

2.6.6 Core Photography

Core over the intervals 701.72 to 706.53m, 781.13 to 781.58m, 782.0 to 782.17m, 783.91 to 784.02m, 784.52 to 788.92m, 789.56 to 789.81m, 790.06 to 790.21m, 880.92 to 881.24m and 881.27 to 882.94m was photographed by Challenger Geological Services under white and ultra-violet light. The photographs are presented in Appendix 13.

3. GEOLOGICAL DATA

(Note: all depths are loggers depths unless otherwise stated).

3.1 Geological Summary

Balmain 1 was designed to test a lateral resistivity anomaly identified using the compensated transient electromagnetic (CTEM) technique. The anomaly was interpreted to occur at the approximate depth of the "Jamison Sandstone" which flowed minor amounts of oil and gas in **Jamison 1**. A secondary objective existed within a sandy interval near the base of the "Hayfield Mudstone" which flowed minor amounts of gas in **Jamison 1** and **Mason 1**.

The well spudded in unconsolidated to poorly consolidated clays, silts and minor sands, believed to be of Cretaceous and Tertiary age, which persisted to 52.5m. The resistivity and gamma-ray logs suggest the well intersected a thinned Cambrian Jinduckin Formation at this depth although returns were obscured by cement after drilling out the 7 inch casing shoe at 56.5m (Driller). Returns were lost entirely after 65m (Driller) however the top of the Tindall Limestone was determined to be at 81.5m from the gamma-ray log.

The well was drilled without returns from 65m (Driller) to the 5 inch casing point at 604m (Driller). Interpretation of the electric logs and penetration rates indicate the well intersected the Antrim Plateau Volcanics at 263m and a Cambrian sand, probably a correlative of the Bukalara Sandstone, at 346m. The sand is significantly thicker than that intersected in **Jamison 1**, but is believed to be Cambrian rather than Proterozoic as rapid penetration rates suggest excellent porosity. Electric logs indicate the top of the "Hayfield Mudstone" was encountered at 404m.

Upon coring out the 5 inch casing shoe, **Balmain 1** intersected a predominantly dark greenish grey mudstone with fining-upward siltstone beds and laminations. Hydrocarbon fluorescence was first noted in partially mineralised fractures and adjoining bedding partings at 637.6m (Driller). Fluorescence in a coarse siltstone first occurred at 659m (Driller) and peaked at 20 percent banded fluorescence in fining upward siltstone beds between 702.2m and 706.5m (Driller). At 779.9m the well entered the very fine to fine grained quartz sands of the "Hayfield Sand" which persisted to 790.0 metres. Oil shows and elevated gas readings over the interval 786.0 to 789.8m (Driller) were particularly encouraging and a closed chamber DST over the sand recovered 4.5 litres of oil and 24.5 litres of oil and water cut rat-hole mud.

Drilling recommenced in the mudstone dominant "Hayfield Mudstone" which exhibited an occasional very fine grained sand content below 838.5m (Driller) indicating proximity to the underlying "Jamison Sandstone". However gas readings dropped off sharply and when the "Jamison Sandstone" was intersected at 854.0m it was found to be water wet.

The "Jamison Sandstone" can be subdivided into an upper facies between 854.0 and 869.7m of fine to coarse grained sandstone, a middle facies between 869.7 and 883.7m of predominantly medium grained, bedded to massive sandstone, and a lower facies between 883.7 and 938.5m of cross-bedded, fining upward, very fine to coarse grained sandstone with abundant clay matrix. DST 2 was conducted to test a zone of black, viscous, foetid oil in core between 880.92 and 882.94m (Driller), but recovered only foetid, salty formation water. Analysis of the oil (Appendix 12) has shown that it is heavily biodegraded.

Below the "Jamison Sandstone" **Balmain 1** passed sharply into an organic rich mudstone sequence with occasional fining-upward siltstone beds and laminations. The mudstone unit is thought to correlate with the Proterozoic Kyalla Member of the McMinn Formation recorded in wells to the north of EP18. **Balmain 1** reached a total depth of 1050m in mudstones of the Kyalla Member.

3.2 Well Objectives and Performance

Balmain 1 was designed to test a lateral resistivity anomaly interpreted to represent hydrocarbons in the "Jamison Sandstone". The well flowed a small volume of oil from its secondary objective but the "Jamison Sandstone" was determined to be water wet.

