



**SheffieldResources**  
LIMITED

**ASX and Media Release**

**17 March 2015**

## **THUNDERBIRD MINERAL SANDS PROJECT UPDATE**

### **KEY POINTS**

#### ***Metallurgical***

- **Improved recoveries of all products using full scale process equipment**
- **Overall recovery of zircon increased by 5% (to 67%)**
- **Primary zircon constitutes 80% of recovered zircon**
- **Testwork indicates likely feasibility of co-disposal of polymer treated slimes and sand tails which will greatly assist water recovery and recycling**

#### ***Geotechnical***

- **Investigations confirm deposit amenable to mining by conventional equipment**

#### ***Groundwater***

- **High volume, very low salinity aquifer confirmed adjacent to Thunderbird deposit**
- **Application to abstract water for processing submitted to Department of Water**

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**Sheffield Resources Limited (“Sheffield” “the Company”) (ASX:SFX)** is pleased to provide a Pre-Feasibility Study progress update on its 100% owned, world-class Thunderbird Mineral Sands Project, located near Derby in northwest Western Australia (Figure 9).

The update comprises results of metallurgical testwork and process engineering, slimes co-disposal testwork, geotechnical and groundwater investigations.

Significantly, the metallurgical testwork, using full scale process equipment, has achieved higher recoveries of all products compared to those obtained from earlier Scoping Study testwork.

Tailings co-disposal testwork indicates polymer treated tails achieve high consolidation rates and high water recovery from tailings is expected. This is likely to result in a reduced operational footprint requirement for tailings disposal and faster environmental rehabilitation.

Sheffield's Managing Director Bruce McQuitty said: “These are very pleasing results, confirming the Thunderbird mineralisation can be treated using full scale equipment with improvements to mineral recoveries an added bonus.

“The 5% increase in zircon recovery and the high percentage (80%) of primary zircon is particularly significant because zircon is the main revenue driver for the project.

“Our metallurgical consultants have excelled in this round of testwork and we expect further process optimisation will continue to achieve incremental improvements in recoveries.

“The tailings co-disposal results are also very favourable, indicating the likely feasibility of co-disposal of slimes and sand tails which will increase the recovery of water to be re-used in processing.

“The results of geotechnical investigations confirm the amenability of the deposit to mining whilst hydrogeological studies have shown that suitable groundwater for processing occurs adjacent to the deposit. The lodgement of a 5C Application for Water is yet another important step in the development of the Thunderbird Project.”

## Metallurgical Testwork and Process Engineering

Leading mineral sands specialists, Robbins Metallurgical, undertook metallurgical process development testwork on a 12.5t bulk sample on full-scale and scalable equipment. The testwork included experimental process variations to maintain or improve recoveries and final product grades. This testwork follows earlier process flowsheet testwork on 6t and 5t samples during the Scoping Study.

The 12.5t sample was collected from composited aircore drill hole samples from closely spaced holes drilled in the up-dip portion of the deposit during 2013.

The head grade of the sample is 9.3% HM, with 4.2% oversize (+5.0mm), 6.0% oversize (+1.0mm) and 20% slimes (-38micron). These grades are similar to those of the high grade (+7.5% HM) component of the Thunderbird resource (11.8% HM, 10% oversize (+1mm) and 15% slimes – refer to ASX release dated 12 December 2014).

The sample was processed through a feed preparation trommel/scrubber and desliming circuit, a spiral separation process, and a concentrate upgrade stage using wet high intensity magnetic separators (WHIMS) and spiral separators to produce magnetic and non-magnetic concentrates. The slimes behaved well, with low flocculant dosages producing high settling rates.



Figure 1: Material loading (easy to work with)



Figure 2: Material feeding (no hang up)



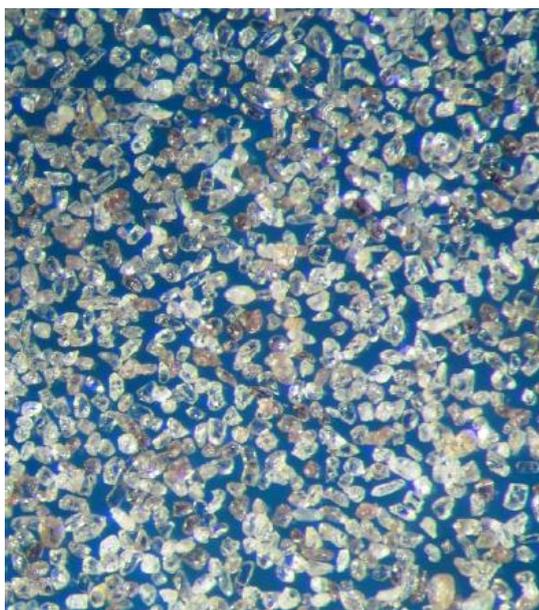
Figure 3: Scrubber/trommel oversize removal



