# A full Stokes-flow thermo-mechanical ice flow model applied to crater glacier simulations

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Glaciers which develop in volcano craters are characterised by a large aspect ratio and special thermodynamic conditions at the bedrock caused by a locally enhanced geothermal heat flux. Those characteristics demand certain requirements on numerical modeling of such ice bodies.

Therefore, the Finite Element package Elmer has been adopted in order to solve the full Stokes-flow problem for ice flow (Elmer/ICE). The non-Newtonian rheology is described by a power law with stress exponent $n = 3$ (Glen's flow law). In addition, a method for the correct numerical implementation of the limitation of the homologous temperature, $T' \leq 0^\circ\mathrm{C}$, in the energy balance in the form of an Uzawa algorithm has been developed. Thermo-mechanical coupling is introduced by a rate factor in the form of a conventional Arrhenius law in Glen's flow law.

The model is applied to the Gorshkov crater glacier at Ushkovsky volcano, Kamchatka; the only crater glacier for which the bedrock topography has been determined so far. Attempts to inversely determine the order of magnitude for the unknown geothermal heat flux at its bedrock such that the modelled temperatures match measured borehole temperatures will be discussed.