Bibliography of Indonesian Geology

BIBLIOGRAPHY OF THE GEOLOGY OF INDONESIA AND SURROUNDING AREAS

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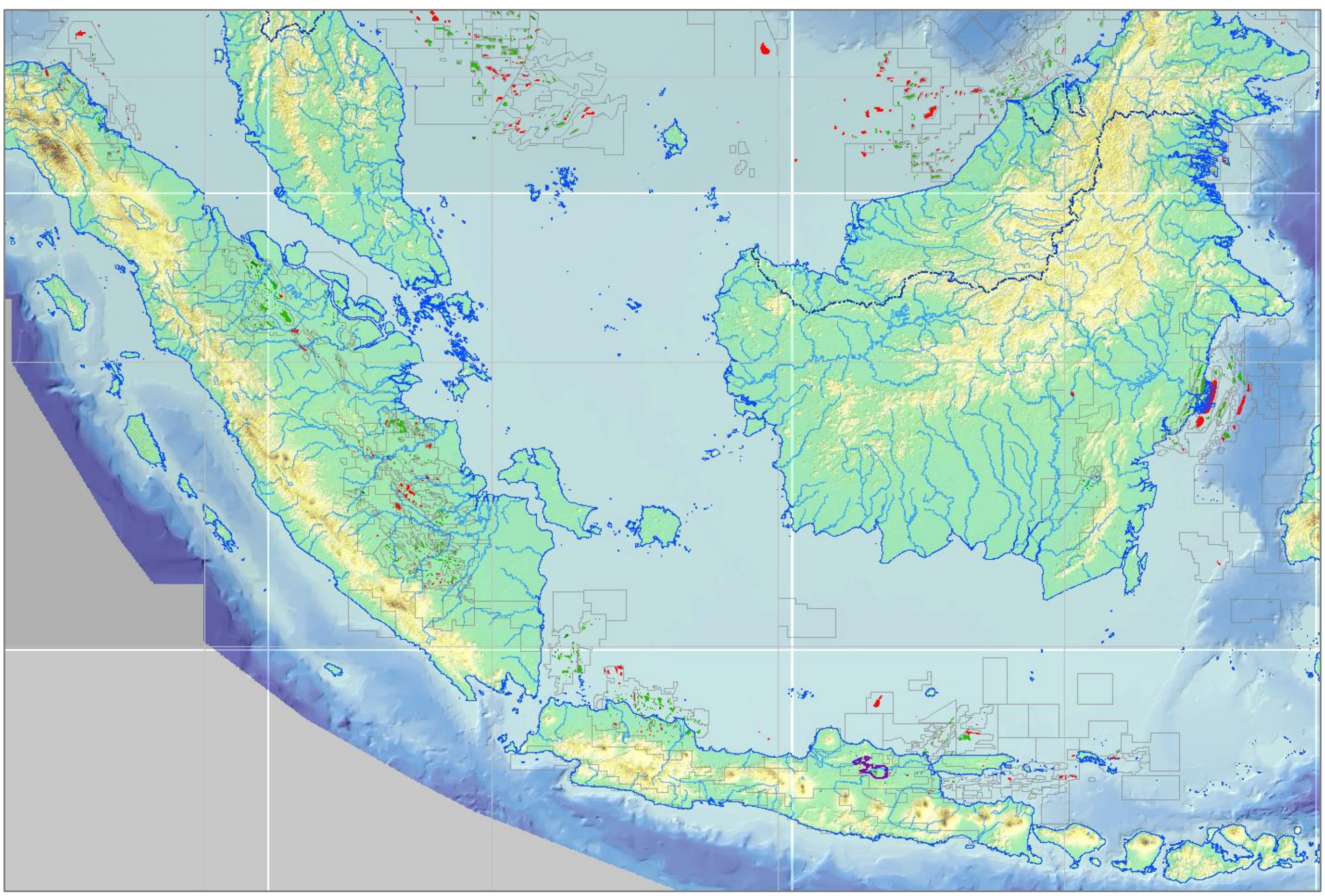
J.T. VAN GORSEL

XI. HYDROCARBONS, COAL, MINING



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XI. HYDROCARBONS, COAL, MINING

This chapter XI of Bibliography 7.0 contains 87 pages with ~545 titles on hydrocarbon occurrences, hydrocarbon source rocks, coal and mineral deposits, primarily of the Indonesian region. It is subdivided into four sub-chapters. Papers in this chapter tend to be of a more general or regional nature; the majority of papers on hydrocarbons, coal and mineral deposits are specific to a region or locality, and are therefore listed in the chapters of areas in which these are located.

Papers date back to the 1860's, reflecting the early interest of the colonial government and private parties in the economic potential of oil, coal and mineral deposits of Indonesia. Actual mining activity by local and Chinese miners dates back to the 1700- 1800's, especially in the gold, tin and diamond districts of Kalimantan and Sumatra.

XI.1. Hydrocarbon Occurrences/ Assessment

Sub-chapter XI.1 of Bibliography 7.0 contains 117 references on oil and gas, mainly regional papers on plays discovered and undiscovered resources, etc. Papers on hydrocarbons or play elements in a basin, fields or wells are in the chapters in which they are located.

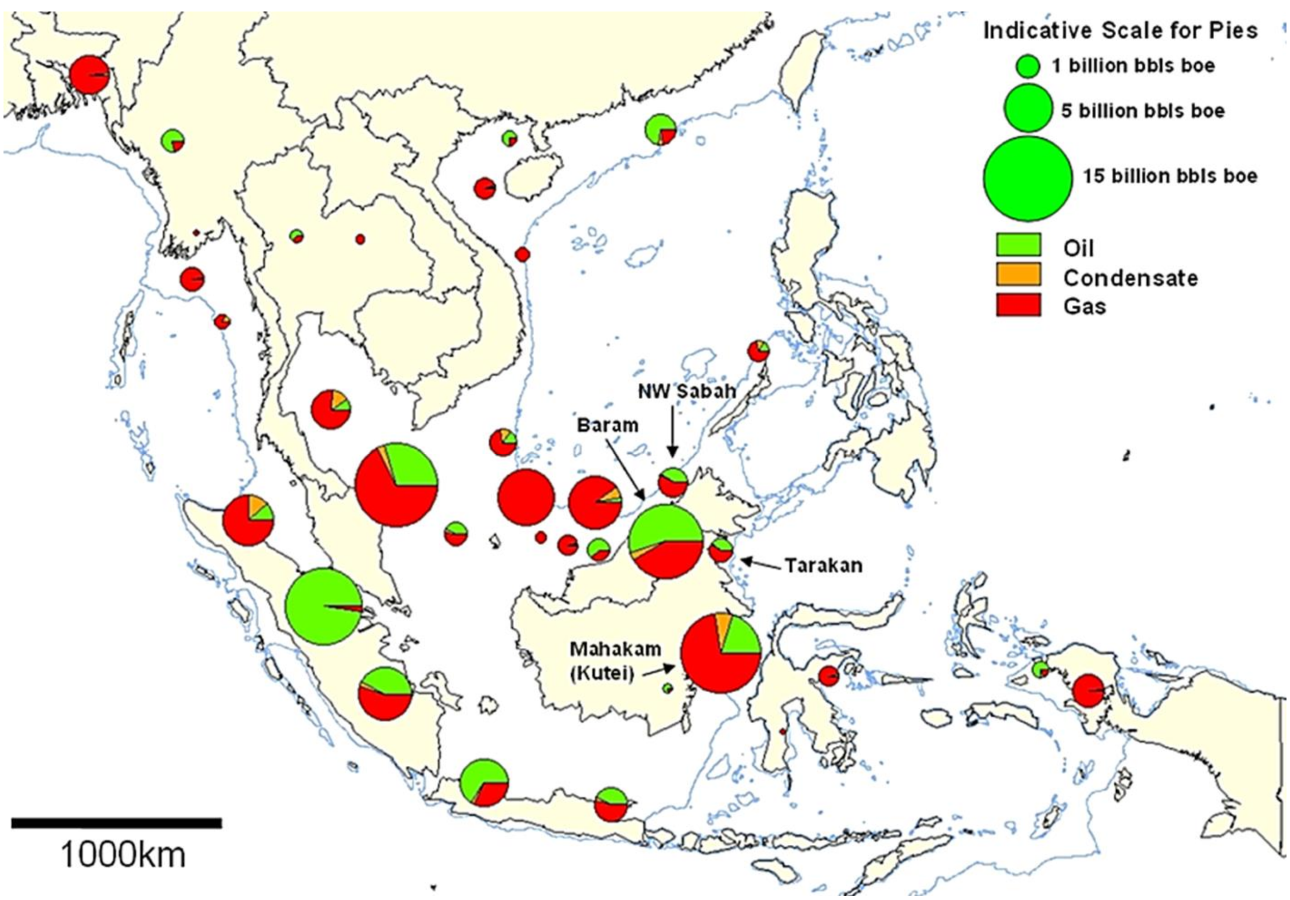

Figure XI.1.1. Discovered oil-gas producing resource of Indonesia- SE Asia (Longley 2005, from IHS).

Indonesia has been a significant oil and gas producer since the first discoveries in North Sumatra and East Java in the late 1800's. Oil production peaked at around 1.5-1.6 MBO/day from ~1977-1998, and has been declining since then due to limited exploration successes, making Indonesia a net importer of oil since 2004.

Indonesia is still a net gas exporter. An elegant overview of Indonesia's Tertiary basins and petroleum geology is Netherwood (2000).

The presence of oil and gas fields in conventional oil and gas occurences is controlled by four parameters: source, reservoir, seal and trap. Reservoir rocks, which can be any kind of porous rocks. In the Indonesian region these are predominantly sandstones (non-marine, shallow marine and deep marine), and in shallow marine carbonates, with both primary and secondary porosity. Fractured basement rocks on highs with onlapping source sediments can also be significant reservoirs locally (Sumatra, Vietnam).

A recent technological development is 'unconventional' oil and gas production, from tight source rocks like shale oil, shale gas and coalbed methane. Despite its potential and several exploration projects in Indonesia, it has not led to commercial production yet.

Oil and gas seeps

Like in many other parts of the world, oil exploration in Indonesia started with drilling shallow wells on oil seeps, which had been known in various parts of the country (mainly East Java, North and South Sumatra and East Kalimantan) since before the mid-1800's (Junghuhn 1854, De Greve 1865, Von Baumhauer 1869, Link 1952, Thompson et al. 1991).

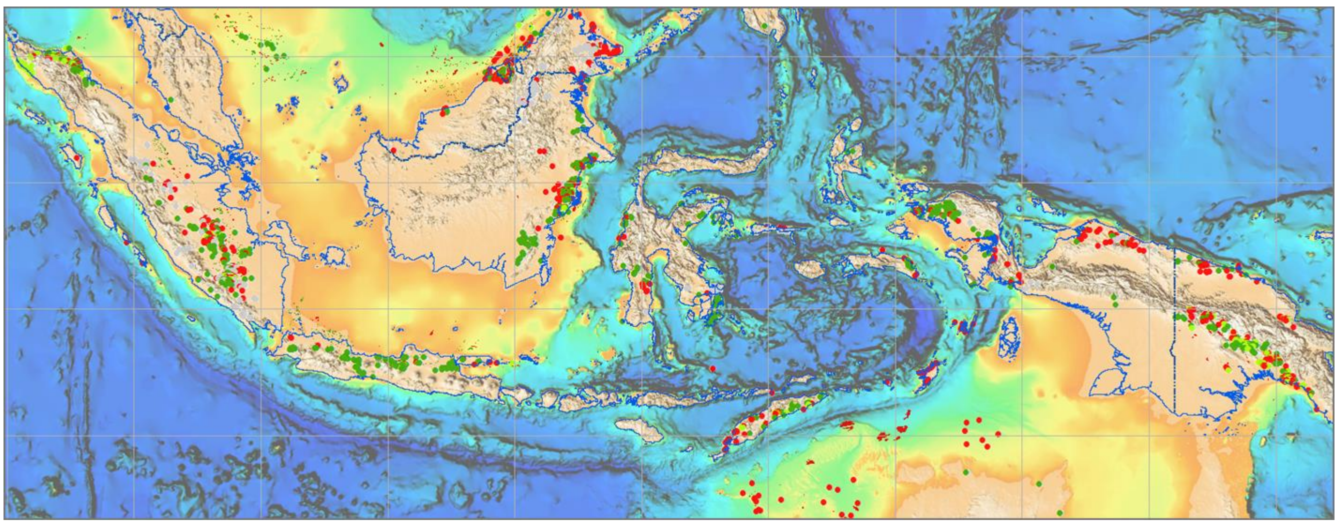

Figure XI.1.2. Distribution of oil (green) and gas (red) seeps in the Indonesian region.

Oil and gas seeps tend to be prevalent in two settings (MacGregor 1995):

1. Basin margins, where lateral seals are lacking: Some of these may represent ongoing oil generation; examples include the Iliran/ Palembang High asphalt field in South Sumatra (Ziegler 1922, Holis et al. 2004, Firmansyah, 2007);
2. Above recent faults, particularly reverse faults These mainly represent destruction of underlying oil accumulations in uplifted structures that no longer generate oil, like the Pleistocene inversion structures of Sumatra.

As argued by MacGregor (1995) and others, the presence of hydrocarbon is a good news- bad news story: the good news is that there is an active hydrocarbon system, the bad news is that it is leaking to the surface. Areas with oil-gas seeps therefore may be viewed as areas with a high chance of finding hydrocarbons, but unlikely to contain large fields. Conversely, areas with no seeps may have a lower chance of finding hydrocarbons, but when present fields may be large.

A good example of this principle is in Sumatra: the North and South Sumatra basins have common seeps and numerous small to medium size fields, that were found early in the exploration cycle (late 1800's). The Central Sumatra basin has no surface seeps, but contains the largest oil fields and by far the largest total reserves, which were first discovered relatively late (1940's). (Figure XI.1.3)

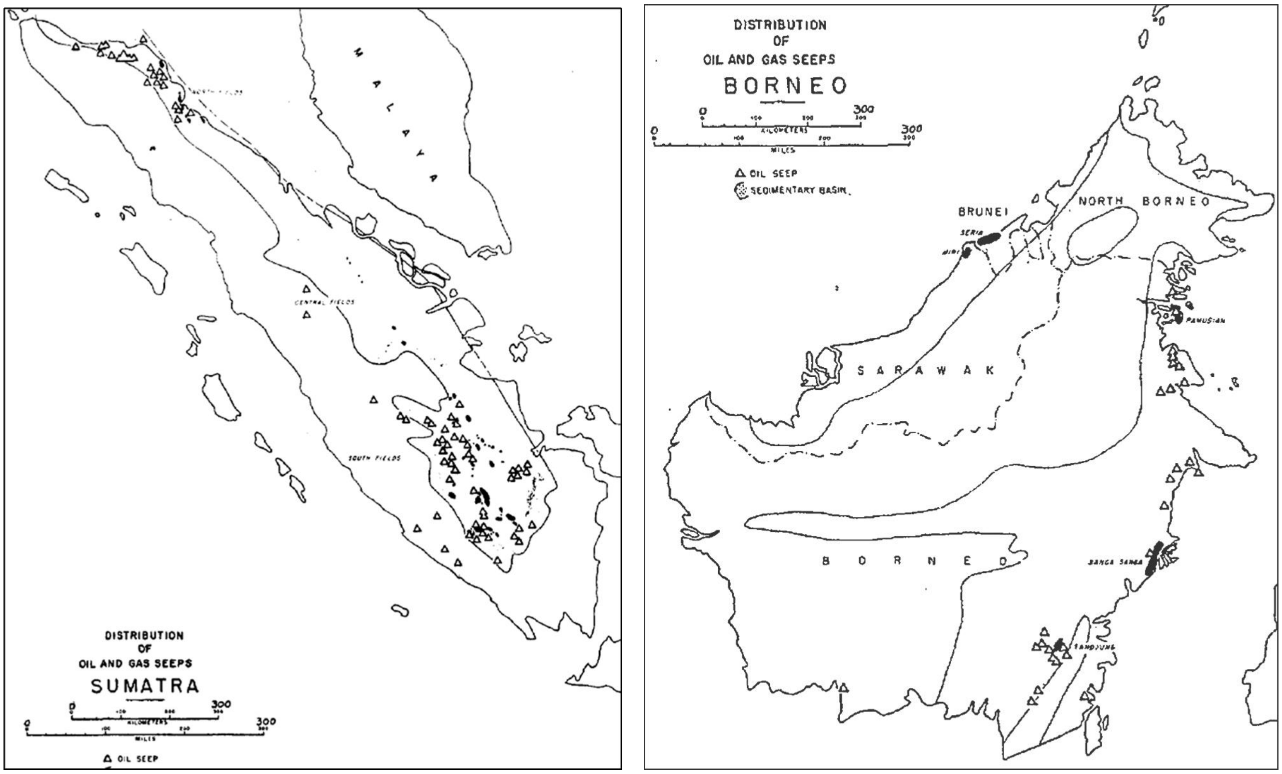

Figure XI.1.3. Oil and gas seeps on Sumatra and Borneo (Link 1952).

Asphalt terranes

Large oil seeps may develop into near-surface tar sands/ asphalt terranes. The largest asphalt deposits of Indonesia are in Buton, which have been intermittently exploited since 1925 (Bothe 1928, Hetzel 1936, Ubaghs and Zeylmans van Emmichoven 1947, Satyana 2011, 2013). (Figure XI.1.4). Buton asphalt represents oils sourced from marine bituminous oil shale of the Late Triassic Winto Formation, but has now impregnated overlying limestones and sandstones of the Miocene Tondo and Sampolakosa Formations.

Other examples of asphalt terranes in Indonesia:

- South Sumatra Tanjung Laut/ Iliran High, 50 km WNW of Palembang: six asphalt terranes along the Palembang sub-basin margin (Ziegler 1922, Firmansyah et al. 2007);
- West Java Kromong Mountains, ~20km West of Cirebon: four small deposits of asphalt-impregnated Miocene limestones along faults of an andesite-cored anticlinal structure (Mannhardt 1920, Buning 1922, Harsono Pringgoprawiro et al. 1977).

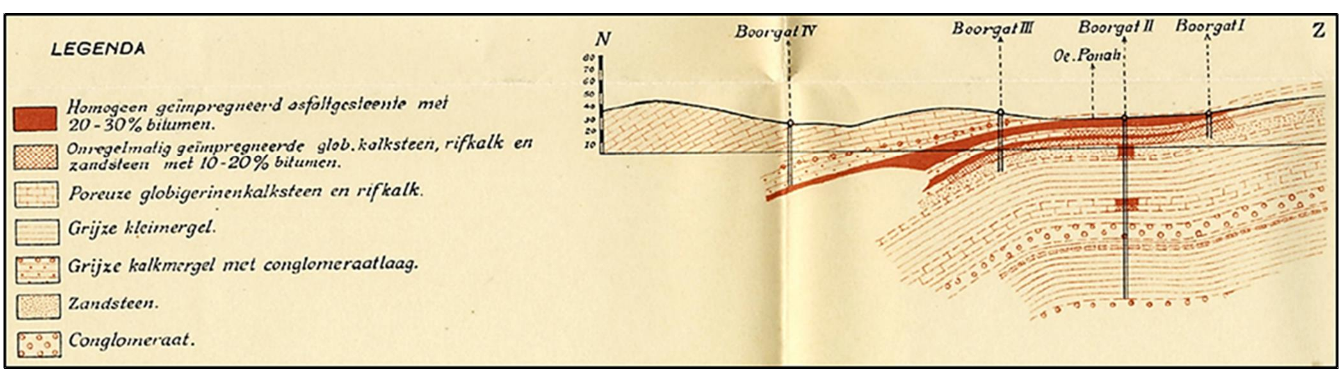

Figure XI.1.4. Cross-section showing near-surface asphalt impregnation in Miocene rocks in Panah asphalt terrain, Buton (Hetzel 1936).

In Eastern Indonesia onshore oil and gas seeps are known mainly from Seram, Timor, Buton (asphalt deposits), East Sulawesi and the Birds Head of West Papua (Figure XI.1.4.). Many of these can be linked to Late Triassic and Jurassic source rocks.

Surveys of oil slicks to detect offshore hydrocarbon seepage were carried out over several marine basins of Indonesia (Thompson et al. 1991).

Submarine oil and gas seepage was demonstrated recently in deep water basins of East Indonesia, using multibeam bathymetry, backscatter surveys and targeted piston coring programs (Decker et al. 2004, Noble et al. 2009, Orange et al. 2009, etc.). This was then used to high-grade exploration areas.

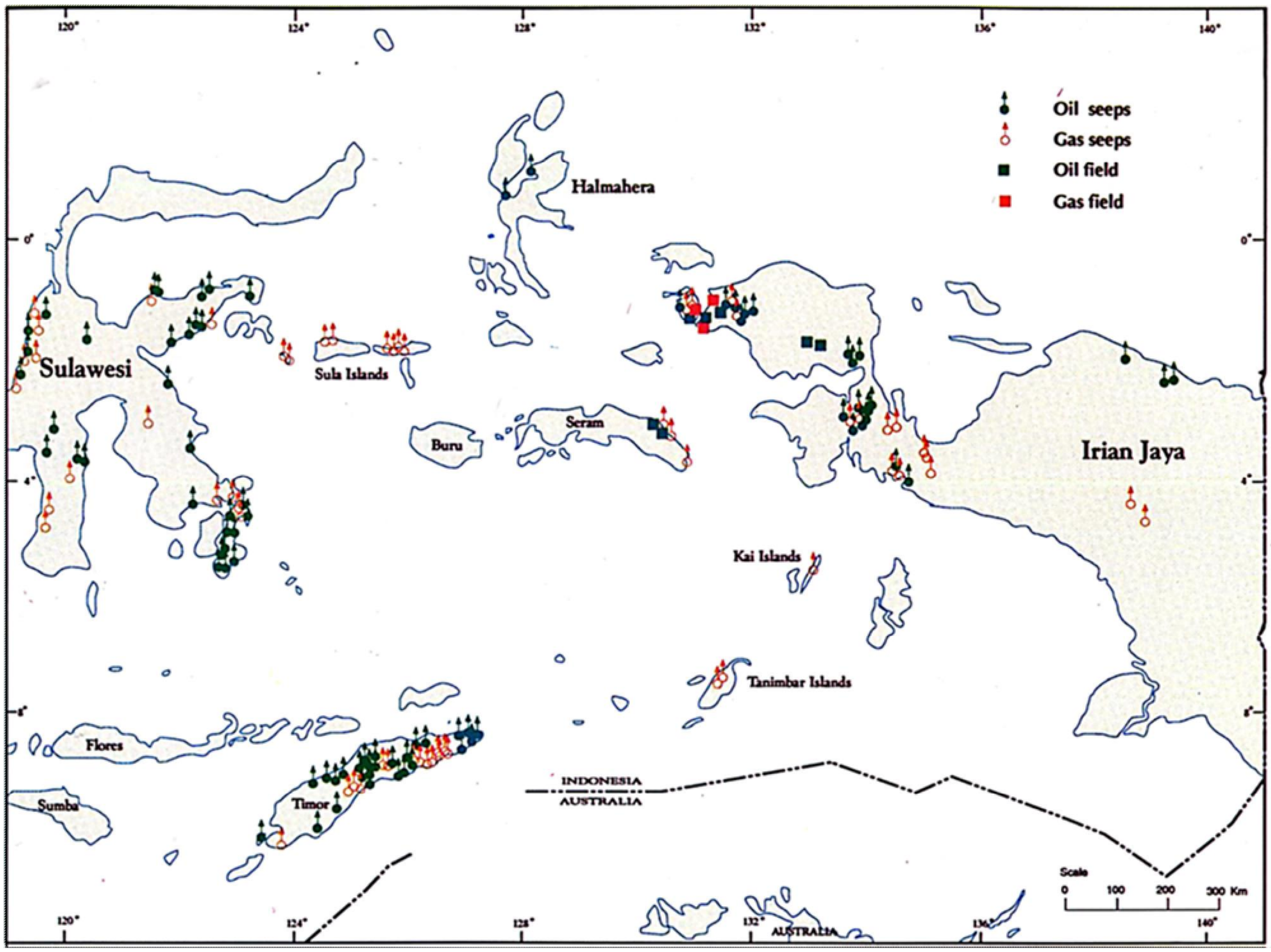

Figure XI.1.5. Oil and gas seeps in Eastern Indonesia (Livsey et al. 1992).

Early history of oil and gas exploration in Indonesia

The earliest oil discoveries in Indonesia were made between 1885-1900 in North and South Sumatra, East Java, Kutai basin, Tarakan and Seram island. Almost all the early wells were on surface anticlines with oil or gas seeps (e.g. Figure XI.1.6).

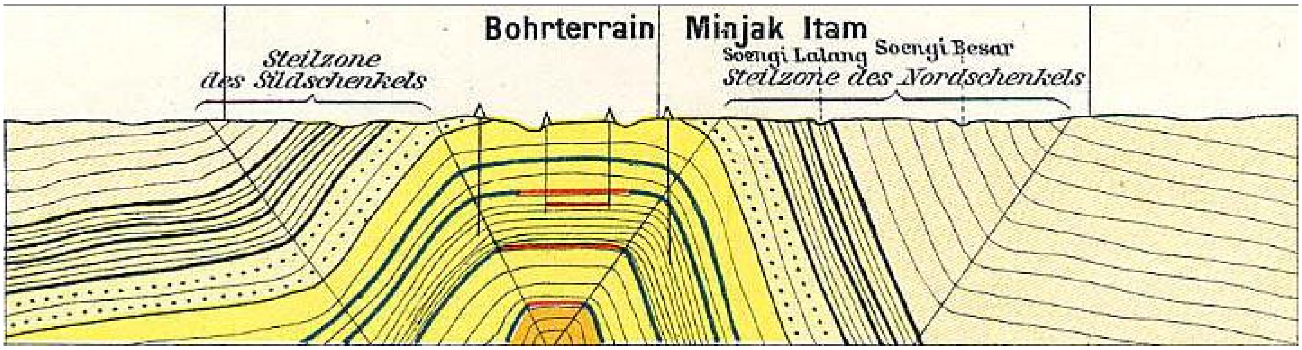

Figure XI.1.6. Example of oil-bearing anticlinal structure: SW-NE cross-section across part of the Kampung Minyak oilfield, S Sumatra (Tobler 1906).

An overview of the earliest oil industry in Indonesia is by Poley (2000) đEroica- the quest for oil in Indonesia (1850-1898)ô (see also Van Gorsel, 2009). The oil industry in Indonesia started with private entrepreneurs drilling shallow wells around surface oil and gas seeps. The first shallow oil well was drilled in 1871 near Cirebon in Central Java, which established the presence of oil, but never led to production. The first producing oil discovery was in 1884 at Telaga Said, North Sumatra. This was the beginning of the ñRoyal Dutchò company in 1890. Shell Transport and Trading discovered oil in East Kalimantan in 1897 (Sanga-Sanga). The first discovery in East Java was the Kuti Field near Surabaya in 1888, followed by discoveries in the Cepu area at Kawengan (1892) and Ledok (1893).

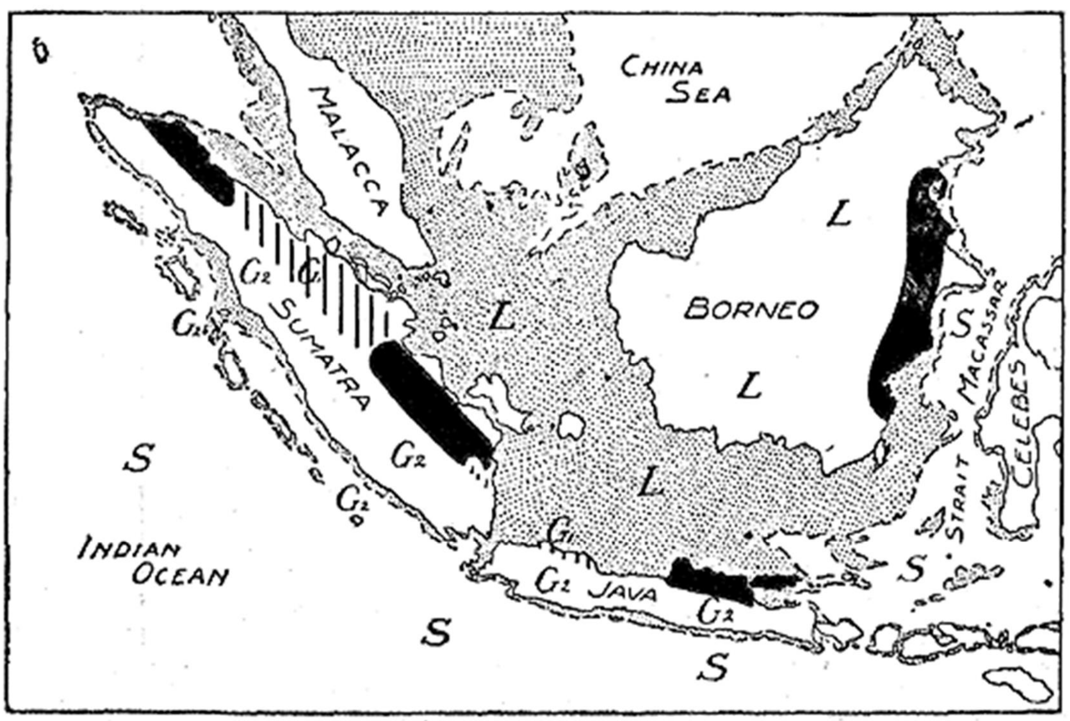

Fig. 2.

Black vertical lining: Neogene geosynclinal deposits, in which the occurrence of petroleum has not yet been established.
Solid black: Oilfields in Neogene geosynclinal deposits.

Figure XI.1.7. Early map of West Indonesia oil basins and potential additional prospective areas: predicting oil and gas fields should be present in the Central Sumatra Basin (Molengraaff, 1921).

After the formulation of the anticlinal theory the prime exploration method became the drilling of onshore surface anticlines. In the early 1900ês much effort went into surface geology mapping in basinal areas with seeps. Virtually all production before WW II was from shallow depths (<1000m).

In an interesting paper by Molengraaff (1921) it was reported that ñexperience has taught that the majority of large oil-fields originated in long enduring synclines where these are marginal areas of sedimentation along the coasts of continentsò and showing a map suggesting that Central Sumatra and NW Java basins are the right setting for the occurrence of petroleum (Figure XI.1.7). No oil had been discovered in these basins yet, but these two basins would become some of the most prolific oil and gas basins of Indonesia after the 1940's..

Several of the companies established by the earliest explorationists eventually merged into the ôRoyal Dutch Company for the exploration of oils fields in the Netherlands East Indiesô. In 1907 'Royal Dutch' merged with Shell Transport and Trading Company to become multinational Royal Dutch/ Shell. Its Indonesian subsidiary ôBataafsche Petroleum Maatschappijô (BPM) had a near-monopoly in the East Indies and had procucing oil fields in all known productive basins, with refineries in North and South Sumatra, East Java and East Kalimantan.

American operators came to Indonesia in 1912, initially through Netherlands-registered subsidiaries. First was the ñNederlandsche Koloniale Petroleum Maatschappij (NKPM)ò, a subsidiary of Standard Oil of New Jersey, which later would become Stanvac (Exxon + Mobil consortium). NKPM first drilled some minor discoveries in East Java between 1913-1916 (Tremboel, Petak, etc.), then became more successful with a string of discoveries in South and Central Sumatra after 1915. Lack of communication between New York headquarters and the Pendopo drillsite around Christmas 1921 delayed instructions to stop drilling after the well had drilled through the traditional óregressiveô Palembang Formation target. This led to the accidental discovery of a deeper sandstone play in the ôtransgressive seriesô and to the largest oil field in the East Indies at that time (Talang Akar- Pendopo; 350 MBO produced). Jirak (1930), Benakat (1932) and other discoveries then firmly established the Americans as the second significant oil company in the Netherlands Indies.

Caltex (Chevron and Texaco consortium) followed in 1931, operating as ñNederlandsche Pacific Petroleum Maatschappij (NPPM)ò. Exploration in the Central Sumatra coastal plains lead to two small discoveries in 1940, followed by the shallow giant Duri field in 1941. No commercial production had been established yet in Central Sumatra by the outbreak of WW II. The Minas discovery well (largest oil field in SE Asia) was drilled by Japanese occupation forces in 1944 on a location prepared by NPPM before the invasion.

BPM (Shell) remained the dominant company until World War II (WW-II). Very few new discoveries were made in the NE Java Basin after ~1910, as all obvious surface anticlines had been drilled. However, discoveries in South Sumatra, North Sumatra and E Kalimantan through the 1920ês-1930ês strengthened their position as the dominant player in the Indies (76% of the countryês total production in 1940).

The 1938 BPM Tanjung discovery was the first (and only significant) field discovered in the Barito Basin, SE Kalimantan (Siregar & Sunarjo, 1980). This was also the first oil discovery in Eocene rocks; all earlier discoveries in Indonesia were in Miocene-Pleistocene beds. The 1939 Lirik field discovery by NKPM/ Stanvac opened up the prolific Central Sumatra basin.

In New Guinea oil exploration activities had been ongoing since the 1920ês in eastern New Guinea (now Papua New Guinea; Wade 1927, APC 1961, Carey 1990), encouraged by common oil and gas seeps there. The NNGPM consortium was formed in 1935 by the ôBig Threeô oil companies (BPM, Stanvac and Caltex) to explore the entire western half of New Guinea (then ôNetherlands New Guineaö). The first minor oil discoveries were in the Birds Head, at surface oil seeps at Klamono in 1936 (the deeper reef play here was not discovered until ~1950), followed by oil in anticlinal structures Wasian (1939) and Mogoi (1941).

Very little of the geological results of 'Big 3' oil exploration acitivities before the pre-Japanese invasion were published Notable exceptions are the publications of Tobler (1906) for South Sumatra petroleum areas near Muara Enim and the Tobler (1913, 1918) reports petroleum-bearing anticlines of the Jambi sub-basin, South Sumatra. Brief summaries on some of the classic oil basins were published long after the main action (Weeda 1958 on East Borneo and East Java, Wennekers 1958 on South Sumatra, etc.).

Earliest oil-gas discoveries in Indonesia and key references

East Java (Surabaya, Gresik)	Kuti-1888, Lidah-1893, Metatu-1894, Sekarkurung-1900
East Java (Cepu)	Kawengan-1892, Ledok-1893, Semanggi-1896, Tungkul-1901, etc. *(Soetantri et al. 1973, Soeparyono & Lennox 1989)*
East Kalimantan (Kutai)	Sanga Sanga-1897 *(Jezler 1916, Jefferies, 1980)*
	Balikpapan/ Klandasan-1898, Samboja-1909
NE Kalimantan (Tarakan)	Karungan-1900, Sesanip-1900, Pamusian-1901, Bunyu-1922 *(Rowley 1973, Wight et al. 1993))*
North Sumatra	Telaga Said-1885 *(Skeels & Cooper 1985),* Darat-1892,
	Perlak-1899 *(Skeels & Cooper 1985),* Peudawah-1904, *etc.*
South Sumatra	Kampung Minyak-1896 *(Tobler 1906),* Suban Jerigi-1902, Babat-1902, etc.
Seram	Bula-1897 *(Zillman & Paten 1975, O'Sullivan et al. 1985, Kemp & Mogg 1992)*

Oil- gas discoveries in the late 1960's- early 1970's and key references

Sunda Basin, off SE Sumatra:	Cinta-1970 *(Tonkin 1995),*
(IIAPCO)	Zelda-1971, Kitty-1971, Selatan-1971 *(Todd & Pulunggono 1971)*
	Rama-1974 *(Ardila & Kuswinda 1982, Tonkin et al. 1992)*
	Krisna-1976 *(Ardila 1982, Wight & Hardian 1982, Talo & Randall 1985, McChesney et al. 1992, Welcker-Haddock et al. 1996)*
NW Java Arjuna basin (ARCO):	Ardjuna B-1968 *(Scheidecker & Taiclet 1976),* E1-1968 + 6 others by 1973
West Java	Jatibarang-1969 *(Sutan Asin 1972, Sembodo 1973, Partakusuma & Effendi 1974, Soewono & Setyoko 1987, Kalan et al. 1994)*
East Java Sea (Cities)	Poleng- 1972 *(Kenyon 1977, Welker-Haddock et al. 2001)*
Mahakam Delta + offshore:	Bekapai-1972 *(De Matharel et al. 1976, 1980, Lemoy et al. 1980)*
(Total)	Tunu-1973 *(Magnier et al. 1975, Sujatmiko et al. 1984)*
	Handil-1974 *(Magnier & Samsu 1975, Verdier et al. 1979, Bellorini et al. 1989)*
Mahakam Delta (Union Oil):	Attaka-1970 *(Burroughs 1972, Schwartz et al. 1973, Partono 1992,*
	Zagalai-1994 (*Trevena et al. 2003, Rosary et al. 2003)*
	Sepinggan-1973 *(Christensen et al. 1998),* Serang-1973 *(Clark et al. 1994)*
Mahakam Delta (Huffington):	Badak-1972 *(Gwinn et al. 1974, Huffington & Helmig 1980, 1990, Nurwono 1978, Hook & Wilson 2003)*
	Nilam-1974 *(Panigoro 1983, Schoell et al. 1985, Ade et al. 1988, Sidi et al. 1998, Butterworth et al. 2001)*
North Sumatra (Mobil)*:*	Arun-1971 *(Alford et al. 1975, Abdullah & Jordan 1987, Houpt & Kersting 1978, Soeparjadi 1983, Jordan & Abdullah 1992, Sunaryo & Djamil 1990, Widarmayana 2007)*
	NSO A-1972 *(Graves & Weegar 1973, Alford et al. 1975, Sunaryo 1994)*
	Lho Sukon South ốAô *(Rory 1990)*
Central Sumatra (Caltex)	Zamrud-1975
East Natuna (AGIP/ Esso):	D-Alpha-1973 *(Eyles & May 1984, May & Eyles 1985, Dunn et al. 1996)*
	Anoa-1974 *(Fahman et al., 1991)*
West Natuna (Conoco):	Udang-1974 *(Mattes 1979)*
Salawati Basin (Petromer Trend):	Kasim-1972, Walio-1973, Jaya-1973, etc. *(Vincelette 1973, Redmond & Koesoemadinata 1976, Gibson-Robinson et al. 1990).*

Oil- gas discoveries in new play areas/ deeper plays since 1980's and key references

1. Banggai-Sula Basin, East of Sulawesi Miocene carbonates
   - Tiaka-1985 *(Hasanusi et al. 2007)*,
   - Matindok-1988,
   - Senoro-1999 *(Hasanusi et al. 2004)*, Donggi-2001 *(Suherman et al. 2008)*
2. Madura Straits Miocene carbonate buildups
   - BD-1987 *(Kusumastuti et al. 2002)*, Jeruk-2004 *(Santos)*
3. Deep water Mahakam Delta/ Makassar Straits Plio-Pleistocene clastics
   - Gendalo-2000 *(Kirschner et al. 2004, Berendson et al. 2005, Sugiaman et al. 2007)*
   - Gula-2000, Ranggas-2001, Sadewa-2002, Gehem-2003
   - West Seno *(Redhead et al. 2000, Guritno et al.,2003, Gallup et al. 2005)*, Gandang, Maha, etc.
4. Madura Straits Pliocene *Globigerina* calcarenites (= extension of late 1800's onshore E Java play)
   - Terang-Sirasun *(Noble & Henk 1996, 1998, Basden et al. 1998, 1999, Cook et al. 2003)*
   - MDA, Oyong
   - Maleo-2002 *(Triyana et al. 2007)*
5. East Java Pleistocene volcanoclastic turbidites play
   - Wunut-1994, Carat-2001 *(Kusumastuti et al. 2000, Darmoyo et al. 2001, Satyana & Armandita 2004)*
6. Deep water Australian NW Shelf (Indonesian and East Timor segments) Middle Jurassic clastics
   - Abadi-2000 *(Nagura et al. 2003, Matsuura et al. 2005)*
   - Sunrise-Troubadour *(Seggie et al. 2000, 2003)*

Deeper plays in established basins:

1. Sumatra- Fractured Basement below traditional Miocene clastics and carbonates play
   - NE Beruk-1976, Central Sumatra (Koning & Darmanto 1984)
   - Sumpal-1994, South Sumatra *(Zeliff & Bastian, 2000, Chalik et al., 2004)*
2. Bintuni Basin, West Papua- Jurassic sandstones below the Miocene carbonates play
   - Roabiba-1990, Ofaweri-1992, Wiriagar Deep-1994, Vorwata-1997 combined to form Tangguh gas development *(Perkins & Livsey, 1993, Casarta et al. 2004, Robertson 2004)*
3. NE Java onshore- Oligocene-Early Miocene carbonate buildups below traditional Mio-Pliocene clastics play:
   - Mudi-1994, Cendana-1998, Kedung Tuban-2000, Banyu Urip-2001, Jambaran-2001, Sukowati-2001 *(Satyana & Darwis 2001, Satyana 2002, 2005, Satyana & Djumlati 2003, Cahyono & Burgess 2007, White et al. 2007)*
4. Seram- Triassic fractured carbonate play below traditional Plio-Pleistocene clastics play
   - East Nief-1983, Oseil-1994 *(Kemp et al 1992-1996).*
5. East Java Sea- Eocene carbonates and clastics below traditional Oligocene- Early Miocene carbonate play
   Pagerungan-1985 *(Phillips et al. 1991, Ebanks & Cook 1993, Kaldi et al. 1997, Musliki 1997, Takano et al. 2008)*

Sedimentary basins
Hydrocarbons and coal deposits are intimately associated with sedimentary basins. In the Indonesian region almost all hydrocarbon-bearing basins are of Tertiary age. Mesozoic basins with oil-gas fields only in the greater NW Australia- New Guinea region, and are part of the NW Australian rifted passive margin.

Most basins in Indonesia have now been explored for hydrocarbons, but at different degrees. PND (1996) classified Indonesians by petroleum exploration activity into mature (14), semi-mature (9) and frontier (18) basins.

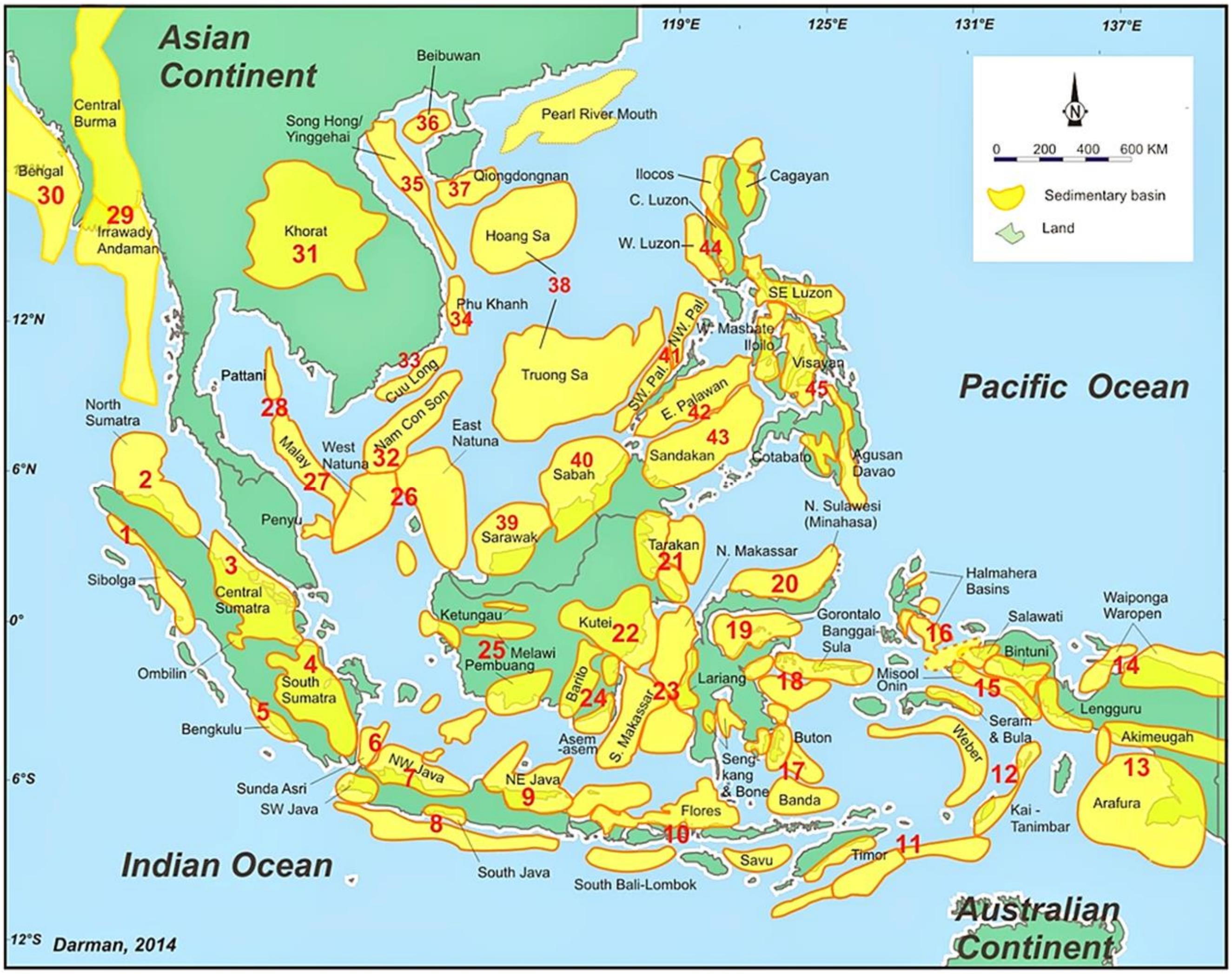

Figure XI.1.8 Sedimentary basins of Indonesia (Herman Darman (2014, at http://geoseismic-seasia.blogspot.com/).

