

1. JURASSIC VULCAN-PLOVER (!) PETROLEUM SYSTEM (Vulcan Sub-basin)

The Jurassic Vulcan-Plover (!) Petroleum system is primarily located in the Vulcan Sub-basin of the Bonaparte Basin and extends a short distance onto the Ashmore Platform to the west and the Londonderry High to the east. The Vulcan Sub-basin is a north-east trending Mesozoic extensional depocentre composed of a complex series of horsts, grabens and terraces. The main depocentres within the Vulcan Sub-basin are the Swan and Paqualin grabens and the Cartier trough.

Source pods in the region are restricted to the Swan and Paqualin grabens (with some potential in the Cartier Trough). There are two main sources in the region; the marine dominated Late Jurassic Lower Vulcan Formation and the more terrestrial Early-Middle Jurassic Plover Formation. The Lower Vulcan Formation is the dominant source for both oil and gas in the region. Geohistory modelling suggests the following expulsion history:

- 1) Late Jurassic to Early Cretaceous gas and oil generation. Only gas was expelled during at this time (generative expulsion).
- 2) Tertiary oil and gas expulsion (compaction expulsion).

The restricted distribution of the source pods indicates migration pathways of up to 40km for established accumulations. Reservoirs in the Vulcan Sub-basin are the Late Triassic Challis and Nome Formations, Early-Middle Jurassic Plover Formation, Late Jurassic Vulcan Formation and Late Cretaceous Puffin Formation, with the Plover Formation being the primary exploration target. The Echuca Shoals Formation forms the regional seal. The Vulcan Sub-basin is a well-established hydrocarbon province with commercial discoveries at Cassini, Challis, Jabiru and Skua. Non-commercial discoveries include: Audacious, Bilyara, Birch, Delamare, East Swan, Eclipse, Halcyon, Keeling, Maple, Maret, Montara, Oliver, Padthaway, Pengana, Puffin, Swan, Swift, Tahbik, Talbot and Tenacious.

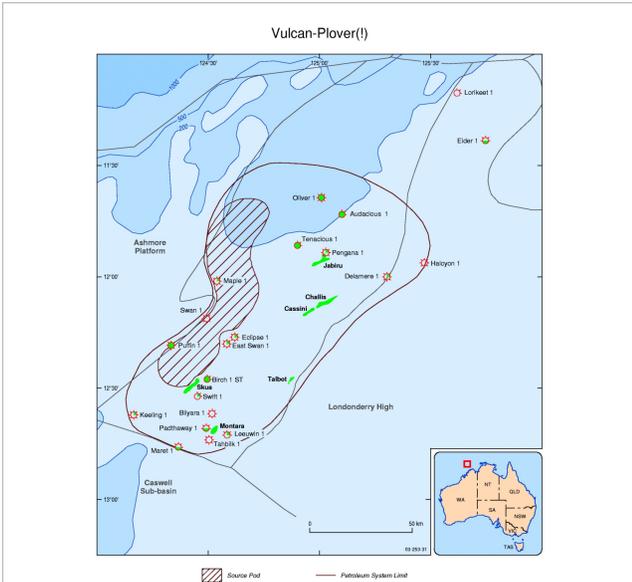


Figure 1: Spatial extent of the Jurassic Vulcan-Plover (!) petroleum system. The petroleum system is restricted to the southern and central parts of the Vulcan Graben. The limit of the source pod is based on geohistory modelling by Kennard et al. (1999).

