GREENPOWER PURSUES OIL/GAS AT COOPER BASIN

Hydrocarbon prospectivity of PELA146, Chimney Springs, South Australia

Consultant’s report infers sediments may contain oil-prone carbonates over 500km²

25 September 2012: Greenpower Energy Limited (ASX:GPP) has received its oil and gas consultant’s report that provides strong encouragement for the company to pursue the granting of its exploration licence for oil and gas in the Cooper Basin.

Greenpower is the applicant for the Chimney Springs Petroleum Licence that covers part of the southern margin of the Cooper Basin in the north of South Australia. The Company commissioned a report by specialist consultant John Karajas to assess the hydrocarbon potential of the application area.

The consultant’s report infers sub surface Cooper Basin to Cambrian Age sediments that may contain oil-prone carbonates over approximately 500km² of the tenement.

Although there is sparse seismic survey coverage of the area, a geothermal well Yerila#1, located in the licence, intersected ferruginous sandstone below Eromanga cover sediments. Temperature logs from Yerila#1 returned a high temperature gradient corresponding to peak oil generation temperatures at depth.

Greenpower views this encouraging report as incentive to continue with the steps necessary to take the Chimney Springs petroleum exploration licence to grant.

Chimney Springs is about 730km north of Adelaide and covers a total area of about 2,400km². The tenement is inferred to contain the Cooper Basin sediments 700-1,500 metres below the surface with shale gas and shale oil prospectivity.

The Greenpower area is sparsely explored with limited seismic coverage. The Geological Survey of South Australia acquired seismic data in 1991 that it interprets as showing Cooper Basin sediments in the northern part of PELA 146. In 2005 Petratherm Ltd drilled a geothermal evaluation well to a depth of 693.5 metres that demonstrated Eromanga Basin covers sedimentary beds to a depth of 648 metres and then went through an indeterminate ferruginised sandstone bed to TD. The well was cased and cemented to TD and provides an inexpensive way of testing the underlying sequence as it may be re-entered and cored to about 1,500 metres.

Confirmation of hydrocarbon-charged beds at around depths of about 1,400-1,500 metres could rapidly lead to commercial development. The area holds good infrastructure especially as the gas pipeline from Moomba to Adelaide and an oil pipeline to Port Bonython pass through the south eastern corner of the application area. The area is also close to service company facilities at Moomba.
Enquiries:

Gerard King: 0418 852 700          John Watts: 0427 943 919
Alan Flavelle: 0438 599 252        Ron McCullough: 0409 680 772

Rudi Michelson
Monsoon Communications: 03 9620 3333

www.greenpowerenergylimited.com.au

Competent Person Statement
The information compiled in this table relating to PELA146 is based on information compiled by John Karajas, who is a member of the Australian Institute of Geoscientists. John Karajas has sufficient experience which is relevant to the report he has written to qualify as a Competent Person as defined in the 2004 edition of the “Australian Code for reporting of Exploration Results, Mineral Resources and Ore Reserves”. John Karajas consents to the inclusion in this report of the matters based on his information and in the form and context in which it appears.

About Greenpower Energy Limited
Greenpower Energy’s (ASX:GPP) focus is to license the technology and establish a commercial operation to convert part of the Latrobe Valley’s massive reserves of brown coal into liquid hydrocarbons. Greenpower’s exploration areas in the Latrobe Valley of Victoria contain substantial brown coal resources. In parallel with its coal and gas exploration the company is investigating technologies and processes whereby brown coal can be used in a cost effective and environmentally responsible way. Some processes, particularly a direct coal to liquids (DCTL) process, have been identified which may allow the company to achieve these objectives.