In the Indonesian region many basins and basin types have been identified (Figures XI.1.8, XI.1.9).

Most oil-gas fields are in Sundaland region of West Indonesia and in the adjacent Malaysian and Thailand waters of the Sunda Shelf. Two main basin types may be distinguished:
1. Sundaland Cenozoic intra-continental rift basins, controlled by the plate-wide extension, starting in early Middle Eocene time (~45 Ma; Pubellier and Morley 2014 or 49 Ma; Morley 2014). These are the most prolific oil basins, due to the happy combination of excellent Eocene- Oligocene lacustrine and deltaic source rocks and Late Miocene - Pleistocene inversion events creating large anticlinal inversion structures.
2. Large Neogene delta systems around the Sundaland margin (Mahakam and Tarakan of East Kalimantan, Baram, Rajang and West Luconia of North Borneo). Some of these deltas may actually prograde over oceanic marginal basin crust. Source, reservoir, seal and structure all formed within the delta system itself.

The oil basins of Sumatra and Java have often been called 'back-arc basins', because of their present-day position behind the modern Sunda volcanic arc. However, their formation and subsidence history can not be tied to subduction-driven back-arc extension, but rather to a plate-wide extension that formed similar mid-Tertiary rift basins away from the arc (e.g. Malay Basin, Natuna basins).

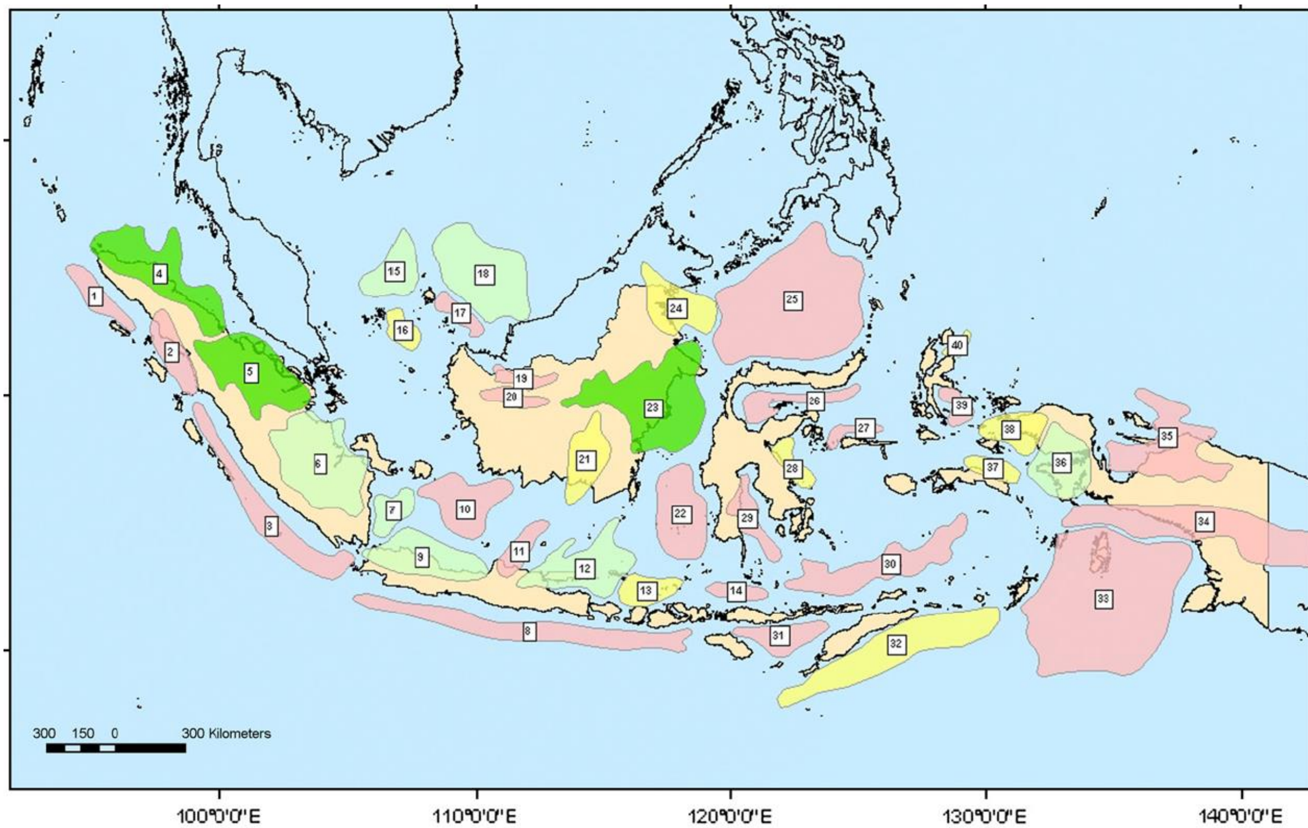

Figure XI.1.9. Sedimentary basins of Indonesia, grouped by discovered oil-gas volumes. Green= >5 Bboe, Light Green = 1-5 Bboe, Yellow= 10-1000 MMboe, Pink = 0-10 MMboe (Doust and Noble 2008).

Finally, access to oil and gas data has been a problem in Indonesia since the start of the oil industry. Vast amounts of surface and subsurface geological and geophysical data have been acquired by the oil industry, but most of this data has stayed in confidential company files and government agency repositories (PND).

Fortunately, after the early 1970's, many petroleum-related publications have appeared in the Proceedings of Annual Conventions of the Indonesian Petroleum Association (IPA).

XI.2. Hydrocarbon Source Rocks, Oils and Gases

This sub-chapter XI.2 of Bibliography 7.0 contains 141 papers on Hydrocarbon source rocks. These are primarily papers of a general or regional nature; many additional papers dealing with source rocks of specific areas are grouped under their area's chapters.

Recent regional review papers on Indonesian source rocks/ petroleum systems include Doust and Sumner (2007), Doust and Noble (2008) and Satyana (2010, 2017).

Effective hydrocarbon source rocks in Indonesia have a patchy, discontinuous distribution, which makes some areas highly prolific, but other large regions non-prospective. Understanding regional source rock distribution is therefore probably the single most important factor in hydrocarbon exploration.

Thermogenic oil and gas generation

Commercial hydrocarbon accumulations are all found in sedimentary basins, with hydrocarbons formed from the degradation of organic material, through both thermal (thermogenic) or biological (biogenic, bacterial) breakdown processes. The vast majority of oil and gas can be linked to thermal maturation of organic-rich sediments, typically at depths 3-4 km or more.

The minimum organic content of an efficient source rocks appears to be around TOC of 1-2%. Normal marine shales from oxygenated marine environments do not have TOC's high enough to generate oil or gas. To be an effective oil or gas source higher-than-normal organic matter is required, which usually means low-oxygen seafloor environments. Such conditions may be met in restricted (silled) basins (Salawati basin, Tomori basin), or in areas and at times when an oxygen-minimum zones develops in an oceanic environment (more common in Mesozoic hothouse climates than in Tertiary?).

Biogenic gas

Low-temperature biogenic gas forms from bacterial degradation of plant material in lakes, wetlands and swamps. In the shallow subsurface biogenic gas also forms in peat and low-rank coals, and also in deep marine sandstones rich in plant debris (Katz 1995, Subroto et al. 2007, 2009, etc.).

Biogenic gas may form shallow, producable gas accumulations, like in:
- Plio-Pleistocene submarine fan sands of Makassar Straits *(Saller et al. 2006)*;
- Late Miocene- Pliocene calcarenites in Madura Straits *(Noble and Henk 1996, 1998, Satyana and Purwaningsih, 2003*);
- Miocene carbonates in the Sumatra forearc basins *(Dobson et al. 1998)*;
- East Java Sea Lengo and Mustika wells *(Pireno et al. 2016)*;
- Late Miocene- Pliocene shallow gas in Central Sumatra basin *(Yuwono et al. 2010, 2012)*;
- Plio-Pleistocene clastics of North New Guinea basins *(Niengo, Waropen, Ramu; Barrett 1997, 1999)*;
- Late Miocene shallow carbonates of the Salawati basin *(Satyana et al. 2007)*
- deep marine turbidites of the Late Pliocene Bengal Fan off Myanmar *(Shwe and other fields; Yi et al. 2015)*.
- most of the gas hydrates in deep water basins (see below).

Biogenic gases are typically >99% methane (CH_4) and can generally be distinguished from thermally matured (thermogenic) gas by their 'light' d13C carbon isotope ratios (Satyana et al. 2007).

Inorganic methane gas

There is also some evidence for the existence of inorganic methane gas formation, in particular associated with the serpentinization of ultramafic igneous rocks (Satyana 2005). Examples of likely inorganic gas seeps have been described from the Philippines (Abrajano et al. 1888, 1990), and from the Tanjung Api gas seep on the North coast of the East Arm of Sulawes. At the latter coastal location methane emanates from ultramafic rocks and has unusually heavy d13C isotopes, leading Subroto et al. (2004) to suggest a possible abiogenic origin. Not many other examples of inorganic gas generation have been identified.

Inorganic hydrothermal methane has also been sampled at oceanic spreading centers (e.g. Marianas Trough, Horibe et al. 1987); The latter appear to be associated with high He and CO_2.

-Source rock types and ages

In the Indonesian region two main petroleum systems are present, which are intimately linked to the two major continental plates, i.e. Eurasia and Australia New Guinea (Figure XI.2.1).

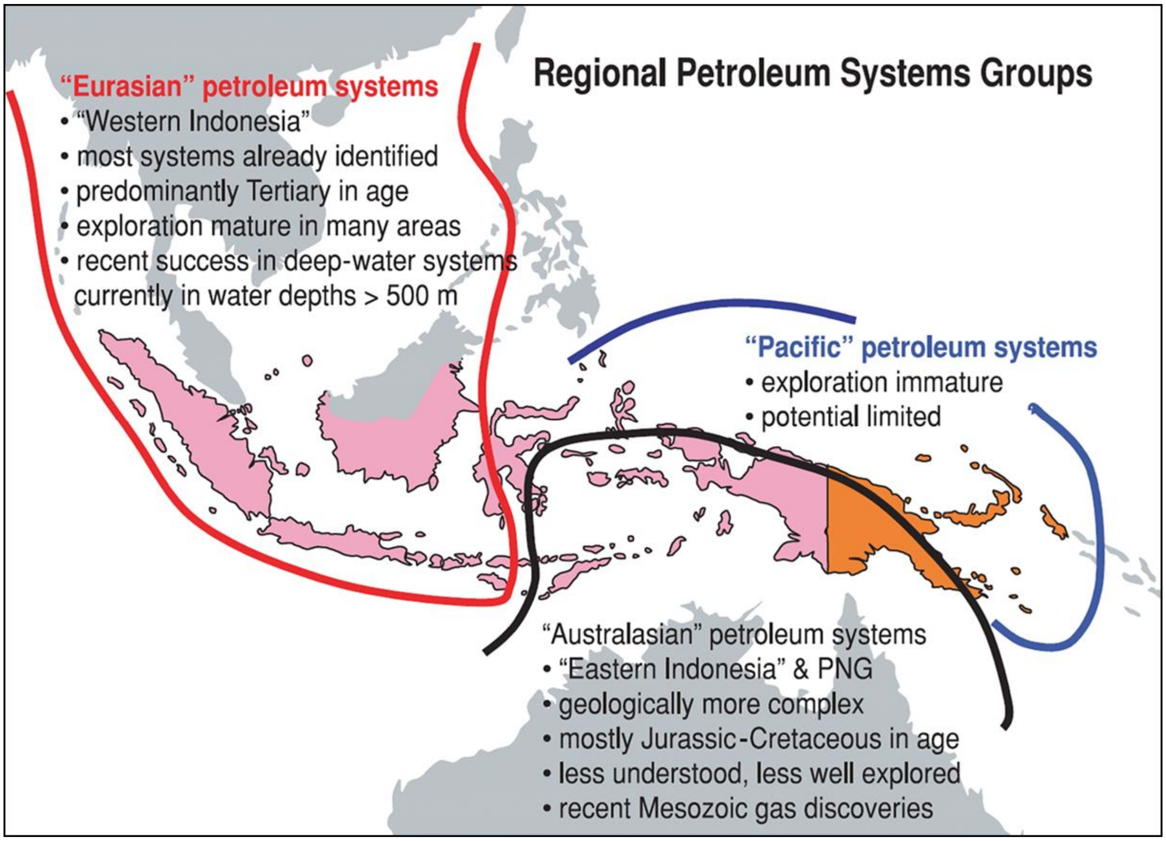

Figure XI.2.1. The Indonesian region with three different main petroleum systems (Howes, 2001).

Eurasian petroleum systems

In West Indonesia (and surrounding Sundaland) all oil and gas has been linked to Cenozoic sediments. Two groups and several sub-groups from different tectonic-depositional settings can be distinguished:

1. Paleogene intracontinental rift basin sources: (a) synrift Eocene- Oligocene restricted lacustrine sources, (b) Eocene- Miocene late rift and post-rift coal-bearing fluvio-deltaic formations;
2. Sundaland margin Neogene deltas, mainly around East and North Borneo, sourced mainly from dispersed plant material in fluvio-deltaic deposits and associated delta-derived deep water sediments.

One'rule-of thumb' for source types in the SE Asia Cenozoic suggested by Doust and Lijmbach (1997) was that (1) proximal basins or basin environments are more oil-prone (lacustrine algae), (2) more distal, marine basins and environments have high gas potential and (3) intermediate basins and deltaic environments generate both oil and gas.

Australasian petroleum systems

In East Indonesia and adjacent Papua New Guinea and the Australian NW shelf the hydrocarbon system is driven mainly by Jurassic and Cretaceous source rocks, but Tertiary-sourced are present as well.

Jurassic marine shales are believed to source the oils in the Upper Jurassic-Lower Cretaceous reservoirs in the PNG foldbelt. Permian coals were probably the main source for the large gas fields in Bintuni Bay, W Papua. Upper Triassic marine bituminous shales were responsible for the tar sands of Buton, the oil seeps on Timor island, and the small oil fields of NE Seram. These oils may have high sulfur content (Satyana et al. 2013)

Miocene- Pliocene marine shales, probably in tectonically restricted basins, are believed to be the oil source in the Salawati Basin of the Birds Head, West Papua (e.g. Satyana 2009), and the Tomori Basin of East

Sulawesi (Zaitun et al. 2016). The Nunu oil seep on Buton contains oleanane, indicating a Tertiary source, probably marine (Satyana et al. 2013).

Pacific petroleum systems

The third petroleum province of the Howes (2011) refers to the relatively minor and little-studied oil and gas occurrences in the Neogene successor basins of northern New Guinea. Oil and gas seeps are present in the area (e.g. Musu et al. 2015), but no commercial discoveries have been made so far.

Source rocks, and the oils generated from them, can be classified in three main categories: lacustrine (most productive?), fluvio-deltaic /coaly (most common?) and marine (most common in East Indonesia?). (Figure XI.2.2; Robinson 1987).

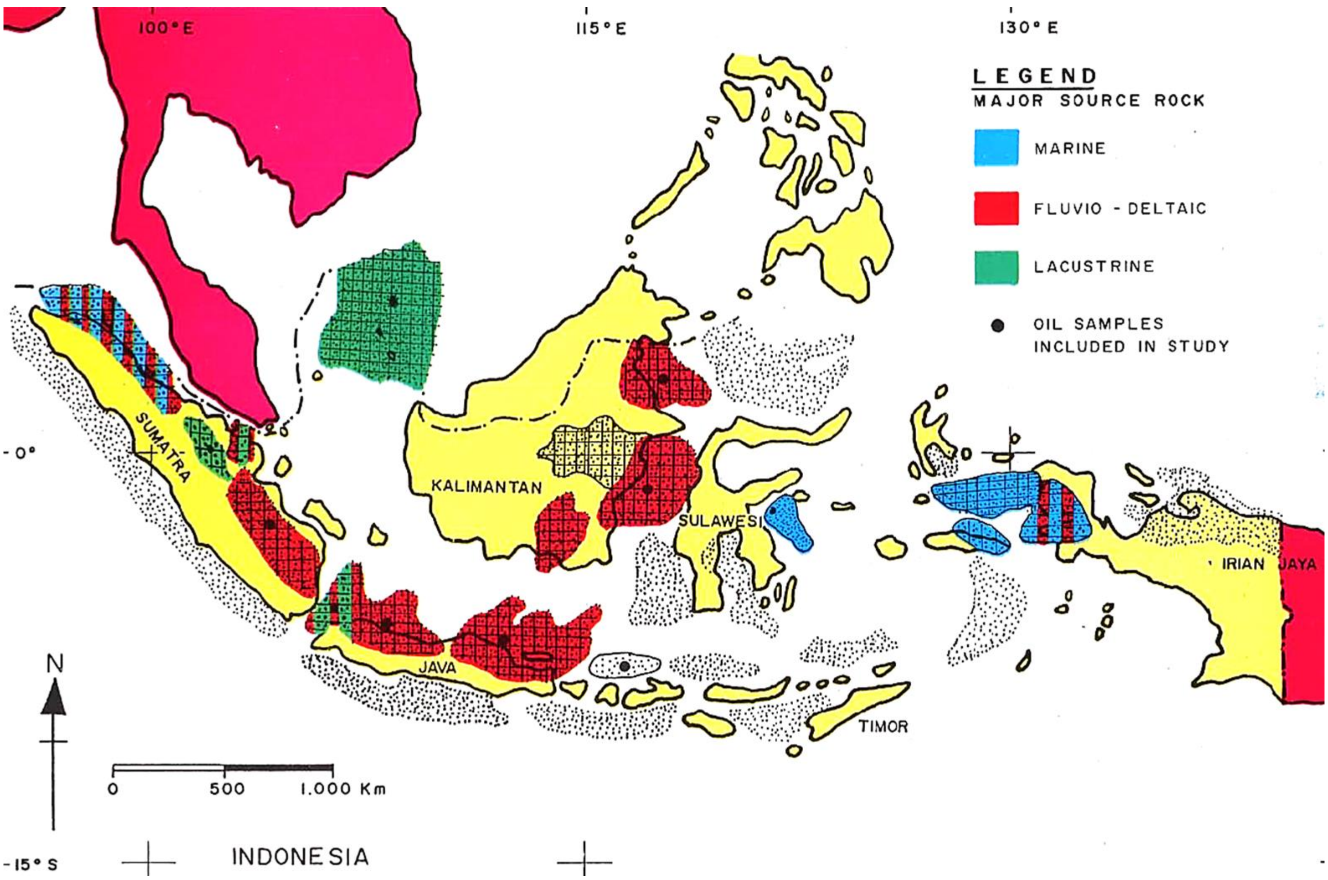

Figure XI.2.2. Major Cenozoic source rock types of Indonesian basins, lacustrine, fluvio-deltaic /coaly and marine (Robinson 1987).

Lacustrine source rocks

Many of the oils in SE Asia have been tied to lacustrine source rocks. They are source rocks rich in algal material that formed and was preserved in relatively deep lake basins. The algal kerogens are derived mainly from freshwater green algae *Botryoccocus* and *Pediastrum* (Sladen 1997, Sefein et al. 2017).

Lacustrine source rocks appear to be the most productive. They are relatively common in the early rift phase of the intra-continental Paleogene basins of Sundaland. In addition to the right tectonic setting this probably also required a humid-warm climate..They tend to produce light, waxy oils, at relatively early stages of maturation. Wax content of lacustrine-sourced oils of Malaysia- West Indonesia varies from 10-35%, up to 45%.

Late Eocene lacustrine shale deposits sourced most of the oils in the Central Sumatra Basin (Pematang Formation Brown Shale), and probaly in many of the Cenozoic rift basins of Malaysia and Thailand. They can be observed in outcrop in the Ombilin Basin of Central Sumatra. Lacustrine shales were also encountered in wells in the Middle-Late Eocene of wells in South Makassar Straits.

Coal source rocks

Before the mid-1980's conventional wisdom held that coals were a good source of hydrocarbon gas, but did not generate oil. Now it is accepted that in the Cenozoic basins of tropical SE Asia fluvio-deltaic coals and coaly clastics can also generate oil, but probably only under specific conditions (MacGregor 1994, Thompson et al. 1994).

Only liptinite-rich coals (>15-20% of total macerals) appear capable of generating significant amounts of liquid hydrocarbons, while vitrinite-rich coals are gas-prone source rocks (Teerman and Hwang 1989).

Oils generated from SE Asian Cenozoic coals may be primarily from the waxy cuticles of leaves. This is a common feature in plants from brackish-water (mangrove) environments, so coals and associated coaly mudrocks from paralic, brackish water settings may have a higher content of oil-prone kerogens (Brown 1989, Thompson et al. 1994, Todd et al. 1997, Saller et al. 2006).

Biomarkers

Certain organic chemical components in oils or source rocks can be traced to plants or animals ('molecular fossils' or refelect particular depositional settings. These are called 'biomarkers' and can be a powerful tool in the interpretation of the origin of oils, correlations to source rocks, depositional environment and maturity.

A recent review of the use of biomarkers in Indonesia is Satyana (2016). Additional references are listed in the table below.

Biomarkers are generally identified from Gas Chromatogam/ Mass Spectrometer (GC/MS) diagrams. In biodegraded oils this method becomes more difficult, as biomarker peaks are highly suppressed.

Biomarker interpretation is a specialist field. A brief selection of commonly used biomarker indicators in oil-source rock interpretation:

1. Pristane- Phytane ratio. The Pr/Ph ratio is used used an indicator of depositional environment: ratios can be very high (> 3) in coal-sourced oils, low ratios (<2) indicate marine sources, very low ratios (<1) reducing depositional environments if.
2. Sterols that have been tied to organisms: C28 dominates in phytoplankton (green algae and diatoms), C27 in zooplankton and red algae, C29 is common in higher land plants and certain algae. A dominance of C27 steranes is almost always associated with marine organisms.
3. Oleanane is identified from the 18B(H) peak on mass chromatograms and is believed to derive from angiosperm flowering land plants. These evolved sometime in the Late Cretaceous, so its presence is commonly used to identify Late Cretaceous and younger oils. However, absence of oleanane needs to be used with caution. It does not always mean pre-Late Cretaceous age of source rocks, but may reflect absence of land-derived plant material in marine facies (e.g. some Salawati basin oils are of Neogene, but have no without oleanane (PT Robertson Utama 2000, etc.). Also, not all Cenozoic terrestrial organic facies rocks in SE Asia contain oleanane (Murray et al. 1997).
4. Gammaceranes peaks (between C31 and C32 peaks on chromatograms) are often linked to high salinites, or to stratified water columns.

Carbon Isotopes

Carbon d13C isotopes have been used to differentiate between oils of marine verus non-marine origins, Organic matter form marine rocks is isotopically heavy (d13C from -19 to -23 ă), while terrestrial organic matter is light (d13C from -24 to -31 ă). However, interpretations are not always straightforward (Williams and Williams 1994).

High-CO2 gases

CO2 is a common component of hydrocarbon gases in Indonesia. It reduces the caloric value of the gas and is a greenhouse pollutant when releasedinto the atmosphere. CO2 can originate from multiple sources, i.e. from the mantle, volcanic degassing, thermal breakdown/ metamorphism of carbonate (carbonate metamorphism), high maturation of organic material, etc..

Examples of high-CO2 gas in the Indonesian region:

1. East Natuna basin: in large Natuna D-Alpha carbonate buildup gas field has 67-82% CO2, possibly from degradation of carbonate *(Cooper et al. 1997)*;

2. North Sumatra : gases in North Sumatra commonly have 20-30% CO_2 (NSB area, Kuala Langsa, etc.), all presumably from thermal breakdown of deep carbonate formations. The highest CO_2 is in areas underlain by Tampur dolomite *(McArthur and Helm 1982, Caughey and Wahyudi 1993).*
3. South Sumatra: locally >40% CO_2 in gases from the Corridor Block; partly inorganic / *(Suklis et al. 2003)*;
4. onshore West Java: several wells with >50% CO_2 *(Cooper et al. 1997)*;
5. onshore NE Java Basin: Cepu area with gases up to 25-78% CO_2 *(Satyana et al. 2007)*;
6. East Java Sea around Bawean Arch: wells with 75-85% CO_2 gas, possibly related to volcanic degassing *(Satyana et al. 2007)*.

Gas hydrates

Gas hydrates, also known as 'clathrates', are layers of 'frozen' gas deposits, that occur in sediments in many deep water areas, mainy in water depths over 600-1000m and between ~200-700 meters below the seafloor. Whilst they are usually buried in sediments not far below the seafloor, they may also be found exposed on the seafloor of (e.g. South China Sea at water depth of 1130m; Zhang et al. 2017).

Gas stored in hydrates represent enormous gas volumes, but exploitation has not yet been technically and commercially viable.

The base of the Gas hydrates stability zone is often identified on seismic lines as a 'Bottom Simulating Seismic Reflector' (BSR). This is a commonly bright reflector that runs parallel to the sea floor, but often cuts across sedimentary bedding.

Most of the gas in hydrates is >99 % methane and appears to be of biogenic origin, formed from microbial breakdown of detrital plant material at shallow depths. This is especially likely where BSR's cover very large areas. In some cases hydrates contain heavier hydrocarbon gases, of probable thermogenic origin from deeper horizons. Such thermogenic hydrates are more likely where BSR's are limited to areas over anticlinal structures, that focused gas seepage to the seafloor.

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In the Indonesia/ SE Asia region region gas hydrates have been identified in numerous deep water areas:
- Java- Sumatra forearc region *(Kopp 2002, Bahar et al. 2005)*;
- Makassar Straits *(Jackson 2004a, b, Sassen and Curiale 2006, Zhang and Wright 2017)*;
- offshore NW Borneo *(Behain 2005)*;
- Celebes Sea off N Sulawesi *(Delisle et al. 1998, Neben et al. 1998)*;
- Andaman Sea *(Chopra 1985, Satyavani et al. 2008, 2014, Rose et al. 2014)*;
- offshore Seram *(Hardjono et al. 1998)*;
- Aru Trough *(Priyanto et al. 2015);*
- South China Sea *(He et al. 2009, Zhang et al. 2017);*
- Timor Sea *(McKirdy and Cook 1980),*
- Rakhine Basin off Myanmar *(Mann et al. 2017);*
- SW Pacific, etc.

Gas hydrates are stable only in a narrow range of (low) Temperature and Pressure. Bottom Simulating Reflectors (BSR) can therefore be a useful tool to calculate temperature gradient/ heat flow if water depth, bottom water temperature and depth below seafloor are known (deep BSR's indicate low geothermal gradients) (Delisle et al. 1998, Hardjono et al. 1998, Courel et al. 2011, Shankar and Riedel 2013, 2014, Priyanto et al. 2015, etc.).

Some suggested reading- Hydrocarbons and Source *(a selective listing of significant papers)*

History of Discovery:	*Pertamina 1986, Poley 2000*
Cenozoic basins	*Beltz 1944, Koesoemadinata and Pulunggono 1974, Hamilton 1974, Hall and Morley 2004, Hall 2009, Pubellier and C.K. Morley 2014, R. Morley 2014*
Hydrocarbon Occurrences:	*Molengraaf 1921, Beltz 1944, Schuppli 1946, Dufour 1957, Weeda 1958a b, Wennekers 1958, Koesoemadinata 1969, Beddoes 1980, 1981, Kingston 1988), Courteney et al. 1989, 1990, Caughey et al. 1994, 1995, Howes and Tisnawijaya 1995.Hutchison 1996, Pertamina BKKA 1996 series, Fraser et al. 1997, Netherwood 2000, Gunawan et al. 2008,.*
Oil- Gas seeps:	*De Greve 1865, Von Baumhauer 1869, Thompson et al. 1991, MacGregor 1995, Noble et al. 2009*
Oil characteristics:	*Von Baumhauer 1869, Escher 1920, Van Aarssen et al. 1990, 1992, Peters et al. 1999, Curiale et al. 2000 (Brunei), Curiale et al. 2005 (Kutai), Subroto et al. 2006 (Kutai),*
Gas geochemistry:	*Satyana et al. 2007, Subroto et al. 2007*
Source Rocks:	*Robinson 1987, Livsey et al. 1992, Ten Haven and Schiefelbein 1995, Schiefelbein et al. 1997, papers in Howes and Noble 1997, Todd et al. 1997, papers in Caughey and Howes 1999, Peters et al. 1999, Longley 2005, Saller et al. 2006, Davis et al. 2007, Satyana 2007, Doust and Sumner 2007, Doust and Noble 2008, Noble 2009, Subroto et al. 2009, Satyana 2012, 2013, 2017.*
Lacustrine source rocks	*Gibling 1988, Katz and Mertani, 1989, Katz 1991, 1995, Williams et al. 1985, 1992, 1994, 1995, Cole and Crittenden 1997, Sladen 1997, Sudarmono et al. 1997, Carnell et al. 1998, Curiale et al. 2003, Satyana and Purwaningsih 2013, Widayat et al. 2013, 2016, Sefein et al. 2017.*
Coaly source rocks	*Gordon 1985, Kelley et al. 1985, Thompson et al. 1994, 1995, Horsfield et al. 1988, Brown 1989, Teerman and Hwang 1989, Katz et al. 1990, MacGregor 1994, Daulay and Panggabean 2001, Saller et al. 2006, Davis et al. 2007, Sykes and Cibaj 2010.*
Biomarkers	*Hoffmann et al. 1984, Subroto et al. 1991, 1992, Sosrowidjojo et al. 1996, Murray et al. 1997, 1994, Peters et al. 2005, Curiale 2006, Satyana and Purwaningsih 2013, Satyana 2016,*

XI.3. Coal

The 152 references in sub-chapter XI.3 of Bibliography 7.0 on coal deposits are primarily papers of a general or regional nature. There are many more papers on coal deposits from certain areas, but these are in the chapters on the areas in which they are located. A major, recent review of the history of coal exploration and production in Indonesia is by Friederich and van Leeuwen (2017).

A number of papers in this chapter discuss recent exploration projects for coalbed methane gas, in South Sumatra and Kalimantan. Many of these projects have been in low-rank coals with biogenic gas. Although most authors agree on its potential, there are no plans for commercial development yet (Hadianto 2000, Stevens and Sani 2001, Hadianto and Stevens 2005, Lalean 2010, Moore 2010, 2011, Susilawati et al. 2013, Harrington 2016, etc.)

Also included are a series of papers on depositional environments of coals, i.e. the peat swamps of Borneo and Sumatra. Modern peat swamps are found mainly within ± 10° of the Equator, commonly in coastal plain settings, with a humid climate and clays substrates that enable ever-wet conditions (e.g. Page et al. 2006, 2012, Morley 2013).

Coal is an important commodity for Indonesia and occurs primarily in Tertiary deposits. The most significant coal deposits of SE Asia are in the Middle-Late Miocene of southern Sundaland (Borneo, Sumatra; Figure XI.3.1), followed by Eocene coals from the same regions.

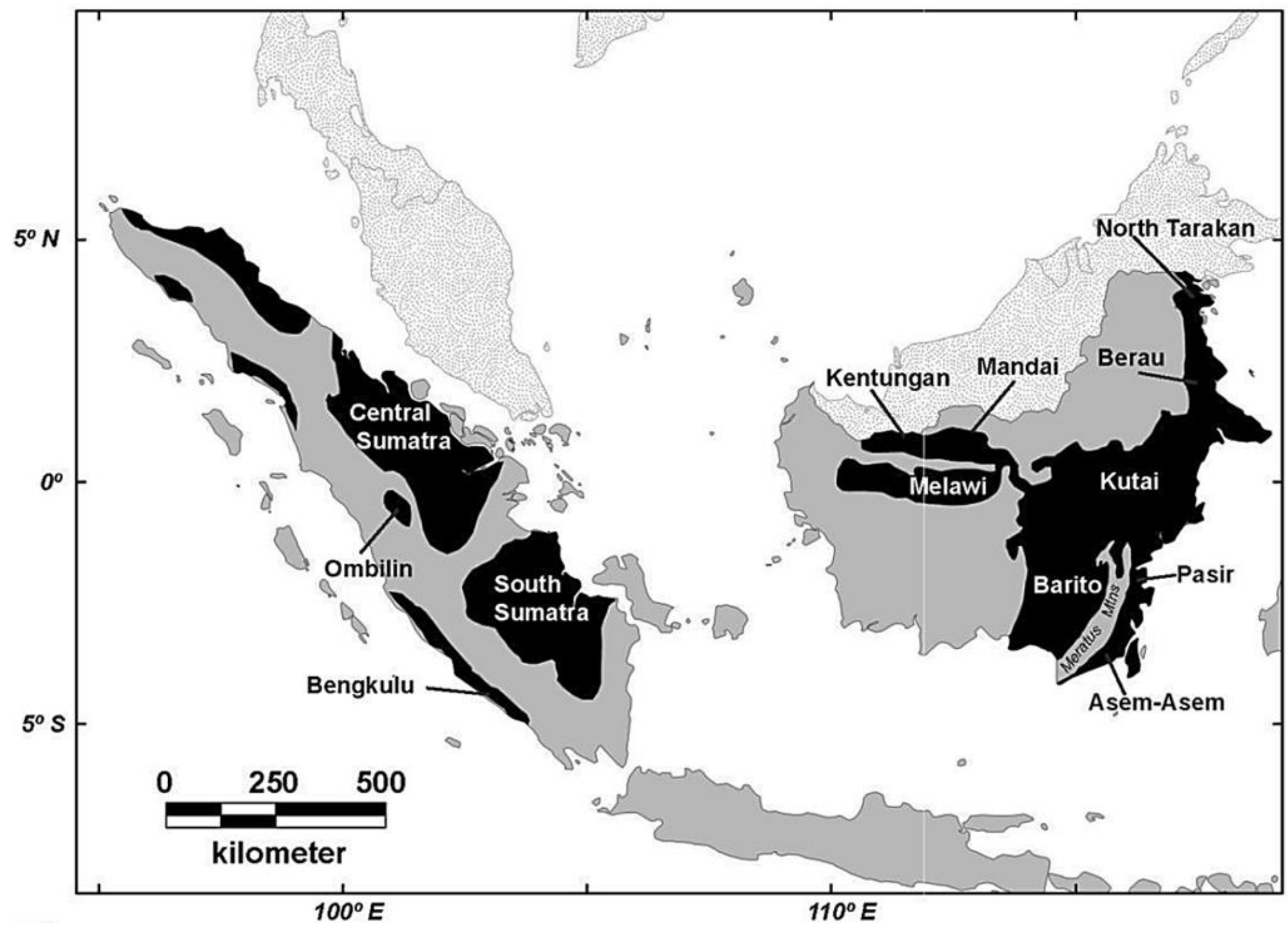

Figure XI.3.1. Principal Cenozoic coal-bearing basins in Indonesia (from Bowe and Moore 2015).

Coal mining started in the mid-1800's in SE Kalimantan (Pengaron; Figure XI.3.2.) and West Sumatra (Ombilin). The mines were operated by the Netherlands East Indies government as a strategic resource to fuel steamships in the region, to reduce dependence on coal that until then was imported mainly from Wales and Australia.

Initially only the higher-grade coals were of interest, i.e. the Eocene-age coals of the Barito basin and Pulau Laut (SE Kalimantan), Eocene coals in the Ombilin basin (West Sumatra), as well as some Miocene coals of the Kutai Basin (East Kalimantan) and Middle-Late Miocene coals around andesite intrusions at Bukit Asam (S Sumatra) and the Bengkulu Basin (SW Sumatra), the grade of which was locally thermally-enhanced by Late Neogene andesitic intrusions.

From 1941 to the 1980's coal production in Indonesia was minimal (e.g. 0.2 Million Tons in 1972), partly driven by the global shift away from coal to oil in running ships and power plants. Since the 1980's the thicker, but lower rank M-L Miocene coals (closer to lignites) have become attractive and numerous open pit mines are currently active in the in the Barito and Pasir Basins of SE and East Kalimantan).

Historic coal mining developments

The first coal mine in Indonesia is the underground Oranje Nassau mine near the Riam Kiwa River at Pengaron, in the Barito Basin, SE Kalimantan. It opened in 1849, but closed in 1884 (Figure XI.3.2).

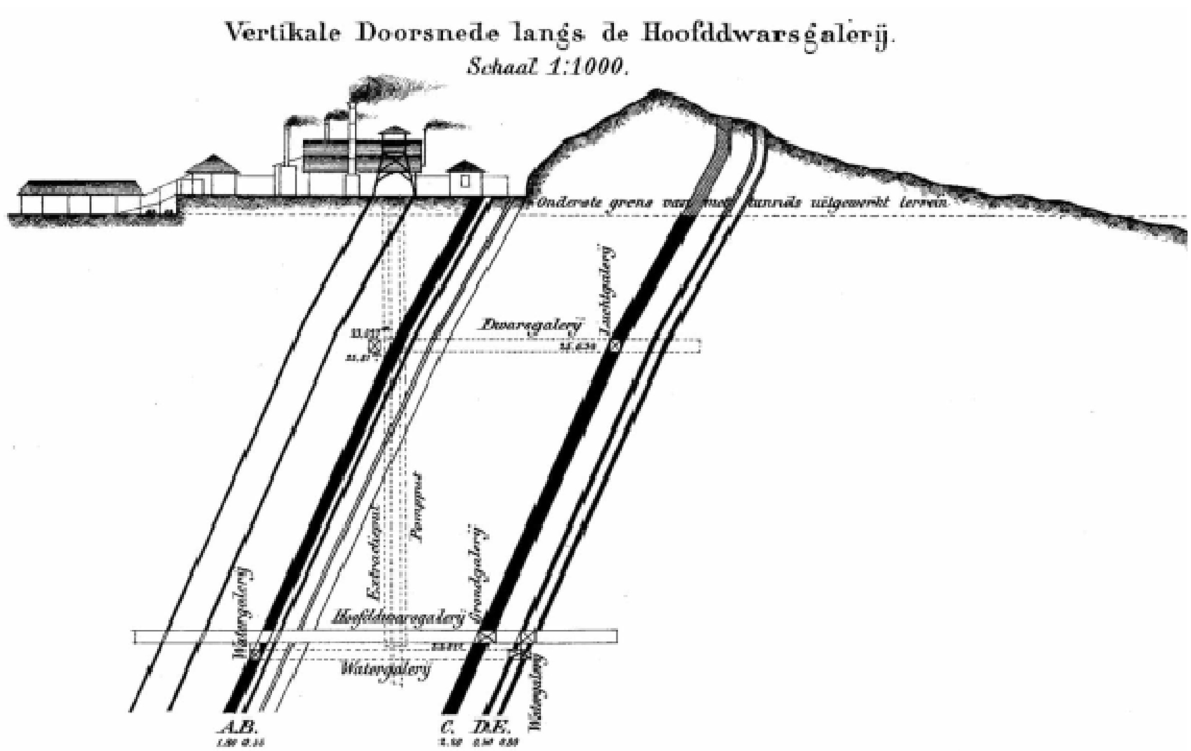

Figure XI.3.2. W-E cross-section across Pengaron coal mine in Eocene coal, Barito Basin, SE Kalimantan (Hooze, 1893). This government-operated mine was the first and one of very few underground coal mines in Indonesia.

There is still active coal mining in this part of the Barito Basin, in both Eocene and Middle Miocene deposits, but it is all in open pit mining.

Another old underground coal mine development that is still ongoing is the Ombilin mine complex at Sawahlunto, in the Ombilin intermontane rift basin, NE of Padang, West Sumatra (Figure XI.3.3). This coalfield was first discovered in 1868 and its geology was t described in detail by Verbeek (1875). Initial reserves estimates were about 200 million tons.

Mining started in 1892, by the Netherlands Indies colonial government, and the Ombilin mines have been in continuous government-operated production since then. Coal is produced from three major seams (A,B,C; 1-5m thick) in the Eocene Sawahlunto Formation. Coal is also produced from the Poro Member of the overlying Oligocene- Early Miocene Sawahtambang Formation.

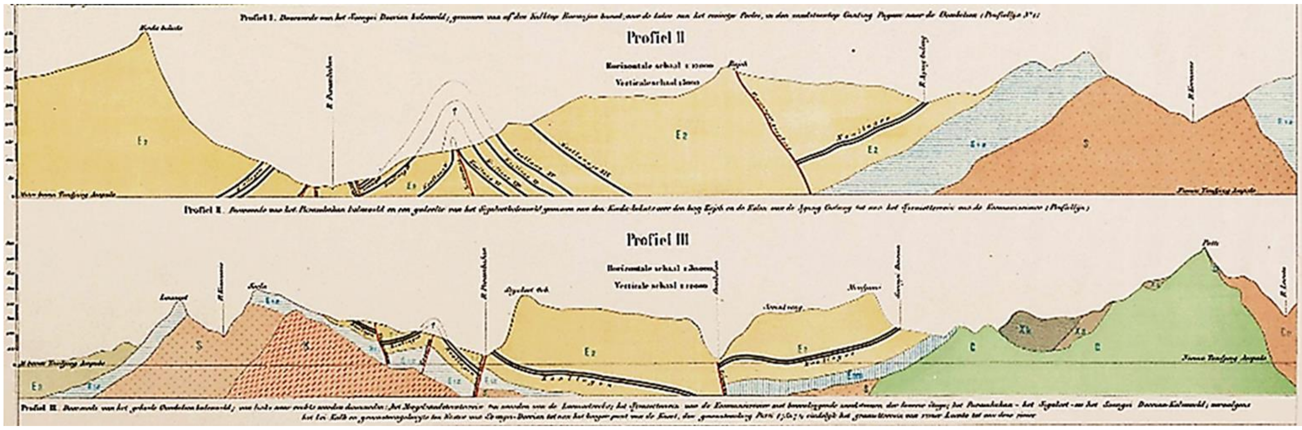

Figure XI.3.3. Cross-sections of Ombilin Basin with Eocene coalbeds, West Sumatra (Verbeek, 1875).

The Eocene Ombilin coals are mainly composed of vitrinite (av. 90%), with minor liptinite (av. 6%), inertinite (av. 2%) and minerals (av. 1% clay, pyrite). Most coals in the area are thermally unaltered coal with vitrinite reflectances of 0.55- 0.77% (sub-bituminous- high volatile bituminous rank). Some coals near igneous intrusions are of higher grade, with Vr of 3.4- 4.7% (anthracite) (Santoso and Daulay 2005).

The third long-running, government operated coal mine is in the Lematang/ Tanjung coal fields of South Sumatra, which started with the Bukit Asam coal mine South of Muara Enim in 1916, and is still operational today. A good recent review of coal distribution and characteristics in the Muara Enim area is by Sanusi et al. (2014).. Coals are found in the Middle- Late Miocene Middle Palembang Formation (= Muara Enim Fm), which is ~700m thick and contains ~90m coal in 11-12 horizons (Mannhardt 1921, Ziegler 1921, Schurmann 1922).

The four main coal horizons are, from old to young: Merapi (D; 8-10m), Petai (C; 5-8m), Suban (B; 7-10m) and Mangus (A; 14-22m). Thinner coals are found above and below these horizons. Coals are composed of wood (incl. palm), amber, leaves and cuticles, fungi and pyite. In coal petrographic terms Bukit Asam coal is composed of vitrinite (88-91%), liptinite (4.2- 5.0%), inertinite (4.1-5.5%) and mineral matter (mainly clay, quartz and minor pyrite (Pujobroto 1997, Amijaya 2006).

Most coals are of relatively low rank (sub-bituminous; Rv 0.35-0.45%), but were locally altered to high-grade anthracite (Rv ~2.0%) around Pleistocene andesite intrusions and sills at Bukit Asam (Hirschi 1916, Mukherjee 1935, Iskandar 1994, Pujobroto 1997).

Smaller coal occurrences

On Java thin Eocene, Oligocene and Early- Middle Miocene coal beds are known from multiple localities in West Java (Eocene of Bayah and Gunung Walat, Cimandiri, Late Miocene of Bojongmanik etc.), Central Java (Nanggulan Eocene) and NE Java (Middle Miocene Ngrayong Fm), but except for small-scale native diggings, none of these coals have been mined commercially.

