AUSTRALIAN
RESEARCH
INDEPENDENT INVESTMENT RESEARCH

Jindalee Resources Limited (ASX: JRL)

February 2020

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INVESTMENT RESEARCH

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INDEPENDENT INVESTMENT RESEARCH

Jindalee Resources Limited (ASX: JRL)

Initiation of coverage

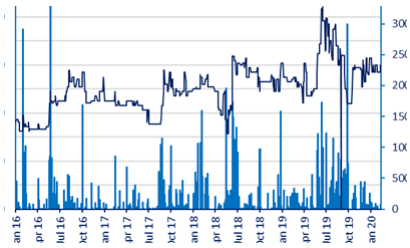
Rating

Investment Profile	
Share Price ($) at 12 February 2020	0.285
Issue Capital:	
Ordinary Shares (M)	38.49
Options (M)	7.10
Performance Shares	0.00
Fully Diluted (M)	45.59
Market Capitalisation (M)	$10.97
12 month L/H ($)	0.215-0.422

Board and Management
Directors:
Justin Mannolini – Non-Executive Chairman
Lindsay Dudfield – Executive Director
Patricia Farr – Executive Director/Company Secretary

Major Shareholders	
LG Dudfield	33.4%
Kale Capital	8.0%
Teck Australia	5.3%
Pillage Investments	3.4%
Yandal Investments	2.6%

Share Price Performance



The investment opinion in this report is current as at the date of publication. Investors and advisers should be aware that over time the circumstances of the issuer and/or product may change which may affect our investment opinion.

LARGE SCALE US BASED LITHIUM PROJECT + GOLD/ NICKEL EXPLORATION

Jindalee has a A$11m market capitalisation, with a portfolio of properties in the lithium, nickel and gold commodity space. The 100% owned McDermitt Project in the USA has been receiving the most attention, and in 18 months from acquisition as a greenfield exploration site, has reported a maiden resource of 1.55Mt Lithium Carbonate Equivalent, with an exploration target that remains larger. Comparable ASX listed companies are trading at market capitalizations of A$30M to A$300M. These companies generally have completed scoping/PFS/DFS studies that provide the market with specifics on project scope. if Jindalee can provide this level of information to the market, we would expect the share price to be re-rated.

KEY POINTS

Jindalee is a geology driven project generator – The management has a track record of acquiring projects early and cheaply, adding significant value during the early lower cost phase of project generation, and partnering when assets entered more capital intensive development phases. The company has been listed since 2002 and still has only 38.5M shares on issue.

McDermitt is one of a new class of lithium deposit – Current global lithium supply comes from hard rock spodumene producers, typically in Australia, or brine based producers in Chile and Argentina. McDermitt is a dried out lake deposit at surface, basically an open pit clay mine, with the potential to have cash operating costs close to the bottom end of the brine producer cost curve, while also having half the time to ramp up to full capacity of brine projects. Being a new class of supply is a source of risk at present, translating to a higher discount at present, but the discount is likely to wind back if similar projects are successfully developed.

Share price drivers – We expect the McDermitt project to deliver news flow relating to additional drilling, and particularly additional metallurgical test work, which we expect will form the basis of a scoping study, or possibly a PFS and Reserve announcement. The PFS/Reserve would be the major share price driver, but we would expect interim announcements along the way to create a positive share price trend.

Lithium price oversold – From our assessment of the cost curve, and more importantly by the actions of some existing producers who are winding back production, it is clear that the current lithium price will rebound, although that will probably have to wait for US/China trade wars, Corona virus impacts, and the effects of the Chinese subsidy changes to ease.

Australian gold and nickel exploration – The newly applied for North Gruyere tenement is certainly a focus, and if Jindalee is allowed to drill in the Dorothy Hills shear zone along strike from the 6Moz Gruyere operation, we would expect that to spark some market interest.

VALUATION

As an exploration story, we find it difficult to place a specific value on the company's assets. Any valuation is contingent on the outcome of value adding activity. From a review of comparable ASX listed lithium project developers, the median market capitalization per tonne of lithium carbonate equivalent resource is around A$80/t LCE, and if Jindalee can convert all its current 1.6 Mt LCE resource into a competitive project, with similar capex and opex metrics to comparable companies, then it should trade at over A$3/sh. The risk is that in the process of building an economic project, the resource typically shrinks, hence the market's caution. The nickel and gold exploration ground in WA provides diversification and additional upside.

Please note any comments on valuation are conditional on the occurrence of events that have yet to happen. All the assets of this company are either at the exploration stage, or very early in the project definition stage. Any comparative valuation comments are also conditional on the company delivering further satisfactory project definition information.

OVERVIEW

- Jindalee was listed on the ASX on 8 July 2002. It has maintained a very tight capital structure, with 20.8M shares on issue at the end of 2002 vs 38.5m today. This has been achieved by being a generator of projects based on sound geology, adding value during the lower cost early stage by exploration and de-risking, then partnering as projects enter more capital intensive phases.
- The current portfolio is very well positioned commodity wise, with exposure to lithium, gold and nickel, all of which we believe have very strong demand fundamentals. While the lithium price has corrected over the last 12 months, the current price is insufficient in our view to encourage sufficient lithium supply for the very strong demand growth that remains intact. The battery revolution is widely expected to also positively impact nickel, and the gold outlook is constructive.

Figure 1 Jindalee shareholder wealth creation model

Source: IIR

- **US Lithium –** McDermitt and Clayton North lithium deposits were acquired in 2018. McDermitt has been the focus of attention, with a maiden Inferred Resource announced on 19 November 2019 of 150Mt at 2000ppm Lithium for 1.55Mt of Lithium Carbonate Equivalent. Both deposits have the potential to be large scale low cost suppliers to the US, and are strategically located close to a number of battery mega-plants in the US. Because McDermitt is very low cost to explore, Jindalee will be able to add substantial value for modest outgoings, with excellent prospects for the company to re-rate to more in line with comparable lithium project sponsors.
- **North Gruyere** gold exploration tenement is an example of highly prospective project generation. The tenement adjoins, and is 3km from, the Gruyere Mine (Gold Fields/ Gold Road). Given that Gold Road has just relinquished this tenement, one might have doubts about its prospectivity but the tenement is shown in Gold Road presentations as entirely covered by a heritage preservation zone, and may have been a no go zone for the company. If Jindalee is allowed to drill in the tenement, then there is up to 8Km of Dorothy Hills Shear Zone to explore. The Dorothy Hills Shear is the structural control for the 6Moz Gruyere Deposit.
- **Widgiemooltha gold and nickel exploration** tenements have been built up over time and at low cost, and are along strike from some significant recent discoveries. There has been a lot of industry consolidation in the immediate area, so there are likely to be acquisitive companies in the region, with whom Jindalee could deal at the appropriate time.
- **Sale of royalty interests** to Silverstream for A$0.5M was announced 26 July 2019 covering West Kundana, Kookynie, Kelly Well, New Bore, and Millrose. Consideration is A$250,000 cash and a A$250,000 convertible note with a 12 month expiry. Discussions are progressing with no cash received as at 31 December 2019.

MAJOR FOCUS: LITHIUM

LITHIUM PEER GROUP ANALYSIS – WHAT MCDERMITT MAY BE WORTH

Table 1 Comparative analysis (market capitalization in A$ per tonne LCE in resource)

Project	Holding Company ASX Code	Resource Mt LCE	Market Cap A$M	Market Cap A$/t LCE
McDermitt	JRL	1.55	11.0	6.86
Rhyolite Ridge	INR	1.13	302.4	267.6
North Carolina	PLL	0.76	98.9	129.5
Maricunga	LPI	0.74	70.9	95.5
Candelas North	GLN	0.68	31.9	46.6
Pular	PNN	0.17	2.9	16.6

Source: Reserve and Resource statements, and PFS/DFS releases by each company. LCE = Lithium Carbonate Equivalent.

- The table above include the ASX listed companies with brine or clay based lithium projects and no other production. The major differences are the size of their resource and how advanced their projects are. We have not included the ASX listed hard rock (spodumene) project developers, because those projects produce a concentrate rather than a final lithium project directly saleable to battery makers, and so the capital and operating costs are not directly comparable. PLL's North Carolina spodumine project is included because it plans to make hydroxide, unlike the other ASX project developers who plan to sell spodumene only.
- Jindalee's market capitalization of A$11M compares to A$31.9M to $302.4M in market capitalization of the others, ignoring Pepinnini (PNN) which has a tiny deposit. Jindalee is valued at A$6.86/LCE resource tonne vs A$46.6/t to A$267/t. At the median A$80/t resource, Jindalee would be trading at a market capitalization of A$124M or a share price of A$3.30/sh.
- Jindalee's McDermitt is at a much earlier stage than the projects of these comparable corporations, and the scope of the project has not been determined, hence a discount is justified to some extent. However, if Jindalee can deliver a project Scoping/PFS/DFS comparable to these others, there should be a substantial share price re-rating.
- Rhyolite Ridge is directly comparable to McDermitt, in that it is a US based clay deposit, but with the addition of a boric acid by-product which reduces its cash operating cost to ~US$1600/t LCE or an All In Sustaining Cost of US$2213/t LCE. North Carolina is a spodumene to hydroxide operation, and the others are brine processing projects.

What Jindalee/McDermitt has to deliver

- For McDermitt to be in this league, it needs a scoping study/PFS of US$500-600M initial capex, 20ktpa LCE equivalent, US$4000-5000/t LCE AISC, and a life of over 20 years. US$5000/t LCE is at the bottom end of the lithium carbonate cost curve (see Figure 21).
- McDermitt, if upgraded by ore sorting, has the potential to be in the same ball park as these other projects, in our view. This is discussed later in this report.
- Note that in the table below, Rhyolite Ridge AISC is reduced by around $5000/t LCE by applying the boric acid revenue credit. The other projects may have by-products but for this analysis, those credits are excluded.

