



## ASX Release

25<sup>th</sup> March 2013

**ASX:NWE**

### **The Kockatea Shale represents the first successful test of the shale oil concept in Australia**

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**Norwest Energy NL (ASX: NWE)** has just completed an extensive review of the Arrowsmith-2 Kockatea Shale dataset and has determined that The Kockatea Shale represents the first successful test of the shale oil concept in Australia. Norwest has reported this today to shareholders in edition five of **Norwesterly** which is attached, and may be viewed at [www.norwestenergy.com.au](http://www.norwestenergy.com.au).



# norwesterly

FIFTH EDITION MARCH / APRIL 2013

**ASX:NWE**

## **SPECIAL ARROWSMITH-2 UPDATE – KOCKATEA SHALE OIL POTENTIAL**

To Fellow Norwest Shareholders

Norwest has just completed an extensive review of the Arrowsmith-2 Kockatea Shale dataset (with more review and analysis ongoing as the program advances), and this analysis highlighted two significant conclusions that Norwest considers warranted a special edition of *Norwesterly*.

### **1. The Kockatea Shale represents the first successful test of the shale oil concept in Australia.**

Ongoing analysis on the Kockatea Shale dataset that followed on from when this interval was sealed off in the well has revealed several important key indicators supporting the statement that the Kockatea Shale is indeed a shale oil discovery, and the first successful test of the shale oil concept in Australia.

The Kockatea Shale is 450m thick at Arrowsmith-2, with results from this stage potentially high-grading up to a 200m thick section capable of producing shale oil / wet gas (Refer Figure 1. for northern Perth Basin Stratigraphic Section). If this indeed proves to be an economic shale oil play, then this is significant, as this formation extends over a large area geographically.

Further details on these conclusions are presented later in this edition of *Norwesterly*.

### **2. Carynginia- the way forward backed by Kockatea experience – extended pressure build-up and monitoring necessary to achieve optimal flow rates**

Similar to the Kockatea Shale, when the Carynginia interval was initially flowed back, a low, consistent gas rate of 22,000 scf/d was recorded, however after the period of pressure build-up whilst operations were being carried out on the Kockatea Shale interval, the Carynginia demonstrated significant pressure recovery, and when flowback re-commenced, had a greatly enhanced gas rate of 355,000 scf/d with an average rate of over 200,000 scf/d. Rather than continuing to flow back the well until sufficient injected fluid is removed from the well (which could take considerable time to complete), it has been demonstrated as per the Kockatea Shale that it is more efficient and cost effective to build up pressure in the well, open the well to flow and monitor gas rates over a number of days. With this strategy, the high volumes of fluid do not need to be removed up front, and demonstrated gas rates can be recorded.

## **Arrowsmith-2: Proof of Concept Well**

Arrowsmith-2 has always been a proof of concept well and the results delivered to date are exceptional;

- “Proof of Concept” has been established in every zone with gas to surface in each as zone as well as oil from the Kockatea.
- Geological objectives have been achieved

Norwest has now effectively created an analogue for the northern Perth Basin in the Arrowsmith-2 well, as it is the first real dataset for shale gas exploration in the region. This process takes time, and it is not until the process of evaluation on this well had advanced that it became more evident what these particular shales required in terms of flow back in order to get true indications of their ability to flow gas. It is well known that each shale is different, and this is certainly the case here.

### **The Drivers -Technical and Economic**

The Arrowsmith-2 well was drilled and fraced to assess four formations of over 1,000 metres combined total thickness – the Kockatea Shale, the Carynginia Formation, the Irwin River Coal Measure and the High Cliff Sandstones, and to fully evaluate their potential for producing natural gas. These are primary drivers in this exploration evaluation program, with data gathering being paramount to the process of high-grading and ranking each of these prospects.

Arrowsmith-2 has extremely positive economic drivers, being situated close to both natural gas pipelines that deliver gas to market, a strong demand for natural gas in the state both for domestic usage and LNG exports, a high domestic gas price, and a clean natural gas product from all formations.