The company has farmed-out an interest in its EP447 conventional and tight gas area in the Perth Basin of Western Australia. The partner has commenced pre-survey field operations for a 2D seismic survey which will be completed in 2012-2013. It is noted that operators in adjacent areas are enjoying technical success in this tight gas environment. In South Australia desktop studies are progressing on PEL 145. Desktop studies for the company’s geothermal project near Esperance in Western Australia have been concluded and shallow investigatory drilling will take place in 2012. The Company has signed a government co-funded drilling grant of $120,000 for the geothermal project. The grant has been provided on a dollar for dollar basis under the Western Australian Royalties for Regions funded, Exploration Incentive Scheme.
HYDROCARBON PROSPECTIVITY OF PELA 146
(CHIMNEY SPRINGS), SOUTH AUSTRALIA

J. Karajas B. Sc. (Hons), MAIG, June 2012
EXECUTIVE SUMMARY

PELA 146 (Chimney Springs) is located approximately 730 km north of Adelaide in South Australia and covers an area of approximately 2,400 sq. km. The northern part of the application area lies at or near the southern boundary of the Cooper Basin and is inferred to contain about 500 sq. km of Cooper Basin sediments, lying between 700-1,500m subsurface, with shale gas and shale oil prospectivity. The Cooper Basin is currently regarded as holding major shale gas potential and companies holding exploration and production licences in the Cooper, such as Beach Petroleum are attracting substantial stock market interest. The northern part of PELA 146 also holds coal seam gas (CSG) potential. Alternatively, the subsurface beds in the 700-1,500m target zone may comprise Cambrian beds including oil-prone shallow marine carbonates.

The area is sparsely explored with limited seismic coverage. The Geological Survey of South Australia acquired seismic data in 1991 which they interpret as showing Cooper Basin sediments in the northern part of PELA 146. Their seismic data certainly appears to indicate that this is so. In 2005 Petratherm Ltd drilled the geothermal evaluation well Yerila #1 to a depth of 693.5m that demonstrated Eromanga Basin cover sedimentary beds to a depth of 648m and then went through an indeterminate ferruginised sandstone bed to TD. The well was cased and cemented to TD and provides a relatively cheap way of testing the underlying sequence whereby it can be re-entered and cored to about 1,500m. Temperature logs recorded subsequent to drilling show that the area holds a high temperature gradient in subsurface and extrapolation of that gradient to 1,400m in subsurface, say, would correspond to peak oil generation temperatures of around 100 degrees C.

Confirmation of hydrocarbon-charged beds at around depths of about 1,400-1,500m could rapidly lead to commercial development. The area holds good infrastructure especially as the gas pipeline from Moomba to Adelaide and an oil pipeline to Port Bonython pass through the southeastern corner of the application area. Yerila #1 is located close to the Strzelecki Track which is suitable for traversing by drilling rigs and heavy articulated trucks. The area is also close to service company facilities located at Moomba.
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INTRODUCTION

PELA 146 is located approximately 730km north of Adelaide in South Australia (see Figure 1) and is currently under application by Greenpower Energy Ltd. Area of the application is approximately 2,400 sq. km. The southeastern part of the application area is traversed by the Moomba to Adelaide gas pipeline as well as by an oil pipeline that delivers crude oil to Port Bonython near Port Pirie. The southwestern portion of the application area encompasses portion of the northernmost part of the Flinders Ranges, but most of the area under application comprises featureless arid plains. The main access to the area is by the Strzelecki Track which passes through the northern part of the permit and which continues northwards towards Moomba. Access from Adelaide is via the main highway to Leigh Creek and Lyndhurst, approximately 200 km west of PELA 146, from where the Strzelecki Track originates. This road is suitable for the transport of drilling rigs and heavy articulated vehicles. The homestead of the Mount Hopeless Pastoral Lease is located adjacent to the Strzelecki Track and 5 km west of a previously drilled geothermal test well, Yerila #1.

The area probably lies at the southernmost boundary of the Cooper Basin. Seismic data appears to indicate up to about 800m of Cooper Basin sediments in the northern part of the application area overlain by Eromanga Basin strata of around 700m in thickness. Should this be so, area of target stratigraphy would total about 500 sq. km. Alternatively, the seismically-indicated lower sedimentary sequence may comprise the northernmost extent of the Cambrian Arrowie Basin. Either stratigraphic scenario presents hydrocarbon prospectivity but seismic interpretation suggests that the lower sedimentary sequence is more likely to comprise Cooper Basin sediments.
PREVIOUS WORK DONE

Outcrop geology of the area is detailed in the Callabonna 1:250,000 geological map compiled by the Geological Survey of South Australia and published in 2001 (Sheard, 2001).