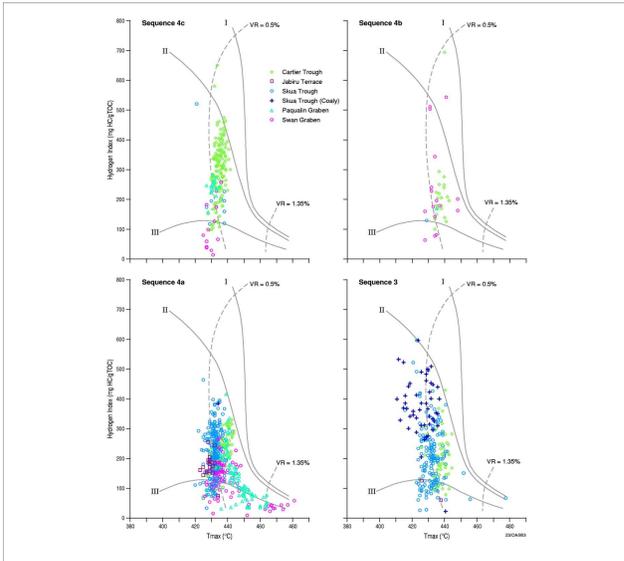


Figure 2: Rock-Eval pyrolysis data plots for potential source rocks in the Plover (Sequence 3) and Vulcan Formations (Sequence 4a, 4b and 4c). The Plover Formation has both oil and gas prone source rocks with Type II, III and IV kerogens. The Lower Vulcan Formation is both oil and gas prone with Type II, III and IV kerogens. It has moderate to good generative potential throughout the Skua Trough, Swan and Paqualin grabens and is leaner in the Cartier Trough.

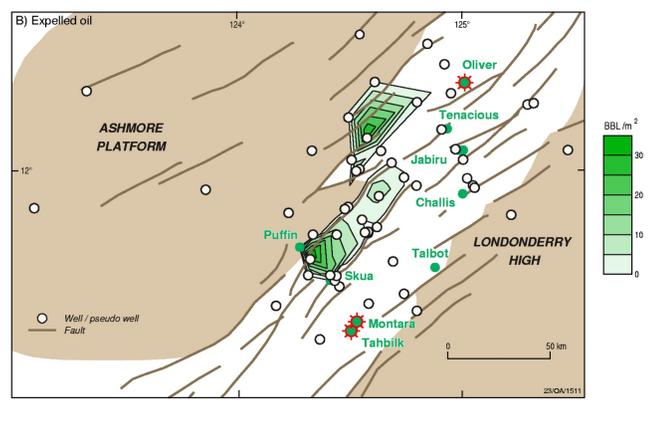
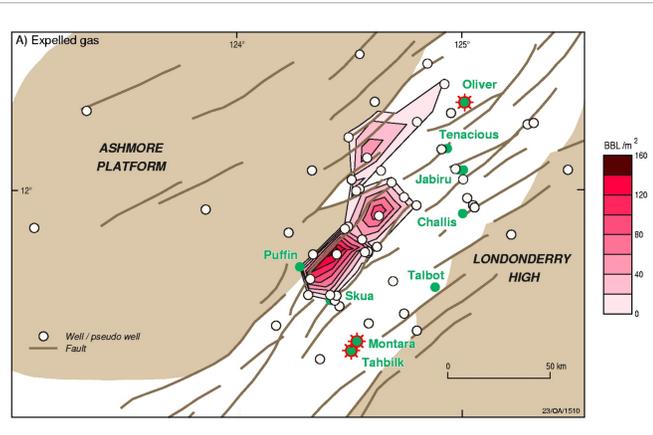


Figure 3: Map of hydrocarbon expulsion from source Unit 4a (Lower Vulcan Formation). A) Gas expulsion. B) Oil expulsion.

Petroleum System Characteristics

- Source:** Vulcan Formation
- Reservoir:** Plover Formation
- Seal:** Echuca Shoals Formation
- Source Quality:** Oil and gas prone
- Source Type:** Marine source with varying terrestrial input
- System Age:** Jurassic
- Expulsion:** Late Jurassic-Early Cretaceous (gas), Late Tertiary (oil and gas)
- Traps:** Horst blocks, delta sands, shoreface sands, basin fans
- Risk:** Fault seal, available migration pathways
- Key References:** Barrett, A.G., Hinde, A.L., & Kennard, J.M., 2004. Undiscovered resource assessment methodologies and application to the Bonaparte Basin. In: Ellis G.K., Baillie P.W. and Munson T.J. (Eds) Timor Sea Petroleum Geoscience. Proceedings of the Timor Sea Symposium, Darwin, Northern Territory, 19-20 June 2003. Northern Territory Geological Survey, Special Publication 1.

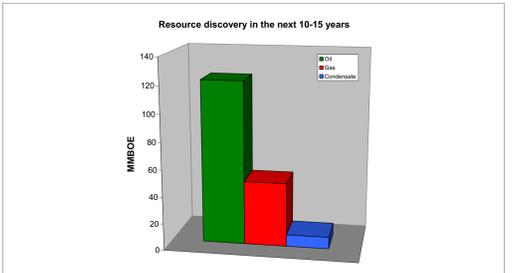


Figure 4: Geoscience Australia (Austplay) estimates of the recoverable hydrocarbons to be discovered in the next 10-15 years in the Jurassic Vulcan-Plover (!) petroleum system. Based on the work of Barrett et al. (2004).

