Source Rocks of Western Australia — Distribution, Character and Models.

John Scott¹

Abstract

Potential source rock intervals are stratigraphically widespread in Western Australia, being documented in every period from the Ordovician to the Cretaceous. Rich source rock intervals are common in continental alluvial and continental to marginal marine deltaic facies associations. In general, source rocks of marine facies are only of moderate quality. Where analysed, generally on basin highs, these marine facies appear to have accumulated beneath an anaerobic rather than an anoxic water column. In many other parts of the world, source rock black shales have clearly accumulated beneath anoxic waters. In addition, compared to many other marine source rock facies, the input of terrestrially derived organic material is high in WA marine source rock facies. Sedimentary models are suggested for selected source rock intervals to account for the depositional conditions under which WA source rocks accumulated and illustrate the possible changes in organic facies that may occur away from the well data points.

Introduction

The aim of this paper is, firstly, to briefly describe the distribution of the main source rocks in WA and summarise their character as shown by data from wells. Secondly, it aims to indicate the possible development of source rocks within selected intervals in areas away from the control of the borehole as suggested by sedimentary models. The depositional environment controls the type and amount of organic carbon that accumulates in a sediment. It is thus a fundamental (but not the only) control on the type of hydrocarbon product, if any, which will come from the rock.

The depositional models discussed are for marine source rock facies. Although rich potential source rocks are widely recognised in continental and deltaic sequences within WA, there are few ‘hard’ data, particularly core data on which models can be built for these depositionally complex systems. The marine source intervals are simpler than those in continental alluvial or deltaic settings. Even within the marine systems, however, the lack of core data means the models can be no more than simple generalisations.

The models discussed are restricted to shelf-epeiric sea settings. Although oceanic facies of the Late Cretaceous contain some source rocks, perhaps associated with oceanic anoxic events, these intervals are so poorly defined that any model is highly conjectural.

Geochemical data derived from wells and outcrop show that source rocks are widely distributed areally and stratigraphically (Table 1). Where marine source rock facies have been analysed, however, they do not seem to be particularly rich when compared with other well-documented source intervals outside of WA. This may partly reflect the distribution of data. Acquisition of reliable data on source rocks is hampered by two factors. Data points (usually wells) are scattered and are often unrepresentative of basinal successions, generally being located on structural highs. In addition, data points are frequently at a high state of thermal maturity; the kerogen has all or virtually all converted to hydrocarbon, which has migrated, leaving only inertinite behind in the rock.

To build an accurate picture of source rock distribution and quality for use in exploration appraisals, it is necessary to extrapolate from widely based well control, which may be only partly representative. Although many marine source sequences in WA do not seem particularly rich, significant quantities of oil and gas have been generated from them. One of the main questions, therefore, is whether the source intervals that have been identified on the highs maintain the same source character in the lows. As the lows are usually undrilled, only sedimentary models can help predict any changes in organic facies that may occur.

Geochemical evidence suggests that many marine source rocks accumulated beneath a water column that contained little or no oxygen, as they are black, finely laminated shales with no record of benthonic fauna (Tyson, 1987). The terminology of oxygen content in water is confused (Tyson & Pearson, 1991). In this paper, the term anoxia is reserved for depositional conditions where no oxygen is present or where oxygen contents are so low that living metazoans are completely absent. Anaerobia is used here for conditions of low oxygen in the approximate range 0.2 to 1.0 mL/L dissolved oxygen, where the fauna is significantly reduced compared to normal, fully oxygenated conditions. Many

¹ PGA Consultants Pty Ltd, Perth, WA.

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