

## **GEOCHEMICAL CHARACTERIZATION OF THE UPPER JURASSIC CHIA-GARA FORMATION, A PROLIFIC SOURCE ROCK IN KURDISTAN**

Ibrahim M.J. MOHYALDIN<sup>1</sup>, Fawzi M. AL-BEYATI<sup>1</sup>, Volker THIEL<sup>2</sup>  
and Lorenz SCHWARK<sup>3</sup>

*1. Department of Geology, College of Science, University of Sulaimani, Kurdistan*

*2. Universität Göttingen, Geowissenschaftliches Zentrum, 37077 Göttingen*

*3. Geological Institute, University of Cologne, 50674 Cologne, Germany*

The Mesozoic Petroleum System in Kurdistan is fuelled by two major potential source rocks the Tithonian-Berriasian Chia Gara and the Valanginian-Campanian Balambo Formations (Sadooni, 2004). From four wells (Hr-1, K-109, Tk-1, Bj1) in north-western Iraq we have investigated 50 sediment samples for bulk and 20 samples for molecular geochemical characteristics, accompanied by 5 oil samples. Bulk geochemical data involve C/N/S-elemental data, Rock Eval and  $\delta^{13}\text{C}_{\text{org}}$  analyses. Following extraction and MPLC fractionation, the aliphatic and aromatic hydrocarbon fractions were investigated by GC-FID and GC/MS. The intervals of the Chia Gara formation studied occurred at a present day burial depth of Hr-1: 3075-3310m, K-109: 2780-3090, Tk-1: 2770-2890, Bj-1: 2150-2310 m.

The TOC content of the formation for all wells varied between 0.70 % and 7.50%, whereby the highest concentrations of 7.0 to 7.5% were encountered at the base of the Chia Gara Fm. The average TOC content of the Chia Gara Formation in individual wells was determined to 3.20% for wells Tk-1 and Bj-1 and 1.85 % TOC for wells Hr-1 and K-109, where the Chia Gara Formation shows a higher burial depth. Sulphur content in the Chia Gara Fm. is notably high, with averaged TOC/S-ratios around 0.9 for wells Tk-1, Bj-1, and K-109 but normal TOC/S-ratios of around 2.50 encountered in well Hr-1.

The HI values of samples from the Chia Gara Fm. averaged per well vary between 390 and 410 (mgHC/gTOC) for wells Tk-1 and Bj-1, and 210 and 90 (mgHC/gTOC) for wells Hr-1 and K-109, respectively. The OI values of the samples vary between 20 and 50 (mgCO<sub>2</sub>/gTOC) for wells Tk-1, Bj-1, and K-109. Slightly higher OI-values are only encountered in samples from the Hr-1 well, varying between 40 and 90 but averaging at 70 (mgCO<sub>2</sub>/gTOC). This site was also characterized by sediments yielding normal TOC/S-ratios. The carbon isotope values of organic matter in total vary between -26.9 to 30.4‰, with lighter carbon dominating in samples from well Tk-1 (average -29.1‰) and heavier carbon isotopes occurring in samples from well (average -27.9‰). In general lighter carbon isotopes correlate with higher HI-values and higher quality of organic matter. The kerogen based on bulk geochemical data is determined as marine type II with some S-enrichment.

Oil generation and expulsion is likely to have occurred in the Chia Gara Fm. at wells well K-109 with PI-values of on average 0.27. Samples from well Tk-1 yield average PI-values of 0.12 and thus represent the onset of oil generation, whereas sediments from the Chia Gara Fm. in wells Bj-1 and Hr-1 with averaged PI-values of 0.06 have not yet reached the oil window. The  $T_{\max}$  values of the sediments on average comprise 443 and 438°C for wells K-109 and Tk-1, respectively, which is in agreement with a maturity within the oil window. Samples from low maturity Chia Gara sediments in wells Bj-1 and Hr-1 only reach  $T_{\max}$  values of 431 and 433°C, insufficient for effective oil generation and expulsion.

Molecular geochemical data for the sediment from the Chia Gara formation support an origin from marine organic matter with some minor admixture of terrigenous material. The envelopes of n-alkane distributions are unimodal with short-chain compounds in the range of  $nC_{13}$  to  $nC_{17}$  predominant but also a presence of n-alkanes in the range of  $nC_{30}$  to  $nC_{40}$  pointing to some contribution by higher plant waxes. Pristane/phytane ratios of <1.0 indicate reducing conditions during sedimentation. This is supported by often high concentrations of squalane and hopanoid biomarkers at sites with sediments of low maturity (all except K-109). A striking feature is the presence of abundant thioaromatics in sediment extracts from all wells, pointing to a sulphur-enriched but iron-depleted carbonate-evaporitic environment of deposition. Dibenzothiophenes and alkylated analogues dominate over phenanthrenes and alkylated analogues. Naphthobenzothiophenes are very prominent in the aromatic fraction and are accompanied by abundant alkylated analogues ( $C_1$ - $C_6$ ). The biomarker and geomarker composition of the oils analyzed allows for a positive oil-source rock correlation due to the presence of extended n-alkanes ( $nC_{30}$  to  $nC_{40}$ ) and squalane, low ratios of phenanthrenes vs. dibenzothiophenes, and occurrence of alkylated naphthobenzothiophenes in the oils.

The distribution of the thioaromatics and aromatics and aliphatic biomarkers of the Chia Gara formation will be discussed with respect to facies, maturation and oil-source correlation.

## REFERENCES

- Sadooni, F.N., 2004: Stratigraphy, depositional setting and reservoir characteristics of Turonian-Campanian carbonates in central Iraq. *Journal of Petroleum Geology* 27, 357-371