Table 2 Comparable projects status and key metrics

	Initial Capex US$M	Production Ktpa LCE	AISC US$/t LCE	Life Yrs	Status
McDermitt					Resource
Rhyolite Ridge[1]	600	20	2213	30	PFS
North Carolina[2]	532	21	4018	25	Scope
Maricunga[3]	563	20	3772	37	DFS
Candelas North[4]					Resource
Thacker Pass Stage 1[5]	581	30	4088	80	DFS

Sources: 1. Ioneer PFS release 23 October 2018: 2 Piedmont DFS release 27 August 2019: 3 Lithium Power DFS release 22 January 2019: 4 Galen release 1 October 2019: 5 Lithium Americas 43-101 release 1 August 2018. LCE = Lithium Carbonate Equivalent. AISC = All In Sustaining Costs.

PROJECT STATUS – ARE WE THERE YET?

- As an interim step towards delivering a Scoping Study/PFS/DFS, Jindalee has to populate its side of the table below. We use Thacker Pass as the comparison because there is more data publicly available than any of the other projects, and the projects are only 30Km apart in similar geology.

Table 3 Check list of project attributes with McDermitt's current status

	Thacker Pass	McDermitt
Resource Mt	533	155
Resource Grade ppm Li	2932	2000
Reserve Mt	179	
Upgraded Resource Grade ppm Li		3120
Reserve Grade ppm Li	3210	
Density t/cubic metre	1.79	1.51
Stripping Ratio	1.84	
Recovery	83%	90-97% Leach Stage only
Ore Processed	Stage 1 2mtpa Stage 2 4mtpa	
LCE Produced Ktpa Li2CO3	Stage 1 30ktpa Stage 2 60Ktpa	
Operating Cost US$/t LCE	4088	
NPV Post Tax US$M	2591	

Source: Lithium Americas Thacker Pass 43-101 dated 1 August 2018, JRL release 19 November 2019.

- Jindalee can add value by progressing the project towards the status of Thacker Pass, which has a reported project NPV of US$2591M at US$12,000/t LCE. Thacker Pass is owned by Lithium Americas Corp, a C$508M market capitalization Toronto listed company. We note that a part of that company's market capitalization is due to its other operation, a lithium brine project in Argentina.
- At present, McDermitt has less tonnes, lower grade and a lower density (Specific Gravity or SG) than that of Thacker Pass. While the detailed technical work has yet to be done, there appear to be similarities.
- The 1.51 density for McDermitt is the same as the Thacker Pass density for unconsolidated material, and if that is the reason, McDermitt could have a lower mining cost than Thacker Pass.
- To counter the lower Run of Mine grade, McDermitt may be able to upgrade its ore by screening. Initial tests indicate that if the ore is attritioned and screened to 10 microns, 50% of the ore mass in eliminated and the remaining fines contain 78% of the original lithium. As shown in the Table below, a cut-off of 1750ppm, the deposit may upgrade to 78Mt at 3120ppm Li, which compares to to the 3210ppm Reserve grade of Thacker Pass.

Table 4 Existing Resource (November 2019 top half of table) and impact of upgrading

	Resource		
Cutoff ppm Li	Mineralisation Mt	ppm Li	Li Kt
Existing Resource (November 2019)			
1000	996	1420	1414
1500	328	1800	590
1750	155	2000	310
2000	64	2200	141
2500	5	2590	13
Impact of Upgrading			
1000	498	2215	1103
1500	164	2808	461
1750	78	3120	242
2000	32	3432	110
2500	3	4040	10

Source: JRL release 19 November 2019, JRL release 19 July 2019

- The cost structure of the Thacker Pass project suggests that mining costs are 11% of total costs. If McDermitt is has a similar stripping ratio and operating costs, by paying an extra US$500/t LCE in mining costs (ie mining twice as much ore per tonne LCE produced), McDermitt could save over US$3000/t LCE in processing costs, and end up with a operating cost of around US$4500-5000/t LCE.

Estimating McDermitt's value without upgrading

- If we re-run the Thacker pass model assuming 150Mt reserve and 2000ppm Li grade, we end up with NPVs from US$1025M to US$2081M depending on commodity price assumptions, ie 55-63% of the original Thacker Pass NPV range. We have left the ore volumes, capex and per tonne opex unchanged, and with no ore upgrading.
- This does not amount to a valuation of McDermitt, because the resource in unlikely to convert 100% into reserve, the mineralogy, residence times, strip ratios etc may be different for better or worse, the expansion strategy may differ in timing, and McDermitt may adopt the upgrading strategy discussed above. What it does demonstrate is that there is a starting point for assessment of the McDermitt project that points to it having substantial potential.
- This analysis also excludes any dilutionary effects that might occur as part of a project financing package.

Table 5 Thacker Pass economics at McDermitt resource grades (Lower Grade case)

Thacker Pass	PFS	Lower Grade
Reserve Mt	179	150
Head Grade ppm Li	3210	2000
NPV US$M @8% real discount rate		
At LCE price of US$10,000/t LCE	1856	1025
At LCE price of US$12,000/t LCE	2591	1553
At LCE price of US$14,000/t LCE	3327	2081

Source: Lithium Americas Thacker Pass 43-101 dated 1 August 2018, IIR estimates

RISK ASSESSMENT

- Investors in Jindalee can draw comfort that the company has managed to put together a substantial lithium resource very quickly, for very little expenditure. The major challenges going forward are:
  - The processing plant, recoveries, capex and opex.
  - Permitting
  - Lithium market – (see Lithium Outlook Section of this report)
  - Corporate market for projects (ie will Jindalee be able to find a partner?)
- **Processing** - The process route has been studied by a number of project sponsors, including Thacker Pass, Sonora (AIM listed Bacanora), Clayton (Cyprus Development) and Rhyolite Ridge. All these projects have all produced lithium from clay deposits through pilot plants. Thacker Pass (closest analogue for McDermitt) expects to commence construction early 2021 with first production early 2023.
- **Permitting** - Oregon has just permitted the Grassy Mountain cyanide gold operation (also in Malheur county where the McDermitt deposit is located). The McDermitt deposit is right on the Oregon Nevada border, so Jindalee may have the choice of locating the processing plant either in Nevada or Oregon, depending on which regulatory environment was more appropriate.
- **Corporate Market** - The US currently imports almost 100% of its lithium for Li-ion batteries so a long life domestic source of lithium has strategic importance, and Jindalee plans to market that proposition to the US battery makers. These clay based projects are very big and long life (potentially the porphyry copper deposits of the lithium space) and the capex is amortized over decades (Thacker Pass current mine life is 46 years).

FINANCIAL POSITION

- Cash on hand at 31 December 2019 was A$0.677M.
- The forecast outgoings in the March 2020 Quarter per the December cash flow statement was A$209K of which the administration costs were a very low A$119K.
- The company raised A$1.05M through an equity issue during the September 2019 quarter

- A proposed sale of various royalty interests to SilverStream SEZC for A$0.5M was announced on 26 July 2019 and is progressing. The payment mentioned in the 26 July release was A$250K plus a convertible note for A$250K with 12 months expiry.
- Jindalee has shareholdings in listed companies, which as at 30 June 2019, were worth A$2.2M, and could be a potential source of liquidity. Cash receipts of A$79K were reported in the December 2019 quarter 5B statement.

Table 6 Jindalee's portfolio of ASX listed equities (Shareholdings at 30 June 2019)

Financial Assets At Fair Value	A$M	Shares M	Share Price A$/sh
Energy Metals	1.825	14.049	0.13
Kin Mining NL	0.055	1.105	0.050
Alchemy Resources	0.176	17.617	0.01
Other	0.172		
Closing Balance	2.228		

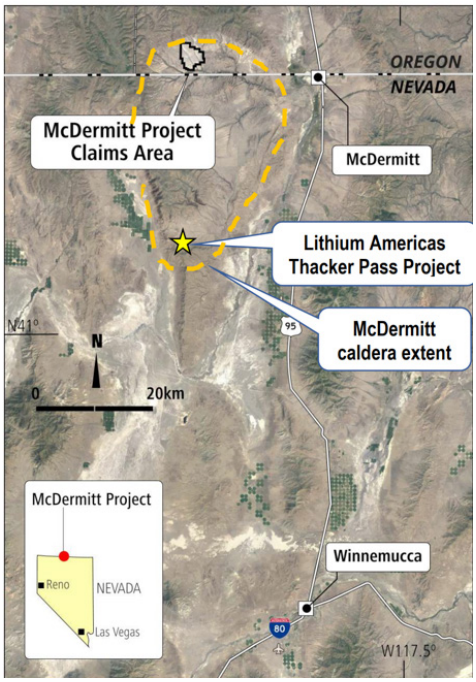
Source: JRL 2019 annual report and other releases

US LITHIUM

Figure 2 Location of the two lithium assets

Source: https://www.jindalee.net/

Figure 3 Location of McDermitt vs Thacker Pass



Source : JRL release 13 June 2019

- In June 2018 Jindalee announced the acquisition of two lithium sediment projects in the United States, at McDermitt and Clayton North. These projects are 100% wholly owned by HiTech Minerals Inc., a wholly owned, US based subsidiary of Jindalee and were generated by Jindalee after an extensive search across Nevada, Arizona and Oregon.
- Jindalee was attracted to the projects by several factors:
  - the mineralisation style has the potential to be a large scale, long life source of lithium that sits at the lower end of the global cost curve;
  - the projects are located in a mining friendly jurisdiction with significant domestic lithium demand currently satisfied by imported material; and
  - there is the opportunity for Jindalee to rapidly advance the projects through the exploration stage at relatively low cost.

OVERVIEW OF CLAYTON NORTH

- The Clayton North project is located 23km north of the only producing lithium operation in the USA at Silver Peak. Extensive areas of lithium (Li) bearing claystones outcrop within the claims area, and have returned assay results of up to 930 ppm Li in sampling by the company's geologists.

- With title to the claims now confirmed, Jindalee is working to obtain the necessary permits and approvals to allow drill testing of the project area. The proposed drilling program is designed to follow up the encouraging values returned from initial surface sampling of weathered material and test for extensions to lithium mineralisation beneath the thin cover observed in the northern part of the claim area. Samples of the oxide material have also been submitted for initial metallurgical test-work to test the amenability of the lithium bearing clays to simple leaching.

