Catena 158 (2017) 30–45

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

Organic geochemistry and palynology of coals and coal-bearing mangrove sediments of the Neogene Sandakan Formation, Northeast Sabah, Malaysia

Khairul Azlan Mustapha[a,*], Wan Hasiah Abdullah[a], Zainey Konjing[b], Sia Say Gee[a], Ahmad Munif Koraini[b]

[a] Department of Geology, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
[b] Biostratex Sdn Bhd., Unit 1A, Jalan Perusahaan 4, Kawasan Perindustrian Batu Caves, 68100 Selayang, Selangor, Malaysia

ARTICLE INFO

Keywords:
Mangrove sediments
Miocene
Sandakan Formation
Petroleum
Paleobiogeography

ABSTRACT

The coals and coal-bearing mangrove sediments of Sandakan Formation have been evaluated for their source rock potential, paleoredox conditions and source of organic input, as well as the age and paleovegetation distribution using geochemical and petrographical methods. The studied samples were generally rich in organic carbon, which varied from 0.60 (massive mudstone) to 62.37 wt% (coal). The studied samples have vitrinite reflectance (R_o) ranging from 0.31 to 0.49% and Tmax values ranging from 353 to 436 °C indicating an immature to very early mature stage for hydrocarbon generation. The sediments were dominated by Type III kerogen, with some Type II/III kerogen, suggesting a significant land plant contribution to the organic matter. The bimodal distribution displayed by gas chromatogram, with a clear odd/even carbon number and skewed to higher molecular weight carbon (nC_{31}), indicating a transitional depositional environment. The variation in pristane/phytane ratio, varied from 0.71 to 2.97, suggesting an alternating anoxic and oxic deposition conditions. The presence of marine dinoflagellate cyst in the mangrove and offshore mudstones were consistent with the relatively higher sulphur content in the studied samples which indicate marine inundations.

Palynomorph recovered in this study, with abundant mangrove and freshwater types of pollen, suggesting a biogeographical distribution of ancient mangrove vegetation that expanded landward into the freshwater peat swamp setting and hinterland. The presence of marker species, viz. *Florschuetzia levipoli*, *F. meridionalis* and *F. semilobata* delineated an Early Miocene to Middle Miocene age for the Sandakan sediments.

1. Introduction

Sediments of Sandakan Formation are widely distributed in the onshore Sandakan Peninsula (Fig. 1) and also in the offshore Sandakan sub-basin where the oil and gas occurrences have long been known (Leong and Azlina, 1999). Nevertheless, it has received inadequate study in the perspective of source rock potential for hydrocarbons. Previous geological studies were mainly focus on the sedimentological aspects where detailed sedimentary facies description was used to develop paleodepositional model. To the best of our knowledge, only Abubaker et al. (2004) applied biological markers as the main proxy in the assessment of depositional environment and thermal maturity of organic matter for the Sandakan sediments.

Mangroves are an important intertidal wetland ecosystem with high primary productivity, abundant detritus, rich organic carbon and anoxic/reducing conditions (Ping et al., 2012). The modern mangrove ecosystem which is an analogue to ancient mangrove recorded high sedimentation rate and are known to efficiently deposit rich organic carbon in sediments (Alongi and Mukhopadyay, 2015). Nevertheless, the organic matter-rich mangrove sediments have yet received little attention in regard to their hydrocarbons generation potential, although quantity of organic matter is one of the key factors for evaluating its hydrocarbon potential. In the present study, the organic rich coals and coal-bearing mangrove sediments of Sandakan Formation have been subjected to geochemical analyses to evaluate source rock potential, depositional conditions, paleoredox conditions and source of organic input to determine quality of the organic matter.

Palynological research was also conducted in this study to determine the age, paleovegetation, paleoecology and paleodepositional environments that control the distribution of source rock, and the preservation of organic matter. Besides bringing a new perspective on geochemistry of ancient mangrove organofacies, the finding could also facilitate hydrocarbon exploration in the offshore area of Sandakan.

