EVALUATION ON RESERVOIR DEVELOPMENT STRATEGY-GAS CAP WATER INJECTION AND GAS CAP BLOW DOWN

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A project report submitted in partial fulfilment of the requirements for the award of the degree of Master of Science (Peroleum Enginnering)

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JUNE 2013

ACKNOWLEDGEMENT

In preparing this thesis, I was in contact with many people, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Dr. Wan Rosli Wan Sulaiman, for encouragement and guidance. I am also very thankful to my industrial supervisors En Mohd Azlan Anuar, the Consultant Reservoir Engineer for Talisman Malaysia Ltd for his guidance, advices and motivation. Also not to forget my colleagues for all the guidance and helps. Without their continued support and interest, this thesis would not have been the same as presented here.

I am also indebted to Talisman Malaysia Limited (TML) for full funding of my Master Degree and give full support to finish off this Master Degree.

My fellow postgraduate students should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family members.

To my beloved Mom Zainon Mohamad and My Late Father Abd Rahman Yahya,
Thanks for everything

To My Best Friend, Siti Zubydah Thanks for continuous help and support during completion of this thesis

To My Family

ABSTRACT

How to get maximum hydrocarbon value from the reservoir without spending huge Capital Expenditure (CAPEX) such as new facilities or new wells has always been considered in managing a reservoir. This study evaluate of the scope of maximizing profit portfolio by Gas Cap Blowdown (GCBD) to recover optimum associated gas and Gas Cap Water Injection (GCWI) to increase the recovery of the unsweep oil underneath gas cap. Case study is East Bunga Kekwa reservoir in I-60 sand which located in PM3-CAA-B46 CN area in Malay Basin. Currently reservoir being develops by 3 Oil Producers and 2 Water Injector for pressure support and to increase sweep efficiency. However, effects of hysteresis have to consider for this studies. Therefore, history matching process by using drainage-imbibition curve have been conducted and managed to improve the matching of a few parameters such as bottomhole pressure, Gas Oil Ratio and Water Cut. The result of the studies predict that by conducting gas cap blowdown cases and concurrent gascap blowdown and gascap water injection cases may reduce the Oil recovery but increase Gas recovery as well as reducing the company gross income. On the other hand, by having Gas Cap Water Injection cases may increase both oil and gas recovery which on this studies showing the incremental of oil recovery factor from 22% to 23% and gas incremental of ~9bcf and total gross monetary incremental is 186.5mmusd as compare to do nothing case.

ABSTRAK

Bagaimanakah untuk memaksimumkan nilai hidrokarbon dari reserbor tanpa mengeluarkan modal yang besar (CAPEX) seperti menyediakan kemudahan baru atau menggali telaga baru adalah aspek yang sentiasa diberi penekanan dalam pengurusan sesebuah reserbor minyak. Kajian in dijalankan untuk menilai dan memaksimumkan portfolio pendatan kasar dengan menggunakan teknik "Gas Cap Blow Down" dan jugan "Gas Cap Water Injection". Kajian ini dijalankan di Lapangan "East Bunga Kekwa" di reserbor I-60. Lapangan ini terletak di Blok PM3CAA-B46CN di "Malay Basin". Lapangan ini dibangunkan menggunakan 3 telaga pengeluar minyak dan 2 telaga untuk suntikan air. Walau bagaimanapun, kesana dari histerisis perlu juga dipertimbangkan untuk kajian ini. "History Matching" yang dilakukan dalam kajian ini dengan mengambil kira "imbibition-drainage curve" berjaya ditingkatkan. Hasil kajian menunjukkan bahawa dengan menjalankan proses "Gas cap blow down" dan juga "Gas Cap Blow Down" dan "Gas Cap Water Injection" dengan serentak akan mengurangkan pengeluaran minyak. Sebaliknya, dengan melakukan proses "Gas Cap Water Injection" dapat meningkatkan pengeluaran kedua-dua minyak dari 22% kepada 25% dan gas dapat ditingkat kepada 9bcf dan jumlah keuntungan kasar adalah 186.6musd.

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CHAPTER 1

INTRODUCTION

1.1 Case Study

Study has been conducted for East Bunag Kekwa I-60 field which located in PM3-CAA area in Malaysia and partly consist of B46 Cai Nuoc area in Vietnam- see Figure 1 below.

