A facies atlas for the wave to tide-dominated Gulf St Vincent (South Australia)

David Swiatek (University of Adelaide)

This Thesis is submitted in partial fulfilment of the requirements for the Honours Degree of Bachelor of Science Petroleum Geology & Geophysics

Australian School of Petroleum,

The University of Adelaide

November 2015

Abstract

Marginal marine depositional systems represent a significant proportion of the world's known and exploitable hydrocarbons; however, they are complex environments containing varying modes of deposition and heterogeneity. Marginal marine process classifications have historically lacked adequate interpretation of the variability in mixed-process systems. Modern analogues provide the most accurate planform geometries of marginal marine elements for input into reservoir models. Observations made during deposition of similar systems can supplement seismic, core and geological outcrop datasets, thus improving 3D models. This research develops a facies atlas for Gulf St Vincent as a modern analogue, examining process variability of marginal marine elements resulting from wave and tide-dominant processes.

Gulf St Vincent is a shallow, inverse estuary in South Australia that connects to the Southern Ocean. Gulf St Vincent was flooded by the most recent Holocene post-glacial marine transgression. The sediments that form the marginal marine deposits accumulated along the eastern coast of Gulf St Vincent are interpreted to be derived from the reworking of the gulf floor as the sea level transgressed to its present location.

Analysis of data collected along the eastern coast of Gulf St Vincent displayed evidence that wave height and energy, along with tidal range, control the geomorphology of the shoreline and sediment heterogeneity. Depositional environments changed as the shoreline transitioned from wave to tide-dominated processes. The carbonate-rich sediments in the tide-dominated northern region indicate they were very different depositional environments from the homogeneous quartz-rich medium-grained sands produced in the wave-dominated areas to the south. The dominant process controls vary from wave through tide in a northerly direction.

This research has determined that four types of depositional environments dominate the eastern coastline of Gulf St Vincent, which were linked to process controls and characterised by their shore face slope, sedimentary deposits and architecture. They were linked to distinct arrangements of depositional elements with their own sedimentary signatures. This study also suggests that the observed carbonate sediments can be classified using the Ainsworth et al. (2011) and Vakarelov and Ainsworth (2013) marginal marine mapping and classification systems. The facies atlas presented herein has the potential to inform hydrocarbon reservoir modellers by providing data on the internal architecture of 2D mapped depositional elements.

Acknowledgements

I would like to thank my supervisors Dr Rachel Nanson and Dr Frank Rarity for their ideas, feedback, guidance and advice.

I would like to thank my parents and Alice Fistr for their support.

Contents

Abstract 2

Acknowledgements 3

1 Introduction 6

1.1 Background 6

1.2 Holocene deposition 7

1.3 Literature Review 8

1.3.1 Hydrocarbon Accumulations 8

1.3.2 Wave, tide and fluvial environments 8

1.3.3 Classification methods for marginal marine systems 9

1.3.4 Marginal marine processes and architecture 13

1.3.5 Facies models and facies atlases 14

1.4 Aims and objectives 15

1.5 Regional Setting 15

1.5.1 Waves 17

1.5.2 Tides 18

1.5.3 Fluvial input 19

2 Methodology 20

2.1 Desktop analyses 20

2.2 Field analyses 22

2.2.1 Topography 22

2.2.2 Sedimentology 23

3 Results 23

3.1 Desktop analyses 23

3.1.1 Wave height and tidal range 23

3.1.2 Relative tide range 26

3.1.3 Architectural and process classifications 30

3.2 Topography and sedimentology 30

3.2.1 Cape Jervis to south of Sellicks Beach; rocky headlands 30
3.2.2 Zone 1 - Headland with frequent wave dominated, tide-affected beaches, generally greater than 1km in length 30
3.2.3 Zone 2 – Wave dominated, tide-influenced shoreline 40
3.2.4 Zone 3 – Mixed process delta 43
3.2.5 Zone 4 – Tide-dominated, wave-influenced coastline 52
4 Discussion 59
4.1 Depositional processes in Gulf St Vincent 59
4.2 Modern reservoir elements 65
4.3 Process and architectural classification 66
4.3.1 Process 66
4.3.2 Architecture 67
5 Conclusions 72
6 References 74
7 Appendix 80