Geophysical Research Abstracts, Vol. 7, 03224, 2005 SRef-ID: 1607-7962/gra/EGU05-A-03224 © European Geosciences Union 2005



Paleoclimate on the Kola Peninsula (Russia) from inversion of subsurface temperatures

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Using an extensive data set of temperature logs and thermal properties from the Kola super-deep borehole and 20 shallow boreholes (up to 1.6 km) from its immediate vicinity, we present results from inversions for ground surface temperature histories. We apply a versatile 1-D inversion technique based on a finite-difference approach in order to take into account the heterogeneity of thermal properties and their nonlinear dependence on temperature including freezing and thawing. Regularization of this generally ill-posed problem is achieved by Tikhonov regularization of variable order. The scheme is easily generalized for use with multiple boreholes.

Although synthetic forward calculations show that the occurrence of permafrost may have a significant influence on subsurface temperatures in high-porosity areas, its influence can be neglected in Kola area due to the low porosity of the crystalline bedrock (< 1 %). We could determine GST histories back to 100 kY BP. The temperature change from the last glaciation period to the Holocene is smaller (5-6 K) than in lower latitudes, suggesting the existence of an insulating ice cover for a considerable time.

The excellent database with respect to thermal conductivity (more than 3400 measurements) allows to complement the inversions by three dimensional forward modeling presented in an accompanying paper (Mottaghy and Rath, this meeting).