

THE OCCURRENCE OF METHANE GAS SEEPAGES IN THE UPPER KETUNGAU AREA, WEST KALIMANTAN

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ABSTRACT

Uplifting event on the Boyan Melange, that formerly known as the Semitau High in West Kalimantan has resulted in the separated Ketungau and Melawi Basins in the Late Cretaceous or Early Tertiary time. Initial stage of sedimentary deposition within the Ketungau Basin occurred in Early Eocene, depositing a fluvial conglomerate unit that subsequently changes upwards into a shallow marine and lacustrine unit of the Kantu Formation. The Eocene Kantu Formation consists of alternating dark grey and laminated carbonaceous shale, mudstone and siltstone with coal seam intercalations and the Ketungau Formation, which is composed of alternating dark grey and laminated carbonaceous shale, claystone, siltstone with coal seam intercalations inferred to be able performed as a source rocks for initial biogenic methane. On the other hand, the Oligo-Miocene Tutoop Sandstone that consists of dominantly a coarse- to fine-grained clastic unit may potentially conduct as a secondary reservoir rock for coalbed methane. Gas seepages that have been observed on surface along the tributary of Peturau and Sebuntung Rivers in the Upper Ketungau region is presumed to be derived from a coalbed methane source within the Kantu and Ketungau Formations. The methane gas is assumed to be ascending on surface through structural faults that trending NW-SE direction.

1. INTRODUCTION

Ketungau Basin that lies in northwest-Kalimantan (Figure 1) was formed in Oligo-Miocene time. It is bordered by the Lubok Antu Melange in Sarawak Area to the north and the Semitau High (Boyan Melange) to the south. The separation of the Ketungau and the Melawi Basins was due to the uplifting of the Semitau High (Boyan Melange). The oldest unit in the Ketungau Basin is the Kantu Formation that can be correlated to the Haloq Formation in the Melawi and west Kutai Basins. The Kantu Formation is unconformably overlain by the Oligo-Miocene Tutoop (Sandstone) Formation which in turn is conformably overlain by the Ketungau Formation.

The Kantu Formation consists of alternating dark grey laminated shale, mudstone and siltstone which was deposited in an intramontane lacustrine environment. The formation contains several coal seams that may perform as a coalbed methane source. The Upper Miocene Ketungau For-

mation which comprises alternating shale, mudstone and coal seams might also perform as a source rock or as a seal. Both the fluvial Tutoop Sandstone and Ketungau Formations may potentially conducted as gas reservoir rocks. The Ketungau Basin which is occupied by a syncline structure might has a potential to increase permeability in the axis of fold due to the extension (Dowson, 1999).

Coalbed methane that occurs on a surface along the Peturau River in the upper Ketungau Region is presumed to be passed through a fault. Several observation points were carried out during the Canadian Occidental Oil exploration in the Ketungau and Melawi Basins. The aim of this study is to describe the occurrence of gas seepages in the upper Ketungau area which indicated a gas source from the coalbed methane within the Kantu and Ketungau Formations.

Data presented in this paper are mostly obtained from field observations during the Geological Re-

