Geotemperature distributions due to surface temperature variations and groundwater flow in a stratum with a convection boundary

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The temperature in a stratum (geotemperature) has been extensively considered as a tracer to estimate the groundwater flow in aquifers. Previous studies commonly assume the stratum with a semi-infinite thickness to simplify the mathematical models for the geothermal problems. However, it is expected that the simplified models are unable to depict the heat flow in a finite-thickness stratum induced by the effects of a medium at the subsurface boundary of the stratum (boundary effects). This study develops a heat transfer model for describing the spatiotemporal distributions of the geotemperature in a stratum of a finite thickness. The geotemperature distributions are governed by a heat conduction-advection equation subject to a convection boundary condition at the bottom of the stratum. The surface temperature is set to change with time. The solution to the present model is derived by the application of the Laplace transform. The results predicted by the present solution show that the effects of the convection boundary on the geotemperature enhances when the stratum thickness decreases. The effects are dominated by a parameter called the heat transfer coefficient of the medium. Additionally, the Darcy groundwater flux significantly influences the geotemperature.

Keywords: convection boundary condition, geotemperature, groundwater, heat transfer

