ASPECTS OF THE SOURCE ROCK AND PETROLEUM GEOCHEMISTRY OF THE EROMANGA BASIN

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BIOGRAPHY

David McKirdy holds B.Sc. (Hons.) and M.Sc. degrees from the University of Adelaide and a Ph.D. from the Australian National University. In 1970 he joined the Petroleum Technology Laboratory of the BMR where, in collaboration with Dr. Trevor Powell, he conducted pioneering work on the geochemistry and origin of Australian crude oils. His post-graduate studies included the first regional geochemical evaluation of the petroleum potential of the Amadeus Basin. In 1977 he joined the S.A. Geological Survey where as a Senior Geologist in the Fossil Fuels Division he initiated a major programme of source rock studies in the Officer, Arrowie, Pedirka, Cooper and Eromanga Basins. In 1981 he spent four months as a visiting scientist with the Organic Geochemistry Unit, Bristol University, before taking up a senior research position with Conoco Inc. in their Exploration Research Division in Ponca City. There he worked on, inter alia, problems related to the generation and occurrence of hydrocarbons in Indonesia, Oklahoma, and the Appalachian Valley and Ridge Province. He is presently a Project Consultant (Fuels) with AMDEL involved in the application of organic geochemical techniques to oil and gas exploration throughout Australia. He was a co-sponsor of IUGS-UNESCO International Geological Correlation Programme Project 157 (Early Organic Evolution and Mineral and Energy Resources) in which he now serves as a sub-project leader.

SUMMARY

This investigation of the source-rock potential and petroleum geochemistry of the Eromanga Basin is based on organic geochemical analyses of rock, oil and gas samples from more than 30 wells in South Australia, Queensland and the Northern Territory. Interpretation of the analytical data is facilitated by dividing the basin into six provinces, broadly delineated by the structural framework of the underlying Permian-Triassic basins. Each province has had a distinctive thermal history, as shown by the depth-reflectance studies of Kantsler and Cook (1980). Regional variation in the maturation state and hydrocarbon-generating potential of Jurassic and Cretaceous shales and siltstones is assessed using vitrinite reflectance, C_{15+} extract yield and composition, various alkane parameters, and the petrology of the dispersed organic matter.

Sequences with the best oil-source potential are the Birkhead Formation and Murta Member (good to excellent). Fair to good oil sources include the shale/siltstone lithofacies of the Poolowanna Beds; basal Jurassic and Namur Sandstone Member. Woody-herbaceous material (including sporinite, resinite, cutinite, suberinite and resinous vitrinite) is the major hydrocarbon precursor throughout the Jurassic section. Kerogen in the Murta Member, Transition Beds, and Wallumibilla Formation has a significant algal component (phytoplankton and bituminite). The 'liptinite facies' of the source rock largely determines both the nature of its primary hydrocarbon product and the level of organic maturity necessary for hydrocarbon genesis to begin.

Adequate maturation levels for the generation of waxy oil from terrigenous organic matter (vitrinite $\overline{R}_o$ max $\geq$ 0.7%) have been attained by Early and Middle Jurassic sediments in the central Pedirka Basin area, and over much of the southern Cooper Basin. Less mature Jurassic and Early Cretaceous sediments containing significant amounts of labile exinite (viz. resinite, suberinite) are potential sources of light oil and condensate. Gas generation from such organic matter commences at $\overline{R}_o$ max = 0.6%.

Jurassic and Cretaceous oils in the Eromanga Basin are of three main types: 'heavy', waxy paraffinic (37-41^o API, 19-41^{o}C pour point) e.g. Poolowanna -1 (Poolowanna Beds), Jackson -1 (Westbourne, Hutton); intermediate paraffinic-naphthenic (45-49^o API, 8-12^{o}C pour point) e.g. Strzelecki -3 (Birkhead, Hutton); and light, low wax paraffinic (49-57^o API, $\leq$0^{o}C pour point) e.g. Cuttapirrie -1 (basal Jurassic), Merrimelia -8, 10 (Namur, Hutton), Dullingari North -1 (Murta). The bimodal distribution of pristane/phytane values displayed by these oils is explicable in terms of early ($\overline{R}_o$ max = 0.5-0.7%, pr/ph = 3-4) and normal ($\overline{R}_o$ max > 0.7%, pr/ph =5-6) expulsion from source beds containing organic matter of higher plant origin. Appreciable differences exist in the extent of their subsequent thermal alteration in the reservoir.

With the exception of the gas at Namur (and possibly some of the gas at Dullingari, Wackett and Naccowlah), Mesozoic oil and gas in the Eromanga Basin are chemically and isotopically distinct from Permian hydrocarbons in the underlying Cooper Basin. However, the presence of bicyclic sesquiterpanes, probably biomarkers of resinite and/or essential oil precursors, is common to both Mesozoic and Permian oils.