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[EA]The First Oil Seep Discovery in South East PNG and its Implications to Torres Basin Petroleum System Analysis*

Michael Swift[1], Ric Malcolm[1], and H. Davies[2]

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[1]Larus Energy Pty Ltd., Papua New Guinea (michael@larusenergy.com.au)
[2]Emeritus Professor, University of Papua New Guinea, Papua New Guinea

Abstract

The Torres Basin is located within the northern Papuan Plateau; see Figure 1. It is a major depocentre with a sediment thickness, derived from seismic and gravity data, of over 10 kilometres. It is a frontier region in respect that there are no exploration wells in the region. The first confirmed oil seep was encountered in 2017, in the foothills of the Aure Thrust Belt near the village of Imila. More specifically the seep is in the very front edge of the Bogoro Shear Zone where the major obduction over-thrust faults come to the surface. The oil characteristics significantly modify the understanding of the petroleum systems in the wider region. The age of the subsurface sediments is unknown, but the oil seep age and maturation depth indicate the shallow section is certainly Paleogene and younger and probably the remaining section is Mesozoic in age. This means the Torres Basin petroleum systems are comparable with the Papuan Basin; see upper right in Figure 1. Further, the shallow section is the southern extension of the Cenozoic age Moresby Trough, a part of the East Papuan Basin.

Geochemical Analysis

The oil seep has been geochemically types via GCMSMSQQQ analysis, which showed the sample to be a light (API 46.4) raw crude of Paleogene age oil with a conventional petrogenic origin. The geochemistry of the oil does not place it among any previously identified fluid family's and it is not from either (a) an upper Jurassic source rock as for many fold belt oils and condensates (b) a Neogene marine source rock as for some Gulf of Papua condensates. Assuming average heat flows and geothermal gradients the oil is from a depth of about four kilometres and the oil has no signature indicating significant liquids to gas cracking. The oil is from a clastic (clay rich) containing a mixture of marine algal and land-plant organic matter. The likely depositional environment is a paralic-marine deltaic setting with transported land-plant organic matter deposited under open-water (sub-oxic to oxic) marine conditions.

Environmental Factors

The environmental factors point to the upper geological section of northern margin of the Papuan Plateau as still being the north facing post rift section of the Jurassic Tethyan rift system, see Figure 2. Seismic stratigraphic analysis also points to a preserved and undisturbed syn-rift (Jurassic and Cretaceous) section below. The seismic data and surface geology allow for cross section reconstruction, see Figure 2, whereby the major elements are:

Permian: Intracratonic basin formed within Australian Plate.

Jurassic: Triassic rifting and then Jurassic sedimentation forms Torres Basin. Location of suspected horst block defining northern margin of Torres Basin derived from gravity modelling. Rift faulting dip is to the north. The basin may be a restricted basin; the extended crust would indicate a failed rift. Otherwise it may be oceanic crust with a more open rift system.

Cretaceous: To the end of the Cretaceous there would have been a rift margin setting (syn and post rift) with sediment derived from the Australian Craton, sediment flow is south to north.

Paleocene: By this time, the Coral Sea Oceanic Crust has formed; this isolates and moves the Papuan Plateau from the Australian Plate. The extent of south dipping faults defines hinge zone of this latest rift system. There is erosion and a major unconformity in the south, at the hinge line the Mesozoic section begins to be preserved and thickens to the north. Further north there is continuous sedimentation.

Eocene: Continuous sedimentation in deeper water with no clastic input, sedimentation is largely carbonate.

Base Miocene: Obduction of the Solomon Sea plate starts to the north, the obducted ultramafic crust segment is now known as the Trobriand Plate. This event sets up foreland basin and peripheral bulge over the Papuan Plateau. There is a major erosional unconformity associated with the peripheral bulge (in parts it cuts deeper than the Coral Sea Unconformity), but the fore-deep allows for a complete Paleogene section to be preserved to the north.

Post Miocene: Obduction of over 150 km of the Trobriand Plate (Fitz and Mann, 2013) (can be referred to as the EPCT, Solomon Sea Plate, and Melanesian Arc) dominated the structuring and creates a regional foreland basin (often referred to as the Aure-Moresby Trough). There has been significant mountain building and crustal thickening due to the over thrust of oceanic crust and ophiolite. The southern Papuan Plateau is now under deep water in a foreland basin setting.