Figure 4: Cyclone overflow (trace +38 micron)

Non-magnetic concentrate was processed via electrostatic and magnetic separators, further screening and gravity separation stages and hot acid leaching (HAL) to produce a HiTi 80 product, and Primary, Secondary and Special Zircon grades. Processing of the non-magnetics was designed to improve zircon recoveries and product grades.

Overall zircon recovery, excluding semi-processed and re-circulated streams, is calculated at 67%, and is 5% higher than in Scoping Study testwork. The primary (66.4%  $ZrO_2$ ) zircon comprises 80% of the recovered zircon. A secondary (65.1%  $ZrO_2$ ) and a special (62.8%  $ZrO_2$ ) zircon were also produced. A HiTi 80 product (87.7%  $TiO_2$ ) incorporating leucoxene, HiTi leucoxene and secondary ilmenite was also produced from the non-magnetic concentrate. High titanium leucoxene recovery, excluding semi-processed or re-circulation streams is 37%, which is 8.8% higher than that achieved in Scoping Study testwork.



**Figure 5: Primary zircon**

These improved recoveries are due to optimisation of the wet concentration and concentrate upgrade processes, an additional dry magnetic separation stage ahead of the HAL process, and a zircon scavenging circuit.

Magnetic concentrates were processed through a simple two-stage electrostatic separation process to produce a primary ilmenite containing 45.9%  $TiO_2$ . Predicted overall recovery of ilmenite to product is 76%.

Although increased mineral recoveries for all products was achieved compared to earlier Scoping work, the Company has committed to additional research and investigation to further improve recoveries and tailor products for specific markets.

The results of the current metallurgical testwork will be used to develop the PFS process engineering design.

### **Tailings Co-Disposal Testwork**

In conjunction with Robbins Metallurgical, tailings co-disposal testwork was undertaken by Golder Associates and BASF using Thunderbird sand tails, slimes and site groundwater.



**Figure 6: Thickened slimes after 5-10 minutes settling**

The program comprised laboratory testing to assess the influence of Rheomax<sup>®</sup> polymer treatment on the initial dewatering and consolidation behaviour of co-disposed tailings. This test work indicated that polymer treatment resulted in an increased rate of water release and dry density development.

The magnitude of the beneficial effect of polymer treatment was comparable to other mineral sands materials that BASF and Golder Associates have investigated. The increased rate of water release is likely to result in a reduced operational footprint requirement for tailings disposal, increased recovery of water from the tailings, and will facilitate faster rehabilitation.

## Hydrogeological Assessment

A 'H3' Hydrogeological Assessment has been prepared by consultants Pennington Scott to support the Company's 5C application to the Department of Water to abstract water from the aquifer underlying the Thunderbird deposit.

Investigations that have been undertaken in support of the 'H3' assessment include:

- drilling and testing of three test production bores to obtain information on aquifer parameters;
- installation of 57 monitoring bores to monitor groundwater levels;
- airborne electromagnetic surveying to characterise the geometry of the aquifer;
- numerical modelling to predict the regional drawdowns from water abstraction; and
- flora and fauna surveys to characterise the ecology of the proposed minesite and surrounding area.

A conceptual borefield design has been developed with approximately 12 bores equipped to pump between 20 and 40 L/sec to provide water for the project. Testing indicates the water is of good quality, with <200 mg/L of TDS (Total Dissolved Solids).

Sheffield's 5C Application to take water has been submitted to the Department of Water.



**Figure 7: Groundwater pump testing at Thunderbird**

## Geotechnical Studies

A geotechnical investigation was undertaken by geotechnical consultants ATC Williams during 2014. The primary aim of the program was to investigate the extent, strength and defect geometry of indurated layers encountered in aircore drilling and to obtain required geotechnical parameters for slope stability analyses.