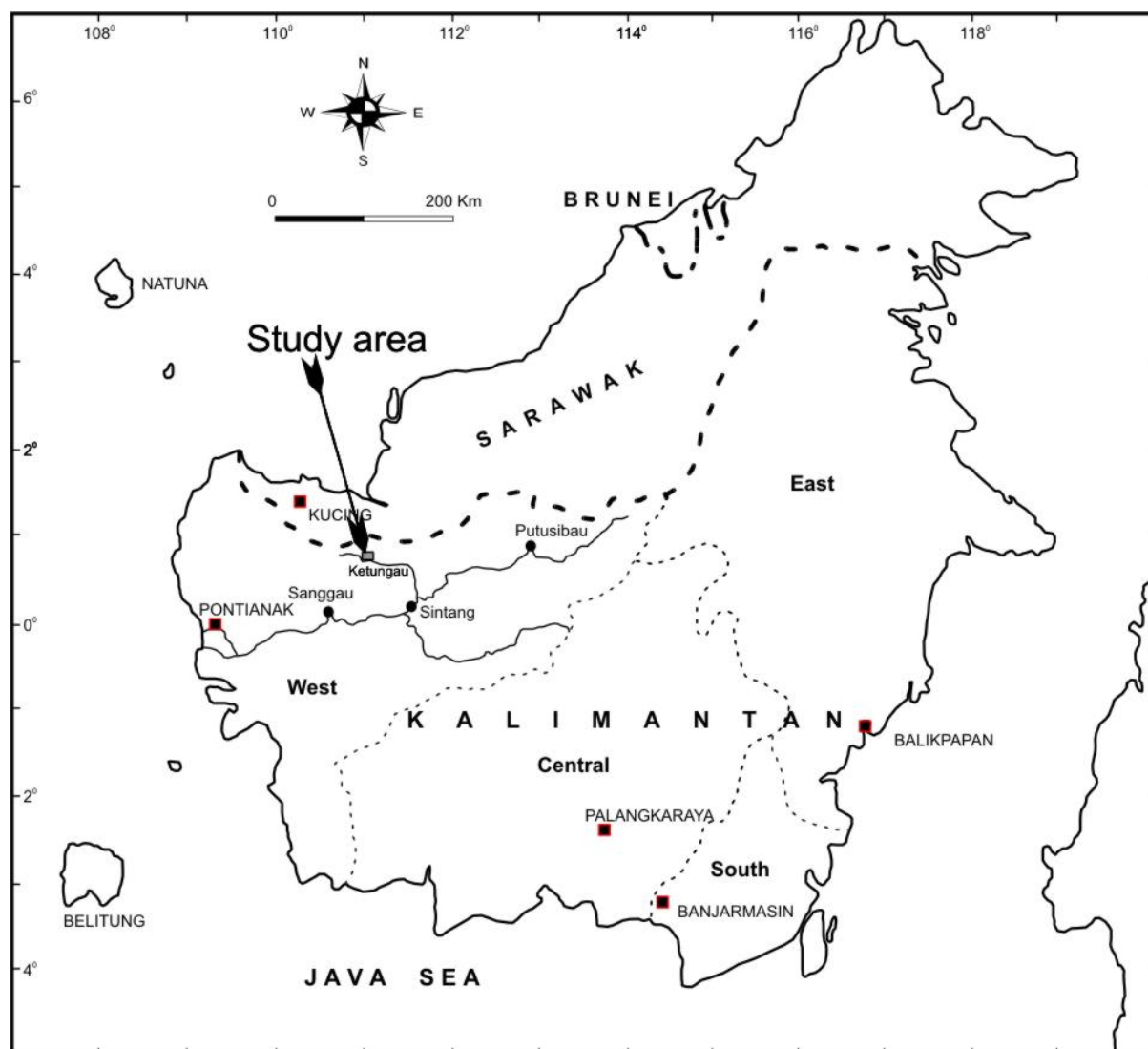


Figure 1. Location of study area in the Upper Ketungau region

search and Development Centre and the Canadian Occidental Petroleum fieldwork the Melawi and Ketungau Basins.

2. REGIONAL GEOLOGY

Kalimantan as the largest island of Indonesian Archipelago is situated in the southern margin of the relatively stable Eurasian Plate. Geology of west Kalimantan have been studied by the generation of Dutch geologists such as Wing Easton (1904), and Emmichoven (1939) which was reported into a generalized geological version of west Kalimantan by van Bemmelen (1949).

Plate tectonic account was expanded by Hamilton (1979) and Tan (1982). The latest up to date geological results have been summarized by Williams *et.al.*(1988), who divided west Kalimantan region into three tectonic-stratigraphic domains as follows :

- (1). NW Kalimantan Domain,
- (2). Schwaner Block and
- (3). Melange and accretionary wedges.

The Ketungau Basin as a focus of the study area is included into the melange and accretionary wedge (Figure 2).