Conclusions

In summary the oil age as pre-collision/obduction indicates the Paleogene section survived the Oligocene erosional unconformity event. The seismic stratigraphy indicates the entire Jurassic rift and Cretaceous post rift section is probably preserved in the northern Papuan Plateau and

under the Trobriand Plate. The maturity/age depth of 4 km of Cenozoic infers the remaining 6 km of sediment to be Mesozoic in age and in the oil and gas generation windows.

Reference Cited

Fitz, G., and P. Mann, 2013, Evaluating upper versus lower crustal extension through structural reconstructions and subsidence analysis of basins adjacent to the D'Entrecasteaux Islands, eastern Papua New Guinea: Geochemistry Geophysics Geosystems, v. 14/6, p. 1800-1818.

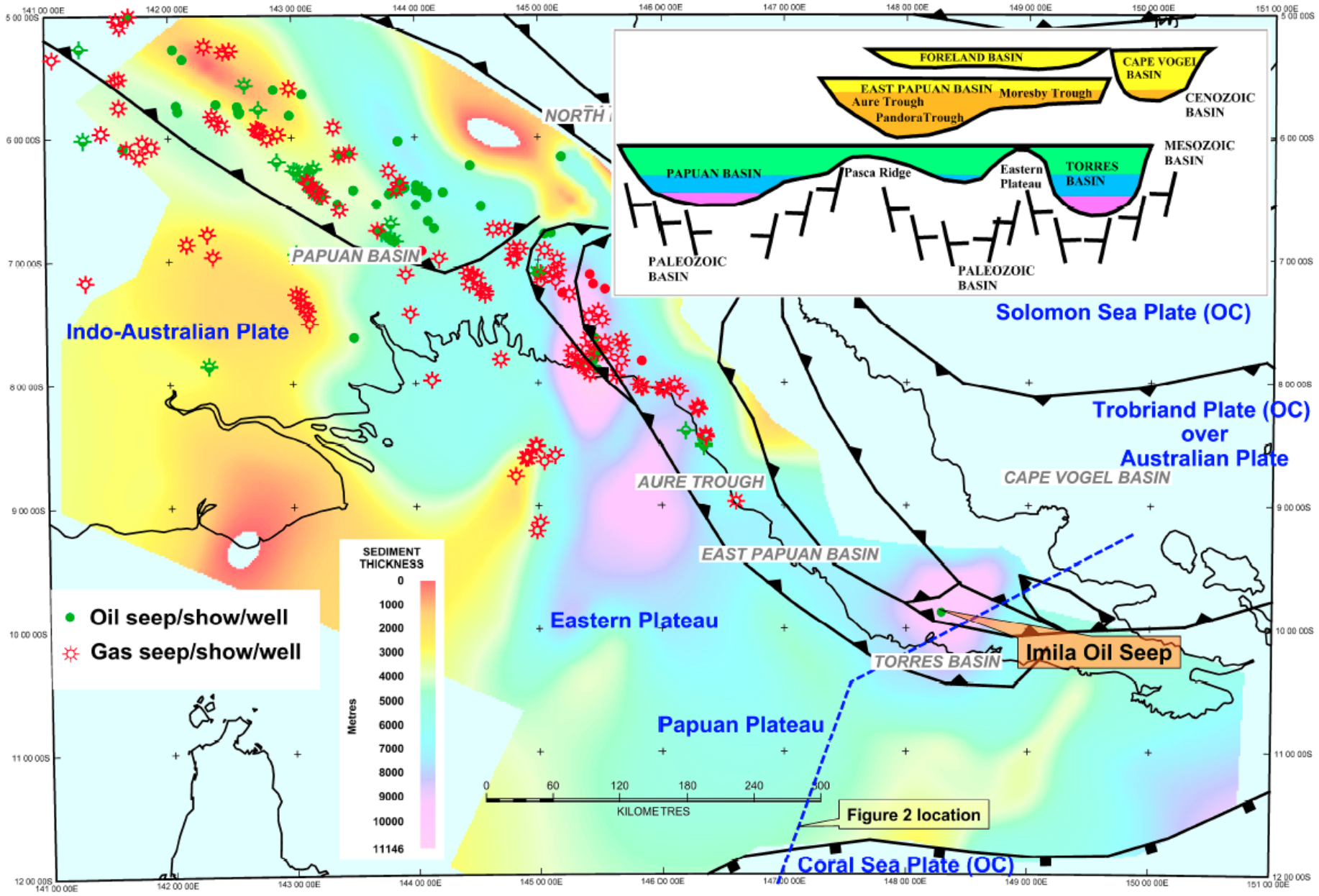

Figure 1. Torres Basin location. The first confirmed oil seep (Imila location) is indicated.

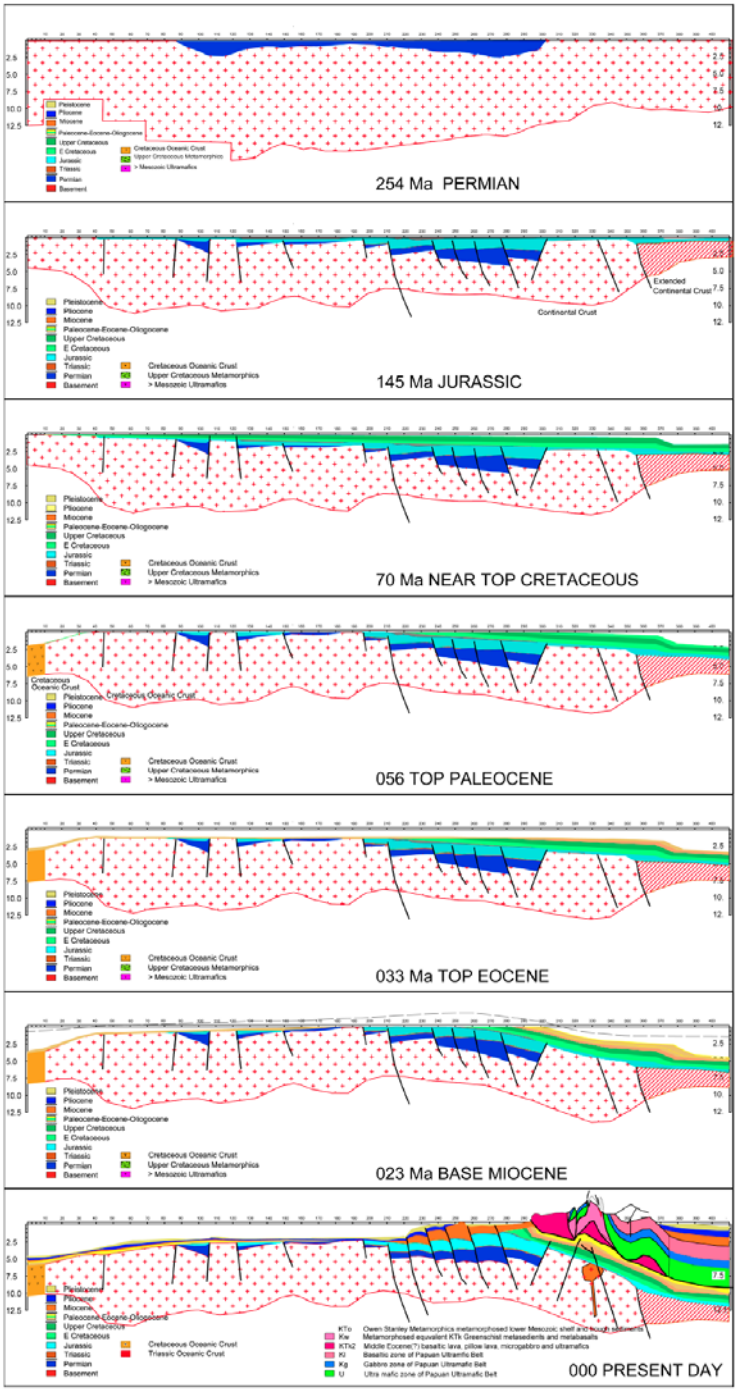

Figure 2. Geological reconstructions. Location shown in Figure 1, south to the left, north to the right.