Criteria for Predicting Oil and Gas Fields in the Paleozoic Sedimentary Rocks of the Timan-Pechora Province

K. R. Chepikov


The petroleum resources of the Timan-Pechora province occur in rocks of the Ordovician-Triassic structural stage of the sedimentary cover, the formation of which was related closely to developments in the adjacent Ural geosyncline. The oil and gas pools occur largely in Middle Devonian-lower Frasnian and upper Visean-Lower Permian rocks; these are controlled by regional seals.

The province has two large sub-regions: the Pechora platform and the Cis-Ural foredeep. In the platform sub-region the main proved reserves and predicted resources are concentrated in linear mobile tectonic zones (Pechora-Kolvin and Varandey-Adz’vin). In the foredeep the pre-orogenic [platformal] section is the most important. In general the platform part is oil-prone, and the foredeep is gas-prone.

In the Pechora-Kolvin linear mobile tectonic zone, the Kolvin mega-arch is on the east margin, and the Pechora-Kozhvin mega-arch is on the west. These formed above a paleo-downwarp of the aulacogen type.

The Kolvin mega-arch is cut into several relatively uplifted and subsided blocks, which have different thickness of sedimentary cover. In the south part of the mega-arch the best traps occur where the sedimentary section is thickest (Usin and Khar’yagin areas). In between them is the Vozey connector, and here the traps are smaller. Inversion of the Kolvin paleo-downwarp and formation of the mega-arch took place in Late Paleozoic and Mesozoic time.

An important factor in assessing the oil-gas potential of the Middle Devonian-lower Frasnian clastic complex here as well as in other regions of the province is the appearance of an early Frasnian partial inversion phase. The scale of this inversion in the Usin and Khar’yagin areas along with the break during Kynov time determined the optimum occurrence of the Middle Devonian sandstone reservoirs beneath the upper Kynov-Sargayev clay seal. Greater inversion and erosion on the Vozey paleohigh led to removal of almost all the pay zone there.

The north part of the mega-arch (Khulchugu, Yareyu) has more subdued structure, and no pools are present in the Middle Devonian-lower Frasnian clastic complex. This situation is due to the greater (more than 4 km) depth of occurrence of this complex and attendant worsening of reservoir and seal properties, as well as less early Frasnian inversion with the result that a thick (up to 200 m) semi-seal separates the reservoir rock from the regional seal. Hydrocarbons are disseminated in this semi-seal, thereby lessening the amount in the reservoir rock. See Fig. 1.

The south and central parts of the Pechora-Kozhvin mega-arch differ in their oil-gas potential. The south part along with its continuation into the Cis-Ural foredeep - the Sredne-Pechora high - has moderate size commercially oil-bearing structures - the Kyrtayel, Pechora-Kozhvin, Yugid, Zapadno-Sople, and others; this region corresponds with part of a paleo-aulacogen where at the beginning of early Frasnian (Kynov) time there was partial inversion movement with some erosion of the Middle Devonian and Pashiy reservoir rocks, which were then overlapped by the upper Kynov-Sargayev regional seal. See Fig. 2. This paleo-uplift persisted and became one of the zones of oil-gas accumulation.

The central part of the mega-arch, which is located to the north, is characterized by larger amplitude folds (Mutno-Materik, Dzelya-Terekhever, Sredne-Shapkov) and greater sedimentary thicknesses and stratigraphic completeness. No discoveries have been made in this part of the arch, however. The Middle Devonian and lower Frasnian here experienced downwarping to a depth of 5 km and more (1.5-2.5 km more than in the south part of the mega-arch) during the pre-inversion stage and consequently were subjected to strong compaction and loss of porosity. Also, an early Frasnian partial inversion did not take place here, and the reservoir rocks are separated from the clay seal by 500 m of semi-seal. Further exploration drilling is not recommended here.

Rifting was widespread in the Timan-Pechora province in early Frasnian time. Narrow grabens of this age in the south of the province are favorable for exploration. Such features have already become productive in the South and North Near-Urals.