Formation tops were prognosed from a combination of CTEM soundings and previous well intersections. Depths for the Proterozoic section determined from preliminary seismic data were approximately 80 metres low to the CTEM prognosis. However problems with seismic depth prognosis were encountered in **Mason 1** and the CTEM prognosis was accepted.

The well came in within expectations down to the base of the Cambrian Tindall Limestone. The Antrim Plateau Volcanics were thinner and the ~~Bukalara~~ Sandstone thicker than prognosed. These thickness changes, compared with previous well intersections, appear to be a facies effect as the "Hayfield Mudstone" came in only 16m high to prognosis (see Plan PetNTcw4842).

Horizons within the Proterozoic section came in significantly lower than prognosed. Fluorescence and oil bleeds were common in fractures and siltstones in the "Hayfield Mudstone" below 637.6m (Driller), and oil was recovered from the "Hayfield Sand". It is possible that hydrocarbons in the interval described above caused the lateral CTEM anomaly at this location. The "Jamison Sandstone" came in 50.7m low to prognosis and was water wet. The "Jamison Sandstone" was also approximately 14m thinner than that intersected in **Jamison 1** and **Mason 1**. This appears to be a facies rather than structural effect.

A comparison of the intersected formations against those prognosed is given in Table 5 and shown diagrammatically in Plan PetNTcw4925.

FORMATION NAME	PROGNOSED TOP (m DF)	ACTUAL TOP (Logger m DF)	DIFF TO PROGNOSED TOP (m)	ACTUAL THICKNESS (m)	THICKNESS DIFFERENCE (m)
Undifferentiated Surface	Surface (3.5)	Surface (3.5)	-	49	13.5 (Tn)
Jinduckin Formation	N P	52.5	N P	29	N P
Tindall Limestone	66	81.5	15.5 (L)	181.5	35.5 (Tn)
Antrim Plateau Volcanics	283	263	20 (H)	83	47.3 (Tn)
Bukalara Sandstone	413.3	346	67.3 (H)	58	51.3 (Tk)
"Hayfield Mudstone"	420	404	16 (H)	450	66.7 (Tk)
- "Hayfield Sand"	735 (to 740)	779.9 (to 790)	44.9 (L)	-	-
"Jamison Sandstone"	803.3	854.0	50.7 (L)	84.5	5.7 (Tn)
Kyalla Member (McMinn Fm.)	893	938.5	45.5 (L)	-	-

Table 5: Comparison of Prognosed and Actual Formation Tops and Thicknesses for Balmain 1.

Note: H = High, L = Low, Tn = Thin, Tk = Thick

3.3 Stratigraphy

Balmain 1 intersected 416.7m of Palaeozoic and 630.0m of Proterozoic section.

A brief stratigraphic summary based on wellsite lithological descriptions and wireline log characteristics is presented below. A stratigraphic table is provided for reference (PetNTcw4588). Appendix 14 contains a full description of cuttings and core including a record of mud gas readings and observed fluorescence.

Undifferentiated (Tertiary/Cretaceous)

Surface to 52.5m (49.2m thick).

Greyish orange, light brown and pale orange claystone with minor dark yellowish orange and moderate brown siltstone. Scattered coarse-grained quartz grains.

Jinduckin Formation (Cambrian)

52.5 to 81.5 (29m thick).

This formation was predominantly drilled without returns. In a nearby well the Jinduckin Formation is composed of thinly bedded moderate yellowish brown and dark reddish brown siltstone, and very pale orange to greyish orange crystalline limestone.

Tindall Limestone (Cambrian)

81.5 to 263m (181.5m thick).

This formation was drilled without returns. In a nearby well the Tindall Limestone consists of off-white to light grey and locally brown/orange fine to coarse crystalline limestone.

Antrim Plateau Volcanics (Cambrian)

263 to 346m (83.0m thick).

This formation was drilled without returns. In a nearby well the Antrim Plateau Volcanics consist of dark greenish to brownish grey, fine to occasionally coarsely crystalline basalt.

Bukalara Sandstone (Cambrian)

346 to 404m (58m thick).

This formation was drilled without returns. In a nearby well the Bukalara Sandstone consists of light brown and grey, poorly sorted, friable, labile sandstone, quite porous and permeable, with patchy calcite cement and very poorly-defined bedding.

"Hayfield Mudstone" (Proterozoic)

404 to 854.0m (450m thick).