Subsurface information is provided by a number of seismic lines acquired over the northern part of PELA 146 (see Figure 2), including line 91-ER01, a vibroseis line commissioned by the Geological Survey of South Australia in 1991.
Numerous water wells and mineral exploration holes have been drilled in the northern part of the application area, but by far the most significant drillhole has been the geothermal well Yerila #1 drilled to depth of 693.5m by Petratherm Ltd in 2005 (see Figure 2). This well confirmed that the area is underlain by Cretaceous Eromanga Basin sediments (to a depth of 648m) but then went into an indeterminately-aged sequence of fine grained highly ferruginous sandstone which Petratherm (2005) tentatively assigned to the Cambrian Frome Group but which can, alternatively, be Cooper Basin sandstone heavily ferruginised by weathering occurring during a latest Permian to earliest Cretaceous sedimentary hiatus.
REGIONAL GEOLOGY

Regional geology of the application area and southwards is shown in Figure 3 and a regional cross section through PELA 146, derived from the Callabonna 1:250,000 geological map, is shown in Figure 4. The target sequence, with inferred hydrocarbon prospectivity, is that which is annotated “interpreted Cooper Basin sediments based on Seismic Line 91-ER01” and which is shown below the TD of Yerila #1 in Figure 4. Figure 3 shows the outcrop locations of crystalline basement rocks, including radiogenic granite, and Adelaidean (late Proterozoic), Early Cambrian and Middle to Late Cambrian sedimentary rocks south of the application area as well as well locations penetrating Middle to Late Cambrian sediments of the Arrowie Basin. Figure 5 is a cross-section of the Arrowie Basin sequence around the south end of Lake Frome. The formations which are prospective for hydrocarbons are the Winealpa Limestone and Wilkawillina Limestone as these contain shallow marine environment oil-prone source rocks. Should they be occurring in the target zone underlying Eromanga Basin sediments along seismic line 91-ER01, these formations would provide adequate hydrocarbon charge for shale gas or shale oil generation in conditions of appropriate thermal maturity. Petratherm Ltd, on conclusion of drilling of Yerila #1 in 2005, inferred that the well had bottomed in Billy Creek Formation (Petratherm, 2005). Based on the proximity of the Yerila #1 location to the Arrowie Basin this stratigraphic interpretation is valid, especially as the sequence intersected at the bottom of the well, between 648-693.5m, comprised fine-grained heavily ferruginous sandstone.

On the other hand, seismic line 91-ER01 shows thinning and pinch-out of Eromanga Basin sediments, as well as the underlying sequence, against the basement rocks at the northern end of the Flinders Range, as well as significant thickening northwards. Stratigraphic relationships in both the Eromanga Basin beds, as well as the underlying sequence, displayed in 91 ER01, appear to point to depocentres to the north. If that is the case, then the beds underlying the Eromanga Basin sequence are thus more likely to represent Cooper Basin sediments of Late Permian age rather than Arrowie Basin sediments. As displayed in the Callabonna 1:250,000 geological map (Sheard 2001) the Geological Survey of South Australia interprets the underlying sequence as belonging to the Cooper Basin. The geometry of the inferred Cooper Basin sediments, as displayed in the cross section, implies that the these beds could have been deposited in an outlier of the Cooper Basin similar, say, to...
the Collie Basin outlier of the Perth Basin in Western Australia. The area which is interpreted as containing Cooper Basin rocks lies over a gravity low, shown in blue in Figure 6, lying within the northeastern part of PELA 416.

If so, the ferruginous sandstone sequence intersected at the bottom of Yerila #1 needs to be accounted for. According to Sheard (2001), the Bopeechee Regolith Surface, a zone of deep chemical weathering, was formed throughout the whole region during the period of the latest Permian to the earliest Cretaceous. The basal sequence in Yerila #1 could thus be a zone of Cooper Basin sandstone overprinted by this episode of chemical weathering. Such fossil regoliths are not unknown e.g. the writer has observed a similar ferruginous chemical weathering regolith from a Precambrian to Cambrian unconformity in core from the Hussar #1 well in the Officer Basin of Western Australia.