Other similar non-commercial coal deposits, some with local-use exploitation, are known from SW Sulawesi and the Melawai Basin (NW Kalimantan).

No commercial coal deposits are known from Eastern Indonesia. Thin Miocene- Pliocene coals are present in the North New Guinea, Salawati and Bintuni basins of West Papua, the latter in the appropriately named 'Steenkool Formation'.

Mesozoic coals are rare in Indonesia. Thin Middle Jurassic coals are present in wells in the Bintuni Basin, West Papua, and in outcrops of the Early- Middle Jurassic Bobong Formation on Taliabu, Sula Islands (Kusnama et al. 2007, Kusnama 2008).

Permian coals are important economically in Eastern Australia (Bowen Basin, etc.), but in Indonesia only thin Permian coals are found in West Papua (outcrops and wells in the Birds Head and West part of the Central Range) and South Sumatra (West Jambi Basin Mengkarang Fm), These are of limited or no commercial value.

Coal depositional environments

Coal deposits started out as peat, which can be deposited, in a variety of paralic sub-environments, Peat forms only where the production of organic plant material exceeds the rate of decomposition of plant organic matter by oxydation, fungii, bacteria, etc.. Normal tropical soils are poor in organic matter, because of rapid oxydation rates in high temperatures.

Preservation of peat biomass therefore requires an oxygen-deficient environment, which means permanent saturation by water. In tropical SE Asia three types of peat accumulations may be distinguished::

1. 'Basin peat' (= 'topogeneous peat', 'low peat'). Forms in poorly-drained low-lying areas with stagnant water, such as swamps or mires, These peats are relatively vulnerable to clastic influx and mineralization from fluvial flooding events;
2. 'Domed peat' (= ombrogeneous peat', ombrothrophic peat, 'high peat', etc.). Domed peat-accumulations may form on higher ground as raised peat bogs above impermeable soils, in coastal and inland regions, and are relatively low in ash and sulfur. This requires a humid climate of high year-round precipitation;
3. Detrital peat: reworked peat beds and eroded peat deposits form up to 2.5m thick detrital peat accumulations as high-tide beach ridges along the Mahakam delta front (Allen 1985, Allen and Chambers 1998, Gastaldo, Allen and Huc 1993).

The formation of peat/ coal therefore requires (or is facilitated by) a number of conditions, including:

- geographic setting (fluvial floodplain/ upper delta plain);
- permanently humid climate, with no significant dry seasons;
- sufficiently prolific vegetation;
- rate of rise in groundwater table ('transgressive', increase in accommodation).

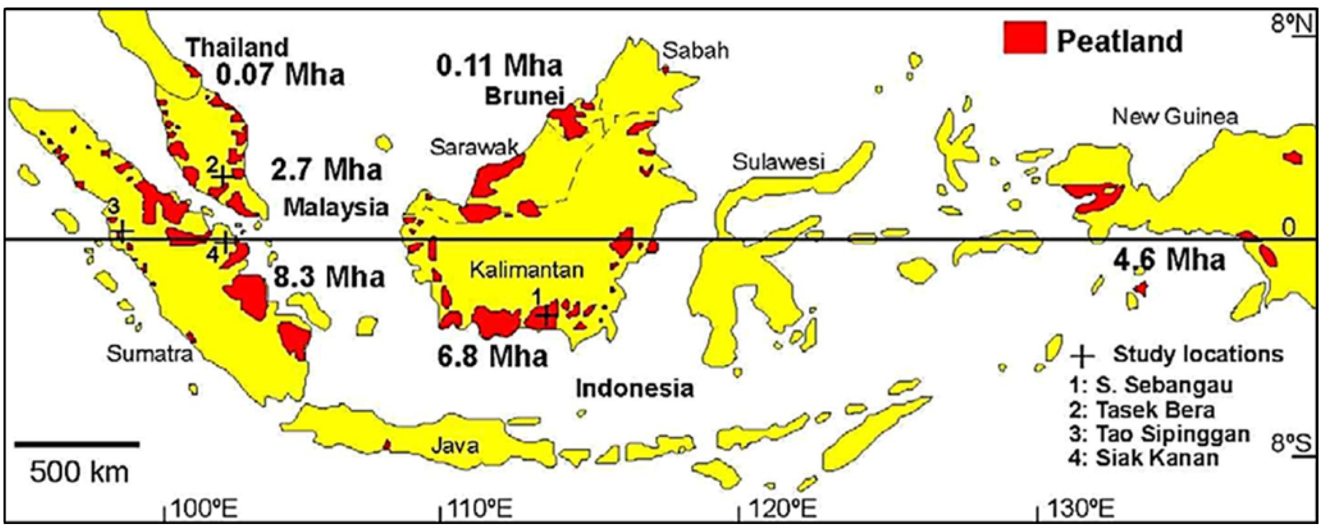

Figure XI.3.4. Distribution of peatlands in SE Asia (after Rieley et al., 1996 in Wust et al. 2007).

Many of the fluvial- coastal plains of Indonesia /SE Asia are home to vast peat-covered lands (Figure XI.3.4). Most modern lowland peat deposits here are all very young, starting formation in the mid-Holocene (~5500 years BP), when sea level was at a maximum and vast areas of the coastal plain were flooded, after stabilisation of the rapid sea level following the Last Glacial Maximum lowstand. Many of the coastal peat deposits of Indonesia started off as mangrove swamps and were replaced by freshwater swamp forests as shorelines prograded (e.g. Wust et al. 2007).

In Sarawak today's peat depositional systems are up to 11,400 km2 in area, while individual peat deposits are >20m thick and 1000 km2 in area. A typical succession shows basal high-ash, high-sulfur, degraded peats, that are overlain by low-ash, low-sulfur, well preserved peats (Esterle and Ferm 1994, Staub and Esterle 1994; Figure XI.3.5).

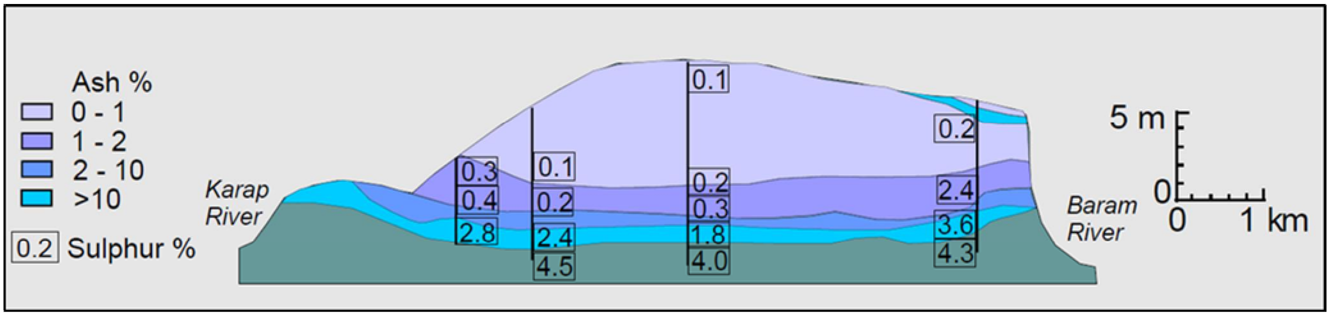

Figure XI.3.5. Typical profile across a domed peat deposit, Baram River, Sarawak, showing upward-decreasing ash and sulfur contents (Esterle and Ferm 1994 in Friederich et al. 2009).

Peat-to-coal compaction

Peat deposits will be reduced to 10% of the original peat thickness when compacted to mature, bituminous coal. Holocene peat deposits in Indonesia tend to be only up to ~20m thick, but some Miocene coal beds can be 90m thick. Such thick coal beds are therefore likely composed of multiple, stacked cycles of paleo-peat mire deposits (Shearer et al. 1994).

Coal distribution in time, paleoclimate

Widespread coals obviously reflect widespread freshwater and brackish water peat deposition. In addition to geographic setting climate probably also has an important role in coal formation.

In the Cenozoic basins of Western Indonesia significant coal deposits appear to be concentrated in two or three periods of globally warm climate periods (e.g. Morley 2013):

1. Middle- Late Eocene (Tanjung Fm of Barito and Asem Asem basins, Sawahlunto Fm of West Sumatra, Ngimbang Fm in NE Java Basin, Nanggulan Fm in Central Java, Bayah Formation in SW Java, Silantek Fm in SW Sarawak?);
2. Middle- Late Miocene: Warukin Fm of Barito Basin, Balikpapan Fm of Mahakam delta system, Middle Palembang Fm of South Sumatra, etc.).

Probably the third most significant period for coal development was in the latest Oligocene (-Early Miocene?), although these appear to be of limited commercial significance:

- Sihapas and Talang Akar Formations of Central and South Sumatra;
- Cibulakan/ Cimandiri Formations of West Java.

These periods all correspond to globally warm climate periods, and that are probably associated with high eustatic sea levels (e.g. Morley 2013). Intervening cooler periods probably had more seasonal climates with distinct dry seasons that probably 'killed' significant peat development.

Coal stacking patterns

Not much has been published on the sequence stratigraphic significance and stacking patterns of coal beds in Indonesia. While small coal deposits may be expected anywhere in an alluvial or coastal plain setting, laterally extensive, stacked coal beds probably always signify an overall transgressive setting (mid-late lowstand wedge and early-middle highstand time in the model of Bohacs and Suter, 1997; Figure XI.3.6).

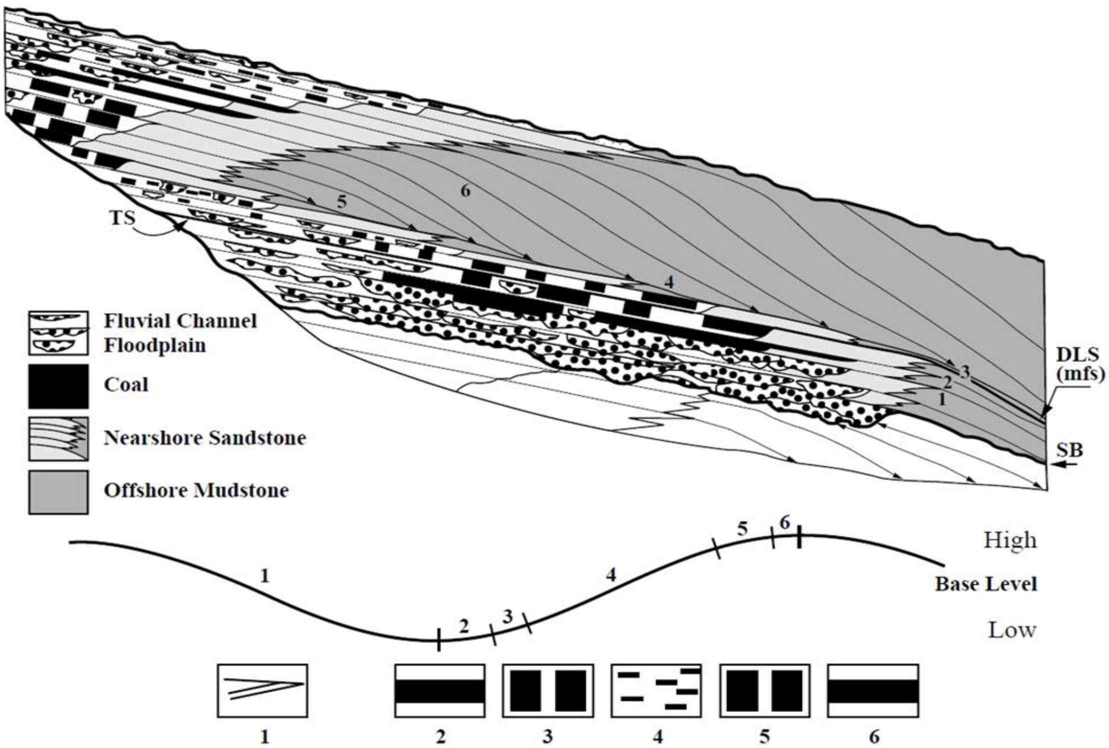

Figure XI.3.6. Distribution of coal beds in a sequence stratigraphic model (Bohacs and Suter, 1997)

Interestingly, a transgressive stacking pattern was already described almost 100 years ago in the Middle-Late Miocene Middle Palembang Formation of South Sumatra (Hartmann 1921, Figure XI.3.7).

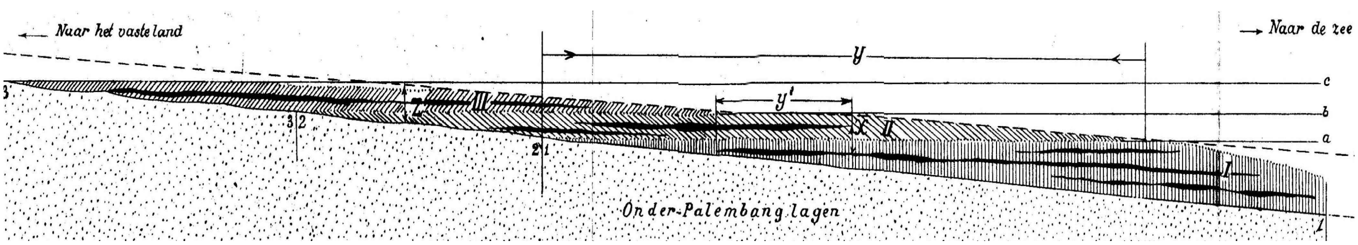

Figure XI.3.7. W-E Diagrammatic cross-section across part of, South Sumatra, showing 'transgressive backstepping' of Middle Palembang Formation coals (Hartmann, 1921)

<u>Some suggested reading- Coal</u> *<u>(not a complete listing of significant papers)</u>*

Coal Occurrences:	*De Groot 1865, Verbeek 1875, Hooze 1892, Mulhadiono et al. 1978, Bainton 1978, Koesoemadinata 1978, 2000, 2002, Prijono 1988, 1989, Soehandojo 1989, Horkel 1990, Friedrich et al. 1995, 1999, 2009, 2016, Cook and Daulay 2000, Daulay et al. 2000, Nas 2003, 2005, Friederich and van Leeuwen 2017*
Kutai Basin:	*Hooze 1887, 1888, Van Leeuwen and Muggeridge, 1987, 1988, Land and Jones 1987, .Nas 1994, Daulay 1994, Ilyas 2003, Situmorang et al. 2006, Suwarna & Hermanto 2007, Daulay et al. 2015*
SE Kalimantan	*Schwaner 1857, Renaud 1874, Verbeek 1875, Hooze 1888, 1893, Gollner 1924, Sigit 1962, 1963, Panggabean 1991, 1994, Moore & Ferm 1992, Friedrich et al. 1996, Milligan et al. 1996, Satyana et al. 2000.*
South Sumatra	*Everwijn 1860, 1873, Hirschi 1916, Tromp 1919, Mannhardt 1921, Ziegler 1921, Tobler 1922, Mukherjee 1935, Matasak & Kendarsi 1980, Von Schwartzenberg 1989, Subiyanto & Panggabean 2004, Amijaya 2005, Amijaya & Littke 2005, 2006, Anonymous 1919, Susilawati & Ward 2006, Belkin et al. 2007, 2008, Sosrowidjojo & Saghafi 2009, Mazumder et al. 2010.*
W Sumatra (Bengkulu)	*Everwijn 1876, Van Dijk 1860, Fennema 1885, Philippi 1918, Maryanto 2001, 2002, Heryanto & Suyoko 2007.*
C Sumatra (Ombilin):	*Verbeek 1875, Wally 1939, Whateley and Jordan 1989.*
Java	*Hooze 1882, Ziegler 1915, 1920, 'T Hoen 1918, Van Es 1920, Nas 1986, Rahmad and Maha 2010, Santoso 2010.*
SE Asia peat swamps	*Polak 1933, 1952, 1975, Anderson 1964, Van de Meene 1984, Sieffermann et al. 1987, 1988, Calvert et al. 1991, Dehmer 1993, Neuzil et al. 1993, 1997, Esterle and Ferm 1994, Staub and Esterle 1994, Shearer et al. 1994, Friederich et al. 1999, 2009, 2016, Gastaldo et al. 1993, Page et al. 2004, 2006, 2012, Wust et al. 2007, Gastaldo 2010, Morley 2013.*
Coal Petrography	*Daulay 1985, 1998, Daulay and Cook 1988, Moore and Ferm 1988, Hutton et al. 1994*

XI.4. Minerals, Mining

This sub-chapter XI.4 of Bibiography 7.0 lists 137 papers on mineral deposits that are of a general or regional nature. As for the previous chapters on hydrocarbons and coal, the vast majority of papers on economic mineral deposits is on individual occurrences, and can be found in the chapters on the areas in which they are located. A metallogenic map of Indonesia was published by the Geological Survey (Harahap and Abidin 2013).

Mineral deposits are generally closely related to magmatic- tectonic events. Westerveld (1939, 1949) characterized the metal ore occurrences in Indonesia:as 3 or 4 main provinces:
1. Tin mineralization of Bangka and Billition islands, associated with Triassic granites;
2. Gold-silver mineralization on Sumatra and Java, associated with Cretaceous and post-Miocene intrusives
3. Nickel and lateritic iron ores, associated with peridotites of East Sulawesi and Banda Arc.

Gold, silver, copper

Primary gold-silver-copper deposits in SE Asia are all related to magmatic-volcanic arcs, most of them of Late Tertiary age, The SE Asia- West Pacific contains >160 deposits, including porphyry, skarn, epithermal, volcanic-associated massive sulfide, disseminated sediment -hosted and other mineralization styles (Garwin 2013).

Not all magmatic arcs contain significant mineralization. Some authors suggested that most gold-copper deposits did not form during steady-state subduction, but during episodes of tectonic reorganization like subduction reversal (e.g. Solomon 1990, Barley et al. 2002).

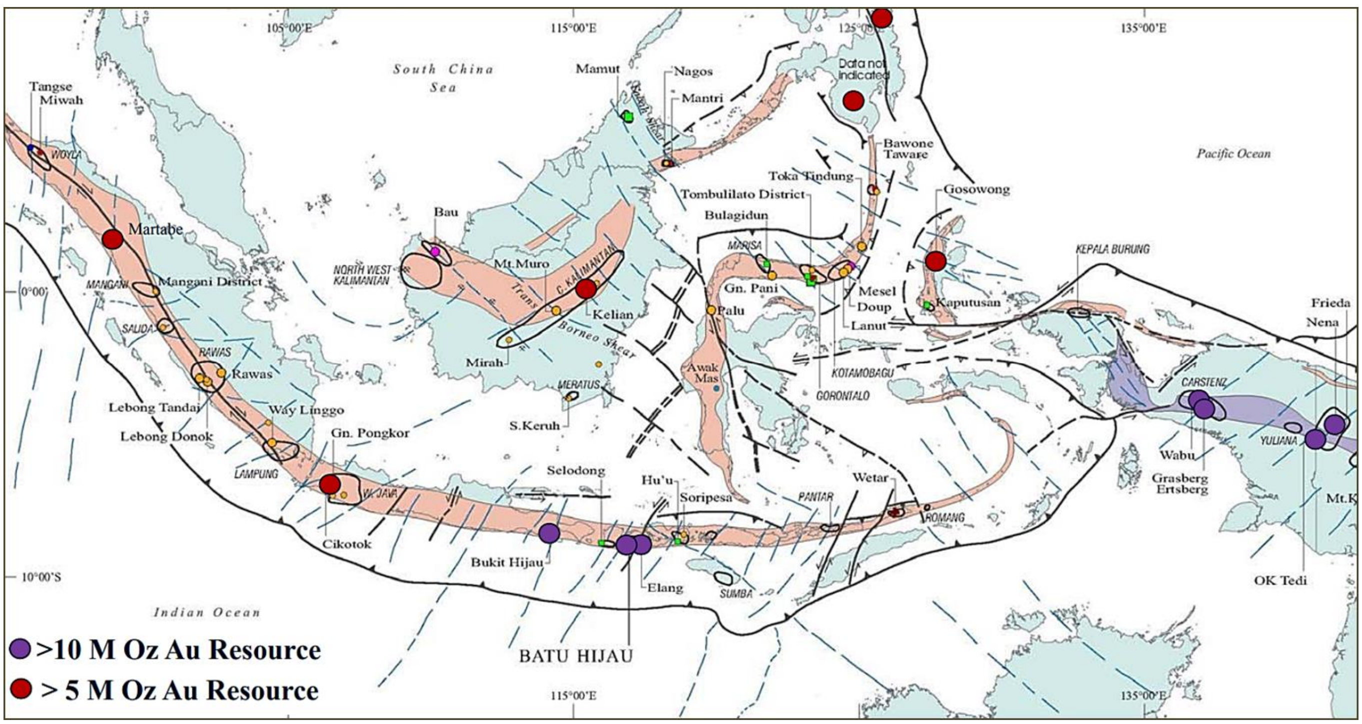

Figure XI.4.1. Major and minor gold-copper deposits in the Indonesian region, all associated with Neogene magmatic arcs (pink) and orogenic belts with significant Neogene magmatism (purple). (Garwin 2013).

Tin

Numerous papers have been published on the tin deposits of the Indonesian 'Tin Islands Bangka, Belitung and others, dating back to the 1800's. The tin deposits in Indonesia are part of the SE Asia tin belt that stretches from Myanmar through West Thailand, the Malay Peninsula to the Indonesian tin islands (Bangka, Belitung, Singkep, possibly extending into western Kalimantan)

Primary tin deposits are around 'post-collisional tin granites' with Sn-W-Sb minerals, that formed during excessive thickening of continental crust after collision of two continental plates.

The SE Asia tin-bearing granitoid belt is actually composed of two parallel belts of granites in the Malay Peninsula and western Thailand (Hutchison 1983, Pitfield 1987, Schwartz et al. 1995):

1. Eastern belt and Main Range of Late Triassic (- Early Jurassic?; mainly 220-200 Ma) granites that formed during or shortly after the Late Triassic closing of the Paleotethys suture, extending from Thailand through the Malay Peninsula to the Indonesian Tin islands Singkep, Bangka and Belitung ;
2. Western belt of Late Cretaceous tin-bearing granites in northern Peninsular and West Thailand and Myanmar, probably extending into North Sumatra (~80 Ma Hatapang granite; Hamidsyah and Clarke 1982, Johari 1988).

Primary tin deposits of the Tin islands occur as cassiterite-bearing hydrothermal veins in and around Late Triassic granite plutons. Veins are usually in country rocks of isoclinally folded, steeply dipping Permian-Triassic metaclastics with radiolarite beds of the Pemali Group. Only a few of these primary vein systems were mined commercially on Bangka island:

- Kelapa Kampit mine, Belitung, was intermittently active since 1908 and reached a depth of almost 300m subsea (Groothoff 1916, Meyer 1975, Adam 1960);
- Pemali mine at the SE side of the Klabath batholith (Akkersdijk 1932, Wisoko 1981, Ko 1984, Ruswandi 1988, Schwartz and Surjono 1991);
- Tikus Mine, Belitung, in greisen zone and Sn-W veins in Late Triassic Tanjungpandan pluton, operational between 1916-1920 (Wing Easton 1937, Schwartz and Surjono 1990,1995).

Exploitation of tin (cassiterite) on Bangka, Belitung and Singkep islands and surrounding offshore areas has been ongoing since the early 1700's, with >95% of extracted tin coming from onshore and offshore Quaternary placer deposits that formed from chemical weathering and erosion of granite and surrounding mineralized rocks. Economic cassiterite placers appear to be limited to an area within 15 km from the contacts with granitic mother rocks, with the largest number of known tin placers ~5-12 km from granites (Kanayama 1973). These deposits are now largely depleted (Figure XI.4.2).

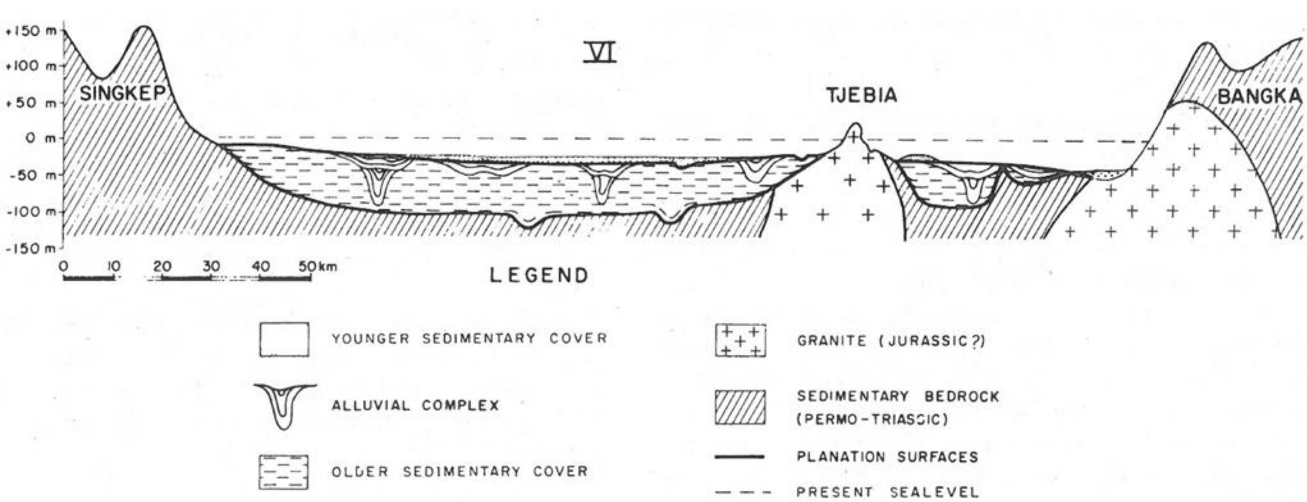

Figure XI.4.2. NW-SE cross-section from Singkep- Cebia to Bangka island, showing steeply dipping Permo-Triassic metasediments, intruded by Late Triassic granitoids, overlain by thin Miocene sediments and a Pleistocene Alluvial Complex of 30-45m deep tin-bearing incised valleys and very thin Late Quaternary sediment cover (Aleva, 1973).

Tin is also present outside the traditional Tin islands off East Sumatra, presumably related to the same belt of Triassic- Early Jurassic tin granites:

1. East Sumatra presence of Late Triassic granites and tin placer deposits (Bukit Batu, Sungai Isahan, Tigapuluh Mountains, Siak area, etc.; Neeb 1902, Brouwer 1915, Van Es 1930, Harahap and Harmanto 1987, Schwartz and Surjono 1990, etc.). Many of the alluvial tin placer deposits in the Siak area were exploited in the 1700's-1800's by local and Chinese miners (Everwijn 1867, Rolker 1891), but were already largely depleted by 1900 (Neeb 1902).
2. West Kalimantan and SE Kalimantan waters: cassiterite placer deposits found offshore SW Kalimantan (Sarmili 1998, 1999). Also onshore tin mineralization in the Ketapang and Singkawang districts of West Kalimantan, presumably from Triassic-Jurassic granites (Setijadji et al. 2014, Batchelor 2015).

Diamonds

Diamonds have been mined for centuries, from four widely separated districts across Kalimantan and SW Sarawak (Figure XI.4.3). The name Kalimantan is supposed to come from 'Kali Mas Intan', meaning 'rivers of gold and diamonds'. A recent review of the 'Sundaland diamonds' is by Van Leeuwen (2014).

Gascuel (1901) reported that the Borneo diamond mining industry was already in serious decline over 100 years ago, but there is still ongoing diamond mining activity in the Martapura area of SE Kalimantan today.

All mining has been in small-scale operations by local and Chinese miners, from is in Quaternary fluvial-alluvial deposits (Halewijn 1838, Schultz 1843, Croockewit 1852, Posewitz 1885, Hooze 1893, Wing Easton 1894, 1895, Doorman 1906).

Figure XI.4.3. Alluvial 'diamond fields' are relatively widespread in Kalimantan and SW Sarawak (Posewitz ?).

The widespread distribution of diamond-bearing Quaternary river terraces all over Kalimantan and SW Sarawak does not clearly point to any source rocks from which they have been eroded. Diamonds have also been observed in Upper Cretaceous and Eocene sediments of SE Kalimantan, and their generally abraded nature suggests they may have gone through multiple cycles of erosion and redeposition (Hovig 1930).

Possibly related but apparently less common diamond occurrences have been described from East Sumatra (SW of Pakanbaru; 'T Hoen 1931) and from West Thailand and Myanmar (Figure XI.4.4). In the latter areas they are spatially associated with Carboniferous-Permian glacial pebbly mudstones of the Phuket series on the Sibumasu Block, which were deposited along the NW Australia/ Gondwana margin (Aranyakanon 1955, Garson et al. 1975, Wathanakul et al. 1998, Griffin et al. 2001).

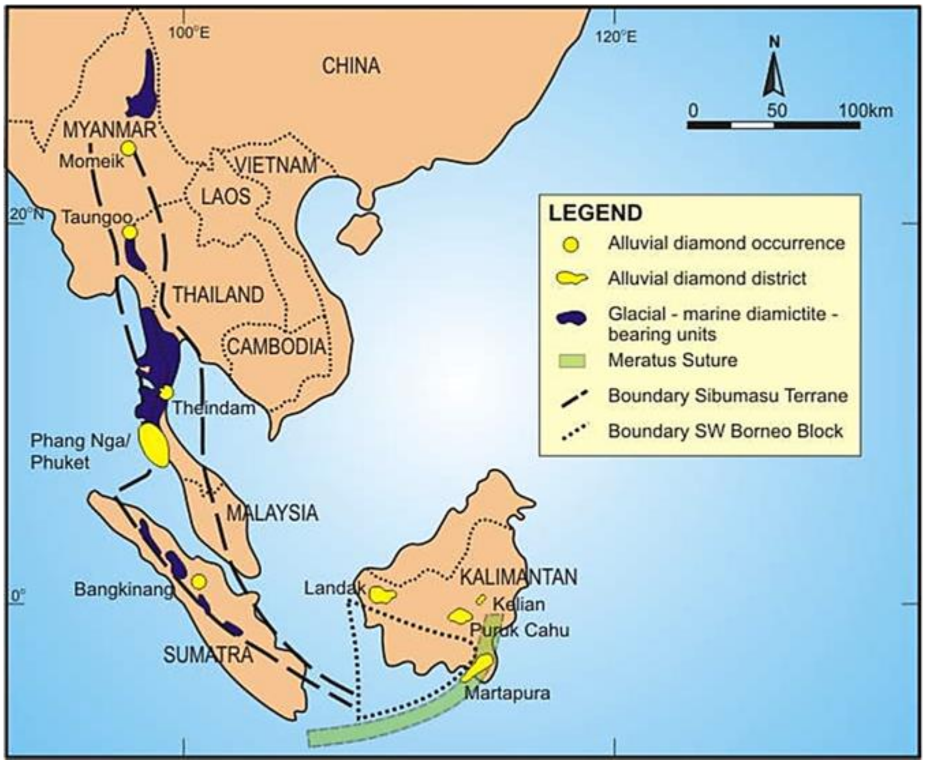

Figure XI.4.4. Alluvial diamond occurrences (yellow) in Kalimantan, Sumatra and SE Asia. Also showing 'Sibumasu' Late Carboniferous- Early Permian glacio-marine deposits (blue) (Van Leeuwen 2014).

Re/Os age dating of sulphide inclusions from one Kalimantan diamond gave an Archean crystallization age of 3100 Ma (Smith et al. 2009).

There has been much debate on the origin of the Kalimantan diamonds (see references in Table below, and Bibliography), including the ultramafic rocks of the Meratus Range, the kimberlite-like Pamali breccia in the Meratus Range (Koolhoven 1935), etc., but none of these are still accepted.

One likely scenario, as suggested by Griffin et al. (2001), is that the diamonds from Kalimantan, East Sumatra and West Thailand all originated from Paleozoic or older igneous rocks in Northern Australia and arrived in Sundaland by tectonic transport and sediment redistribution. They were initially eroded and redeposited in Carboniferous-Permian glacial deposits in rifts along the NW Australian margin, which were then transported with the Sibumasu Block to the Asian margin in Permian- Triassic time, and subsequently re-eroded and redeposited in the Kalimantan region as early as early Late Cretaceous.

If the Kalimantan diamonds did indeed transit through an intermediate detrital stage in Late Paleozoic Sibumasu-terrane sediments, this would have interesting plate tectonic implications. The Cretaceous-Recent sandstones of Kalimantan and Central Sumatra would have been eroded from 'Sibumasu' basement, and parts of Kalimantan could be underlain by or bordered by an extension of the Sibumasu Terrane. This may require modification of some of the prevalent recent plate reconstruction scenarios for the amalgamation of the Borneo region (e.g. Metcalfe, Hall).

Nickel, chromium, cobalt

Nickel and chromium are widely disseminated in ultramafic (mantle) rocks, but commercial deposits require concentration of ore minerals in weathered lateritic zones. They are currently mined in the ophiolites of East Sulawesi and Halmahera; the Soroako mine in East Sulawesi has been operational since 1977. Small scale chromite mining took place in Gebe in the 1970's.

Lateritic nickel-chromite deposits are known from ophiolite outcrop regions in (Sopaheluwakan 1985, Ernowo and Oktaviani, 2010):

1. East Sulawesi: several areas in the East Sulawesi Ophiolite terrane, including Kabaena Island. Initially explored in colonial time (Adam 1922, Dieckmann and Julius 1925). Commercial nickel exploitation in the Matano area by PT INCO since the early 1970's (Golightly et al. 1979, Rafianto and Tutuko 2010).
2. Cyclops Mountains of NE part of West Papua (Ubaghs 1955).
3. Halmahera, Gag, and Gebe Islands (Totok and Friedrick 1988, Permanadewi et al. 2017),
4. Waigeo Island, West Papua

Other minerals

Iron ore deposits are relatively widespread in Sumatra and Kalimantan, but have been little explored or exploited (Subandrio 2014). Potential iron deposits include:
- iron (magnetite) sands of South Java;
- lateritic iron ores associated with ultramafic rocks in Eastern Indonesia and SE Kalimantan (Dieckmann 1922, Gisolf 1924, 1928, 'T Hoen 1924, Swamidharma 2015)
- epithermal magnetite-hematite mineralization around granites in South Sumatra and Central Sulawesi (Hovig 1917, 1918, Utoyo 2008);
- 'banded iron ore' in metamorphic rocks of Sumatra (Subullussallam, Tanggamus) and SW Kalimantan (Kendawangan) (Elbert 1909, Subandrio and Tabri 2006, Subandrio 2007, 2014).

Relatively small uranium prospects are known from Tertiary sediments in North Sumatra (Koesoemadinata and Sastrawiharjo 1988, adjacent to Triassic granite) and in veins associated with Upper Cretaceous Sukadana Granite in Central Kalimantan (Subiantoro et al. 2003). No commercial uranium mines have ever been operational in the Indonesian region.

Small-scale manganese mining has taken place on along the Southern Mountains of Java (presumably in weathering zones of Early Miocene andesitic volcanics; Fermin 1951; Figure XI.4.5).

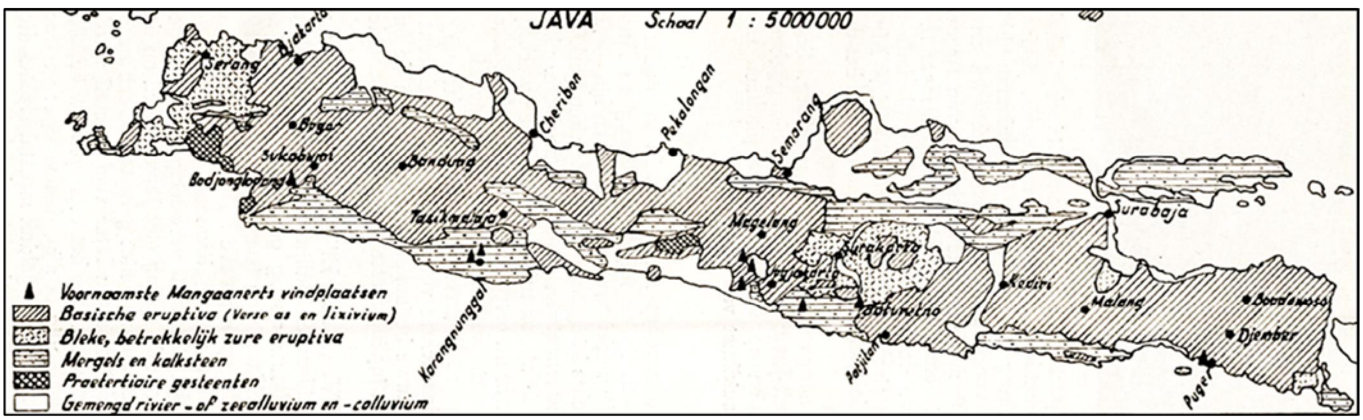

Figure XI.4.5. Manganese ore localities (triangles) across the Southern Mountains of Java (Fermin 1951).

Another interesting recent small-scale manganese mining development is in Cretaceous oceanic pelagic deposits in SW Timor. Manganese occurs both as small nodules and as thin MnO layers, which may be fueled by nearby ocean floor hydrothermal vents (Idrus et al. 2012, 2013).

Noteworthy concentrations of Rare Earth Elements (REE) have been documented in various granites of the tin islands, West Kalimantan, Sulawesi, etc. (Setijadji 2014, Syaeful et al. 2014, Aryanto and Kamiludin 2016, Setiawan 2018). Commercial exploitation targets would probably require concentrations in lateritic weathering deposits and associated placers. There is no commercial REE exploitation yet.

Some suggested reading- Mineral deposits *(not a complete listing of all significant papers)*

General reviews	*Westerveld 1939, 1949, Ter Braake 1944, Van Bemmelen 1949, Sigit et al. 1969, Katili 1973, Gatinsky et al. 1978, Hutchison & Taylor 1978, Mitchell 1986, Carlile and Mitchell 1994, Sillitoe 1994,1997,2010, Van Leeuwen 1994, Van Leeuwen, and Pieters 2013 (Sulawesi)*
Gold, tectonic controls	*Taylor and Van Leeuwen 1980, Sunarya 1989, 1992, White et al. 1995, Soeria-Atmadja et al. (1998), Garwin 1997, 2005, Corbett and Leach 1998, MacPherson and Hall 1999, 2002, Hartono 2009, Barley et al. 2002, Blundell 2002, Garwin et al. 2005, 2013, Maryono et al. 2014, 2018*
Tin	*De Groot 1852, 1887, Posewitz 1886, Rolker 1891, Verbeek 1897, Van den Broek 1921, Bothe 1924, 1925, Zwierzycki,1933, Wing Easton 1937, Westerveld 1937, 1941, Adam 1960, Krol 1960, Van Overeem 1960, Cissarz and Baum 1960, Osberger 1965, 1967, 1968,, Aleva et al. 1973, 1985, Kanayama 1973, Hosking 1971, 1979, 1986, 2015, Omer-Cooper et al. 1974, Mitchell 1977, 1979, Sujitno 1977, 1981, Batchelor 1983,1988, Hutchison 1983, 1988, U. Ko Ko 1984, Soeria-Atmadja et al. 1986, Pitfield 1987, Ruswandi 1988, Schwartz and Surjono 1990, 1991, Schwartz et al. 1995, Abidin 1999-2005, Dirk 2013.*
Nickel, chromite	*Dieckmann 1919, 1925, Adam 1922, INCO 1972, Suparka 1977, Sopaheluwakan 1985, Rafiantoand Tutuko 2010, Ernowo and Oktaviani 2010, Permanadewi et al. 2017.*
Diamonds	*Halewijn 1838, Croockewit 1852, Posewitz 1885, Wing Easton 1894, 1895, 1933, Gascuel 1901, Doorman 1906, Krol 1922, Hovig 1930, Witkamp 1932, Koolhoven 1933, 1935, Bergman et al. 1987, 1988, Taylor et al. 1990, Burgath and Mohr 1991, Spencer et al. 1988, Aziz 1999, 2004, 2007, Tay et al. 2005, Graham et al. 2006, Smith et al. 2009, Kadarusman 2010, Van Leeuwen 2014, Kueter et al. 2016, White et al. 2016, Shen et al. 2017,*

XI. HYDROCARBONS, COAL, MINING

XI.1. Hydrocarbon Occurrences/ Assessment

(Additional references on hydrocarbons/ fields that are specific to one region are listed under these regions)

Akil, I., H.M.S. Hartono, J. Widartoyo, K. Roeslan et al. (1980)- Note on the hydrocarbon potential of eastern Indonesia. Proc. 17th Sess. CCOP, Bangkok, p. 334-356.
(Only 5% of Indonesia current oil production from E Indonesia, but higher potential)

Atkinson, C., M. Renolds & O. Hutapea (2006)- Stratigraphic traps in the Tertiary rift basins of Indonesia: case studies and future potential. In: M.R. Allen et al. (eds.) The deliberate search for the stratigraphic trap. Geol. Soc., London, Spec. Publ. 254, p. 105-126.
(Stratigraphic traps require charged petroleum system, favourable basin and reservoir architectures, low dips and good seal integrity. Paleogene rift basins: syn-rift source and reservoir sands; 'early post-rift' phase with better quality reservoir sandstones and reef carbonates; 'late post rift' transgression with marine shale regional seal. Late Tertiary 'orogenic' phases trigger migration up flanks and create structures at shallower levels. Potential for large reserves in stratigraphic traps. Unexplored basins in Asahan Offshore PSC, N Sumatra and Biliton PSC, W Java discussed)

Barber, C.T. (1935)- The natural gas resources of Burma. Mem. Geol. Survey of India 66, 1, p. 1-172.
(Review of oil and gas fields and seeps in Tertiary of Myanmar. Descriptions of gas fields Yenangyaung, Singu, Lanywa, Yenangyat-Yethaya, Minbu-Palanyon, Indaw, etc.)

Bataafsche Petroleum Maatschappij (BPM) (1957)- Oil in Netherlands New Guinea. Bataafsche Petroleum Maatschappij, Public Relations Department, Mouton, The Hague, p. 1-32.

Beddoes, L.R. (ed.) (1973)- Oil and gas fields of Australia, Papua New Guinea and New Zealand. Tracer Petroleum and Mining Publ., p. 1-391.
(78 oil-gas fields in 12 basins with reserves and production data to end 1972)

Beddoes, L.R. (1980)- Hydrocarbon plays in Tertiary basins of Southeast Asia. SEAPEX Offshore SE Asia Conf., Singapore 1980, 18p.

Beddoes, L.R. (1981)- Hydrocarbon plays in Tertiary basins of Southeast Asia. In: M.J. Valencia (ed.) Proc. EAPI/CCOP Workshop, Honolulu 1980, Energy 6, 11, p. 1141-1163.
(Eight basin areas, peripheral to Sunda Shield exhibit general continuity of Tertiary sedimentary cycles, but each basin unique structural, stratigraphic and temperature gradient character, reflecting its individual plate tectonic setting. With examples of Tertiary depositional cycles and hydrocarbon occurrences from E Java Sea and NW Palawan)

Beers, H.W. (ed.) (1970)- Indonesia: resources and their technological development. University Press of Kentucky, Lexington, p. 1-282.
(Papers and papers and discussions from seminar held in Lexington, May 1967)

Brouwer, H.A. (1926)- Oil provinces in the Netherlands East Indies. Proc. 2nd Pan-Pacific Science Congress, Melbourne and Sydney, Australia 1923, 2, p. 1280-1284.
(Oil producing areas in Netherlands Indies in 'geosynclinal areas' of Tertiary sediments, that were subsequently folded)

Brown, J.L. & J. E. McCallum (1997)- An atlas of sealing faults in SE Asia. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Conf. Petroleum systems of SE Asia and Australasia, Jakarta, Indon. Petroleum Assoc., p. 837-841.

Carlson, R.M.K., S.C. Teerman, J.M. Moldowan, S.R. Jacobson, E.I. Chan et al. (1993)- High temperature gas chromatography of high-wax oils. Proc. 22nd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 483-507.

Caughey, C., T.C. Cavanagh, J.N.J. Dyer, A. Kohar, H. Lestarini, R.A. Lorentz et al. (eds.) (1994)- Seismic atlas of Indonesian oil & gas fields, vol. 1 (Sumatra). Indon. Petroleum Assoc. (IPA), Jakarta.

Caughey, C., J.N.J. Dyer, A. Kohar, H. Lestarini, W.R. Lodwick et al. (eds.) (1995)- Seismic atlas of Indonesian oil & gas fields, vol. 2 (Java, Kalimantan, Natuna and Irian Jaya). Indonesian Petroleum Assoc. (IPA), Jakarta, , p.

CCOP (1974)- The offshore hydrocarbon potential of East Asia: a review of investigations 1966- 1973. Techn. Rept., p. 1-67.

CCOP (2002)- Energy overview in East and Southeast Asia. Petromin, August 2002, p. 8-36.

