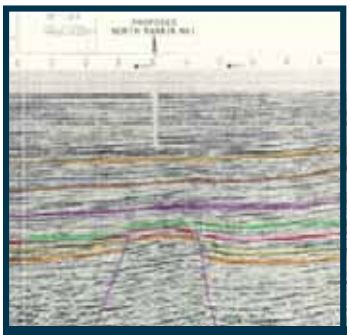
Historical Highlights is an ongoing EXPLORER series that celebrates the "eureka" moments of petroleum geology, the rise of key concepts, the discoveries that made a difference, the perseverance and ingenuity of our colleagues – and/or their luck! – through stories that emphasize the anecdotes, the good yarns and the human interest side of our E&P profession. If you have such a story – and who doesn't? – and you'd like to share it with your fellow AAPG members, contact Hans Krause at historical.highlights@yahoo.com.



BOCAL's seismic interpretation across the North Rankin structure, 1971. Green = base Tertiary; red = Calcilutite objective; orange = Barrow Beds.

Wake-up call worked out OK

Aussie North Rankin Discovery Was Game-Changer

By PETER PURCELL

It was nearly midnight on a Saturday late in June 1971 when BOCAL's new palynologist Barry Ingram telephoned chief geologist Peter Kaye to tell him the gas discovery in North Rankin-1 were in Triassic sediments.

"I still remember the sound of him waking up," Ingram says today from his home in Perth, Western Australia.

"I'd already done this a month earlier at another well," he continued. "He'd been pretty annoyed with me then, but this time he was okay. Maybe he was getting used to me waking him up and telling him it was Triassic!"

BOCAL is the Burmah Oil Company of Australia Ltd., operator for the Woodside/Shell/Chevron/BP/Burmah joint venture on Australia's North West Shelf that had just discovered the North Rankin gas field.

It was to prove the first of many discoveries on what is now one of the world's giant gas provinces.

PURCELL

AAPG member Peter Purcell is a consultant in Perth, Western Australia, working mainly on Australia's North West Shelf and East Africa. He and wife Robyn were vice chairs of the very successful 2006 International Conference and Exhibition in Perth, which remains the largest ICE in AAPG history.

Excitement Begins to Build

The adventure had begun 17 years earlier when Rees Withers and business associates in Melbourne floated Woodside (Lakes Entrance) Oil Co. NL, mainly to explore Victoria's onshore Gippsland Basin. Geoff Macdonald took over as chairman in 1956.

Early exploration efforts were unsuccessful, but the company's fortunes changed in 1961 when experienced oil explorer Nicholas Boutakoff, then working for the Victorian government, was hired as chief geologist.

Boutakoff took with him his ideas about the oil potential of the vast offshore region between Australia's northwest coast and the island of Timor far to the north. Ownership of those ideas would later prove a major point of conflict, but they led to Woodside's successful application for a large region of the North West Shelf, granted as Permit to

See **Rankin**, page 40

Graphic courtesy of Woodside Energy

Location of Woodside's original permit and early wells on Australia's North West Shelf.

Rankin

from page 38

Explore 213H on June 25, 1963.

Burmah and Shell farmed-in immediately for 33.33 percent interest each, and soon after California Asiatic (later Chevron) acquired half Shell's interest and BP purchased half Woodside's interest. Burmah became the operator.

It was a vast permit, covering over 400,000 square kilometers. To remind the head office of this scale, BOCAL location maps from those early years showed the British Isles within the permit outline.

Aeromagnetic surveys confirmed a deep basin, and seismic surveys commenced.

Boutakoff's idea was simple, albeit couched in terms from an era before plate tectonics. Bathymetric maps of the Australian continental shelf showed a series of submarine ridges, which he interpreted as large geanticlinal folds. Located between the "alpine nappes" of Timor, where oil seeps were known, and the gently warped sediments onshore Australia, they were deemed ideally "suitable for considerable accumulation of petroleum."

Less than a year later, Wapet's Barrow Island-1, located immediately south of the Burmah permit, discovered a major oil field in previously unknown deltaic Upper Jurassic/Lower Cretaceous sediments. The potential of the North West Shelf permit seemed assured, and the BOCAL wells were watched with great expectation and excitement.

Where Are the Beds?

The first well, at Ashmore Reef in the far north, was dry. The second well, Legendre-1, drilled closer to Barrow Island in the south, discovered oil in the "Barrow Beds," but the flow rates were low and a follow-up well was dry.

BOCAL's attention shifted to a major anticline mapped by seismic surveys west of Legendre and seemingly analogous to the Barrow Island structure. But the two wells drilled on that anticline yielded only minor oil shows and a small gas flow and, of more concern, did not encounter the porous Barrow Beds.

This was a major issue. Gravity and seismic surveys had identified a major platform even further west, dubbed the Rankin Trend or, more elaborately, the Ancient Rankin Bank Gravity Positive. If there was no sand at Madeleine and Dampier, there was even less chance in the more distal setting of the Rankin structures.

The BOCAL team did what good explorers always have done in such circumstances: they envisaged a new objective.

A thin, Upper Cretaceous section mapped on seismic above a small fault block at the North Rankin Prospect was correlated with the Senonian Toolonga Calcilutite seen in nearby wells. This "friable calcaranite, composed of shell fragments and microgranular lime mudstone" became the main objective. Sandstones in the Lower Tertiary and Lower Cretaceous section were deemed secondary objectives, but were not considered to have much potential.

"Not everybody was keen on drilling it," recalls Ed Kopsen, then a junior geologist with BOCAL, "but Tony Challinor was the Dampier team leader and he really pushed it."

