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Laboratory studies of long term bulk rheology on original (non-treated) and thermally treated samples

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Deformation of rocks significantly affects fluid flow processes in the Earth and is responsible for generation of many interesting geological structures such as volcanoes, kimberlite pipes, dykes, veins, sand injections, etc. It was previously suggested that creep of the rock plays an essential role in formation of such structures. The bulk viscosity of the rock is an important parameter that affects porous fluid flow and created deformation pattern. However, determination of this parameter is a time consuming and labor-intensive process and thus is rarely reported. Time-dependent creep deformation should be measured particularly carefully under different loading scenarios. Series of multistage creep experiments under the triaxial compression conditions were conducted using the multifunctional system MTS 815.04. This system enables loading of rocks and sedimentary deposits in pseudo-triaxial conditions. Two kinds of samples were studied: original (non-treated) dry synthetic samples and samples, which were preliminary decompacted by pre-loading of the samples and/or cyclic freezing/heating of the samples. This was done to create microcracks imitating natural procesess of glaciation/deglaciation. The load was applied in several stages leaving the sample to either creep at constant load or relax stresses under fixed displacement for 6 to 13 hours. Changes in stress and strain with time were recorded. During the experiment, elastic and strength properties of the samples were measured together with changes in porosity and permeability. Creep strain rates and bulk viscosity were calculated. Experimental results show significant creep in both treated and non-treated samples on a laboratory time scale. Bulk viscosity shows nonlinear dependence on mean stress and has values between 1014 Pa·s and 1016 Pa·s. Samples have gone through several stages of homogeneous deformation in a dilating regime before failure by shear banding or fracturing.