Reservoir has been produced from 3 oil producer (BKA-10, BKC-4 and BKC-17) with support from 2 water injector (BKC-3ST1 and BKC-34). However, BKC-4 has been shut in and abandoned and existing Reservoir Management Plan (RMP) is to produce the reservoir from 2 oil producer (BKA-10 & BKC-17) with support from 2 water injectors. The simulated Recovery Factor (RF) by using this RMP is ~22% only.

This study has been conducted to optimize both oil and gas production by only using existing wells inventory and existing facilities. Therefore, no capital expenditure (CAPEX) will be required to increase the portfolio value. The two potential project is Gas Cap Blow Down (GCBD) which by blowdown the gascap will increase the Sales Gas production and Gas Cap Water Injection (GCWI) which can help to increase sweep efficiency on the unsweep oil underneath gas cap.

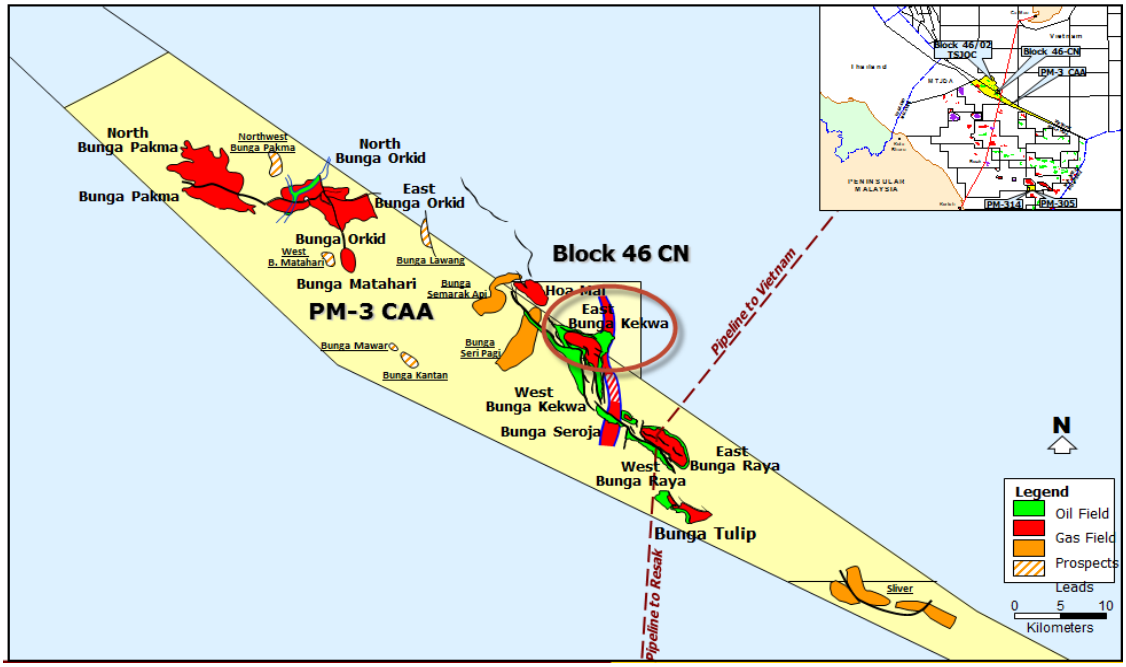


Figure 1.1

Reservoir Description and historical production

The Bunga Kekwa I-60 reservoir is currently the shallowest producing oil reservoir in the Bunga Kekwa Field and has been developed since Phase I of the PM3-CAA development. Hydrocarbons are encountered in two separate pools, namely the West Bunga Kekwa Pool and the unitized East Bunga Kekwa-Cai Nuoc Pool (1)

The reservoir group consists of a thick sequence of thinly bedded argillaceous sandstones, clean channel sandstones, mudstones and coals. The interbedded (organic) claystones and coals have probably contributed to the oil charge in the region.

This reservoir is formed by a combination of structural and stragtigraphy trapping. Stratigraphic trapping is important in the sands where hydrocarbons have been penetrated deeper than the mapped structural closure in the East Bunga Kekwa I60.

The laterally migrating meandering channels in this reservoir form a North West-South East to North-North West to South-South East trending channel belt complex.

As for the reservoir properties for EBK-I60, the average net sand thickness is ~18.9m, the average porosity is approximately 24% and permeability range is between 150-1200mD.