A program of sonic core drilling comprising 20 holes for 781 metres was completed between 15 July and 5 October 2014. The holes were sited as twins to previously completed aircore drill holes and were selected to investigate a range of combined thickness, induration type and hardness encountered in the aircore program. The fieldwork and logging was carried out by experienced ATC Williams Engineers who logged and sampled the test holes. The sonic drilling was undertaken by Groundwave Drilling Services with a Boart Longyear DB320 Sonic Drill Rig.

Geotechnical logging of the sonic core indicated that the predominant material encountered was dense, fine to medium grained sand, occasionally with extremely weathered fine and medium-grained sandstone. This material is expected to be readily excavatable using

conventional mining equipment. Geotechnical logging indicated that between 85% and 90% of the material falls into the dense sand category.



**Figure 8: An example of dense sand which constitutes 85-90% of the Thunderbird deposit (the sample has been cut with a hand trowel)**

Approximately 10% of the sonic core was logged as hard material comprising either siliceous to weathered sandstone situated above the mineralisation in localised domains or as discontinuous zones within the mineralisation containing multiple thin (typically less than 2cm) iron cemented sand layers. The engineering assessment indicated that the majority of hard layers likely to be encountered, regardless of type, can be classified as 'hard digging' or 'easy ripping'.

An assessment of trafficability indicated that the residual sands and silty sands are very dense and are expected to be readily trafficable in dry conditions. During the wet season 'good' to 'excellent' trafficability has been inferred with temporary interruption of mining likely only during extreme rainfall events.

Based on in-situ testing, inflows into excavations are likely to be relatively slow due to low permeability and dewatering should be readily managed by conventional sump pumping as required.

Open pit stability studies indicate that overall design slopes between 40° and 60° should be feasible. It was also concluded that this was a conservative assessment because cut slopes in the unsaturated residual soils with appreciable fines content should be capable of standing at steeper angles. In addition, due to successive backfilling of voids the active pit slopes are not exposed for long periods of time.

### **Remaining Pre-feasibility work**

Pre-feasibility work is nearing completion and is on schedule to be finalised during April 2015. The remaining work in progress comprises:

- Process engineering using results of metallurgical testwork on the 12.5 tonne sample;
- Stage 2 infrastructure study focusing on site infrastructure and power;
- Market appraisal and product quality assessment;
- Pit optimisation and mine scheduling studies;
- Investigation of project capex and opex, development and throughput options; and
- Financial modelling.

## About Thunderbird

The Thunderbird deposit is one of the largest and highest grade mineral sands discoveries in the last 30 years. The total mineral resource is **3.2Bt @ 6.8% HM** (Measured, Indicated and Inferred) (at 3% HM cut-off), containing 95Mt of valuable heavy mineral, including 19.3Mt of zircon (see ASX release dated 12 December 2014 and Appendix 1).

Within this is a coherent high grade zone of **1.080Bt @ 11.8% HM** (Measured, Indicated and Inferred) (at 7.5% HM cut-off), containing 10.0Mt of zircon, 3.1Mt of high-titanium leucoxene, 2.8Mt of leucoxene and 36Mt of ilmenite.

A Scoping Study, released on 14 April 2014 and based on the smaller 19 March 2014 resource, showed the project has potential to generate consistently strong cash margins from globally significant levels of production over an initial 32 year mine life.

Sheffield was recently granted preferred proponent status for the Derby Wharf Bulk Handling Facility, which represents a potential infrastructure solution for the project (see ASX release dated 2 March 2015).

The project has been designated a Level 2 Lead Agency Project Proposal by the WA Department of Minerals and Petroleum ("DMP"). The DMP will advise and assist the Company with coordination of approvals across other WA Government agencies during the pre-submission and submission stages of the Project proposal (see ASX release dated 6 March 2015).

