Special features of secondary migration of hydrocarbons of the southern part of the Caspian depression based on geochemical analysis of oils

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A special feature of the Caspian depression is the large stratum of the sedimentary basin and, accordingly, its early age of source rock(s) (SR). The likelihood of finding new HC prospects in this region, despite good knowledge, remains high in both subsalt and post-salt complexes. In this paper, complex geochemical analysis (mass spectrometry analysis on GCMS-SIM, GCMSMS-MRM, gas chromatography on HRGC, isotope analysis of carbon on GC-IR-MS) of roughly 700 crude oil samples obtained from 45 different oil-fields and structures of Southern Caspian depression, was carried out in the laboratory of geochemical studies of oil, water and rocks of subsidiary of LLP "SRI" KMG "Caspimunaigas" in 2016-2018 to characterize the possible source rocks of oil samples and discern their genetic relationship. Biomarkers in oils allowed determining the organic matter type (OM), bio-organisms that served as source of OM and environmental conditions that prevailed at the time of sedimentation, possible age of source rock and also thermal maturity. According to the research results, all oils were derived from marine OM, as indicated by the presence of C30-sterane, the sterane and hopane ternaries, the distribution of n-alkanes and isoprenoids. Based on biomarker distributions, source rocks with clays and carbonate lithology were predicted: the presence of high ratios of C29 hopane / C30 hopane, C35 homohopanes, DBT/Phen, and high C24 tetracyclic terpanes in oils obtained from some fields are indicators of carbonate source rock, while low values of these ratios in oils from other fields suggest shaly (clastic) source rock. It should be noted that massive carbonate sediments are found only in the subsalt complex, and clays (shales) can be identified both under and above the salt deposits of the region, depending on the age of sedimentary rocks. In consideration of integration of lithology of reservoirs and source rocks of oil samples, based on biomarker analysis a map of the sedimentary basin of the southern part of the Caspian depression was made (Figure 1), where three distinct groups of fields were identified, which are characterized in the following order:

I. Fields in terrigenous (clastic) deposition saturated with HC, whose source rocks were predicted to be marine shales;

II. Fields in terrigenous (clastic) deposition saturated with HC, whose source rocks were predicted to be marine carbonates;

III. Fields in subsalt carbonate strata saturated with HC, whose source rocks were predicted to be marine carbonates.

Of course, more substantial arguments in support of these findings can be obtained from the results of basin modeling using information from the complex laboratory studies. As is known, the secondary migration of hydrocarbons in sedimentary basins takes place mainly in the vertical direction along the faults formed during tectonic shifts. Such type of migration occurred mainly in fields of the post-salt complexes (type II). Lateral migration is mainly observed in fields of type I. Making a regional map based on the results of geochemical
analysis of oil samples from several deposits, it is possible to assess the prospects of the remaining undrilled structures for discovering hydrocarbon reserves, which are widely used by Western companies.

Figure 1 Sedimentary map showing lithology of the reservoir and predicted source rock type based on biomarker analysis

According to the biomarker analysis of oil in the southern part of the Caspian basin, an unusual phenomenon of the distribution of hydrocarbons in terms of source rock lithology was discovered. Hydrocarbons collected from most oil fields of the post-salt complex were generated from carbonate source rocks, located mainly in the southern part of such large fields as Kashagan and Tengiz. From this we can conclude that the prospect of carbonate rocks of the subsalt complex of the South onboard part of the Pre-Caspian basin is huge and requires further research complex with drilling deep project wells for subsalt deposits.

It should be noted that the effective use of the results of geochemical studies of oil for practical purposes is possible only in conjunction with other types of research for an objective justification of the findings and subsequent decisions.