

**Abstract**

## **ORGANIC FACIES IN THE LATE CRETACEOUS TO TERTIARY COAL MEASURES SECTIONS OF THE GIPPSLAND AND BASS BASINS, SOUTH EASTERN AUSTRALIA**

ALAN C. COOK

Sedimentary basins developed along the southern rift margins of the Australian continent show a Cretaceous to Recent section with the development of coal measures sections being more prominent in the more eastern basins. The coals have been extensively mined onshore, and the offshore areas have been subject to intensive exploration for oil and gas. Gippsland Basin was the first major oil province developed within Australia and contains two giant fields, Kingfish and Halibut. The oils and associated gas are clearly derived from the coal measures sections, although there is still debate concerning the contribution of the coals as opposed to that from the dispersed organic matter (dom).

The sections drilled range down to the upper part of the Cretaceous. The coals show three distinct organic facies and these can be related to the progression of climatic conditions that were associated with the opening of the seaway between the Australian and Antarctic continents and the development of the circumpolar current. This current is still a major factor in the present climate of southern Australia and its initiation coincides with a major change in organic facies.

Extensive analyses have been made on the coals that are mined within the Latrobe Valley (E of Melbourne) and at Bacchus Marsh (SW of Melbourne). Approximately 2000 samples have been examined from oil and gas exploration wells, mainly in the offshore areas. Most of the samples have been cuttings, but about 25% are sidewall cores, and a smaller proportion is from conventional cores.

The oldest of the facies is termed the Lower Eastern View Facies and is found within the upper part of the Cretaceous section, the Paleocene and the lower part of the Eocene. It is characterised by coals that have an aspect similar to that of most older coals such as those from the Carboniferous and the Permian. Liptinite contents are typically moderate and inertinite content ranges from low to high, but all of the populations represent inertinite derived from higher plants, being dominated by semifusinite, inertodetrinite and fusinite. Micrinite tends to be rare. Two subfacies are recognised, one with >50% inertinite and one with <50% inertinite. It is probable that these subfacies show a systematic distribution, but the lateral coverage of data is insufficient to show this. Cutinite and sporinite are the main liptinite macerals in these coals.

Within the lower part of the Eocene, the Upper Eastern View Facies constitutes a transitional facies. The diverse inertinite population characteristic of the Lower Eastern View Facies is present but, in addition, funginite is also present. Liptinite is locally a major component and the main components are sporinite and resinite.

The uppermost facies is termed the Latrobe Valley Facies and the coals that outcrop within the Latrobe Valley belong to this facies. These coals are dominated by vitrinite and resemble the maceral compositions of most other coals of Tertiary age. The overall content of liptinite is moderate, averaging about 8%. However, the range is high with some relatively thick plies of seams containing up to 45%. Suberinite and resinite are the most prominent liptinite macerals, although sporinite and cutinite are locally prominent. Apart from the organic facies within the Latrobe Valley Facies, it is also associated with the presence of ultra-thick coal seams – some over 100 m in thickness. In part, this change may be related to the changed peat conditions, but a lower overall rate of basin subsidence is likely to be an additional factor in this change.

Vitrinite reflectance ranges from about 0.30% in the shallower part of the section up to about 1.20% in some of the deeper sections. The relationship between depth and vitrinite reflectance is complicated by the existence of a relatively early phase of coalification that mainly affected the nearshore parts of the sedimentary basins. In the

deeper offshore parts of the basins, relatively low vitrinite reflectance values persist to considerable depths. Thus at about 3,400 metres in the near-offshore Tuna field reflectances reach about 1.00% whereas at similar depths in the deep-water Hapuku field, vitrinite reflectance values are about 0.45%. Some complexities in the distribution of vitrinite reflectance are also due to zones with overpressuring.

Some of the sections are sufficiently thick for rank-driven transitions to be seen between the textures typical of brown coals (such as textinite and attrinite) through intermediate textures (such as ulminite or texto-ulminite and densinite) to those typical of bituminous coals (telocollinite and desmocolinite).

The oils are probably derived in the main from the Lower Eastern View Facies coals. In this respect, the oilfields differ from those of provinces such as the Mahakam Delta in Indonesia, or the NW Jawa Basin where the coals are all similar in facies to the Latrobe Valley Facies. The significance of this is that the major sources of the oils are coals that are similar in organic facies to those of many of the older coal measures sequences.

A number of fallacies have been “read into the literature” and it is worth highlighting some of these. The coals are not marine coals (concept proposed by a major oil company at one stage). Indeed, marine influence is generally minor and pyrite is usually not prominent. Although a small number of layers with lamalginitite are known, most of the coals contain no alginite. Thus, the proposal that the coals are an unusual algal rich facies is also untrue. Although some layers have a high content of liptinite, overall liptinite contents are similar to those from older coal measures such as those from the Carboniferous.

Many features within the coals indicate that oil generation is relatively early in the maturation history. Exsudatinitite is present, but possibly only in the few areas where igneous intrusions are found. Certainly, meta-exsudatinitite is restricted to contact altered aureoles.

The transition from the Lower Eastern View Facies to the Latrobe Valley Facies is associated with the establishment of the circumpolar current and the development of a wet Mediterranean type of climate. This permitted the development of forest communities similar to those found nowadays in the wetter parts of western Tasmania and the SW part of the South Island of New Zealand.