North Rankin-1 was spudded on May 3, 1971. The mood at BOCAL was mixed. Their Scott Reef-1, drilled on a large faulted anticline far to the north, had tested eight MMcfd of gas, with high condensate levels. The objective sands turned out to be Triassic – the reason for Ingram's first late-night call to his boss – but it was far offshore and remote, in relatively deep water.

Kopsen was on wellsite duty later that month when North Rankin-1 drilled through the Toolonga with minor shows, hit a thin shale section and broke suddenly into high porosity sandstones with high gas readings.

"It happened at nighttime and I've always remembered the depth – and in feet: 8,818," he said. "We had no idea what it was. It was supposed to be distal Barrow Beds."

Samples were rushed to Perth for dating – and Barry made that second midnight call.

"We were dumbfounded when he said it

See **Discovery**, page 43

Continued from previous page

are below seismic resolution, shallow bowl-shaped collapse features or modest dome-shaped carbonate buildups.

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Figures 3 and 4 compare long-wavelength and short-wavelength computations of most-positive and most-negative amplitude curvatures and structural curvatures.

In figure 3, note that for both long and short wavelengths, most-positive estimates of amplitude-curvature (figures 3a and 3c) provide considerable detail, whereas most-positive structure-curvature displays (figures 3b and 3d) show larger-scale features.

The same physics occurs for estimates of most-negative curvature – amplitude curvature (figures 4a and 4c) depicts fine detail, but structural curvature (figures 4b and 4d) shows larger features.

Amplitude curvature is not a better seismic attribute than structural curvature; it is simply a different attribute. Although structural highs and reflection amplitude anomalies are mathematically independent, they may be coupled by geology.

For example, gas trapped by structure may create a bright spot. In such a case, the second derivatives of structure curvature and reflection amplitude curvature may be related.

Conclusions

When seismic data are processed with amplitude-preserving procedures, amplitude variations can be diagnostic of geologic information – such as changes in porosity, thickness or lithology.

Computing curvature of reflection-amplitude gradients enhances the detection of gas-charged fractures, mineralized cleats in coal seams and other subtle features.

We hope to extend the work shown here to generate rose diagrams of lineaments observed on amplitude-curvature maps and compare these with rose diagrams obtained from image logs.

Acknowledgments

We thank Arcis Corporation for permission to show the data examples, as well as for the permission to publish this work.

(Editor's note: AAPG member Satinder Chopra is with Arcis Corp., Calgary, Canada, and AAPG member Kurt J. Marfurt is with the University of Oklahoma, Norman, Okla.)

Discovery
from page 40

was Triassic," exploration manager Dave McDonald recalled years later.

Kopsen, now a veteran North West Shelf consultant in Perth, described it recently as 'the experience of a lifetime.'

"I was there for the discovery, had a week off, and was back for the final logging run," he recalled. "I was the first geologist to see the logs. It was unbelievable. I still remember the gas-water contact, too: 10,667 feet."

Discovery Channels

The first test flowed 12.8 MMcfd, with 25 bbl/Mcf of condensate: North Rankin was declared a gas discovery. Original reserves were about 11.5 Tcf and 200 MMbbl of condensate.

Rankin-1, Angel-1 and Goodwyn-1 followed consecutively. All were major gas discoveries, with large condensate reserves, cumulatively about 7 Tcf of gas and 400 MMbbl of liquids.

The Rankin Trend is now seen to be the uplifted and eroded shoulder of the Jurassic rift system that formed the Barrow and Dampier sub-basins. The gas in the thick fluvial Triassic sandstones are sourced mainly by interbedded and underlying coals and shales, and sealed by Cretaceous shales deposited on the subsiding Australian margin.

Boutakoff's "highs" turned out to be horst blocks formed in the extensional regime associated with break-up of eastern Gondwana – not folds within a compressive geosyncline province, but he was certainly right about them being "suitable for considerable accumulation of petroleum," albeit mainly gas.

Exploration manager McDonald recalled years later in an interview, 'Every day it was almost ho-hum. We would drill another 100 feet of pay."

Woodside and BOCAL merged soon after the discovery and Woodside Burmah Oil NL became the new operator. Turbulent years lay ahead – first, a nationalistic Federal Labour government opposed export of gas and threatened nationalization, and then Burmah's financial troubles forced it to sell its interests to Shell and BHP and Shell became the dominant force in guiding and staffing the Woodside operating office.

Much to Celebrate

In 1977, with strong support from Western Australian State Premier Sir Charles Court and the new federal government, Woodside commenced the project planning stage.

Two decisions in subsequent years were critical:

- First, the decision to complete a domestic gas development before the LNG phase.
- Second, Court's decision to contract gas for domestic power generation on a take-or-pay basis.

The decision to proceed with the Domgas project was announced in September 1980. The hub of the North West Shelf Venture, as it became known, was the platform on the North Rankin field, very close to that first well site.

First gas flowed ashore in July 1984 and onto domestic customers the following month.

Geoff Donaldson retired later that year, having guided the company for nearly three decades.

The size and costs of the LNG project forced Woodside and partners to rearrange their JV interests: Japanese companies Mitsubishi and Mitsui, purchased one-third of Woodside's 50 percent interest, with BHP and Shell acquiring one-sixth each. The first LNG shipment left for Japan in July 1989.

To celebrate the 40th anniversary of the North Rankin-1 gas discovery, BOCAL veterans are planning celebrations later this year in Perth and London. They have a lot to celebrate: The Rankin Trend fields have produced about 15.8 MMcfd of gas and 630 MMbbl of condensate to end 2010, with vast reserves remaining, and are an important part of the Australian economy.

No doubt there will be a toast or two to BOCAL/Woodside's many exploration successes and surprises, but none more so than this first well where it all started.