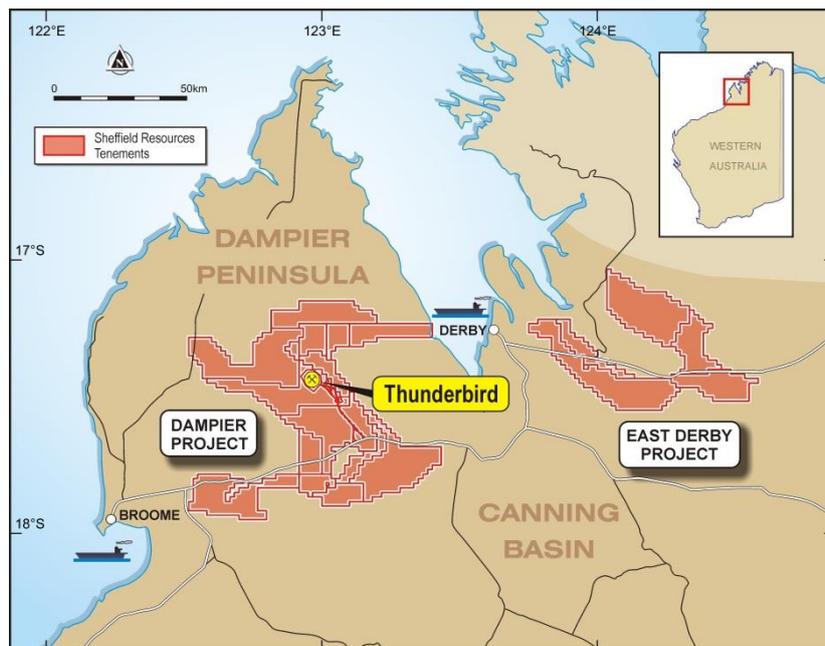


Figure 9: Location of Thunderbird deposit

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For further information please contact:

Bruce McQuitty  
Managing Director  
Tel: 08 6424 8440

[bmquitty@sheffieldresources.com.au](mailto:bmquitty@sheffieldresources.com.au)

Media: Luke Forrestal  
Cannings Purple  
Tel: 08 6314 6300

[lforrestal@canningspurple.com.au](mailto:lforrestal@canningspurple.com.au)

Website: [www.sheffieldresources.com.au](http://www.sheffieldresources.com.au)

## **COMPLIANCE STATEMENTS**

### **PREVIOUSLY REPORTED INFORMATION**

This report includes information that relates to Exploration Results, Mineral Resources and Scoping Study results which were prepared and first disclosed under the JORC Code 2012. The information was extracted from the Company's previous ASX announcements as follows:

- *"THUNDERBIRD HIGH GRADE RESOURCE SURPASSES ONE BILLION TONNES"* 12 December 2014
- *"SHEFFIELD DOUBLES TOTAL MINERAL RESOURCES AT WORLD CLASS THUNDERBIRD HMS DEPOSIT"* 19 March 2014
- *"SCOPING STUDY HIGHLIGHTS THUNDERBIRD'S EXCEPTIONAL FINANCIAL RETURNS"* 14 April, 2014

These announcements are available on Sheffield Resources Ltd's web site [www.sheffieldresources.com.au](http://www.sheffieldresources.com.au).

The Company confirms that it is not aware of any new information or data that materially affects the information included in the original market announcements and, in the case of reporting of Exploration Results, estimates of Mineral Resources or results of Scoping Studies, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcements continue to apply and have not materially changed. The Company confirms that the form and context in which any Competent Person's findings are presented have not been materially modified from the original market announcement.

### **SCOPING STUDY**

The Scoping Study referred to in this report is based on low-level technical and economic assessments, and is insufficient to support estimation of Ore Reserves or to provide assurance of an economic development case at this stage, or to provide certainty that the conclusions of the Scoping Study will be realised.

The Company believes it has a reasonable basis for making the forward looking statements in this report, including with respect to any production targets, based on the information contained in the announcement *"SCOPING STUDY HIGHLIGHTS THUNDERBIRD'S EXCEPTIONAL FINANCIAL RETURNS"*, dated 14 April 2014, and with respect to the Mineral Resource for Thunderbird as at 19 March 2014, independently compiled by QG Pty Ltd, together with independent metallurgical, processing design, engineering, mining and marketing studies, product quality assessment, external commodity price and exchange rate forecasts and global operating cost data.

### **FORWARD LOOKING STATEMENTS**

Some statements in this report regarding estimates or future events are forward-looking statements. They involve risk and uncertainties that could cause actual results to differ from estimated results. Forward-looking statements include, but are not limited to, statements concerning the Company's exploration programme, outlook, target sizes and mineralised material estimates. They include statements preceded by words such as "anticipated", "expected", "likely", "should", "scheduled", "intends", "potential", "prospective" and similar expressions.