THE MCDERMITT PROJECT

- McDermitt is the more advanced of the two projects, as because it has a resource and has completed initial metallurgical testing. It can be compared to the nearby Thacker Pass project of Lithium Americas Inc.

MAIDEN RESOURCE ANNOUNCED 19 NOVEMBER 2019

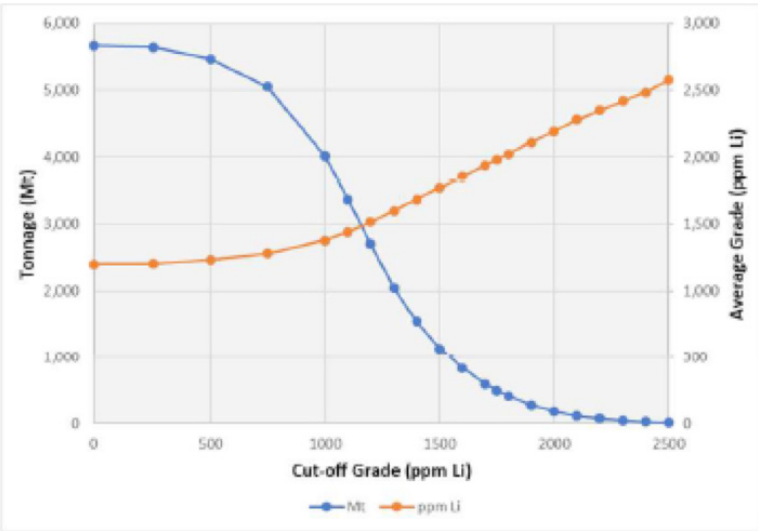
Table 7 McDermitt Resource

Resource	Resource			Exploration Target		
Cutoff ppm Li	Mt	ppm Li	Li Kt	Lower Mt	Upper Mt	Grade Range ppm Li
1000	996	1420	1414	1200	3000	1200-1600
1500	328	1800	590	370	800	1600-2000
1750	155	2000	310	180	330	1800-2200
2000	64	2200	141	75	120	2000-2400
2500	5	2590	13	2	3	2400-2800

Source: JRL release 19 November 2019

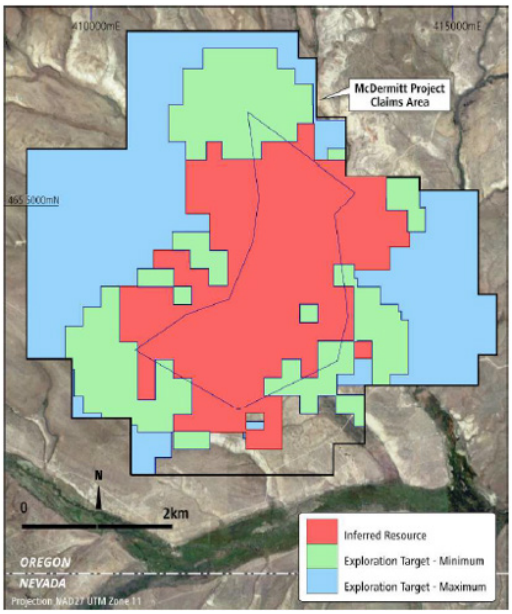
- The maiden Inferred Resource has been defined 18 months after staking the initial claims.
- The entire resource is within 100m of surface, meaning the resource definition is relatively low risk and very low cost. Improving Resource definition to Indicated status and hence being able to generate Reserves will be more about the costs of producing a Pre Feasibility Study rather that the cost of significant additional drilling.

Figure 4 McDermitt Resource grade - tonnage curves



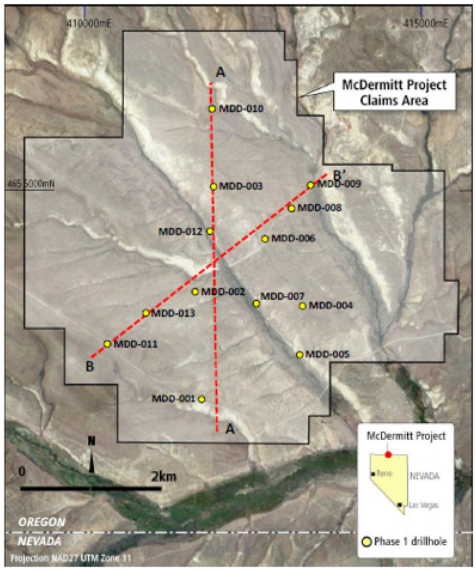
Source: JRL release 19 November 2019

Figure 5 Inferred Resource outline in red, exploration target 1750ppm cut-off in green



Source: JRL release 19 November 2019

Figure 6 Drill hole locations used to determine the Resource (see sections in Fig 7)

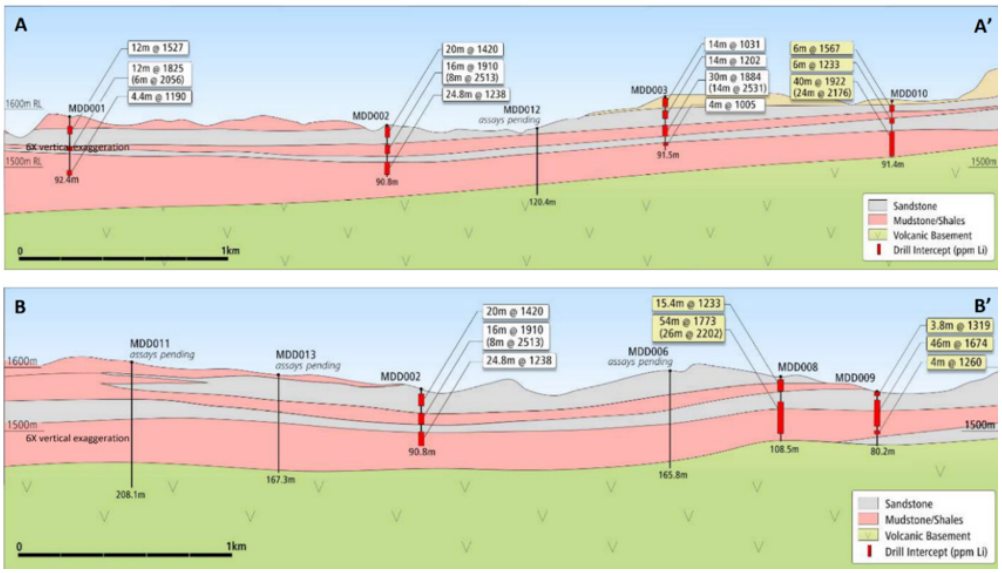


Source : JRL release 29 October 2019

GEOLOGY

- The deposit is hosted in flat lying lacustrine sediments deposited within the McDermitt caldera. The mineralisation is extensive, and continues beyond the mineral claims.
- The estimated dry bulk density averages 1.51 tonnes/cubic metre.
- From a visual review of the deposit's cross sections, the likely stripping ratio should be very low, ie less than 1t waste:1t ore. What is unclear is the impact of stratification and interburden layers within the deposit. While the presence of waste strata within the Resource would add to the stripping ratio, it may also result in an uplift in ore grade.

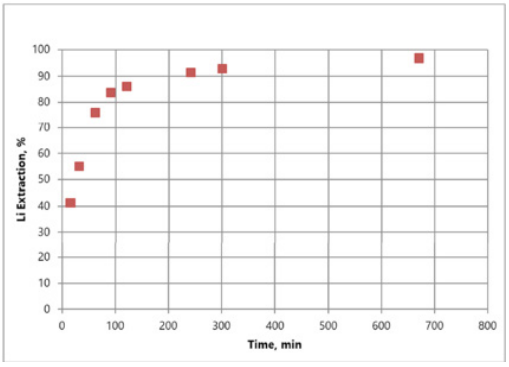
Figure 7 McDermitt deposit cross sections



Source: Quarterly Activities Report 29 October 2019

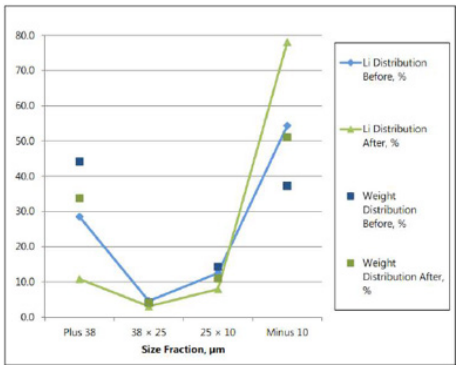
METALLURGICAL TESTWORK POINTS TO HIGH RECOVERY

Figure 8 Recovery vs residence time in sulphuric acid leach at atmospheric pressure



Source: JRL release 2 April 2019

Figure 9 Distribution of lithium by size range, before and after grinding (attrition)



Source : JRL release 19 July 2019

- 90% of the available lithium reported to the leach solution after 4 hours in a heated agitated environment, and at atmospheric pressure. 97% was extracted after 11 hours (JRL release 2 April 2019). Note this is not the overall recovery for an entire processing flowsheet, just the leaching section. However, this is the most critical stage from a recovery perspective.
- Acid consumption was 506kg sulphuric acid per tonne of ore, or 450kg sulphuric acid per tonne of ore if the leachate was topped up with fresh acid and recycled to leach a fresh batch of ore.
- A high proportion of the lithium is contained in the sub 10 micron fraction. Before attrition (ie grinding), this fraction contained ~55% and after attrition this increased to 78%
- In this series of tests, after attrition, 78% of the lithium reported to 50% of the rock mass, and the grade of the sub 10 micron fraction was 0.34% or 3400ppm.
- The test was based on a composite sample from drill hole MDD-004 submitted to Hazen Research in Golden Colorado for leach test work. Broader testing across the orebody is required for confirmation.
- In the table below, the upper half is the reported Resource at various cut off grades, and the lower half assumes the 50% of the ore tonnes remain after attrition and screening, and that 78% of the contained lithium also remains, and the grade is the result of the two.