The results to date are some of the best in Australia per fraced interval (for a vertical well), and in line with the North American experience from the early days of shale gas exploration using vertical wells. These North American shale plays, which originally had quite low initial production rates are now consistently demonstrating high rates from horizontal shale gas wells, and shale gas is now contributing approximately 30% of America’s energy consumption. The Australian shale gas exploration story is still in its infancy, however following on from predictions from the U.S. Energy Information Administration with 59 Tcf recoverable in the northern Perth Basin out of a total of 288 Tcf recoverable in the Western Australian Basins, and current exploration programs in place, it is expected that Western Australia will follow the trends demonstrated in the USA. The Arrowsmith-2 well is not only showing excellent rates of gas flow to date for the size of the intervals fraced, but is also the first shale exploration well to produce oil in Australia.

The flowback methodology applied by Norwest is different from that applied by most other operators in Australia testing unconventional wells. This well is being flowed back and reported by individual zones, which provide a clear picture on assessing performance characteristics for each interval. Another important point is that flowing back up 5 1/2” casing is not optimal as the weight of the fluid column in the well impedes gas production. It is intended that smaller diameter tubing will be

installed later in this program as part of the ongoing plan; this will greatly assist the flow of gas as the effect of the fluids will be reduced.

Arrowsmith-2 maximum gas rate per interval (to date) and total maximum rates are:

Kockatea Shale	414,000 scf/d
Carynginia	355,000 scf/d (higher rate expected upon clean-up)
High Cliff Sandstone	780,000 scf/d (higher rate expected upon well test)
<b>Total:</b>	<b>1,549,000 scf/d</b>

This does not include a contribution from the Irwin River Coal Measures, which will be flowed back later in this program.