**APPENDIX 2: THUNDERBIRD MINERAL RESOURCE 12 DECEMBER 2014**

**Table 1: Thunderbird Deposit Mineral Resource**

Resource Category	Cut-off HM%	Mineral Resources		Valuable HM Grade (In-situ) <sup>1</sup>			
		Material Million Tonnes	HM %	Zircon %	HiTi Leucoxene %	Leucoxene %	Ilmenite %
Measured	3.0	75	7.9	0.71	0.21	0.19	2.4
Indicated	3.0	2,550	7.0	0.60	0.19	0.22	2.0
Inferred	3.0	580	5.6	0.47	0.16	0.20	1.5
<b>Total</b>	<b>3.0</b>	<b>3,205</b>	<b>6.8</b>	<b>0.58</b>	<b>0.19</b>	<b>0.21</b>	<b>1.9</b>
Measured	7.5	35	12.7	1.1	0.32	0.27	3.7
Indicated	7.5	920	11.9	0.93	0.29	0.26	3.3
Inferred	7.5	125	10.8	0.83	0.25	0.24	3.0
<b>Total</b>	<b>7.5</b>	<b>1,080</b>	<b>11.8</b>	<b>0.92</b>	<b>0.28</b>	<b>0.25</b>	<b>3.3</b>

**Table 2: Thunderbird Deposit contained Valuable HM (VHM) Resource Inventory<sup>2</sup>**

Resource Category	Cut off (HM%)	Zircon (kt)	HiTi Leucoxene (kt)	Leucoxene (kt)	Ilmenite (kt)	Total VHM (kt)
Measured	3.0	500	200	200	1,800	2,600
Indicated	3.0	15,900	5,200	6,500	50,400	78,100
Inferred	3.0	2,800	1,000	1,300	9,000	14,100
<b>Total</b>	<b>3.0</b>	<b>19,300</b>	<b>6,300</b>	<b>8,000</b>	<b>61,100</b>	<b>94,800</b>
Measured	7.5	400	100	100	1,300	1,800
Indicated	7.5	8,600	2,600	2,400	30,700	44,300
Inferred	7.5	1,100	300	300	3,800	5,400
<b>Total</b>	<b>7.5</b>	<b>10,000</b>	<b>3,100</b>	<b>2,800</b>	<b>35,700</b>	<b>51,500</b>

<sup>1</sup> The In-situ grade is determined by multiplying the percentage of HM by the percentage of each valuable heavy mineral within the heavy mineral assemblage. All tonnages and grades have been rounded to reflect the relative uncertainty of the estimate, thus sum of columns may not equal. Refer to Sheffield's ASX announcement dated 12 December, 2014 for further details.

<sup>2</sup> Estimates of Mineral Assemblage are presented as percentages of the Heavy Mineral (HM) component of the deposit, as determined by screening, magnetic separation, QEMSCAN and XRF. Magnetic fractions were analysed by QEMSCAN for mineral determination as follows: Ilmenite: 40-70% TiO<sub>2</sub> >90% Liberation; Leucoxene: 70-94% TiO<sub>2</sub> >90% Liberation; High Titanium Leucoxene (HiTi Leucoxene): >94% TiO<sub>2</sub> >90% Liberation; and Zircon: 66.7% ZrO<sub>2</sub>+HfO<sub>2</sub> >90% Liberation. The non-magnetic fraction was submitted for XRF analysis and minerals determined as follows: Zircon: ZrO<sub>2</sub>+HfO<sub>2</sub>/0.667 and High Titanium Leucoxene (HiTi Leucoxene): TiO<sub>2</sub>/0.94.

## ABOUT SHEFFIELD RESOURCES

Sheffield Resources Limited (**Sheffield**) is a rapidly emerging heavy mineral sands (HMS) company.

ASX Code:	SFX	Market Cap @ 72.5cps	\$97.4m
Issued shares:	134.4m	Cash: \$7.7m*	

\*includes \$2.5 million proceeds from sale of Oxley Potash tenements (see ASX announcement dated 9 March 2015)

Sheffield's projects are all situated within the state of Western Australia and are 100% owned by the Company.

### HEAVY MINERAL SANDS

The Dampier project, located near Derby in WA's northwest, contains the large, high grade zircon-rich Thunderbird HMS deposit. Sheffield is currently undertaking a pre-feasibility study on Thunderbird.

The Eneabba project comprises multiple HMS deposits and is located near Eneabba approximately 140km south of the port of Geraldton in WA's Mid-West region.

Sheffield is also evaluating the large McCalls chloride ilmenite project, located 110km to the north of Perth.

### NICKEL-COPPER

Sheffield has over 2,000km<sup>2</sup> of tenure in the Fraser Range region, including the Red Bull project which is within 20km of Sirius Resources NL's (ASX:SIR) Nova Ni-Cu deposit.