Dare to Think Outside the Box: A Success Story in Shallow Reservoirs, Offshore Sarawak, Malaysia*

M. Sharir Mustafa[1], Sharifah Shahira Wafa[1], Khairul Amry Kamarudzaman[1], and Azlan M. Sabirin[1]

Search and Discovery Article #20184 (2012)
Posted December 31, 2012

*Adapted from extended abstract prepared in conjunction with poster presentation at AAPG International Conference and Exhibition, Singapore, September 16-19, AAPG©2012

[1]PETRONAS Carigali Sdn Bhd, Kuala Lumpur, Malaysia (mohdsharir@petronas.com.my)

Abstract

What can we do in an overly matured basin like the Central Luconia province? With top oil and gas companies having explored the area exhaustively, there exists a crucial need to find better ways or implement new mindsets of seeking and finding hydrocarbons (HC).

In an area well known to house carbonate plays, the existing platforms and pinnacles have already been drilled and tested for HC. Even the pre- and post-carbonate levels of structural plays have been extensively drilled. If all conventional plays are already tested and we still need to find more HC, the question will be “what else are we still missing?” Therefore, finding new plays are necessary.

The presence of Low Resistivity HC was currently proven through a couple of wells successfully drilled by PETRONAS. This aspect was actually overseen by previous operators in the area; however, the wells yielded hundreds of cubic feet of gas. Thus, a new approach has been adopted to look at the stratigraphic plays within the area. Detailed seismic interpretation and mapping were done in order to extract accurate amplitude for seismic attribute analysis.

Method

RMS amplitude maps were generated for the targeted reservoirs at Near Stack and Far Stack from a very thin window of only around 10 ms above and below. The amplitude maps were overlain by depth maps of the same horizons. AVO Inversion for the Cycle V/VI reservoir was also generated. However, there were anomalies in other locations, including the ‘K’ Field, but not in the offset and target

well. This trait was attributed to the possibility that these wells could most likely house multiple layers of shallow gas of stronger amplitudes that potentially shadowed or masked these particular reservoirs.

Examples

Recently, PETRONAS drilled the ‘K’ Prospect in offshore Sarawak and made a HC discovery in shallow reservoirs where the depth ranged from 600 m to 1100 m. Two Plays were identified - Cycle VI Structural Stratigraphic Play, and Cycle V/VI Stratigraphic Play.

The Cycle VI reservoir (Figure 1, Figure 2) showed a strong amplitude response where amplitude anomalies conformed the structure on the northern and western parts related to fluid change with the southern section displaying facies change. The reservoir was trapped by NE-SW normal faults separating the western and eastern blocks.

The Cycle V/VI reservoir (Figure 1, Figure 3) was purely stratigraphic and exhibited non-conformance to structure. Strong amplitude from PSTM Far Stack proved to be HC bearing sands. Amplitude shut off corresponded to free water level and this was confirmed by the presence of water in another well at the edge of the amplitude. The seismic facies were interpreted as Convergent Thinning High Amplitude (Cth) facies with the traits of a parallel high amplitude reflector and thinning on the side. It was interpreted to represent distal lower shoreface sheet sands of interbedded sandstone and shale with high N/G of 50%-80% and porosity of 25-33%.

These interbedded sandstone and shale reservoirs, aged Miocene to Early Pliocene, prograded perpendicular to the W-E paleo-coastline during the depositional. Source rock is mainly from the older pre-carbonate levels consisting of terrestrial and marine of Cycle I, II and III formation.

Cycle VI and Cycle V/VI reservoirs have low resistivity readings of four and two ohm respectively that was normally regarded as unpromising reservoirs. Analysis indicated that the reservoirs were thinly bedded which camouflaged the reading of tools to be of shale dominant beds. Samples were taken and production test have proven the existence of HC in the area.

Conclusions

The success of Prospect K has proved that HC had migrated beyond the carbonate level, thus proving the existence of a workable petroleum system in shallow reservoirs. The impact of this discovery resulted in upgrading all shallow reservoirs with similar stratigraphic traps in the area and opened up exploration for relatively small stratigraphic traps/prospects in the area.

In terms of operation, the well was successfully drilled with minimal non-productive time. With a total cost utilized around 84% from proposed cost and 31.32 days of operation, the well was completed with USD 3M and 5 days less than planned.

The use of good seismic quality 3D seismic data and advanced geophysical applications proved to be viable in predicting thickness of relatively thin sands, low resistivity low contrast sands and revealing subtle stratigraphic traps. A significant hydrocarbon volume that is free of inert gas proven and tested this new play.

