Structural Stratigraphic " Halo" plays in the Amadeus Basin

Introduction

There are a myriad of structural stratigraphic plays in the Amadeus Basin. The sedimentary history and tectonic controls favour, amongst other plays, the " Halo" type structural stratigraphic play type. This play is very important because: 1) it is very large scale and widespread offering potentially large incremental in-place oil/gas potential for future drilling programs, and 3) the play targets several petroleum systems and associated reservoir-seal couplets occurring at multiple stratigraphic levels.

Over wide areas of the Amadeus Basin, but most commonly in the northern part of the basin where Devonian – Carboniferous Alice Springs Orogeny (ASO) structuring predominates, current day outcrop patterns reflect a largely elongate E-W trending, enechelon style of compressional folding. This structural pattern is dominated by broad synclinal structures complimented by very tight anticlinal axes sometimes thrust over adjacent synclinal zones and often cored by salt. The current structural expression, which largely reflects major N-S compression during the latter stages of the ASO, was preceded by a multi-phase structural history encompassing two major phases of foreland basin development during the Petermann Ranges Orogeny (PRO- Late Neoproterozoic to Early Cambrian) and the ASO (Late Ordovician to Carboniferous). Intervening rift tectonic/ sedimentary regimes were in place during most of the Neoproterozoic and Lower Middle Palaeozoic but PRO and ASO structural overprints generally mask any tensional tectonics. Major block faulting occurred during the Areyonga Orogeny and halotectonics linked to Gillen Member and Chandler Formation evaporites were intermittent throughout the basin's history.

Halo plays may have been neglected to some extent during previous exploration because of fears regarding effective hydrocarbon charge. For instance it was believed in the past that Dingo field was considerably underfilled. This study shows that at Dingo field the top Arumbera section contains tight gas with thick Chandler Formation salt forming regional seal – the total gross gas column is 328 m whereas the mapped vertical closure is only 194 m. Thus Dingo field would appear to be gas charged to a level well below the mapped structural spill point. The exact extent of the deposit needs to be reassessed but upside estimates could be in hundreds of BCF original-gas-in-place. Porosities in the Arumbera Sandstone in this field range up to 16% (core) and 22% (log). Further evidence of the massive gas charge from the Orange Creek – Missionary Plain synclines comes from Mereenie field where Ordovician reservoired oil and gas have been detected 230 m below structural spill point. This data supports the idea of extensive gas and possibly oil deposits in updip Halo plays on the flanks of the anticlinal highs bounding these basinal areas.

In a broad sense it appears that in the northern-central part of the basin, major synclinal axes reflect basinal areas and attendant anticlines often reflect reactivation of antecedent intra-basinal highs. The structural reactivation of the original depositional footprint sets up some potentially important onlap plays ("Halo" plays) around partially bald structural highs bounded by synclinal source kitchen areas. Some examples, based on outcrop distribution are described below. No doubt many other plays will be revealed on review of new and existing seismic ; this paper asserts that nearly all traps should be filled to spill point.

Gardiner Range High: Arumbera Sandstone " Halo" play on the northern margin.

One characteristic of the Orange Creek Syncline, which lies immediately north of the Gardiner Range High, is major thickening of the Arumbera / Chandler Salt reservoir- seal couplet into this basinal area. For example in Dingo-1, a thick gross gas column in the

Arumbera Sandstone section totalling nearly 300 m is sealed by 275 m of Chandler salt. The latter appears to play a key role in preserving Arumbera Sandstone gas deposits and definition of its distribution is a key component of the play. The Arumbera Sandstone is absent from the Gardiner Range High as is the Chandler Salt, suggesting the potential for a halo play on the northern flank of this bald high. The anticline displays a major thrust fault on its northern flank and the play would be prospective along a strike length of over 70 km in the hanging wall. Mapping of existing seismic should give an indication of structural embayments or fault disruptions and also the Arumbera zero edge, all pre-requisites for a viable trap.

