Paper 4

Tertiary coal measures as source sequences for oil

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Prolific oil provinces occur in Tertiary coal measures in SE Australia, Indonesia and Malaysia. Oils associated with coal measures have distinctive properties: typically paraffinic, waxy, high API gravity, low sulphur, high pristane to phytane ratio and a distinctive suite of resin related triterpanes. Although extracts from coal measures sediments show a resemblance to

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oils probably generated from them, systematic differences are common.

Organic matter in coal measures occurs as coal seams and as dispersed organic matter (dom). Coals and dom form a continuous series, boundaries are arbitrary. Most coals are autochthonous and most dom is allochthonous. Within coal measures, ratio of coal to dom is greater than one. It ranges up to about ten and about four is typical.

Tertiary coals are unusual compared with older coals in having a ratio of vitrinite to inertinite of about 90:1, and because most inertinite is of fungal origin. Liptinite is abundant in some, but not all, Tertiary coals. Resinite and suberinite are the dominant liptinite macerals. A few Tertiary coals have canneloid affinities, the main non-vitrinite maceral being referable to bituminite. Algal-rich coals occur but are uncommon. Some Tertiary basins in Southeast Asia have lacustrine sequence rich in lamalginite. Typically, the algal and coaly facies are spatially separated; few source rocks are of mixed higher plant and algal origin.

Many SE Asia coal measures have abundant optically discrete bitumens and oil drops. Bitumens range from exsudantinite veins to lenses and some impregnate coal. A paragenetic sequence occurs; liptinite macerals are first affected, followed by detrovitrinite, telovitrinite and, in extreme cases, by inertinite. Bitumen impregnation has a marked effect on vitrinite reflectance, so recognition of bitumen impregnation is important in assessing maturation and hydrocarbon generation history.

Bitumen abundance may indicate source potential of coals but it could indicate extent of migration from coals. Coals of similar type and rank but with different thermal histories contain variable amounts of bitumens. Migration from coals appears efficient in the early stages of maturation and bitumen-rich examples may represent coals where the migration process has been "frozen". Loss of liquids through cleat fractures in coals is likely mechanism for primary migration. Humic matter at deposition contains up to 90% moisture. At vitrinite reflectance of about 0.8% moisture content is about 2%. Carbon dioxide, dehydration water and methane are also expelled. Early fluid expulsion is probably associated with the major phase of oil generation and expulsion from coals. Above vitrinite reflectance of 0.65% migration is less effective and bitumens are retained. At higher ranks, petroleum liquids are generated, but migration of liquids into adjacent reservoirs is less probable.

Generation of migratable hydrocarbons from coals is a function of thermal history rather than of type. Average composition of suites of coals from different sets of coal measures shows a small range, and type control on source potential does not vary markedly between different coal measures sequences. Maturation control, is considered to be critical. Rapid coalification has occurred for most Tertiary coal measures and is probably the most important characteristic for prospective sequences. Oil generation from coal measures is biased to coals rather than dom and effective generation and migration occur earlier from coal measures sequences than from algal-rich source rocks.