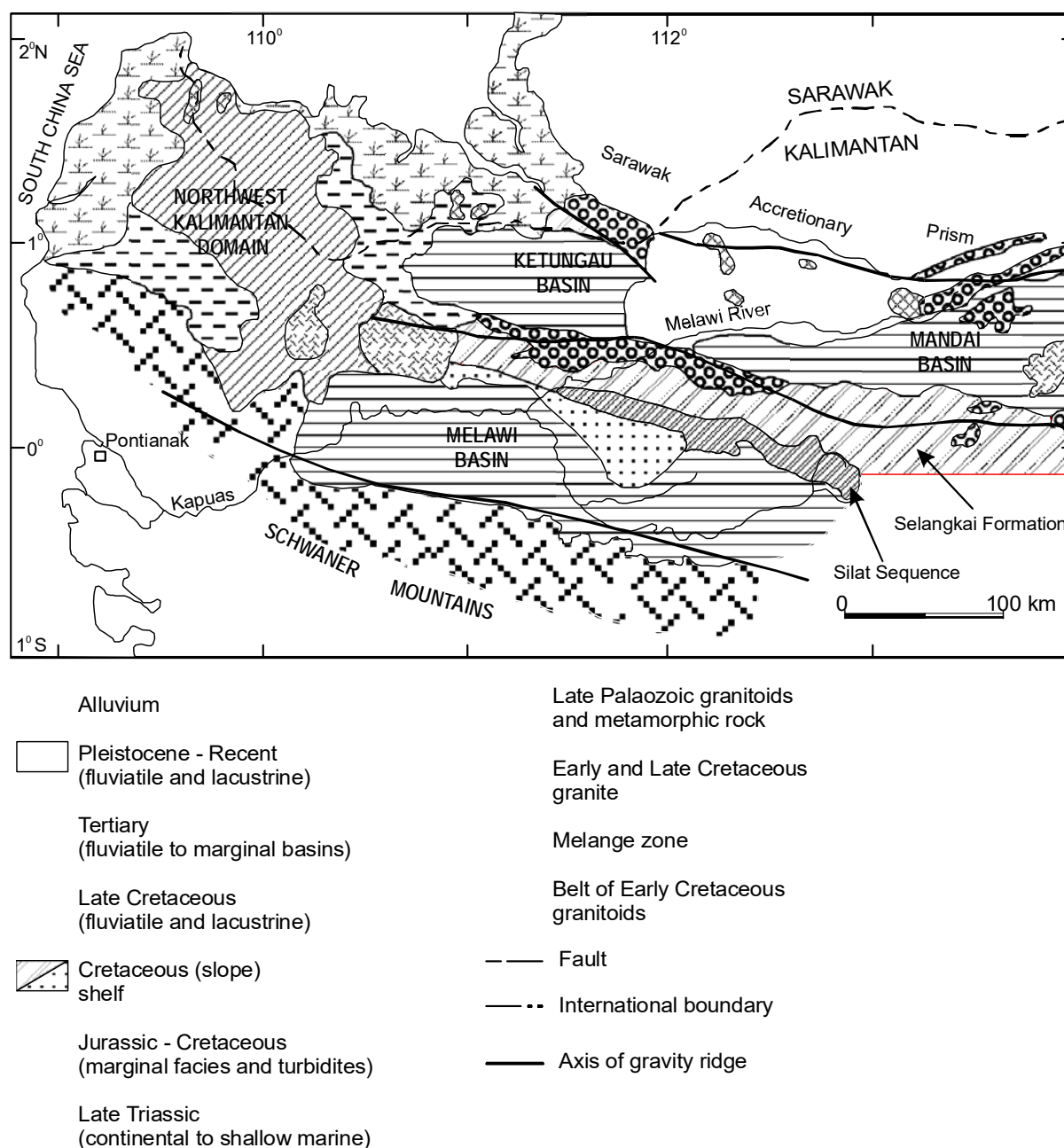


Figure 2. Generalized geological map and domain of West Kalimantan and Sarawak (modified after Williams et al., 1988), and location of study area in Ketungau Basin

3. STRATIGRAPHY

The Ketungau Basin in west Kalimantan forms a syncline structure which is bounded by two major structural linears. The stratigraphy of the basin described here starts from the oldest unit to the younger sequence as follows (Figure 3).

