References

Mares, T.E., Moore, T.A., Moore, C.R., 2009. Uncertainty of gas saturation estimates in a subbituminous coal seam. International Journal of Coal Geology 77, 320-327.

Raza, A., Hill, K.C., Korsch, R.J., 2009. Mid-Cretaceous uplift and denudation fo the Bowen and Surat Basins, eastern Australia: relationship to Tasman Sea rifting from apatite fission-track and vitrinite-reflectance data. Australian Journal of Earth Sciences 56, 501-531.

Ryan, D.J., Hall, A., Erriah, L., Wilson, P.B., 2012. The Walloon coal seam gas play, Surat Basin, Queensland. APPEA Journal 52, 273-289.

Abstract 32

Topic: Coal geology, resources, and utilization

Volcanic and volcanogenic sediments in the coal-bearing Tanjung Formation (Late Eocene), Senakin Peninsula, South Kalimantan (Borneo), Indonesia

Moore, Tim A.[1,2,3,*], Mike C. Friederich[4], Ferian Anggara[5], D. Hendra Amijaya[5], Jessica Trofimovs[2]

[1] China University of Mining and Technology, Xuzhou, China

[2] School of Earth, Environmental and Biological Sciences, Queensland University of Technology, Brisbane, QLD, Australia

[3] Cipher Consulting Pty. Ltd., 6 Stardust Street, Kenmore, QLD, Australia

[4] Independent Consultant, PO Box 636, Kenmore, QLD, Australia

[5] Gadjah Mada University, Yogyakarta, Indonesia

[*] Corresponding author: tmoore@ciphercoal.com

In Southeast Asia the Paleogene was a time of rifting. Indonesia, in particular, is characterised by rift sediments beginning in the middle to late Eocene (Cloke et al., 1999; Doust and Noble, 2008; Pubellier and Morley, 2014). There is significant variation in the sedimentology between basins, but overall basal units unconformably overlie Mesozoic to Palaeozoic sequences. Initial deposits are coarse, often conglomeratic and grade conformably upwards into sandstones interbedded with siltstones and mudstones. These sediments progressively become more interbedded with organic-rich intervals and then coal beds are often present that can be of considerable thickness (>3 m) and lateral extent (>20 km). The presence of coal beds is thought to mark widespread coastal plain environments. Overlying sediments are mostly mudstones and eventually carbonates, marls and marine shales. The sequence is interpreted as transgressive, initially high energy freshwater fluvial at the base, to a broad coastal plain setting bordered by brackish water embayments, to shallow marine environments, then finally full open marine environments at the time of maximum subsidence (Doust and Noble, 2008; Friederich et al., 1999; Friederich et al., 2016).

In almost all cases, Eocene-age rift sediments in Kalimantan, Indonesia (Borneo) have not been reported to contain volcanic or volcanogenic sediments. A notable exception is the Nyaan volcanics in the upper Kutai basin in East Kalimantan (Pieters et al., 1993), which have been dated at 48.6-50 Ma (Soeria-Atmadja et al., 1999).

The Late Eocene-age Tanjung Formation (and lateral equivalents) in southeastern Kalimantan can be considered a typical rift-fill sequence. Numerous studies have been conducted that focus on the significant quantities of oil and coal (Bon et al., 1996; Friederich and van Leeuwen, 2017; Satyana et al., 2001; Siregar and Sunaryo, 1980). Recently, Witt et al. (2012) conducted one of most comprehensive regional studies of the Tanjung Formation, though it was concentrated mainly within the Barito Basin, South Kalimantan. A commonality of all studies is the notable absence of any volcanic influence.

In contrast, the Tanjung Formation in the Senakin Peninsula is unusual because it contains volcanic ash-fall (Ruppert and Moore, 1993), volcanics and volcanogenic sediments, which, for the latter two have as of yet, not been described. Recent fieldwork in the Senakin Peninsula collected samples of both volcanogenic sediments and dark, mafic, fine-grained basaltic rocks. At the Gumbil sampling site the volcanogenic sediments were greater than 5 m thick and consisted of soft grey, pelitic mudstones with hard, rounded pumice-like material. The basal 0.5 m and the top meter of the volcanogenic sediments were bedded and void of pumice-like pebbles. The middle 3.5 m showed a distinct lack of bedding but contained abundant pumice-like pebbles. At the Sebuli sampling site, the basalt was over 30 m thick with distinct columnar jointing. Although the top could not be observed, the basal contact with the underlying mudstone showed a white, probable alteration zone. Unpublished data by Moore (1990) shows that where the basalt does cross cut the coal, rank is elevated from 0.5 Ro_{max} to over 2.2.

Geochemistry and mineralogy are currently underway that will identify which intervals have potential for zircon extraction and age dating for the volcanogenic sediments. In addition, analysis of the basalt will determine if they are intrusives or flows. The relationship with the regional basin evolution and tectonic setting remains unclear until these analyses are complete. What is clear is that there is an as yet unidentified volcanic source in eastern Kalimantan that was contemporaneous with rift formation.

References

Bon, J., Fraser, T.H., Amris, W., Steward, D.N., Abubakar, Z., Sosromihardjo, S., 1996. A review of the exploration potential of the Paleocene Lower Tanjung Formation in the South Barito Basin, Proceedings, Indonesian Petroleum Association, Twenty-fifth Silver Anniversary Convention. Indonesian Petroleum Association, IPA96-1.0-027, Jakarta, Indonesia, pp. 69-79.