Table 8 McDermitt Resource (November 2019) and estimated impact of upgrading

Resource	Resource		
Cutoff ppm Li	**Mt**	**ppm Li**	**Li Kt**
1000	996	1420	1414
1500	328	1800	590
1750	155	2000	310
2000	64	2200	141
2500	5	2590	13
Impact of Upgrading			
1000	498	2215	1103
1500	164	2808	461
1750	78	3120	242
2000	32	3432	110
2500	3	4040	10

Source: JRL release 19 November 2019, JRL release 19 July 2019

Comparison with Thacker Pass project

- Thacker Pass uses a flow sheet that is likely to be very similar to that of Jindalee's McDermitt Project, and the grades and acid consumption are comparable. We would expect the McDermitt grades will rise slightly and the acid consumption fall after further optimisation.
- Thacker Pass does not upgrade the run of mine ore. All ore is treated. McDermitt could selectively process only the sub 10 micron ore to get a similiar grade as Thacker Pass.

Comparison of leaching recovery and estimation of overall recovery for McDermitt

- When we come to compare the metallurgical test work on these two projects, we have problems with the data, in that there is not enough public data to benchmark the tests. The percent recovered into sulphate solution is a function of minerology, acid concentration and time, and we do not have access to all these variables.
- We can say that both deposits can be successfully leached, and both ores could be processed by similar flowsheets, but we do not know the strength of acid used by either set of tests so comparing leach times is not particularly meaningful.
- For the record, Thacker Pass recovers between 80.8% and 96.95% into solution after two hours residence time, and McDermitt recovers 90% after four hours and 97% after 11 hours, pointing to the composite sample from McDermitt appearing to perform similarly to the Thacker Pass LG Type 2 sample.
- Future testing of individual lithologies at McDermitt, rather than creating composite samples, is likely to generate a range of recoveries.

Table 9 Comparison of McDermitt and Lithium Americas Thacker Pass Recovery into leach solution

	Li ppm	Li Recovery (%)	Acid Consumption (g H2SO4/g LCE)	Acid Consumption (kg H2SO4/t ore)
Thacker Pass				
LG Type 1	2800	95.75	20.21	293
LG Type 2	2810	80.80	30.69	445
HG Type 2	3490	91.75	24.49	355
HG Type 1	3920	96.95	17.23	250
McDermitt				
Whole of Ore	2000	90-97		
Fraction sub 10 micron	3400			
Whole of Ore No recycle				506
Whole of Ore with recycle				450

Source: Lithium Americas Thacker Pass 43-101 1 August 2018, with acid consumption per LCE (Lithium Carbonate) converted to acid per tonne ore using the life of mine 2.6Mt LCE from 179Mt ore, JRL releases 4 April 2019 and 19 July 2019.

- Longer residence times means more tankage, and more acid in the first fill of the tanks on start-up, which means more capex.

Table 10 Recovery by downstream process at Thacker Pass (ie after the leaching process)

	Neutralization	Crystalization	Precipitation	Overall
Recovery in each process	89.3%	99.6%	98.6%	87.7%

Source: Lithium Americas Thacker Pass 43-101 1 August 2018

- The Thacker Pass economic model assumes 83% recovery from ore to product. The recoveries downstream from the initial leaching are shown in the table above giving an overall recovery of 87.7% for those process stages. That means the implied average recovery of lithium into the leach solution has to be 94.5%.
- Likewise, if the recovery of McDermitt into leach solution is 90% to 97%, the overall recovery is likely to be 78.9% to 85.1%. McDermitt's recovery in the later process stages is likely to be very similar to Thacker Pass.

LITHIUM AMERICAS' THACKER PASS PROJECT

- Thacker Pass is a useful study for Jindalee shareholders, because Thacker Pass is in the same geological terrain 30 Km south of McDermitt, and is likely to be a similar processing route. It is a guide as to what McDermitt could become, as Jindalee works up and de-risks the project, so we present a summary of that project below.

COSTS

- As discussed earlier, the mining costs are a very small part of the costs structure being 8.1% of the capital costs and 11.9% of operating costs. This is of relevance to McDermitt, because low mining costs mean that low mine grades can be offset if screening or optical sorting can achieve low cost ore concentration, as appears to be the case at McDermitt.

The bulk of the costs are in the processing plants and the large volumes of reagents required.

Table 11 Thacker Pass Capital Costs

Capital Costs	Phase 1 2.2Mtpa	Phase 2 4mtpa	Total	Cost Split Phase 1
Mine	47.00	0.70	47	8.1%
Lithium Carbonate Plant	218.00	96.00	313	37.5%
Sulphuric Acid Plant	135.00	158.00	293	23.2%
Railroad & Yards	2.80	81.00	84	0.5%
Total Direct Cost	401.00	336.00	737	69.0%
Indirect Costs	89.00	65.00	154	15.3%
Contingency	91.00	77.00	168	15.7%
Total Capital Cost	581.00	478.00	1059	100.0%

Source: Lithium Americas Thacker Pass 2018 43-101 PFS

Table 12 Thacker Pass operating costs

Operating Costs	US$Mpa	US$/t ore processed	US$/t LCE Produced	Cost Split US$/t LCE
Mining Cost	27.59	7.07	488	11.9%
Processing	93.28	23.92	1649	40.3%
Sulphuric Acid Plant	100.70	25.83	1780	43.5%
G&A	8.58	2.27	158	3.9%
Electricity Wheeling	850.64	0.02	15	0.4%
Total	1080.80	59.11	4089	100.0%

Source: Lithium Americas Thacker Pass 2018 43-101 PFS

- Of the US$23.92/t (ie tonnes of ore processed) Carbonate plant costs, US$18.14/t is reagents and utilities, and of the Acid Plant costs of US$25.83/t, US$22.18/t is the cost of raw materials, over half of which is purchased sulphur. Combined that means that US$40.32/t of the US$59.11/t operating costs is raw materials, and the consumption of regents is a function of the ore throughput, and ore mineralogy.
- The competitive economics of this kind of operation is all about sulphuric acid consumption. Sulphuric acid bonds with metals, ie lithium, but also sodium, calcium, magnesium, aluminium, and iron. Any process which can maximise the ratio of lithium to other metals will reduce acid consumption and unit costs, as well as the capital cost of building the acid plant.
- At Thacker Pass, the mining costs are US$488/t LCE and processing is US$3429/t LCE. This relative distribution of costs is what can make upgrading work successfully. The processing cost is largely driven by ore throughput from the leaching stage onwards, so the cost per tonne LCE is a largely function of the leach plant head grade and recovery.

GEOLOGY

Regional geological history quoted from Thacker Pass 43-101 2018 PFS

- *The exact cause for the Li enrichment in the caldera lake sediments is still up for debate. Benson et al. (2017b) demonstrated that the parent rhyolitic magmas of the McDermitt Volcanic Field were enriched in lithium due to assimilation of approximately 50% continental crust during magma genesis. In their model, eruption of the Tuff of Long Ridge and the collapse of the McDermitt Caldera resulted in a large volume of Li-enriched glass, pumice, and ash on the surface of the earth near the caldera. Subsequent weathering transported much of this lithium into the caldera which served as a structurally controlled catchment basin. Benson et al. (2017b) further hypothesize that Li-enriched clays then formed under low-temperature and low-pH hydrothermal conditions primarily along the ring fractures of the caldera.*
- *New assay data from the 2017 exploration drilling program indicates that the Li-enriched interval is laterally extensive throughout the southern portion of the caldera, just above the intra-caldera Tuff of Long Ridge. This suggests that the formation of the Li clays is not associated with hydrothermal activity, but rather due to burial diagenesis and/or primary erosional processes. Burial diagenesis is consistent with XRD data that show a transition from smectite to illite with depth in the caldera lake sequence.*

- *Reference quoted: Benson, T.R., Coble, M.A., Rytuba, J.J., and Mahood, G.A. (2017b). Lithium Enrichment in Intracontinental Rhyolite Magmas Leads to Li Deposits in Caldera Basins. Nature Communications, 8(1). https://doi.org/10.1038/s41467-017-00234-y.*

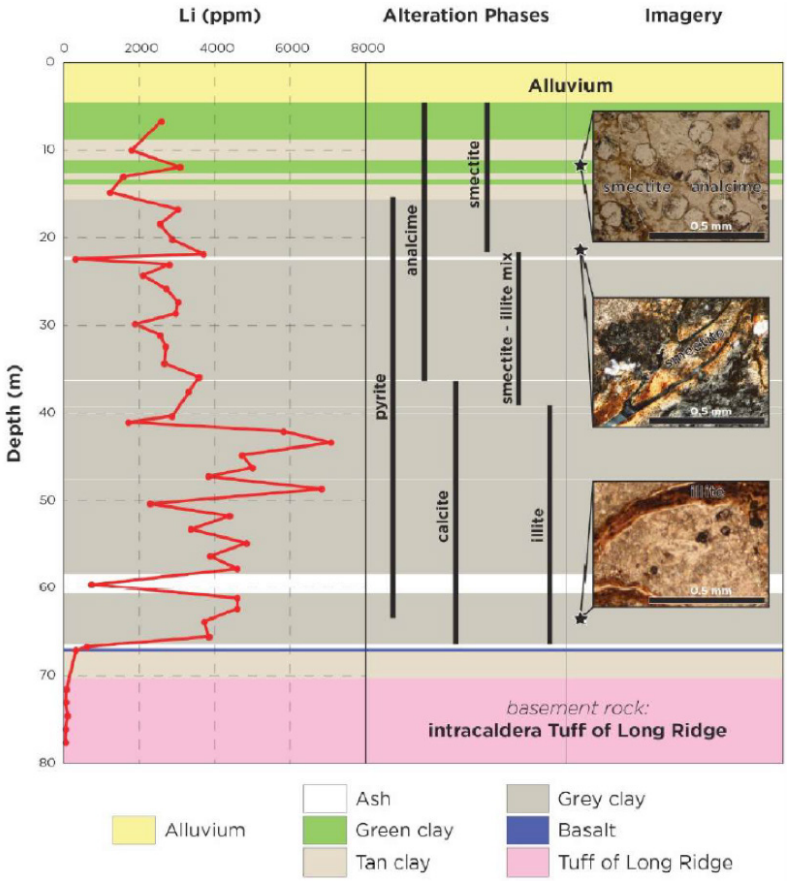
Table 13 Thacker Pass Resource and Reserve

	Tonnage (million metric tonnes)	Average Li (ppm)	Lithium Carbonate Equivalent (LCE) ('000 metric tonnes)
Resources (Cut-off 2000ppm)			
Measured	242.2	2948	3800
Indicated	143.1	2864	2182
Measured Indicated	385.3	2917	5982
Inferred	147.4	2932	2301
Measured and Indicated Inferred	532.7	2921	8283
Reserves			
Proven	133.9	3308	2358
Probable	45.5	3210	777
Proven and Probable	179.4	3283	3135

Source: Lithium Americas Thacker Pass 2018 43-101 PFS

- IIR Comment: Of relevance to Jindalee's McDermitt project, Thacker Pass Project is designed around taking out a higher grade lens within the sedimentary sequence which in Figure 9 occurs between 40m and 60m depth, but in practice down to as deep as 120m in the mine plan. The adopting of any such higher grading strategy would have a material impact on the mining economics of the McDermitt project if it were possible.

