Geothermal Assessment of the Northeastern Gulf of Gabes Based on New Borehole Temperature and Thermal Conductivity Corrections: Petroleum Generation Fallout

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Abstract

Thermal modeling in sedimentary basins uses concepts and techniques allowing thermal reconstruction of the contained sediments, which is the basis of a suitable assessment of source rocks activeness in a given area. To obtain a sophisticated insight into the thermal evolution, it is necessary to: (i) investigate the internal thermal properties of the basin; and (ii) assess the external thermal influences of the geodynamic progression of the area. Internal thermal parameters are mainly (a) borehole temperatures which are of mostly of three types (BHT, DST, MDT); and (b) thermal conductivity introducing the ability of a rock to transmit heat from one sedimentary level to another. Basin formation temperatures are a must in oil and gas exploration because temperature controls the rates of chemical reactions in rocks such as kerogen transformation. Data on rock thermal conductivity are important for the quantification of subsurface temperatures regimes and for the determination of heat flow. However, in Tunisia, no previous study has scrutinized thermal conductivity behavior, but all previous studies were established based on temperature corrections only using methods that are specific to other basins not to Tunisian basins. In addition, an update of the geothermal gradient and heat flow maps for offshore Tunisia is long overdue. So, this paper comes to present a new thermal study of the eastern part of the Gulf of Gabes. This area is considered as one of the most promising regions in Tunisia. It was selected given the availability of oil and gas wells and subsequently temperature data. For that, 1146 temperatures values, including 1099 BHT, 19 DST and 28 MDT, were collected from 84 offshore boreholes. The obtained equation generates new corrected temperatures close to the true formation temperature. The first step towards interpreting the thermal conductivity of a sedimentary sequence was its lithological subdivision with a high-resolution appraisal of 5m margin sometimes of 2,5 m margin. The second step requires the choice of the mixing model that best describes the geometry of each layer. Geometric mean was applied to wells where cuttings data are available only. Particular conductivities are obtained for each layer. Then, the effective conductivity of layered sequence between two depth (d) is the harmonic mean conductivity λm of particular conductivities. Thermal conductivity corrections was based on the relationships between conductivity and porosity. After heat flow calculation with the Fourier law, three different scenarios were tested, using the BasinMod software in order to assess the impact of these corrections on source rock maturation. Results show that the combination of both corrected temperature and conductivity provides higher source rock maturation than when uncorrected data are used. Consequently, amounts of generated hydrocarbons show notable increase.