Further investigation and exploration should include more investigation on shallow amplitude anomalies presence in the area around Prospect K. It is believed that there is still more HC potential surrounding the area.

Acknowledgements

We would like to extend our appreciation to PMU and PETRONAS Carigali for the approval on publishing this paper. And to Mr. Effendy Cheng Abdullah, Chow Kok Tho, Jamlus Md Yasin, Mazman Abu Bakar, Goh Leong Kee, Nurul Saadah, Noor Iryani, Ahmad Din, Phillip Gordon Cassidy, Rusli Din for their respective contributions in this study

References

Chopra, S., and K.J. Marfurt, 2007, Seismic Attributes for Prospect Identification and Reservoir Characterization, Society Exploration Geophysics Developments, Series No. 11, p. 99-122.

K-1 Well Proposal, 2011, PCSB in-house report, May.

K-1 Well Evaluation Report, 2011, PCSB in-house report, December.

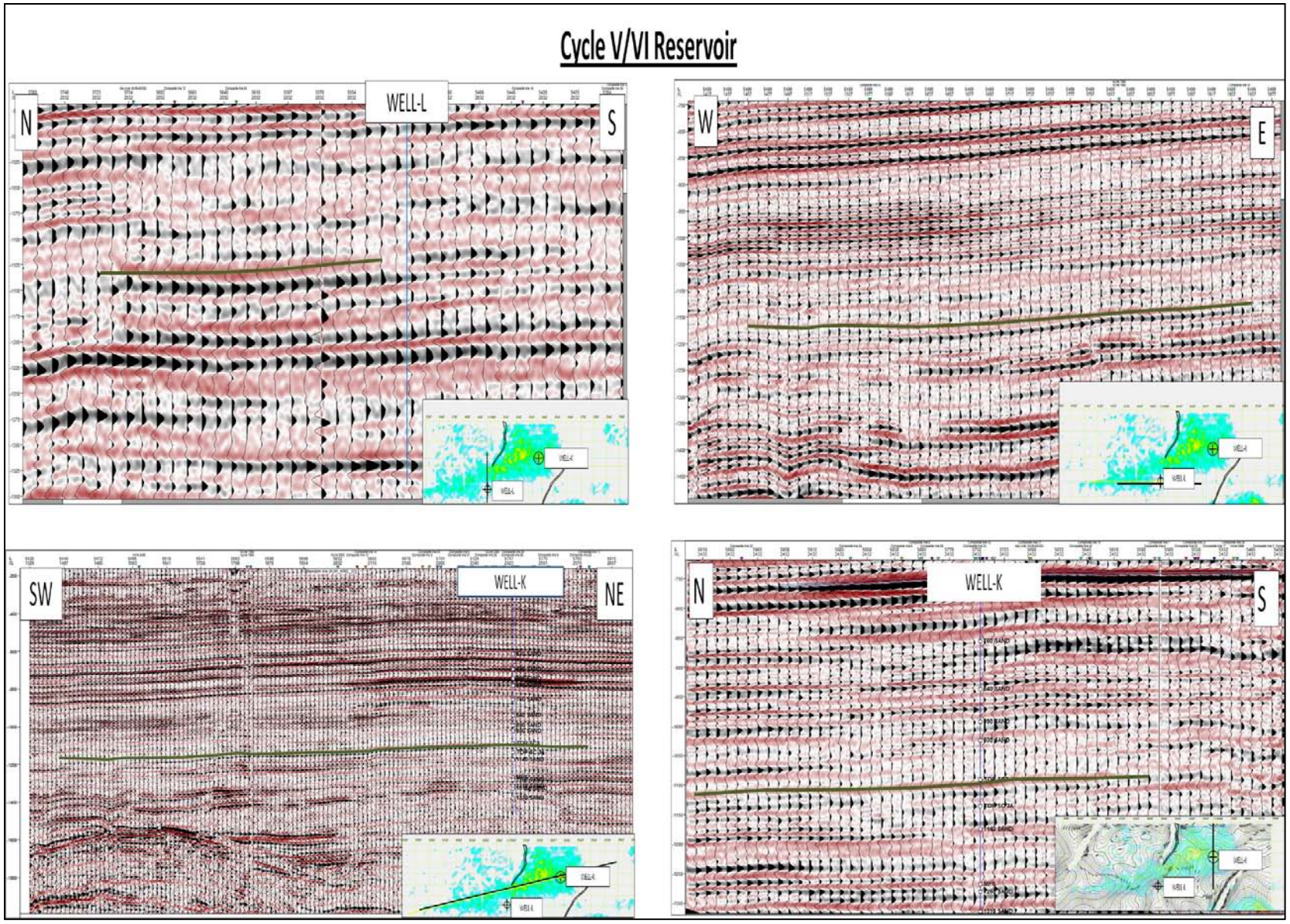

Figure 1. Strong amplitude from PSTM Far Stack proved to be HC bearing sand. Amplitude shut off corresponds with free water level and this is confirmed with the presence of water in KMSE-2. Convergent Thinning High Amplitude (Cth) facies with the characteristics of a parallel high amplitude reflector and thinning on the side. It is interpreted to represent distal lower shoreface sheet sand of interbedded sandstone and shale with high Net to Gross (80%) and porosity (33%). The same theory is also applied in the Cycle V/VI reservoir where the amplitude shut off is proven to be water as encountered by Well-L.

