Depositional and Diagenetic History of the Upper Permian Beefkeeper Formation, Woodada Gas Field, Onshore Northern Perth Basin, Western Australia

by Jirka Just

Abstract

The mixed carbonate/siliciclastic Beekeeper Formation is the key reservoir interval in the gas-bearing Woodada Field in the onshore northern Perth Basin. The objective of this study was to establish a depositional model for the Beekeeper Formation and to examine post-depositional aspects, notably its diagenesis and fracture porosity and permeability, and their implications for reservoir quality.

The Beekeeper Formation is Late Permian (latest Ufimian to Kazanian) in age and is restricted to the subsurface. The Beekeeper Formation rocks are predominantly 'clean' rudstones/grainstones, wackestones/packstones and bioclastic quartz sandstones, with minor mudstones. Seven facies are recognised and three facies associations. The formation is very fossiliferous with a typical Heterozoan Association of cool-water sessile filter feeding fauna dominated by brachiopods, bryozoans, and crinoids, with minor bivalves and benthic foraminifera.

Deposition was controlled by temporal and/or lateral alternation of two phases: fair-weather, low energy conditions, during which primary carbonate production occurred; and storm-dominated conditions of erosion and redeposition by storm waves and storm ebb-currents. The storm-deposited strata make up the rock record and the fairweather phase of primary deposition is inferred from the faunal assemblage in preserved storm deposited facies. Deposition of the Beekeeper Formation occurred on a shallow, low-gradient, coolwater, storm-dominated ramp.

Cont'd On Page 23

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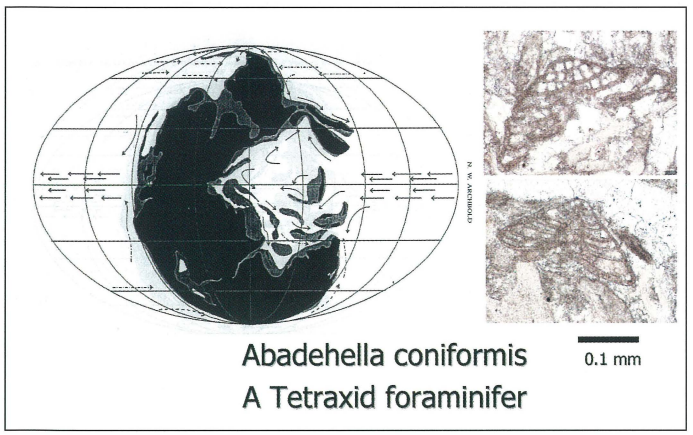
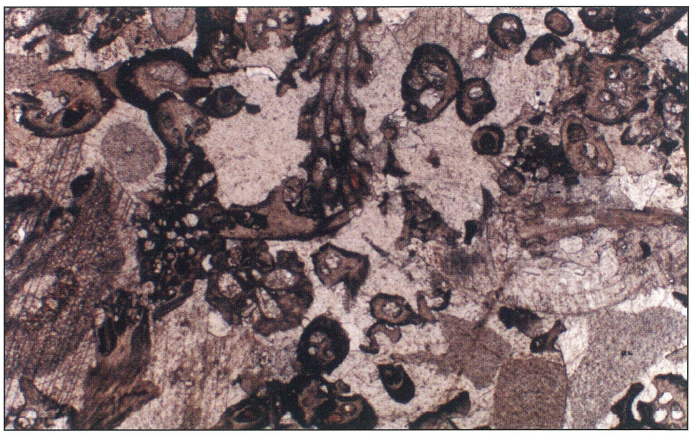
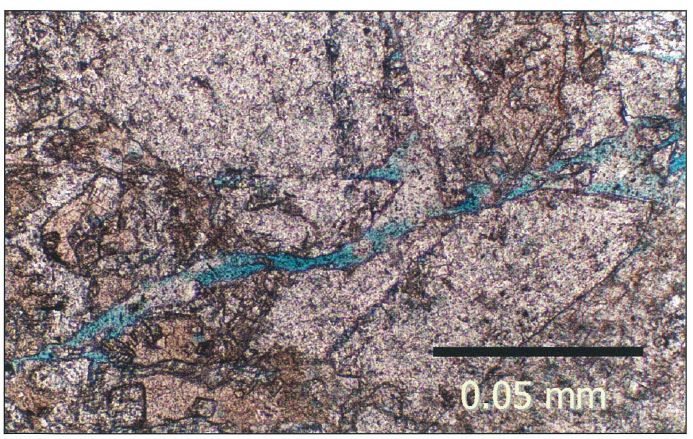
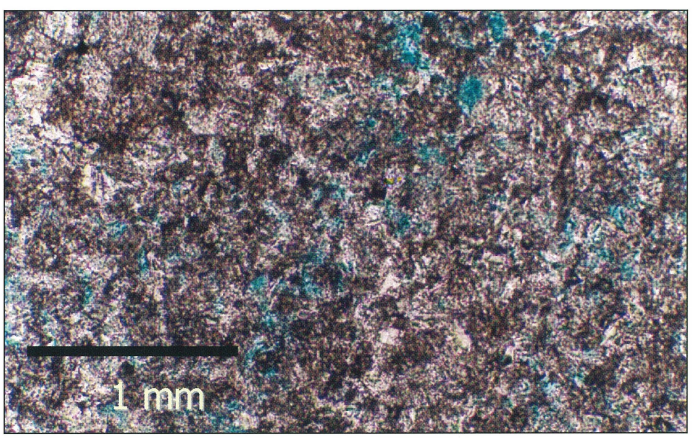


