Compartmentalization of the Gobe and Moran Fields; Examples from the Papuan Fold Belt

Ken Richards* (Chevron Canada Resources, Calgary), Michael Daniels (Chevron Australasia, Perth, Australia), and David Moffat (Chevron Australasia, Perth, Australia)
rcke@chevron.com

The Papuan Fold Belt, in the Southern Highlands of Papua New Guinea, is a late Tertiary to Recent compressional belt that runs northwest to southeast along the axis of the island of New Guinea. Compressional structures trap oil and gas forming a number of fields in the fold belt, and of the six fields currently on production, three are known to be significantly compartmentalized at the reservoir level. This compartmentalization has led to challenging and risky delineation drilling, and continues to complicate the development of the Jurassic and Cretaceous aged reservoirs in Papua New Guinea. The Gobe and Moran fields are prime examples of compartmentalization in a compressional belt and are the focus of this paper.

Two fields are located in the Gobe area, namely Southeast Gobe and Gobe Main. These were discovered in 1991 and 1994 respectively, and lie in separate culminations on a sinuous, 40km long faulted anticline. Both oil and gas are contained in the Iagifu sandstones of the Jurassic Imburu Formation. Pressure data collected during the initial delineation of these two fields suggested that they were each single compartments with continuous hydrocarbon columns throughout. Subsequent development drilling and production history information indicate, however, that numerous reservoir compartments exist and that the initial interpretations were overly simplistic. Differential depletion was the first indication of major discontinuities in the reservoir, as the Gobe compartments contained identical hydraulic potentials in both oil and water legs prior to the commencement of production. The nature of the compartmentalizing boundaries in the field are in most cases uncertain, but presumed to be faults with relatively minor offsets. In the case of Gobe Main, one of these compartmentalizing faults was penetrated by a well bore and appears to have approximately 50m offset and sand on sand contact. Stratigraphic continuity is high in this reservoir, and it is highly unlikely that the compartmentalization has any stratigraphic component. In a few cases, the seal integrity between compartments appears to have broken down as production has created differential pressures across them.

The Moran Field lies along strike to the north west of Gobe, and was discovered in 1996. The field is located in the crestal region of a large amplitude (2500m) asymmetric fold with a highly faulted forelimb and steeply dipping backlimb. Oil was encountered in the Jurassic Digimu sandstone in the discovery well, while the overlying Cretaceous Toro sandstone was wet. Subsequent delineation drilling, including updip, downdip, and along-strike wells, demonstrated the

presence of at least four separate compartments, each containing two hydraulically independent reservoirs.

Compartments in the Moran Field are distinguished on the basis of hydraulic potential of the oil and water legs, and are confirmed with geochemical fingerprint analyses of the oils. At least one backthrust and probably several transverse faults form the compartmentalizing elements. In spite of small offsets, large differential pressures are maintained across several of the faults exceeding 4800 kPa in at least one case, and hydraulic potentials for all blocks (not necessarily adjacent) span a 9000 kPa range.

Two types of compartmentalization are represented in the Moran and Gobe Fields. Those with distinct gas, oil, and water pressure gradients (and thus unique fluid contacts) and those that become apparent only after production and differential depletion begins. The key difference between these two types is likely the extent of the compartmentalizing faults and whether or not they have complete seal integrity throughout their entire length and history. In addition to differences in fault seal dimensions, the dramatic range in hydraulic potential and the distribution oil observed at Moran, suggest a complex history of fault seal/leak and hydrocarbon migration.

Field delineation strategies, at least in the Papuan Fold Belt, need to assess compartmentalization expressed explicitly with different fluid contacts/hydraulic potentials and expressed more cryptically only after production begins. The cost of delineation in compartmentalized reservoirs is obviously higher than what it would otherwise be, however, along with the additional cost comes the potential for unanticipated reserves adjacent to existing productive and unproductive blocks as observed at Moran. In some cases, compartment seal breakdown during field production may mitigate somewhat the development challenges of the Papuan compartmentalized reservoirs.