One oil producer (BKA-10) was drilled in 2002, and another oil producer (BKC-4) and water injector (BKC-3st1) were drilled during in 2004. BKC-17,an infill oil producer located in North area has been drilled to achieve bigger drainage area of the I-60 and BKC-34ST1 the water injector have been drilled and completed right after BKC-17 to support and sweep the oil into BKC-17. This location targets a sweet spot (area of low acoustic impedance) within the I-60 channel belt.

Figure 1.2 below shows the AI map and location of the wells:

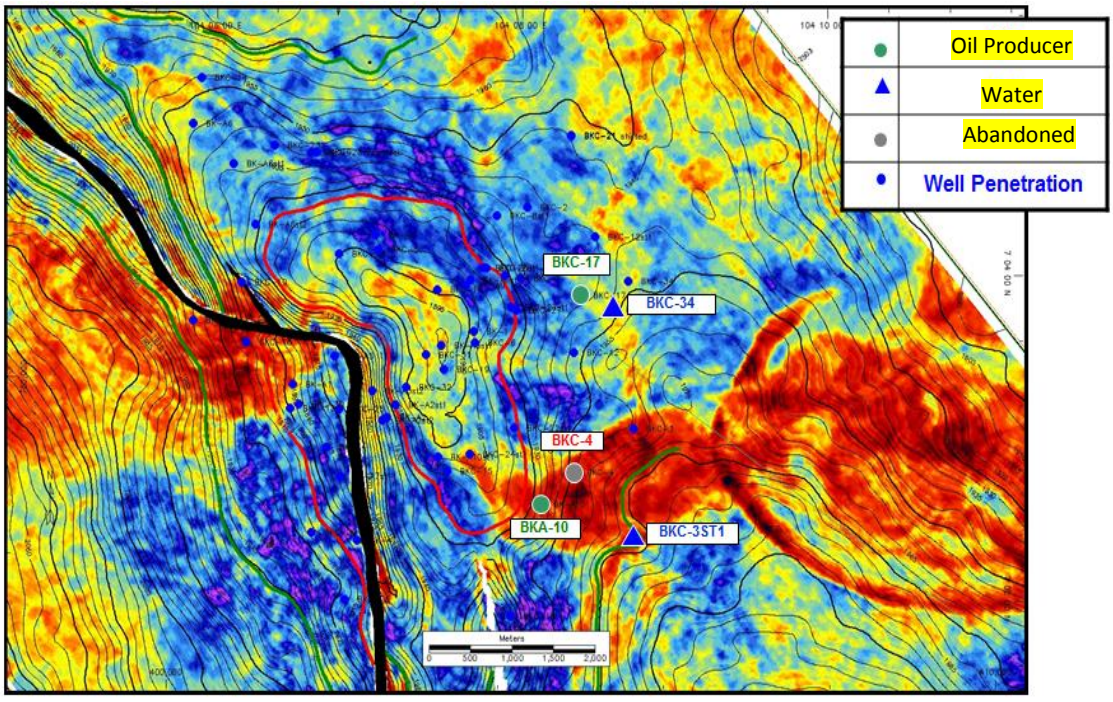


Figure 1.2

Figure 1.3 shows the East Bunga Kekwa I60 sand probability map with the Gas Oil Contact (GOC) shown in green libe and Oil Water Contact (OWC) in blue line. This

sand probability map is derived from the seismic Acoustic Impedance (AI) map. Firstly the seismic AI map is normalised between 0 to 1, then the geologist edited the normalised seismic AI map by honouring the well and pressure data.

