S34A-02 - Geophysical and Thermal Modelling for Geothermal Exploration in the Northeast Pannonian Basin (Romania)

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Abstract

We developed a 3D lithospheric geophysical and temperature model to investigate the geothermal potential of the Baia Mare region, northern Romania. This model incorporates available geological, hydrogeological and geophysical data in the region.

The study area is located within the Neogene Inner Carpathian volcanic arc and includes the area of the recent tectonic uplift in the north-eastern part of the Pannonian Basin. Borehole temperature measurements showed a geothermal gradient of 45-55oC km-1 and temperatures more than 150oC at the depth of 3000 m, which are the highest values recorded to date in Romania. The young sub-volcanic intrusions, surface hot springs and epithermal volcanic ore deposits collocated along the Bogdan-Dragos Voda fault systems are supporting evidence of a potential geothermal system.

The constructed 3D model includes sediments, magmatic intrusions, crystalline crust and mantle layers. The lithosphere-asthenosphere boundary was constrained by seismic tomography and gravity modelling. The magnetic anomalies indicate deep crustal high magnetic susceptibility geological structures underlying the late Miocene volcanoes, which correlate with high present-day heat flow. The residual magnetic anomalies were inverted for distribution of magnetic susceptibility using a 3-D magnetic inversion method. The subsurface susceptibility structure was related to the shape of magmatic intrusions, which thereafter, were included into the 3D model.

We model the thermal state of the lithosphere by solving a 3-D heat diffusion-advection equation using a finite element method. The predicted heat flow reflects the thickness of the mantle lithosphere with a higher heat flow within the uplifted area of the northern Pannonian Basin of 70-80 mW m-2 to lower values of 40-50 mW m-2 within the northeast Carpathian Mountains. In the observed data, this trend is disrupted by a high-temperature anomaly within the inner Carpathian volcanic arc. Our model explains the temperature anomaly by a combination of transient heat transfer due to large intrusive bodies and heat advection with groundwater flow controlled by surface topography, permeability of faults and lithological changes.