
**ORAL PRESENTATION**

# Deep Water Sabah: The Past, Present, Future

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Shell has had an active exploration and production presence in offshore Sabah since the late 1950's. In fact, Shell was the first company to drill offshore Labuan (Hankin-1) after being granted a marine concession off the Western coast of Sabah in 1958. Early exploration was based on dynamite-sourced single fold 2D seismic with lines targeting large geological features and yielded disappointing well results. However, with the adaptation of airguns and improved seismic penetration complemented with optimal seismic migration techniques, the improved imaging led to a string of commercial discoveries starting with Erb West-1 in 1971. This unlocked the Sabah Inboard TB2.4-2.6 and TB 3.1 Topsets structural plays demonstrated in well-known fields such as Samarang, South Furious, St Joseph and Barton, and a host of smaller lesser-known non-commercial discoveries.

Whilst pioneering multiple detailed basin evaluation and play assessments in support of exploration campaigns, these activities also assisted in deciphering some of the earliest sequence stratigraphic framework of NW Borneo known as "Stages". This unconformity-bounded classification was established by in-house geologists Bol and van Hoorn (1980) in the 1970s. Subsequently in the late 90s, studies began to integrate eustatic sea level changes (Haq et.al., 1988) and tectonic influences resulting in the creation of a "Tertiary Boundary (TB) Sequence Framework" linking NW Borneo deepwater turbidite sequences. Despite multiple nomenclatures being introduced by different researchers in this basin, this foundational work remains central to current understanding of NW Borneo geological evolution.

After discovery of oil and gas in the Kinabalu field in 1989, Shell's exploration focus began to shift away from the shallow water heartland towards the realm of TB 3 Late Miocene turbidite sequences that were postulated to exist outboard and structured within the delta-toe fold belt play. With drilling technology advances allowing for safe cost-effective deepwater exploration, the 90's and 2000's became decades dominated by deepwater activities. The first material success was the giant Kebabangan gas field discovered in 1994 and followed-up with Kamunsu East gas field in 1998, signifying the presence of a major new gas play. Increased drilling activity followed, leading to the discovery of oil as well as gas in the Limbayong, Gumusut, Malikai and Ubah fields. One of the key enablers that allowed these prospects to be drillable was the availability of a carpet of high-quality 3D seismic data resulting in reliable identification of Direct Hydrocarbon Indicators (DHI's) such as flat spots supported by AVO analyses for predicting reservoir fairways. This polarized fold-belt prospects towards a more manageable level of risk. With ever greater 3D seismic coverage and improved seismic fidelity, many of the identified folds were perceived to have limited hydrocarbon retention due to pervasive overlying gas clouds, signifying retention failure. However, bold appraisal wells such as KMEUC-1s1 and Ubah-2 proved that NW Borneo fold-belt fields are dynamic traps leaking hydrocarbons due to mechanical and/or capillary seal failure but were also capable of retaining full-saturation hydrocarbons as seals reformed on pressure drop.

The deepwater turbidite play has been chased into the outer fold belt and ever deeper waters but unfortunately reservoir properties, sand thickness and quality, deteriorate towards the distal edge of the fan systems. Despite hydrocarbons being discovered in many of the fold structures outboard, most remain undeveloped due to insufficient recoverable volumes to meet the economic thresholds. Wells encountered oil in more thin beds resulting in challenging recovery. It was realized that commercial reservoir fairways were not as widespread and abundant as initially envisaged. Following Gumusut field first oil in 2014 and Malikai first oil in 2016, efforts were concentrated on near field exploration with some success. An example was Malikai 103 KMU-1 exploration-keeper where it was brought on stream within 6 months' time. Entering the current decade, it is generally believed that the conventional FTB play has been creamed, and new plays were needed to justify further wild-cat exploration.

Today, Sabah basin remain core to Shell with more wildcat exploration expected in coming years. Attention has now shifted towards the ultra-deep waters of the Sabah trough and foreland. The oil and gas discovery of Tepat-1 (2018) in Oligo-Miocene carbonates has undoubtedly stimulated excitement that another working petroleum system exists in this basin – an extension

of the Nido carbonate play in the Philippines. However, with so few exploration wells having been drilled, the materiality and commercial viability of this play remains yet to be proven.

Offshore Sabah is a world class geological laboratory in which to study the interaction of tectonics and stratigraphy. The study of inboard tectonostratigraphy enabled prediction of the presence of effective turbidite plays outboard long before seismic was acquired to reveal them in all their glory. Over the last six decades seismic data acquisition and wildcat exploration drilling have been crucial in unlocking the potential of this basin, polarising understanding of key hydrocarbon play elements and leading to commercial oil discovery. The scientific methods used here have been exported by geoscientists all over the world and have contributed to unlocking petroleum systems in many other basins.

**References**

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**SPEAKER BIOGRAPHY**

Pollux Sii is a versatile and curious geoscientist who has been working on the NW Bornean margin since joining Shell in 2017. He worked primarily on maturing fold-and-thrust belt deep water turbidite NFE prospects towards safe well execution. Prior to that, Pollux obtained a PhD in Applied Geosciences at Heriot-Watt University Edinburgh focussing on East African margin tectonic evolution and holds a MSc in Petroleum Geoscience from Imperial College London. Today his work focussed mainly on evaluating and assessing new play potentials in ultra-deepwater Sabah.