Champeny, J.D. (1981)- Petroleum potential in the Far East. In: M.T. Halbouty (ed.) Energy resources of the Pacific region, American Assoc. Petrol. Geol. (AAPG), Studies in Geology 12, p. 189-194.

Chung, S.K., A.S. Gan, K.M. Leong & C.H. Kho (1977)- Ten years of petroleum exploration in Malaysia. United Nations ESCAP, CCOP Techn. Bull. 11, p. 111-142.

Clement, M. (1910)- Le petrole aux Indes neerlandaises. Annales des Mines 10, 17, p. 386-433.
(‘Petroleum in the Netherlands Indies’)

Cockcroft, P., J. Anli & J. Duignan (1988)- EOR potential of Indonesian reservoirs. Proc. 17th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 2, p. 73-108.

Cockroft, P.J., G.A. Edwards, R.S.K. Phoa & H.W. Reid (1987)- Applications of pressure analysis and hydrodynamics to petroleum exploration in Indonesia. Proc. 16th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 1-40.
(General paper on pressure, hydrodynamics, etc.)

Cockroft, P.J. & K. Robinson (1988)- Chemistry of oilfield waters in South East Asia and their application to petroleum exploration. Proc. SE Asia Petroleum Expl. Soc. (SEAPEX) 8, p. 221-238.
(Most subsurface formation waters in SE Asia fresh-brackish and range from meteoric bicarbonate to connate chloride-calcium waters. Predominance of fresh waters may be related to depositional environment and relatively young age of sediments which are typically undergoing compaction and dewatering)

Courteney, S. (1996)- The future hydrocarbon potential of Western Indonesia. In: C.A. Caughey, D. Carter et al. (eds.) Proc. Int. Symp. Sequence Stratigraphy in SE Asia, Jakarta 1995, Indon. Petroleum Assoc., p. 397-415.
(Correlative framework based on sequence stratigraphy established for productive basins in Sumatra, Java and Kalimantan. Examples of 'hydrocarbon system' from perspective of source, reservoir, seal and timing)

Courteney, S., P. Cockroft, R.S.K. Phoa & A.W.R. Wight (eds.) (1989)- Indonesia Oil and Gas Fields Atlas. Indon. Petroleum Assoc. (IPA), 6 volumes.

Courteney, S., P. Cockroft, R. Lorentz, R. Miller et al. (eds.) (1990)- Indonesian Oil and Gas Fields Atlas, VI Eastern Indonesia. Indon. Petroleum Assoc. (IPA), Jakarta, p. 1-119.

Darissalam, M.M. (1992)- Peluang dan tantangan lapangan-lapangan minyak tua di Indonesia. Proc. 21st Ann. Conv. Indon. Assoc. Geol. (IAGI), Yogyakarta,1, p. 35-44.

('Chance and challenge of old oil fields in Indonesia'. Listing of early 1900's oil fields in N, C and S Sumatra (12+6+35), Java- Madura (33), Kalimantan (11) and West Papua (8) with potential for redevelopment. With cumulative production, number of wells and year of abandonment)

De Greve, W.H. (1865)- Petroleum en aardolie en haar voorkomen in Nederlandsch Indie. Tijdschrift Nijverheid en Landbouw in Nederlandsch Indie 11, p. 281-356.
('Petroleum and its occurrence in Netherlands Indies'. Very early paper on petroleum occurrences and surface seeps in Netherlands Indies, and description of oil samples in now defunct 'Colonial Museum' in Haarlem. All seeps on Java N of volcanic arc (except one in Banyumas), and not related to volcanism. Most seeps in sandstone beds of Lower Tertiary and commonly associated with gas seeps, mud volcanoes and salt water wells. Listing of seeps in West Java (Priangan, Cirebon), C Java (Semarang, Rembang, Banyumas, Madiun, Solo), East Java (Surabaya, Madura, Pasaruan, Kediri). Also in Sumatra (Palembang), Kalimantan (SE), Sulawesi (Manado) and East Seram. No maps, figures)

De Jongh, C.A. (1922)- Geschiedenis van de petroleumindustrie op Java. De Mijningenieur 3, 5, p. 63-66.
(online at: https://babel.hathitrust.org/cgi/pt?id=coo.31924081565537;view=1up;seq=279)
('History of the petroleum industry on Java'. Brief history of petroleum exploration on Java-Madura since. With total production figures from 300 to 33,625 tons in 1890-1918)

De Loos, D. (1899)- Gesteenten en mineralen van Nederlandsch Oost-Indie, 4: Petroleum. Koloniaal Museum Haarlem, Erven Loosjes, p. 1-59.
('Rocks and minerals from Netherlands East Indies- 4: petroleum'. Early, popular review of occurrence and properties of petroleum in Indonesia)

De Stoppelaar, L.P. (1897)- De petroleum industrie, in het bijzonder die van Nederlandsch Oost-Indie: overzicht bewerkt ten behoeve van houders van petroleumwaarden. J.H. de Bussy, Amsterdam, p. 1-225.
('The petroleum industry, in particular that of Netherlands East Indies: overview modified for holders of petroleum shares')

Du Bois, E.P. (1980)- Major gas reserves of Southeast Asia and Australasia: an overview. Proc. 17th Sess. CCOP, Bangkok 1980, p. 286-303.

ECAFE (1967)- Case histories of oil and gas fields in Asia and the Far East (Second Series). United Nations ECAFE Mineral Resources Dev. Ser. 29, p. 1-96.

Fletcher, G.L. & R.A. Soeparjadi (1976)- Indonesia's Tertiary basins- the land of plenty. In: Proc. Offshore South East Asia Conf. 1976, Singapore, SE Asia Petroleum Expl. Soc. (SEAPEX), Paper 8, p. 1-54.

Fletcher, G.L. & R.A. Soeparjadi (1977)- The land of plenty: Indonesia's 28 Tertiary basins hold 99 percent of production. Oil and Gas J. 75, 1, p. 150-156.
(Abbreviated version of Fletcher and Soeparjadi (1976) paper in SEAPEX Conference)

Gunawan, B.K., S.E. Saputra, M.K. Utama, C. Armandita & J.A. Paju (2008)- Play system from the last decade discoveries in Indonesia basins. Presentation AAPG Ann. Convention, San Antonio, April 2008, 24p.
(online at: http://www.searchanddiscovery.com/documents/2008/08119gunawan/images/gunawan)
(Overview of old and new plays in Indonesian basins)

Hatley, A.G. (1976)- Offshore petroleum exploration in East Asia, an overview. In: Offshore SE Asia Congress 1976, Singapore, SE Asia Petroleum Expl. Soc. (SEAPEX), Paper 1, p. 1-22.

Hatley, A.G. (1978)- Asia's oil prospects and problems: an overview of petroleum exploration activity in East Asia. Offshore SE Asia Congress 1978, Singapore, SE Asia Petroleum Expl. Soc. (SEAPEX), p.

Heriyanto, N. & S. Aloy (1995)- Mesozoic petroleum exploration in the eastern part of Indonesia: status, concept and future activity. In: IPA Symposium on Mesozoic stratigraphy of eastern Indonesia, 8p.

Hiller, K. (1994)- Thailand/ Thailand. In: H. Kulke (ed.) Regional petroleum geology of the world, I, Borntraeger, Berlin, p. 709-722.
(Brief review of oil-gas basins and fields of Thailand, Sarawak, Sabah; in German)

Hiller, K. (1994)- Malaysia/ Malaysia. In: H. Kulke (ed.) Regional petroleum geology of the world, I, Borntraeger, Berlin, p. 723-738.
(Brief review of oil-gas basins and fields of Malay Basin, Sarawak and Sabah; in German)

Hiller, K. (1988)- On the petroleum geology of Bangladesh. Geol. Jahrbuch, D 90, p. 3-32.
(Five petroleum-geological provinces distinguished in Bangladesh. Gas fields in Miocene sandstones of foldbelt province)

Holloway, N. (2011)- SE Asia exploration, still going strong or heading for eclipse? Proc. 2011 SE Asia Petroleum Expl. Soc. (SEAPEX) Conf., Singapore, 18, p. 1-38. *(Abstract + Presentation)*
(IHS review. SE Asia still attrctive for independents)

Howes, J.V.C. (1997)- Petroleum resources and petroleum systems of SE Asia, Australia, Papua New Guinea and New Zealand. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Conf. Petroleum Systems of SE Asia and Australasia, Jakarta, Indon. Petroleum Assoc. (IPA), p. 81-100.

Howes, J.V.C. (2001)- Future petroleum production from Indonesia and Papua New Guinea. In: M.W. Downey et al. (eds.) Petroleum provinces of the Twenty-first century. American Assoc. Petrol. Geol. (AAPG) Mem. 74, p. 281-286.

Howes, J.V.C. & R.A. Noble (eds.) (1997)- Proceedings International Conference Petroleum Systems of SE Asia and Australasia, Jakarta 1997, Indonesian Petroleum Assoc. (IPA), p. 1-1025.

Howes, J.V.C. & S. Tisnawijaya (1995)- Indonesian petroleum systems, reserve additions and exploration efficiency. Proc. 24th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 1-18.
(Indonesia EUR ~50 BBOE, roughly even oil- gas)

Ibrahim, A., N. Pudyo, A. Satyana & S. Saputra (2006)- Exploration hot zones in Kalimantan and Eastern Indonesia: a two decade review. Proc. SEG Ann. Meeting, New Orleans 2006, p. 1-5. *(Extended Abstract)*
(>160 exploration wells drilled in last two decades with success ratio of 41% and discovered in place reserves of 6 BBOE. Most attractive plays are Jurassic Roabiba-Plover Play system (Tangguh, Abadi gas fields), Jurassic carbonates (Oseil), and Miocene carbonate in collision zone (Tomori))

Jardine, J. (1997)- Dual petroleum systems governing the prolific Pattani Basin, offshore Thailand. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Symp. Petroleum Systems of SE Asia and Australia, Jakarta 1997, Indon. Petroleum Assoc. (IPA), p. 351-363.
(Pattani Basin largest of series of N-S trending Tertiary rifts in Gulf of Thailand. Gas and less oil trapped in Miocene fluvial sandstones in faulted graben systems. Two petroleum systems in basin: (1) dominant Miocene gas-generating coals and shales, currently mature in deeper portions of basin; (2) Oligocene oil-prone lacustrine shales, mature in basin flank areas but overmature in central trough)

Junghuhn, F. (1865)- Brief gerigt aan Zijne Excellentie den Gouverneur-Generaal van Ned. Indie omtrent de exploitatie van aardolie op Java. Tijdschrift Nijverheid Landbouw in Nederlandsch-Indie 11, p. 357-361.
('Letter to His Excellency the Governor-General of Netherlands Indies regarding the exploitation of petroleum on Java'. Oil seeps present at several localities in e Cirebon Residency, but bitumen is tar-like. Also, none of thousands of hot springs contain oil, chance of successful exploitation of petroleum from wells on Java is deemed to be low. Recommends to drill saltwater well in Grobogan Plain instead)

Kingston, J. (1988)- Undiscovered petroleum resources of Indonesia. U.S. Geol. Survey (USGS), Open File Report 88-379, p. 1-217.
(online at: http://pubs.usgs.gov/of/1988/0379/report.pdf)
(Nearly all of Indonesia's petroleum resources in 13 of 44 sedimentary basins. W Indonesia, underlain by Sunda continental block, contains >% of present petroleum reserves and exploration reached early-middle maturity. Undiscovered recoverable petroleum resources of Indonesia are 10 BBO and condensate, and 95 Tcf gas (not including 60 Tcf of discovered, but undeveloped gas))

Koesoemadinata, R.P. (1969)- Outline of the geologic occurrence of oil in Tertiary basins of West Indonesia. American Assoc. Petrol. Geol. (AAPG) Bull. 53, 11, p. 2368-2376.
(Many W Indonesian Tertiary basins similar geologic history, beginning with transgression, followed by bathyal conditions, and terminating with regression ate end of basin evolution. Transgressive facies with excellent petroleum potential in all basins, and greater reserves than regressive facies. Heavy paraffinic oil expected in transgressive strata, light paraffinic or asphaltic oil in regressive facies)

Koesoemadinata, R.P. (1980)- Geologi minyak dan gas bumi, 2nd Ed. Institut Teknologi Bandung (ITB), vol. 1, p. 1-259, vol. 2, p. 1-295.
(Geology of oil and gas textbook, with examples from Indonesian basins)

Koning, T. (2003)- Oil and gas production from basement reservoirs: examples from Indonesia, USA and Venezuela. In: N. Petford & K.J.W. McCaffrey (eds.) Hydrocarbons in crystalline rocks. Geol. Soc., London, Spec. Publ. 214, p. 83-92.
(Basement reservoirs main contributor of oil production in Vietnam. In Indonesia production from basement rocks has been minimal, but recent large gas discovery in pre-Tertiary fractured granites in S Sumatra)

Kusumastuti, A., A. Mortimer, C. Todd, E. Guritno, G. Goffey, M. Bennet & S. Algar (2001)- Deep-water petroleum provinces of SE Asia: a high level overview. In: A. Setiawan et al. (eds.) Proc. Deep-water sedimentation of Southeast Asia, FOSI 2nd Regional Seminar, Jakarta 2001, p. 10-15. *(Extended Abstract)*

Longley, I. (2015)- Counter-cyclic strategic thinking and symbiotic serendipity- will they work in Australasia? Or are we all doomed to work for myopic engineers in the onshore USA? A personal view of the future. Proc. 2015 SE Asia Petroleum Expl. Soc. (SEAPEX) Conf., Singapore, 5.3, p. 1-3. *(Extended Abstract + Presentation)*
(Australasia (SE Asia, Australia, PNG and NZ) viewed by many as mature exploration province since glory days of 1960's-1970's, but at least seven lightly drilled provinces with significant remaining potential)

Masters, C.D. & J.P. Riva (1981)- Assessment of conventionally recoverable petroleum resources of Indonesia. U.S. Geol. Survey (USGS), Open File Rept. 81-1142, 7p.
(1981 USGS oil-gas resource estimate of Indonesia. See also later version by Riva (1983))

Molengraaff, G.A.F. (1920)- De geologische ligging der petroleumterreinen van Nederlandsch Oost Indie. Verslagen Kon. Nederl. Akademie Wetenschappen, Amsterdam, 29, p. 141-149.
('The geological setting of petroleum terrains of the Dutch East Indies'. Dutch version of Molengraaff 1921)

Molengraaff, G.A.F. (1921)- On the geological position of the oil-fields of the Dutch East-Indies. Proc. Kon. Nederl. Akademie Wetenschappen, Amsterdam, 23, 2-3, p. 440-447.
(online at: www.dwc.knaw.nl/DL/publications/PU00014628.pdf)
(Majority of large oil-fields in world in long enduring geosynclines, where these are marginal areas of sedimentation along coasts of continents. In Indonesia main proven oil basins all along edge of Sundaland. Accurately predicted NW Java and C Sumatra as settings to look for new oil-gas fields)

Murphy, R.W. & I. Longley (2005)- Main producing systems in Southeast Asia. Proc. 2005 SE Asia Petroleum Expl. Soc. (SEAPEX) Conf., Singapore, 64p.

(Three main petroleum systems in SE Asia: (1) rift-sag basins on continental crust (Sumatra- W Java, Malay basin, etc.), (2) Miocene platform carbonates (Sumatra, Luconia shoals, Salawati, Malampaya) and (3) shallow to deep water deltas, largely M- Late Miocene in age (E Bengal, Kutei, NW Borneo))

Nayoan, G.A.S. (1981)- Offshore hydrocarbon potential of Indonesia. In: M.J. Valencia (ed.) Proc. EAPI/CCOP Workshop, Honolulu 1980, Energy 6, 11, p. 1225-1246.
(Offshore producing Tertiary sedimentary basins in Indonesia account for 34% of total daily oil production and 12% of cumulative production. Most ofoffshore production from basins that are geological continuation of onshore basins (NW Java, Sunda, Kutai))

Nayoan, G.A.S., L. Samuel, M.G. Rukmiati & D.N. Imanhardjo (1991)- Regional aspect of Pre Tertiary hydrocarbon potential in Eastern Indonesia. Proc. 20th Ann. Conv. Indon. Assoc. Geol. (IAGI), Jakarta, p. 11-25.

Ooi Jin Bee (1980)- Offshore oil in Indonesia. Ocean Management 6, 1, p. 51-73.
(Review of history and status of Indonesia offshore oil in 1980. Started with first offshore Production Sharing Contracts in 1966, which triggered series of significant discoveries between 1969-1974, mainly off NW Java and E Kalimantan. First offshore production in 1971, from NW Java basin)

Ooi Jin Bee (1982)- The petroleum resources of Indonesia. Oxford University Press, p. 1-256.
(Somewhat dated, mostly non-technical book on Indonesian oil industry and history)

Owen, N.A. & C.H. Schofield (2012)- Disputed South China Sea hydrocarbons in perspective. Marine Policy 36, 3, p. 809-822.
(Geological evidence does not indicate vast hydrocarbon reserves in S China Sea)

Patmosukismo, Suyitno, A. Pulunggono, Mulhadiono & L.Samuel (1989)- Hydrocarbon potential of Eastern Indonesia and required research direction. In: J.E. van Hinte et al. (eds.) Proc. Snellius II Symposium, Jakarta 1987, Netherlands J. Sea Research 24, 2-3, p. 153-164.
(E Indonesia underexplored. Structural and stratigraphic trapping models and geochemical data on E Sulawesi, Seram and Irian Jaya indicate possibilities for exploration plays in Tertiary and Mesozoic)

Pattinama, S. & L. Samuel (1992)- Petroleum exploration in deep water and frontier areas of Indonesia. Proc. 21st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 479-497.
(86% of E Indonesia basins are deep sea basins and rel. little explored frontier areas; little or no G&G)

Poley, J.P. (2000)- Eroica- the quest for oil in Indonesia (1850-1898). Kluwer Academic Publ., Dordrecht, p. 1-175.
(History of 19th century oil exploration in Sumatra, E Java, E Kalimantan)

Prijono, R., J. Widjonarko, E. Sunardi & B. Adhiperdana (2007)- Petroleum potential of the East Java - Lombok Basin, North and South Makassar Strait and offshore Kutei Basin. Proc. 21st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA07-G-068, 12p.
(Review of six Oligocene- Miocene hydrocarbon plays along E and SE Sundaland margin)

Pulunggono, A. (1976)- Recent knowledge of hydrocarbon potentials in sedimentary basins of Indonesia. In: M. Halbouty et al. (eds.) Proc. Circum-Pacific Energy and mineral resources Conference, Honolulu 1974, American Assoc. Petrol. Geol. (AAPG), Mem. 25, p. 239-249.
(Early, general paper on Indonesian basins. S part of Sunda Shelf many Tertiary sedimentary basins and intervening uplifts. Main oil production in W Indonesia is from Oligocene-Miocene regressive and deeper transgressive sandstone series, except in E Kalimantan, where producing zones range from Eocene- Pliocene. Carbonate rocks becoming prime objective, especially in E Java-Madura basinal area)

Rachmat, J.B. & T. Wibowo (1992)- Peringkat potensi hidrokarbon cekungan-cekungan Tersier Indonesia. Proc. 21st Ann. Conv. Indon. Assoc. Geol. (IAGI), Yogyakarta, 1, p. 19-34.
('Hydrocarbon potential ranking of Indonesian Tertiary basins'. 23 of 60 Tertiary basins of Indonesia tested hydrocarbons; 14 are producing by 1991. Ranking for oil: 1. C Sumatra, 2. Kutei, 3. NW Java, 4. S Sumatra, 5. W Natuna and 6. E Natuna)

Ramdhan, A.M., L.M. Hutasoit & A. Bachtiar (2012)- Some Indonesiaôs giants: óunconventionalô hydrodynamic trap? Proc. 36th Ann. Conv. Indon. Petroleum Assoc. (IPA) Jakarta, 12-G-004, p. 1-15.
(Peciko and Tunu gas fields and some reservoirs in Nilam Field, Kutai Basin proven unconventional hydrodynamic traps. Arun (N Sumatra) and Tangguh (W Papua) possibly also hydrodynamic traps)

Ramdhan, A.M., L.M. Hutasoit & E. Slameto (2018)- Lateral reservoir drainage in some Indonesiaôs sedimentary basins and its implication to hydrodynamic trapping. Indonesian J. Geoscience 5, 1, p. 65-80.
(online at: https://ijog.geologi.esdm.go.id/index.php/IJOG/article/view/394/255)
(Lateral reservoir drainage is hydrodynamic flow type driven by differences in overpressure and can lead to hydrodynamically tilted hydrocarbon-water contacts. Tilted contacts present in fields in Lower Kutai Basin, Arun Field in N Sumatra, Vorwata Field in Bintuni and BD Field of East Java)

Ramli, N. (1985)- The history of hydrocarbon exploration in Malaysia. Energy 10. 3-4, p. 457-473.
(First offshore petroleum exploration in Malaysia in 1950's offshore Sarawak, with first commercial discovery Temana in 1962. Malay Basin exploration, E of Malay Peninsula, began in 1968. First well Tapis 1 by EPMI, with first production in 1978 from Pulai and Tapis fields)

Redfield, A.H. (1922)- Petroleum in Borneo. Economic Geology 17, 5, p. 313-349.
(Early review of petroleum discoveries on Borneo, including Tarakan, Sanga Sanga in E Kalimantan and Miri district of Brunei)

Reminton, C.H., N. Mujahidin & T. Yunus (2000)- Opportunity and challenge beyond the year 2000: the role of exploration in maintaining the oil and gas business in Indonesia. Proc. 27th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 1-12.

Renolds, M. & C. Atkinson (2013)- Stratigraphic traps in the Tertiary rift basins of Indonesia: case studies and future potential. SEAPEX Press 73, 16, 3, p. 54-78.
(Reprint of Atkinson et al. (2006))

Riva, J.P. (1983)- Assessment of undiscovered conventionally recoverable petroleum resources of Indonesia. U.S. Geol. Survey (USGS) Circular 899, p. 1-17.
(online at: http://pubs.usgs.gov/circ/1983/0899/report.pdf)
(Estimates of undiscovered conventionally recoverable petroleum in Indonesia (means 16 BB Oil, 42 TCF gas) in five types of basins. See also more elaborate version of USGS assessment by Kingston 1988)

Robinson, K. (1984)- Assessment of undiscovered recoverable petroleum resources in Tertiary sedimentary basins of Malaysia and Brunei. U.S. Geol. Survey (USGS), Open File Rept. 84-328, p. 1-19.
(online at: http://pubs.usgs.gov/of/1984/0328/report.pdf)

Robinson, K. (1984)- Assessment of undiscovered conventionally recoverable petroleum resources in Tertiary sedimentary basins of Thailand. U.S. Geol. Survey (USGS) Open-File Report OF, 84-0330, p. 1-14.
(online at: http://pubs.usgs.gov/of/1984/0330/report.pdf)

Robinson, K. (1985)- Assessment of undiscovered conventionally recoverable petroleum resources in Tertiary sedimentary basins of Malaysia and Brunei. Bull. Geol. Soc. Malaysia 18, p. 119-132.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm1985005.pdf)
(Undiscovered petroleum resources assessment suggests mean 8 billion B Oil and 80 TCF gas remaining to be discovered in Malaysia and Brunei)

Said, M. (1982)- Overview of exploration for petroleum in Malaysia under the Production Sharing Contracts. In: Offshore Southeast Asia 82 Conf., Singapore, SE Asia Petroleum Expl. Soc. (SEAPEX), p. 1-14.

Satyana, A.H. (2014)- Successful and prospective exploration play concepts of Indonesia: lessons from history and recent progress - anticipating future challenges. Proc. 38th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA14-G-276, 19p.
(10 proven economic hydrocarbon play types in Indonesia: (1) Paleogene regressive clastics of Java- Sumatra- Kalimantan (Talang Akar, Tanjung); (2) Neogene regressive clastics of Java- Sumatra- Kalimantan (Wonocolo, Warukin); 3. Neogene deltaic complex of Kutai- Tarakan (Handil, Tarakan); (4) Neogene deep water clastics of Kutai- Tarakan (W Seno); (5) Oligo-Miocene carbonate platforms of Sumatra- Java (Kaji Semoga); (6) Neogene pinnacle reefs (Arun, Banyu Urip, Kasim); (7) Fractured volcanics of Sumatra- Java (Suban, Jatibarang); (8) Australian Mesozoic marginal rift grabens (Vorwata- Tangguh); (9) Neogene microcontinental collisions (Tiaka, Donggi- Senoro); (10) Neogene island arc- Australian passive margins (Oseil- Bula). Five additional play types with indications of hydrocarbons: (11) Subvolcanic North Serayu, C Java (Karangkobar-Cipluk); (12) Paleogene rifted structures of Makassar Straits (Kaluku type); (13) Neogene reefs of Sumatra-Java forearcs (Singkel Ibu Suma); (14) Papuan fold- thrust belt (Cross Catalina) and (15) N Papua Neogene volcanoclastic sediments (Niengo))

Satyana, A.H. (2016)- Review of Indonesia's petroleum exploration 2000-2015: where from. Proc. IPA 2016 Technical Symposium, Indonesia exploration: where from- where to, Indon. Petroleum Assoc. (IPA), Jakarta, 28-TS-16, p. 1-26.
(In Indonesia 974 exploration and appraisal wells drilled from 2002-2015, 617 onshore and 357 offshore. Of 676 new field wildcats 310 encountered hydrocarbons, adding in-place resources of 18,500 MMBOE. Discoveries in W Indonesia in 5 plays: (1) Paleogene rift sections of Sumatra, W Java, W Natuna; (2) pre-Cenozoic fractured basement in S Sumatra, W Java, E Java; (3) Oligo-Miocene carbonate build ups of E Java and U Kutai; (4) Mio-Pliocene deep-water turbidites of N Makassar and Tarakan; (5) Mio-Pliocene growth-faults of delta progradation of Tarakan Basin. In E Indonesia in 2 plays (Jurassic and Miocene). With details on significant discoveries and dry wells)

Satyana, A.H., C. Armandita & J.A. Paju (2012)- Acceleration in regional exploration of Indonesia: requirement for survival. Proc. 36th Ann. Conv. Indon. Petroleum Assoc., Jakarta, IPA12-G-158, p. 1-14.

Schenk, C.J. (2012)- Assessment of undiscovered conventional oil and gas resources of Thailand. In: Int. Petroleum Techn. Conference (IPTC), Bangkok, IPTC, p. 38-42.
(US Geological Survey estimated mean 1.6 billion barrels of undiscovered conventional oil and 17 trillion cubic feet of undiscovered conventional natural gas in three geologic provinces of Thailand. Most of undiscovered conventional oil and gas in offshore Thai Basin Province)

Schenk, C.J. (2012)- Potential unconventional oil and gas resource accumulations, Onshore Thailand. In: Int. Petroleum Techn. Conference (IPTC), Bangkok 2012, 3p. *(Extended Abstract)*
(Tight gas and shale gas accumulations may exist in Triassic clastics of Khorat Plateau Province. Shale oil and shale gas may be present in extensional structures in Thai Cenozoic Basins Province. Coalbed gas does not appear to be viable resource in N Thailand)

Schenk, C.J., M.E. Brownfield, R.R. Charpentier, T.A. Cook, T.R. Klett et al. (2010)- Assessment of undiscovered oil and gas resources of Southeast Asia, 2010. U.S. Geol. Survey (USGS) Fact Sheet 2010-3015, p. 1-4.
(online at: http://pubs.usgs.gov/fs/2010/3015/pdf/FS10-3015.pdf)
(SE Asia undiscovered conventional oil and gas resources in 23 geologic provinces. Oil mean total is 21.6 Billion BO (range 8.9- 41.6); gas mean total 299 TCFG (range 129- 557) and mean natural gas liquids 9.1 Billion barrels. About 70% of oil in 6 provinces: Baram Delta/Brunei-Sabah, Kutei, S China Sea Platform, E Java, Cuu Long and Thai Basins. About 60% of gas in 6 provinces: Kutei, Greater Sarawak Basin, East Java, Baram Delta/Brunei-Sabah, S China Sea and Nam Con Son Basin)

Schenk, C.J., M.E. Brownfield, R.R. Charpentier, T.A. Cook, T.R. Klett, J.K. Pitman & R.M. Pollastro (2012)- Assessment of undiscovered oil and gas resources of Papua New Guinea, eastern Indonesia, and East Timor, 2011. U.S. Geol. Survey (USGS) Fact Sheet 2012-3029, 2p.
(online at: http://pubs.usgs.gov/fs/2012/3029/FS2012-3029.pdf)
(USGS assessed undiscovered conventional oil and gas in five geologic provinces of the PNG, E Indonesia, and E Timor: (1) oil mean total 5.78 MMBO (2) gas mean total is 115.2 BCFG. Of undiscovered oil 36% in Timor Thrust and Seram Thrust provinces, 37% in fold- thrust belts of PNG and Irian Jaya. Undiscovered Gas mean estimates for PNG Fold Belt 18.1 BCFG, Arafura Platform 15.9 BCFG and Bintuni Basin 20.8 BCFG)

Schuppli, H.M. (1946)- Oil basins of the East Indian Archipelago. American Assoc. Petrol. Geol. (AAPG) Bull. 30, p. 1-22.
(Oil fields of Tertiary basins of Sumatra, Java, and Borneo produced >1 billion barrels of oil to end of 1940. Oil produced almost exclusively from sands of Miocene and Pliocene age. Shortly before the Japanese invasion commercial accumulations discovered in Eocene beds. Bula field in Seram, probably produces Triassic oil, accumulated in overlapping Plio-Pleistocene sands)

Siddayao, C.M. (1980)- The off-shore petroleum resources of South-East Asia- potential conflict situations and related economic considerations. Oxford University Press, Kuala Lumpur, p. 1-205.

Siddiq, F., Z.M. Rubianto, J. Prasetyo & S. Damayanti (2018)- Evaluation and assessment of all play and resources of petroleum system Indonesia to optimize big resources exploration for big oil and gas discoveries in Indonesia. Proc. 42nd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA18-267-G, 13p.
(Play assessment: 563 plays in 1954 prospects and 2173 leads in 43 sedimentary basins in Indonesia. Total in-place resources at P90 is 45.5 BBO and 155 TCF (cut-off of big resources is 500 MMBO for oil, 1 TCF for gas). Current oil production in Indonesia ~810,000 BOPD, against demand of >1.5 MMBOD)

Singh, H. (2005)- The occurrence and exploitation of Malaysian oil and gas resources. Oil Industry History (Petroleum History Institute), 6, 1, p. 129-152.

Situmorang, B. (1986)- Offshore exploration for hydrocarbons in Indonesia. Lemigas Scientific Contr. 9, 2, p. 3-8.
(Brief review of hydrocarbon exploration in Indonesia until 1985)

Soeparjadi, R.A., G.A.S. Nayoan, L.R. Beddoes & W.V. James (1975)- Exploration play concepts in Indonesia. Proc. 9th World Petroleum Congress, London, 3, p. 51-64.

Suardy, A., B. Simbolon & P.J. Taruno (1987)- Two decades of hydrocarbon exploration activities in Indonesia. In: M.K. Horn (ed.) Trans. 4th Circum Pacific Energy Mineral Resources Conf., Singapore 1986, p. 243-261.
(Statistics on hydrocarbon acreage and drilling in Indonesia 1966-1985. Sixty sedimentary basins identified)

Sujanto, F.X. (1986)- Hydrocarbon geology of producing basins in Indonesia and future exploration for stratigraphic traps. Proc. Joint ASCOPE ECOP Workshop I, Jakarta, p.

Sujanto, F.X. (1997)- Substantial contribution of petroleum systems to increase exploration success in Indonesia. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum systems of SE Asia and Australasia, Jakarta 1997, Indon. Petroleum Assoc. (IPA), p. 1-14.
(Broad overview Indonesia basins exploration and hydrocarbons)

Sujanto, F.X., L. Kartanegara, Y.R. Sumantri & L. Gultom (1993)- An assessment of Indonesian natural gas reserves and resources. Proc. 22nd Ann. Conv. Indon. Assoc. Geol. (IAGI), Bandung, 2, p. 638-652.
(June 1993 Pertamina gas assessment in 60 basins of Indonesia: remaining 'proven' recoverable gas reserves ~105 TCF and expected additional reserves 54.5 TCF. Most basins in E Indonesia small speculative resources)

Sujanto, F.X. & Pramu Hartoyo (1984)- Observasi atas status eksplorasi Migas di Indonesia Awal Pelita IV. Proc. 13th Ann. Conv. Indon. Assoc. Geol. (IAGI), p. 423-438.

Sumantri, Y.R. & E. Sjahbuddin (1994)- Exploration success in the Eastern part of Indonesia and its challenges in the future. Proc. 23rd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 1-20.
(General overview E Indonesia discoveries, plays)

Supraptono (1973)- The status of petroleum exploration in the offshore areas of Indonesia. United Nations ECAFE, CCOP Techn. Bull. 7, p. 75-79.
(Offshore oil exploration in Indonesia started in 1967. In 1973 exploration by 21 companies in 27 (some very large) contract areas. 91 offshore exploration wells drilled in 1971)

Suryana, A. & Fatimah (2008)- Tinjauan terhadap bitumen padat dan gas metan batubara di Indonesia. Colloquium Fossil Energy, p. 1-13.
(online at:http://psdg.bgl.esdm.go.id/kolokium%202008/ENERGI%20FOSIL/ etc.)
('Review of heavy oil and coalbed methane gas in Indonesia'. With maps of occurrences and assessed volumes)

Tiratsoo, E.N. (1973)- Oilfields of the world (Indonesia). Scientific Press, Beaconsfield, United Kingdom, p. 171-189.

Tjia, H.D. (2006)- Potential of impact-structure hydrocarbon plays in continental Southeast Asia. In: Petroleum Geol. Conf. & Exh. 2003, Kuala Lumpur, Bull. Geol. Soc. Malaysia 49, p. 111-117.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm2004018.pdf)

Todd, D.F. & A. Pulunggono (1971)- The Sunda basinal area, an important new oil province. Oil and Gas J., June 14, p. 104-110.

US Energy Information Administration (EIA) (2015)- Technically recoverable shale oil and shale gas resources: Indonesia. EIA/ARI World Shale Gas and Shale Oil Resource Assessment Report XXIII, p. 1-25.
(online at: https://www.eia.gov/analysis/studies/worldshalegas/pdf/Indonesia_2013.pdf)
(Highest shale gas and shale oil potential in Indonesia in oil-prone, lacustrine shales in C and S Sumatra basins. Kutei and Tarakan basins of Kalimantan also thick lacustrine source rock shales with oil- gas potential. Indonesia has estimated 46 TCF gas and 7.9 BBO of risked, technically recoverable shale gas and shale oil resources out of 303 TCF and 234 BBO of risked shale gas and shale oil in-place)

US Energy Information Administration (EIA) (2015)- Technically recoverable shale oil and shale gas resources: Thailand. EIA/ARI World Shale Gas and Shale Oil Resource Assessment Report XXII, p. 1-18.
(online at: www.eia.gov/analysis/studies/worldshalegas/pdf/Thailand_2013.pdf)

US Embassy, Jakarta (2006)- Petroleum report Indonesia 2005-2006. p. 1-121.
(One of annual overview reports on Indonesia petroleum industry. Available from www.usembassyjakarta.org)

Von Baumhauer, E. (1869)- Over de aardolien der Nederlandsch Oost Indische bezittingen. Verslagen Meded. Kon. Akademie Wetenschappen, Amsterdam, Afd. Natuurkunde (2), 3, p. 340-383.
('On oils in the Netherlands Indies'. Recorded 44 oil seeps in Java. Also occurrences on Borneo, Sumatra, Ceram, E Sulawesi)

Von Baumhauer, E. (1869)- Over de aardolien der Nederlandsch Oost Indische bezittingen. Tijdschrift Nederl. Maatschappij ter bevordering van Nijverheid, 310, Haarlem, p. 190-246.
('On oils in the Netherlands Indies'. Same paper as above)

Warga Dalem, M. A., S. Padmosubroto & A. Khazoom (1985)- The occurrences of heavy crude and tar sands in Indonesia. In: Proc. Third Int. Conf. Heavy crude and tar sands, UNITAR/UNDP, New York, p. 205-216.

Widarsono, B. (2014)- Porosity versus depth characteristics of some reservoir sandstones in Western Indonesia. Scientific Contr. Oil and Gas, Lemigas, Jakarta, 37, 2, p. 87-104.
(online at: www.lemigas.esdm.go.id/publikasi/read/scientific/1/)
(Porosity depth models derived from core samples from 549 wells in 8 producing sedimentary basins in W Indonesia)

Widarsono, B. (2016)- Petrophysical characteristics of some Indonesian reservoir rocks. Lemigas, LIPI Press, p. 1-257.

Widarsono, B., A. Muladi & I. Jaya (2007)- Vertical-horizontal permeability ratio in Indonesian sandstone and carbonate reservoirs. Proc. Simp. Nasional IATMI, July 2007, UPN Yogyakarta, IATMI 2007-TS-09, 20p.
(Permeablity anisotropy in both sandstones and carbonate rocks inwells in Indonesia (KV/KH) generally below 1.2. Carbonate rocks greater portion of data above 1.2)
(online at: www.iatmi.or.id/assets/bulletin/pdf/2007/2007-09.pdf)

Witkamp, H. (1917)- Onze koloniale Mijnbouw, II. De Petroleum. Tjeenk Willink, Haarlem, p. 1-96.
('Our colonial mining industry, II, Petroleum'. Early popular overview of oil industry in Indonesia)

Witoelar Kartaadipura, L. & L. Samuel (1988)- Oil exploration in Eastern Indonesia, facts and prospective. Proc. 17th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 1-8.

Yazid, A., Sunoto & D. Djatmiko (1992)- Development of oil and gas exploration activities In Indonesia. Proc. 21st Ann. Conv. Indon. Assoc. Geol. (IAGI), Yogyakarta,1, p. 1-18.
(Brief review of hydrocarbon exploration activities in Indonesia. Of 60 sedimentary basins in Indonesia only 38 explored. 14 basins produce oil and gas)

XI.2. Hydrocarbon Source Rocks, Oils and Gases

(Additional references on hydrocarbon source that are specific to one region are listed under these regions)

Amijaya, H. (2010)- Indonesian low rank coal as petroleum source rock: high petroleum potentional but no expulsion? Proc. 34th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA10-G-071, 6p.
(Petrographic and geochemichal study on low rank coals from Muara Enim Fm, S Sumatra. Coals can generate gas and oil, but with huminite reflectance 0.35-0.52% threshold to generate and expel oil not yet reached)

Astawa, I.N., D. Setiady, P.H. Wijaya, G.M. Hermansyah & M.D. Saputra (2016)- Indikasi gas biogenik di perairan Delta Mahakam, Provinsi Kalimantan Timur. J. Geologi Kelautan 14, 2, p. 103-114.
(online at: http://ejournal.mgi.esdm.go.id/index.php/jgk/article/view/354/282)
('Indications of biogenic 'swamp gas' in waters of the Mahakam Delta. Numerous indications of biogenic methane in shallow seismic profiles and cores in shallow sediments of Mahakam Delta distributary channels)

Astawa, I.N., P.H. Widjaja & W. Lugra (2011)- Pola sebaran gas charged sediment dasar laut di perairan Sidoarjo, Jawa Timur. J. Geologi Kelautan 9, 2, p. 66-77.
(online at: http://ejournal.mgi.esdm.go.id/index.php/jgk/article/view/201/191
('The distribution pattern of gas charged sediment in seabed of waters of Sidoarjo, East Java'. Belt of biogenic shallow gas-charged sediments on shallow seismic profiles off Porong Delta, Madura Straits)

Atkinson, C.D. & A. Livsey (2000)- Role of resinite in hydrocarbon generation from Indonesian coals. AAPG Int. Conf. Exhib. Abstracts, American Assoc. Petrol. Geol. (AAPG) Bull. 84, 9, p. 1400. *(Abstract only)*
(Liptinite maceral "resinite" important constituent of Tertiary coals in W Indonesia, probably from resins of Dipterocarp family tropical lowland trees. Samples from Miocene of Kutei Basin and Oligocene of Ardjuna Basin (off NW Java) have abundant resinite, particularly in vitrinite-rich delta plain coals. Resinites hydrogen-rich, but not paraffinic, suggesting resinite not significant contributor to terrestrially-derived oils in these basins, but contribute cyclic hydrocarbons and biomarkers to these oils)

Barber, P.M. & J. Winterhalder (2013)- The Northern Australia- Eastern Indonesia- PNG Super Gas Province: why so much gas and so little oil? AAPG Int. Conv. Exhib., Singapore 2012, Search and Discovery Art. 10475, 32p. *(Abstract + Presentation)*
(online at: www.searchanddiscovery.com/documents/2013/10475barber/ndx_barber.pdf)
(N Australia-E Indonesia-PNG Gas Province of Late Paleozoic-Mesozoic age overwhelmingly gas-prone (80% of all hydrocarbons discovered to date). Distribution of oil- vs. gas-prone source rocks controlled by successive Permian-Mesozoic passive margin extension, rifting and breakup, overprinted by global eustatic cycles and tectonic interaction with W Papua-PNG foldbelt. Two major source rock types: (1) oil-prone Organofacies B (only in local Oxfordian-Kimmeridgian syn-rifts and PNG foreland basins); (2) Organofacies D/E much more widespread, in U Permian-Jurassic lower delta-plain coals)

Bernard, B.B., J.M. Brooks, P. Baillie, J. Decker, P.A. Teas & D.L. Orange (2008)- Surface geochemical exploration and heat flow surveys in fifteen (15) frontier Indonesian basins. Proc. 32nd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 45-58.
(Piston core survey in E Indonesia with many samples with migrated hydrocarbon. Not much detail)

Bernard, B.B., D.L. Orange, J.M. Brooks & J. Decker (2013)- Interstitial light hydrocarbon gases in jumbo piston cores offshore Indonesia: thermogenic or biogenic? In: Offshore Technology Conf. (OTC), Houston 2013, OTC 24228, p. 1-12.
(Interstitial light hydrocarbons in 12m long piston cores from deepwater offshore NW Papua (no locality details; all deemed to be of biogenic origin)

Bertrand, P. (1984)- Geochemical and petrographic characterization of humic coal considered as possible oil source rocks. Organic Geochem. 6, p. 481-488.

Bradshaw, M., D. Edwards, J. Bradshaw, C. Foster, T. Loutit et al. (1997)- Australian and Eastern Indonesian petroleum systems. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum Systems of SE Asia and Australasia, Jakarta 1997, Indon. Petroleum Assoc. (IPA), p. 141-153.
(Six Phanerozoic petroleum supersystems in Australia, three of these also in E Indonesia. Source rock intervals in Cambrian, Ordovician, Late Devonian, E Carboniferous, Permian, Triassic, Late Jurassic and Cretaceous. Petrel gas field in Bonaparte Basin example of Gondwanan Supersystem accumulation in Late Permian sandstones with earliest Triassic marine shale seal. Similar system may be operating in Bintuni Basin)

Brown, S. (1989)- The "mangrove model", can it be applied to hydrocarbon exploration in Indonesia? Proc. 18th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 385-401.
(On mangrove-derived organic matter as likely hydrocarbon source, and mangrove forests as a highly productive ecosystem and ideal place for accumulation and preservation of organic matter)

Carlson, R.M.K., S.C. Teerman, J.M. Moldowan, S.R. Jacobson, E.I. Chan, K.S. Dorrough, W.C. Seetoo & B. Mertani (1993)- High temperature gas chromatography of high-wax oils. Proc. 22nd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 483-507.
(High Temp Gas Chromatography can provide paleoenvironmental information on geologic source of oils and bitumens. Oil from Salawati Basin in Irian Jaya and Telisa Shale extracts from C Sumatra show profiles consistent with marine sources. C Sumatran high-wax oils consistent with fresher water lacustrine source)

Carr, A.D. (2008)- Suppression and retardation of vitrinite reflectance, part 2. Derivation and testing of a kinetic model for suppression. J. Petroleum Geol. 23, 4, p. 475-496.
(Vitrinite reflectance may be suppressed and lead to erroneous predictions of hydrocarbon generation in sedimentary basins. Case studies include Bunga Orkid-1 (Malay Basin))

Caughey, C.A. & J.V.C. Howes (eds.) (1999)- Gas habitats of SE Asia and Australasia. Proc. Int. Conf., Indon. Petroleum Assoc. (IPA), Jakarta, October 1998, p. 1-237.

Cole, J.M. & S. Crittenden (1997)- Early Tertiary basin formation and the development of lacustrine and quasi-lacustrine/ marine source rocks on the Sunda Shelf of SE Asia. In: S.J. Matthews & R.W. Murphy (eds.) Petroleum Geology of Southeast Asia, Geol. Soc., London, Spec. Publ. 126, p. 147-183.