404 to 604m.

No returns.

604 to 679.8m

Predominantly dark greenish grey mudstone stained very dusky red in places with minor interbedded light grey siltstone rarely grading to very fine sandstone. Thin dolostone bands at 639m and between 671 to 673m.

679.8 to 720.4m

Interbedded coarse siltstone grading to very fine sandstone, and dark greenish grey mudstone. Generally fining upward beds.

720.4 to 732.8m

Predominantly dark greenish grey with minor very dusky red mudstone. Trace siltstone laminations.

732.8 to 779.9m

Brownish black mudstone becoming dark greenish grey towards the base of the interval with minor fining-upwards light grey siltstone interbeds and occasional fining-upward sandstone interbeds. Siltstone and sandstone most common between 753 and 763m.

779.9 to 790.0m

Very fine to fine grained light grey quartzose sandstone with common clay matrix. Cleanest sand occurs between 786 and 790m with wavy laminations and thin beds of siltstone grading to mudstone more common over the interval 779.9 to 786m.

790.0 to 854.0m

Dark greenish grey mudstone becoming brownish black towards the base of the interval, with minor fining upward light grey siltstone interbeds and rare very fine sandstone interbeds. Medium to coarse grained ?siderite ooids sparsely dispersed through mudstone between 807.9 and 820m (Driller).

"Jamison Sandstone" (Proterozoic)

854.0 to 938.5m (84.5m thick)

854.0 to 869.7m

Predominantly fine grained, occasionally grading to coarse grained, well sorted, quartzose sandstone, with abundant clay matrix and quartz cement. Fine micaceous siltstone laminations occur along some bedding planes.

869.7 to 883.7m

Predominantly medium grained, quartzose sandstone with clay matrix and quartz cement. Minor irregular micaceous siltstone laminations. Apparently porous and permeable, friable sandstone with minor carbonate cement between 880.9 and 881.3m (Driller).

883.7 to 938.5m

Very light grey, fine to medium grained, pyritic, ?chloritic sandstone, with very abundant clay matrix. Micaceous siltstone laminations in places and occasional dark greenish grey mudstone beds. Conglomerate at the base of the interval (938.2 to 938.5m) contains chert granules, mud clasts and rounded spherical quartz grains suspended in a light bluish grey mudstone matrix.

Kyalla Member, McMinn Formation (Proterozoic)

938.5 to 1050m (111.5m cut)

Medium grey, brownish grey, brownish black and minor olive grey mudstone carbonaceous in places, with minor fining upward siltstone beds and laminations.

3.4 Contributions to Geological Knowledge

Balmain 1 has provided a major contribution to the knowledge of the central Beetaloo Sub-basin, and the distribution of hydrocarbons within it.

Oil was recovered from the "Hayfield Sand" at **Balmain 1** whilst the "Jamison Sandstone" was water wet. The extent of the hydrocarbon accumulation in the "Hayfield Sand" is unknown.

Balmain 1 is the first well in this area in which facies changes in the Jamison Sandstone-Hayfield Mudstone package have been identified. Correlations to **Jamison 1** and **Mason 1** show that sands at the top of the "Jamison Sandstone" and the base of the "Hayfield Mudstone" pinch out toward **Balmain 1**. These sandstone pinch-outs represent opportunities for stratigraphic traps that may be pursued in the future.

Balmain 1 was also significant as it showed that CTEM may in fact be able to detect zones of elevated hydrocarbons. The interval 637 to 800m had numerous live oil shows and elevated gas readings. It is possible that hydrocarbons in this interval caused the lateral resistivity anomaly detected by CTEM. However CTEM is still considered an experimental technique and much work is required before its usefulness is fully evaluated.

KEYWORDS

Petroleum, Proterozoic, Rotary Drilling, Diamond Drilling, Geophysical Anomaly, Hydrocarbons, Joint Venture, McArthur Basin, Roper Group, Drill Stem Test, Well logs.

LOCATION

Approximately 20km east-north east of the Wayside Inn, Dunmarra.

AMG Zone 53

E 348 256m

N 8161 886m

Latitude 16° 37' 13.6" South

Longitude 133° 34' 38.5" East

1:100,000 Sheet Warramban 5664

1:250,000 Sheet Tanumbirini SE53-2

LIST OF DPO's

77801, 78141, 78142, 78143, 78144, 78145, 78146, 78147, 78148, 78149, 78150.