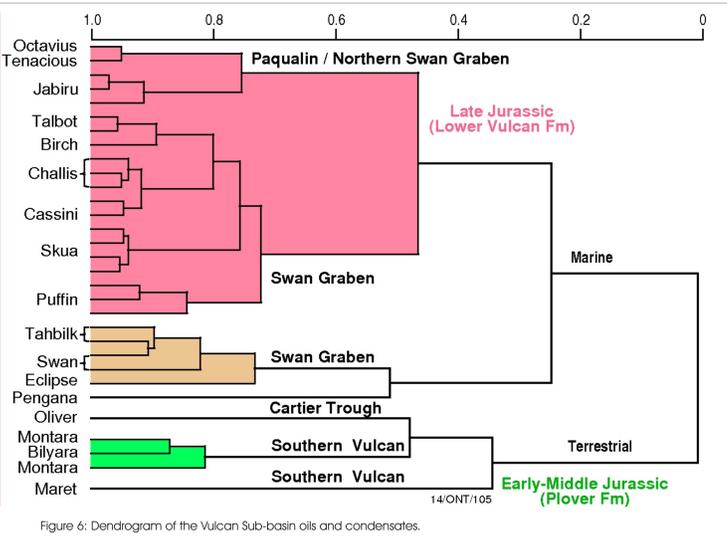


Figure 6: Dendrogram of the Vulcan Sub-basin oils and condensates.

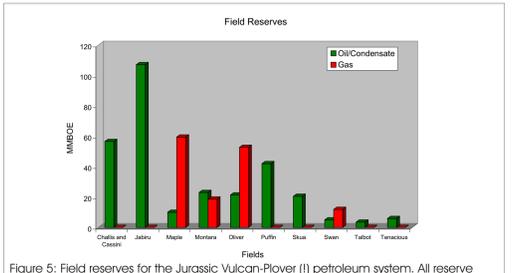


Figure 5: Field reserves for the Jurassic Vulcan-Plover (!) petroleum system. All reserve numbers are sourced from the Northern Territory Government Department of Business, Industry and Resource Development. Reserves/resources are estimated by the Department and exploration companies.

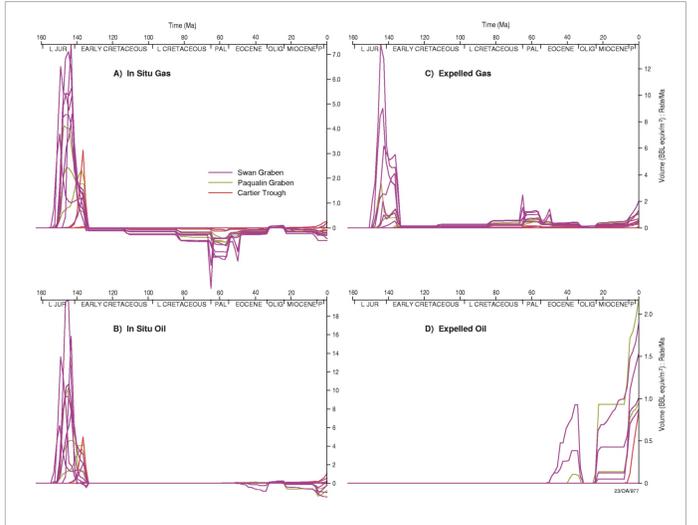


Figure 8: Hydrocarbon generation and expulsion models for the Lower Vulcan Formation. A) Rate of in-situ gas formation (positive values) and gas expulsion (negative values). B) Rate of in-situ oil formation (positive values) and oil expulsion (negative values). C) Rate of gas expulsion. D) Rate of oil expulsion. The main phase of gas generation and has been classed as "generative expulsion". There was no coinciding expulsion of oil with the main oil generative phase. Oil expulsion occurred in the mid-late Tertiary during burial and compaction (compactional expulsion).