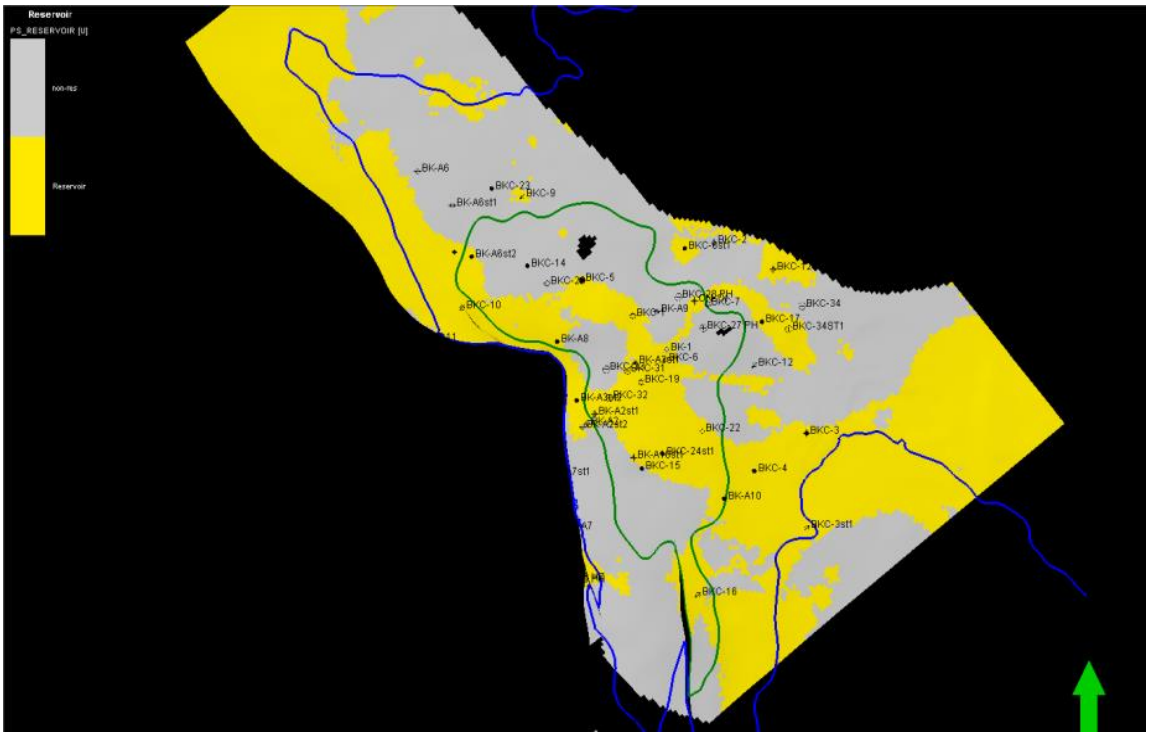


Figure 1.3

The EBK I-60 sand probility map shows the main channel has a North West-South East to North-North West to South-South East trend direction. As the main channel migrates laterally with time, there are minor East-West trending channels developed at the BKC-17 area. As the main channel flows from a South East to North West direction, the good quality thick blocky sand are seen in the South East part of the map (i.e, BKC-3, BKC-4, BKC-3ST1, BKA-10) which forms the key producer and injector wells for this reservoir.

Well Correlation of EBK-I60

One of the studies scope is for Gas Cap water injection and Gas Cap Blowdown from BKC-1. Therefore, it is crucial to know the communication between this well to the rest of reservoir area.

Figure 1.5 shows the sand connectivity within the main channel belt (between BKC-1 to BKC-3ST1). Even though the AI map indicates low probability of sand at the BKC-19 area, there are a few wells drilled adjacent to the BKC-19 area which is sand and hydrocarbon bearing.

Figure 1.4 indicates the sand connectivity from the main channel to the East-West trending minor channels (BKC-17 area). Even though the wells in this area are thin, there are 3 possibilities of connectivity between BKC-1 to BKC-17:

a) Via cross –section A (BKC-7)

b) Via cross section B (BKC-6)

