Poster 8

Suberinite: oil-prone maceral of Borneo coals

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The coals currently investigated are of Tertiary age, collected from areas of Sarawak, Brunei and Kalimantan. Tertiary coals of Southeast Asia are known to be effective source rocks in the prolific gas- and oil-producing basins of the region (e.g. Todd *et al.*, 1977; Mazlan and Abolins, 1999). Much of the petroleum in the region was generated from organic matter of higher plant origin that was deposited within a lower delta plain to prodelta setting. The nature and origin (other than being 'higher plant') of the organic matter, however, has not previously been specified. In this study, the maceral suberinite and the associated macerals bituminite, liptodetrinite/fluorinite and phlobaphinite have been recognised as the most oil-prone macerals of the Borneo coals. The depositional setting of coals with adundant suberinitic components appears to be mangrove swamps. As mangrove paleo-belts are known to be widespread between latitudes 30°N and 30°S (Morley, 2000), it seems apparent that oils within these regions, particularly Southeast Asia, are sourced from mangrove-derived coaly constituents of which suberinite is the dominant component.

Suberinite, derived from suberin-impregnated cell walls of cork tissue (Fig. 1), is a maceral that is almost exclusively known to Tertiary coals and a few Mesozoic coals. It occurs mainly in bark but may also be found in the stems and roots of woody and herbaceous plants. *Rhizophora sp.*, in particular, contains abundant suberinitic and the associated phlobaphinitic cell fillings (Teichmuller, 1982). Suberin and subereous components are waxy constituents, considered to be predominantly polymers containing polyesters and aromatics (Kolattukudy, 1980).

Organic geochemical evaluation performed on the coals that are rich in suberinite and/or bituminite yielded HI values in the range of 250–400 mgHC/gTOC. The S2 Py-GC pyrograms of these coals are dominated by n-alkane/alkene doublets as well as aromatic components, thus supporting the oil-prone nature of these suberinitic macerals. Saturated hydrocarbon fractions of these coals are dominated by higher molecular weight n-alkanes and display waxy appearances.

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The generation of fluvio-deltaic oils has been associated with terrestrially-derived organic matter of mangrove origin (e.g. Brown, 1989, Wan Hasiah 2001). Mangrove pollen, particularly of Rhizophoraceae, are known to have been widely distributed within the Sunda region since early Tertiary times (Morley, 2000).

Under the microscope, liquid hydrocarbons generated occur in the form of an oil haze or oil globules, while solid hydrocarbon occurs in the form of exsudatinite which was seemingly soft and mobile when exuded from the precursor material. The texture of the coal fabric and the association of the macerals present are expected to govern the mode of hydrocarbon generation and the expulsion pathways (Wan Hasiah, 1999, 2000).

As could be observed petrographically, subsequent to hydrocarbon generation, the suberinite-phlobaphinite framework breaks down, giving rise to liptodetrinite, fluorinite, vitrodetrinite and exsudatinite (Fig. 2). Accumulation of disordered or disintegrated suberinitic constituents subsequently forms bituminite (Fig. 3). Thus, bituminite (as defined by ICCP, 1975) is recognised here as a secondary maceral (an intermediate stage) which represents a transformation product from the precursor maceral suberinite during hydrocarbon generation.

The hydrocarbon material directly associated with suberinite and bituminite began to generate at about 0.4%Ro and was exhausted by 0.7%Ro. This early generated material is believed to play a significant role in saturating the source rock pore system and deactivating adsorptive sites. Upon reaching a saturation threshold, materials that are expelled should be able to leave the coaly source rock without being held back within the pore systems. Incorporation of remnant suberinitic material within the vitrinite fabric, however, is still apparent in higher maturity coals of about 1.0%Ro (Fig. 4) suggesting that suberinite-derived components, such as fluorinite/liptodetrinite, also possess good oil generating potential and expel their hydrocarbon components at a higher maturation level (> 0.7%Ro). The inclusions of hydrocarbon generating material and suberinitic components appear to be responsible for the perhydrous nature of the coaly source rocks and for the fluorescence phenomena of the vitrinitic coal fabric.