# Reconstruction of the ground surface temperature history from borehole temperature profiles in the Kamchatka Peninsula

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Temporal variation of the ground surface temperature (GST) affects the underground temperature distribution by thermal diffusion. The temperature versus depth profiles measured in boreholes should therefore contain information on the GST variation in the past and can be used for reconstruction of the GST history (or paleoclimate) for the last several hundred years. Studies on past climate changes by this geothermal method have been extensively conducted in North America and Europe, but only a few works have been made in East Asia.

We have conducted a three-year international (Japanese/Czech/Russian) cooperative research project 'Reconstruction of the climatic change from borehole temperature profiles and tree rings in the Kamchatka Peninsula' in 2000 to 2002. As part of this project, we made precise temperature loggings down to 400 m below the surface in 12 boreholes in Central Kamchatka (between 52 and 54 degN). Water samples were collected from these boreholes and chemical and isotope analyses were made for investigation of the groundwater flow system, which may affect the subsurface temperature structure. Paleoclimate reconstruction studies based on tree-ring data were also conducted in order to complement results from borehole temperature analyses. Tree-ring sampling was made mainly in Kronotsky area to the north of the boreholes (around 55degN), though some samples were taken in the vicinities of the boreholes as well.

Temperature measurements were made repeatedly in most of the holes (up to six logs per hole) to test the stability of the temperature profiles. We found the temperatures in two boreholes were not very stable probably due to water convection in the holes and the temperature profiles in some other holes are strongly affected by groundwater flows. In the remaining six holes, the temperature profiles were stable and mostly conductive. They agree well with older temperature profiles measured in the early 1980s for heat flow determinations. The latter data are of poorer quality (accuracy of about 0.1 K) but provide valuable information of the subsurface temperature conditions about 20 years ago. Reconstruction of the past GST variation was made through inversion analyses of the temperature profiles measured in these six holes. The obtained GST histories show a general warming of about 1 to 1.5 K since the beginning of the 20th century. The warming rate has increased in the last three to four decades up to 0.02 K/year. It is not clear whether there was a minimum of the GST before the warming in the 20th century. The reconstructed GST histories are consistent with the surface air temperature data in Petropavlovsk-Kamchatsky since 1890. For paleoclimate reconstruction, we need to convert the GST into the air temperature, which will be made using air and soil temperature data at meteorological stations located in the study area for the last several ten years.