Figure 10Profile through the Thacker Pass deposit



Source: Lithium Americas Thacker Pass 2018 43-101 PFS p53

- The grades reported in the Resource at McDermitt point to very little higher grade material above 2000ppm suggesting that there is little of the higher grade illite clays and more of the lower grade smectite clays in the deposit. It is still too early in the history of proving up the McDermitt deposit to say there are no higher grade zones.

- As discussed earlier, lower run of mine grades can be offset by simple screening that can be used to reject mass and elevate grade. In operations where mining costs are a low portion of total cost, such as this, the economics of upgrading can be compelling, to the point of largely eliminating any disadvantage caused by lower run of mine grades.

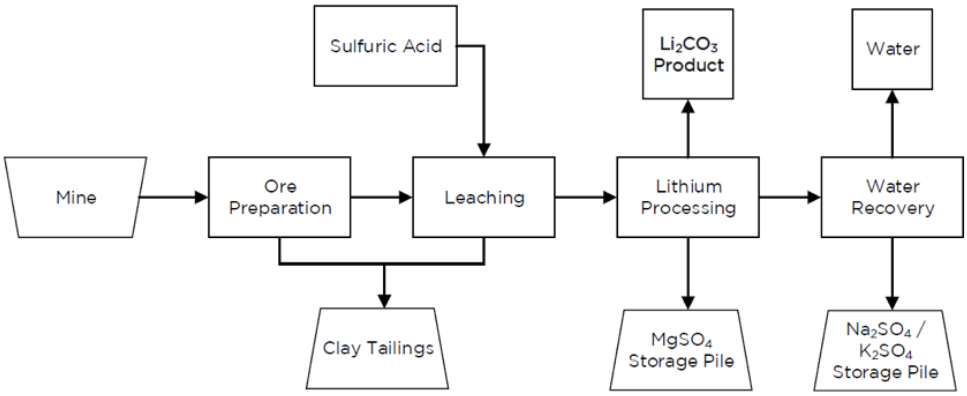
MINING AT THACKER PASS

From Thacker Pass 43-101 S16.1

- *The shallow and massive nature of the deposit makes it amenable to open pit mining methods. The mining method chosen is a modified panel mining method which employs excavators and surface miners. In this method, a section along the length of the pit is mined to the entire width and depth before moving to the next section of the pit. The ore body is perfectly set up for this as it is massive and the floor is fairly consistent.*
- *Waste removal will be done by means of an excavator and haul truck operation. Once the ore has been exposed and a running surface prepared to a relatively consistent profile, the excavator will move to the next panel section. Following the waste removal, the surface miner will mine the exposed ore and load the haul trucks directly.*
- *The ore will be hauled to the head of an overland ore conveyor or to nearby short-term stockpiles. A frontend loader will be used for any rehandling of ore and for managing the short-term stockpiles.*
- *During the first year of pre-production, mine waste will be hauled to the plant site to be used for construction fill material and will also be used to construct the tailings embankment. During the second year of preproduction, mine waste continues to be used for construction with any excess mine waste hauled directly to the waste dump. The waste dump has been designed to accommodate sufficient material such that when it is complete the remaining waste mined for the life of the mine can be backfilled directly into the mined-out pits, less any that is used for subsequent tailing embankment construction.*
- *Due to the sequence of mining, the majority of in-pit ramps will be temporary, and some will be built on backfill. Exposure to final pit walls will also be temporary.*
- *A bench height of 5 m was chosen to limit dilution. Double benching was included to increase the bench widths while still maintaining the inter-ramp slope requirements.*
- *Three geotechnical zones were included in the pit design. A delineation between soil and bedrock occurs around 30 m depth. The inter-ramp angle for the soil is 25 degrees for all areas of the pit. For total pit wall depths less than 90 m, the bedrock slope is 47 degrees. Areas of the pit with wall depths between 90 m and 120 m have a bedrock inter-ramp angle of 39 degrees.*

PROCESSING AT THACKER PASS

Figure 11 Simplified processing flowsheet for Lithium Americas Thacker Pass Project



Source: Lithium Americas Thacker Pass Project 43-101 Report p6

- *The process contemplates the use of conventional and commonly available equipment arranged to take advantage of the distinctive qualities of the high-grade ore. The process comprises a series of steps to concentrate, separate and produce battery-grade lithium carbonate.*
- *First, ore from the mine will be sized, slurried, screened and then transferred to the leaching circuit. In the leaching circuit, sulfuric acid will be added to attack the ore and liberate the lithium from the clay. The high grade quality of the ore allows for leaching to occur in stirred reactors specifically designed to maximize speed and efficiency of lithium dissolution and minimize sulfuric acid consumption.*

- *The slurry from the leaching system will be filtered to remove the spent clay and send the lithium bearing solution to neutralization. The spent clay will be washed, and the wash solution will be recycled to the leaching system. The clay will then be transported and dry stacked by conveyor in a tailings storage facility.*
- *The resulting lithium bearing solution from filtration will then go through a pH neutralization step. Neutralization will be achieved with ground limestone during startups and sustained with recycled alkaline solids from an upstream precipitation process during normal operation.*
- *Next, the lithium solution will undergo an evaporation and crystallization step using steam and electricity from the sulfuric acid production process to recover pure water and produce magnesium sulfate. The magnesium sulfate from the crystallizer, also known as Epsom salt, will be dry-stacked in a magnesium sulfate (Epsom salt) storage facility.*
- *Any remaining magnesium is removed in a second step after crystallization that involves the addition of reagents to precipitate magnesium hydroxide. The precipitated alkaline solids will be filtered and returned to the neutralization step.*
- *Finally, saturated soda ash solution will be added to the lithium bearing solution to precipitate a high-quality, battery-grade lithium carbonate. The lithium carbonate solids will be filtered, washed, dried and packaged for sale. The liquid separated from the lithium carbonate solids will then be sent for water recovery in a zero liquid discharge evaporator and crystallizer. This crystallizer will send any solids to a sodium/potassium sulfate storage facility, and the pure water being produced will be re-used in the process.*
- IIR comment: The ore grade and mineral variability impacts the leaching stage, and particularly acid consumption. In the neutralization, the limestone addition is related to amount of acid that has to be neutralized, so is also dependent on the original ore mineralogy. After that, the subsequent stages reagent consumption is directly related to lithium carbonate production, and largely independent of original mineralogy.
- In terms of capital costs, that means the sulphuric acid plant capacity is sized off the amount of ore processed. The lithium carbonate plant front end (neutralization) is driven of ore processed while the back end capacity is driven by lithium carbonate output. The rail infrastructure is driven by reagent consumption, which is largely related to ore processed.

Permitting (Thacker Pass 43-101 S20.3)

- A multi-agency regulatory process will be completed to obtain all required Federal, State and local agency permits and approvals necessary to construct, operate and ultimately reclaim and close the Project, including all mining, ore processing, and transportation related operations. The following key permits are required for open pit mining, ore processing, and transportation operations:
- Federal Permits
  - Bureau of Land Management (BLM); Mine Plan of Operations; for open pit mining, ore processing, and transportation operations on public lands;
  - Surface Transportation Board (STB); for railroad construction and operation; and
  - U.S. Army Corps of Engineers (USACE); for facility construction in jurisdictional waters of the US for Phase 2 construction of infrastructure.
- State Permits
  - Nevada Division of Environmental Protection (NDEP)-Bureau of Mining Regulation and Reclamation (BMRR); Reclamation Permit; for reclamation of the mine and process facilities;
  - NDEP-BMRR; Water Pollution Control Permit; for the construction, operation, and closure of the mine and process facilities to maintain surface and groundwater quality;
  - NDEP-Bureau of Air Quality (BAQ); Air Quality Permit for the construction and operation of the mine and process facilities to maintain ambient air quality; and
  - Nevada Division of Water Resources (NDWR); appropriation to use groundwater for mining and milling purposes.
- Humboldt County Permits
  - Regional Planning Dept.; conditional use permit allowing mining and processing;
  - Building Dept.; various permits to construct and inhabit structures and facilities at the Project, including building, electrical, plumbing and mechanical permits and inspections.

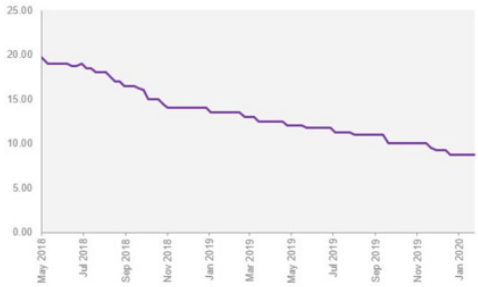
- Note that McDermitt is in Oregon State while Thacker Pass is in Nevada, so there are likely to be some differences in the permitting at the State level. The McDermitt processing plant may be located in Nevada, in which case, all these approvals will be relevant.

