Advanced Tectonic Heat Flow Modelling in Kuwait, Implication for Temperature and Petroleum System Modelling

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Abstract

Heat flow is an important input for basin and petroleum system modelling as it controls the temperature distribution and therefore the maturity and hydrocarbon generation in the basin. Heat flow are often calculated either from temperature gradients as measured in wells or modelled from simplified crustal models. These are assumed to be valid for the whole basin area and through the history of the basin. However, applying such a “flat” heat flow over the whole basin and through geological times can results in errors during modelling of the petroleum systems. This is because heat flow can vary significantly spatially and temporally and thus impact the modelled maturity history in the basin. Heat flow is mainly controlled by the structure and composition of the lithosphere and crust as well as the tectonic history of the basin. Reconstruction of heat flow and its variations in time and space requires a good understanding of the crustal structure and tectonic history. Tectonic heat flow modelling approach was applied to model heat flow in Kuwait. The input of the model for Kuwait consists of the complete 3D geological model as well as a model of the crust and the lithosphere (thicknesses and properties). We used an improved crustal model derived from regional and global gravity data as well as regional thermal analysis. A novel approach was used to reconstruct the deformation the crust through geological times. The tectonic heat flow model shows that, despite regional variations, relatively low heat flow values are dominant at present-day (average 41 mW/m^2). The heat flow, however, varied in time and reached higher values in previous geological times. The formation of the foreland basin after the Zagros orogeny event resulted in the rapid tectonic subsidence and an associated reduction of heat flow in the basin. Heat flow maps derived generated from tectonic heat flow modelling at 30 different geological time windows were included in a regional basin model for petroleum system analysis. The temperature models were calibrated to a maturity and temperature data collected from many wells covering the area of Kuwait. The temperature data were derived from different sources (example DST, BHT). The data was analyzed and corrected before using it for model calibration. The heat flow and temperature models showed good fit with the measured temperature and maturity data. It led to a better understanding of the evolution of the petroleum systems in Kuwait.