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Main controlling factors and development strategy of heterogeneity in platform carbonate reservoirs

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The platform carbonate reservoirs in the Mishrif Formation of the HF Oilfield in Iraq are highly heterogeneous and can easily lead to water injection breakthrough along the high permeable thin layer to reduce the water injection sweep efficiency. Therefore, it is of great significance to clarify the main controlling factors of heterogeneity and formulate a reasonable development strategy.

Based on conventional physical property, mercury injection capillary pressure test, casting thin sections, scanning electron microscopy, carbon and oxygen isotope analysis, combined with production dynamic and production-injection profile test, the heterogeneity characteristics caused by sedimentary and diagenesis and the corresponding development countermeasures are systematically studied. The results show that: (1) The beaches in platform can be divided into shoal and inter-shoal, the shoal is mainly composed of bioclastic packstone and grainstone, while the inter-shoal is given priority to bioclastic wackstone. The types of bioclastic are mainly benthic foraminifera and rudist, including some echinoderms and bivalves. The shoal and inter-shoal is interactively distributed, and the single beach is a reverse cycle with a thickness of about 2-6m. (2) The bioclastic shoal is formed in the high position of strong hydrodynamic, the content of micrite is low, and the atmospheric freshwater dissolution is frequent during the diagenesis stage. It includes intergranular pore, intergranular dissolved pore, mould pore and intragranular pore, throat contains reduced-neck and silt throat with medium-high permeability. The inter-shoal is a lower area with deep water between shoals, with high micrite content and less freshwater dissolution at the diagenetic stage. In addition, dissolution product from the shoals results in calcium cement which blocking throat of the inter-shoal. It includes mould pore, intragranular pore and micropore, throat contains silt and cluster throat with low-permeability. (3) On the basis of sedimentation, diagenesis further enhances the heterogeneity of the reservoir, especially the top of the shoal turns into high permeability layer, accordingly inter-shoal becomes a region with low water seepage efficiency. During the development of waterflooding, the injected water quickly breakthrough along the top of the shoal, and the water content of the production well rises rapidly, meanwhile the production-injection profile test shows the monolayer breakthrough. (4) In the development strategy, the injection wells must avoid the high-permeability layer at the top of the shoal, and perforate in the lower part of the shoal and the whole inter-shoal, while all the production wells should be perforated in the whole beach. The reasonable development technology countermeasure effectively circumvents the high permeability layer may lead to rapid waterflooding and monolayer breakthrough, and have achieved good application effects.

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