

Geometries of Fluvial Reservoir Facies and Trapping of Unconventional (Basin-Centred) Gas Accumulations

Doug Cant
Doug Cant Geological Consulting
Redwood Meadows AB
dcant@personainternet.com

Fluvial reservoir facies differ considerably in geometry and scale thus affecting the basin-centered gas accumulations hosted in them. Conventionally, braided stream deposits, either sandstone or conglomerate, are believed to form sheet-like bodies of reservoir quality. Conversely, meandering or anastomosed rivers form relatively narrow channelized reservoir bodies within a shale-dominated framework that commonly have few or impaired connections. Another important type of reservoir facies is largely to completely non-marine incised valley fills. A number of unconventional basin-centred gas accumulations occur in North America in all these types of non-marine deposits.

The differences in reservoir geometries control the type of unconventional gas recovered in different units and different basins. They also shed light on the broader question of “basin-centre gas trapping”. The original concept (Masters, 1979) implied 1) gas was generated in the deeper part of the basin, 2) all the rocks had low porosities and permeabilities, 3) the updip migration of gas (and downdip migration of water) was extremely slow. This resulted in gas-saturation of the basin centre, with no downdip water. No specific seal was required. Lately, however, some geologists have suggested that basin-centre gas is not really much different from conventional accumulations. They believe traps of different types are responsible for basin-centre gas trapping. The gas coexists with water but the water is almost immobile in the very low permeability rocks until the gas pressure is reduced by production. A conventional-type trap is required to stop updip gas migration.

Large amounts of gas have been produced from the Mesaverde Formation of the Western United States. The reservoirs consist of a large number of relatively thin (<20m), narrow (generally less than 1km) channel sandstone bodies. The narrow sands do not correlate between wells farther than about 1km apart. However, on an average basis, the formation generally is uniform, about 30% sandstone. The transition from the gas-bearing zone toward the shallower water-bearing zone is somewhat irregular. The trapping mechanism is at least partly structural – the best producing fields are higher than their surroundings. No specific seal has been documented between the gas and the oil. However the limited lateral extent of the individual channel sand act as a barrier to updip migration. The trap, on the scale of an individual reservoir sand is stratigraphic. On a basinal scale, the trap essentially regional, with no specific regional seal needed.

Within sheet-like units such as the Cadomin, the same slow rates of fluid movement have been invoked with a “compromise” boundary established between the gas and water. However, the contact between producers of the two fluids is sharp, not gradational. The updip edge of the gas zone is actually a subtle stratigraphic trap that stops updip leakage of the gas. Where sheet sands occur in a gas saturated interval, they act as conduits for downdip water movement and gas escape. The sheet-like geometry of braided-stream deposits requires a specific seal to stop gas escape.

References

Masters, J.A., 1979, Deep Basin gas trap: American Association of Petroleum Geologists Bulletin, v.63, p.152-181.