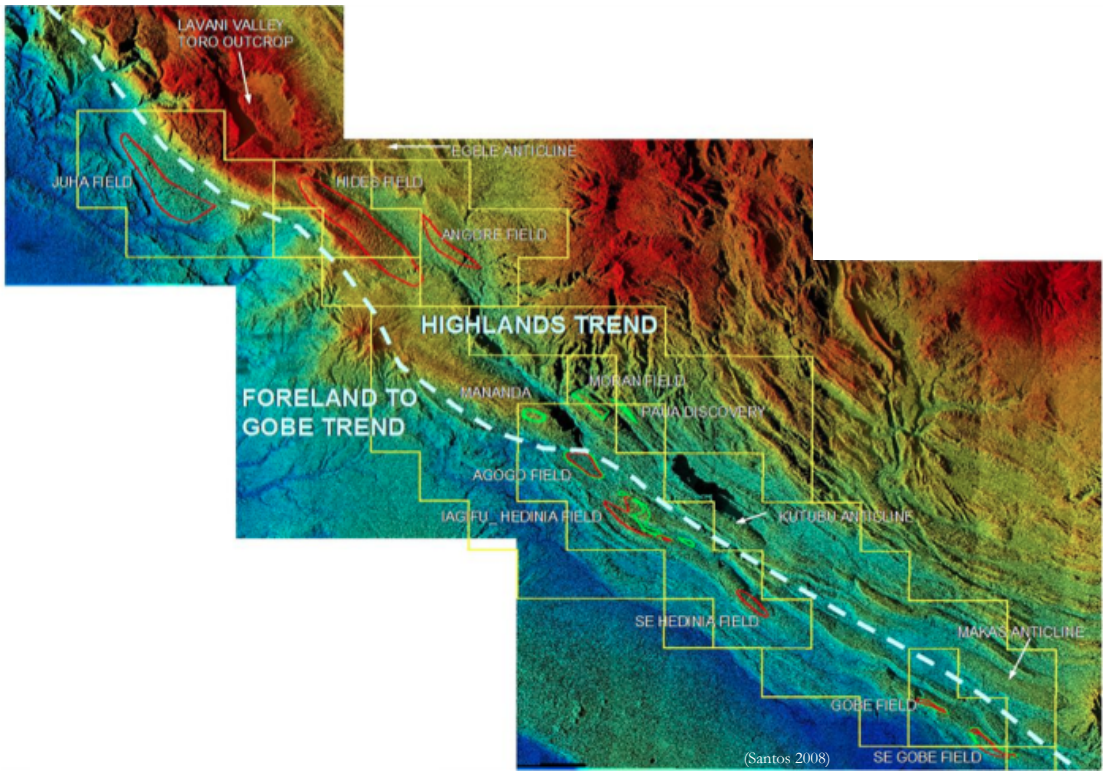
A Regional Study of the Toro and Imburu Formation Aquifers in the Papuan Basin, Papua New Guinea



Blair Hopwood, BSc (Geology) - University of Adelaide

This thesis is submitted in partial fulfilment of the requirements for the
Honours Degree of Bachelor of Science (Petroleum Geology and Geophysics)

Australian School of Petroleum
University of Adelaide

November 2013

Abstract

This study represents a regional review of the Toro and Imburu Formation aquifers in the fold belt and foreland regions of the Papuan Basin, Papua New Guinea (PNG). This study extends previous Toro aquifer studies in the Papuan Basin (Eisenberg 1993; Eisenberg et al., 1994; Kotaka 1996). A comprehensive data set was assembled containing all currently available well formation fluid pressure, salinity and temperature data. These data were used to calculate hydraulic potential (Hw) values, which were subsequently used to generate a regional potentiometric map for the Toro Sandstone reservoir and semi-regional maps for the Digimu, Hedinia and Iagifu Sandstone reservoirs of the Imburu Formation.

