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Lithosphere temperature model and resource assessment for deep geothermal exploration in Hungary

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The demand for deep geothermal energy has increased considerably over the past years. To reveal potential areas for geothermal exploration, it is crucial to have an insight into the subsurface temperature distribution. Hungary is one of the most suitable countries in Europe for geothermal development, as a result of Early and Middle Miocene extension and subsequent thinning of the lithosphere.
Hereby we present the results of a new thermal model of Hungary extending from the surface down to the lithosphere-astenosphere boundary (LAB). Subsurface temperatures were calculated through a regular 3D grid with a horizontal resolution of 2.5 km, a vertical resolution of 200 m for the uppermost 7 km, and 3 km down to the depth of the LAB The model solves the heat equation in steady-state, assuming conduction as the main heat transfer mechanism. At the base, it adopts a constant basal temperature or heat flow condition. For the calibration of the model, more than 5000 temperature measurements were collected from the Geothermal Database of Hungary. The model is built up by five sedimentary layers, upper crust, lower crust, and lithospheric mantle, where each layer has its own thermal properties. The prior thermal properties and basal condition of the model is updated through the ensemble smoother with multiple data assimilation technique.
The conductive model shows misfits with the observed temperatures, which cannot be explained by neglected transient effects related to lithosphere extension. These anomalies are explained mostly by groundwater flow in Mesozoic carbonates and other porous sedimentary rocks. To account for the effect of heat convection, we use a pseudo-conductive approach by adjusting the thermal conductivity of the layers where fluid flow may occur.
After constructing the subsurface temperature model of Hungary, the resource base for EGS (Enhanced Geothermal Systems) is quantified. To this end, we applied a cash-flow model to translate the geological potential into economical potential for different scenarios in Hungary. The calculations were made for each grid cell of the model. Results of the temperature modeling together with the economical resource assessment provide an indication on the potential sites for future EGS in Hungary.