LITHIUM MARKET

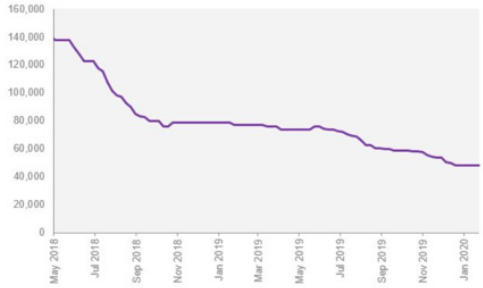
LITHIUM PRICE OFF 2018 HIGHS, NOW TESTING CYCLE LOWS

Figure 12 Current prices of battery grade lithium feedstocks

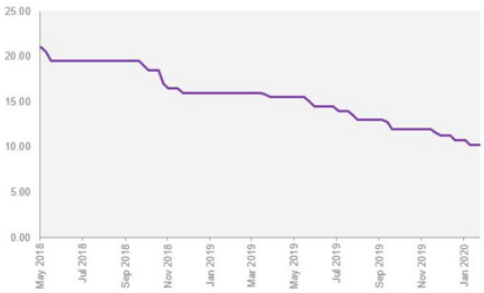
BATTERY-GRADE LITHIUM PRICES	New price (midpoint)	w-o-w % change	Monthly average	Previous month average	Quarterly average
Lithium carbonate 99.5% Li2CO3 min, battery grade, spot price exw domestic China, yuan/tonne	48,000	0	48,000	49,125	48,000
Lithium carbonate 99.5% Li2CO3 min, battery grade, spot price cif China, Japan & Korea, $/kg	8.75	0	8.75	9.00	8.75
Lithium hydroxide 56.5% LiOH. H2O min, battery grade, spot price exw domestic China, yuan/tonne	54,500	0	54,500	54,500	54,500
Lithium hydroxide monohydrate 56.5% LiOH.H2O min, battery grade, spot price cif China, Japan & Korea, $/kg	10.25	0	10.42	11.00	10.42
Source: Fastmarkets					



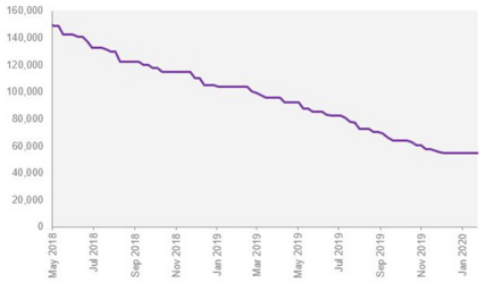
Lithium carbonate, 99.5% Li2CO3 min, battery grade, spot price cif China, Japan & Korea, $/kg (midpoint)



Lithium carbonate 99.5% Li2CO3 min, battery grade, spot price exw domestic China, yuan/tonne (midpoint)



Lithium hydroxide monohydrate 56.5% LiOH.H2O min, battery grade, spot price cif China, Japan & Korea $/kg (midpoint)



Lithium hydroxide monohydrate 56.5% LiOH.H2O, battery grade, spot price exw domestic China, yuan/tonne (midpoint)

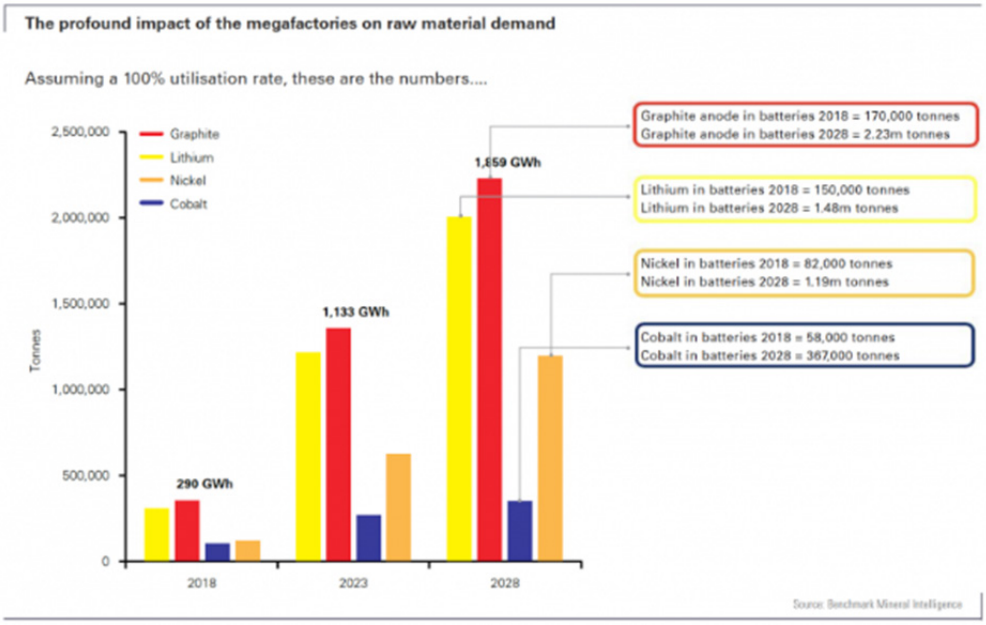
https://www.metalbulletin.com/lithium-prices-update

- The lithium price across all product forms has been falling throughout 2019. We see the price boom in 2018, and the slump in 2019 as typical of an emerging commodity market where demand is rising very strongly, but from a small base, and supply arrives in relatively large chunks of capacity. If expected supply is delayed, the result is the price spike like in 2018, and once it arrives the market is in temporary oversupply and the price falls. This is typical until the overall market grows to a sufficient size, relative to units of new supply.

- The USDRMB exchange rate is 6.94, so the carbonate price of RMB48,000/t is US$6900/t in China and US$8750/t in South Korea. For reference, Orocobre guidance for its FOB Argentina selling price was US$6200-6500/t for the December 2019 quarter, so the Chinese price is more relevant for that operation.
- The other source of volatility is the impact of changes in Electric Vehicle buyer subsidies, particularly in China. This can be positive or negative, and is discussed later. The effect of subsidies is to stimulate demand, and if they are cut back, and particularly if the cut back was signalled in advance, then there will be an acceleration of demand in advance of the change, and a slump after.
- Jindalee's projects are too early a stage to be requiring lithium price forecasts for detailed financial modelling, so we have not done so.
- However, the message is that while there will be price volatility, we expect that future volatility will be up as well as down, and that the current low prices will recover, and have the potential to return to the region of previous highs.
- In this environment, it makes sense for a junior like Jindalee to continue to advance its lithium projects, so they are shovel ready when the next uplift in the demand and price cycle increases the capacity to monetize the asset, or fund the development.

LITHIUM DEMAND – STILL FORECASTING OVER 10%PA GROWTH

Figure 13 Growth in demand for lithium from planned battery mega-factories



Source: https://www.benchmarkminerals.com/lithium-supply-revisited/

- The demand picture remains structurally very positive. The Electric Vehicle story is well understood, with drivers including the need to improve air quality, use more sustainable sources of energy, and electric vehicles have been made appealing to the consumer.
- Total lithium consumption in 2018 was 269,000 tonnes lithium carbonate equivalent according to major producer SQM, of which Benchmark Minerals estimates 150,000t was used in batteries. Benchmark expects battery use to rise to 1.5Mt in 2028 from currently planned or announced mega-factories.

Changes to Chinese NEV subsidies has caused a demand pause in H2 2019

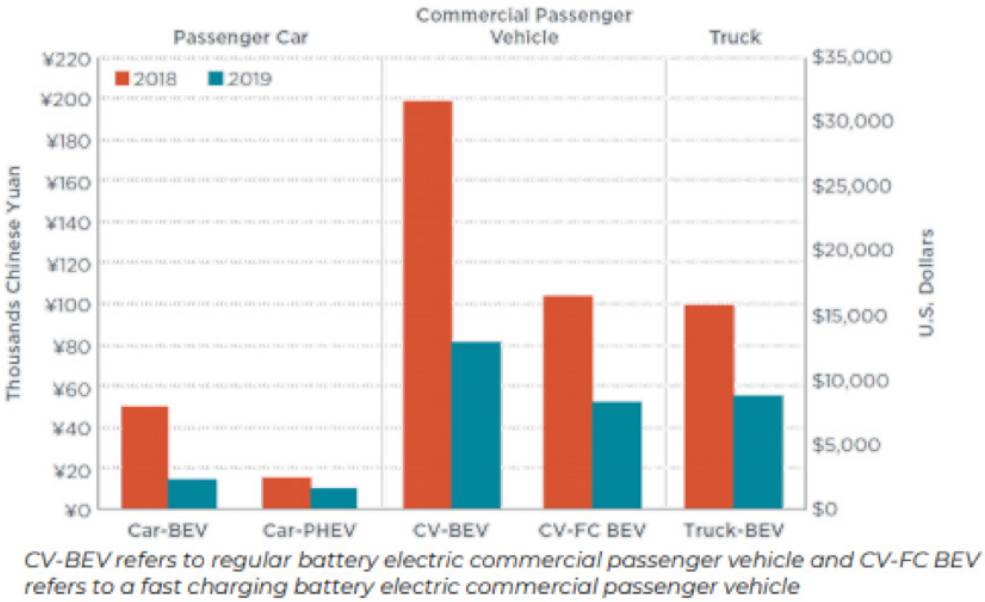
- The changes to the subsidies offered in China has slowed NEV (New Energy Vehicle) sales. Pilbara Minerals (ASX:PLS) has covered this in a number of presentations. In summary, 2019 saw a significant reduction in subsidies. The size of the subsidies depend on the vehicle range, and for very short range vehicles (Range up to 24Km) the subsidy was cut to zero, and halved in the other categories.

