphic phase transitions can be used as conduits for fluid migration. On the other hand, creep mechanisms lead to plastic rock deformation, which in turn leads to compaction and closure of this transient permeability. We show natural examples of syn-metamorphic interconnected porosity associated with different types of mineral reactions that is preserved in metasomatic high pressure-low temperature rocks. Utilising focused ion beam techniques and transmission electron microscopy this porosity can be visualized and processes during fluid-rock interaction can thus be studied in situ down to sub-micron scale. A combination of thermodynamic and geochemical forward models are then used to quantify the effect of fluid-rock interaction and the amount of percolating fluids through the pore network.