Cook, A.C. (1989)- Source potential and maturation of hydrocarbon source rocks in Indonesian sedimentary basins. In: B. Situmorang (ed.) Proc. 6th Regional Conf. Geology, Mineral Hydrocarbon Resources of Southeast Asia (GEOSEA VI), Jakarta 1987, IAGI, p. 319-342.
(General overview of petroleum source rocks)

Cooper, B.A., M.J. Raven, L. Samuel & S.W. Hardjono (1997)- Origin and geological controls on subsurface CO2 distribution with examples from Western Indonesia. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum systems SE Asia and Australasia, Jakarta 1997, Indonesian Petroleum Assoc. (IPA), p. 877-892.
(Potential sources of CO2 include mantle degassing, reaction (metamorphic and diagenetic) of carbonates and catagenesis of coals)

Core Laboratories Indonesia (1993)- A non-exclusive study of the hydrocarbon potential and stratigraphic occurrence of coals in Indonesia. Unpublished report BS-01, 5 vols.

Courteney, S. (1996)- Middle Eocene, older sequences in rifts key to potential in western Indonesia. Oil and Gas J., May 27, p. 71-74.
(Part 2 of Western Indonesia paper. M Eocene most effective source interval in W Indonesia rift basins)

Curiale, J.A. (2006)- The occurrence of norlupanes and bisnorlupanes in oils of Tertiary deltaic basins. Organic Geochem. 37, p. 1846-1856.
(On the occurrence of the C28 and C29 lupanoid hydrocarbons in crude oils and their use in oil-source correlations. With examples from Kutai Basin, E Kalimantan)

Curiale, J. & J. Decker (2007)- Eocene oil-prone source rock potential of Central Indonesia. American Assoc. Petrol. Geol. (AAPG) Bull. 91, Program Abstracts 2007 AAPG Ann. Mtg. Long Beach.
(Occurrence of oil-prone, terrigenous Eocene source potential in extensive areas of E Borneo and W Sulawesi, and oil-prone, lacustrine Eocene potential in S part Makassar Strait. Eocene-sourced oil accumulations known in Barito Basin (Tanjung Field). Extent of other Eocene-sourced accumulations (e.g., Tengkawang oil of E Kalimantan, surface seeps in SW Sulawesi, Pangkat oil tests in S Makassar Strait) not determined)

Curiale, J.A., J. Decker, C.A. Caughey & H.F. Schwing (2003)- Oil-prone lacustrine source rock potential in Central Indonesia. 2003 AAPG/ SEPM Conv., p. 35-36. *(Abstract only)*
(E Borneo and W Sulawesi oils show partial or total lacustrine signature. C Indonesian oils with partial or complete lacustrine signature include Pantai-1 (off E coast Borneo) and Pangkat-1 (S Makassar Strait). Both oils elevated 4-methylsteranes. Pangkat-1 oil with beta-carotane, elevated sulfur (S = 2.1%) and very light carbon isotope ratios (d13C = -30.3 ppm). Very low maturity levels, possibly early generation from Type I-S kerogen deposited in hypersaline setting. Other C Indonesian oils reveal lacustrine source signature indicating freshwater depositional setting. Paleogene rifting between Borneo and Sulawesi provided potential development of oil-prone lacustrine source rocks)

Curiale, J.A., E. Lumadyo & R. Lin (2002)- Petroleum and source rock geochemistry of the Salayar Basin (offshore Sulawesi), Indonesia. AAPG-SEPM Ann. Conv., Houston 2002, p. *(Abstract only).*
(Salayar Basin off SW Sulawesi, at S-most extent of Makassar Strait in Indonesia. Cretaceous- M Eocene rifting created Dewakang graben, followed by inversion through M Miocene. Depositional models and regional data suggest lacustrine, oil-prone sources in Paleocene, and oil-prone coaly sequences in M Eocene. Both source facies proven to E and NE at basin margins. Eocene 'Kelara Limestone' source for low-wax, low-asphaltene oil in basin center. Underlying Eocene coals- coaly shales analogous to oil-prone Barito Basin sapropelic coals, and responsible for oil seeps in SW Sulawesi. Possible occurrence of older, lacustrine oil-prone sources in Salayar Basin significant upside to exploration. Oil-prone sources mature in deepest parts of basin)

Curiale, J.A., P. Kyi, I.D. Collins, D. Aung, N. Kyaw, N.M. Nyunt & C.J. Stuart (1994)- The Central Myanmar (Burma) oil family-composition and implications for source. Organic Geochem. 22, 2, p. 237-255.
(Geochemical characteristics of 31 Eocene-Miocene oils/seeps, Eocene coal and Eocene resin from C Myanmar suggest Eocene resinous shale/coal is source for oils)

Daulay, B. & H. Panggabean (2001)- Batubara sebagai sumber hidrokarbon: studi kasus cekungan Kutai dan Barito. J. Geologi Sumberdaya Mineral 11, 118, p. 26-34.
('Coal as a source of hydrocarbons: a case study in the Kutai and Barito Basins'. Coals good potential petroleum source rocks)

Davis, R.C., S.W. Noon & J. Harrington (2004)- Influence of depositional environment on the petroleum potential of Tertiary Indonesian coals. Abstracts 21th Ann. Mtg. Soc. Organic Petrology, Sydney, 21, 3p.

Davis, R.C., S.W. Noon & J. Harrington (2007)- The petroleum potential of Tertiary coals from Western Indonesia: relationship to mire type and sequence stratigraphic setting. Int. J. Coal Geology 70, p. 35-52.
(500 deltaic sediments analysed from 14 basins in W Indonesia. Main peat-forming episodes: (1) Paleogene syn-rift transgressive, (2) Paleogene-Neogene post-rift transgressive, (3) Neogene regressive. Paleogene syn-rift coals more hydrogen-rich than Neogene coals and more oil-prone. Pliocene coals from regressive sequence in Sumatran fore-arc very hydrogen-poor. Systematic increase in HI with increasing rank suggests pyrolysis underestimates petroleum potential in low rank coals. Vitrinite type more important for petroleum potential than liptinite content. Four coal sub-types: I, II and III low ash coals and likely deposited in raised mires. Sub-type IV hydrogen-rich, high-ash Eocene coals, deposited in submerged mire. Highly degraded peats result in hydrogen-rich coals with higher proportion of detrital vitrinite. Degree of degradation related to time peat spends in zone of influence of water table; unlikely related to tectonostratigraphic setting)

Doust, H. & G. Lijmbach (1997)- Charge constraints on the hydrocarbon habitat and development of hydrocarbon systems in Southeast Asia Tertiary Basin. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum Systems of South East Asia and Australasia, Jakarta, Indon. Petroleum Assoc. (IPA), p. 115-125.
(Most SE Asia basins similar geological history of Early Tertiary graben formation, fill and transgression, followed by E-M Miocene marine transgression and Late Tertiary regressive deltaic progradation. Main source rocks: (1) Early synrift lacustrine (Oligocene- E Miocene), oil prone; (2) Late synrift transgressive deltaic (Oligocene- E Miocene), oil and gas prone; (3) Early postrift marine (E-M Miocene transgression), mainly gas prone; and (4) Late postrift regressive deltaic (M Miocene-Pliocene), oil and gas prone. Lacustrine shales, fluvio-deltaic coals/coaly shales and organic-rich marine shales generated light waxy oils and abundant gas of region. Proximal basins and environments more oil prone, more distal basins and environments more gas potential; intermediate basins and environments both oil and gas prone)

Doust, H. & R.A. Noble (2008)- Petroleum systems of Indonesia. Marine Petroleum Geol. 25, 2, p. 103-129.
(Four Petroleum System Types (PSTs) corresponding to main stages of geodynamic basin development (1) oil-prone Early Synrift Lacustrine in Eocene-Oligocene deeper parts of synrift grabens, (2) oil and gas-prone Late Synrift Transgressive Deltaic in shallower Oligocene- E Miocene portions of synrift grabens, (3) gas-prone Early Postrift Marine of E Miocene transgressive period, and (4) oil and gas-prone Late Postrift Regressive Deltaic of shallowest late Tertiary basin fills. Mixing of predominantly lacustrine to terrestrial charge has taken place. Grouped basins according to dominant PSTs and identified 'basin families', termed proximal, intermediate, distal, Borneo and E Indonesian, according to paleogeographic relationship to Sunda craton)

Doust, H. & H.S. Sumner (2007)- Petroleum systems in rift basins- a collective approach in Southeast Asian basins. Petroleum Geoscience 13, p. 127-144.
(Shell view of SE Asia Tertiary basins. Four types of petroleum systems, correlating with basin evolution stages (early and late synrift, early and late postrift). Petroleum system types characteristic environmentally-controlled source, reservoir and seal lithofacies which, in combination with structural trap style, determine hydrocarbon habitat. Variations in tectonostratigraphic evolution due to differences in paleogeographical position and proximity to late Tertiary collisions. This is reflected in volumes, field sizes and oil- gas ratios)

Dowling, L.M., C.J. Boreham, J.M. Hope, A.P. Murray & R.E. Summons (1995)- Carbon isotopic composition of hydrocarbons in ocean-transported bitumens from the coastline of Australia. Organic Geochem. 23, 8, p. 729-737.
(Bitumens stranding along coastlines of Northern Territory, W Australia, S Australia, Victoria and Tasmania with biomarker signatures similar to SE Asian oils. Comparison with C Sumatra Minas and Duri lacustrine oils shows very similar isotopic patterns to waxy bitumens from Australian coastline. Asphaltic bitumens from S Australian coastline lighter carbon isotopes)

Edwards D. & J. Zumberge (2005)- The oils of Western Australia II: Regional petroleum geochemistry and correlation of crude oils and condensates from Western Australia and Papua and New Guinea. GeoMark Research Ltd. *(Unpublished multi-client study)*

Escher, B.G. (1920)- The composition of the crude-oils of the Netherlands East Indian Archipelago in connection with the oil bearing strata. In: Algemeen Ingenieurs Congres (General Engineering Congress), Batavia 1920, sect. 5, Mijnbouw en Geologie, Intr. Paper 1, p. 1-33.
(On composition of crude oils from BPM fields in N and S Sumatra (oils with asphalt base, rich in benzine), E Kalimantan (medium oils with paraffin or with asphalt base with common aromatic and unsaturated hydrocarbons), Tarakan (heavy oils with asphalt base) and Java (oils with paraffin and asphalt base))

Geneau, M.E. (1990)- A discussion of 'sniffer' geochemical surveying offshore Malaysia. Bull. Geol. Soc. Malaysia 25, p. 57-73.

GEOMARK (1993)- Far East oil study. 15 volumes. *(Unpublished multi-client report on oils chemistry)*

George, S.C., H. Volk & M. Ahmed (2004)- Oil-bearing fluid inclusions: geochemical analysis and geological applications. Acta Petrologica Sinica 20, 6, p. 1319-1332.
(On fluid inclusion geochemistry, with examples from Timor Sea, etc., NW Australia)

Gibling, M.R. (1988)- Cenozoic lacustrine basins of Southeast Asia, their tectonic setting, depositional environment and hydrocarbon potential. In: A.G. Fleet, K. Kelts & M.R. Talbot (eds.) Lacustrine petroleum source rocks, Geol. Soc., London, Spec. Publ. 40, p. 341-351.
(Cenozoic strike-slip tectonism in SE Asia generated many short-lived, but deep basins. Formed ideal sites for lakes during Oligocene- Miocene early basinal history. Examples from N Thailand basins with lacustrine mudstone and coal with Type I, hydrogen-rich kerogen, with good hydrocarbon generation potential)

Gordon, T.L. (1985)- Talang Akar coals; Ardjuna subbasin oil source. Proc. 14th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 2, p. 91-120.

Grantham, P.J., J. Posthuma & A. Baak (1983)- Triterpanes in a number of Far-Eastern crude oils. In: M. Bjoroy et al. (eds.) Proc. Int. Meeting on Organic Geochemistry 1981, Wiley & Sons, New York, Advances in Organic Geochemistry 10, p. 675-683.
(First authors to suggest relation between uncommon triterpanes in crude oils from SE Asia and dammar (resinous material from Dipterocarpaceae angiosperm hardwood trees common in SE Asia))

Grunau, H.R. & U. Gruner (1978)- Source rocks and the origin of natural gas in the Far East. J. Petroleum Geol. 2, p. 3-56.
(Most source rocks of SE Asa, Australia have strong humic component and therefore large gas-generating capacity, so Far East largely a gas province. Most source rocks Paleocene- Miocene age. Source rock maturity and post-maturity in many cases reached in Neogene to Recent times. Retention of gas may have been inadequate in areas of strong Neogene folding (e.g. Sumatra, E Kalimantan, Burma Tertiary basins)

Hoffmann, C.F., A.S. MacKenzie, C.A. Lewis, J.R. Maxwell, J.L. Oudin, B. Durand & M. Vandenbroucke (1984)- A biological marker study of coals, shales and oils from the Mahakam Delta, Kalimantan, Indonesia. Chemical Geology 42, p. 1-23.
(Distributions of steroidal and triterpenoidal alkanes and aromatic hydrocarbons in oils, coals and shales from Mahakam Delta suggest high relative abundances of components of higher-plant origin, agreeing with Type III organic matter interpretation. Source for Handil oils must have present depth of at least 3000m)

Horsfield, B., K.L. Yordy & J.C. Crelling (1988)- Determining the petroleum-generating potential of coal using organic geochemistry and organic petrology. In: Proc. 13th Int. Meeting on Organic Geochemistry, Organic Geochem. 13, p. 121-129.
(Arjuna Basin of NW Java contains high-wax crude oil. Pyrolysis-gas chromatography shows potential precursors of long chain (waxy) paraffins in coals of Talang Akar formation, and are most abundant in those that are rich in 'matrix liptinite' (better expulsion potential than vitrinite-rich coals))

Howes, J.V.C. & S. Tisnawijaya (1995)- Indonesian petroleum systems, reserve additions and exploration efficiency. Proc. 24th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 1-17.

Imbus, S.W., B.J. Katz & T. Urwongse (1998)- Predicting CO2 occurrence on a regional scale: Southeast Asia example. Organic Geochem. 29, p. 325-345.
(In SE Asia gas fields CO2 may vary from <10% to 90% in same basin. Multiple possible origins for CO2, incl. from mantle, carbonate metamorphism, maturation of organic material, etc.). Tectonic setting, basement fault density, reservoir temperature and reservoir pressure are key elements controlling CO2 abundance)

Kang An & Yang Lei (2010)- Lacustrine source rock occurrence and its petroleum reservoir distribution of Paleogene fault basins in offshore China and Southeast Asia. Xinjiang Petroleum Geol. 2010, 4, p.
(Hydrocarbons generated from lacustrine source rocks in Paleogene rift basins of offshore China and SE Asia account for 95% and 48% of total petroleum resources in these areas. Two models of source rock distribution

(1) Bohai Bay basin model with widely distributed, thick, deep lacustrine shale; (2) Asri- C Sumatra basin model with rel. thin, shallow lacustrine shale of limited distribution)

Katz, B.J. (1991)- Controls on lacustrine source rock development for Indonesia. Proc. 20th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 587-619.
(Lacustrine source rocks >80% of Indonesia's known petroleum reserves. Nonmarine source systems not universally distributed. Factors favoring lacustrine source development: tectonic development of narrow basins, subsidence rates in excess of sedimentation rates, rainfall rates in excess of evaporation but insufficient to support growth of rain forests, lack of winter storms, and limited seasonality of surface temperatures)

Katz, B.J. (1995)- Biogenic gas- its formation and economic significance. Proc. 24th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 461-474.
(Significant proportion of global gas reserve-base not thermogenic but of bacterial origin. Several Indonesian basins, with high sedimentation rates, locally high TOC and rel. low T gradients, may be suitable for biogenic gas generation)

Katz, B.J. (1995)- A survey of rift basin source rocks. In: J.J. Lambiase (ed.) Hydrocarbon habitat of rift basins, Geol. Soc., London, Spec. Publ. 80, p. 213-240.
(Rift basins contain disproportionate amount of petroleum relative to their area and sediment volume, but not all rifts contain organic-rich deposits, nor are all organic-rich deposits volumetrically significant. Includes examples from C Sumatra, etc.)

Katz, B.J. (2001)- Gas geochemistry- a key to understanding formation and alteration processes. Proc. 28th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 789-802.
(Multiple gas formation mechanisms, reflected in bulk and isotope geochemistry; can be used to decipher gas accumulation history)

Katz, B.J. & B. Mertani (1989)- Central Sumatra- a geochemical paradox. Proc. 18th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 403-425.
(Crude oil data suggest four crude oil families in C Sumatra. Source rock data indicated only one effective oil source, Pematang Brown Shale. Facies variations in Brown Shale may explain differences in crude oils)

Katz, B.J., R.A. Royle & B. Mertani (1990)- Southeast Asian and Southwest Pacific coals contribution to the petroleum resource base. Proc. 19th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 299-329.
(Considerable variation in ability of coals to generate hydrocarbons. With exception may be of algal-dominated coals, coals generally do not contribute to petroleum resource base. Lacustrine source rocks account for 90% of petroleum resource base of Indonesia, 95% of China's)

Kelley, P.A., K.K. Bissada, B.H. Burda, L.W. Elrod & R.N. Pheifer (1985)- Petroleum generation potential of coals and organic rich deposits: significance in Tertiary coal rich basins. Proc. 14th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 2, p. 3-21.
(Contribution of coal to accumulated hydrocarbons controversial. Only alginite produces molecular fingerprint that resembles crude oil, hydrocarbons generated by vitrinite do not. Vitrinite generates minor quantities of hydrocarbons and is not viable oil source. Algae and bacteria probably represent basis for all crude oils)

Kewley, J. (1921)- The crude oils of Borneo. Petroleum Times, London, 5, p. 337-339.
(also in J. Inst. Petrol. Technologists 7, 37, p. 209-233)
((Plummer 1921 AAPG review): In Kutei region in E Borneo Miocene Pliocene deltaic deposits overlie glauconitic marls, limestones and marls of E Miocene and Eocene age. Oil originated in lower Miocene and Eocene marls and limestones and migrated upward, saturating delta deposits. Oil accumulated along Sanga Sanga fold (Sanga Sanga and Sambodja oil fields). Deeper oil rich in paraffin wax; oils from higher levels in or above coal beds poorer in paraffin and richer in aromatic and asphaltic constituents. In Miri field where coal is absent, oil also low in aromatic and asphaltic content. At Perlak in Sumatra where coal is also absent oils lower in aromatic and asphaltic constituents than oils of Moera Enim, Sumatra, where coal seams present)

Kjellgren, G.M. & H. Suguharto (1989)- Oil geochemistry: a clue to the hydrocarbon history and prospectivity of the Southeastern North Sumatra Basin, Indonesia. Proc. 18th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 363-385.
(Oils from Pertamina wells in N Sumatra basin suggest two oil sources: (1) E Oligocene synrift Bampo Fm (early generation, now overmature; oils mostly biodegraded) and (2) post-rift Late Oligocene- M Miocene Baong-Belumai Fms)

Kristadi, H.J. & D.W. Dati (2012)- Gas metana batu bara: energi baru untuk rakyat. Pusat Penelitian dan Pengembangan Teknologi Minyak dan Gas Bumi (LEMIGAS), Jakarta, p. 1-129.
(online at: www.lemigas.esdm.go.id/id/pdf/buku_populer/Buku%20Gas%20Metana%20Batubara.pdf)
('Coal methane gas: new energy for the people'. Review of coalbed methane principles, occurrences in Indonesia (Sumatra, Kalimantan), extraction, economics, etc.)

Lawrence, G., A. Fleming, M. Broadley & N.A. Press (1997)- Offshore seepage mapped from space high-grades unexplored parts of Southeast Asia basins. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum Systems of SE Asia and Australasia, Jakarta 1997, Indon. Petroleum Assoc. (IPA), p. 995-999.
(General discussion of offshore satellite slicks in SE Asia)

Leckie, A.J. & H.R. Woltjer (1935)- Het Helium-gehalte van aardgassen der petroleumbronnen. Handelingen 7e Nederl. Natuurwetensch. Congres, Batavia 1935, p. 170-181.
('The Helium content of natural gases from the oil wells'. Analyses of 15 gases from Java, Sumatra, Borneo and sera. Highest He content in Bula field, Seram)

Link, W. (1952)- Significance of oil and gas seeps in world exploration. American Assoc. Petrol. Geol. (AAPG) Bull. 36, 8, p. 1505-1549.
(General discussion of oil-gas seepage. Most common in young sediments that were folded, faulted and eroded and on basin margins. With 3 maps showing oil seep distribution on Sumatra (fig. 38), Borneo (fig. 39) and Java (fig. 40), based on information from Standard-Vacuum Oil Company)

Livsey, A.R., N. Duxbury & F. Richards (1992)- The geochemistry of Tertiary and Pre-Tertiary source rocks and associated oils in eastern Indonesia. Proc. 21st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 707-761.
(Overview of E Indonesia source rocks. Main source rock ages Late Permian, Late Triassic (restricted marine oil-source in Buton, Seram, Timor, Buru), E-M Jurassic (coaly and marine facies in New Guinea), Miocene (Salawati, Sengkang basins).

Longley, I. (2005)- Topical tropical non-marine deep water deltaic charge systems in SE Asia. a model to explain why some are oily and some are not. Proc. 30th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 625-646.
(General Asia hydrocarbon source discussion, mainly dealing with Borneo Baram and Mahakam deltas)

MacGregor, D.S. (1994)- Coal-bearing strata as source rocks- a global overview. In: A.C.Scott & A.J. Fleet (eds.) Coal and coal-bearing strata as oil-prone source rocks? Geol. Soc. London Special Publ. 77, p. 107-116.
(Coal-bearing sequences are significant oil generators only in very specific and relatively uncommon settings. Coals primary or important secondary source facies in Australasia/ SE Asia. In other regions of world no evidence they expelled major oil, but sourced significant amounts of gas. Liquid hydrocarbons restricted to two 'fairways'. (1) Tertiary angiosperm assemblages within 20° of Paleo-Equator and (2) Late Jurassic-Eocene gymnosperm assemblages formed on Australian and associated plates)

MacGregor, D.S. (1995)- The exploration significance of surface oil seepage: an Indonesian perspective. Proc. 24th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 97-109.
(Majority of Indonesian oil provinces with belt of seeps on basin edge. Relationship between seeps and reserves good on basin scale, but poor at sub-basin and field scale. Seeps in W Indonesia controlled by extent of Plio-

Pleistocene structural inversion over oil-bearing portions of backarc basins. Less disturbed extensional fabric of C. Sumatra less seepage than inverted fabric of N and S Sumatran basins, despite higher oil reserves. Active seeps frequent over active reverse faults and eroded steep anticlinal crests. High success rate of wells near seeps, but most seeping fields shallow and small. In inverted areas, oil generation usually no longer active and surface oil shows represent destruction of oil pools. Larger fields generally basinward of seep belt)

Mann, A.L., N.S. Goodwin & S. Lowe (1987)- Geochemical characteristics of lacustrine source rocks: a combined palynologial/ molecular study of a Tertiary sequence from offshore China. Proc. 16th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 241-258.
(Study of Eocene-Miocene lacustrine source rocks from undisclosed well offshore China)

Marty, D.G. & J.E. Garcin (1987)- Presence de bacteries methanogenes methylotrophes dans les sediments profonds du detroit de Makassar (Indonesie). Oceanologica Acta 10, 2, p. 249-253.
(online at: http://archimer.ifremer.fr/doc/00109/22074/19716.pdf)
('Occurrence of methylotrophic methane-producing bacteria in deep-sea sediments from Makassar Strait (Indonesia)'. Competition between sulfate reducing and methane producing bacteria one of main factors controlling biogenic methane genesis in anoxic marine sediments. Methylotrophic methanogenic bacteria found in shallow marine sediments, and methanogenic bacteria able to produce methane from methylamines in sediments from oceanic trench at depth of 2000m in Makassar Strait)

McKirdy, D.M. & A. Horvath (1976)- Geochemistry and significance of coastal bitumen from southern and northern Australia, Australian Petrol. Explor. Assoc. (APEA) J. 16, p. 123-136.
(Bitumen strandingsin N Territory of Australia are paraffinic oils, probably from natural submarine oil seeps in Money Shoal Basin. Probably derived from Cretaceous or younger non-marine or deltaic source rocks (see also Summons et al. 1993))

Michels, R., N. Enjelvin-Raoult, E. Marcel, L. Mansuy, P. Faure & J.L. Oudin (2002)- Understanding of reservoir gas compositions in a natural case using stepwise semi-open artificial maturation. Marine Petroleum Geol. 19, 5, p. 589-599.
(Two types of variations with depth of d13C values of gases observed in multilayered gas fields in SE Asia (E Kalimantan?). In normally pressured zones steady increase of d13C values of methane with depth; in overpressured zones first decrease with depth, then regular trend. Experiments on pyrolysis of Mahakam Delta coal show closed pyrolysis carbon isotope trends very similar to high pressured reservoirs; normal pressured reservoirs follow values of semi-open pyrolysis. Gas distributions and d13C isotope composition may be explained in terms of degree of opening of system: high P reservoirs fairly closed systems, with in situ gas generation, normally pressured zones more open and subject to lateral migration)

Munir, N., S. Sanusi, S. Gunawan, T. Nugroho & M. Dwiantoro (2015)- Early screening tools to determine the hydrocarbon potential from unconventional coals and shales source rocks: organic petrology and geochemistry. Proc. Joint Conv. HAGI-IAGI-IAFMI-IATMI, Balikpapan, JCB2015-096, 12p.
(Organic petrology and geochemistry of lignite from Muara Enim Fm (S Sumatra), shales from Sangkarewang Fm (Ombilin Basin) and Brown Shale Fm (C Sumatra). All potential for unconventional oil and gas)

Murray, A.P., I.B. Sosrowidjojo, R. Alexander, R.I. Kagi, C.M. Norgate & R.E. Summons (1997)- Oleananes in oils and sediments: evidence of marine influence during early diagenesis? Geochimica Cosmochimica Acta 61, 6, p. 1261-1276.
(Oleananes derived from angiosperm plants. Abundance of oleananes in terrigenous oils and sediments may be sensitive to changes in early diagenetic conditions and need to be used with caution as age and source markers in fluvio-deltaic and lacustrine petroleum systems. Oleananes absent from base of Eocene coal seam affected by postdepositional seawater intrusion. In deltaic sediments from S Sumatra Basin, oleanane/hopane is strongly correlated with indicators of marine influence. Angiosperm-derived Miocene coal from Philippines, deposited under freshwater conditions, abundant aromatic oleanoids but no oleananes)

Murray, A.P., I.B. Sosrowidjojo, R. Alexander & R.E. Summons (1997)- Locating effective source rocks in deltaic petroleum systems; making better use of land-plant biomarkers. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum Systems of SE Asia and Australasia, Jakarta 1997, Indon. Petroleum Assoc. (IPA), p. 939-945.
(Distribution of oleananes and bicadinanes, land plant biomarkers in many SE Asian oils, can be used to better define maturity and depositional environment of effective source rocks)

Murray, A.P., R.E. Summons, C.J. Boreham & L.M. Dowling (1994)- Biomarker and n-alkane isotope profiles for Tertiary oils: relationship to depositional setting. Organic Geochem. 22, p. 521-542.
(Biomarker and n-alkane isotope profiles for Late Cretaceous/Tertiary oils from SE Asia, China, PNG, etc., interpreted with respect to six kinds of source rock depositional settings: fluvio-deltaic (S Sumatra, NW Java, NE Kalimantan, etc.), freshwater transitional, lacustrine (C Sumatra), saline lacustrine, marine deltaic and marine carbonate. Oleanane/hopane ratio may overestimate higher plant contribution to marine oils)

Murtrijito, N.A., F.M. Naibaho & W. Ashuri. (2014)- Shale gas: geological perspective of Baong Formation for future chances of North Sumatra Basin; compared to Fort Worth Basin in USA. Majalah Geologi Indonesia 28, 1, p. 41-49.
(online at: www.bgl.esdm.go.id/publication/index.php/dir/article_detail/719)
(Interbedded black shale and limestone of M Miocene Baong Fm in N Sumatra Basin similarities with Barnett Shale of Fort Worth Basin, therefore Baong Fm may also become commercial gas resource)

Noble, R., D. Orange, J. Decker, P. Teas & P. Baillie (2009)- Oil and gas seeps in deep marine sea floor cores as indicators of active petroleum systems in Indonesia. Proc. 33rd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA09-G-044, p. 385-394.
(Results of geochem analysis of deep sea floor samples from ten 'Black Gold- TGS' areas in Indonesia, suggesting presence of mainly marine-origin Mesozoic and Tertiary source rocks)

Nytoft, H.P., G. Kildahl-Andersen & O.J. Samuel (2010)- Rearranged oleananes: structural identification and distribution in a worldwide set of Late Cretaceous/Tertiary oils. Organic Geochem. 41, p. 1104-1118.
(Angiosperm biomarkers include oleanane isomers 18a(H) and 18b(H) oleanane, also C30 angiosperm markers lupane and taraxastanes. Rearranged oleananes probably formed by dehydration and rearrangement of higher plant triterpenoids; present in all 25 oleanane-containing oils used. Include analyses from Kutei Basin and Lufa seep, PNG)

Nurachman, Z., Hartati, S. Anita, E.E. Anward, G. Novirani, B. Mangindaan et al. (2012)- Oil productivity of the tropical marine diatom *Thalassiosira* sp.. Bioresource Technology 108, p. 240-244.
(Successful laboratory experiment in generating biofuel from cultures of marine diatoms)

Okui, A. (2005)- Characteristics of non-marine dual petroleum systems in Southeast Asia. In: Oil and gas from the Cenozoic non-marine source rocks in East Asia; a point of contact between petroleum system and Earth system, Sekiyu Gijutsu Kyokaishi (J. Japanese Assoc. Petroleum Technologists), Tokyo, 70, 1, p. 91-100.
(Miocene coal formerly thought to be main source rock in basins in and around Indochina Peninsula in SE Asia. However, new investigations reveal important role of Oligocene lacustrine source rocks)

Orange, D.L., P.A. Teas, J. Decker, P. Baillie & T. Johnstone (2009)- Using SeaSeep surveys to identify and sample natural hydrocarbon seeps in offshore frontier basins. Proc. 33rd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA09-G-090, p. 363-383.
(Black Gold-TGS methodology of deep water hydrocarbon seeps detection from multibeam bathymetry and backscatter surveys)

Permana, A.K. (2017)- Aplikasi petrologi organik dalam analisis cekungan dan eksplorasi hidrokarbon pada beberapa cekungan di Indonesia dan Australia. J. Geologi Sumberdaya Mineral 18, 3, p. 117-135.
(online at: http://jgsm.geologi.esdm.go.id/index.php/JGSM/article/view/235/289)

('Application of organic petrology in basin analysis and hydrocarbon exploration in several basins in Indonesia and Australia'. Brief review of organic petrology in Miocene of S Sumatra, Triassic of W Timor and Permian-Triassic of Bowen Basin, NE Australia)

Peters, K.E., T.H. Fraser, W. Amris, B. Rustanto & E. Hermanto (1999)- Geochemistry of crude oils from Eastern Indonesia. American Assoc. Petrol. Geol. (AAPG) Bull. 83, 12, p. 1927-1942.
(Oils from Irian Jaya and Sulawesi from Tertiary marine source. Seram oils from Triassic-Jurassic marine carbonate source. Timor seep oil Triassic-Jurassic clastics. Irian Jaya Wiriagar field oil from Jurassic, gas from Permo-Carboniferous)

Peters, K.E., C.C. Walters & J.M. Moldowan (2005)- The biomarker guide: Vol. 2, Biomarkers and isotopes in petroleum systems and Earth history, 2nd Ed., Cambrige University Press, p. 1-1150.
(Geochemistry text book, with sections on petroleum source rocks of Mahakam Delta, etc.)

Petersen, H.I., C. Andersen, P.H. Anh, J.A. Bojesen-Koefoed, L.H. Nielsen et al. (2001)- Petroleum potential of Oligocene lacustrine mudstones and coals at Dong Ho, Vietnam- an outcrop analogue to terrestrial source rocks in the greater Song Hong Basin. J. Asian Earth Sci. 19, p. 135-154.

Petersen, H.I., M.B.W. Fyhn, L.H. Nielsen, H.A. Tuan, C.D. Quang, N.T. Tuyen, P.V. Thang, N.T. Tham, N.K. Oang & I. Abatzis (2014)- World-class Paleogene oil-prone source rocks from a cored lacustrine synrift succession, Bach Long Vi Island, Song Hong Basin, offshore northern Vietnam. J. Petroleum Geol. 37, 4, p. 373-389.
(Oil-prone source rocks in lacustrine syn-rift successions of inverted Bach Long Vi Graben exposed on Bach Long Vi island. Cored 500m dominated by lacustrine mudstones interbedded with gravity flow deposits. Mudstones thermally immature, eith sapropelic Type I and mixed Types I- III kerogen. Average TOC 2.88%, Hydrogen Index 566 mg HC/g TOC. Net-source rock thickness of ENRECA-3 well ~233 m)

Petersen, H.I., H.P. Nytoft, M.B.W. Fyhn, N.T. Dau, H.T. Huong, J.A. Bojesen-Koefoed & L.H. Nielsen (2012)- Oil and condensate types in Cenozoic basins Offshore Vietnam: composition and derivation. Proc. Int. Petrol. Techn. Conf. (IPTC), Bangkok 2012, 1, IPTC 14383, p. 612-621.
(Vietnamese shelf several petroleum-producing Cenozoic rift basins, including Song Hong, Cuu Long, Nam Con Son and Malay-Cho Thu basins. Cuu Long Basin is main oil-producing basin, with paraffinic oils from lacustrine source. Lacustrine oils also known from N margin of Song Hong Basin. Oil with coaly biomarker signature in the Nam Con Son Basin; also condensates from Song Hong Basin contain high proportions of higher land plant biomarkers. Oils from N margin of Malay Basin suggestive of coaly source)

Petersen, H.I., H.P. Nytoft & L.H. Nielsen (2004)- Characterisation of oil and potential source rocks in the northeastern Song Hong Basin, Vietnam: indications of a lacustrine-coal sourced petroleum system. Organic Geochem. 35, p. 493-515.
(Oil in B10-STB-1x well in NE Song Hong Basin, Vietnam, has typical lacustrine-coaly geochemical features. Presence of lacustrine source rocks in basin indicated by high-amplitude seismic reflectors in undrilled half-grabens and outcrops of Oligocene immature mudstones and humic coals at Dong Ho (Type I kerogen, TOC 8-17%, HI >500) and on Bach Long Vi Island (TOC 2-7%, HI 200-700))

Petersen, H.I., Vu Tru, L.H. Nielsen, Nguyen A. Duc & H.P. Nytoft (2005)- Source rock properties of lacustrine mudstones and coals (Oligocene Dong Ho Formation), onshore Song Hong Basin (northern Vietnam). J. Petroleum Geol. 28, p. 19-38.
(Oligocene lacustrine mudstones and coals outcropping at N margin of mainly offshore Song Hong Basin include oil-prone potential source rocks. Organic material in mudstones mainly amorphous (Type I), up to 19.6.% TOC and Hydrogen Index values 436-572 mg HC/g TOC. Only 0.5 wt.% TOC required to saturate source rock to expulsion threshold. Coals and coaly mudstones dominated by huminite (Type III kerogen) and contain terrestrial-derived liptodetrinite. Coals generate at or before maturity of vitrinite 0.97%Ro)

Philp, R.P. & T.D. Gilbert (1986)- Biomarker distributions in Australian oils predominantly derived from terrigenous source material. Organic Geochem. 10, p. 73-84.

Pillon, P., L. Jocteur-Monrozier, C. Gonzalez & A. Saliot (1986)- Organic geochemistry of Recent equatorial deltaic sediments. Organic Geochem. 10, p. 711-716.
(Study of organic matter of recent deltaic sediments cored in Misedor core hole, Mahakam delta, E Kalimantan)

Prabowo, B. & G.B. Sulistyo (1999)- Organic geochemical study for hydrocarbon generation identification. Proc. 28th Ann. Conv. Indon. Assoc. Geol. (IAGI), Jakarta, 2, p. 79-98.
(Geochemistry of 22 oils from C Sumatra basin. Two groups, both sourced from lacustrine facies in Pematang Fm: (1) Minas, Oki and Libo fields (with botryococcane, heavy C-isotopes, etc.); (2) Kotabatak area, Kotagaro, Nusa, NW Minas (Telisa Fm) (no botryococcane, light C-isotopes, etc.))

Pramana, A.A., S. Rachmat, D. Abdassah & M. Abdullah (2012)- A study of asphaltene content of Indonesian heavy oil. Modern Applied Science 6, 5, p.
(online at: http://ccsenet.org/journal/index.php/mas/article/view/15690/11133)

Robertson/ Horizon (1998)- Timor Sea: Mesozoic source rock distribution and palaeoenvironments. Multi-client study, 65p. *(Unpublished)*

Robertson Utama (2000)- Eastern Indonesia and northern Papuan New Guinea- a review of Tertiary oil occurrences. Mult-client study, p. 1-9 + figs., tables *(Unpublished)*
(Geochemical study of Tertiary-sourced oils and oil stains from Salawati Basin, Bintuni Basin, E Sulawesi Basin and oil seeps from PNG N New Guinea Basin. Presence of angiosperm-derived biomarkers (oleanane) used to distinguish Tertiary-sourced oils, but oil stains lacking oleanane from S Salawati Basin included, due to similarity to main group of Salawati oils. All oils similar and derived from mixture of marine-derived organic matter and terrigenous debris, deposited in marine facies, and deeper marine time-equivalents of carbonate reservoir horizons or slightly younger, more open marine horizons)

Robertson Research (Singapore) Pte Ltd. (1983)- Petroleum geochemistry of Indonesian basins. Unpublished multi-client study, 5 vols.

Robinson, K.M. (1987)- An overview of source rocks and oils in Indonesia. Proc. 16th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 97-122.
(Indonesia source rocks lacustrine, fluvio-deltaic and marine. Lacustrine source most productive (most oil in C Sumatra, some Sunda Basin, possibly oil in W Natuna). Fluvial-deltaic source rocks sourced oil in majority of foreland/back-arc basins of W Indonesia. Marine source rocks in E Indonesia (Salawati, E Sulawesi). Pre-Tertiary (Permian/Jurassic) oil source in Bintuni and Bula (Seram) and possible source in E Sulawesi and Banggai-Sula. Lacustrine oils low-medium gravity, waxy, low sulfur and often high C30 4-methyl steranes. Marine oils low-medium gravity, low wax, medium-high sulfur oils and high C27-C29 diasteranes and steranes. Fluvio-deltaic oils from higher plants medium-high gravity, waxy, low sulfur and abundant C30 alkanes)

Saller, A., R. Lin & J. Dunham (2006)- Leaves in turbidite sands; the main source of oil and gas in the deep-water Kutei Basin, Indonesia. American Assoc. Petrol. Geol. (AAPG) Bull. 90, 10, p. 1585-1608.
(Gas-oil- condensate in Upper Miocene in deep-water Kutei Basin, off E Kalimantan, derivated from land-plant source material. Best source rocks are deep-water sandstones with coaly fragments, pieces of wood, resinite, and other coaly debris. Laminar coaly fragments are dominant, and were leaf fragments, carried into deep water by turbidity currents during lowstands of sea level. Kutei Basin deep-water shales contain mainly silt-size vitrinite grains with poor generative qualities. Liquids from leaves high wax contents)

Saptorahardjo, A. (1985)- Diagenese precoce de la matiere organique dans la serie sedimentaire du delta de la Mahakam, Indonesie: aspects moleculaires. Doct. Thesis Universite Louis Pasteur, Strasbourg, p. 1-181. *(Unpublished)*

('Early diagenesis of organic matter in the sedimentary series of the Mahakam Delta: molecular aspects')

Saptorahardjo, A., J.M. Trendel & P. Albrecht (1987)- Diagenese precoce de la matiere organique dans la serie sedimentaire du delta de la Mahakam, Indonesie: aspects moleculaires. In: A. Combaz (ed.) Geochimie organique des sediments plio-quaternaires du delta de la Mahakam (Indonesie)- le sondage Misedor, Editions TECHNIP, Paris, p. 307-316.
('Early diagenesis of organic matter in the sedimentary series of the Mahakam Delta, Indonesia: molecular aspects'. Analysis of lipids of shales and coals from Misedor cored well (0-617m), to study molecular transformations of organic matter during early stages of diagenesis)

Satyana, A.H. (2005)- Possible an-organic petroleum formation in collision zones of eastern Indonesia: abiogeneic genesis of petroleum by "Fischer-Tropsch" synthesis. Proc. Joint 34th Ann. Conv. Indon. Assoc. Geol. (IAGI), 30th Indon. Assoc. Geoph. (HAGI), Surabaya, Poster JCS2005-G059, p. 886-898.
(Possibility of abiogenic petroleum formation from CO2 and H2 by FT synthesis is reviewed for collision zones of E Sulawesi-Banggai, Buton-Tukang Besi, Timor-Seram-Buru, Halmahera, and Papua. Stratigraphy and tectonics of these collision zones fulfill requirements for organic petroleum formation by FT synthesis. Gas discovered recently in E Sulawesi- Banggai collision may represent such hydrocarbon)

Satyana, A.H. (2010)- Regional petroleum geochemistry of Mesozoic and Paleozoic systems of Indonesian Basins. Int. Symp. Mesozoic- Paleozoic petroleum basins in Indonesia, Indon. Assoc. Geol. (IAGI), Bandung 2010, 9p.
(Mesozoic and Late Paleozoic source rocks identified in Indonesian basins, primarily in basins with Australian crustal affinity; accordingly they are all located in E Indonesia)

Satyana, A.H. (2010)- Proven and potential Mesozoic and Paleozoic exploration play types of Indonesia. Int. Symp. Mesozoic- Paleozoic petroleum basins in Indonesia, Indon. Assoc. Geol. (IAGI), Bandung 2010, 4p.
(Brief review of pre-Tertiary play types in Indonesia)

Satyana, A.H. (2016)- The power of oil biomarkers for regional tectonic studies: how the molecular fossils imply exploration ventures- cases from Indonesia. Proc. 40th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA16-582-G, 28p.
(Three case studies of use of biomarkers in identifying source rock depositional environments: (1) Paleogene rift basins of Sumatra, with different biomarkers for early rift lacustrine facies, late rift fluviodeltaic and marine facies; (2) Eocene of Makassar Straits and W Sulawesi (with Eocene waxy lacustrine oil in Kaluku 1), and(3) Salawati Basin, with Tertiary anoxic marine, possibly lagoonal source rocks)

Satyana, A.H. (2017)- Regional petroleum geochemistry of Indonesian basins: updated, and implications for future exploration. Proc. 41st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA17-555-G, 32p.
(Comprehensive review of petroleum geochemistry of Indonesian basins. Oils of W Indonesian basins three broad families: (1) lacustrine (C Sumatra, Sunda-Asri, partly W Natuna, and W Sulawesi offshore/N Makassar Straits);(2) fluvio-deltaic (S Sumatra, W Java, E Java, Barito, Kutai, Tarakan), and (3) marginal-shallow marine (N Sumatra. W Sulawesi onshore). Most oils from E Indonesia basins marginal-shallow marine; sourced from Neogene (Salawati, Banggai), Jurassic (Bintuni), Triassic-Jurassic (Timor, Buton, Seram, Timor). Both thermogenic and biogenic gases)

Satyana, A.H. (2017)- Future petroleum play types of Indonesia: regional overview. Proc. 41st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA17-554-G, 33p.
(Review of 8 future hydrocarbon play types (proven and unproven) in Indonesia: (1) Paleogene synrift and pre-Tertiary Basement (Sumatra-Java-Natuna-Barito); (2) Neogene delta and deepwater of E Kalimantan-Makassar Straits, (3) Paleogene synrift and postrift of W Sulawesi offshore-Bone-Gorontalo; (4) Gondwanan Mesozoic sections of Sumatra-Java-Makassar Straits; (5) Paleogene-Neogene sub- and intra-volcanic of Java-W Sulawesi, (6) collided Mesozoic Australian passive margin sediments (Gorontalo-Buton-Banggai-Sula-Outer Banda Arc-Lengguru-Central Ranges of Papua); (7) Paleozoic of Arafura Sea- S Papua; (8) Neogene Pacific province of North Papua)

Satyana, A.H., L.P. Marpaung, M.E.M. Purwaningsih & M.K. Utama (2007)- Regional gas geochemistry of Indonesia: genetic characterization and habitat of natural gases. Proc. 31st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA07-G-050, 31p.
(Geochemistry of natural gases in Indonesian basins, using 350 gas occurrences. Both thermogenic and biogenic (bacterial) gas types recognized. Thermogenic gases generally <95% methane and heavier C isotope ratios (>-45‰). Biogenic gases >98% methane and lighter C isotope ratios (< -60‰). Thermogenic gases dominate in Indonesia. Biogenic gases mainly in W Sumatra fore-arc basins, E Java Basin and foredeep of Sorong Fault Zone, NW Papua. High CO2 mainly inorganic origin (thermal destruction of carbonates or volcanic degassing). H2S in some gas fields due to thermo-chemical sulfate reduction of deep, hot carbonates)

Satyana, A.H. & M.E.M. Purwaningsih (2013)- Variability of Paleogene source facies of circum- and drifted Sundaland Basins, Western Indonesia: constraints from oil biomarkers and Carbon-13 isotopes. AAPG Int. Conv. Exhib., Singapore 2012, Search and Discovery Art. 10474, p. 1-36. *(Abstract + Presentation)*
(online at: www.searchanddiscovery.com/documents/2013/10474satyana/ndx_satyana.pdf)
(Tertiary basins around Sundaland of W Indonesia and its drifted parts (S Makassar Strait, W & S Sulawesi, and Bone Basins) initially formed in Mid- Late Eocene. Thick Paleogene sediments in rift and early post-rift phases of basins contain important hydrocarbon source rocks. Biomarkers and carbon isotopes of oils allow identification of Paleogene lacustrine, fluvio-deltaic and marine source facies)

Satyana, A.H. & M.E.M. Purwaningsih (2013)- Variability of Paleogene source facies of Circum-Sundaland basins, Western Indonesia: tectonic, sedimentary and geochemical constraints- implications for oil characteristic. Proc. 37th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA13-G-162, p. 1-23.
(Similar to paper above. Paleogene source rocks in Sundaland basins include lacustrine facies (most significant; C Sumatra, Sunda-Asri, S Sumatra, W Natuna) to carbonaceous shales and coals of fluvio-deltaic and paralic facies (S Sumatra, W Java, E Java, Barito, W Sulawesi) and marine facies (N Sumatra))

Schiefelbein, C.F., J.E. Zumberge & S.W. Brown (1997)- Petroleum systems in the Far East. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum systems of SE Asia and Australasia, Jakarta 1997, Indon. Petroleum Assoc. (IPA), p. 101-113.
(~350 crude oils analyses used to identify different petroleum systems in Far East. Oils separated into three groups: terrigenous, lacustrine, and marine. More specific geochemical criteria allowed establishment of sub-groups of oils according to specific source environment)

Schiefelbein, C. & N. Cameron (1997)- Sumatra/Java oil families. In: A.J. Fraser, S.J. Matthews & R.W. Murphy (eds.) Petroleum Geology of Southeast Asia. Geol. Soc., London, Spec. Publ. 126, p. 143-146.
(122 oils analyzed. Majority of oils either 'lacustrine' or 'terrigenous' Tertiary source. Two oils from N Sumatra marine signature. Several oils from C and S Sumatra mixed characteristics)

Schumacher, D. & L. Clavareau (2015)- Geochemical exploration strategies for Southeast Asia. Asia Petrol. Geoscience Conf. Exhib. (APGCE), Kuala Lumpur, 25954, 2015, 5p. *(Extended Abstract)*
(Brief review of hydrocarbon microseepage surveys. Microseepage predominantly vertical, so surface anomalies may approximate size and shape of hydrocarbon accumulation. Little detail)

Sosrowidjojo, I.B. (2006)- On going Coalbed Methane (CBM) development in the South Sumatera Basin. Lemigas Scientific Contr. 23, 3, p. 15-29.

