Porosity development during reactive fluid flow through Carrara marble

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Understanding how fluids move through and alter low permeability rocks is crucial for understanding many geological processes. In natural rocks, fluids can infiltrate through grain boundaries and/or pre-existing fractures, playing an important role on the rate at which chemical alteration occurs. Permeability can also be generated by the chemical alteration itself. This is the case of coupled dissolution-precipitation reactions, characterized by the generation of porosity that confers increased permeability to the rock/mineral.

The porosity generation is dependent on two main factors: the molar volume changes between the parent and the product minerals, and their relative solubilities. Thus, the rate at which replacement reactions occur will depend on: the rate of dissolution, the rate of precipitation, and the characteristics of the new porosity (such as size and interconnectivity).

These replacement reactions can occur both when molar volume increases or decreases are involved, and in both cases the development of reaction induced fracturing can also play an important role.

The replacement of Carrara marble by calcium phosphates ($\Delta V \sim$ -14%) and by fluorite ($\Delta V \sim$ -34%) were used as model systems to explore replacement rates, porosity generation, and fluid preferred pathways at different fluid compositions.

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