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Author: Brent McInnes; b.mcinnes@curtin.edu.au; +61 411 800 875

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The Exotica Carbonate Debrite Formation: A Potential Source for Thermogenic Hydrocarbon Seeps Offshore New Ireland, New Ireland Basin, Papua New Guinea

Brent I.A. McInnes*[1,2] and Timothy F. McConachy[2]
[1]John de Laeter Centre, Curtin University, Perth Australia
[2]Peak Oil (PNG) Pty Ltd, Melbourne Australia

Abstract

The New Ireland Basin (NIB) is a 900 km x 180 km frontier offshore basin in northern Papua New Guinea (PNG). Research cruises in the 1990's reported submarine hydrocarbon seeps of thermogenic origin emanating from scarp slopes and volcanic mounds in the offshore deepwater basin (Schmidt et al. 2002). The source of the seeps was tested in 2017 by long offset, deep tow 2D seismic during the Solomon Sea 2017 survey (Searcher Seismic, 2019). The seismic data reveal a new sub-basin (Lihir sub-basin) with 8 km of sediment overlying a basement of Eocene oceanic crust.

The seafloor seeps are located above a low amplitude anticlinal structure with an apparent wavelength on the order of 6 km. Sedimentary layering in the deeper portion of the anticlinal hinge is obscured by attenuation of the seismic signal, however the limbs of the anticline show a seismic interval with discontinuous and contorted reflections consistent with a debrite deposit. Based on a limited number of lines, this seismic unit, named the *Exotica Formation*, can be demarcated at 45 km long, 32 km wide, 100-400 m thick and buried to a depth of 2 km.

The source of the Exotica debris apron can be traced to a graben structure on New Ireland bounded by Nabuto Bay to the north, the Ramat Fault to the west and the Matakan Fault to the east. Here a 160 sq km section of Miocene Lelet Limestone (250-400 m thick) is missing from the rock strata in the evacuation area. The vertical relief from head-to-toe of slope is 2 km. Pliocene samples of bituminous carbonate breccia, collected as xenoliths ejected onto the basin seafloor by kimberlite-type eruptions, may be representative of the Exotica Formation.

A model to explain the combined observational evidence is that subduction-related earthquake activity triggered a catastrophic collapse of the New Ireland coastline, transporting substantial carbonate platform sediments downslope into deepwater to form a toe-of-slope carbonate megabreccia debris flow deposit. The seep emissions and bituminous samples suggest that portions of the Exotica Formation may be charged with hydrocarbons. Potential global analogues include the Tamabra Formation in the Poza Rica field in the Gulf of Mexico (Loucks et al., 2011), the K/T carbonate breccias of

the Cantarell field in the Gulf of Mexico (Grajales-Nishimura et al., 2000) and the carbonate debris reservoir of the Ruby field in the South Makassar Basin of Indonesia (Pireno et al., 2015).

Grajales-Nishimura et al., 2000. Geology 28, 307-310.
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Pireno et al., 2015. J. Eng. Technol. Sci. 47(6), 640-657.
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Schmidt et al., 2002. Chemical Geology 18, 249-264.

Presenter CV

Brent McInnes completed his PhD at the University of Ottawa in 1995 and has subsequently worked in geoscience research at Caltech and CSIRO. In 2009, he co-founded Peak Oil to explore for hydrocarbons in the New Ireland Basin and joined Curtin University as Executive Director of the John de Laeter Centre. His honours include the 2018 Paul Dunn Award for Research Development, the 2007 Fulbright Coral Sea Scholarship (NASA Goddard Space Flight Centre), the 2007 CSIRO National Service from Science Award (Technology Commercialisation) and the 2003 CSIRO Chairman's Gold Medal for Research Excellence (Marine Exploration).