Modern and Ancient Analogues for Complex Eolian Reservoirs

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ABSTRACT

Complex dunes, such as linear, star, reversing and parabolic, are common in modern depositional environments (Breed et al., 1979; Fryberger and Goudie, 1981). For example, there are more linear dunes (31%) in the world's deserts than barchanoid dunes (24%). Despite this natural occurrence, most eolian petroleum reservoirs are interpreted using models based on barchanoid dunes, whether they are simple or compound in nature. While it is true that there are many such reservoirs, we suggest that there are also many eolian dune reservoirs that are built from linear, reversing or star dunes, and that many of them may remain unrecognized in subsurface work. If true, this presents opportunities in both production and exploration.

The performance of linear, and reversing dune reservoirs, for example, might be sub-par if they are wrongly interpreted using a model based on migrating barchanoid dune forms. An assumption of barchanoid bedforms with a unidirectional permeability structure can lead to a reservoir model that is far too optimistic, because other dune forms, such as linear and reversing, have multi-directional permeability structures, a higher proportions of eolian ripple strata. These are commonly much less permeable than the avalanche strata that typify barchanoid dunes. The result in practical terms is that non-barchanoid reservoirs can have low recovery factors due to early water breakthrough and/or bypassed production. It is possible, however, to adjust well spacing and other aspects of primary and secondary recovery to optimize such complex reservoirs.

On the other hand, it is also possible that some fields remain undiscovered because DST or other evaluation techniques have misunderstood the eolian reservoir. For example, due to cross bedding permeability contrasts, a test may wrongly evaluate the size or extent of a field. In linear dune reservoirs, it might be possible to miss a field entirely by testing tight ripple strata on the flank of a large dune while missing the avalanche strata of the good reservoir. There would seem to be an upside in exploration for those who understand eolian reservoir complexity in formation evaluation.

In our poster we present examples of the internal structure (cross bedding and lamination) of linear dunes in Saudi Arabia and Australia, reversing dunes at Great Sand Dunes, Colorado and Killpecker Dunes, Wyoming, and coastal parabolic/reversing barrier dunes at Hawk's Nest, Australia. We also describe ancient linear dunes in Lyons Formation of the Colorado Front Range (USA), and at Auk oil field in the Northern North Sea Basin of the United Kingdom.

We hope the examples presented in our poster encourage others working ancient eolian dune reservoirs to consider the many possible dune types that exist in nature, and possibly in their eolian reservoir. For example, a pattern of relatively low dips, accompanied by a high proportion

of ripple strata may reveal the presence of linear dunes. Further, expanding interpretation beyond the restrictive window of perpetually climbing bedform trains will drive more representative architectural description of reservoirs. We suspect that careful interpretation of dune type in eolian reservoirs will result in improved recovery strategies or exploration outcomes in eolian reservoirs in the Rockies of the USA and worldwide.