c) Or a combination of both forming a loop to the main channel

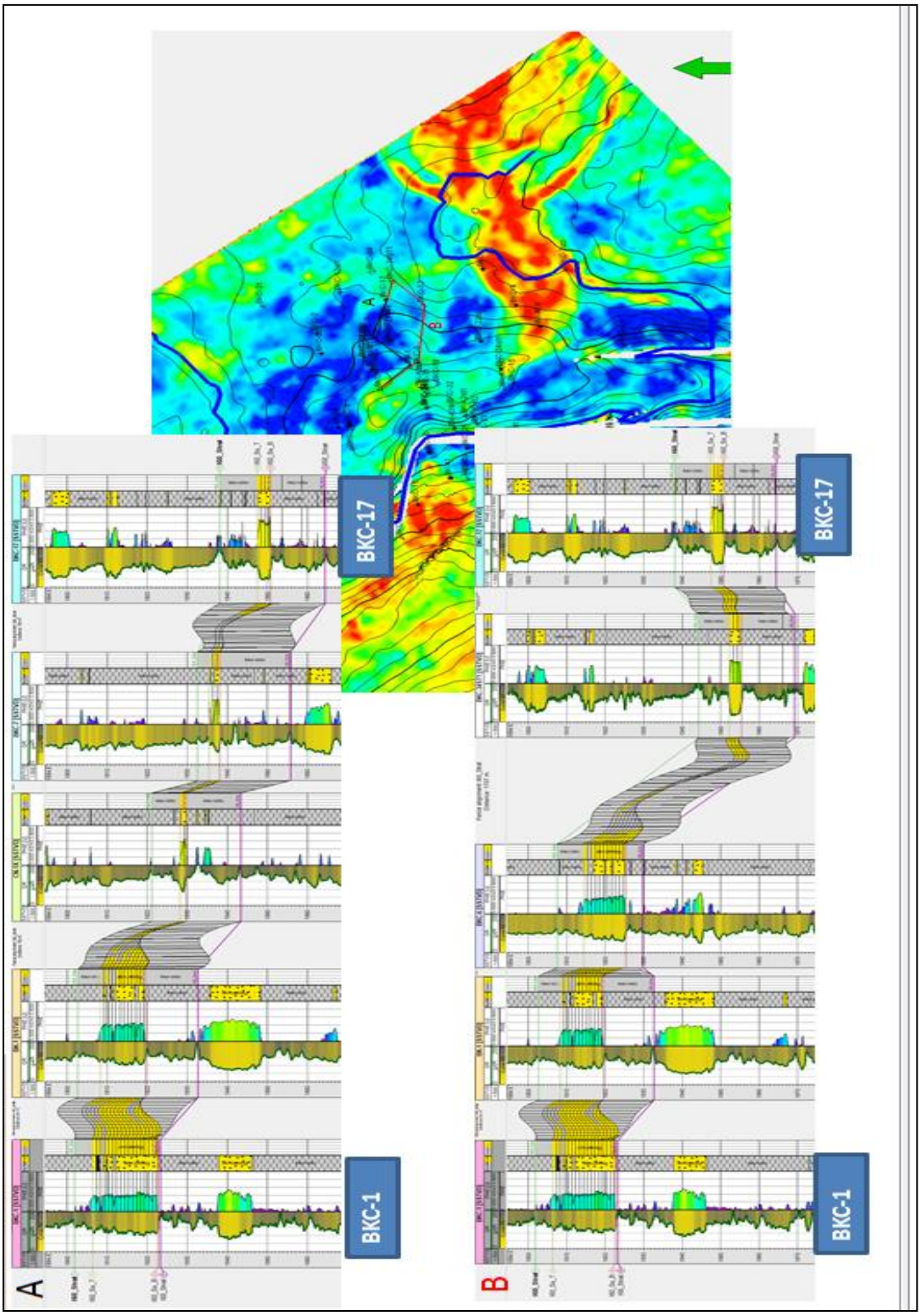
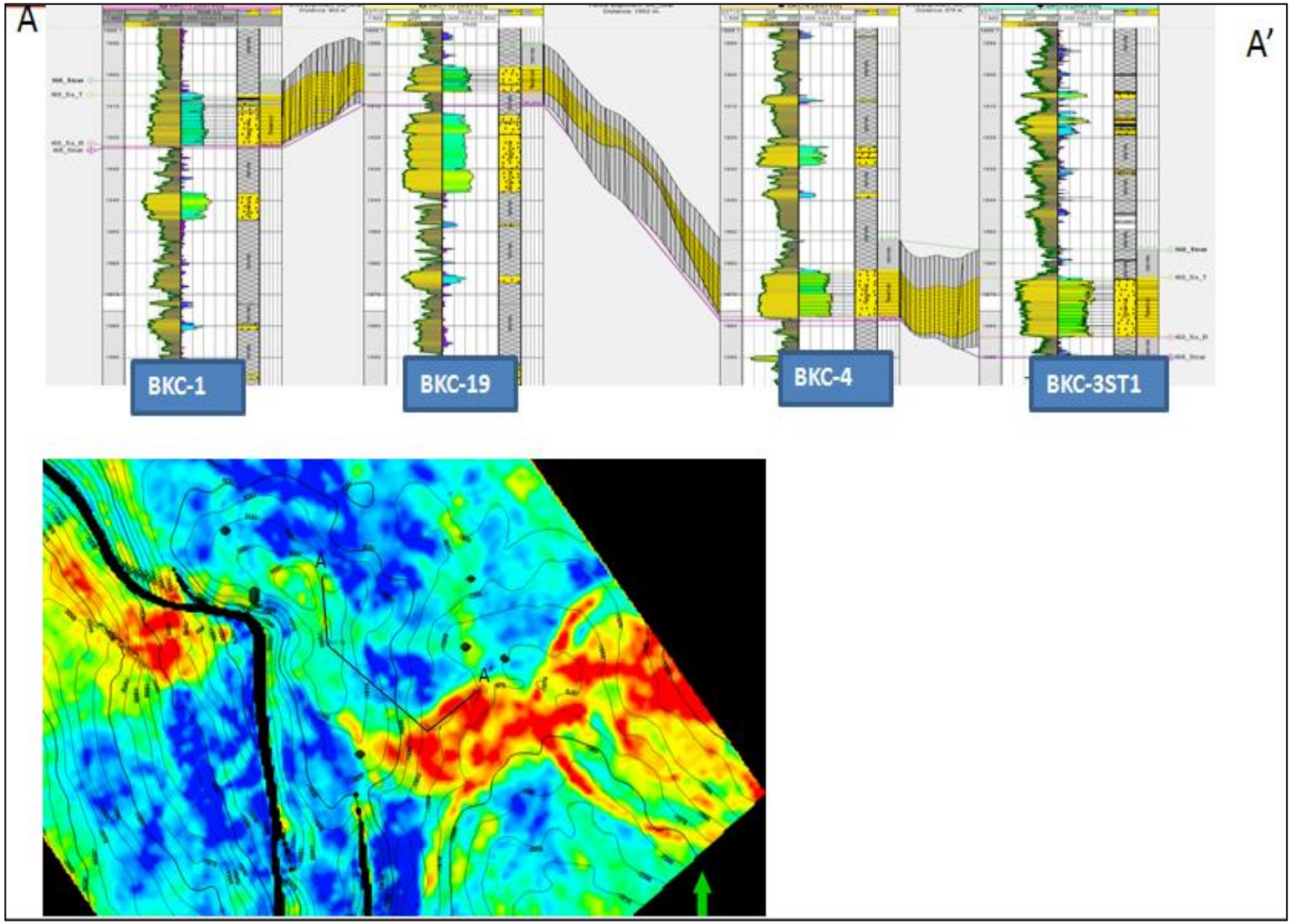