Figure 14 Changes in electric vehicle subsidies in China

	BEV electric range (R, km)					PHEV electric range (R,km)
	150≤R<200	200≤R<250	250≤R<300	300≤R<400	R≥400	R≥50
2019	0		18		25	10
2018	15	24	34	45	50	22

Source Pilbara Minerals presentation 3 December 2019

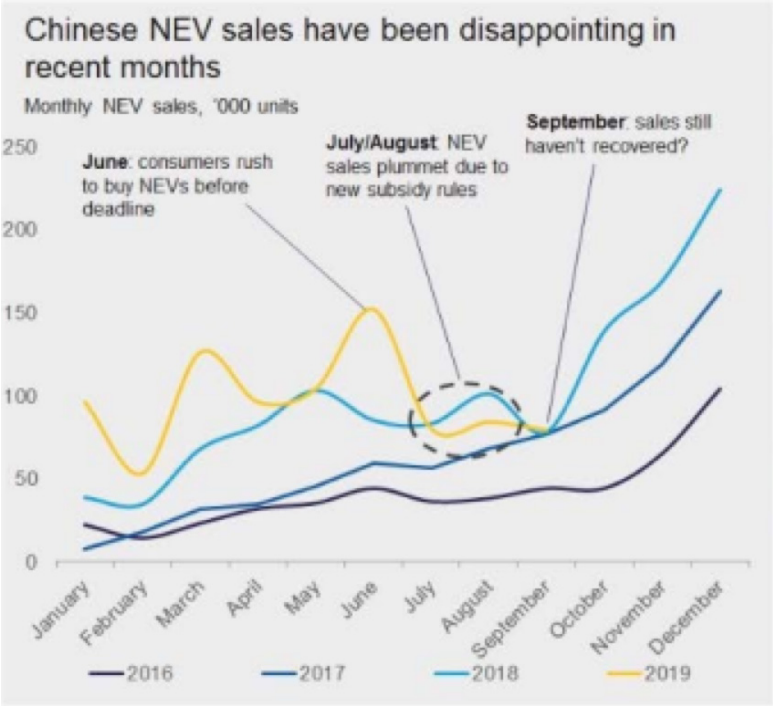
Figure 15 Change is cost of vehicle in China as a result of subsidy changes



Source Pilbara Minerals presentation 3 December 2019

- The subsidy changes appear to have caused a pause in NEV sales in China as shown in the figure below, relative to the strong growth profile seen in previous years.
- This may be due to demand being pulled forward into early 2019, which stands out in the figure below, or it may be just a pause as the market re-assesses the NEV value proposition in the light of the new economics, and possibly because consumers are waiting to see if there is a backflip and reinstatement of the subsidies.
- The Chinese Government have maintained a target of 2M NEV sales for CY2020, vs CRU expectations of 1.5M units in CY2019 and actual sales of 1.2M units in 2018 (Pilbara Minerals presentation 3 December 2019).

Figure 16 Timing and impact of Chinese subsidy changes on electric vehicle sales



Source CRU quoted in Pilbara Minerals presentation 3 December 2019

- A complicating factor in calculating demand is the variety of battery chemistries, and the changing preference for different chemistries, depending of energy storage density, safety, and recharge rates. The table below includes some of the main Electric Vehicle battery chemistries in use, and the indicative lithium contents.

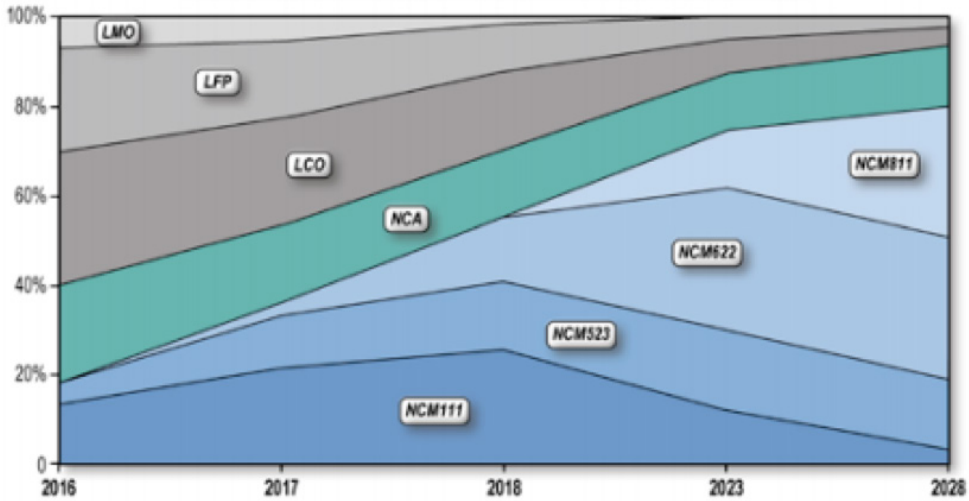
Figure 17 Some of the major vehicle battery chemistries

Cathode material	Main advantage	Main disadvantage	Applications	Lithium content	Lithium material
Nickel manganese cobalt oxide (NMC)	Safety	High cycle life/lower capacity	HEV	7%	Lithium carbonate or Lithium hydroxide
Nickel cobalt aluminum (NCA)	High capacity	Safety concerns	EV – P-HEV	7%	Lithium hydroxide
Lithium iron phosphate (LFP)	High thermal stability/safety	High cycle life/lower capacity	HEVs – EVs	4%	Lithium carbonate

Source Pilbara Minerals presentation 3 December 2019

- A battery requires between 0.15 -0.30kg of lithium for each KWh of power stored in the battery.

Figure 18 Market share history and forecast for different battery chemistries with emerging dominance of Nickel Cobalt Manganese batteries



Source: Neometals presentation 15 January 2019. The numbers after NCM refer to the ratio of nickel to cobalt to manganese in the various battery chemistries.

- LMO - Lithium Manganese Oxide ($LiMn_2O_4$)
- LFP - Lithium Iron Phosphate ($LiFePO_4$)
- LCO - Lithium Cobalt Oxide ($LiCoO_2$)
- NCA - Lithium Nickel Cobalt Aluminum Oxide ($LiNiCoAlO_2$)
- NCM - Lithium Nickel Manganese Cobalt Oxide ($LiNiMnCoO_2$)
- Lithium carbonate accounted for around 60% of lithium demand in 2018, but battery technology development is increasing demand for lithium hydroxide. The switch to NCM batteries is to increase battery life.
- The higher nickel content in the NCM batteries means a higher temperature is required to synthesise cathode material with lithium carbonate, which damages the crystal structure of the cathode and changes the oxidation state of the nickel metal. However, lithium hydroxide allows rapid and complete synthesis at lower temperatures, increasing the performance and lifespan of the battery.

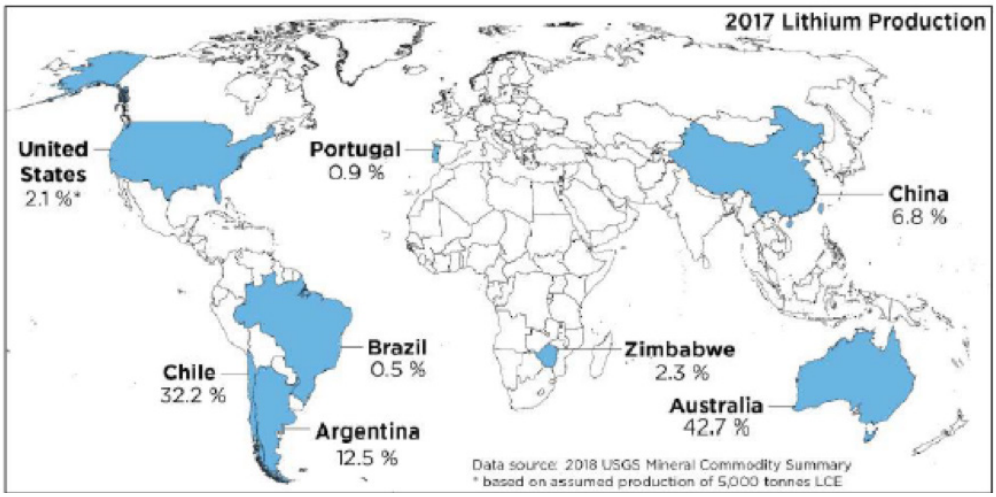
Hydroxide demand expected to grow twice as fast as carbonate, maybe

- According to major producer SQM, demand for lithium carbonate is expected to rise at a compound annual growth rate (CAGR) of 10-14pc in 2018-27, while lithium hydroxide demand is seen rising at a 25-29pc CAGR. http://s1.q4cdn.com/793210788/files/doc_presentations/2019/11/3Q2019_long-presentation_nov2019.pdf
- Potentially slowing this is the battery makers resistance to depending on a constrained supply source (ie hydroxide), so we expect technical developments will tend to equalize demand growth of the two sources. Also, lithium carbonate is easier to store than hydroxide, so it is preferred as a buffer stock within the supply chain.