An additional halo play applies to the Pioneer Sandstone which is also bald over the Gardiner Range High. Little is known of this unit but in basinal areas it could thicken considerably from ? condensed sections intersected so far on anticlinal depositional highs. It would seem logical that both the Pioneer reservoir and Pertatataka seal/source thicken into the syncline. Given the changing stratigraphy on the flanks of this structural/depositional high, other target reservoir seal-couplets are likely to become prospective given a reservoir zero edge is established.

On the southern side of the Gardiner High analogous Halo plays are a strong possibility. The contiguous Katilka Syncline has produced Ordovician oil and gas reservoired at Mereenie field and hence would certainly have generated hydrocarbons from the deeper Aralka/ Pertatataka petroleum systems which are those pertinent to the play.

James Range High : Arumbera oil potential ; Pioneer Sandstone "Halo" play.

This high also has the potential to trap hydrocarbons in a Halo play similar to that described above. The play is probably largely gas prone but application of Gussau's principle could result in oil being displaced to the basins margins by subsequent gas charge from basinal areas. There are numerous exploration possibilities on the flanks of this partially bald high.

There is also evidence of oil charge to the Arumbera Sandstone in James Range -1 and Finke-1 in what is a conventional Arumbera 4 way dip closure on the high sealed by Chandler Formation. Firstly, the strong evidence for oil charge bodes well for Halo oil plays but the crest of the structure may also have remaining oil potential. Strong bitumen shows were recorded in down flank well,James Range 1 in the Arumbera Sandstone immediately below the Chandler seal. Nearby updip well Finke-1 also recorded excellent oil shows updip from the bitumen shows. The best fluorescence was noted in the Johnny's Creek Member which was cored ; a DST over the zone showed it to be tight. The directly overlying Arumbera Sandstone was air drilled and recorded no shows, which can happen in oil zones which have been air drilled. On drilling out the casing shoe in the top Johnny's Creek Member live oil shows were recorded and good oil shows were recorded over about a 100 ft interval below this zone. The main question mark surrounds the fluid content of the Arumbera which was air drilled and recorded bitumen shows downflank- why were there no oil shows in the Finke-1 Arumbera section? It is possible this zone was oil saturated and contiguous with the underlying oil leg within the Johnny's Creek Beds; the Chandler Formation could provide regional top seal. In this case the mean estimate of potential oil-in-place in the Arumbera Sandstone updip of James Range-1 would total about 300 mmbl OOIP. This assumes:

100 ft net pay, Sh = 0.9, porosity = 0.12, Bo = 1.1, area updip 10,000 acres, 50 ft net pay.
Target depth is about 300m.

Waterhouse High : Stairway Sandstone "Halo" play

Applying the same geological rationale as used for the afore mentioned plays presents numerous other possibilities throughout the basin. One of these is the oil prone Stairway Sandstone Halo play on the flanks of the Waterhouse High. On the crest of the high, oil prone Horn Valley Siltstone source rocks directly underlie the Mereenie Sandstone. Earlier studies

this year of the Tempvale-1 well indicated an intra-Stairway seal directly above the basal Stairway Sandstone, is the first seal above the latter rather than the usually invoked Stoke Siltstone. If this relationship holds on the southern flanks of the Waterhouse High, and considering the Stairway is absent from the crest,an important oil prone Stairway Sandstone Halo play can be invoked. This possibility could be reviewed during the upcoming seismic interpretation given the coverage extends sufficiently downflank.

Conclusions

Many of the anticlinal and synclinal folds in the Central-Northern Amadeus Basin were depositional highs and lows at various times during the Neoproterozoic and early-middle Palaeozoic. Depositional onlap of reservoir-seal couplets, combined with massive hydrocarbon charge from the basinal synclinal areas provide the dynamics necessary for widespread hydrocarbon entrapment. These " Halo" plays occur over almost all of the basin including major trends: Waterhouse, Gardiner Range, James Range, Glen Edith Hills, Parana, Mereenie Hills, Johnny's Creek ,Wells etc.

I believe the Halo play could become very important in the forthcoming years, largely because of its scale and widespread extent. We should consider these possibilities when laying out seismic grids and indeed during the seismic interpretation phase of our work programs. In time this play could lead to a multifold increase in the company's leads and prospects inventory which are an important component of its assets.