Figure 1.4


A
A'
BKC-1
BKC-19
BKC-4
BKC-3ST1
A
A'

1.2 Problem Statement

1) Improve the history matching process by includes the effect of hysteresis (drainage/imbibition) on EBK-I60

    - Current matching process doesn't includes the imbibition effect for oil-water and gas-oil system. Water injection underneath the oil-water contact will increase the wet phase saturation (water) and reduce the non-wetting phase saturation (oil) which is called imbibition process.

    - Hysteresis effect also crucial for oil and gas recovery, as the trapped gas saturation and residual oil saturation will increasing during the imbibition process

2) Evaluate Portfolio Profile in term of gross company income for EBK-I60 reservoir

    The normal production strategy for oil reservoir which overlain by gas cap and underlain by water is to deplete the oil by reservoir energy or with normal oil and water injection. However, the portfolio/economics can be raise by a few other method whether secondary recovery or EOR. For this purposes, a few method by using existing facilities and well inventories has been choose which is:

        1. Evaluation on ***Gas Cap water injection only*** on ultimate recovery of oil and gas- This method might be able to maximize oil recovery by increase the recovery of unsweep oil underneath gascap.

        2. Evaluation on ***Gas Cap Blowdown only*** to increase the hydrocarbon gas recovery- Higher gas recovery might help to increase sales gas production to achieve "Gas Sales

Agreement (GSA)" and help to avoid penalty from host government

3. Evaluation on Concurrent Gas Cap Blowdown and Gas Cap water injection to maximize both oil and gas production.

1.3 Scopes Of Study

1 Study only be conducted at East Bunga Kekwa-I60 sand area

2 Study only be conducted by using existing well penetration and wells that will be available to be used for injector or producer in the future. No additional wells will be considered in this studies

3 Base Case of this studies will be current Reservoir Management Plan (RMP) which 2 wells will be the Oil Producer with support from 1 water injector.

4 Studies will only be consider Gas Cap Water Injector and Gas Cap Blowdown opportunity.

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