Sosrowidjojo, I.B., A.P. Murray, R. Alexander, R.I. Kagi & R.E. Summons (1996)- Bicadinanes and related compounds as maturity indicators for oils and sediments. Organic Geochem. 24, p. 43-55.
(Maturity of oils and sediments derived from catagenetic products of plant material. Polycadinene indices tested for Tertiary oils from S Sumatra, PNG, New Zealand and Australia. Bicadinane maturity indicator continues to change into oil window and may be useful in ranking relative maturity of oils)

Stout, S.A. (1995)- Resin-derived hydrocarbons in fresh and fossil dammar resins and Miocene rocks and oils in the Mahakam Delta, Indonesia. In: K.B. Anderson & J.C. Crelling (eds.) Amber, resinite, and fossil resins, Chapter 3, American Chemical Soc., Washington, Symposium Series 617, p. 43-75.
(Hydrocarbons derived from fresh dammar resin are compared to those in Miocene fossil resins and Miocene-sourced oils in Mahakam Delta. Dammar resins undergo few chemical changes during early diagenesis. Bicadinanes are absent in immature resins, but form upon heating in lab or subsurface)

Subono, S. (1996)- Hydrocarbon generation and multiprocess thermal model in oil basins of Indonesia. In: S.Y. Kim et al. (eds.) Proc. 32nd Ann. Sess.Coord. Comm. Coastal Offshore Geosc. Progr. E and SE Asia (CCOP), Tsukuba 1995, p. 53-68.

Subroto, E.A. (1990)- 30-NOR-17 [alpha] (H) - hopanes and their applications in petroleum geochemistry. Ph.D. Thesis Curtin University, Perth, p. 1-186.
(online at: http://espace.library.curtin.edu.au)
(22 oils and sediments analysed for biological marker compounds. Compounds typical of carbonate-rich source rocks identified. Sediments and oils from N Sumatra Basin contain very different biomarkers)

Subroto, E.A. (1990)- 30-Norhopane, biomarker baru penunjuk lingkungan karbonat: suatu studi geokimia petroleum terhadap sampel batuan dan minyak mentah. Proc. 19th Ann. Conv. Indon. Assoc. Geol. (IAGI), Bandung, 1, p. 230-241.
('30-Norhopane, a new biomarker as carbonate environment indicator: a study of petroleum geochemistry of rock and crude samples'. Study of rocks and oil samples from Seram and other countries identify C30 biomarker as typical of carbonate hydrocarbon source rocks)

Subroto, E.A., B.Y. Afriatno & P. Sumintadireja (2007)- Prediction of the biogenic gas occurrences in Indonesia based on studies in East Java and Tomori (Central Sulawesi). Jurnal Teknologi Mineral 14, 2, p. 115-124.
(online at: www.fttm.itb.ac.id/galeri/prediction.pdf)
(Some Indonesian gas fields with biogenic gas, characterized by dryness (>99% methane) and light carbon-isotopes (-61 to -67‰). One field producing biogenic gas in E Java Basin, probably derived from Plio-Pleistocene. Similar situation in Tomori, Sulawesi. Plio-Pleistocene sediments in Indonesia generally high sedimentation rates, low thermal gradients and high organic content, thus potential source for biogenic gas)

Subroto, E.A., R. Alexander & R.I. Kagi (1991)- 30-Norhopanes: their occurrence in sediments and crude oils. Chemical Geology 93, 179-192.
(Ratios of hopanes types geochemical biomarker in oils and sediments reflect sample maturity, with higher norhopanes in more mature samples. Incl. examples from Triassic oils from Seram and Buton asphalt)

Subroto, E.A., R. Alexander, U. Pranjoto & R.I. Kagi (1992)- The use of 30-Norhopane series, a novel carbonate biomarker, in source rock to crude oil correlation in the North Sumatra Basin, Indonesia. Proc. 21st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 145-163.
(30-norhopanes as carbonate biomarker proposed recently. Three types of source rocks in N Sumatra Basin: shale, carbonaceous shale and calcareous shale. n-Alkanes and steranes can only be used to distinguish two source types since shale and calcareous shale show similar characteristics. Recognition of three source types can only be observed using the hopane distribution. One crude oil can be correlated to calcareous shale and two crude oils are correlative to shale source rock. Crude oil of coaly shale type is not found during this study)

Subroto, E.A., A. Bachtiar, B. Priadi, R.P. Koesoemadinata & D. Noeradi (1998)- Could oleanoids, substances found abundantly in coaly sediments, be used as geochemical maturity indicator? A case study in the Kutai Basin. Proc. 27th Ann. Conv. Indon. Assoc. Geol. (IAGI), Yogyakarta, 1, p. 129-139.
(oleanoid ratio OR1 correlates with vitrinite reflectance, and may be maturity indicator)

Subroto, E.A., D. Noeradi & B.Y. Afriatno (2009)- Geochemical identification of favorable basins for biogenic gas exploration in Indonesia. Proc. 33rd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA09-G-185, p. 405-415.
(Biogenic gas formed at T <75°C is dry (>95% methane) and isotopically light (<-55‰). May contribute >20% of global gas resources. Biogenic gas large component of gas produced from E Java. Other favorable sites for biogenic gas are basins with young sediments (Plio-Pleistocene), high sedimentation rates (>50 m/My) and low Temp (0-75°C))

Sudarmono, T. Suherman & B. Eza (1997)- Paleogene basin development in Sundaland and its role to the petroleum systems in Western Indonesia. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum Systems of SE Asia and Australasia, Jakarta, Indon. Petroleum Assoc. (IPA), p. 545-560.
(ARCO paper with Eo- Oligocene paleogeography maps based on Daly (1987) reconstructions. Syn-rift continental deposits followed by late rift marine incursion and fully marine facies during post-rift. Paleogene basins commonly complete petroleum systems with source, reservoirs and seals. Maturity only after Neogene deposition. Lacustrine source rocks during rifting; marine carbonaceous shales and coals during late rift to post-rift. Productive reservoirs mostly upper syn-rift or post-rift. E Java- E Kalimantan- W Sulawesi rifts older (Late Paleocene- E Eocene) than Sumatra- W Java- W Kalimantan systems (Late Eocene- E Oligocene)

Sujanto, F.X. (1997)- Substantial contribution of petroleum systems to increase exploration success in Indonesia. In: J.V.C. Howes & R.A. Noble (eds.) Proc. Int. Conf. Petroleum Systems of SE Asia and Australasia, Jakarta, Indon. Petroleum Assoc. (IPA), p. 1-14.
(Overview of Indonesia basins and petroleum systems)

Summons, R.E., M. Bradshaw, J. Crowley, D.S. Edwards, S. George & J.E. Zumberge (1998)- Vagrant oils; geochemical signposts to unrecognised petroleum systems. In: P.G. & R.R. Purcell (eds.) The sedimentary basins of Western Australia 2., Proc. Petroleum Expl. Soc. Australia (PESA) Symp. 2, p. 169-184.
(Study of biodegraded oils and stains from wells in Arafura, Bonaparte and Carnarvon basins. Biodegraded Arafura 1 oil shares many characteristics with E Paleozoic oils of Canning Basin)

Sunarjanto, D. & S. Widjaja (2013)- Potential development of hydrocarbon in Basement reservoirs in Indonesia. J. Geologi Indonesia 8, 3, p. 151-161.
(online at: http://ijog.bgl.esdm.go.id/index.php/IJOG/article/view/165/165)
(Review of hydrocarbon occurrences in Pretertiary 'basement' in Sumatra (granitoids and metamorphics in NE Beruk, Suban, Sei Teras), Kalimantan (Tanjung granitoid, volcanics, metamorphics) and Seram (Oseil Mesozoic limestone))

Suwarna, N., H. Panggabean, M.H. Hermiyanto & A.K. Permana (2007)- Characterization of unconventional fossil fuels of selected areas, in Sumatera and Kalimantan, using organic petrography and geochemistry. Proc. 31st Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA07-G-079, 15p.
(Oil shale and coalbed methane studies in Sumatra and Borneo)

Sykes, R. & I. Cibaj (2010)- Peat biomass and early diagenetic controls on oil generation from Mahakam Delta Coals, Kutei Basin: preliminary study of coals from the Jalan Baru section near Samarinda. Proc. 34th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA10-G-105, 17p.
(Geochem study of 11 outcrop coal samples from M Miocene Balikpapan Group near Samarinda. Analysed coals have potential to expel oils ranging from borderline gas condensate to high-wax, paraffinic- naphthenic-aromatic oil. Non-volatile, paraffinic oil potential of Mahakam Delta coals controlled primarily by abundance of leaf- and cork-derived macerals. These macerals expected to be more abundant in thin, planar mire coals and coaly mudstones than in thicker, raised mire coals owing to better preservation potential of surface leaf biomass under higher groundwater levels in planar mires)

Tahir, N.T., H.M. Abd. Rahim, Tay Joo Hui, Tan Hock Seng, M.F. Fadzil & M.R. Abas (2009)- Distribution and sources of hydrocarbons in lagoon sediments of Setiu Wetland, Terengganu, Malaysia. Aquatic Ecosystem Health and Management 12, 4, p. 344-349.

(Hydrocarbon compounds in surface sediment of Setiu Wetland analysed and characterized using GCMS. Terrestrial plants input (epicuticular plant waxes) are dominant contributor of organic compounds in the sediments with a minor input from marine phytoplankton (algae) as well as bacteria)

Teerman, S.C. & R.J. Hwang (1989)- Evaluation of the source rock potential of Sumatran coals by artificial maturation of coal. Proc. 18th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 469-489.
(Hydrous pyrolysis experiments on Miocene Muara Enim Fm lignite from Bukit Asam, S Sumatra. Lignite is liptinite-rich (32% of total macerals); resinite is the most abundant liptinite maceral (13.7%). Rock Eva1 Hydrogen Index values of 483 mg HC/g OC. Significant amounts of liquid hydrocarbons assimilated by vitrinitic matrix of coal prior to expulsion, making vitrinite-rich coals poor oil source rocks. Only liptinite-rich coals (>15-20% of total macerals) appear capable of generating significant amounts of liquid hydrocarbons but expelled product will probably be low. Most Sumatran coals not liptinite-rich (typically 5-10%))

Teerman, S.C., R.J. Hwang, Y.C. Tang, B. Mertani, M. Stauffer & T.T. Ta (1994)- Geochemical evaluation of the liquid hydrocarbon potential of "marginal source rocks"- application to Indonesian basins. Proc. 23rd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 457-478.
(Expulsion efficiency is critical factor in potential of marginal source rocks to provide adequate hydrocarbon charge. Expulsion efficiency in marginal source rocks highly variable due to amount of hydrocarbon generation and adsorptive capacity of certain organic matter assemblages. Numerous examples of marginal source rocks in Indonesian region. With case study of Telisa Fm in Sumatra.)

Ten Haven, H.L. & C. Schiefelbein (1995)- The petroleum systems of Indonesia. Proc. 24th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 443-459.
(>200 oil analyses. W Indonesia 2 main petroleum systems: Tertiary lacustrine and Tertiary terrigenous, with additional marine petroleum system in N Sumatra and E Natuna. E Indonesia 3 main systems: Tertiary marine carbonate, Mesozoic marine carbonate and Mesozoic marine siliciclastic)

Thompson, M., C. Remington, J. Purnomo & D. MacGregor (1991)- Detection of liquid hydrocarbon seepage in Indonesian offshore frontier basins using Airborne Laser Fluorosensor (ALF); the results of a Pertamina/ BP joint study. Proc. 20th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, p. 663-689.
(ALF surveys over Sumatra Forearc, Java Forearc, Billiton Basin, Salayar, Spermonde, S and N Makassar, Bone, Gorontalo and Halmahera Basins. Hydrocarbons seeping from all basins except Java forearcs, though further analysis is required. Areas of greatest interest are Billiton, S Bone and S Makassar basins)

Thompson, S., B.S. Cooper & P.C. Barnard (1994)- Some examples and possible explanations for oil generation from coals and coaly sequences. In: A.C. Scott & A.J. Fleet (eds.) Coal and coal-bearing strata as oil-prone source rocks?, Geol. Soc. London, Spec. Publ. 77, p. 119-137.
(Coals and associated shales important oil source rocks in some deltaic environments. Formation of hydrogen-rich kerogen either by concentration of plant cuticles and spores after reworking of delta top freshwater peats, or by accumulation of delta margin peats under saline conditions. Examples include Oligo-Miocene Talang Akar Fm of S Sumatra-NW Java (perhydrous vitrinite source of isotopically light waxy oils with biomarkers from tree resins). Waxy oils also produced in Sunda Basin (derived from algal kerogen in older, lacustrine Banuwati Fm shales (low contents of land plant biomarkers and heavier carbon isotopic signature))

Thompson, S., R.J. Morley, P.C. Barnard & B.S. Cooper (1985)- Facies recognition of some Tertiary coals applied to prediction of oil source rock occurrence. Marine Petroleum Geol. 2, 4, p. 288-297.
(Coals are oil source rocks in many Tertiary basins of SE Asia. Precursors of these hydrogen-rich and oxygen-poor coals are coastal plain peats in everwet tropical climate. Distribution, petrography and chemistry of coaly Miocene source rocks present in Kutai Basin described)

Todd, S.P., M.E. Dunn & A.J.G. Barwise (1997)- Characterizing petroleum charge systems in the Tertiary of SE Asia. In: A.J. Fraser, S.J. Matthews & R.W. Murphy (eds.) Petroleum Geology of Southeast Asia, Geol. Soc., London, Spec. Publ. 126, p. 25-47.

(Most SE Asian Tertiary petroleum from paralic (higher land plant) source, although larger proportion of oil from lacustrine algal sources. Lacustrine sources mainly in Paleogene syn-rift lakes, paralic coals and coaly mudrocks in Miocene post-rift. Oil-prone source rocks preferentially paralic between lower coastal plain and lower estuary/delta front facies, perhaps involving mangrove system. Younger plays more gas prone. Significance of biogenic gas poorly understood. Vertical migration common; lateral migration restricted to ~20 km or less from kitchen)

Tran Cong Tao (1994)- Maturation of organic matter in Tertiary sediments of the Mekong Basin, offshore South Vietnam. In: J.L. Rau (ed.) Proc. 29th Sess. Comm. Co-ord. Joint Prospecting Mineral Resources in Asian Offshore Areas (CCOP), Hanoi 1992, Bangkok, 2, p. 169-181.

Van Aarssen, B.G.K., H.C. Cox, P. Hoogendoorn & J.W. De Leeuw (1990)- A cadinene biopolymer present in fossil and extant dammar resins as a source for cadinanes and bicadinanes in crude oils from Southeast Asia. Geochimica Cosmochimica Acta 54, p. 3021-3031.
(Chemical composition of fossil resin from Miocene outcrop in Lumapas, Brunei, compared to Recent counterpart dammar from trees of family Dipterocarpaceae, to establish nature of precursor of bicadinanes)

Van Aarssen, B.G.K., J.K.C. Hessels, O.A. Abbink & J.W. de Leeuw (1992)- The occurrence of polycyclic sesqui-, tri-, and oligoterpenoids derived from a resinous polymeric cadinene in crude oils from southeast Asia. Geochimica Cosmochimica Acta 56, 3, p. 1231-1246.
(Structurally related hydrocarbons consisting of one or more sesquiterpane units in saturated and aromatic hydrocarbon fractions of crude oils from SE Asia (Java, Sumatra, Malaysia). Thought to originate from cadinene polymer present in dammar resins from angiosperms like Dipterocarpaceae trees, which depolymerises on thermal stress)

Wahab, A. & Harun Nasir (1987)- Petroleum geochemistry of Western Indonesia Basins. Proc. 16th Ann. Conv. Indon. Assoc. Geol. (IAGI), p.

Williams, H.A., M. Fowler & R.T. Eubank (1992)- Geochemical characteristics of Paleogene and Cretaceous hydrocarbon source basins in Southeast Asia. In: 9th Offshore Southeast Asia Conf., Singapore 1992, Proc. SE Asia Petroleum Expl. Soc. (SEAPEX) 10, OSEA 92101, p. 35-66.
(Lacustrine rift systems sourced large portion of SE Asia hydrocarbons. Description of rift systems Bandar Jaya- S Sumatra, Kampar Kanan- C Sumatra, Petchabun-Thailand (all Paleogene- humid) and Dongting-China (Cretaceous-Paleogene; arid))

Williams, H.H., M. Fowler & R.T. Eubank (1995)- Characteristics of selected Palaeogene and Cretaceous lacustrine source basins of Southeast Asia. In: J.J. Lambiase (ed.) Hydrocarbon habitat in rift basins. Geol. Soc. London, Spec. Publ. 80, p. 241-282.
(Rift architecture, sequences and sedimentary geochemistry of four Paleogene and one Cretaceous/ Paleogene graben systems: Bandar Jaya Basin (S Sumatra), Kampar Kanan Basin (C Sumatra), Ombilin Basin (W Sumatra), Phetchabun Basin (N Thailand) and Dongting Basin (China). Geochemical characteristics of source rocks described in context of depositional systems)

Williams, H., E.N. Reyes & R.T. Eubank (1992)- Geochemistry of Palawan oils, Philippines: source implications. In: 9th Offshore Southeast Asia Conf. (OFFSEA 92), Singapore 1992, Proc. SE Asia Petroleum Expl. Soc. (SEAPEX) 10, OSEA 92103, p. 115-129.
(Palawan non-waxy oils traditionally interpreted as marine sourced. Oils from recent Calauit fields characteristics of non-marine algal source)

Williams, S.L. & H.H. Williams (1994)- Carbon isotopes in Southeast Asian lacustrine sourced oils and source rocks. In: 10th Offshore SE Asia Conf., Singapore 1994, p. 167-183.
(Review of carbon isotopes of 174 lacustrine sourced oils and 109 lacustrine source rocks suggest carbon isotopes can not be used to differentiate between marine and lacustrine environments)

XI.3. Coal

(Additional references on coal that are specific to one region are listed under these regions)

Adhi, R.N., A. Pujobroto, C.K.K. Gurusings, U. Kuntjara, D.N. Sunuhadi et al. (2004)- National resources and reserves of mineral, coal, and geothermal. Indonesian Direct. Gen. Geology and Mineral Resources, Special Publ. 103, p. 1-130.

Anderson, J.A.R. (1961)- The ecology and forest types of the peat swamp forests of Sarawak and Brunei in their relation to sylviculture. Ph.D. Thesis Edinburgh University, p. *(Unpublished)*

Anderson, J.A.R. (1964)- The structure and development of peat swamps of Sarawak and Brunei. J. Tropical Geography, Singapore, 18, p. 7-16.

Anderson, J.A.R. (1983)- The tropical peat swamps of western Malesia, In: A.J.P. Gore (ed.) Ecosystems of the World: mires, swamp, bog, fen and moor, 4B. Regional studies, Elsevier, New York, p. 181-199.

Andriesse, J.P. (1974)- The characteristics, agricultural potential and reclamation problems of tropical lowland peats in Southeast Asia. Communication Koninklijk Instituut voor de Tropen, Amsterdam, 63, 63p.

Atkinson, C.M. (1989)- Coal and oil shale in Tertiary intermontane basins of Indonesia and eastern Australia. In: T. Thanasuthipitak & P. Ounchanum (eds.) Proc. Int. Symp. Intermontane basins: geology and resources, Chiang Mai 1989, p. 77-88.

Bainton, C.S. (1978)- Coal formations in Indonesia. In: S. Wiryosujono & A. Sudradjat (eds.) Proc. Regional Conf. Geology and Mineral Resources of Southeast Asia (GEOSEA), Jakarta 1975, Indon. Assoc. Geol. (IAGI), p. 55-63.
(Organized coal mining in Indonesia started in 1849 at Pengaron, SE Kalimantan. Most important surface mine in Indonesia Bukit Asam in S Sumatra, opened in 1919. Coal deposition requires paralic- limnic environments with slow subsidence, mainly in backarc basins)

Belkin, H.E. & S.J. Tewalt (2007)- Geochemistry of selected coal samples from Sumatra, Kalimantan, Sulawesi, and Papua, Indonesia. U.S. Geol. Survey (USGS) Open-File Report 2007-1202, 34p.
(online at: http://pubs.usgs.gov/of/2007/1202/ofr2007-1202.pdf)
(Brief report on geochemical analysis of 8 coal samples from Sumatra (3; Eocene- Miocene), Kalimantan (3; Eocene-Miocene), W Papua (Timika, Permian) and S Sulawesi (1; Eocene)

Belkin, H.E., S.J. Tewalt, J.C. Hower, J.D. Stucker & J.M.K. O'Keefe (2008)- Geochemistry and petrology of selected coal samples from Sumatra, Kalimantan, Sulawesi, and Papua, Indonesia. Int. J. Coal. Geol. 77, 4, p. 260-268.
(Most of Indonesian coal Paleogene and Neogene age, low- moderate rank and low ash and sulfur. Tectonic and igneous activity resulted in significant rank increase in some basins. Eight coal samples described from Sumatra, Kalimantan, Sulawesi and Papua)

Biagioni, S., V. Krashevska, Y. Achnopha, A. Saad, S. Sabiham & H. Behling (2015)- 8000 years of vegetation dynamics and environmental changes of a unique inland peat ecosystem of the Jambi Province in central Sumatra, Indonesia. Palaeogeogr. Palaeoclim. Palaeoecology 440, p. 813-829.
(Study of 7.3m peat core a 733 cm-long core from Air Hitam peatland in Jambi Province. In last ~7800 years site covered by dipterocarp-swamp mixed rainforest during first 2000 years, after which freshwater swamp taxa more important, in particular Durio trees. At ~4500 years ago swamp vegetation shifted to pole forest with Pandanus thickets in response to change from minerotrophic to ombrotrophic conditions)

Bowe, M. & T.A. Moore (2015)- Coalbed methane potential and current realisation in Indonesia. In: AAPG Asia Pacific Region GTW, Opportunities and advancements in coal bed methane in the Asia Pacific, Brisbane, Search and Discovery Art. 90234, 5p. *(Extended Abstract)*

(Estimates for CBM potential ranged up to 450 TCF, but realisation of resource limited so far. Main CBM targets Miocene coal seams in S Sumatra and Kutai Basins. S Sumatra coal seams generally thicker (5-25 m) than Kutai Basin and laterally continuous over 10s of km. 54 PSCs since 2008. 84 CBM core and pilot wells drilled by 18 operators. Gas contents generally higher in Kutai Basin (2-10 m3/t) than in S Sumatra Basin (<3 m3/t). Gas saturations tend to be >80% at depths >300m. Gas dominated by biogenically-derived methane)

Boudou, J. (1983)- Chloroform extracts of a series of coals from the Mahakam Delta. Organic Geochem. 6, p. 431-437.
(Study of changes in organic matter during early thermal maturation in Mahakam delta Tertiary coals)

Boudou, J.P., B. Durand & J.L. Oudin (1984)- Diagenetic trends of a Tertiary low-rank coal series. Geochimica Cosmochimica Acta 48, 10, p. 2005-2010.
(Mahakam delta coals all stages between peat, lignites and bituminous coals. Mechanisms of early maturation are loss of oxygenated compounds, aromatisation and condensation of organic matter, similar to other coals)

Boudou, J., R. Pelet & R. Letolle (1984)- A model of diagenetic evolution of coaly sedimentary organic matter. Geochimica Cosmochimica Acta 48, 6, p. 1357-1362.
(Diagenetic evolution of coal from Mahakam delta. Carbon loss during diagenesis mainly as CO2, hydrogen loss mainly as H2O. Hydrocarbon production negligible, in accordance with absence of bacterial methane accumulations in Mahakam Delta. δ13C of coals becomes ~2 per mil more positive with diagenesis)

Brady, M.A. (1997)- Organic matter dynamics of coastal peat deposits in Sumatra. Ph.D. Thesis, University of British Columbia, Vancouver, p. 1-258.
(online at: https://open.library.ubc.ca/cIRcle/collections/ubctheses/831/items/1.0075286)
(Organic matter characteristics of Holocene surface peat layers in 3 raised ombrothrophic peat deposits on E coast of Sumatra. Thickness of peat 3-12m, age 4500/4000 yrs and younger)

Bruenig, E.F. (1990)- Oligotrophic forested wetlands in Borneo. In: A.E. Lugo et al. (eds.) Ecosystems of the World 15, Elsevier, p. 299-334.

Calvert, G.D., J.R. Durig. & J.S. Esterle (1991)- Controls on the chemical variability of peat types in a domed peat deposit, Baram River Area, Sarawak, Malaysia. Int. J. Coal Geology 17, p. 171 188.
(Chemical analyses of domed peat deposits of Baram River delta. Four end members distinguished, which can be traced to type of plants and degree of degradation. Pollen from center of deposit indicates succession from mangrove substrate followed by fresh water peat forest, then stunted vegetation)

Cameron, C.C., J.S. Esterle & C.A. Palmer (1989)- The geology, botany and chemistry of selected peat-forming environments from temperate and tropical latitudes. Int. J. Coal Geology 12, p. 105-156.
(Peat studied in several geologic settings, including coast of Sarawak and delta of Batang Hari River, Sumatra. Most deposits are domed bogs in which peat accumulation continued above surface of surrounding soil. Typical sequence of environments from pond stage, through grassy marsh, through forested swamp to heath dome stage, with associated changes in acidity and ash, volatile matter, carbon, hydrogen, nitrogen, sulfur and oxygen contents, as well as trace elements. Ombrotrophic peat deposits of tropical Sarawak and Sumatra thick and extensive, low-ash and low-sulfur, and high heating values)

Casdira, R. Budiana & E.R. Tantoro (2014)- Coal Bed Methane exploration in Sumatera. In: I. Basuki & A.Z. Dahlius (eds.) Sundaland Resources, Proc. Indon. Soc. Econ. Geol. (MGEI) Ann. Conv., Palembang, p. 461-466.
(Although gas resource probably huge, CBM is yet to be proved that it can be produced economically)

Chen, S.P. (1993)- Coal as an energy resource in Malaysia. In: Proc. Tectonic framework and energy resources of the western margin of the Pacific basin, Kuala Lumpur 1992, Bull. Geol. Soc. Malaysia 33, p. 399-410.
(online at: www.gsm.org.my/products/702001-100999-PDF.pdf)

(Review of coal resources in Malaysia: 98% in Sarawak and Sabah. All coal of Tertiary age and quality ranges from lignite to anthracite, with bituminous coal predominant. Largest known coal deposits in Merit Pila and Mukah- Balingian in Sarawak and in Meliau basin in south C Sabah.)

Cole, J.M. (1987)- Some fresh/brackish water depositional environments in the SE Asian Tertiary with emphasis on coal-bearing and lacustrine deposits and their source rock potential. Proc. 16th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 429-449.
(Review of terrestrial coal bearing sedimentary sequences where oil-prone organic material was deposited in SE Asian Tertiary. Autochthonous coal deposits more favourable oil sources than allochthonous coals. Lacustrine environments may be most prolific (Botryococcus-derived) oil source in SE Asia)

Cook, A.C. & B. Daulay (2000)- Comparative analysis of Indonesian coal fields. In: H. Darman & F.H. Sidi (eds.) Tectonics and sedimentation of Indonesia, FOSI-IAGI-ITB Regional Seminar to commemorate 50th anniversary of Van Bemmelen's Geology of Indonesia, Bandung 1999, p. 16-17. *(Abstract)*

Barret, R.A. (1999)- Plio-Pleistocene sedimentation and biogenic gas generation Waropen and Ramu Basins, NeuGuinea (Irian) Island, In: H. Darman & F.H. Sidi (eds.) Tectonics and sedimentation of Indonesia, FOSI-IAGI-ITB Regional Seminar to commemorate 50th anniversary of Van Bemmelen's Geology of Indonesia, Bandung 1999, p.

Cook, A.C. & B. Daulay (2000)- The Indonesian coal industry. The Australian Coal. Rev., April 2000, p. 4-15.
(online at: www.australiancoal.csiro.au/pdfs/cook_daulay.pdf)

Daulay, B. (1985)- Petrology of some Indonesian and Australian Tertiary coals. M.Sc. Thesis University of Wollongong, p. 1-265. *(Unpublished)*

Daulay, B. (1998)- Exsudatinite in Eastern Kalimantan coals. Indonesian Mining J. 4, 1-2, p.
(Five types of exsudatinite in E Kalimantan coals)

Daulay, B. (2005)- Petrography of raw coal and its UBC product. Indonesian Mining J. 8, 3, p.

Daulay, B. (2010)- Evaluation of Kalimantan coal quality in order to select the appropriate and effective utilizaton tecnologies. In: N.I. Basuki & S. Prihatmoko (eds.) Proc. Kalimantan coal and mineral resources, MGEI-IAGI Seminar, Balikpapan 2010, p. 49-59.
(Most Kalimantan coal mainly low rank with high moisture content. Most coal currently exploited medium-high rank)

Daulay, B. & A.C. Cook (1988)- The petrology of some Indonesian coals. J. Southeast Asian Earth Sci. 2, p. 45-64.
(Indonesian coals rich in vitrinite and variable contents of liptinite. Inertinite rare to sparse, with exception of a few (typically Neogene) coals. No major differences between Paleogene and Neogene coals. Most coals low in rank. Coals, and associated dispersed organic matter, important source rocks for some oil accumulations)

Daulay, B., N.S. Ningrum & A.C. Cook (2000)- Coalification of Indonesian coal. In: Proc. Southeast Coal Geology Conference, Directorate General of Geology and Mineral Res. Indonesia, Bandung, p. 85-92.

Daulay, B., B. Santoso & N.S. Ningrum (2015)- Evaluation of selected high rank coal in Kutai Basin, East Kalimantan, relating to its coking properties. Indonesian Mining J. 18, 1, p. 1-10.
(online at: http://jurnal.tekmira.esdm.go.id/index.php/imj/article/view/301/186)

De Groot, C. (1865)- Eene bijdrage tot de kennis van de Nederlandsch Indische steenkolen. Kramers, Rotterdam, 55p.
('A contribution to the knowledge of the Netherlands Indies coals'. Mainly on composition and quality of coal in 'Oranje Nassau' government-operated coal mine at Pengaron, Barito Basin, SE Kalimantan, which produced

coal since 1848. Five Eocene coal horizons, three of which deemed suitable for use on navy steam ships. Ash content 2.7-6.3%)

De Gruyter, P. (1940)- Een voorloopige classificatie der Indische steenkolen, gericht op hun technische toepassing. De Ingenieur in Nederlandsch-Indie (III) 7, 12, p.
('A provisional classification of the Indonesian coals, aimed at their technical application'. First part mainly of general coal classification properties)

De Gruyter, P. (1941)- Een voorloopige classificatie der Indische steenkolen, gericht op hun technische toepassing- vervolg. De Ingenieur in Nederlandsch-Indie (III) 8, 1, p. 1-14.
('A provisional classification of the Indonesian coals, aimed at their technical application- continued'. Second part mainly on properties of Bukit Asam coal. S Sumatra, also Ombilin, Borneo)

De Loos, D. (1899)- Gesteenten en mineralen van Nederlandsch Oost-Indie, 3: Steenkolen. Koloniaal Museum Haarlem, Erven Loosjes, p. 1-42.
('Rocks and minerals from Netherlands East Indies- 3: Coal'. Early, popular review of occurrences and quality of coal in Indonesia, mainly on Java, Sumatra and Kalimantan)

Dehmer, J. (1993)- Petrology and organic geochemistry of peat samples from a raised bog in Kalimantan (Borneo). Organic Geochem. 20, 3, p. 349-362.
(Peat cores, from margin and center of tropical raised bog from Sebangau River near Palangkaraya. Peats from margin of raised bog more decomposed than center and basal peats more decomposed than peats from upper layers. Basal peats deposited under mesotrophic conditions and more seasonal climate)

Dommain, R., J. Couwenberg & H. Joosten (2011)- Development and carbon sequestration of tropical peat domes in south-east Asia: links to post-glacial sea-level changes and Holocene climate variability. Quaternary Science Reviews 30, p. 999-1010.
(Three peat dome regions distinguished: inland C Kalimantan, Kutai basin and coastal areas across entire region. With the onset of Holocene first peat domes developed in C Kalimantan as response to rapid post-glacial sea-level rise over Sunda Shelf and intensification of Asian monsoon. Peat accumulation rates in C Kalimantan declined after 8500 BP with lower rate of sea-level rise. Kutai basin peat domes younger than ~8300 BP, driven by accretion rates of Mahakam River. Most coastal peat domes initiated between 7000-4000 BP as consequence of Holocene maximum in regional rainfall and stabilisation and regression of sea-level)

Dunlop, N. F. & R. B. Johns (1999)- Thermally induced chemical changes in the macromolecular structure of an Indonesian coal. Organic Geochem. 30, p. 1301-1309.

Esterle, J.S. (1990)- Trends in petrographic and chemical characteristics of tropical domed peats in Indonesia and Malaysia as analogues of coal formation. Ph.D. Thesis University of Kentucky, Lexington, p. 1-270. *(Unpublished)*

Esterle, J.S. (1999)- Can peats be used to discriminate local subsidence from regional tectonism? Examples from Sarawak, Malaysia and Sumatra, Indonesia. In: H. Darman & F.H. Sidi (eds.) Tectonics and sedimentation of Indonesia, FOSI-IAGI-ITB Regional Seminar to commemorate 50th anniversary of Van Bemmelen's Geology of Indonesia, Bandung 1999, p. 24-28.
(Holocene peats of E Sumatra and Sarawak started forming at ~6000 BP and are models for formation of coal measures. Two modes of peat accumulation, one where it keeps up with clastic sedimentation (rel. high preservation potential), and one where it outstrips clastic sedimentation (rel. poor preservation potential))

Esterle, J.S., G. Calvert, D. Durig et al. (1992)- Characterization and classification of tropical woody peats from Baram River, Sarawak and Jambi, Sumatra. In: B.Y. Aminuddin (ed.) Proc. Int. Symposium on Tropical Peatland, Kuching, MARDI, Kuala Lumpur, p. 33-48.

Esterle, J.S. & J.L. Ferm (1994)- Spatial variability in modern tropical peat deposits from Sarawak, Malaysia, and Sumatra, Indonesia. Int. J. Coal Geology 26, p. 1-41.
(Study of two Recent (<5,000 yrs) domed peat deposits at Baram River (Sarawak) and Jambi area (Sumatra), examined as modern analogues for coal. Both in microtidal alluvial-deltaic plain settings, similar vegetation. One deposit convex, mature dome, rising 10m above river level; the other is low-gradient dome, rising only x m above river level but with concave base up to 6m below. Both deposits eroded by adjacent rivers)

Fatimah (2008)- Potensi Batubara bawah permukaan di Indonesia. Proc. 37th Ann. Conv. Indon. Assoc. Geol. (IAGI), Bandung, 1, p. 501-512.
(Assessment of potential volumes of deep-seated coal in Sumatra and Kalimantan)

Flores, R.M. & Hadiyanto (2006)- Patterns of Sumatran domed peatlands; from alluvial to coastal settings. Geol. Soc. America (GSA), 2006 Ann. Mtg., Abstracts with Programs 38, 7, p. 233. *(Abstract only)*
(Sumatran rain-fed and domed (ombrogenous) mires used as models for thick coal deposits worldwide. Kumpeh and Dendang peatlands between anastomosing Batang Hari and Kumpeh Rivers domed topography despite meander channels and tributaries forming re-entrants into peatlands and flood-plain levee sediments. Resulting peat deposits small area (240-540 km2), discontinuous, lenticular, <9 m thick. Endapan domed to flat peatland from edge of Batang Hari and Kumpeh Rivers to coast, is blanket-like (4000 km2) peat deposit, >11m thick. Raised peatlands along rivers reflect buildup of flood sediments that sustained robust vegetation, which in turn, accumulated raised peat (<9 m) that reduced extent of flooding. Flat coastal peatlands (Endapan) reflect peat accumulation (>11m) from stunted vegetation removed from flood-sustaining nutrients)

Friederich, M., J. Esterle, T. Moore & C. Nas (2009)- Variations in the sedimentological characteristics of Tertiary coals in SE Asia; and climatic influences on Tertiary coals and modern peats. In: Variations in fluvial-deltaic and coastal reservoirs deposited in tropical environments, AAPG Hedberg Conf., Jakarta 2009, 6p. *(Extended abstract)*
(online at: www.searchanddiscovery.com/abstracts/pdf/2010/hedberg_indonesia/abstracts /ndx_friederich.pdf)
(Modern domed peat swamps in Sumatra and Sarawak may be used as analogues of Tertiary coals of Kalimantan)

Friederich, M.C., R.P. Langford & T.A. Moore (1999)- The geological setting of Indonesian coal deposits. In: G. Weber (ed.) Proc. PACRIM '99 Congress, Bali 1999, Australasian Inst. of Mining and Metallurgy Publ. 4/99, p. 625-631.
(Indonesia economic coal deposits mainly of Eocene and Miocene-Pliocene age and mainly in Kalimantan and Sumatra. Formed from peat deposits in equatorial paleoclimate. Some peats domed peats, which grew above normal water tables in climate of year-round rainfall, are low in ash and sulphur and locally thick (Miocene coals). Eocene coals typically thinner, with higher contents of ash and sulphur. Eocene coals formed mainly in extensional tectonic settings. Miocene-Pliocene coals in range of tectonic settings)

Friederich, M.C., G. Liu, R.P. Langford, C. Nas & B. Ratanasthien (2000)- Coal in Tertiary rift systems in Southeast Asia. In: Proc. Southeast Asia Coal Geology Conference, Bandung 2000, p. 33-43.

Friederich, M.C., T.A. Moore & R.M. Flores (2016)- A regional review and new insights into SE Asian Cenozoic coal-bearing sediments: why does Indonesia have such extensive coal deposits? Int. J. Coal Geology 166, p. 2-35.
(SE Asia Cenozoic coal-bearing basins grouped in five regions: N Sundaland, S Sundaland, Philippines, W Myanmar and E Indonesia; first three discussed here. Most significant coal deposits of SE Asia in Neogene of S Sundaland (Borneo, Sumatra), over extensive coastal plains in regressive setting. Coal deposits of N Sundaland (i.e. SE Asian continental) in small disconnected non-marine grabens, and are areally restricted. S Sundaland resided mainly within ± 10° of equator, with paleoclimate conducive to ever-wet conditions. N Sundaland resided >10°N of equator, probably monsoonal with annual dry periods. Etc.)

Friederich, M.C., T.A. Moore, M.S.W. Lin & R.P. Langford (1995)- Constraints on coal formation in Southeast Kalimantan, Indonesia. Proc. 6th New Zealand Coal Conf., Coal Research Ltd., 1, p. 137-149.

Friederich, M.C. & T. van Leeuwen (2017)- A review of the history of coal exploration, discovery and production in Indonesia: the interplay of legal framework, coal geology and exploration strategy. Int. J. Coal Geology 178, p. 56-73.
(Review of geologic setting and 160 years history of coal exploration and commercial production in Indonesia. Coal exploration and production of Eocene and Miocene coal started in late 1800's in SE Kalimantan and W and S Sumatra. Very limited production from World War 2 until 1980s when modern coal mining industry started to develop. In 2005 Indonesia became world's largest coal exporter)

Furukawa H (1988)- Stratigraphic and geomorphic studies of peat and giant podzols in Brunei: 1. Peat. Pedologist 32, 1, p. 26-42.

Gastaldo, R.A. (2010)- Peat or no peat: Why do the Rajang and Mahakam Deltas differ? Int. J. Coal Geology 83, p. 162-172.
(Borneo Holocene peats are models for Tertiary coals. Sarawak Rajang River delta- coastal plain with extensive peat up >13 m thick in ombrogenous peat domes, deposited over Pleistocene podzols when sea level stabilized at 7.5 ka and delta progradation started. Mahakam River delta also began progradation at this time, but no peat accumulation. Rajang River clays up to 60% mixed layer and expandable clays that restrict pore water flow in tidal and overbank deposits, promoting accumulation of organic matter. Mahakam River low % mixed-layer and expandable clays in system)

Gastaldo, R.A. & J.R. Staub (1999)- A mechanism to explain the preservation of leaf litter lenses in coals derived from raised mires. Palaeogeogr. Palaeoclim. Palaeoecology 149, p. 1-14.
(Leaves are easily degradable and rarely preserved in coals. May be preserved in acid-water filled depressions)

Gastaldo, R.A., G.P. Allen & A.Y. Huc (1993)- Detrital peat formation in the tropical Mahakam River delta, Kalimantan, eastern Borneo: sedimentation, plant composition, and geochemistry. In: J.A. Cobb & C.B. Cecil (eds.) Modern and ancient coal-forming environments, Geol. Soc. America (GSA), Spec. Paper 286, p. 107-118.
(In Mahakam Delta fluvial distributary channels are main conduits for transport of plant parts to delta front, where they are commonly reworked into up to 2.5m thick accumulations, onlapping interdistributary tidal flats. Allochthonous peat composed of fragmented canopy detritus from various sources, including leaves, cuticles, wood, petiole parts, damar (dipterocarp resins), fruits, and seeds. Deposits occur as high-tide beach ridges)

Godfrey, P., Tan Ee & T. Hewitt (2010)- Coal Bed Methane development in Indonesia: golden opportunity or impossible dream ? Proc. 34th Ann. Conv. Indon. Petroleum Assoc. (IAP), Jakarta, IPA10-BC-180, 19p.
(Mainly on commerciality and regulatory environment of Indonesian CBM projects)

Grady, W.C., C.F. Eble & S.G. Neuzil (1993)- Brown coal maceral distributions in a modern domed tropical Indonesian peat and a comparison with maceral distribution in Middle Pennsylvanian-age Appalachian bituminous coal beds. In: J.C. Cobb & C.B. Cecil (eds.) Modern and ancient coal-forming environments, Geol. Soc. America (GSA), Spec. Paper 286, p. 63-82.

