Time-resolved 3D characterisation of flow and dissolution patterns in a single rough-walled fracture

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Abstract. Application of X-ray microtomography (XCMT) for 3D measurement of fracture geometry is presented. The study demonstrates the ability of XCMT to non-invasively measure periodically fracture walls and aperture in course of a reactive flow experiment. The method allows local and global scale estimation of the kinetic rate of dissolution in a fractured limestone sample percolated by acidic water. Then, the fracture walls are then used as input for flow modelling, in order to compare hydraulic aperture calculated by numerical simulation with different evaluations of the aperture: hydraulic aperture measured from pressure drop during the flow experiment, mechanical aperture measured with XCMT, and chemical aperture deduced from calcium removal in the sample. The effects of reactive transport on geometry and fluid flow are discussed. Dissolution appears heterogeneous both at small scale due to presence of insoluble clays in the rock, and at large scale with the formation of preferential flow pathways. These heterogeneous dissolution patterns are not simply predictable by the identification of the areas of higher fluid velocity, where transport of the chemical reaction products (i.e. rate of aperture increase) is presumed to be higher.