Cloke, I.R., Milsom, J.S., Blundell, D.J.B., 1999. Implications of gravity data from East Kalimantan and the Makassar Straits: a solution to the origin of the Makassar Straits? Journal of Asian Earth Sciences 17, 61-78.

Doust, H., Noble, R.A., 2008. Petroleum systems of Indonesia. Marine and Petroleum Geology 25, 103-129.

Friederich, M.C., Langford, R.P., Moore, T.A., 1999. The geological setting of Indonesian coal deposits, Pacrim '99, Bali, Indonesia, pp. 625-631.

Friederich, M.C., Moore, T.A., Flores, R.M., 2016. A regional review and new insights into SE Asian Cenozoic coal-bearing sediments: Why does Indonesia have such extensive coal deposits? International Journal of Coal Geology 166, 2-35.

Friederich, M.C., van Leeuwen, T., 2017. A review of the history of coal exploration, discovery and production in Indonesia: The interplay of legal framework, coal geology and exploration strategy. International Journal of Coal Geology 178, 56-78.

Moore, T.A., 1990. An alternative method for sampling and petrographically characterizing an Eocene coal bed, southeast Kalimantan, Indonesia. University of Kentucky, Lexington, p. 240.

Pieters, P.E., Abidin, H.Z., Sudana, D., 1993. Geology of the Long Pahangai Sheet Area, Kalimantan. Department of Mines and Energy, Geological Research and Development Centre, Bandung, Indonesia, p. 56.

Pubellier, M., Morley, C.K., 2014. The basins of Sundaland (SE Asia): Evolution and boundary conditions. Marine and Petroleum Geology 58, 555-578.

Ruppert, L.F., Moore, T.A., 1993. Differentiation of volcanic ash-fall and water-borne detrital layers in the Senakin coal bed (Eocene), Tanjung Formation, Indonesia. Organic Geochemistry 20, 233-247.

Satyana, A.H., Eka, M., Imron, M., 2001. Coal seams within Eocene Tanjung Formation of the Barito Basin, Southeast Kalimantan: sequence stratigraphic framework and geochemical constraints for source potential. Berita Sedimentology 15, 14-26.

Siregar, M.S., Sunaryo, R., 1980. Depositional environment and hydrocarbon prospects, Tanjung Formation, Barito Basin, Kalimantan, Indonesian Petroluem Association, 9th Annual Convention Proceedings. Indonesian Petroleum Association, Jakarta, Indonesia, pp. 379-400.

Soeria-Atmadja, R., Noeradi, D., Priadi, B., 1999. Cenozoic magnatism in Kalimantan and its related geodynamic evolution. Journal of Asian Earth Sciences 17, 25-45.

Witts, D., Hall, R., Nichols, G., Morley, R., 2012. A new depositional and provenance model for the Tanjung Formation, Barito Basin, SE Kalimantan, Indonesia. Journal of Asian Earth Sciences 56, 77-104.

Abstract 33

Topic: Coal geology, resources, and utilization

What tell us biomarkers and stable carbon isotopes in coal and lignite about climate change during the Tertiary?

Püttmann, Wilhelm[1], Achim Bechtel[2]

[1] Institute of Atmospheric and Environmental Sciences, Department of Analytical Environmental Chemistry, Goethe-University Frankfurt am Main, Altenhöferallee 1, 60438 Frankfurt a.M., Germany

[2] Department of Applied Geosciences & Geophysics, University of Leoben, Peter-Tunner-Str. 5, A-8700 Leoben, Austria

In this study, results from our biomarker and carbon isotope analyses of coal and lignite samples and woody macrofossils obtained from abundant deposits in Central Europe (Austria, Bulgaria, Germany, Hungary, Slovenia) and Asia (China and Indonesia) covering the time interval from Early Eocene to Pliocene are summarized. The concentrations of diterpenoid biomarkers (including abietane-, pimarane-, isopimarane-, beyerane-, kaurane-, and phyllocladane-type hydrocarbons) relative to the sum of diterpenoids plus triterpenoid hydrocarbons, containing the structures typical of the oleanane-, the ursane-, or the lupane-skeleton, are used as proxies for the former contribution of gymnosperms versus angiosperms to peat formation. The results demonstrate that bulk organic matter of Tertiary lignites and coal is influenced by varying contributions of angiosperms and gymnosperms, by different isotopic composition of land plant tissue (e.g. leafs, wood, bark), as well as by microbial activity. The concentration ratios of diterpenoid/terpenoid biomarkers indicate for Central Europe the predominance of angiosperms in the peat-forming vegetation during Eocene and Early Oligocene, whereas Late Oligocene to Pliocene coals are derived from gymnosperm-dominated (i.e. coniferous) sources. In Miocene coal from Southeast Asia (Mahakam Delta, Indonesia) biomarkers of conifers appear only in low abundance at the end of the Miocene (Late Miocene Cooling). In Pliocene lignites from Southern China cycles with increasing abundances of diterpenoids relative to the dominating triterpenoids reflect the presence of alternating cooling and warming cycles. The observed vegetation changes are also reflected by the variation of ^{13}C values of bulk organic matter in the coal and lignite samples due to the offset of ^{13}C values of approximately 3 ‰ between the angiosperm and gymnosperm remains in the same lignite/coal seam. The results are in general agreement with paleobotanical records and demonstrate the potential of biomarker analyses in paleoecological and paleoclimatic studies.