3.1 Kantu Formation

The Kantu Formation was firstly defined by Emmichoven and ter Burgen (1935) as the Kantu Bed. The unit is composed of alternating dark grey laminated shale, mudstone and siltstone with coal bed intercalations. Mudstone is dark grey,

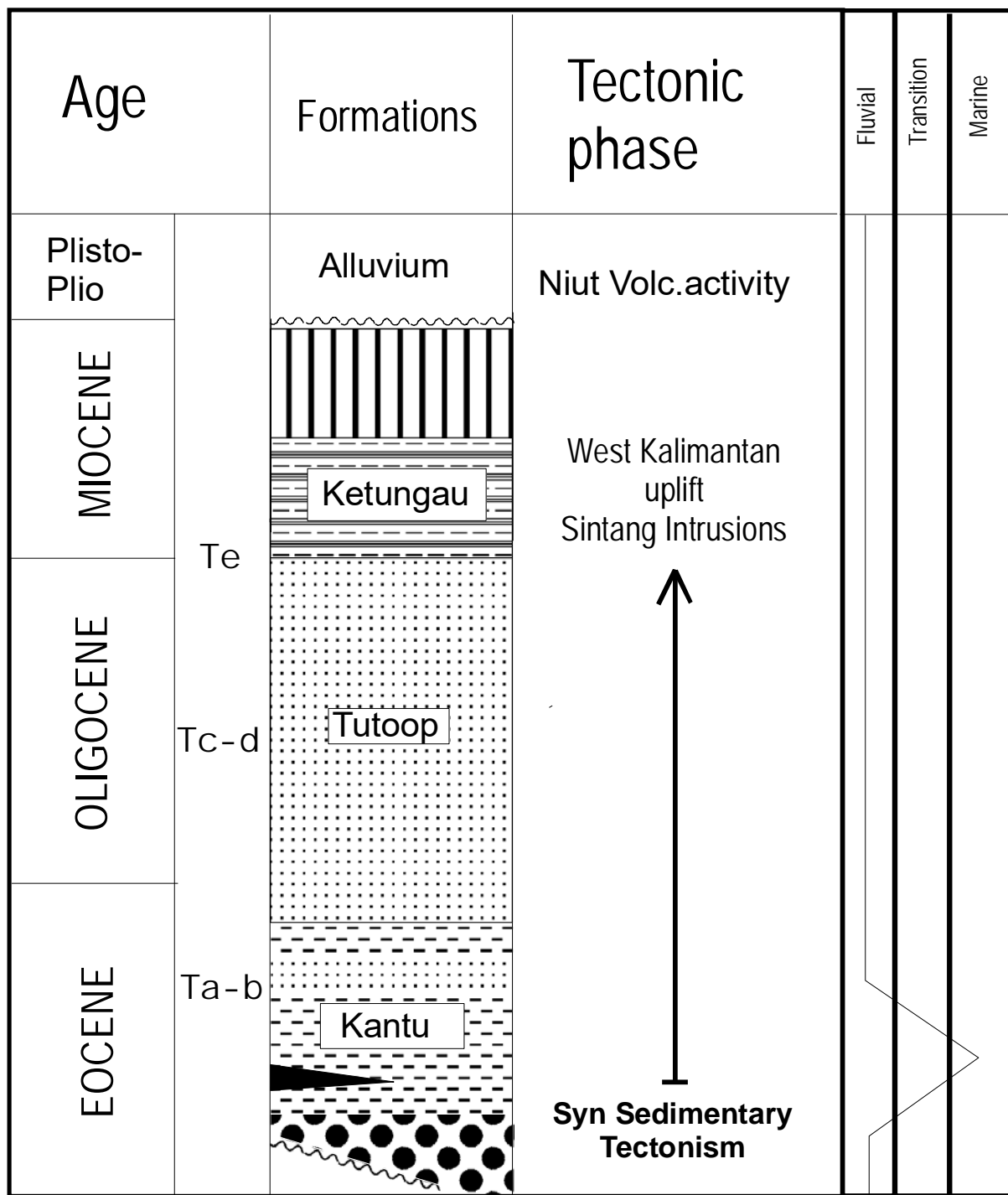


Figure 3. Stratigraphic scheme of the Ketungau Basin, West Kalimantan (modified after Pieters et al., 1987)

soft and poorly bedded. Siltstone is greenish grey and well-bedded; the thickness of beds range from 10- 30 cm. The formation was deposited in an intramontane lacustrine environment. Age of the unit is determined as an Early Eocene, and it is equivalent and correlatable to the Haloq Sandstone in the Melawi and west Kutai Basins. The unit is unconformably overlain by the fluvial Tutoop Sandstone. Across the border in Sarawak area, the Kantu Formation is referred to as the Silantek Formation (Leichti *et al.*, 1960), which contains several coal seams that have been mined.

These similar coal seams have also been reported from the Tabun River, southwest of Merakai River, Upper Ketungau area (Sumaatmadja *et al.*, 1996). The outcrop consists of four coal seams with thickness varies from 0.10 to 1.55 m dipping northward between 20-35 degrees. The coal seams have a calorific value ranging from 6825 to 7895 cal/grams and also a vitrinite reflectance value (Ro) ranging from 0.68-0.82 %. On the basis of those properties, Sumaatmadja *et al* (1996) classified those coal seams into a High Volatile sub-Bituminous A level. Furthermore, locally the coal rank probably have been upgraded by a widespread Oligo-Miocene Sintang intrusives.

3.2 Tutoop Sandstone Formation

