Sedimentology, Sequence Stratigraphy and Reservoir Quality of the Early Cretaceous Murta Formation, Eromanga Basin, Central Australia

Homoud Al-Anzi, BSc.

This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Science (Petroleum Geology & Geophysics)

Australian School of Petroleum,
The University of Adelaide

April 2008

Statement of Authenticity

The work contained in this thesis has not been previously submitted for a degree or diploma at any other higher education institution. To the best of my knowledge, this thesis contains no material previously published or written by another person except where due reference is made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

..……
Homoud Al-Anzi
10/4/2008

To my parents and my family *(Zarefah, Deema and Basel)*

Abstract

The Eromanga Basin hosts the Early Cretaceous reservoir sediments of the Murta Formation and its basal McKinlay Member of prograding fluvio-lacustrine and deltaic origin that are characterized by low oil production and recovery factors which are heavily controlled by depositional facies. The integration of the concepts of facies associations, sequence stratigraphy and petrography enabled this study to map the continuity of the Murta Formation and to point out the effect of the diagenetic features on the reservoir quality. The diagenetic effects and spatial distribution of the depositional facies in the basin are essential in nominating locations of good quality reservoirs.

The aims of this study were: to characterize the chronostratigraphic depositional facies and distribution, to examine the affect of diagenesis on reservoir quality and to define those parts of the basin where potential reservoir sands are likely to be found.

A detailed analysis of depositional facies in the Murta Formation and its basal McKinlay Member was based on drill core analysis and regional wireline log correlations. The application of non-marine sequence stratigraphic concepts to the wireline logs and core description data have led to the identification of 7 chronostratigraphic units. This data was used in constructing a series of schematic palaeogeographic and isopach maps of the study area to predict the changes in depositional styles with time and space. Six depositional facies were identified in the study area with overall fine-grained sandstones, siltstones and mudstones. These depositional facies include; distributary channels, shoreline, protected shoreline, deltaic mouth bars, tempestites and turbidites deposits.

One particular unit, the transgressive systems tracts of the McKinlay Member, (Unit 7) is the best target for reservoir development because of relatively high proportion of pay sands, medium to coarse-grained sand sizes and good reservoir quality with low diagenetic affects. High stand systems tract units 2, 3 and 5 are considered to be secondary reservoir targets because of diagenetic affects and their fine-grained character. Units 1, 4 and 6 are not considered of economic value for oil production because of their extremely low reservoir quality and muddy lithologies.

The main diagenetic affects on sandstones (quartzarenites) in the study area are quartz overgrowths, formation of authigenic clay (kaolinite), carbonate cement (calcite and siderite), formation of microstylolites (pressure solution) and dissolution of the framework grains to form secondary pores.

The McKinlay Member of the Murta Formation in South Australia consists mainly of medium to coarse-grained sandstones of distributary channel origin (facies association 1). It has the highest recorded porosity and permeability (9.5% and 36.8mD respectively). Shoreline, protected shoreline, deltaic mouth bars and tempestites deposits, mainly from Jackson-Naccowlah Trend wells in Queensland, are of fine-grained sandstones (facies associations 2, 3, 4 and 5 respectively). They have adequate average porosity (7%), but the formation of microstylolites and associated mica parallel to the bedding planes inhibited vertical permeability and has been recorded to be as low as 3.1mD. Turbidites in the central basin are characterized by extremely low reservoir quality (2.6% and 0.25 mD) and muddy lithologies of facies association 6 that are severely degraded by diagenetic effects.

Acknowledgements

I would like to thank the following people and companies for their help, support and guidance during this study. Their support was of considerable value in helping me completing this study.

First of all, I am very grateful to Saudi Aramco for granting me the scholarship to pursue my Master degree at the Australian School of Petroleum (ASP) and for unlimited financial support and encouragement.

Very special thanks must be given to Dr. Nicholas Lemon (Santos Ltd.) for organizing this project and providing me with his precious ideas and helpful comments. Discussions with Dr. Lemon contributed significantly to the progress of this project. This study would not see the light without you. Full cooperation and data support was given by Santos Ltd. by granting unrestricted access to their database and core store.

My further special thanks extended to my supervisor Dr. Tobias Payenberg for his patience, continuous support and outstanding supervision. I wanted to say that I am truly grateful to you and without your support I would not have been able to complete this study.

Thanks go to Alan Sansome and Les Tucker of Primary Industries and Resources of South Australia (PIRSA) for their helpful cooperation during this study and for access to the South Australian cores.

I would like to thank all the staff at (ASP), particularly Dr. Peter Tingate and Dr. Ric Daniel for their guidance and valuable conversations. Thanks to all of my colleagues at (ASP) for their friendship and help during this two year study.

Last, but most of all, I want to thank my parents and my family for their prayers, love and support.

TABLE OF CONTENTS

All the appendices are contained on the included CD-ROM. The CD-ROM files are in Microsoft word, document imaging, PowerPoint and Excel format.

Appendix 2.1: A detailed core description for all cored wells.

Appendix 2.2: Logging scheme.

Appendix 3.1: Definition of selected sequence stratigraphic terms.

Appendix 3.2: A-A' regional cross section from Harkaway Fault area in Queensland (N-NE) to Murteree Ridge in South Australia (S-SW).

Appendix 3.3: B-B' cross section through Tenaperra Trough, Murteree Ridge, Nappamerri Trough and Patchawarra Trough in South Australia.

Appendix 3.4: C-C' cross section through Patchawarra Trough, GMI Ridge and Tenaperra Trough in South Australia and part of SW Queensland.

Appendix 3.5: D-D' cross section of Jackson-Naccowlah Trend in Queensland.

Appendix 3.6: E-E' cross section of group of northeastern wells representing the thickest sand columns (sand input) in the study area close to Harkaway fault area in Queensland.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

GR……Gamma Ray
DT……Sonic log
Sm……Massive sandstone
Sb……Bioturbated sandstone
Sr…….Rippled sandstone
Ss…….Storm sandstone
Sh……Laminated sandstone
Sd……Deformed sandstone (storm reworking)
St…….Trough cross bedded sandstone
Stt……Thin sand sheets
Fl…….Laminated mud
Fb……Bioturbated mud
F.A……..Facies Association

LST…….Low Stand System Tract
TST…….Transgressive Stand System Tract
HST…….High Stand System Tract
FS……Flooding Surface
TS……...Transgressive Surface
MFS……Maximum Flooding Surface
mMFS…….minor Maximum Flooding Surface
SB……Sequence Boundary

Q…….Quartz
F……. Feldspar
M…….Mica
K…….Kaolinite
I……...Illite
S……..Siderite
C…….Calcite
D…….Dolomite
XRD……X-Ray Diffraction
SEM……Scanning Electron Microscope