The source rock and petroleum geochemistry of the Early Jurassic Poolowanna Formation, Eromanga Basin

by

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This thesis is submitted for the degree of

Doctor of Philosophy

March 1997

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Table of contents

Abstract

Source rock evaluation based on Rock-Eval pyrolysis and organic petrography was undertaken on silty shales, carbonaceous shales and coal samples from the Early Jurassic fluviolacustrine Poolowanna Formation in oil fields located along the western edge of the Eromanga Basin, South Australia. Potential source rock lithofacies were delineated using gamma ray and sonic wireline logs. Their total organic carbon (TOC) values range from 1.5% in silty shales to 70% in coal facies. Maceral analysis data show that vitrinite (notably fluorescent desmocollinite) is the dominant maceral group (vitrinite≥liptinite>inertinite). The liptinites are mainly resinite and sporinite in the Poolowanna Trough . In the Patchawarra Trough, inertinite is the dominant maceral group (inertinite≥liptinite>vitrinite) and the liptinite group comprises mainly *Botryococcus*-like telalginite, indicative of lacustrine depositional environments. Generally the whole study area seems to have been subject to fluvial and paludal processes leading to a variety of sub-oxic to oxic terrestrial depositional environments, as illustrated by a wide range of vitrinite to inertinite ratios (V/I = 0.13–13.0). Low V/I ratios suggest either intense oxidation of autochthonous humic organic matter prior to burial, or a strong input of reworked allochthonous inertodetrinite. Both Rock-Eval and organic petrographic data indicate the presence of oil-prone Type II/III (or, more rarely, resinite-enriched Type II) kerogen. The maturity of source rock lithofacies range from early mature (R_o = 0.5–0.6%) in the Patchawarra Trough to mature (R_o = 0.9%) in the Poolowanna Trough.

In order to ascertain whether the potential source rocks of the Poolowanna Formation have actually contributed hydrocarbons to adjacent basin-edge reservoirs, fifteen representative rock samples and eighteen oils from five oil fields (Poolowanna, Tantanna, Sturt, Sturt East and Taloola) were selected for comparative isotopic and biomarker analysis. Three of these fields produce from stacked reservoirs which range in age from Cambrian (Mooracoochie Volcanics), through Permian (Patchawarra Fm), to Jurassic (Poolowanna Fm, Hutton Sst, Birkhead Fm and Namur Sst). All the oils appear to be early expulsion products (R_c = 0.5–0.8%). A primary higher plant input to both oils and source rocks is shown by the relative abundances of acyclic isoprenoids and *n*-alkanes (Pr/*n*-C_{17} versus Ph/*n*-C_{18}) and the presence of conifer resin-derived diterpenoid hydrocarbons. Intense microbial activity in the depositional environments of the source rocks is indicated by high hopane/sterane ratios and the presence of 2α-, 2β-, and 3β-methyl-17α(H), 21β(H)-hopanes in the C_{29}-C_{31} pseudohomologous series.

Pristane/phytane values and the relative concentrations of a suite of aromatic biomarkers characteristic of organic matter derived from the conifer family Araucariaceae (viz. 1,2,5-trimethylnaphthalene, 1-methylphenanthrene, 1,7-dimethylphenanthrene and retene) allow recognition of four oil families: pre-Permian, Permian, Jurassic and mixed

Permian/Jurassic. The distinction of Jurassic from Permian and pre-Permian hydrocarbons is substantiated by cross plots of calculated reflectance (Rc) versus aromatic isotopic signature ($\delta^{13}C_{aro}$) and methylphenanthrene index (MPI) versus trimethylnaphthalene ratio (TNR-2). In these plots the Poolowanna source rocks coincide with most of the oils in Jurassic reservoirs. However, an unusually high abundance of 30-norhopane (C_{29}/C_{30} hopane ~1) was observed in the intra-Poolowanna shales and coals at Sturt, Sturt East and Tantanna, a feature seen in none of the oils. The Poolowanna-1 (Poolowanna) crude has a distinctively light isotopic signature, analogous to that of one of the waxy Jurassic source facies in Sturt Field. Sterane distributions are without exception ethylcholestane-dominant in both oils and source rock extracts.