The Tutoop Sandstone Formation is dominated by a fluvial clastic unit that previously report as "the Plateau Sandstone" by van Emmichoven (1939) and Tan (1979) determined the continuation of that unit in the Sarawak Region and suggested that the unit is Miocene age, where as Pieters *et al* (1987) correlated this sandstone unit to the Late Eocene Dangan Sandstone Formation in Melawi Basin. Sutjipto (1991) correlated the sandstone to the Alat Sandstone in east Melawi Basin and the Sekayam Sandstone in west Melawi Basin. In the Ketungau Basin, the Tutoop Sandstone is dominated by a coarse to fine grained sandstone unit which is conformably overlain by the Upper Miocene Ketungau Formation.

3.3 Ketungau Formation

The Ketungau Formation was originally defined by van Emmichoven (1939) as the Ketungau beds, which is correlatable to the Silat Shale in the Melawi Basin.

This formation forms an undulating country with

low relief and shows dendritic drainage pattern. The formation consists of sparsely fossiliferous shallow marine to non marine sandstone, siltstone and mudstone with coal seams intercalations in the lower and upper part. The coal seams (Sekalau and Malintang) exposed in the southern part dip northward between 25-35 degrees, with thickness varying from 0.10- 0.95 m. The coal shows calorific value ranging from 5780- 7070 cal/grams and vitrinite reflectance value (Ro) of 0.66-0.70 % (Sumaatmadja *et al.*, 1996). In addition, the formation contains abundant gastropods and pelecypods, however these fossils are not age diagnostic. The formation conformably overlies the Tutoop Sandstone. It suggests that the Ketungau and the Tutoop Formations appear to form a continuous sequence which overlies the Eocene Kantu Formation. Age of the Ketungau Formation is inferred to be Late Oligocene or Miocene. A geological cross section reconstruction shows the thickness of this formation is not more than 2000 m thick.