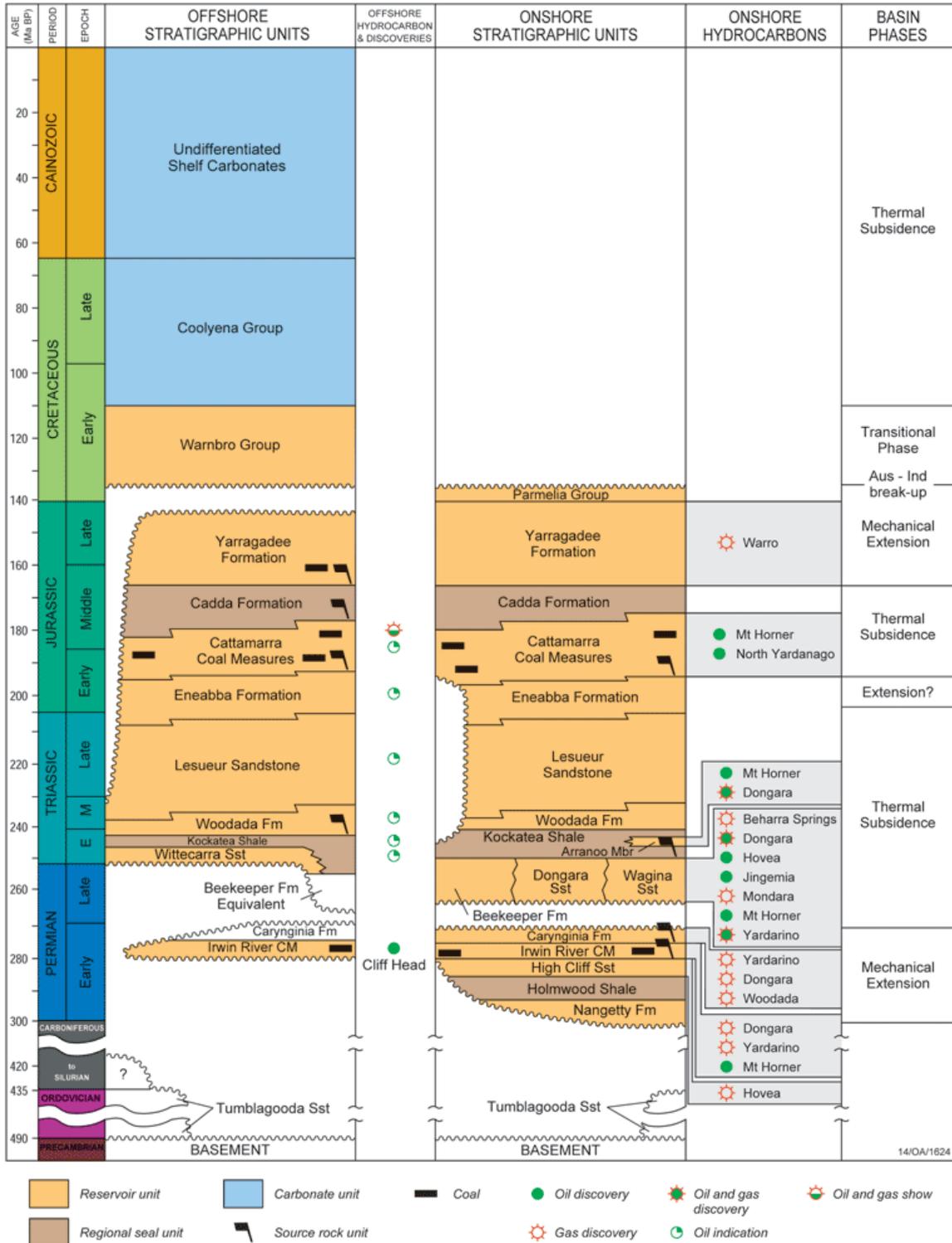
### **Kockatea Shale**

As reported previously, flowback and monitoring of the Kockatea Shale interval is now complete, with this interval now sealed, and operations now focused on the Carynginia Formation (Frac Stages 3&4 in Figure 2).

There is a clear indication from operations to date that as more frac fluid is recovered from each interval, gas rates significantly improve, and after a period of pressure-build up in the well, both fluid recovery and gas rates increase. In the initial period of flowback on the Kockatea, for example, a flow rate of 120,000 scf/d was recorded, however post ~49 days of pressure-build-up testing on this interval, a gas rate of 414,000 scf/d was recorded, with an average rate over 2 days of 200,000 scf/d.

*The Kockatea Shale represents the first successful test of the shale oil concept in Australia.* Current studies undertaken by Norwest indicate the likelihood of the waxier oil first encountered in the well being sourced from the carbonate and organically rich basal section of the Kockatea, whereas the lighter oil produced more consistently across the duration of flowback likely produced from the shale itself. Other features such as inter-bedded sequences and natural fractures may be the primary mechanism for oil production from this interval. The Kockatea Shale is 450m thick at Arrowsmith-2, with results from this stage potentially high-grading up to a 200m thick section capable of producing shale oil / wet gas (Refer Figure 1. for northern Perth Basin Stratigraphic Section). If this indeed proves to be an economic shale oil play, then this is significant, as this formation extends over a large area geographically.

## Northern Perth Basin Stratigraphy



Stratigraphy, petroleum systems elements, and major basin phases of the Northern Perth Basin.

Figure 1. Northern Perth Basin Stratigraphy

## **Carynginia Formation**

Similar to the Kockatea Shale, when the Carynginia interval was initially flowed back, a low, consistent gas rate of 22,000 scf/d was recorded, however after the period of pressure build-up whilst operations were being carried out on the Kockatea Shale interval, the Carynginia demonstrated significant pressure recovery, and when flowback re-commenced, had a greatly enhanced gas rate of 355,000 scf/d with an average rate of over 200,000 scf/d.

In order to better understand the potential of this interval, the decision has been made to conduct an additional pressure build-up test, followed by a period of further flowback in order to obtain additional gas flow-rate data. This interval was ranked as a primary target for this program, and results indicate the Carynginia could be ranked as one of the most prospective intervals in this well. As such, more data points are required for evaluation purposes, hence the current additional pressure build-up and flowback testing period. This pressure test will extend the duration of the overall program on the well, but is considered vitally important to the data gathering process required on this highly prospective interval. The Carynginia Formation is 250m thick at Arrowsmith-2, and geographically extensive across the Basin.

## **Irwin River Coal Measures**

The Irwin River Coal Measures interval (IRCM) has had very limited opportunity for flowback and gas rate testing. This interval will be flowed back over a longer period of time during the forward program on the well. This interval is extremely interesting, as it is an inter-bedded shale and sandstone play, with the sandstone layers representing higher storage capacity for gas. The nature of this formation and results from core and logs indicate that high gas rates can be expected from this interval. The IRCM is 330m thick at Arrowsmith-2 and aerially extensive in the Basin.

