Tertiary source rocks, coals and reservoir potential in the Asem Asem and Barito Basins, Southeastern Kalimantan, Indonesia

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a. Cutinite (C), bright yellow, in siltstone; Warukin Formation; sample 22529, PB-1, 402 m; R\textsubscript{max}=0.43%; field width=0.46 mm, fluorescence-mode.

b. Same field of view as for (a), vitrinite (v); reflected light.

c. Cutinite (C), bright orange, in siltstone; oblique section; Warukin Formation; sample 22519; PRN-2, 1601 m; R\textsubscript{max}=0.62%; field width=0.46 mm; fluorescence-mode.

d. Same field of view as for (c): vitrinite (v); reflected light.

e. Sporinite (Sp), bright orange; liptodetrinite (L), bright orange, in shale; Warukin Formation; sample 22492; BK0-1, 2551 m; R\textsubscript{max}=0.73%; field width =0.23 mm, fluorescence-mode.

f. Sporinite (Sp), bright orange; in sandstone; Tanjung Formation; sample 22564, MRTP-IX, 2990 m; R\textsubscript{max}=0.60%; field width=0.18 mm; fluorescence-mode.

b. Same field of view as for (f); reflected light.

g. Same field of view as for (f); reflected light.

h. Resinite (R), orange, in siltstone; Tanjung Formation; sample 22311; SMD-1, 3771 m R\textsubscript{max}=0.83%; field width=0.28 mm; fluorescence-mode.

i. Same field of view as for (h); reflected light.
a. Suberinite (Sb), yellow; gelovitrinite (V); Miocene coal, Warukin Formation; sample 22571; DS-1, 1302 m; \(R_{\max} = 0.50\%\); field width = 0.46 mm; fluorescence-mode.

b. Same field of view as for (a); reflected light.

c. Botryococcus-related telalginitite (Al), bright yellow, sporinite (Sp) and telovitrinite (V); Miocene Coal, Warukin Formation; sample 22295; SMD-1, 924 m; \(R_{\max} = 0.46\%\); field width = 0.37 mm; fluorescence-mode.

d. Same field of view as for (c), pyrite (py); reflected light.

e. Suberinite (Sb), yellow; sporinite (Sp); mibrabitumen/exsudatinite (Mb/E), bright yellow; clarite; Miocene coal, Warukin Formation; sample 22153; DS-1, 132 m; \(R_{\max} = 0.34\%\); field width = 0.46 mm; fluorescence-mode.

f. Same field of view as for (e), detroitvitrinite (V), inertodetrinite (Id), sclerotinite (Sc); reflected light.

g. Fluorinite greenish yellow, telovitrinite (textinite) with gelovitrinite, Eocene coal, Tanjung Formation; 22596; shallow drilling; 53 m; \(R_{\max} = 0.58\%\); field width = 0.23 mm; fluorescence-mode.

h. Same field of view as for (g); reflected light.

i. Cutinite (C), orange; Botryococcus-related telalginitite, (Al), bright yellow; telovitrinite (V); Eocene coal, Tanjung Formation; sample 22587; shallow drilling, 21 m; \(R_{\max} = 0.55\%\); field width = 0.18 mm; fluorescence-mode.
a. Migrabitunen in gelovitrinite, bright yellow, Eocene coal, Tanjung Formation; sample 22587; shallow drilling, depth=21 m; $R_{max}=0.55\%$; field width=0.23 mm; fluorescence-mode.

b. Same field of view as for (a), gelovitrinite (V); reflected light.

c. Fluorinite (F), greenish yellow, Eocene coal, Tanjung Formation; sample 22596; shallow drilling, depth=51 m; $R_{max}=0.58\%$; field width=0.23 mm; fluorescence-mode.

d. Same field of view as for (c), telovitrinite (V) and suberinite, dull yellow fluorescence as shown in plate (c); reflected light.

e. Sporangium, bright yellow, Eocene coal, Tanjung Formation; sample 22629; shallow drilling, depth=48 m; $R_{max}=0.62\%$; field width=0.23 mm; fluorescence-mode.

f. Same field of view as for (e), telovitrinite (V); reflected light.

g. Resinite (R), bright orange, Eocene coal, Tanjung Formation; sample 22620; outcrop; $R_{max}=0.73\%$; field width=0.42 mm; fluorescence-mode.

h. Same field of view as for (g), telovitrinite (V); reflected light.

i. Botryococcus-related telalginate (Al), bright yellow, sporinite, dull yellow, telovitrinite (V), Eocene coal, Tanjung Formation; sample 22796; $R_{max}=0.58\%$, field width=0.27 mm; fluorescence-mode.
a. Migrabitum/en/exsudatinite
(Mb/E) and oil droplets (Od),
bright yellow, in vitrinite
(V), sporinite (Sp), dull
yellow, Miocene coal; Warukin
Formation; sample 22570, DS-1,
1005 m; R_max=0.52%;
field width=0.46 mm;
fluorescence-mode.