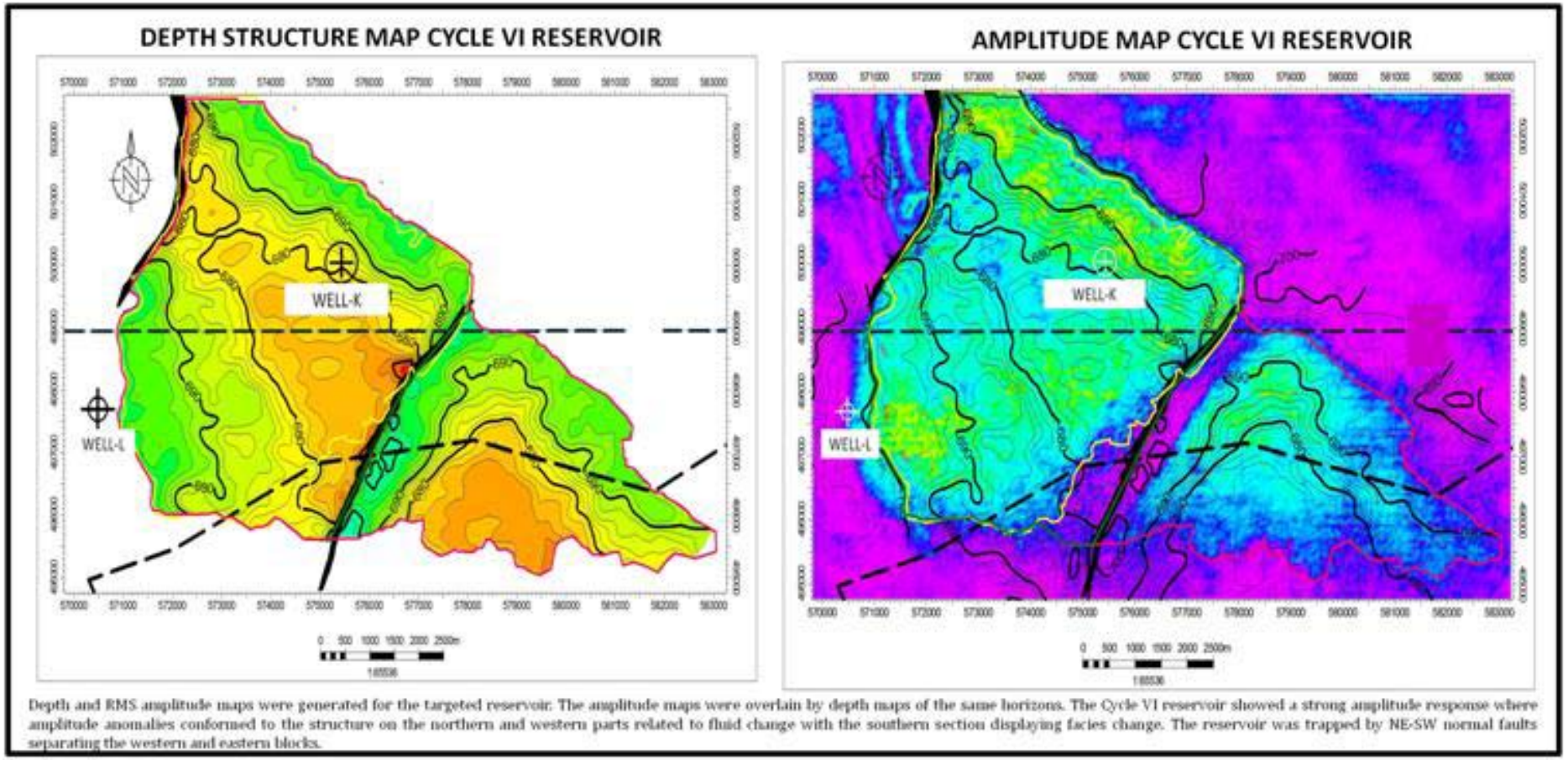

Figure 2. The amplitude anomalies conform to the structure on the northern and western part which relate to fluid change, while the southern part is representing facies change. The Free Water Level (FWL) is at 699 m. Cycle VI is lower shoreface sheet sand. In terms of volumetric calculation, 1C area is the bright amplitude within the upthrown block. 2C is the area extends to the fault on the side where the bright amplitude is still above the FWL. The prograding sequence was perpendicular to the W-E trending paleo-coastline during depositional of sediments.