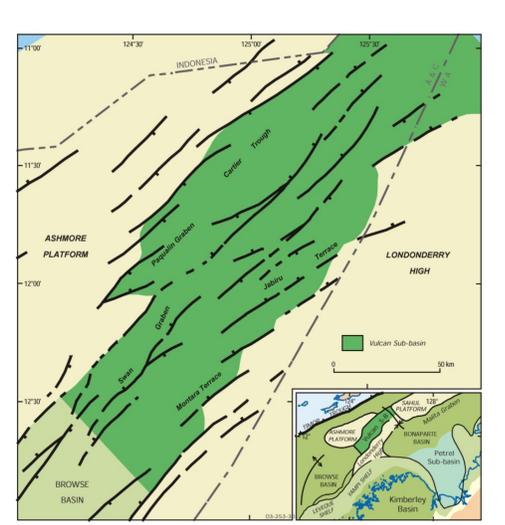


Figure 9: Structural elements of the Vulcan Sub-basin. The main hydrocarbon generating depocentres in the Vulcan Sub-basin are the Swan and Paqualin grabens and the Cartier Trough.

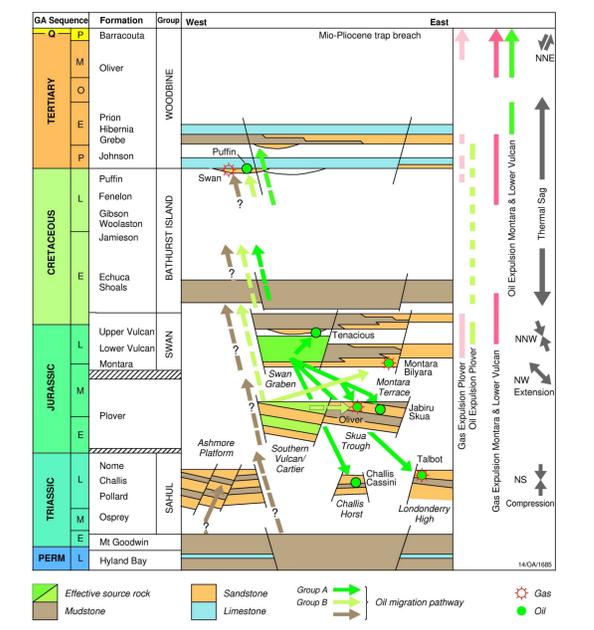


Figure 10: Schematic diagram of the Jurassic Vulcan-Plover (!) petroleum system.

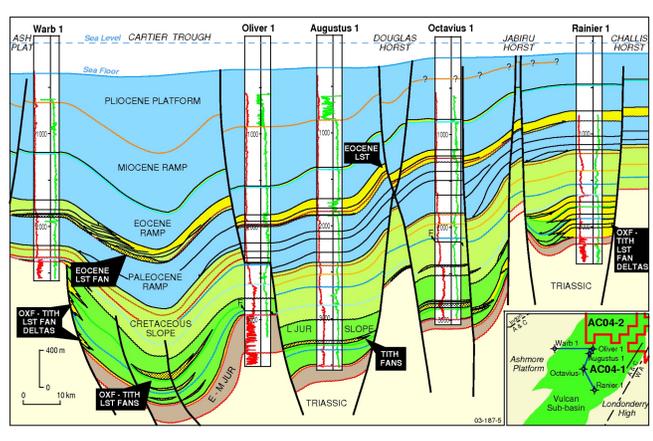


Figure 7: Schematic cross-section and sequence correlations through the northern Vulcan Sub-basin.

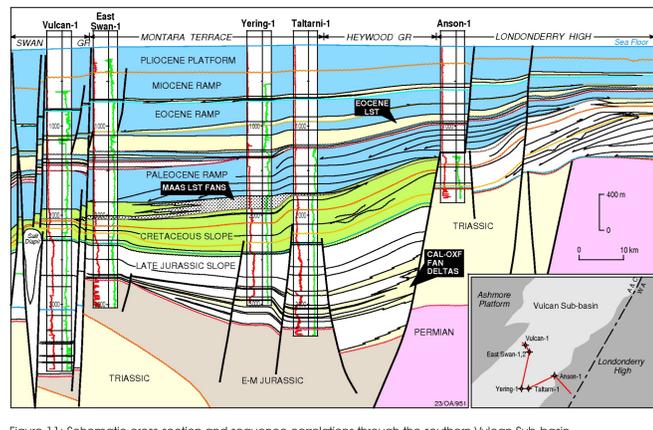


Figure 11: Schematic cross-section and sequence correlations through the southern Vulcan Sub-basin.