b. Oil haze (Oh) and
migrabitum/en/exsudatinite
(Mb/E), bright yellow,
detritovitrite (Ds), showing
secondary fluorescence of dull
yellow, Miocene coal; Warukin
Formation; sample 22492;
BKO-1, 2551 m; R_max=0.70%;
field width=0.23 mm;
fluorescence-mode.

c. Migrabitum (Mb), oil
droplets (Od), bright yellow;
vitrinite (V), in siltstone,
Warukin Formation; sample
22484, BKO-1, 1347 m; R_max=
0.45%; field width=0.23 mm;
fluorescence-mode.

d. Dead oils, bright orange, in
sandstone, Warukin Formation,
sample 22484; BKO-1, 1347 m;
R_max=0.45%; field width=0.23 mm;
fluorescence-mode.

e. Migrabitum/en/exsudatinite,
in siltstone, Tanjung Formation;
sample 22536, PB-1, 1673 m;
R_max=0.55%; field width=0.29 mm;
fluorescence-mode.

f. Migrabitum/en/exsudatinite,
bright yellow, filling cracks,
telovitrite (V); Eocene
coal, Tanjung Formation;
sample 22690; shallow
drilling, depth=27 m;
R_max=0.56%; field width=
0.23 mm, fluorescence-mode.

g. Migrabitum/en/exsudatinite
(Mb/E) bright yellow,
telovitrite (V); Eocene
coal, Tanjung Formation;
sample 22629; outcrop; R_max=
0.62%; field width=0.23 mm;
fluorescence-mode.

h. Oil droplet/migrabitum (Od),
yellow, showing fractures/
cracks; telovitrite (V);
Eocene coal, Tanjung
Formation; sample 22616;
outcrop; R_max=0.56%;
field width=0.42 mm,
fluorescence-mode.

i. Migrabitum/en/exsudatinitelte
(Mb/E) and oil cut (Oc),
yellow; telovitrite (V),
Eocene coal, Tanjung
Formation; sample 22578;
outcrop; R_max=0.60%; field
width=0.23 mm; fluorescence-
mode.
PLATE 5

a. Fine-grained sublitharenite, Warukin Formation, showing quartz grains (Q) and rock fragments (RF); the grains are commonly coated by very thin chlorite; pore spaces are partially filled by clay matrix; porosity 15%; sample HP557, outcrop; field width=1.8 mm; crossed-polars.

b. Same field of view as for (a), plane-polarized light.

c. Fine-grained sublitharenite, Warukin Formation, showing quartz grains (Q), chert (CR) and volcanic rock fragments; pore spaces are partially filled by clay matrix; porosity 16%; sample 22495, cuttings, BK0-1, 3124 m; field width=1.6 mm; crossed-polars.

d. Same field of view as for (c), quartz grain (Q), quartz overgrowths (o); plane-polarized light.

e. Medium-grained quartzarenite, Tanjung Formation, showing quartz (Q), calcite cement (C) and siderite (S) partly filling pore spaces; porosity 25%; sample HP685, shallow drill core; depth=6 m; field width=1.8 mm; crossed-polars.

f. Same field of view as for (e), quartz (Q), calcite (C), plane-polarized light.

g. Coarse-grained quartzarenite, Tanjung Formation, showing quartz grain (Q) rimmed by quartz overgrowths (o) and clay minerals (kaolinite); porosity 32%; sample HP521, shallow drill core; depth=22 m; field width=0.8 mm; crossed-polars.

h. Same field of view as for (g), quartz (Q), quartz overgrowths (o), feldspar (F), pore spaces (P); fracture is filled by silica cement (Si); plane-polarized light.
a. Very coarse-grained sublitharenite, Tanjung Formation, showing quartz grains (Q), chert; carbonate cement (C) and clay matrix filling pore spaces, porosity 25%; sample HP378, shallow drill core; depth=105 m; field width=4.9 mm; crossed-polars.

b. Same field of view as for (a); quartz (Q), chert (CR); plane-polarized light.

c. Coarse-grained quartzarenite, Tanjung Formation, showing quartz grains (Q) coated by thin clay minerals (probably smectite/illite); porosity 25%; sample HP184, shallow drill core; depth=77 m; field width=1.8 mm; crossed-polars.

d. Same field of view as for (c); quartz grain (Q), pore space (P); plane-polarized light.

e. Fine-grained sublitharenite, Tanjung Formation, showing quartz grains (Q); feldspar (F) which were partially altered and dissolved to form pore; porosity 18%; sample HP529, shallow drill core; depth=41 m; field width=0.7 mm; crossed-polars.

f. Same field of view as for (e); quartz grains (Q) and feldspar (F), pore space (P); plane-polarized light.

g. Medium-grained quartzarenite, Tanjung Formation, showing quartz (Q) and an altered feldspar grain (F); porosity 25%; sample HP511, outcrop; field width=1.8 mm; crossed-polars.

h. Same field of view as for (g); quartz (Q), feldspar (F) and pore space (P); plane-polarized light.
PLATE 7

a. Sublitharenite, Warukin Formation, showing quartz grains (Q) of fine sand size (0.2 mm); pore spaces are clearly visible and partial filled by carbonate cement and kaolinite clays; porosity 25%; sample 22488, side wall core, BK0-1, 2024 m; magnification x85.