## **High Cliff Sandstone**

The High Cliff Sandstone interval (HCSS) is a tight gas interval. It had the longest opportunity for flowback in the initial program, with 14 days flowback. This enabled the well to return ~84% of injected fluids back to surface, and just prior to shut-in achieved a maximum gas rate of 777,000 scf/d. Across the period of flowback, this interval (as per the Kockatea and Carynginia) demonstrated that as additional fluids were removed, the gas rate improved. The gas rate from this interval demonstrated a cyclical production profile, with the gas trend definitely improving over time. As this interval has been shut-in since August 2012, it is anticipated that this period of time will have provided opportunity for strong pressure build-up and recovery, and that high gas rates will be recorded once the interval is opened to flow.

This interval is highly ranked as a prospective target in this well, and an extended well test planned later in this program is expected to confirm this position.

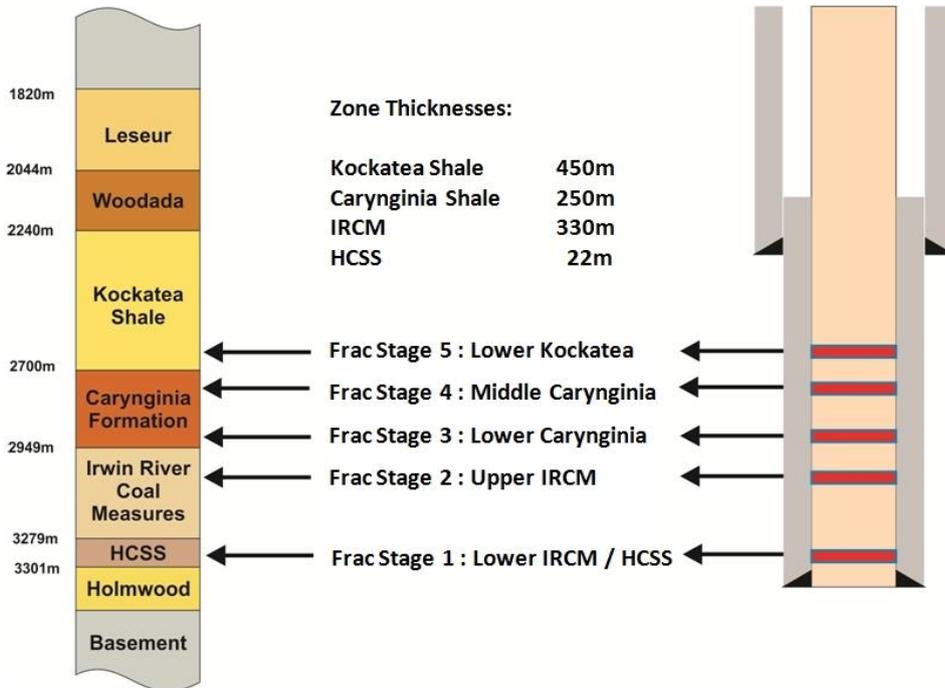


Figure 2. Arrowsmith-2 Frac Stages

### Program going forward

The last six months, or indeed the last twenty four months have been extremely busy as Norwest continued to establish the dataset to understand the full potential of the Arrowsmith field. In recent times we have made advances that we have discussed here and we are encouraged with the progress, however there is still much anticipation of what is to come, with the ongoing analysis of the Carynginia, the planned well test for the High Cliff Sandstone interval, and the flowback and testing of the IRCM.

Additionally, during the next four to five weeks, Norwest expects to receive the DeGolyer and Mac Naughton resource evaluation report, which will be significant in assisting with the planning of a development program and strategy for the Arrowsmith field.

Apart from continuing activity in the Arrowsmith well, the next major field activity will be the 100sq km 3D seismic survey scheduled for Q3/4 2013. The prime objectives of the 3D seismic survey are to:

- More accurately map HCSS closure,
- Map the base of the Kockatea Shale,
- Identify shale “sweet spots” to target in future drilling programs,
- Map the areal extent and profile of each shale section, and
- Assist with the planning of future horizontal well(s).

At this time it is not known which interval(s) will be high-graded, and therefore targeted for a future drilling program. Each of the formations targeted by Norwest in the Arrowsmith-2 campaign are considered prolific and extensive plays within the Basin.

**Peter Munachen**

Chief Executive Officer / Director  
Norwest Energy NL

**EP413/Arrowsmith-2 Project Joint Venture partners:**

Norwest Energy NL (Operator)	27.945%
AWE Limited (via subsidiaries)	44.252%
Bharat PetroResources Ltd	27.803%

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Map showing location of Arrowsmith-2, EP413, northern Perth Basin, Western Australia