4. DISCUSSION

The methane gas derived from coal beds has the potential source to become an energy substitution in the future. Coalbed methane can be trapped in the natural fractures within the coal seams both in cleat and shear fracture types existing as coalbed methane reservoirs. Permeability of the fractures will increase in a syncline structure especially in the axis of fold due to the extension. In addition, the pressure gradient of the methane gas will also enhanced by the influx of meteoric water (Dowson, 1999).

The presence of gas seepages in the upper Ketungau Area is presumed to be related to the occurrence of coal seams within the Kantu and Ketungau Formations. The Kantu Formation consists of alternating dark grey laminated shale, mudstone and siltstone which is intercalated by several coal seams. Its thickness varying from 0.10 to 1.55 m and dipping northward between 20-35 degrees. These coal seams are classified into a High Volatile Sub-Bituminous- A level, with calorific value ranging from 6825 to 7895 cal/grams and vitrinite reflectance (Ro) between 0.68-0.82 %. Similar to the Kantu Formation, the Ketungau Formation composes of sparsely fossiliferous shallow marine to non marine sandstone, siltstone, claystone and mudstone with coal seams intercalations in the lower and upper part. The thick-

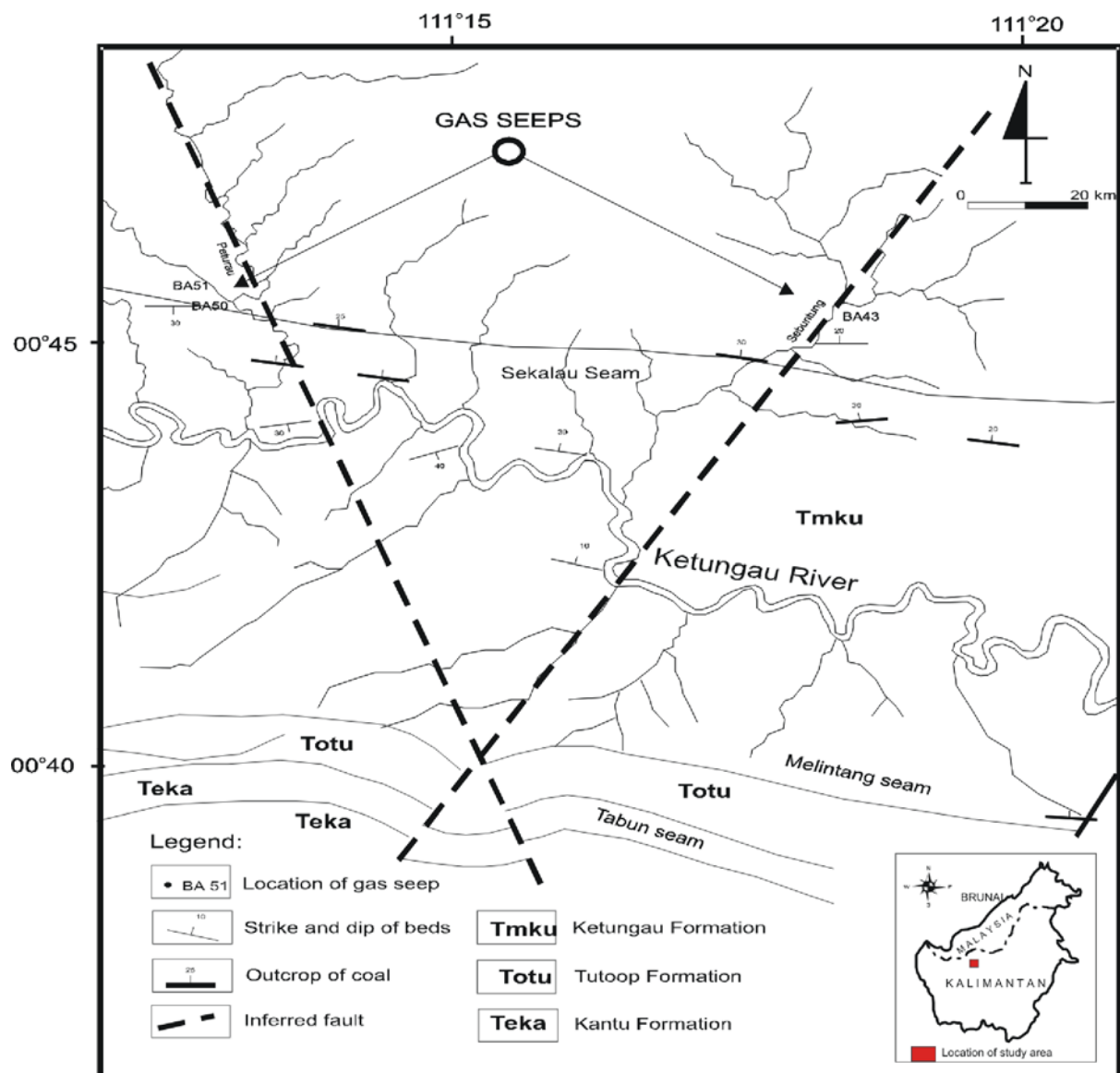


Figure 4. Location of gas seepages in the upper Ketungau Area, West Kalimantan (modified after Johnson, 1993; and Sumaatmadja et al., 1996)

ness of coal seams within the Ketungau Formation varying from 0.10 to 0.95 m which shows caloric value ranging from 5780-7070 cal/grams and vitrinite reflectance value (R_o) between 0.66-0.70 %. Based on kerogen type vs generative windows (Daimaison and Moore., 1980), the coalbed methane within the Kantu and Ketungau Formations fall into a condensate group.

Several gas seep locations have been observed (Figure 4) along the Peturau River (BA50, 51 & 55) and Sebuntung River (BA 41 & 43). These gas seeps will flame up as high as 20-50 cm when

they are burning (Photos of 1 - 4). As discussed earlier that the coal seams cropping out in the Tabun River (call as Tabun Seam) belong to the Kantu Formation. They can be classified as a "High Volatile sub-Bituminous A" coal (Sumaatmadja *et al.*, 1996). On the other hand, the Ketungau Formation contains at least three exposed coal seams (Sekalau 1-2 and Melintang) with calorific and vitrinite reflectance values are less then the Tabun seam.