b. Same sample as for (a); showing quartz grains (Q) and rock fragments (RF) which have partially been dissolved during diagenesis; magnification x280.

c. Same sample as for (a); showing calcite cement (c) and kaolinite filling pore spaces; micropores within carbonate cement and detrital kaolinite are clearly defined ranging from 2 to 20 μm; magnification x2700.

d. Very fine- to fine-grained sublitharenite, Warukin Formation, showing grain framework of quartz (Q), feldspar (F) and rock fragments; pore spaces were partly filled by clay matrix; porosity 15%; sample 22489, side wall core, BK0-1, 2056 m; magnification x110.

e. Same sample as for (d), showing an irregular form of detrital kaolinite (K) filling pore spaces, micropores are visible ranging from 2 to 5 μm; magnification x1700.

f. Detrital kaolinite (K) filling pore spaces in sandy siltstone from the Warukin Formation; sample 22496, side wall core, BK0-1, 3125 m; magnification x1500.

g. Same sample as for (f), showing quartz grains (Q) and a mica-flake (M); porosity 10%; magnification x870.

h. ?Smectite-illite (Sm) lining pore spaces in fine-grained sublitharenite, Warukin Formation; sample 22209, side wall core, BK0-1, 1073 m; magnification x2000.

i. Same sample as for (h); calcite crystals filling pore spaces; magnification x3000.
PLATE 7
a. Medium-grained sublitharenite, Tanjung Formation, showing grain framework, quartz grains (Q), pore spaces are well defined ranging from 20 to 500 um; porosity 28%; sample Hp781, shallow drill core, depth=58 m; magnification x34.

b. Same sample as for (a), showing booklets of authigenic kaolinite cement filling pore spaces, micropores are clearly visible ranging from 2 to 10 um; magnification x1200.

c. Detrital kaolinite (K) and "verniform" kaolinite, filling pore spaces in sublitharenite, Tanjung Formation; porosity 20%; micropores within kaolinite range from 2 to 10 um; sample HP521, shallow drill core, depth=22 m; magnification x3200.

d. Authigenic kaolinite booklets filling pore spaces in sublitharenite, Tanjung Formation, micropores within kaolinite range from 5 to 20 um, sample HP685, shallow drill core, depth=5 m; magnification x2000.

e. Pore-filling clots of kaolinite (K) and ?organic matter (OM), probably vitrinite, sandy siltstone, Tanjung Formation; sample HP721, shallow drill core, depth 7 m; magnification x1800.

f. Authigenic smectite/chlorite (Sm/Cl) clays filling pore spaces in medium-grained sublitharenite, Tanjung Formation; porosity 12%; sample Hp551, shallow drill core, depth=43 m; magnification x3300.

g. Medium-grained sublitharenite, Tanjung Formation, showing detrital of rock fragments (RF), quartz (Q) and mica-flakes (M); porosity 20%; sample HP624, shallow drill core, depth=28 m; magnification x280.

h. Rhombohedral dolomite in sublitharenite, Tanjung Formation, also showing smectite-illite (S-I); sample HP685, shallow drill core, depth= 5 m; magnification x1100.

i. Quartz overgrowths (O) in sublitharenite, Tanjung Formation, smectite/chlorite (SM/Cl) coates quartz overgrowths; sample Hp630, shallow drill core, depth=59 m; magnification x2000.
PLATE 9

a. Medium-grained sublitharenite, Tanjung Formation, showing quartz grain (Q) and pore spaces which are well defined; porosity 23%; sample HP249, shallow drill core, depth=120 m; magnification x29.

b. Same sample as for (a) showing detrital kaolinite (K) filling pore spaces, micropores are visible ranging from 2 to 10 um; magnification x2000.

c. Detrital quartz (Q) and "vermiform" kaolinite (Kv), Tanjung Formation; sample HP715, shallow drill core, depth=50 m; magnification x2000.

d. Smectite/chlorite (Sm/Cl) matrix filling pore spaces in medium-grained sublitharenite, pyrite (p); porosity 10%; sample HP622, shallow drill core, depth=137 m; magnification x5000.

e. Sublitharenite showing feldspar grain (F) and quartz (Q); quartz overgrowths (Qo) bridging pore spaces; kaolinite matrix (K); porosity 20%; sample HP184, shallow drill core, depth=77 m; magnification x1300.

f. Authigenic quartz overgrowths (Qo) in sublitharenite, Tanjung Formation; sample HP405, outcrop; magnification x2400.

g. Kaolinite (K) matrix filling pore spaces in fine-grained sublitharenite, Tanjung Formation; sample HP147, shallow drill core, depth=71 m; magnification x2200.

h. Carbonate cement (C) in sublitharenite showing intracemnt pores ranging from 40 to 60 um, sample HP756, shallow drill core, depth=127 m; magnification x790.

i. Feldspar grain (F) has partially been dissolved forming pore spaces, kaolinite (K); porosity 12%; sample HP768, shallow drill core, depth=123 m; magnification x1100.