Geophysical Research Abstracts
Vol. 12, EGU2010-14350, 2010
EGU General Assembly 2010

New Data and Processes Controlling Subsurface Temperatures in the Roer Valley Graben, Southern Netherlands, the Northwestern Branch of the European Cenozoic Rift System

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Knowledge of the thermal state of sedimentary basins is often limited by the lack of quality subsurface temperature data and uncertainty of processes (crustal and local scale) controlling those temperatures. A new data set is presented of temperatures taken between 0.5 km and 4.0 km depth from the Roer Valley Graben, the northwestern branch of the European Cenozoic rift system. The temperature data was compared to model studies of crustal thinning, sedimentary blanketing, basin scale groundwater flow and the effects of Pleistocene surface temperature changes.

On a regional scale, the results did not support a large contrast in temperatures between the rift basin and the structural highs. The lack of variation in temperatures suggests a passive rifting mode and no mantle upwelling which contrasts with other rift basins in the European Cenozoic Rift System. In addition, model simulations indicate that the effect of sedimentary blanketing is low due to the more than 6 km depth to the basement on both the rift basin and the adjacent structural highs.

Model simulations suggest that both Pleistocene surface temperature changes and basin scale groundwater flow could have a large effect on the temperature distribution in sedimentary basins. Pleistocene surface temperature changes strongly affect subsurface temperatures in the upper 1000 m. Two-dimensional numerical models of fluid flow suggest that a basin scale groundwater flow system established following the northward tilting of the basin during the Quaternary has a net cooling effect. This can account for the relatively low temperatures in the southern part of the basin. A number of localized positive (> +10-20 °C) anomalies at 1000 m to 1500 m depth are the result of local convection of groundwater along the basin's bounding normal faults.