Hadianto (2000)- Coal bed methane resources of Indonesia. Proc. 36th Sess. Coord. Comm. Coastal and Offshore Program East and SE Asia (CCOP), Hanoi 1999, p. 51-65.
(Statistics of coal and coalbed methane resources in Indonesia. CBM resource of Indonesia estimated 2.89 Tm3, with greatest resource in S Sumatra, followed by Ketungau and Kutai basins on Kalimantan)

Hadiyanto & S.H. Stevens (2005)- Coal bed methane prospects in lower rank coals of Indonesia. In: S. Prihatmoko et al. (eds.) Indonesian mineral and coal discoveries, IAGI Spec. Issue, p. 152-162.
(Brief overview of Indonesian basins with coalbed methane potential. Over 12.7 Tm3 (450 TCF) of CBM resources identified in 11 basins.(similar paper to to Stevens and Hadiyanto 2004))

Hadiyanto, S.S. & R. Susilawati (1998)- Geological overview, coal resources and Coalbed Methane potential of Indonesia. Proc. 27th Ann. Conv. Indon. Assoc. Geol. (IAGI), p. 213.

Haris, A., A. Mujiantoro & R.E Kurniawan (2010)- Evaluation of Coal Bed Methane potential of Bentian Besar, Kutei Basin. Proc. 34th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA10-G-139, 10p.

Harrington, J. (2016)- CBM Indonesia- dull past, bright future. In: 2016 Technical Symposium Where from, where to, Indon. Petroleum Assoc. (IPA), Jakarta, p.

Hooze, J.A. (1892)- Overzicht der voornaamste kolenterreinen van den Nederlandsch Indischen Archipel. Tijdschrift Kon. Nederlands Aardrijkskundig Genootschap 9, p. 129-160.
('Overview of the principal coal terrains of the Netherlands East Indies Archipelago'. Coal in Netherlands Indies only in Tertiary formations. Best quality coal in Eocene. Main exploitation on Sumatra and Kalimantan)

Hope, G., U. Chokkalingam & S. Anwar (2005)- The stratigraphy and fire history of the Kutai Peatlands, Kalimantan, Indonesia. Quaternary Research 64, p. 407-417.
(Equatorial peatlands of Kutai lowland generally 4-10m thick, but some sections >16m thick. Deposition of peat started ~8000 yrs ago after flooding of basin by Mahakam River. Earliest vegetation is Pandanus swamp which grades upwards to dipterocarp-dominated swamp forest. Peatland expanded laterally and rivers maintained narrow levee-channels through swamp. Fires of 1982 and 1997 burnt up to 85% of vegetation)

Horkel, A. (1990)- On the plate tectonic setting of the coal deposits of Indonesia and the Philippines. Mitteilungen Osterreichischen Geol. Gesellschaft 82 (1989), p. 119-133.
(online at: http://geologie.or.at/index.php/downloads2/category/7-archiv-mitteilungen)
Geodynamic evolution of SE Asian archipelago controls development of Tertiary sedimentary basins that contain coal deposits of Indonesia and Philippines. Plate-tectonic setting and associated geothermal gradients and tectonic stress are more relevant for quality and rank of Tertiary coals than age. With brief discussions of coal in Sumatra and E Kalimantan)

Hutton, A., B. Daulay, Herudiyanto, C. Nas, A. Pujobroto and H. Sutarwan (1994)- Liptinite in Indonesian Tertiary coals. Energy Fuels 8, 6, p. 1469-1477.
(Indonesian Tertiary coals similar compositions with vitrinite dominant maceral group. Most coals abundant secondary liptinite, especially exsudatinite but also fluorinite. Association of exsudatinite with oil suggests it is an indicator of early stage oil generation, and probably intermediate product in pathway vitrinite/ liptinite to oil. Where exsudatinite present in other rocks it should be termed bitumen)

Jaenicke J. (2010)- 3D modelling and monitoring of Indonesian peatlands aiming at global climate change mitigation. Dissertation Ludwig-Maximilians Universitat, Munich, 89p.
(online at: http://edoc.ub.uni-muenchen.de/11761/2/Jaenicke_Julia.pdf)

Jaenicke J., J.O. Rieley, C. Mott, P. Kimman & F. Siegert (2008)- Determination of the amount of carbon stored in Indonesian peatlands. Geoderma 147, p. 151-158.

Katili, J.A. (1984)- Coal and peat in Indonesia: potentials and prospects. Indonesian Quart. 12, 1, p. 50-61.

Kendarsi, R. (1985)- The coal resources of Indonesia and South East Asia. In: M.B. Katz & E. Langevad (eds.) Geosciences in International Development, Assoc. Geosc. Int. Development (AGID), Report 11, p. 23-57.

Kleinschmiede, J. (1937)- Coal in the East Indian Archipelago. IV. Borneo. Geol. Survey Indonesia, Bandung, Open File Report F37-04, 36p.

Kleinschmiede, J. (1939)- Coal in the East Indian Archipelago. VI. New Guinea. Geol. Survey Indonesia, Bandung, Open File Report. F39-01, 39p.

Koesoemadinata, R.P. (1978)- Sedimentary framework of Tertiary coal basins of Indonesia. In: P. Nutalya (ed.) Proc. 3rd Regional Conf. Geology and Mineral Resources of SE Asia (GEOSEA III), Bangkok, p. 621-639.

Koesoemadinata, R.P. (2000)- Tectono-stratigraphic framework of Tertiary coal deposits of Indonesia. Proc. Southeast Coal Geology Conference, Dir. Gen. Geol. Mineral Res. Indonesia, Bandung 2000, p. 8-16.

Koesoemadinata R.P. (2002)- Outline of Tertiary coal basins of Indonesia. Berita Sedimentologi (FOSI) 17, p. 2-13.
(Tertiary coals found mainly in basins of W Indonesia, on continental crust of Sunda shield. Tectonostratigraphic settings include (1) syn-rift deposits, (2) post-rift Transgressive sequence and (3) 'syn-orogenic' Regressive sequence In E Indonesia lignite/ coal in West Papua syn-orogenic basins)

Koesoemadinata, R.P. & Harjono (1977)- Kerangka sedimenter endapan Batubara Tersier di Indonesia. Proc. 6th Ann. Conv. Indon. Assoc. Geol. (IAGI), p. 1-21.
('Depositional framework of Tertiary coals in Indonesia')

Koesoemadinata, R.P., Hardjono, I. Usna & H. Sumadirdja (1978)- Tertiary coal basins of Indonesia. CCOP Techn. Bull. 12, p. 43-86.
(Overview of Indonesian Tertiary basin types and coal basins of Sumatra, Kalimantan, W Java and W Sulawesi. More detailed discussions of W Sumatra Ombilin Basin, S Sumatra Bukit Asam and E Kalimantan)

Korasidis, V.A., M.W. Wallace & B. Jansen (2017)- The significance of peatland aggradation in modern and ancient environments. Palaios 32, 10, p. 658-671.
(Modern and ancient Cenozoic peat cycles commonly evolve from inundated wetland assemblages to more elevated and well-drained forest. Changing floral compositions result from changes in substrate wetness during peatland aggradation in high rainfall settings. Includes some discussion of SE Asian peatlands)

Lalean, B. (2010)- Launching a first Coalbed Methane (CBM) project In Indonesia- a case study. Proc. 34th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA10-BC-189, 7p.
(Account of Medco S Sumatra work on Sekayu and Rambutan CBM projects)

Maltby, E., C.P. Immirzi & R.J. Safford (1996)- Tropical lowland peatlands of Southeast Asia. IUCN, Cisarua, Indonesia, p. 1-294.

Moore, T.A. (2010)- Critical reservoir properties for low-rank Coalbed Methane resources of Indonesia. Proc. 34th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA10-G-055, 5p.
(Most of Indonesian's coalbed methane resources from low-rank coals and of biogenic origin, requiring different assessment than more mature strata. Macroporosity- permeability in low rank coal largely function of cleat spacing, which may vary with coal composition. High moisture content reduces gas holding capacity)

Moore, T. (ed.) (2015)- Hydrocarbons in the tropics: on the edge. A field trip guide to ancient and modern organic-rich environments in Kalimantan Timur (Borneo), Indonesia. 32nd Ann. Meeting Society for Organic Petrology, Yogyakarta, Field guide, p. 1-107.
(Guidebook to 4-day fieldtrip in Paleo-Mahakam delta deposits around Samarinda-Balikapapan)

Moore, T.A. & C.I. Butland (2005)- Coal seam gas in New Zealand as a model for Indonesia. In: S. Prihatmoko et al. (eds.) Indonesian mineral and coal discoveries, Indon. Assoc. Geol. (IAGI), Spec. Issue, p. 192-200.
(On similarities between Indonesian and New Zealand low rank coal seam gas reservoirs)

Moore, T.A. & J.C. Ferm (1988)- A modification of procedures for petrographic analysis of Tertiary Indonesian coals. J. Southeast Asian Earth Sci. 2, p. 175-183.
(Study of SE Kalimantan Eocene coals required new procedures which relates megascopic appearance to petrographic character. Highest concentration and best preservation of plant parts in banded coal)

Moore, T.A., T.E. Mares & C.R. Moore (2010)- Assessing uncertainty of coalbed methane resources. Proc. Indon. 33rd Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA09-G-056, 11p.

Moore, T.A. & S.J. Zarrouk (2011)- The origin and significance of gas saturation in Coalbed Methane plays: implications for Indonesia. Proc. 35th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, IPA11-G-195, 10p.

Morley, R.J. (1981)- Development and vegetation dynamics of a lowland ombrogenous peat swamp in Kalimantan Tengah, Indonesia. J. Biogeography 8, p. 383-404.
(Palynological study of 6 sediments cores from Holocene lowland peat swamp along Sebangau River near Palangkaraya, C Kalimantan. Peat formation started abruptly over freshwater topogenous swamp with common Graminae and Lycopodium. Local river patterns may have changed markedly during Holocene)

Morley, R.J. (2013)- Cenozoic ecological history of Southeast Asian peat mires based on comparison of coals with present day and Late Quaternary peats. J. Limnology 72, 2s, p. 36-59.
(online at: www.jlimnol.it/index.php/jlimnol/article/view/jlimnol.2013.s2.e3/573)
(Tropical peat swamps more widespread in Sundaland than any other equatorial region, with ombrotrophic, rheotrophic and brackish mangrove peat swamps. Cenozoic deposits from area rich in coals. Extensive brackish water peats formed M-L Eocene and M-L Miocene, often laterally very extensive. Rheotrophic peats formed widely through most of Cenozoic. Ombrotrophic kerapah type peats are first recognised in Late Oligocene. Kerapah peats sometimes developed great thickness. Basinal peats increased during Miocene. No convincing evidence for doming in Cenozoic peats has yet been noted)

Nas, C. (2003)- Sedimentary features in some Indonesian coal seams. Proc. 32nd Annual Conv. IAGI and 28th Ann. Conv. HAGI, Jakarta, 8p.
(Brief review of coal seam geometries and coal sedimentology)

Nas, C. (2005)- Coking coals in Indonesia: occurrences and properties. In: S. Prihatmoko et al. (eds.) Indonesian mineral and coal discoveries, Indon. Assoc. Geol. (IAGI), Jakarta, Spec. Publ., p. 163-176.

Nas, C. & Hidartan (2010)- The quality of Kalimantan coking coals, Indonesia. In: N.I. Basuki & S. Prihatmoko (eds.) Proc. MGEI-IAGI Seminar Kalimantan coal and mineral resources, Balikpapan 2010, p. 1-11.
(Kalimantan coals wide variation in quality. Neogene coals generally low rank. Eocene coals locally high rank and of coking coal quality. Descriptions of coking coal deposits in N Barito (Buntok) and Upper Kutai (Muara Teweh) basins)

Nas, C. & Hidartan (2010)- Quality of Kalimantan coking coals, Indonesia. In: Proc. 37^{th} Symp. Geology of the Sydney Basin, Hunter Valley, NSW 2010, p.
(Same paper as above?)

Nas, C., B.G. Jones & E. Baafi (2000)- Statistical variation in coal data sets: are they of geological significance? Proc. Southeast Asian coal geology conference, Bandung 2000, p. 175-182.

Nas, C. & A. Pujobroto (2000)- Vitrinite macerals in Indonesian coal. In: Proc. Southeast Asian Coal Geology Conference, Bandung 2000, p. 215-226.

Neuzil, S.G. (1997)- Onset and rate of peat and carbon accumulation in four domed ombrogenous peat deposits, Indonesia. In: J.O. Rieley & S.E. Page (eds.) Biodiversity and Sustainability of tropical peatlands, Samara Publishing Ltd, Cardigan, p. 73-80.

Neuzil, S.G., Supardi, C.B. Cecil, J.S. Kane & K. Soedjono (1993)- Inorganic geochemistry of domed peat in Indonesia and its implications for the origin of mineral matter in coal. In: J.C. Cobb & C.B. Cecil (eds.) Modern and ancient coal-forming environments, Geol. Soc. America (GSA), Spec. Paper 286, p. 23-44.
(Inorganic geochemistry of three domed ombrogenous peat deposits in Riau (Siak, Bengkalis peats) and W Kalimantan (Keramat peat). Mineral matter limited to small amounts from allogenic sources of dryfall, rainfall

and diffusion from substrate pore water. In interior of deposits much of mineral matter is authigenic. Ash yield (av. 1.1%) and sulfur content (av. 0.14%) generally low, but exceed 5% and 0.3% near base of deposits. Domed ombrogenous peat deposits will result in low ash and sulfur coal, even if marine rocks adjacent to coal)

Orem, W.H., S.G. Neuzil, H.E. Lerch & C.B. Cecil (1996)- Experimental early-stage coalification of a peat sample and a peatified wood sample from Indonesia. Organic Geochem. 24, 2, p. 111-125.

Osman, T.H. (2013)- The development of the Indonesian coal industry. Australasian Inst. of Mining and Metallurgy (AusIMM), Bull. 2013, 3, p. 38-40.

Page, A., A. Hooijer, J. Rieley, C. Banks & A. Hoscilo (2012)- The tropical peat swamps of Southeast Asia. In: D. Gower et al. (eds.) Biotic evolution and environmental change in Southeast Asia, Cambridge University Press, Chapter 16, p. 406-433.

Page, S.E., J.O. Rieley, O.W. Shotyk & D. Weiss (1999)- Interdependence of peat and vegetation in a tropical peat swamp forest. Philos. Trans. Royal Soc. London, B354, p. 1885-1897.
(online at: www.ncbi.nlm.nih.gov/pmc/articles/PMC1692688/pdf/11605630.pdf)
(Study of peat swamp forest composition in upper Sungai Sebangau area, S of Palangkaraya, C Kalimantan. Peat thickness up to 10m. Radiometric age dating suggest young peat (~400- 1760 yr BP) overlying older peat (~6-10.3 ka))

Page, S.E., J.O. Rieley & R. Wust (2006)- Lowland tropical peatlands of Southeast Asia. In: I.P. Martini, et al. (eds.) Peatlands: evolution and records of environmental and climate changes, Dev. Earth Surface Proc. 9, Chapter 7, Elsevier, p. 145-172.
(Review of SE Asia peatlands. Most AE Asia peatlands in low altitudes, and almost all domed/ ombrogenous. Geogenous peatlands confined to edges of coastal lagoons, banks and floodplains of rivers and margins of upland lakes. C Kalimantan peatland surface rel. flat: gradient (7.6m over 5500m). Ash in ombrogenous peats generally <1%. Most SE Asia peat deposits started to form around 4000- 5500 yr BP.; some Borneo peats older, up to 29,000 yr BP.)

Page, S., R. Wust & C. Banks (2010)- Past and present carbon accumulation and loss in Southeast Asian peatlands. PAGES news 18, 1, p. 25-27.
(online at: www.pages-igbp.org/products/newsletters/2010-1/)
(Peat accumulation rates in SE Asia studied peatlands average 1.3 mm/year, highside 4-6 mm/year)

Page, S., R.A.J. Wust, J.O. Rieley, W. Shotyk & S.H. Limin (2004)- A record of Late Pleistocene and Holocene carbon accumulation and climate change from an equatorial peat bog (Kalimantan, Indonesia): implications for past, present and future carbon dynamics. J. Quaternary Science 19, p. 625-635.

Pei, C.S. (1993)- Coal as an energy resource in Malaysia. In: G.H. Teh (ed.) Proc. Symposium on tectonic framework and energy resources of the Western margin of the Pacific Basin, Kuala Lumpur 1992, Bull. Geol. Soc. Malaysia 33, p. 399-410.
(98% of Malaysian coal in Tertiary of Sarawak and Sabah. Quality ranges from lignite to anthracite, mainly bituminous coal. Summaries of Merit Pila and Mukah-Balingin coal fields, Sarawak, and Meliau coal, Sabah)

Phua, M.H., O. Conrad, K.U. Kamlun, M. Ficher & J. Bohner (2008)- Multitemporal fragmentation analysis of peat swamp forest in the Klias Peninsula, Sabah, Malaysia using GIS and remote sensing techniques. Hamburger Beitrage zur Phys. Geographie und Landschaftsokologie 19, p. 81-90.

Polak, E. (1933)- Ueber Torf und Moor in Niederlandisch Indien. Verhandelingen Kon. Akademie Wetenschappen, sect. 2, 30, 3, p. 1-85.
(online at: www.dwc.knaw.nl/DL/publications/PU00011853.pdf)

('On peat and swamps in the Netherlands Indies'. Swamp areas subdivided into: (1) regionally extensive coastal peat swamps of Sumatra and Borneo and (2) 'topogenous' raised mires on the plains of Java, Sumatra and mountains of Java, Sulawesi and Buru. Mainly on plant and pollen distributions)

Polak, B. (1941)- Veenonderzoek in Nederlandsch Indie. 1. Stand en expose der vraagstukken. Meded. Alg. Proefstation voor den landbouw 53, Buitenzorg, p. 1-30.
('Peat research in the Netherlands Indies: an outline of the problems')

Polak, B. (1952)- Veen en veenontginning in Indonesia. Majalah Ilmu Alam Indon. (Indonesian J. Natural Science) 5-6, p. 146-160.
('Peat and peat exploitation in Indonesia'. Brief general overview with map of distribution of peat deposits in Indonesia)

Polak, B. (1975)- Character and occurrence of peat deposits in the Malaysian tropics. In: G.J. Bartstra & W.A. Casparie (eds.) Modern Quaternary Research in Southeast Asia, A.A. Balkema, Rotterdam, 1, p. 71-81.
(Brief review of peat distribution and peat types in Indonesia)

Prijono, A. (1988)- Review of coal development in Indonesia. In: Proc. First Asia/ Pacific mining conference, Thailand, 27p.

Prijono, A. (1989)- Overview of the Indonesian coal development. Geologi Indonesia 12, 1 (Katili Comm. Volume), p. 253-278.
(Review of coal reserves, coal properties, production, transportation, etc. in Indonesia. Little or no geology)

Purnomo, H. (2007)- CBM development in Indonesia, Proc. 43rd CCOP Ann. Sess., Daejeon 2006, 2, p. 143-150.
(online at: www.ccop.or.th/download/pub/43as_ii.pdf)
(Recent studies identified approximately 450 TCF of prospective CBM resources in 11 onshore coal basins in Indonesia including S Sumatra, Kutai and Barito Basins)

Radjagukguk, B. (1997)- Peat soils of Indonesia: location, classification and problems for sustainability. In: J.O. Rieley & S.E. Page (eds.) Tropical peatlands, Samara Publishing Ltd, Cardigan, p. 45-54.

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Ratanasthien, B., W. Kandharosa, S. Chompusri & S. Chartprasert (1999)- Liptinite in coal and oil source rocks in northern Thailand. J. Asian Earth Sci. 17, p. 301-306.
(N Thailand Tertiary coal and oil deposits similar palynological associations to Borneo region. Oldest coal-oil deposits of Late Oligocene- E Miocene age and dominated by Botryococcus or related algae. Thick-walled lamaginites and temperate spores- pollen in some areas. Thin-walled lamaginite dominant in late M Miocene time. Resinite, suberinite, and cutinite dominant in forest swamp coals; alginite, cutinite and lycopodium spores dominant in lacustrine environments. Liptinite macerals can be major source of oil and gas)

Rieley, J.O., A.A. Ahmad-Shah & M.A. Brady (1996)- The extent and nature of tropical peat swamps. In: E. Maltby et al. (eds.) Tropical lowland peatlands of Southeast Asia, Gland, Switzerland, p. 17-53.

Rieley, J.O., S.E. Page & B. Setiadi (1996)- Distribution of peatlands in Indonesia. In: E. Lappalainen (ed.) Global peat resources, International Peat Society, Jyvaskyla, Finland, p. 169-178.

Rieley, J.O., G. Sieffermann, M.Fournier & F. Soubies (1992)- The peat swamp forests of Borneo: their origin, development, past and present vegetation and importance in regional and global environmental processes. 9th Int. Peat Congress, Uppsala, Sweden, p. 78-95.

Robertson Research International (1977)- Coal in Indonesia. Multi-client study, Sydney, p. *(Unpublished)*

Santoso, B. (2015)- Petrologi batu bara Sumatra dan Kalimantan: jenis, peringkat dan aplikasi. Lembaga Ilmu Pengetahuan Indonesia (LIPI) Press, Jakarta, p. 1-132.
('Petrology of coals from Sumatra and Kalimantan: types, ratings and applications')

Santoso, B. (2017)- Petrographic characteristics of selected Tertiary coals from Western Indonesia according to their geological aspects. Indonesian Mining J. 20, 1, p. 1-30.
(online at: http://jurnal.tekmira.esdm.go.id/index.php/imj/article/view/178/110)
(Tertiary coals from W Indonesia (Sumatra, Kalimantan, Java) similarities and differences. Coals dominated by vitrinite (detrovitrinite,telovitrinite), common liptinite (resinite, cutinite, suberinite) and rare inertinite (semifusinite, sclerotinite, inertodetrinite) and mineral matter. Differences reflect differences in climate and peat conditions. Vitrinite reflectance variations caused by variations in burial and effects of igneous intrusions)

Santoso, B. & N. Suwarna (1998)- Indonesian coal: its potential, production and utilization. J. Geologi Sumberdaya Mineral 8, 78, p. 20-26.
(Indonesia coal reserves 36.6 billion tonnes. Economic coal resources mainly in Tertiary basins of Sumatra (67.4% of total) and Kalimantan (32.2%). Minor resources on Java (0.2%), Sulawesi (0.1%) and W Papua (0.2%). 59% of coal classified as lignite, 26.6% sub-bituminous, 14.4% bituminous and 0.4% anthracite)

Sanusi, S., A. Kuswandi, Radian M. Jufri & K.S. Anggarini (2014)- Evaluation of Coalbed Methane potential of Muara Enim Formation in the Muara Enim Area, South Sumatera. In: I. Basuki & A.Z. Dahlius (eds.) Sundaland Resources, Proc. Indon. Soc. Econ. Geol. (MGEI) Ann. Conv., Palembang, p. 467-483.
(Three well drilling program for CBM evaluation in Late Miocene lignite- sub-bituminous coals of Muara Enim Fm indicates favourable gas content: average 3.55 m3/t (125.31 scf/t) at depth of 410- 812m)

Shearer, J.C., J.R. Staub & T.A. Moore (1994)- The conundrum of coal bed thickness: a theory for stacked mire sequences. J. Geology 102, 5, p. 611-617.
(Modern peat deposits up to ~20m thick and will compact appreciably during burial, whereas coal beds can be 90m thick. Thick coal beds likely composed of multiple, stacked paleo-peat bodies. Three types of bounding surfaces seen in modern peat bodies can be used to distinguish individual paleo-peats in coal beds)

Shimada, S., H. Takahashi, A. Haraguchi & M. Kaneko (2001)- The carbon content characteristics of tropical peats in Central Kalimantan, Indonesia: estimating their spatial variability in density. Biogeochemistry 53, 3, p. 249-267.

Sia, S.G. & W.H. Abdullah (2011)- Concentration and association of minor and trace elements in Mukah coal from Sarawak, Malaysia, with emphasis on the potentially hazardous trace elements. Int. J. Coal Geology 88, p. 179-193.

Sieffermann, G., M. Fournier, S. Triutomo, M. Sadelman & A. Semah (1988)- Velocity of tropical forest peat accumulation in Central Kalimantan Province, Indonesia (Borneo). In: 8th Int. Peat Society Congress, Leningrad, p. 90-98.

Sieffermann, G., S. Triutomo, M.T. Sadelman, A. Kristijono & S.A. Parhadimulyo (1987)- The peat genesis in the lowlands of Central Kalimantan province, the respective influence of podzolisation and bad drainage, the two main processes of peat genesis in Kalimantan. Int. Peat Congress, Yogyakarta, ORSTOM, 17p.
(online at: http://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_5/b_fdi_18-19/26068.pdf)
(Profiles of modern peat deposits in Sebangau valley (<1 to >5m thick) near Palangkaraya, S Central Kalimantan. Peat formation tied to podzolization led to decrease of microbiological activity, thus facilitating accumulation of non-decomposed organic matter, and to bad drainage)

Sigit, S. (1981)- Pengembangan batubara Indonesia, prospek dan permasalahannya. Proc. 10th Ann. Conv. Indon. Assoc. Geol. (IAGI), p. 1-6.

('Development of coal in Indonesia, prospects and its issues')

Sigit, S. (1981)- Coal development in Indonesia: past performance and future prospects. Journal Indon. Assoc. Geol. (IAGI) 8, p. 3-9.

Soehandojo (1989)- Coal exploration and exploitation review in Indonesia. Geologi Indonesia (J. Indon. Assoc. Geol. IAGI) 12, 1 (Katili Comm. Volume), p. 279-325.
(Overview of Indonesia coal concessions, mine operators, etc.. Most reserves on Sumatra and Kalimantan, lesser reserves on Sulawesi, Java, Irian Jaya)

Staub, J.R. & J.S. Esterle (1994)- Peat-accumulating depositional systems of Sarawak, East Malaysia. Sedimentary Geology 89, p. 91-106.
(Sarawak prograding coastal depositional systems contain domed peat-accumulating environments in which low-ash, low-sulfur peats are deposited in areas of active siliciclastic sedimentation. Depositional systems up to 11,400 km2 large, individual peat deposits >20m thick and 1000 km2 in area. Basal high-ash, high-sulfur, degraded peats overlain by low-ash, low-sulfur, well preserved peats)

Staub, J.R., J.S. Esterle & A.L Raymond (1991)- Comparative geomorphic analysis of Central Appalachian coal beds and Malaysian peat deposits. Bull. Geol. Soc. France 162, p. 339-351.

Stevens, S.H. & Hadiyanto (2004)- Indonesia: coalbed methane indicators and basin evaluation. Soc. Petrol. Engineers (SPE) Asia Pacific Oil and Gas Conf., Perth 2004, Paper SPE 88630, 8p.
(Indonesia has many untested thick, low-rank coal deposits, prospective for coalbed methane development. Assessed resource 12.7 trillion m3 (450 Tcf) of prospective CBM in 11 onshore basins)

Stevens, S.H. & K. Sani (2001)- Coalbed methane potential of Indonesia: preliminary evaluation of a new natural gas source. Proc. 28th Ann. Conv. Indon. Petroleum Assoc. (IPA), Jakarta, 1, p. 727-738.
(Study sponsored by Caltex estimates 337 TCF of potentially completable CBM resources in S and Central Sumatra, Barito, Kutei and other coal basins in Indonesia. 10% of this resource (~30 TCF) may be in high-quality, gas-saturated, permeable 'fairways', where development may be economic)

Stevens, S.H., K. Sani & S. Hardjosuwiryo (2001)- Indonesiaȇs 337 TCF CBM resource a low-cost alternative to gas, LNG. Oil and Gas J. 99, 43, p. 40-45.
(337 TCF of coalbed methane (CBM) resource potential in 11 Indonesian coal basins)

Suparka, S., M. Djuwansah & S. Siregar (1996)- Peat in Indonesia: a dilemma of utilization and environmental impact. In: B. Ratanasthien & S.L. Rieb (eds.) Proc. Int. Symposium on Geology and Environment, Chiang Mai, Thailand, p. 109-121.
(online at: http://library.dmr.go.th/Document/Proceedings-Yearbooks/M_1/1996/)

Supardi, A.D. Subekty & S.G. Neuzil (1993)- General geology and peat resources of the Siak Kanan and Bengkalis Island peat deposits, Sumatra, Indonesia. In: J.C. Cobb & C.B. Cecil (eds.) Modern and ancient coal-forming environments, Geol. Soc. America (GSA), Spec. Paper 286, p. 45-62.
(Modern peat deposits cover 48,000 km2 on lowlands of Riau Province, Sumatra. Two peat dome areas studied. Domes formed in last 5000 yrs, on flat surface, growing 4-5 mm/yr in first 1000 yrs, then 2 mm/yr for past 3500-4000 years. Low ash and sulfur content)

Supiandi, S. (1988)- Studies on peat in the coastal plains of Sumatra and Borneo Part I: physiography and geomorphology of the coastal plains. Southeast Asian Studies 26, p. 308-335.

Supiandi, S. (1990)- Studies on peat in the coastal plains of Sumatra and Borneo Part IV: a study of the floral composition of peat in coastal plain of Brunei, Borneo. Southeast Asian Studies 27, p. 461-484.

Susilawati, R., S.L. Papendick, P.C. Gilcrease, J.S. Esterle, S.D. Golding & T.E. Mares (2013)- Preliminary investigation of biogenic gas production in Indonesian low rank coals and implications for a renewable energy source. J. Asian Earth Sci. 77, p. 234-242.
(Indonesia has abundant coal resources. Most coals thermally immature, but composed of hydrogen-rich organic components suitable for biogenic methane production. Gas isotope results from pilot wells in S Sumatra interpreted to indicate biogenic origins for methane)

Suwarna (2002)- Coalbed methane in Indonesia. Bull. Geol. Res. Dev. Centre 22, p. 19-39.
(Review of coalbed methane potential of Indonesia. Most prospective basins in descending order: S. Sumatra, Barito, Kutai, C Sumatra, N Tarakan, Berau, Bengkulu, etc.)

Teodosio, N.R. (1987)- An overview of coal deposits in the Philippines. ESCAP Series on Coal. 5, p. 142-150.

Tie, Y.L. & J.S. Esterle (1992)- Formation of lowland peat domes in Sarawak, Malaysia. In: B.Y. Aminuddin (ed.) Proc. Int. Symp. on Tropical Peatland, Kuching, MARDI, Kuala Lumpur, p. 81-89.

Van de Meene, E.A. (1984)- Geological aspects of peat formation in the Indonesian- Malayan lowlands. Bull. Geol. Res. Dev. Centre (GRDC), Bandung, 9, p. 20-31.
(Good overview of modern peat formation and distribution in W Indonesia)

Van Diest, P.H. (1871)- De kolenrijkdom der Padangsche Bovenlanden en de mogelijkheden van de voordeelige ontginning. Stemler, .Amsterdam, p. 1-76.
(online at: https://books.googleusercontent.com/books/..)
('The coal resources of the Padang Highlands and the possibilities of profitable exploitation'. Historic economic evalution of Ombilin coalfield in West Sumatra. Ombilin coals relatively high in carbon (79-80%) and low in ash (0.27-0.95%), Sulfur 0.34-0.87%)

Van Dijk, P. (1858)- Over de waarde van eenigen Nederlandsch-Indische koolsoorten. Natuurkundig Tijdschrift Nederlandsch-Indie 15, p. 139-158.
('On the value of some Indonesian coal types'. Brief discussion of coals SE Kalimantan, Bengkulu-Sumatra)

Van Doorn, Z. (1959)- Enkele waarnemingen aan oorspronkelijke Indonesische veenmoerassen ter vergelijking met de Hollands-Utrechtse venen. Boor en Spade 10, p. 156-170.
(online at: http://edepot.wur.nl/109967)
('Some observations on original peat bogs in Indonesia for comparìson with the Holland-Utrecht peat area')

Van Lier, R.J. (1917)- Onze koloniale mijnbouw, III, De steenkolenindustrie. Tjeenk Willink, Haarlem, p. 1-87.
('Our colonial mining industry, III, the coal industry'. Popular 1917 booklet on coal mining industry in Indonesia)

Winarno, T. & C. Drebenstedt (2014)- Opportunity of low rank coal development in Indonesia. In: C. Drebenstadt & R. Singhal (Eds.) Mine planning and equipment selection, Proc. 22nd MPES Conf., Dresden 2013, Springer Int., p. 1485-1494.

Wust, R., J. Rieley, S. Page, S. van der Kaars, W.M. Wang, G. Jacobsen & A. Smith (2007)- Peatland evolution in Southeast Asia during the last 35,000 cal years: implication for evaluating their carbon storage potential. In: J.O. Rieley et al. (eds.) Carbon-climate-human interaction on tropical peatland. Proc. Int. Symposium Tropical Peatland, Yogyakarta 2007, Gadjah Mada University, Indonesia and Univ. Leicester, 19p.
(online at: www.geog.le.ac.uk/carbopeat/media/pdf/yogyapapers/p2.pdf)

Zetra, Y., H.S. Kusuma, F. Riandra, I.B. Sosrowidjojo & R.Y. Perry Burhan (2018)- The oxygenated biomarker as an indicator of origin and maturity of Miocene brown coal, Sangatta coal mines, East Kalimantan. Indonesian J. Geoscience 5, 2, p. 107-116.
(online at: https://ijog.geologi.esdm.go.id/index.php/IJOG/article/view/289/260)

Ziegler, K.G.J. (1915)- Kritische Studie uber die auf Java bekannten Kohlenvorkommen. Geol. Survey, Bandung, Open File Report E15-04, p. 1-107.
('Critical study of the known coal occurrences on Java')

Zulkifley, M.T.M., Ng T.F., W.H. Abdullah, J.K. Raj, S.P. Param, R. Hashim & M.A. Ashraf (2013)- Distribution, classification, petrological and related gochemical (SRA) characteristics of a tropical lowland peat dome in the Kota Samarahan-Asajaya area, West Sarawak, Malaysia. Open Geosciences (C. European J. Geoscience) 5, 2, p. 285-314.
(online at: www.degruyter.com/downloadpdf/j/geo.2013.5.issue-2/s13533-012-0130-y/s13533-012-0130-y.pdf)
(Lateral variations in Plaie peat forest W of Samarahan, Sarawak. Peat thickness 0.2-2.3m, increasing to W)

XI.4. Minerals, Mining

(Many additional references on minerals/mining that are specific to one region are listed under these regions)

Abidin, H.Z. & A.S. Hakim (2005)- Endapan sulfida masif volkanogenik: ciri dan sebarannya di Indonesia. Publikasi Ilmiah Pendidikan dan Pelatihan Geologi. 1, 1, p. 47-57.
('Volcanogenic Massive Sulphide deposits: characteristics and distribution in Indonesia'. Reprinted in Metalogeni Sundaland I (2014), p. 263-273. Polymetallic Massive Sulfide deposits always associated with volcanics and sediments. VMS deposits in Indonesia two types (1) Kuroko-type Sangkaropi (S Sulawesi, Cu-Pb-Zn), (2) Lerokis and KaliKuning (Wetar), with stratabound Au-Ag bodies of sedimentary exhalative origin)

Agoes, E. (1988)- Uranium exploration in Indonesia. In: Proc. Conf. Uranium deposits in Asia and the Pacific; geology and exploration, Jakarta 1985, Int. Atomic Energy Agency (IAEA), Vienna, IAEA-TC-543/12, p. 167-178.
(Radioactive minerals found in several areas in W and E Indonesia)

Andrew, R.L. (1995)- Porphyry copper-gold deposits of the southwest Pacific. Mining Engineering 47, 1, p. 33-38.

Anonymous (1918)- Voorkomen en gebruik van mangaanertsen. Verslagen Mededelingen Indische delfstoffen en hare toepassingen, Dienst Mijnwezen Nederlandsch Oost-Indie, 5, p. 1-51.
('Occurrences and application of manganese ores'. Review of manganese ores in Indonesia)

Anonymous (1919)- Phosphaat. Verslagen Mededelingen Indische delfstoffen en hare toepassingen, Dienst Mijnwezen Nederlandsch Oost-Indie, 6, p. 1-23.
('Phosphate'. Brief review of phosphate occurrences in Indonesia. Usually asociated with bat caves. No commercially significant deposits)

Anonymous (1919)- Yzerertsen in Nederlandsch-Indie. Verslagen Mededelingen Indische delfstoffen en hare toepassingen, Dienst Mijnwezen Nederlandsch Oost-Indie, 7, p. 1-71.
('Iron ores in the Netherlands Indies')

Anonymous (1922)- Jodium. Verslagen Mededelingen Indische delfstoffen en hare toepassingen, Dienst Mijnwezen Nederlandsch Oost-Indie, 14, p. 1-64.
('Iodine'. Review of iodine occurrences in Indonesia, mainly from wells in Tertiary basins of East Java, north of the volcanic arc)

Balce, G.R. (1990)- Coastal and offshore mineral development in the East Asian region:the CCOP experience. In: Second Asia/Pacific Mining Conf. Exhib., Jakarta 1990, ASEAN Federation of Mining Association, Manila, p. 141-170.

Bartels, T.T. (1950)- Bauxietwinning der Nederlandsch-Indische Bauxiet Exploitatie Maatschappij op Bintan. De Ingenieur in Indonesie 2, 1, IV, p. 1-5.
('Bauxite exploitation of the Netherlands Indies Bauxite Exploitation Company on Bintan'. Brief history of exploitation of bauxite in SE Bintan island, which started in 1935, continued during Japanese occupation, then resumed in 1947. Bauxite believed to have formed from lateritic weathering of hornfels (Van Bemmelen 1940))

Barthel, F.H. (1988)- Sandstone uranium deposits in central Sumatera, Indonesia and northern Thailand. In: Uranium Deposits in Asia and the Pacific: geology and exploration. Int. Atomic Energy Agency, Vienna, p. 179-192.
(Regional stream sediment surveys combined with radiometric measurements carried out over large areas in C Sumatera, but results disappointing. In NE Thailand more favourable conditions in Tertiary sandstone basins)

Binns, R.A. (2013)- Seafloor massive sulfide deposits and 'black smokers': the potential in Maluku and Papua, and guides for exploration. Proc. Indon. Soc. Econ. Geol. (MGEI) Ann. Convention2013, Kuta, p. 1-9.

Bousquet, J.G. (1904)- Les richesses minerales des Indes Orientales neerlandaises. Mem. Soc. Ingen. civils de France, 57, Paris, p. 1-62.
('The mineral riches of the Netherlands East Indies' First countrywide review of mineral occcurences in Indonesia, including oil, coal, tin, iron, diamonds, etc.)

Bowles, J.F.W. (1984)- The distinctive low- silver gold of Indonesia and East Malaysia. Proc. Gold '82 Symposium, Harare 1982, Geol. Soc. Zimbabwe, Spec. Publ. 1, Balkema, Rotterdam, p. 249-260.

Carlile, J.C., I.J.L Heesterman & A.H.G. Mitchell (1996)- Gold distribution, production and potential in Indonesia. The AusIMM Bull. 1, p. 42-46.

Cooke, D.R., P. Heithersay, R. Wolfe & A.L. Losada Calderon (1998)- Australian and western Pacific porphyry Cu-Au deposits. AGSO J. Australian Geol. Geophysics 17, 4, p. 97-104.
(online at: https://d28rz98at9flks.cloudfront.net/81527/Jou1998_v17_n4_p097.pdf)
(Porphyry copper-gold deposits in PNG (Panguna, Wafi, Ok Tedi), W Papua (Grasberg), Sumbawa (Batu Hijau), Philippines, generally associated with andesitic volcanics and diorite to quartz diorite intrusions. Cu-Au porphyries generally in island arc tectonic setting, Cu-Mo porphyries in continental margin or cratonic settings. Some deposits localized at fault intersections (Grasberg, Batu Hijau). Depth of emplacement ~1-2 km; mineralization may extend 1.5 km vertically (Grasberg). Many formed in island arcs after period of reversal in arc polarity)

Dahlkamp, F.J. (2009)- Uranium deposits of the world, Chapter 3- Indonesia. Springer Verlag, Berlin, p. 157-173.
(Mainly summary of Uranium deposits in Kalan Region, W-C Kalimantan, explored in 1970's by CEA- BATAN. U deposits hosted by Paleozoic meta-sediments and meta-volcanics)

De Jongh, C.A. (1917)- Over het voorkomen van zwavel en natuurlijke zwavelverbindingen in Nederlandsch-Indie. Verslagen Mededelingen Indische delfstoffen en hare toepassingen, Dienst Mijnbouw in Nederl. Oost-Indie, 1, p. 1-32.
('On the occurrence of sulfur and natural sulfur minerals in Netherlands Indies'. Brief review of sulfur occurrences associated with Quaternary volcanoes of Indonesia)

De Jongh, C.A. et al. (1925)- Onderzoekingen naar de mogelijk winbare hoeveelheden zwavel in kraters van verschillende vulkanen in den Nederlandsch Oost Indischen Archipel. Verslagen Mededelingen Indische delfstoffen en hare toepassingen, Dienst Mijnwezen Nederlandsch Oost-Indie, 17, p. 1-37.
('Investigations into potentially mineable quantities of sulphur in craters of volcanoes in the Netherlands East Indies Archipelago'. Reviews of sulfur deposits on volcanoes on Java (Kawah Putih, Tangkuban Perahu, Ciremai, Dieng), Sumatra (Tapanuli residency), Sulawesi (N Sulawesi, Una-Una) and Flores)

De Neve, G.A. (1981)- Indonesian non-metallic mineral resources, outline on a decade of development aspects in exploration and evaluation for Mining (1970-1980). Proc. 10th Ann. Conv. Indon. Assoc. Geol. (IAGI), p. 248-262.

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('Minerals of Indonesia'. Listings of occurrences of 4 precious metals, 6 ferrous metals 7 non-ferrous metals, coal, and 30 industrial minerals. Published by Indonesian Department of Mines).

Digdowirogo, S., S. Prihatmoko & H. Lubis (2000)- Sediment-hosted lead-zinc deposits, the existence in Indonesia. Berita Sedimentologi 14, p. 2-5.
(Brief review of sediment-hosted Pb-Zn-Ag in Indonesia at Kelapa Kampit (Belitung). Also identified in 1997 at Sopokomil, N Sumatra)

Djaswadi, S. (1997)- Prospective of base metal minerals in Indonesia. Direktorat Sumberdaya Mineral (Directorate of Mineral Resources), Bandung, Spec. Publ. 47, p. 1-227.

Dorian, J.P., A.L. Clark & Djumhani (1986)- A geologic and mineral resource assessment of Indonesia. J. Southeast Asian Earth Sci, 1, p. 33-44.
(Broad overview of Indonesia mineral resource assessment)

Elias, M. (2013)- Nickel laterites in SE Asia- Geology, technology and economics: finding the balance. Proc. Symposium East Asia: Geology, exploration technologies and mines, Bali, Australian Inst. Geoscientists, Bull. 57, p. 3-4. *(Abstract only)*
(Presentation online at: www.aig.org.au/images/stories/Resources/Nickel-Laterite-in-SE-Asia-M-Elias.pdf)
(Nickel laterites are products of intense weathering in humid climate of Mg-rich or ultramafic rocks which have primary Ni contents of 0.2-0.4%. Over 50% of global resources of nickel laterites in New Caledonia, Indonesia, the Philippines and Papua New Guinea)

Ernowo & P. Oktaviani (2010)- Review of chromite deposits of Indonesia. Bul. Sumber Daya Geologi 5, 1, p. 10-19.
(online at: www.bgl.esdm.go.id/publication/index.php/dir/article_detail/412)
(Indonesian chromite deposits widely distributed in E Indonesia and result of weathering of ophiolite rocks in SE Kalimantan, Sulawesi, Maluku, Halmahera, Gebe, Gag, Waigeo, and Papua)

Faiman, G.S. & A. Wikrama (2005)- Indonesian bentonites: case study in western Java. In: S. Prihatmoko et al. (eds.) Indonesian mineral and coal discoveries, Indon. Assoc. Geol. (IAGI) Special Issue, p. 137-151.
(Different types and (Tertiary) ages of bentonite deposits present across Java, mainly formed by devitrification of glassy tufffs/ ash)

Fletcher, W.K. (1996)- Aspects of exploration geochemistry in Southeast Asia: soils, sediments and potential for anthropogenic effects. J. Geochemical Exploration 57, p. 31-43.

