AAPG Datapages/Search and Discovery Article #90234 © 2015 AAPG Asia Pacific Region, Geoscience Technology Workshop, Opportunities and Advancements in Coal Bed Methane in the Asia Pacific, February 12-13, 2015, Brisbane Australia

Coalbed Methane Potential and Current Realisation in Indonesia

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Abstract

Conventional oil and gas exploration and production has a long history in Indonesia. Exploration for oil in Indonesia dates back to 1871, with the first commercial production beginning in 1885 (see also Poley, 2010). Coalbed methane (CBM) exploitation however is much younger. The legal framework for CBM production sharing contracts (PSCs) was only initiated in 2006 (Godfrey et al., 2010) and is still maturing. The first CBM PSC was awarded in 2008 (Boger et al., 2014).

It is estimated that Indonesia has over 105 billion tons of coal resources, and 99% of those are located in either the islands of Sumatra or eastern Kalimantan (Anonymous, 2012). All of the coal has been formed in Tertiary-age basins (Fig. 1) and it is not surprising that these are also targets for CBM exploration. Preliminary estimates for hydrocarbon potential range up to 450 trillion cubic feet (TCF) (Hadiyanto and Stevens, 2005; Stevens et al., 2001) but the realisation of this resource has so far been limited.

The primary CBM targets are Miocene-age coal seams in the South Sumatra and Kutai Basins. In the Kutai Basin, the coals are generally thin (<0.5 to 4 m; Moore et al., (2014)), laterally discontinuous but have a net coal thickness of 40 – 80 m over a stratigraphic interval of 400-800+ m. Coal ranks vary from 0.30 to over 0.70 vitrinite reflectance (Moore et al., 2014; Nas, 1994). The dominant depositional setting for the Kutai Basin coal-bearing sediment is fluvial deltaic (Bachtiar et al., 2013; Cibaj, 2010; Nas, 1994).

In contrast to the Kutai, the South Sumatra coal seams are thicker (generally >5 m and up to 25 m), laterally continuous over tens of kilometers and in some areas net coal can exceed 120 m over less than 300 m of stratigraphic section. The rank range for the coal seams is generally lower than for the Kutai Basin, with vitrinite reflectance values rarely exceeding 0.45% (Mazumder et al., 2010; Sosrowidjojo and Saghafi, 2009) except where they have been thermally altered (Amijaya and Littke, 2006).

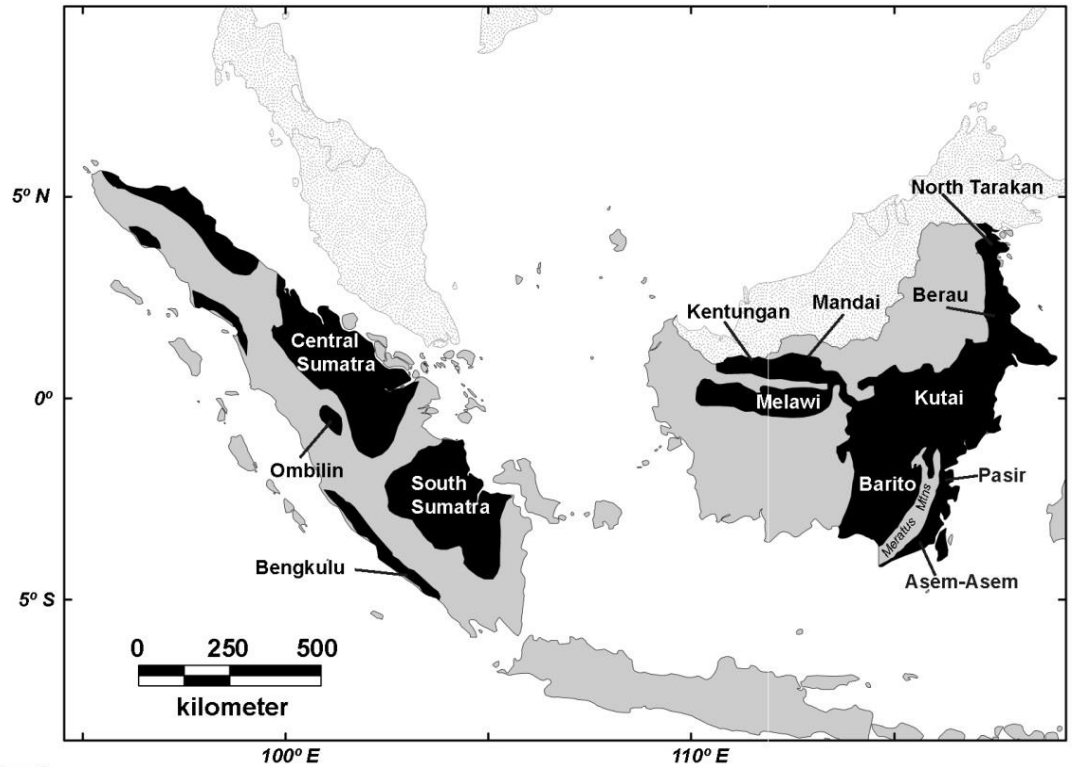

Figure 1: Tertiary-age coal-bearing basins in Indonesia (modified from Moore et al., 2014).

