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Diagenesis and porosity evolution of tight sand reservoirs in Carboniferous Benxi Formation, Southeast Ordos Basin

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Abstract: The Ordos Basin, situated in west-central China, is one of the oldest and most important fossil-fuel energy base, which contains large reserves of coal, oil and natural gas. The Upper Palaeozoic strata are widely distributed with rich gas-bearing and large natural gas resources, whose potential is tremendous. Recent years have witnessed a great tight gas exploration improvement of the Upper Paleozoic in Southeastern Ordos basin. The Carboniferous Benxi Formation, mainly buried more than 2,500m, is the key target strata for hydrocarbon exploration, which was deposited in a barrier island and tidal flat environment. The sandy bars and flats are the favorable sedimentary microfacies. With an integrated approach of thin-section petrophysics, constant velocity mercury injection test, scanning electron microscopy and X-ray diffractometry, diagenesis and porosity evolution of tight sand reservoirs of Benxi Formation were analyzed in detail. The result shows that the main lithology of sandstone in this area is dominated by moderately to well sorted quartz sandstone. The average porosity and permeability is 4.72% and 1.22mD. The reservoirs of Benxi Formation holds a variety of pore types and the pore throats, with obvious heterogeneity and poor connection. Based on the capillary pressure curve morphological characteristics and parameters, combined with thin section and phycical property data, the reservoir pore structure of Benxi Formation can be divided into 4 types, including mid pore mid throat type(I), mid pore fine throat type(II), small pore fine throat type(III) and micro pro micro throat type([U+2163]). The reservoirs primarily fall in B-subsate of middle diagenesis and late diagenesis, which mainly undergo compaction, cmentation, dissolution and fracturing process. Employing the empirical formula of different sorting for unconsolideated sandstone porosity, the initial sandstone porosity is 38.32% on average. Quantitative evaluation of the increase and decrease of porosity caused by different diagenesis reveals that mechanical compaction and chemical cementation are the main mechanisms for destroying primary pores, which contribute 19.61% and 8.75% to the loss of primary posoity, respectively. Dissolution of volcanic fragments and feldspar increased reservoir porosity by 4.14%. The pores were occluded by late minerals and carbonate cements, resulting in a reduction of 9.38%. Overall, the dual influence of compaction and cementation is the key of the key, controlling formation of tight gas sandstone reservoirs.

Keywords: diagenesis, porosity evolution, tight sandstone, Benxi Formation, Southeast Ordos Basin

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