Garwin, S.L. (2013)- Tectonic and structural controls to porphyry and epithermal mineralization in the Cenozoic magmatic arcs of Southeast Asia and the West Pacific. In: Proc. Symposium East Asia: Geology, exploration technologies and mines, Bali 2013, Australian Inst. Geoscient., Bull. 57, p. 19-23.
(Presentation online at: www.aig.org.au/images/stories/Resources/Garwin_AIG_Bali_27May2013_final.pdf)
(Gold- copper deposits in SE Asia and W Pacific mainly in Neogene (25- 1 Ma) magmatic arcs, and mainly in porphyry and epithermal deposits. Region contains >160 deposits, including porphyry, skarn, epithermal, volcanic-associated massive sulfide, disseminated sediment -hosted and other mineralization styles)

##Garwin, S.L. (2013)- Tectonic and structural controls to porphyry and epithermal mineralization in Cenozoic magmatic arcs of SE Asia and the W Pacific. Presentation CET Seminar Series, 13th September 2013, University of Western Australia, Perth, 31p.
(online at: http://www.cet.edu.au/docs/presentations/garwin_uwa_13sep2013.pdf?sfvrsn=4)
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Gemmell, J.B. (2005)- Geology, geochemistry and exploration implications of hydrothermal alteration associated with epithermal Au-Ag deposits. In: Proc. New Zealand Minerals and Mining Conference 2005, p. 98-104.
(online at: www.nzpam.govt.nz/cms/pdf-library/minerals/conferences-1/098_papers_60.pdf)
(Summary of research project on characteristics of hydrothermal alteration associated with low sulfidation, gold-silver epithermal deposits. Deposits investigated were Ladolam (PNG, Pleistocene), Gosowong (Halmahera, Pliocene mineralization in Miocene andesitic rocks) and Mt Muro (Miocene mineralization in Oligocene andesitic rocks))

Gryc, G., W.O. Addicott, F. Sidlauskas et al. (1999)- Mineral-resources map of the Circum-Pacific region, Northwest Quadrant. U.S. Geol. Survey (USGS) Circum-Pacific Map 46, 1:10M scale.

(online at: https://pubs.usgs.gov/cp/46/plate-1.pdf)

Gryc, G., W.O. Addicott, F. Sidlauskas et al. (1999)- Explanatory notes for the Mineral-resources map of the Circum-Pacific region, Northwest Quadrant. U.S. Geol. Survey (USGS) Circum-Pacific Map 46, p. 1-29.
(online at: http://pubs.usgs.gov/cp/46/report.pdf)
(see also Palfreyman et al. 1996 for SW Quadrant))

Hammarstrom, J.M., A.A. Bookstrom, C.L. Dicken, B.J. Drenth, S. Ludington, G.R. Robinson, B.T. Setiabudi et al. (2013)- Porphyry copper assessment of Southeast Asia and Melanesia. U.S. Geol. Survey Scientific Investigations Report 2010-5090-D, p. 1-332.
(online at: http://pubs.usgs.gov/sir/2010/5090/d/sir2010-5090d_text.pdf)
(Regional review of volcanic and magmatic arc systems of SE Asia, known porphyry copper occurrences and probabilistic assessment of areas with potential porphyry copper resources. Estimate of undiscovered copper resources in study area (~288 Mt) is ~3.5 times amount of copper in identified resources (84 Mt))

Harahap, B.H. & H.Z. Abidin (co-ord.) (2013)- Peta Metalogeni Indonesia, 1:5.000.000. Badan Geologi, Geol. Survey Indonesia, Bandung.
('Metallogenic map of Indonesia'. 1: 5M scale map of mineral deposits and mineralization zones of Indonesia)

Harahap, B. & R. Yuniarni (eds.) (2014)- Metalogeni Sundaland, vol. I. Kimpulan karya tulis ilmiah Prof. Dr. Hamdan Zainal Abidin. Badan Geologi, Bandung, p. 1-296.
('Metallogeny of Sundaland, vol. I'. Reprint collection of scientific papers by Prof. Dr. H.Z. Abidin from 1987-2012)

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('Metallogeny of Sundaland, vol. II'. Second reprint collection of scientific papers by Prof. Dr. H.Z. Abidin from 1994-2005)

Harjanto, S., S. Virdhian & E. Afrilinda (2013)- Characterization of Indonesia Rare Earth minerals and their potential processing techniques. Conf. Tools for Materials Science & Technology 2013, Montreal, 9p.
(In Indonesia REE minerals monazite, xenotime and zircon are associated with tin, uranium and gold in alluvial deposits. REE range from 30-400 ppm in sands on Bangka and Belitung REE minerals, and are by-product of tin ore mining and extraction. Also: lower grade monazite and xenotime as alluvial in Kampar and Riau Islands, REE minerals in uranium alluvial in W Kalimantan)

Hartono, H.M.S. (1989)- Indonesian off-shore mineral occurrences. In: Proc. 24th Sess. Comm. Co-ord. Joint Prospecting Mineral Resources in Asian Offshore Areas (CCOP), Bangkok 1987, 2, p. 19-31.
(Brief overview of distributions of offshore hydrocarbons, tin, chromite, iron sand, manganese nodules, etc. Not much detail)

Hehuwat, F. (1978)- A review of mineral exploration in Indonesia. In: Wiryosujono & A. Sudradjat (eds.) Proc. 2nd Regional Conf. Geology and Mineral Resources of SE Asia (GEOSEA), Jakarta 1975, p. 37-42.
(Brief review of mineral occurences and production in Indonesia: tin (Bangka, Belitung, Karimata Islands?), bauxite (W Kalimantan), nickel (SE Sulawesi), gold, silver, manganes, iron sand (S Java, W Sumatra), copper (W Papua))

Hosking, K.F.G. (1970)- The primary tin deposits of South-East Asia. Min. Sci. Eng., 2, p. 24-50.

Hosking, K.F.G. (1971)- The offshore tin deposits of Southeast Asia. United Nations ECAFE, CCOP Techn. Bull. 5, p. 112-129.
(Brief review of offshore cassiterite placer deposits of Burma, W Peninsular Thailand, W Malaysia and Indonesian tin islands Singkep, Bangka, Billiton)

Hosking, K.F.G. (1977)- Known relationships between the óhard-rockô tin deposits and the granites of SE Asia. Bull. Geol. Soc. Malaysia 9, p. 141-157.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm1977027.pdf)
(SE Asian Tin Province stretches for ~1800 miles from mainland Burma and NW Thailand to Tin Islands of Indonesia. E and W belts granites of several distinct ages and types, associated with different primary tin deposits)

Hosking, K.F.G. (1979)- Tin distribution patterns. Bull. Geol. Soc. Malaysia 11, p. 1-70.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm1979001.pdf)
(General review of origins and distribution of tin, with examples of SE Asian tin belt)

Hosking, K.F.G. (1982)- The nature and significance of the pleochroism of the cassiterites of the Southeast Asian Tin Belt. In: Ore Genesis, Soc. Geology Applied to Mineral Deposits, Spec. Publ. 2, Springer, p. 753-759.
(Tin belt of SE Asia composed of two parallel E and W belts, with primary tin deposits of different ages and types in each. Intensely red-pale cassiterites with Ta and possibly Nb in lattice, restricted to W belt and are paramagnetic; brown-pale colour pleochroic (also due to Nb/Ta or W in lattice) in both belts and may be ferromagnetic. Tin sources in both belts crustal, in W belt comparatively rich in Ta and Nb, E belt rel. rich in iron)

Hosking, K.F.G. (1986)- A review of what is presently known about the nature, distribution and genesis of certain authigenic minerals in the stanniferous alluvial deposits of Southeast Asia. In: G.H. Teh & S. Paramananthan (eds.) Proc. 5th Reg. Congress Geology, Mineral and Energy Resources of SE Asia (GEOSEA V), Kuala Lumpur 1984, 2, Bull. Geol. Soc. Malaysia 20, p. 537-577.
(SE Asia tin-bearing alluvial sediments commonly with authigenic minerals like pyrite, marcasite, siderite, etc.)

Hovig, P. (1918)- Contactmetamorfe ijzerertsafzettingen in Nederlands-Indie. Natuurkundig Tijdschrift Nederlandsch-Indie 77, 1, p. 71-104.
(online at: http://62.41.28.253/cgi-bin/..)
('Contactmetamorphic iron ore deposits in the Netherlands Indies'. Investigation of two contact metamorphic iron deposits: (1) C Sulawesi (Salo-Talimbangan, 12 km NW of Rante Pao) and (2) S Sumatra Bukit Rajah. No maps or figures)

Hovig, P. (1920)- De ertsafzettingen van Nederlandsch Indie. In: Algemeen Ingenieurs Congres, Batavia 1920, sect. 5, Mijnbouw en Geologie, Mededeeling 1, p. 1-60.
('The ore deposits of the Netherlands Indies'. Old review of occurrences of iron, manganese, gold-silver, copper, tin, etc. No figures, maps)

Hovig, P. (1923)- 's Lands mijnbedrijven. Vereeniging voor Studie van koloniaal maatschappelijke vraagstukken 15, Kolff, Weltevreden, p. 1-89.
('The country's mining enterprises'. Booklet on Netherlands Indies mining companies, mainly on coal mines and mainly on the business side of the industry, with little or no geological information. Author is pessimistic about profitability of government-operated coal mines, but these are important for strategic reasons)

Hutchison, C.S. (1978)- The impurities of Southeast Asian tin ore concentrates. Warta Geologi 4, 2, p. 39-44.
(online at: https://gsmpubl.files.wordpress.com/2014/09/ngsm1978002.pdf)
(Review of 'impurities' in tin ore concentrates from smelters in W Malay Peninsula, SW Thailand and Bangka-Belitung, Indonesia. Tin concentrate generally of cassiterite with 70-75% Sn content)

Hutchison, C.S. (1988)- The tin metallogenic provinces of S.E. Asia and China: a Gondwanaland inheritance. In: C.S. Hutchison (ed.) Geology of tin deposits in Asia and the Pacific, Selected papers from Int. Symp. Geology of tin deposits, Nanning, China, 1984, Springer Verlag, p. 225-234.
(SE Asia is composite of stable continental blocks which rifted from N margin of Australia. Tin was carried in continental infrastructure of these blocks, which are all of Gondwanaland ancestry. Tectonic events which have

greatest continental crustal involvement are most important in mobilizing tin into economic concentrations. Main metallogenic events are Malayan-type collisions between two continental blocks, resulting in crustal thickening and S-type granite batholiths: (1) Mesozoic belt formed by collision of Sinoburmalaya, Burma Plate, Qantang-Tangla, and Lhasa-Gandise blocks with E Asian Continent, (2) Caledonian E China belt)

Hutchison, C.S. (2009)- Mineral deposits. In: C.S. Hutchison & D.N.K. Tan (eds.) Geology of Peninsular Malaysia, University of Malaya and Geol. Soc. Malaysia, Kuala Lumpur, p. 331-364.

Hutchison, C.S. & K.R. Chakraborty (1979)- Tin: a mantle or crustal source? In: C.H. Yeap (ed.) Int. Symp. Geology of tin deposits, Kuala Lumpur 1978, Bull. Geol. Soc. Malaysia 11, p. 71-79.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm1979002.pdf)
(Primary tin deposits overwhelmingly associated with acid igneous or quartz-rich hydrothermal rocks; genetically related to granites. Distribution of tin deposits suggests anatexis of sialic crust most likely cause of evolved SiO2 and K2O rich tin granites. Tin commonly associated with high sphene and biotite)

Hutchison, C.S. & D. Taylor (1978)- Metallogenesis in SE Asia. J. Geol. Soc., London, 135, p. 407-428.
(Overview of SE Asia economic metals distribution. Three metallogenic provinces (1) peripheral Cenozoic volcanic arc (copper, gold, silver), (2) Mesozoic Sundaland core (tin with minor tungsten, antimony), and (3) cratonic China N of Red River Suture (tungsten, antimony with tin, mercury). Ophiolites, obducted from Pacific and marginal basin lithosphere, yield substantial chromite and nickel from residual laterite)

Hutchison, R.W. (1986)- Massive sulphide deposits and their possible significance to other ores in Southeast Asia In: G.H. Teh & S. Paramananthan (eds.) Proc. 5th Reg. Congress Geology, Mineral and Energy Resources of SE Asia (GEOSEA V), Kuala Lumpur 1984, 1, Bull. Geol. Soc. Malaysia 19, p. 1-22.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm1986001.pdf)
(Discussion of massive base metal sulphide deposits, which formed on sea floor by chemical precipitation from metalliferous hydrothermal fluids. Many geological characteristics of massive base metal sulphides duplicated in barite, manganese, iron-tin, iron skarn and base metal deposits of C and E belts in Peninsular Malaysia (Sokor, Bukit Besi, Bukit Bangkong, Tasek Cini) and extensions N into Thailand (Pinyok) and S into Indonesia (stratiform zinc-lead-silver at Kelapa Kampit and Selumar, Belitung))

Imai, A., T. Ikuno, K. Sanematsu, T. Sueoka, K. Watanabe (2009)- Rare Earth Elements in weathered crusts of granitic rocks in Southeast Asia tin belt (

Ishlah, T. (2012)- Tinjauan keterdapatan emas pada kompleks ofiolit di Indonesia. Bul. Sumber Daya Geologi 7, 1, p. 23-32.
(online at: http://psdg.bgl.esdm.go.id/images/buletin/)
('Review of gold deposits in ophiolite complexes in Indonesia'. On little-known gold occurrences in Bobaris and Meratus Mts in S Kalimantan, Tanah Grogot in E Kalimantan, Bombana in SE Sulawesi and CycloopsMts/ Lake Sentani in NE West Papua. No commercial occurrences identified yet)

Irving, E.M. (1956)- Observations on Indonesia mineral resources and their development. The Philippine Geologist 10, 2, p. 33-51.

Irzon, R., P. Sendjadja, Kurnia, Imtihanah & J. Soebandrio (2014)- Kandungan Rare Earth Elements dalam tailing tambang timah di Pulau Singkep. J. Geologi Sumberdaya Mineral 15, 3, p. 143-151.
(online at: http://jgsm.geologi.esdm.go.id/index.php/JGSM/article/view/54/56)
('Rare Earth Elements in tailings from tin mining on Singkep Island'. Tailings of former tin mines on Singkep island (probably also on Bangka, Belitung) contain 123-368 ppm Rare Earth Elements (REE) in monazite, etc. In concentrate upto 5800 ppm)

Irzon, R., I. Syafri, J. Hutabarat & P. Sendjadja (2016)- REE comparison between Muncung Granite samples and their weathering products, Lingga Regency, Riau Islands. Indonesian J. Geoscience 3, 3, p. 149-161.
(online at: https://ijog.geologi.esdm.go.id/index.php/IJOG/article/view/344/226)

(Rare Earth Eelemnts in Muncung Granite and its weathered layers on Lingga, Selayar and Singkep islands, Riau Province. Average REE content of 7 granites 265 ppm, but 4x enrichment in laterization layer)

Jackson, K.J. & H.C. Helgeson (1985)- Chemical and thermodynamic constraints on the hydrothermal transport and deposition of tin: II. Interpretation of phase relations in the Southeast Asian tin belt. Economic Geology 80, p. 1365-1378.
(On Thailand- Malay Peninsula tin deposits. Hydrothermal mineral assemblages in SE Asian tin deposits consist of quartz, cassiterite, muscovite, K-feldspar, topaz, magnetite, and rarely, hematite, fluorite, tourmaline, and zinnwaldite. Assemblage estimate to have formed at ~350°C and 500 bars)

Johnson, R.F. & R. Sukamto (1960)- Cave deposits of phosphate rock in Central Djawa. Djawaten Geologi, Techn. Publ. 2, Economic Geology Ser., p. 1-35.

Johari, S. & U. Kuntjara (1990)- The occurrences of Rare Earth minerals in Indonesia. In: B. Siribumrungsukha et al. (eds.) Proc. Int. Conf. Rare Earth minerals and minerals for electronic uses, Prince Songkla University, Hat Yai, Thailand, p. 645-662.

Johari, S. & U. Kuntjara (1990)- The occurrences of rare metal minerals in Indonesia. Proc. 19th Ann. Conv. Indon. Assoc. Geol. (IAGI), Bandung, 1, p. 350-364.
(Indonesia potential for yttrium group REE mainly in xenotime from cassiterite placers in Tin Islands, particulary Belitung, and likely equivalents in Tigapuluh Mts and Bangkinang areas of Riau, Sumatra. Areas with (mainly pre-Jurassic) granitic intrusions with favorable characteristics for lithophile rare metal mineralization mainly in Sumatra, Banggai-Sula islands and W Papua)

Johari, S. (1992)- A guide to rare metal and Rare Earth metals in Indonesia. In Memorial to Sunarya Johari, MSc. Directorate of Mineral Resources, Bandung., p.

Kadarusman, A. (2016)- Advances in understanding various ore deposits in ultramafic rocks in Indonesia. Proc. 8th Ann. Conv. Indonesian Soc. Economic Geol. (MGEI), Bandung, p. 19-22.
(Ultramafic rocks exposed in many parts of Indonesia. May be source of Fe, Cr, Platinum-Group Minerals, V, Ti, Ni, Co and Cu deposits)

Koesoemadinata, R.P. & V.E. Nelson (1970)- Mineral resources in Indonesian development. In: H.W. Beers (ed.) Indonesia; resources and their technological development, University Press of Kentucky, p. 117-139.
(Brief review of Indonesia petroleum and mineral deposits)

Kun, N. de (1961)- Die Zinn- Niob- Tantal- Lagerstatten von Sudost Asien. Neues Jahrbuch Mineral. Geol., Monatshefte, 1961, 4, p. 89-96.
('The tin, niobium and tantalium deposits of SE Asia')

Kurnio, H. (1999)- Review and recent data on the occurrences of offshore minerals in Indonesia. Bull. Marine Geol. (MGI, Bandung), 14, 2, p. 9-27.
(Indonesian offshore minerals tin and iron sand already exploited. Recent data on offshore gold, silver, quartz sand, coal and zircon discovered by Marine Geological Institute expected to become future reserves. Offshore aggregates in Java Sea and Malaka Strait potential construction materials)

Kurnio, H. (2007)- Coastal characteristics of iron sand deposits in Indonesia. Indonesian Mining J. 10, 3, p. 27-38.
(online at: http://jurnal.tekmira.esdm.go.id/index.php/imj/article/view/611/473)
(Review of coastal iron sand deposits in Indonesia. Black or gray iron sands in Sumatra, Java, Bali and Nusatenggara Islands largely derived from denudation of andesite and 'Old Andesite Fm' enriched in magnetite and ilmenite minerals. Coastal zones, especially S parts of Neogene Sunda Banda magmatic arc from N Sumatra to E Indonesia, potential areas for iron sand deposits)

Liebenam, W. (1902)- Vorkommen und Gewinning von Gold in Niederlandisch-Ost-Indien (nach einem Vortrag von S.J. Truscott,...). Zeitschrift Praktische Geologie 10, p. 225-230 and p. 260-268.
(online at: https://babel.hathitrust.org/cgi/pt?id=uc1.31822032651069;view=1up;seq=241)
('Occurrences and exploitation of gold in the Netherlands East Indies (after a presentation by S.J. Truscott,..')
(Brief review of gold mining regions of Sumatra, Kalimantan (W Kalimantan near Samba, C Kalimantan in source areas of Kahayan and Kapuas Rivers and SE Kalimantan) and N Sulawesi, as known in 1902)

MacDonald, E.H. (1971)- Detrital heavy minerals. Country report: Indonesia. United Nations ECAFE CCOP Techn. Bull. 5, p. 48-53.

Madiadipoera, T. (1999)- Bahan galian industri di Indonesia. Directorate Mineral. Res., Bandung, Spec. Publ. 36, p. 1-224.
('Extractive industries in Indonesia')

Madiadipoera, T. & S. Harjanto (1988)- Potential of industrial minerals in Indonesia. Directorate Mineral. Res., Bandung, p.

Mamengko, D.V. (2013)- Potensi bauksit di kabupaten Lingga, Provinsi Kepulauan Riau. Istech 5, 2, p. 66-70.
(online at: http://download.portalgaruda.org/article.php?article=101637&val=1606)
('Bauxite potential in the Ligga Districts, Riau Islands'. Potential bauxite evenly distributed on Singkep, Selayar, Bendahara and Rusuk Buaya Islands)

McDivitt, J.F. (1989)- Overview of mineral development in Indonesia. Geologi Indonesia (J. Assoc. Indon. Geol. IAGI) 12, 1 (Katili volume), p. 327-343.
(Brief historic overview of mining in Indonesia until 1988. Little or no detail on geology, areas or projects)

Miyamoto, H. (1943)- Mineral resources of Lesser Sunda and Molucca islands. J. Geography, Tokyo, 55, 7, p. 229-236.
(online at: www.jstage.jst.go.jp/article/jgeography1889/55/7/55_7_229/_pdf)
(In Japanese. Mainly literature review. No maps or sections)

Mohr, E.C.J. (1934)- Diatomeeenaarde (kieselgur) in Ned.-Indie. De Indische Mercuur, 26 December 1934, p. 3-15.
('Diatomaceous earth in Netherlands Indies'. Very brief review of diatomite occurrences in Indonesia, incl. Samosir (Lake Toba) and Cirebon, Cicurug areas of Java)

Molengraaff, G.A.F. (1910)- Das Vorkommen und die Gewinnung von Eisenerz in den Niederlandischen Kolonien. In: The iron ore resources of the world, 11th Int. Geol. Congress, Stockholm 1910, 2, p. 993-996.
(online at: https://babel.hathitrust.org/cgi/pt?id=nyp.33433089972370;view=1up;seq=489)
('The occurrence and exploitation of iron ore in the Netherlands colonies'. Very brief listing of known iron ore occurrences in Indonesia: Gunung Besi (Sumatra; hematite), Teluk Betung (S Sumatra; magnetite), Banyumas (Java; iron sand) Gunung Tambaga (SE Kalimantan; hematite). None producing. All of questionable commercial value)

Muller, D. & D.I. Groves (2015)- Direct associations between potassic igneous rocks and gold-copper deposits in volcanic arcs. In: Potassic igneous rocks and associated gold-copper mineralization, 4th Ed., Mineral Resource Reviews, Springer, p. 97-190.
(Examples of direct associations between potassic igneous rocks and copper-gold deposits include: (1) Late Oceanic Arc associations: Ladolam gold (Quaternary, Lihir Island, PNG); Emperor gold (Tertiary, Viti Levu, Fiji), Dinkidi copper-gold (Miocene, Didipio district, Philippines); and (2) Post-collisional Arc associations: Grasberg copper-gold (Pliocene, W Papua), Misima gold (Pliocene, Misima Island, PNG); Porgera gold (Miocene, PNG))

Palfreyman, W.D., H.F. Doutch, R.L. Brathwaite et al. (1996)- Mineral-resources map of the Circum-Pacific region, Southwest Quadrant. U.S. Geol. Survey (USGS) Circum-Pacific Map 42, 1: 10M scale.
(online at: https://pubs.usgs.gov/cp/42/plate-1.pdf)

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(online at: http://pubs.usgs.gov/cp/42/report.pdf)

Peters, S.G. (2006)- The distribution of major copper deposits in the Southeast Asia region. In: Q. He et al. (eds.) Proc. 42nd CCOP Ann. Sess., Beijing 2005, p. 55-58.
(Brief overview of distribution of porphyry copper deposits in SE Asia. No figures)

Peters, S.G., W.J. Nokleberg, J.L. Doebrich, W.J. Bawiec, G. Orris, D.M. Sutphin & D.R. Wilburn (2006)- Geology and nonfuel mineral deposits of Asia and the Pacific. U.S. Geol. Survey (USGS) Open-File Report 2005-1294C, p. 1-63.
(online at: http://pubs.usgs.gov/of/2005/1294/c/OFR2005-1294C.pdf)
(Overview of mineral deposits in SE Asia (China, India, Indonesia)- Pacific (Japan, Australia, New Zealand)

Pudjowalujo, H. (1981)- Copper exploration in Indonesia. Proc. 10th Ann. Conv. Indon. Assoc. Geol. (IAGI), p. 209-317.

Reksalegora, W. & Djumhani (1973)- Metallic mineral deposits of Indonesia. In: N.H. Fisher (ed.) Metallic provinces and mineral deposits in the Southwest Pacific, 12th Pacific Science Congress Symposium, Canberra 1971, Bureau Mineral Res. (BMR), Geol. Geophysics, Bull. 141, p. 59-67.
(online at: www.ga.gov.au/corporate_data/108/Bull_141.pdf)
(Brief review of Indonesian mineral provinces. Malaya orogen (Late Jurassic) characterized by cassiterite-bearing pegmatites and veins. Pyrosomatic iron and copper ores tied to Sumatra orogen (U Cretaceous). Epithermal gold-silver important in Sunda orogen (M Miocene) in W Sumatra and S Mountains of Java. West Papua separate unit, with lateritic deposits in N and gold-silver-copper in C Range))

Reynolds, N. (2013)- Tectonics and metallogeny of mainland Southeast Asia- framework for new discovery opportunities. In: Proc. Symp. East Asia: Geology, Exploration Technologies and Mines, Bali 2013, Australian Inst. Geoscient., Bull. 57, p. 78-79. *(Extended Abstract)*
(Mainland SE Asian metallogeny related to history of accretion of Gondwanan terranes. Late Carboniferous-Triassic development and accretion of arc/ back-arc belts fringing Indochina block important metallogenic period in SE Asia. Indosinian orogenic gold in Raub-Bentong zone of Malaysia. Late Triassic first phase of SE Asian tin-tungsten belt, related to Indosinian late orogenic granites. Re-initiation of subduction outboard of collision zones along W Sibumasu margin and E Indochina-South China margin in Late Triassic- Jurassic. In S China- Indochina, Jurassic-Cretaceous 'Yanshanian' magmatism evolved from I-type to A-type in continental arc setting and associated with mineral systems. On W Sibumasu margin, Late Cretaceous second phase of tin-tungsten mineralisation associated with A-type magmatism. Porphyry copper-gold and epithermal systems in C Myanmar arc belt in Oligocene- Miocene)

Rochani, S., Pramusanto, Sariman & R.I. Anugrah (2008)- The current status of iron minerals in Indonesia. Indonesian Mining J. 11, 2, p. 1-17.
(online at: http://jurnal.tekmira.esdm.go.id/index.php/imj/article/view/590/452)
(Indonesia iron resources include (1) primary iron ore (hematite, magnetite; 17%), (2) iron sand; commonly used for cement industries (8%) and (3) lateritic iron ore (limonite, from weathered ultrabasic rocks) used as coal liquefaction catalyst (75%). With listings of main iron sand deposits (10) and lateritic deposits (10) and primary iron ore deposits (10))

Sainsbury, C.L. (1969)- Tin resources of the world. U.S. Geol. Survey Bull. 1301, p. 1-55.
(online at: https://pubs.usgs.gov/bul/1301/report.pdf)

(With brief reviews of tin deposits of Indonesia, Malaysia, Thailand, Burma)

Sanematsu, K. (2014)- Resource potential of REE in Sundaland, Southeast Asia. In: I. Basuki & A.Z. Dahlius (eds.) Sundaland Resources, Proc. Indon. Soc. Econ. Geol. (MGEI) Ann. Conv., Palembang, p. 163-180.
(Rare Earth Elements ore deposit types in SE Asia mainly placer and ion adsorption (weathered granite) types. Placer monazite and xenotime mostly in ilmenite-series granite areas of SE Asian Sn Belt. Few prospective areas identified in Indonesia, except possibly Bangka, with possible placer REE from tailings of Sn processing or from beach sand)

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(Rare Earth Element in mainland SE Asia (nothing in Indonesia))

Sendo, T. (1941)- Tin of the Dutch East Indies. J. Geography, Tokyo, 53, 633, p. 475-500.
(online at: www.jstage.jst.go.jp/article/jgeography1889/53/11/53_11_475/_pdf)
(In Japanese. Mainly literature compilation of 'Tin Islands' geology)

Setijadji, L.D. (2014)- Regional evaluation on the Rare Earth Elements (REE) mineralization potentials in the Sundaland of Indonesia. In: I. Basuki & A.Z. Dahlius (eds.) Sundaland Resources, Proc. Ann. Conv. Indon. Soc. Econ. Geol. (MGEI), Palembang, p. 145-162.
(Study of REE potential in Indonesia. Prospectivity in areas of continental crust, where multiple events of granitoid magmatism took place. Tin Islands and West Kalimantan granitoids may be linked. REE exploration targets in Indonesia: (1) primary alkaline-peralkaline igneous rocks, (2) lateritic deposits, and (3) placer monazite (xenotime; byproducts of placer tin mining))

Setijadji, L.D., I.W. Warmada, A. Imai & K. Sanematsu (2009)- Investigation on Rare Earth Elements mineralization in Indonesia. In: 2nd Reg. Conf. Interdisciplinary Research on Natural Resources and Materials Engineering, Yogyakarta, p. p. 53-58.
(REE most likely associated with Mesozoic granitic rocks in W Indonesian, i.e. Tin islands (Bangka, Belitung, Bintan and Singkep) and west C Kalimantan. Tin islands similar geology with REE-producing China and SE Asia granite belts)

Sigit, S. (1973)- Large scale mineral exploration and new mining development prospects in Indonesia. Bull. Geol. Soc. Malaysia 6, p. 288-296.
(online at: https://gsmpubl.files.wordpress.com/2014/09/bgsm1973019.pdf)

Sigit, S., M.M. Purbo-Hadiwidjojo, B. Sulasmoro & S. Wirjosudjono (1969)- Minerals and mining in Indonesia. Ministry of Mines, Jakarta, p. 1-123.
(1969 overview of Indonesia coal and minerals mining)

Sillitoe, R.H. (1994)- Indonesian mineral deposits- introductory comments, comparisons and speculations. J. Geochemical Exploration 50, p. 1-11.
(Indonesia has range of precious and base metal deposits typical of Cenozoic volcano-plutonic arcs. Porphyry Cu-Au, skarn Cu-Au and low-sulphidation epithermal Au economically most important, including world-class ore bodies. Also present: porphyry Mo, sediment-hosted Au, high-sulphidation epithermal Au and volcanogenic massive sulphide Au. 70% of deposits discovered by regional geochemical surveys)

Sillitoe, R.H. (1995)- Exploration and discovery of base- and precious-metal deposits in the Circum-Pacific region during the last 25 years. Resource Geology (Shigen Chishitsu), Special Issue 19, p. 1-119.
(Exploration and discovery histories of 54 major base- and precious-metal deposits around Pacific Rim from 1970-1995)

Sillitoe, R.H. (1997)- Characteristics and controls of the largest porphyry copper-gold and epithermal gold deposits in the circum-Pacific region. Australian J. Earth Sci. 44, 3, p. 373-388.
(Includes data from Indonesia- Philippines porphyry copper deposits. Grasberg, Ok Tedi and Porgera in New Guinea, Ladolam and Panguna in nearby islands and Baguio in N Philippines all very young and emplaced during rapid tectonic uplift induced by collision processes)

Sillitoe, R.H. (2010)- Exploration and discovery of base- and precious metal deposits in the Circum-Pacific region- a 2010 perspective. Resource Geology, Spec. Issue 22, p. 1-139.
(Review of 101 case histories of metal deposits discovered in Circum-Pacific region in last 40 years)

Silitonga, P.H. & Surjono (1985)- Exploration for titaniferous iron sand in the coastal area of Cipatujah, West Java. Proc. 21st Sess. Comm. Co-ord. Joint Prospecting Mineral Resources in Asian Offshore Areas (CCOP), Bandung, 2, p. 40-45.

Solomon, M. (1990)- Subduction, arc reversal, and the origin of porphyry copper-gold deposits in island arcs. Geology 18, 7p. 630-633.
(Tertiary-Quaternary porphyry copper-gold deposits of SW Pacific rim (Luzon, New Guinea, Bougainville, Guadalcanal, Fiji) mostly formed after reversal of arc polarity. Where this reversal has not occurred (New Zealand and Japan), porphyry copper-gold deposits absent or scarce. Gold enrichment of magmas may be result of two-stage melting)

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('The strategic commodity chromite, geology technology and its potential in Indonesia'. Chromite known from several areas inIndonesia (associated with peridotites): SE Kalimantan, Latau, Barru, Malili, Halmahera, Gebe. Small scale mining in Gebe in 1970's, but most deposits in Indonesia non-commercial at the moment)

Subandrio, A.S. (2014)- Mesozoic-Cenozoic iron ore mineralization associated with magmatism in the Indonesian Sundaland Region. In: I. Basuki & A.Z. Dahlius (eds.) Sundaland Resources, Proc. Indon. Soc. Econ. Geol. (MGEI) Ann. Conv., Palembang, p. 425-447.
(Iron ore deposits widespread in Sumatra and Kalimantan, but little explored. 'Banded' iron ore deposits probably related to Mesozoic submarine hydrothermal activity described from Subullusalam (Aceh, N Sumatra), Tanggamus (Lampung, S Sumatra) , Kendawangan (W Kalimantan; ore mined from late Mesozoic Pinoh meta-sedimentary complexes), and Balaisebut iron ore mineralization (NE of Pontianak, NW Kalimantan, in Sanggau area))

Sunarya, Y. (1989)- Overview of gold exploration and exploitation in Indonesia. Geologi Indonesia (J. Assoc. Indon. Geol., IAGI) 12 (Katili volume), 1, p. 345-357.
(Widespread epithermal gold deposits associated with subduction volcanism in Indonesia. Gold production from 1899-1989 130 tonnes: 80 from Bengkulu (W Sumatra), 10 from Cikotok (W Java), 20 from N Sulawesi) + additional production from Kalimantan and West Papua)

Sunarya, Y. (1992)- Overview of gold exploration and exploitation in Indonesia. In: Epithermal gold in Asia and the Pacific, mineral concentrations and hydrocarbon accumulations in the ESCAP Region series, UN ESCAP, 6, p. 155-161.
(Same paper as Sunarya 1989. Gold mining in Indonesia began in 1899. Early mining from epithermal lode deposits hosted by volcanics in W Sumatra and W Java, with subsequent discoveries in Kalimantan (Kelian, Mt Muro, Muyuo, etc.) and on Flores-Wetar. Porphyry copper- associated gold in Ertsberg (Irian Jaya), N Sulawesi and Bacan. Alluvial gold exploited on Sumatra, Kalimantan and Sulawesi)

Sunarya, Y. & J. J. Bache (1995)-Previous epithermal gold mines in Indonesia. Direktorat Sumberdaya Mineral, Spec. Publ. 80, p.

Supriyadi & N. Umar (1996)- Tin exploration in Indonesia; problems and solution. In: Diversity; the key to prosperity, AusIMM Ann. Conf., Perth 1996, Australasian Inst. of Mining and Metallurgy 1/96, p. 385-391.
(Exploration for tin deposits has been ongoing in Indonesia over ~300 years. Indonesia is part of tin belt from Myanmar in N through Malaysia to Singkep, Bangka and Belitung islands in Indonesia in S. Discovery of alluvial tin deposits becoming harder as obvious geological targets are exhausted and topographical conditions become more difficult)

Syaeful, H., K. Setiawan W., I.G. Sukadana & A. Gunawan (2014)- Rare Earth Element exploration in Indonesia. In: I. Basuki & A.Z. Dahlius (eds.) Sundaland Resources, Proc. Indon. Soc. Econ. Geol. (MGEI) Ann. Conv., Palembang, p. 205-217.
(REE Regions in Indonesia with potential REE resources in Bangka Belitung, Kalimantan and W Sulawesi)

Tampubolon, A. (2013)- The Indonesia Titanium deposit types and their resources, The aspects for Titanium commodity development. Bul. Sumber Daya Geologi 8, 3, p. 100-109.
(online at: www.bgl.esdm.go.id/publication/index.php/dir/article_detail/682)
(Indonesia has beach placer, alluvial and lateritic types of titanium deposits. Sumatra, Java and Flores with beach placers of iron sands, derived from Tertiary volcanics. Alluvial deposits associated with cassiterite alluvial from Triassic-Jurassic granites of Bangka-Belitung Islands. Lateritic deposits associated with bauxite and nickel in Riau, Kalimantan, Sumatra ad Sulawesi)

Taranik, J.V., C.D. Reynolds, C.A. Skeenan & W.D. Carter (1978)- Targeting exploration for nickel laterites in Indonesia with Landsat data. Proc. 12th Symposium of Remote Sensing, Manila, Environmental Research Institute of Michigan, p. 1037-1051.
(Using vegetation anomalies on satellite imagery to target nickel laterites)

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Ter Braake, A.L. (1944)- Mining in the Netherlands East Indies. Netherlands and Netherlands Indies Council of the Institute of Pacific Relations, New York, Bull. 4, p. 1-110.
(Overview of mineral deposits in Indonesia as known during WW-II)

Ter Braake, A.L. (1977)- Mining in the Netherlands East Indies. Arno Press, New York, p. 1-110.
(Reprint of Ter Braake (1944))

Thaib, J. (1960)- Tanah diatomea di Indonesia. Publ. Teknik, Ser. Geol. Ekonomi, Djawatan Geologi, Bandung, 1, p. 1-24.
('Diatomaceous earth in Indonesia')

Truscott S.J. (1902)- The occurrence and mining of gold in the Dutch East Indies. Trans. Inst. Mining Metallurgy 10, 31, p. 52-86.

Van Bemmelen, R.W. (1940)- Bauxiet in Nederlandsch-Indie. Dienst Mijnbouw Nederlandsch-Indie, Verslagen Mededelingen betreffende Indische delfstoffen en hare toepassingen 23, p. 1-115.
('Bauxite in Netherlands Indies'. Lateritic weathering of probably basic igneous rocks lead to formation of bauxite. Occurrences in Indonesia on islands of Banka and Bintan)

Van Bemmelen, R.W. (1940)- Delfstoffen van Nederlandsch Indie als grondstoffen der inheemsche industrie. Natuurwetensch. Tijdschrift Nederl. Indie 101, 1, p. 11-19.
('Minerals from the Netherlands Indies as raw materials for local industry'. A brief review)

Van Bemmelen, R.W. (1945)- On the mineral resources of the Netherlands Indies and their industrial possibilities. In: P. Honig & F. Verdoorn (eds.) Science and scientists in the Netherlands Indies, Board for Netherlands Indies, Surinam and Curacao, New York, p. 5-10.

(Brief review of minerals and production volumes in late 1930's in Indonesia)

Van Bemmelen, R.W. (1949)- The geology of Indonesia. Government Printing Office, Martinus Nijhoff, The Hague, vol. 2, Economic geology, p. 1-265.
(Comprehensive review of deposits of oil, coal, metals, industrial minerals in Indonesia, as known in 1949)

Van den Broek, J. (1921)- Onze koloniale Mijnbouw, IV. Tinmijnbouw. Tjeenk Willink, Haarlem, p. 1-95.
('Our colonial mining industry, IV, Tin mining'. Early popular overview of tin mining in Bangka, Belitung and Singkep, Indonesia. Main tin ore cassiterite. Banka mining since ~1710, Belitung (Billiton) since 1851 and Singkep since 1860. All mining in alluvial deposits, eroded from granites. Max. depth of exploitation ~100m)

Van den Ploeg, F.P.C.S. (1945)- Insulinde, schatten van den bodem. W. van Hoeve, Deventer, p. 3-216.
(Overview of natural resources and mining activity in Netherlands Indies until 1940. Written for broad audience, but quite thorough)

Van Leeuwen, T.M. (1994)- 25 years of mineral exploration and discovery in Indonesia. J. Geochemical Exploration 50, 1-3, p. 13-90.
(Extensive review of mineral exploration by foreign companies in Indonesia between 1967 and 1991. Four main phases: (1): 1967-1976, mostly investigations of mineral prospects previously identified by Dutch; (2) 1970-1975, extensive porphyry copper search in Sunda arc, W Sulawesi and central belt of Irian Jaya; (3) 1981-1988, extensive coal exploration in S and E Kalimantan; (4) 1984-1990, second gold rush, ~100 years after first, focused primarily on Cenozoic magmatic belts of Kalimantan, Sulawesi, Moluccas and Sunda arc. Only significant uranium discovery was at Kalan in fault breccias in metasediments in W Kalimantan)

Van Lier, R.J. (1918)- De mijnbouw in Nederlandsch-Indie. Koloniaal Instituut, Amsterdam, p. 1-60.
('Mining in the Netherlands Indies'. Early popular overview of coal, mineral (tin, gold-silver, iron) and petroleum exploitation in Netherlands Indies since 1700's)

Verloop, J.H. (1916)- Onze koloniale Mijnbouw, I. De Goudindustrie. Tjeenk Willink, Haarlem, p. 1-95.
('Our colonial mining industry, I, The gold industry'. Early popular overview of gold mining in Indonesia)

Verloop, J.H. (1917)- De economische beteekenis van onze koloniale goudindustrie. H.A. van Bottenburg, Amsterdam, p. 1-91.
('The economic significance of our colonial gold industry')

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(online at: https://minerals.usgs.gov/minerals/pubs/country/2013/myb3-2013-id.pdf)
(Listing of minerals produced in Indonesia in 2013. No geology)

Wahju, B.N. (2004)- Current status of mining in Indonesia. J. Mines, Metals and Fuels 52, p. 158-166.

Wanner, J. (1942)- Die mineralischen Rohstoffe der Niederlande und der niederlandischen Kolonien. Kriegsvortage Rheinischen Friedrich-Wilhelms-Universitat, Bonn, 70, p. 1-24.
('Mineral resources of The Netherlands and Netherlands Indies'. Brief wartime review, mainly on distribution of petroleum and minerals of Indonesia)

White, N.C., M.J. Leake, S.N. McCaughey & B.W. Parris (1995)- Epithermal gold deposits of the southwest Pacific. J. Geochemical Exploration 54, 2, p. 87-136.
(BHP data tabulation for 137 epithermal gold deposits and prospects in Australia (30), Fiji (2), Indonesia (43), New Zealand (22), Palau and Yap (2), Papua New Guinea (18), Philippines (19), and Solomon Islands (1). Epithermal deposits in SW Pacific similar to other regions, but low-sulfidation style deposits formed at deeper levels than typical elsewhere; high-sulfidation deposits more common than along NE Pacific margin. Differences can be partly understood in terms of tectonic setting and evolution of volcanic arcs of SW Pacific)

Whitehouse, J. (2011)- Manganese resource potential Banda arc region, Eastern Indonesia. Stratum Resources Pty Ltd, non-confidential report, p. 1-31.
(N Flores and Timor with many scattered occurrences of manganese)

Wijayanti, K., M.F. Rosana, E.T. Yuningsih, R.I.. Sulistyawan (2017)- Karakteristik jasper merah di Pulau Jawa bagian selatan berdasarkan analisis SEM dan XRF. J. Geologi Sumberdaya Mineral 18, 1, p. 25-32.
(online at: http://jgsm.geologi.esdm.go.id/index.php/JGSM/article/view/82/123)
('Characteristics of red jasper in S Java based on SEM and XRF analysis'. Red, yellow and green jasper widespread in Indonesia. Red jasper most common, especially in S Mountains of Java. All S Java samples same cryptocrystalline texture. Red color from Fe, Cr, and V. High Ti content in Pacitan red jasper)

Wing Easton, N. (1917)- De minerale rijkdom van Ned. Oost-Indie en de toekomstige mijnbouwpolitiek aldaar. De Ingenieur 1917, 11, 15p.
('The mineral wealth of the Netherlands East Indies and the future mining politics there'. Early review of mineral potential of Indonesia. Argues that potential is limited to orogenic belts. Gold-silver deposits found only in areas with Late Tertiary acid volcanics, tin in Paleozoic granites, etc.)

Zen, M.T. (1969)- On the Indonesian sulphur deposits. Bull. Nat. Inst. Geology and Mining, Bandung, 2, 2, p. 33-41.
(Sulfur deposits in Indonesia are of volcanic origin. Pure sulphur produced from sublimation of volcanic gases from solfatara fields in extinct and active volcanic regions. Crater lakes contain sulfuric mud with >40% sulfur. Potential crater deposits in Sumatra (Namora Langit, Sorik Merapi), Java (Kawah Putih, Telaga Bodas, Tangkuban Perahu, Kawah Karaha, Siterus, Idjen) and N Sulawesi (Mahawu, Telaga Masem))

Zientek, M.L. & N.J. Page (1990)- Consultancy services in Platinum-group mineral exploration for the Directorate of Mineral Resources. U.S. Geol. Survey, Open-File Report 90-527, p. 1-332.
(online at: http://pubs.usgs.gov/of/1990/0527/report.pdf)
(Review of platinum-group mineral occurrences in Indonesia. Generally in placer deposits derived from ultramafic rocks. Main occurrences in SE Kalimantan (placers in front Meratus Range). Traces of platinum-group in N Sumatra (Woyla River), C Sumatra (Bengkalis, Riau), South Java (Cilacap, Jampang Kulon), S Sulawesi)