Investigation of porosity and permeability effects from microstructure changes during limestone dissolution

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Abstract. We studied experimentally the dissolution of a porous limestone core during CO_2-enriched water injection. We measured the changes in porosity and permeability arising from modifications of the pore network geometry and the fluid-rock interface. A methodology based on periodic X-ray microtomography imaging was implemented to record the evolution of the time- and scale-dependent microstructures with a spatial resolution of 4.91 μm. Two processes were successively involved in the rapid permeability increase of the sample, as documented from microscale to core-scale measurements. First, the microcrystalline phase was partially dissolved, associated with displacement of mineral particles. During this process, the exponent n of the power law $k \sim \phi^n$ decreased continuously. Secondly the sparitic phase dissolved, accompanied by a decrease of the pore wall roughness and an increase of the pore connectivity. This second period was characterized by a constant value of n. The reactive surface decreased noticeably during the transition from the microcrystalline to the sparitic dissolution periods, whereas the effective porosity increased strongly.