* Corresponding author.
E-mail addresses: azlan.geo@gmail.com, azlan_0401@um.edu.my (K.A. Mustapha).

http://dx.doi.org/10.1016/j.catena.2017.06.005
Received 19 February 2016; Received in revised form 21 April 2017; Accepted 3 June 2017
Available online 17 June 2017
0341-8162/

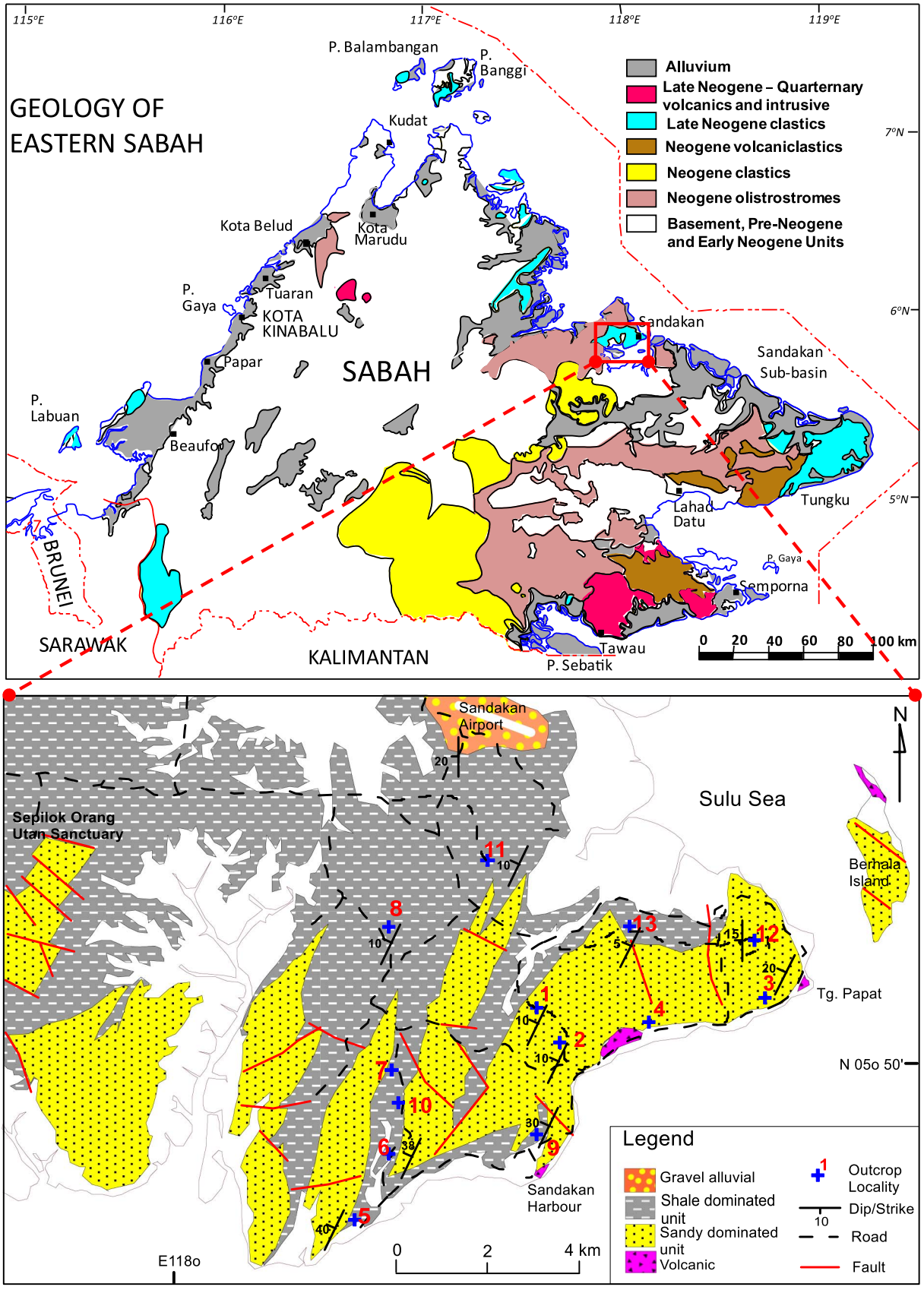

Fig. 1. Maps show the location of Sandakan area (above) and the distribution of shaly and sandy unit of Sandakan sediments (below) as well as outcrop locality (geological map after Lee, 1970).