The Toro potentiometric surface map generated in this study is consistent with an extensive hydrodynamic Toro aquifer system existing in the Papuan Basin Fold Belt. The Toro aquifer likely flows northwest to southeast parallel to the fold belt, from the Lavani Valley Toro outcrop (likely recharge region) in the Highlands, through to the Kutubu Complex, potentially via Hides, (possibly Angore) and the Mananda/South East Mananda Fields. The evidence for Toro aquifer hydrodynamic flow is strongest through the Kutubu Complex of fields, with water flow, entering via Agogo and exiting the fold belt, at the southern end of the Usano Field into the foreland of the basin. However, it should be noted that gas water contacts (GWCs) for Hides and Angore Fields are not yet available. These have been estimated in this study from Hides and Angore gas pressure gradient intersections with water pressure gradients identified from nearby wells (Lavani-1 and Egele-1). Therefore it is not currently possible to unequivocally identify a connected Toro aquifer system between Lavani Valley, (possibly Angore) and Hides. Nevertheless, the Lavani Valley-Hides-Mananda/South East Mananda system (LV-H-M/SEM) represents the most likely flow path for a Toro hydrodynamic aquifer model in the fold belt. Evidence for hydrodynamic Toro aquifer flow was identified in the opposite direction, in a southeast to northwest direction, in the South East Hedinia Field. Significant compartmentalisation of the Toro reservoir was identified in several Hinterland Fields and anticline structures (Egele, Angore, Moran, and Paua Fields along with the Kutubu and Makas Anticlines) and in the southeast region of the central fold belt (Gobe/South East Gobe Fields).

Likely Toro aquifer flow exit points from fold belt into foreland were identified at the southern end of Usano at Iorogabaui-1 and at southern end of South East Mananada Field at Libano-1 involving the Bosavi Lineament. Possible northwest to southeast Toro aquifer flow was identified in the foreland region of the basin from the Stanley Field in the northwest to the sea in the southeast. The Komewu and Darai Fault systems appear to operate as barriers to northeast to southwest Toro aquifer flow in the foreland.

Considerably less data were obtained in this study for the Digimu, Hedinia, Iagifu Sandstone reservoir aquifers compared to the Toro reservoir unit. However, key findings include; (1) for the Digimu Sandstone, hydrostatic and compartmentalised aquifer behaviour in the Agogo, Hedinia/Iagifu and Moran Fields, (2) for the Hedinia Sandstone, hydrodynamic aquifer behavior in the Hedinia/Iagifu and South East Hedinia Fields and (3) for the Iagifu Sandstone, hydrodynamic aquifer behavior in the Hedinia/Iagifu Fields, a significant Hw step between the Agogo and Hedinia/Iagifu Fields (not seen with any of the other reservoir sandstones) and a compartmentalised aquifer in the Gobe/South East Gobe Fields (where it acts as the main hydrocarbon reservoir).

The updated regional data and potentiometric maps generated in this study will assist sub-regional and field scale modelling of the Toro and Imburu Formation aquifers, future hydrodynamic trapping studies and provide increased confidence for hydrocarbon reserve determination in the Papuan Basin Fields.

Acknowledgements

I would like to thank Mike Starcher at Santos for his guidance on all aspects of the project and for giving me the opportunity to undertake this study. Many thanks for critically reviewing a draft version of my thesis. I am extremely grateful to Sharon Langston at Santos for her patience and help with the project, particularly with hydrogeology, Petrosys potentiometric mapping and reviewing a draft of my thesis. I would like to thank Mark Bunch for his supervision of the project at the ASP and providing feedback on a draft of my thesis. Thank you to Trish Moorfield for her help tracking down well completion reports and Darren Graetz for his help with Petrosys software during my stay at Santos. Thank you to everyone in the 2013 ASP class for making it an enjoyable year. Finally, a big thank you to Louise, Callie and Jess for their support and understanding throughout the year.

Table of Contents