Influence of Surface Temperatures on Source Rock Maturity

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In September 2004, the first-ever drilling of the Lomonosov Ridge (Arctic Coring Expedition, ACEX, or IODP Expedition 302) recovered unprecedented sedimentary records of the central Arctic Ocean spanning the past ~56 Million years (Moran et al., 2006). With paleontological and geochemical techniques it has been possible to document the environmental setting and paleoclimatic evolution of the Arctic which turned out very different from that expected prior to the drilling operation. In order to study the effect of surface temperatures on the maturity of a source rock, a synthetic well in the northern part of the West Siberian Basin was created and modeled with 5 different surface temperature curves from different sources.

With a newly developed technique, independent absolute paleo-temperature data can be obtained from the relative distribution of specific lipids (branched Glycerol Di-alkyl Glycerol Tetraether, or GDGTs) from unicellular organisms (Crenarcheota) contained in the strata (see e.g. Sluijs et al., 2009). The relative composition GDGTs has been calibrated to modern reference values for reconstruction of absolute past temperatures. The new surface temperature curve was used as an input for tectonic heat flow and maturity modeling (Van Wees et al., 2009) and compared to 2 variations of existing surface temperature curves from basin modeling software.

A comparison of the results from the surface temperature curves shows that the Cenozoic surface temperature has a big effect on the source rock maturity. A detailed study of paleo surface temperatures can have a huge impact on the estimated source rock maturity and on the estimated timing of generation. Especially in frontier areas where the quality of a source rock is not yet known it is therefore crucial to get a good understanding of the paleo surface temperature evolution. But also in well developed basins an analysis of the paleo surface temperatures can lead to a reevaluation of regions previously deemed unprospective.

Moran et al. [2006] The Cenozoic palaeoenvironment of the Arctic Ocean. Nature, 441, 602-605

Sluijs et al. [2009] Warm and wet Cenozoic Arctic temperatures during Eocene Thermal Maximum 2. Nature Geoscience, 2, 777-780.

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