Figure 3. Arrowie Basin, Regional Geology.
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Figure 4. PELA 146 Cross Section A - A'

Figure 5. Arrowie Basin Regional Cross Section Around Lake Frome Wells.
COOPER BASIN HYDROCARBON PROSPECTIVITY

The Cooper Basin is one of the prime natural gas producing areas within Australia. Battersby (1975) states that there are two main producing formations: the Patchawarra Formation and Toolachee Formation, both of Late Permian age. Coal and shales with abundant plant remains are common throughout the formations of the Cooper Basin and are considered as the source of the hydrocarbons. The Patchawarra Formation occurs towards the base of the Cooper Basin sequence and is more likely to be found in the PELA 416 area than those units towards the top of the Cooper Basin sequence such as the Toolachee Formation. The Patchawarra Formation consists of a sequence of sandstones, shales, coals, siltstones and minor conglomerates deposited mainly in upper deltaic and flood plain environments. Commercial flows of wet gas have been found in numerous structures throughout the southern half of the Cooper Basin (Battersby, 1975). Oil has also been produced from two of these structures, from the Moorari Beds, a thick carbonaceous shale and coal unit immediately underlying the Patchawarra Formation. Sandstones in the basal unit of the Cooper Basin sequence, the Tirrawarra Formation have also flowed oil of about 50 degree API oil plus associated gas (Battersby, 1975). Source rocks in the Cooper Basin are predominantly gas prone but the near-basal shale beds, in the Moorari Beds for example, also contain significant oil-prone alginite derived from Botryococcus (Battersby, 1975).

For a number of decades since the late 1960's the Cooper Basin has been the site of major natural gas production out of conventional sandstone reservoirs. Reservoir engineering studies have also shown that there has been, in effect, substantial coal seam gas (CSG) extraction as a result of reservoir pressure drawdown leading to gas diffusion out of coal beds and then migration through permeable sandstone beds into well bores (Santos personnel, pers. comm.).

There is now major interest in the “shale gas” potential of the Cooper Basin resulting from the success of the application of horizontal drilling technology as well as fracking techniques in the USA. The wholesale application of these technological developments in the USA has led to dramatic increases of natural gas production in that country over the last few years. Increasingly, the focus in the USA is now on “shale oil” production whereby these techniques are used to produce oil out of shale beds that were formerly regarded as too “tight” for
commercial production. Companies which hold substantial acreages in the Cooper Basin, such as Beach Petroleum, Drillsearch Energy and Senex, have experienced dramatic increases in their share prices as their exploration and production licences are now inferred to hold very good potential for eventual major new gas production. Whereas new shale gas basins such as the Canning Basin in Western Australia have no established infrastructure, the Cooper Basin contains major gas gathering systems and processing plants as well as being connected to markets such as Adelaide, Sydney and Brisbane via pipelines. Therefore new gas production in the Cooper has the potential to be rapidly commercialised with resultant quick cash flow.

PELA 146 may also hold Cooper Basin sediments with shale gas and shale oil potential. This area is well south of where there has been past exploration success and has therefore been only sparsely investigated by seismic and has had no hydrocarbon exploration drilling. What the area has experienced, however, is geothermal energy evaluation in the form of the Yerila #1 well drilled by Petratherm Ltd in 2005. Serendipitously, this well demonstrates that the lower beds in the sequence underlying the TD of Yerila #1, at depths of around 1300-1500m, are probably in the peak of the oil generation window (see discussion about temperature logging of Yerila #1 below). Confirmation that this zone contains either hydrocarbon-bearing near-basal Cooper Basin beds or Cambrian oil-prone beds, suitable to the application of horizontal drilling/fracking can be achieved relatively cheaply by re-entering Yerila #1 and coring from TD at 693.5m through to about 1,500m depth.

Seismic line 91-ER01 demonstrates that there are sedimentary beds lying below the TD of Yerila #1 (see Figure 4).