To date, 54 PSCs have been issued since 2008 and 84 CBM core and pilot wells have been drilled by 18 PSC operators in Indonesia. Of these, approximately one third have been drilled in one PSC in East Kalimantan. Five PSCs have commenced pilot well activity, amounting to 12 wells.

In March 2014 the government lowered its production forecasts reflecting this slow progress (Len, 2014).

These early programs have however, yielded some interesting results. Gas contents are generally higher in the Kutai Basin (2-10 m3/t, as received basis [ar]) than in the South Sumatra Basin (generally <3 m3/t, ar). There is generally a good relationship between depth and gas content, though most of that variation is driven by down hole rank increases (Moore et al., 2014). Gas saturations tend to be greater than 80% at depths greater than 300 m. Both basins are also dominated by biogenically-derived methane, although the Kutai Basin may have some thermogenic gas (Fig. 2; Moore et al., (2014)). Gas composition is generally high in methane (>90%) in both basins, though some areas appear to be high in CO2, possibly from volcanic sources (Moore et al., 2014), although other areas of high (~20%) CO2 are less well understood.

Finally, permeability determinations continue to be a bane of CBM reservoir characterization in Indonesia. Ranges from single digits to tens of millidarcies have been recorded in both basins, although the veracity of the data is often questionable. In general, the Kutai Basin may have lower permeability than the South Sumatran coals, but more robust data are needed.

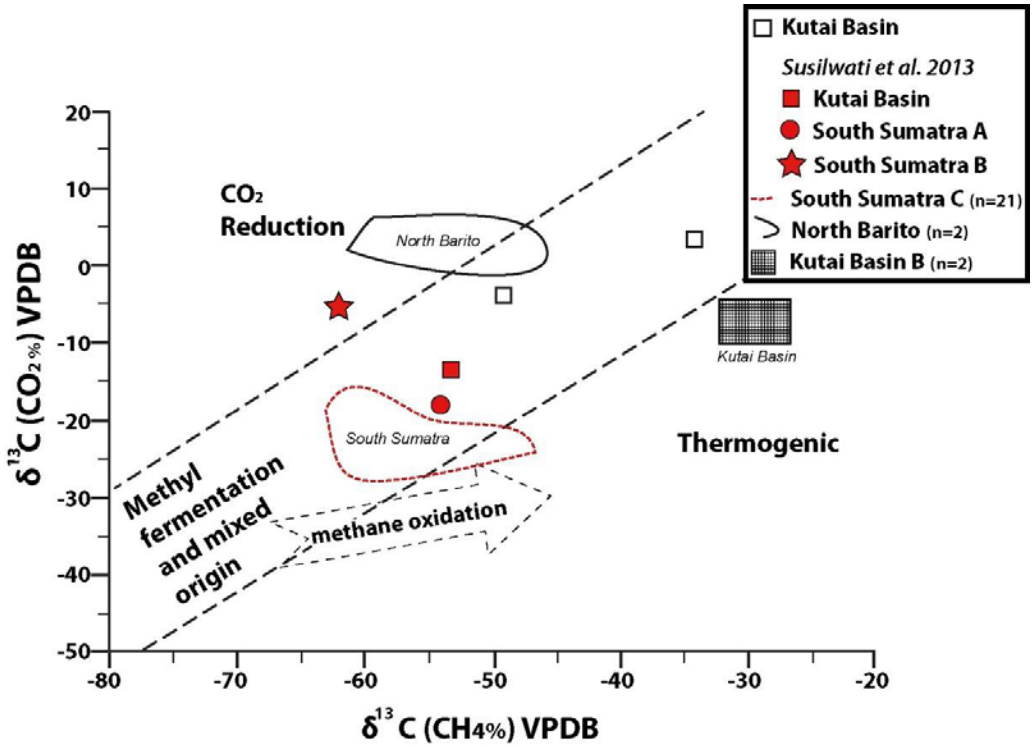

Figure 2: Isotopic analysis of methane from some coals from Indonesia (Moore et al., 2014; Susilawati et al., 2013).

Early attempts by operators in Indonesia to adopt techniques used in CBM plays in the USA and Australia have met with disappointment. Geomechanical properties have caused many pilot wells to fail because of improper completion types. Analogies with other CBM plays, while useful have had limited application in Indonesia.

Successful drilling techniques applied in Indonesia have had to take into account wellbore stability as a priority over formation damage. Shallow gas is common from as little as 90 m and risks loss of rigs. Cementing in Indonesian CBM wells is problematic without careful engineering. As a consequence of these difficulties, high quality data, especially gas content from coring and in-situ permeability testing has been difficult and expensive to obtain.

Completion techniques in Indonesia that have had success to date involve casing, cementing and perforation. Completions involving slotted liners and external casing packers have invariably failed and leave little scope for remediation. Low permeability necessitates fracture stimulation. Coals are often quite brittle and fracture well. There is also scope for horizontal drilling, especially in South Sumatra but a good understanding of the geomechanical properties of both the coal and its overlying formations are required first.

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