Consequently, the presence of gas seeps on surface along the Peturau and Sebuntung Rivers prob-



Photo 1. Flameable methane gas at location BA 56, the Peturau River



Photo 2. As above flameable methane gas at location BA 56, the Peturau River



Photo 3. Location of gas seepage at the Sebuntung River (BA 42)



Photo 4. Indication of methane gas seepage at location BA 55, the Peturau River

ably is related to the gas which is trapped within the cleat and shear fractures of these coal seams. In addition, the Tutoop Sandstone which is dominated by a coarse to fine grained clastic unit may also performed as a secondary reservoir for methane gas.

Lineaments tracing from the imagery indicates the occurrence of faults which trend NW-SE (Peturau Fault) and NE-SW (Sebuntung Fault). These faults exist across the axis of syncline structure diagonally. Based on these features lead to the conclusion that the gas seep are controlled by structural faults.

5. CONCLUSIONS

The Ketungau Basin which is situated in West Kalimantan, forms a syncline structure. The basin is bordered by a structural thrust against the Boyan Melange to the south. The basin contains three sedimentary formations: the Kantu, Tutoop, and Ketungau Formations. Several coal seams which belong to the Kantu and Ketungau Formations crop out to adjacent region. Outcrop of coal seams in the Tabun River is part of the lower part of the Kantu Formation, that can be correlated to the mined coal within the Silantek Formation in the Sarawak Region. Coal seam within the

Ketungau Formation has less calorific and vitrinite reflectance values compared to the Kantu coal seam.

The presence of methane gas seepages in the Peturau and Sebuntung Rivers are probably related to the occurrence of coal seams within the Kantu and Ketungau Formations and the Tutoop Sandstone may also performed as a secondary reservoir for methane gas. The occurrence of these gas seeps is generally controlled by syncline and fault structures, and even the pressure potential has been enhanced by the influx of down dip meteoric water.

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