PETRATHERM GEOTHERMAL INVESTIGATION

As part of its regional investigation of the geothermal potential of this part of South Australia, Petratherm Ltd drilled Yerila #1 in 2005. The well completion report is given in Petratherm (2005) and data given below are from that report. Petratherm Ltd drilled the Yerila #1 well into a regional gravity low (see Figure 6) that the company interprets as being underlain by the “Callabonna” granite at a depth of about 3,500m. Other gravity lows in the region are
associated with radiogenic granites (e.g. see Figure 6) which Petratherm believes are sufficiently hot so as to cause high heat flows in their overlying sediments.

Figure 7 details the stratigraphy encountered by Yerila #1 and it is noteworthy that the actual formation tops accord reasonably with the stratigraphy in the Callabonna 1:250,000 geological map cross-section given by the Geological Survey of South Australia, an interpretation made on the basis of analysis of the 91-ER01 seismic line prior to the drilling of the well. Given that the Survey analysis of the upper, Eromanga Basin sequence, predicted that section quite accurately, their prediction of underlying Cooper Basin sediments should be given substantial credence.

A well schematic of Yerila #1 is given in Figure 8. The well was completed as an eight and a half inch hole cased and cemented to surface. It is therefore engineered appropriately so that it can be re-entered and cored from 693.5m onwards. The well thus provides a relatively cheap opportunity for evaluating the hydrocarbon potential of the sub-Eromanga Basin sequence.

As part of the logging program subsequent to the drilling of Yerila #1, temperature logs were run on 8th September and then on 24th September 2005 (see Figure 9). These logs were run, obviously, as part of the evaluation program in order to ascertain potential for hot geothermal fluids at depth. The 24th September log is the more relevant as it was taken after the drilling mud in the hole equilibrated with the temperatures of surrounding formation. The log shows that the temperature increases from 25 degrees C at surface to 65 degrees C at 700m. Extrapolation of this trend to a depth of 1,400m, say, suggests that sediments at that depth would have a temperature of 105 degrees C, a temperature that corresponds with peak oil generation. The temperature log thus indicates that PELA 146 does indeed have an anomalously high heat flow gradient, confirming Petratherm's interpretation of this area holding valid potential for geothermal energy. What is relevant from a viewpoint of hydrocarbon prospectivity is that depth of hydrocarbon maturation and generation in the PELA 146 area can be considerably shallower than in the area to the north containing the southern Cooper Basin gas fields. This implies that, should there be hydrocarbon-charged shales or coals in PELA 146, the shallower depths than further north would enable lower well
costs. Coal beds in the area may also hold substantial CSG potential as less permeability-
destroying burial would have occurred (than in zones of normal, lower, heat flow) enabling
gas-charged coal beds to deliver gas relatively efficiently to the well bore.

Figure 6. PELA 146, Bouguer Gravity.
Figure 7. Yerila#1, Intersected Stratigraphy.
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Figure 8. Yerila#1 Completion Schematic.
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CONCLUSIONS

The northern part of PELA 146 is likely to contain approximately 500 sq. km of Cooper Basin sediments lying between 700-1,500m sub-surface and overlain by Eromanga Basin strata.

The target stratigraphy is likely to comprise the wet gas prone Patchawarra Formation underlain by the oil and wet gas prone Moorari Beds and Tirrawarra Formation.

Alternatively, the Eromanga Basin sediments may be underlain by Cambrian Arrowie Basin units such as the oil prone Wilkawillina Formation.

Temperature logs recorded in Yerila #1 show that the northern part of PELA 146 has high heat flow and, extrapolating from these logs, beds at around 1,400m subsurface, say, are likely to be in the peak oil generation window.
The area thus comprises a highly interesting potential extension of the Cooper Basin shale gas province that currently is inferred by the market as having major economic potential.

The area also holds CSG potential.

The Yerila #1 well is cased and cemented to TD at 693.5m and re-entry and coring through to 1,500m represents a relatively cheap way of testing for shale gas and shale oil prospectivity of the sub Eromanga Basin sequence.

Infrastructure in the area is good including proximity to a gas as well as oil pipeline and the Yerila #1 well is close to the Strzelecki Track. Oil and gas industry service providers are stationed at Moomba nearby.
REFERENCES


Petratherm (2005), Yerila 1 Stage 1 Rotary mud pre-collar Well Completion Report GEL 157 (unpublished company report).