Molecular evidence of the depositional environment evolution during the Oligocene and Miocene in the early Paratethys and its manifestations in the related petroleum systems

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The closure of the Tethyan Ocean in Oligocene associated with the convergence of the African and Arabian plates with Eurasia gave birth to Paratethys. This remnant ocean occurred from Central Europe to the Caspian region in Oligocene to Miocene. Prolific oil and gas source rocks were deposited in this basin known as Fischschiefer in Austria, Menilite formation in the Carpathians, Maikop Series in the Caucasian realm and South Caspian Basin. Detailed analysis of the continuously cored boreholes in the West Carpathians provided characteristics of the bulk geochemistry and molecular patterns of the rock extracts in the sedimentary strata. Correlation study was made with the eastern Paratethys in the South Caspian Basin. The objective was to trace geochemical signatures evidencing the local or global environmental and climatic changes resulting in variations in bioproductivity.

Well logs and analysis of mineral and organic carbon, biomarkers and other proxy parameters complement detailed sedimentological and paleontological observations. Several depositional phases are distinguished within these strata poor in macrofossils. Eocene variegated shales were deposited in a partly oxygenated open marine environment and have a very low hydrogen index (HI) and generative potential. The following isolation of the northern Tethys is marked by deposition of calcareous clays and marls with total organic carbon of 1-2% and rather low HI. The sea level drop and tectonic separation of the Paratethys from the rest of the Tethys resulted in deposition of black marl with TOC as high as 6% and HI of 300-400 mg/g. The environment became restricted in oxygen during the late Oligocene with stratified water column, brackish at the sea level and highly saline and anoxic at the sea bottom. The number of species decreased significantly and the diatoms became the dominant group. The biomarkers such as highly branched isoprenoids (HBI) are sensitive indicators of this silica rich and carbonate poor member. Similar biomarker pattern was found in Maikop formation in the South Caspian basin and in genetically related oils in the entire Paratethys basin.

The chert-rich beds are covered by a marly member with HI over 500 mg/g and TOC of 5-6% followed by Late Oligocene/Miocene low-carbonate shale with low HI and Low generative potential thicker turbidites with alternating organic-rich and -poor strata. Recent investigation of the shale gas potential suggests that the Menilite formation is associated with geochemically specific gas accumulations.