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Quantification of palaeoclimatic effects on heat flow in the Paris basin

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Deep geothermal resources of the Paris basin have been harnessed for more than 40 years with nearly 40 operating plants supplying heat to district networks in the Parisian suburbs. The target of all these operations is the deep “Dogger” aquifer. Though these areas are densely exploited, no thermal breakthrough has been observed yet, except for a few isolated cases. As new geothermal projects are currently scheduled, heat transfers and thermal anomalies are now quantified considering the whole sedimentary pile. At this scale, thermal profiles are particularly relevant to discriminate different possible causes for the observed temperature and heat flow anomalies.

Based on 10 thermal profiles in the centre of the Paris basin, a mean heat flow profile is reassessed. For each geological formation, a mean thermal gradient is estimated and heat flow is calculated with an averaged formation thermal conductivity. A simple 1D conductive numerical model is then set up with 19 sedimentary layers and a bedrock layer. Palaeoclimatic effects are quantified by testing different published temperature scenarios. These scenarios cover time scales ranging from 65 ky to 5 My.

Although the uncertainty on heat flow derived from thermal profiles is around +/- 15 mW/m2, the model reproduces satisfactorily the main heat flow anomaly present in the upper part of the basin, with heat flow decreasing from 85 mW/m2 at 1200 m depth to less than 60 mW/m2 at the surface. Consequently, climatic variations over a long period of time (5 My scenario) seem enough to reproduce this anomaly correctly, which was previously attributed to convective effects. Yet, smaller scale heat flow fluctuations match aquifer levels exactly and are probably related to (relatively) short time convective water transfers at the basin scale.