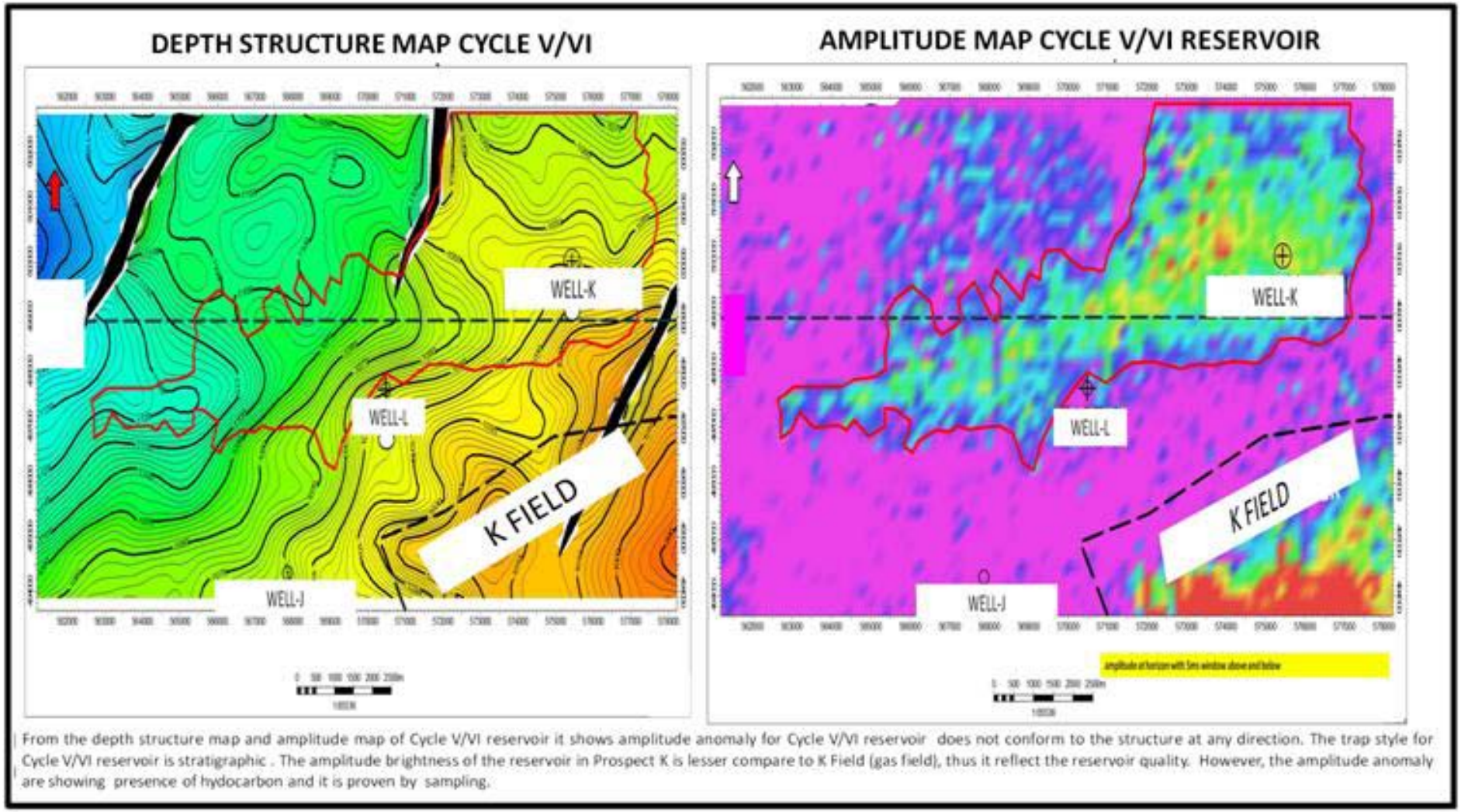

Figure 3. The amplitude anomalies do not conform to the structure. Cycle V/VI sand is purely stratigraphic. The amplitude brightness of the reservoir in Prospect K is lesser compare to K Field, hence reflecting the reservoir quality. Nevertheless, the attributes are showing presence of hydrocarbon and this is proven by sampling.