A Tethyan Influence?



Open Depositional Fabric
Mid ramp rudstones/grainstones = reservoir potential.





Secondary porosity in dolomitised rudstone/grainstone from Woodada14.

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The first Australian recognition of the typically warm-water microgranular foraminifer Abadehella coniformis in a cool-water setting may have palaeogeographic significance for models of the breakup of Gondwana.

A complex diagenetic history of burial cementation and compaction is recognised. The main cement phases are sparry calcite, sparry ferroan calcite and dolomite with minor silica. Cementation and compaction have wholly destroyed primary depositional porosity with secondary porosity created by subsequent dolomitisation and fracturing. Integration of depositional and diagenetic features has shown a link between depositional facies and the creation of effective porosity and permeability. Only 'clean' rudstones/grainstones appear to be susceptible to the extensive dolomitisation required for reservoir development.

A key problem in the Woodada Field is that although a well can be confidently sited to encounter specific lithological objectives, the type and degree of porosity to be encountered has proven to be unpredictable. This study provides the first steps towards a solution. The depositional model defines the lateral and vertical relationships between the different facies. Rudstones/grainstones with reservoir potential are found only in a mid-ramp setting and may or may not be dolomitised. Matching the drill-core position of the dolomitised rocks in relation to other facies with their wireline log signature may facilitate similar recognition in wireline logs from other wells. Thus it may be possible to map facies and dolomitisation distribution over the Woodada Field.

This study has demonstrated how useful core-based analysis can be in enhancing understanding of reservoir units but has been limited by few cored intervals from the Woodada field. Routine coring of reservoir intervals is recommended during future drilling. A large amount of cuttings are available from most wells and geochemical analysis of selected reservoir interval samples will further define reservoir petrology. Reinterpretation of wireline logs based on quantitative geochemical data and depositional relationships may be the most important step in determining the distribution of reservoir rocks.

Determining the depositional relationship between the Wagina Formation, Dongara Sandstone and the Beekeeper Formation may be significant in locating potential siliciclastic shoreface sandstone reservoirs. Determining the provenance of the siliciclastic sand grains of each formation could establish a potential link. A comprehensive regional study that fully integrates all available geophysical and lithological data would be an important step toward the development a regional model for Late Permian deposition in the Woodada Field.

The interest generated by recent hydrocarbon discoveries at Cliff Head and Hovea may make it worthwhile to acquire new seismic data to better define reservoir boundaries and the role of faulting and fracturing in reservoir development at Woodada and throughout the Northern Perth Basin.

Biography

Jirka completed a B.Com (Curtin) in 1985 and then spent five years with the public service as a cost accountant (budgeting, financial forecasting and business analysis). Leaving in 1991 and getting married and travelling the world. He has since worked as a plumber's offsider, childcare centre manager and a kitchenhand on the Stag platform (Apache Energy). This motivated him to change direction and in 1999 he enrolled in the B.Sc at UWA. He completed his B.Sc Hons (Geology) last year. Currently an exploration geologist with Newcrest Mining, based in Kalgoorlie, married with two kids and looking to establish a career in the petroleum industry.