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Fractures in Steep-Rimmed Carbonate Platforms: Comparison of Tengiz Reservoir, Kazakhstan, and Outcrops in Canning Basin, NW Australia

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SUMMARY

Natural fractures bear significant influence on productivity in Tengiz field, which is one of several giant light-oil accumulations trapped in isolated carbonate platforms in the Pricaspian Basin of Kazakhstan. Outcrop analogs are particularly important for understanding reservoir fracture systems because many aspects of fracture character (e.g. height, length) are impossible to measure with subsurface data. The Devonian margin of the Canning Basin in NW Australia presents a well-exposed outcrop analog for steep margin and slope deposits of Tengiz field. Fracture data gathered from Tengiz core and image logs suggest affinity to fractures in the Canning outcrops in terms of origin, orientation, and range of density. Inclusion of additional information - gained through outcrop study - into reservoir fracture description leads to improved understanding of stratigraphic influence on their occurrence and character.

Shallow-burial fractures – those formed in carbonate strata prior to significant burial, including neptunian fractures – are the most important for reservoir productivity at Tengiz field. These fractures dip steeply and strike dominantly parallel and/or normal to the local orientation of the depositional margin. They are most well-developed in brittle, boundstone-dominant facies of the outer-platform to upper slope environment. Dissolution by corrosive fluids following burial led to enlargement of fracture apertures, which range from small to cavernous. In Tengiz field, cavernous fractures pose both high lost-circulation risk, as well as the reward of highly productive wells.

Outcrop data from the Canning Basin show fractures in the mid- to upper-slope facies and reef core are, on average, not limited by bedding and hence much taller than fractures in the reef flat and outer platform areas. Fracture size cumulative distributions are mainly exponential, and they differ between stratigraphic settings. We expect such size differences will have important effects on fracture connectivity and permeability in a reservoir. Fracture density, which is measured routinely in the Tengiz reservoir, was measured with long pseudowells (i.e. scanlines) “drilled” along Canning outcrops. Fracture density shows significantly less variation among facies than does fracture height. Thus, outcrop-based data can add substantially to our understanding of key fracture system characteristics that are unavailable from well data alone.

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