Maximizing Oil Recovery From Cross-Bedded Sandstone Reservoirs

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All reservoir rocks are heterogeneous, and recovery efficiency is inversely proportional to the degree of heterogeneity. Many types of heterogeneity occur on a variety of scales, but one of the most pervasive in siliciclastic sediments is cross-bedding.

Textural and compositional variations, which define the individual beds, always occur and, in some instances, are extreme. Laboratory experiments and computer simulations have shown that, in a water-wet system, oil is preferentially displaced by water in finer-grained beds, while coarser-grained, more porous beds are by-passed. The problem is particularly exasperated when flow direction is perpendicular to cross-bed dip direction. Therefore, every effort should be made to create a flow pattern during production which is oriented parallel to the dominant cross-bed foresets. Where core, log and regional geology considerations indicate large cross-bed sets which show a low variance in flow direction, the most favourable production flow direction is clear. Where cross-bed sets are small and flow direction diverse, it is difficult to establish a best-flow direction. However, even here, a best overall direction can still be established if careful core observations are made, and regional paleogeography can be established.

Primary production will always by-pass much of the oil in cross-bedded sandstones, and waterflooding also may be very inefficient due to trapping of oil by capillary forces and by-passing of zones due to permeability baffles. Small-scale cross-bedding heterogeneities may be overcome by one of the EOR methods which can increase capillary number and improve displacement efficiency.

It is imperative that the geological model be carefully established in order to produce the best possible reservoir model. Location of development wells, the number of wells, and the relative positioning of injectors and producers in waterflood and EOR phases, all depend upon an accurate sedimentological model. Without it, there is every probability that recovery will be less than optimum, and costs will be much higher than they should be.