LITHIUM SUPPLY

- Quote from Global Lithium LLC in Lithium Americas 2018 Thacker Pass 43-101 S19.1 –
- *"Currently (ie 2018), around 80% of the total lithium production worldwide originates from Australia, Chile, and Argentina, as shown in Figure 19-1. Lithium production is dominated by five companies: SQM, Albemarle, FMC, Tianqi Lithium, and Jiangxi Ganfeng Lithium. Currently, all the lithium production in Chile and Argentina is sourced from brine, and all of Australia's production is sourced from hard rock. China's production is from both hard rock and brine. Australia produces a concentrated spodumene which is transported to China for upgrading into specialty lithium chemicals (primarily lithium hydroxide).*

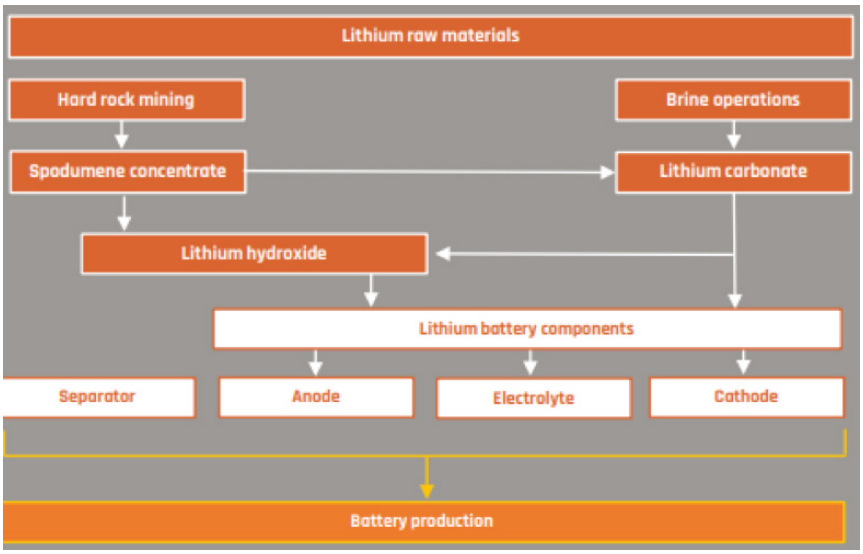
Figure 19 Distribution of Lithium production globally, highlighting the low US share



Source: Global Lithium LLC in Lithium Americas 2018 Thacker Pass 43-101 S19.1

- *In the second half of 2015, the two shareholders of Talison Lithium's JV, Sichuan Tianqi (51%) and Albemarle (49%), announced a change in the distribution policy of spodumene concentrate produced at Talison's Greenbushes mine. The Joint Venture stopped selling directly to the market and began to limit sales only to the two owners, who receive their pro-rata share of the material. The change in policy limited spodumene concentrate feedstock available to independent converters. As a result, the output of lithium chemicals in China decreased briefly, prices spiked in the fourth quarter of 2015 and due to surging demand, have remained high ever since.*
- *Over the same period, demand for lithium carbonate was increasing as well in response to growing demand for battery cathodes needed in the transportation segment (electric buses and electric vehicles). The net result was a steep run-up in China domestic prices. Prices doubled in Q4 of 2015 and then settled early in 2016 at nearly three times the Q3 2015 price."*
- The period post 2018 has seen the price reversal that is now testing the downside limits of the supply chain.

Figure 20 Structure of lithium supply showing the hydroxide and carbonate pathways. McDermitt would be a new ore source box beside the Brine Suppliers feeding into the lithium carbonate route



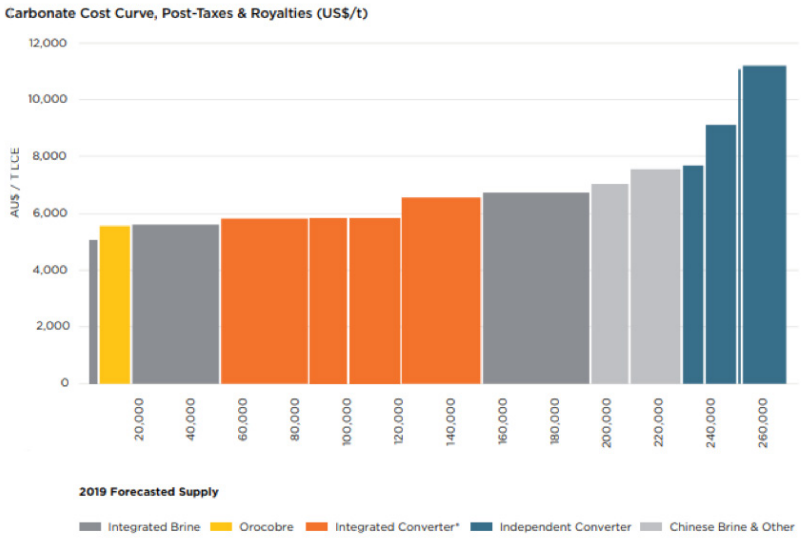
Source Pilbara Minerals presentation 3 December 2019

- Battery manufacture used both lithium carbonate and lithium hydroxide as inputs. The hard rock supply chain includes the spodumene miners, typically in Australia, feeding converters which make the hydroxide. The brine operations typically produce carbonate for direct feed into the battery makers. Increasingly, brine producers also convert carbonate into hydroxide.
- The lithium supply industry therefore operates with two cost curves, one for brine into carbonate, and the other from hard rock into hydroxide. Figure 21 below is a blend of the two, and highlights the lower cost of the brine based supply vs the hard rock based supply.

In the recent price down turn, it is the hard rock miners that are shutting in production more aggressively than the brine producers.

- In the main, that is likely to be related to the positions on the cost curve, but is also because the hard rock producers can shut in production more easily than the brine operations. Hard rock operations can cease mining and production stops, restart mining and production restarts. The limit on this process is adding or removing people and contract structures. The chemistry of the brine evaporation ponds does not lend itself to stop – start operations. The long residency in the evaporation ponds makes the process slow to start and slow to shut down.
- It is important to keep in mind that any specific market outcome is also about the battery makers relative appetites for carbonate vs hydroxide.

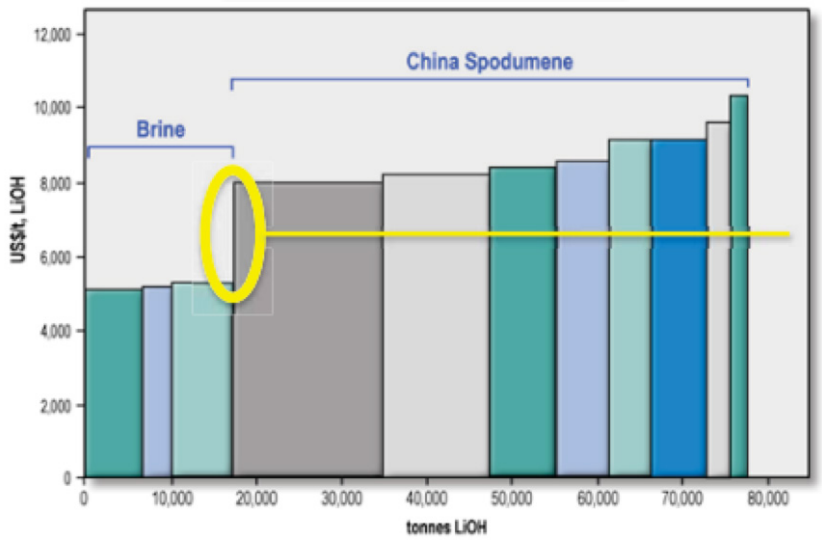
Figure 21 Cost curve for the production of lithium carbonate



Source Orocobre annual report 2019

- The carbonate supply cost has a relatively flat at around US$6000/t LCE cost pf production with the high cost tail (figure above). The total supply covered by this figure is 260Ktpa. The hydroxide curve below covers a bit under 80Ktpa of supply, making the total around 340ktpa, which is consistent with current quoted global supply volume.
- The hydroxide cost curve (figure below) is generally also relatively flat at between US$8000-9000/t of hydroxide with a very low cost tail. There may be cost definitions which reduce the comparability of these two figures, but the overall message is that hydroxide is more expensive generally than carbonate, but if the battery maker wants hydroxide, for reasons of specific battery chemistry, that puts them onto the more expensive cost curve.

Figure 22 Cost curve for the production of lithium hydroxide



Source: Neometals presentation 15 January 2019

- The cost of conversion of spodumene into hydroxide is typically given as US$6000/t hydroxide. Given hydroxide contains 29% lithium, roughly 10 tonnes of spodumene is required to make a tonne of hydroxide, so at a price of US$550/t spodumene and US$6000/t conversion cost, the breakeven price appears to be around US$11,700/t hydroxide, US$3,800/t more than the current hydroxide price, hence the current industry pain.

Table 14 Current lithium feedstock pricing including the conversion of spodumene into lithium hydroxide

	Li Content	Price US$/t	Conversion Cost US$/t	Feedstock cost US$/t	Li Cost US$/t
Lithium Carbonate	32%	6900		6900	21563
Lithium Hydroxide	29%	7850		7850	27069
6% Spodumene Concentrate	2.80%	550			19643
Spodumene into Hydroxide	29%	5696	6000	11696	40333

Source: Fastmarkets/Metals Bulletin prices, IIR estimates

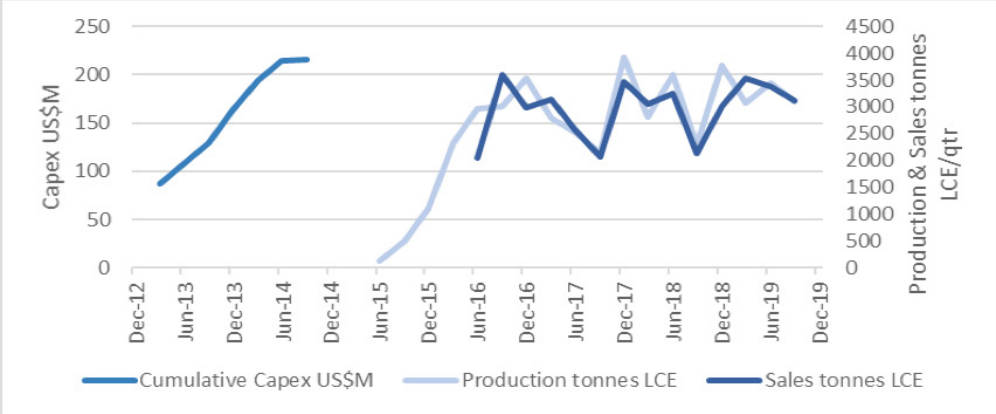
Comparison to Brine vs Hard Rock projects

- Brine to carbonate projects take longer to build and ramp up than hard rock to hydroxide projects. In the examples below, Olaroz took 40 months vs Pilgangoora's 22 months.
- Brine is lower cost into carbonate, and also into hydroxide. Olaroz reports a cost of sales of US$4885/t LCE, while Pilgangoora reports US$530/t spodumene 6% concentrate. Around 10t of spodumene is required to make one tonne of lithium hydroxide, so the spodumene cost is US$5500/t lithium hydroxide, and conversion costs are in addition.

Brine cost and supply dynamics – Orocobre's Olaroz as an example

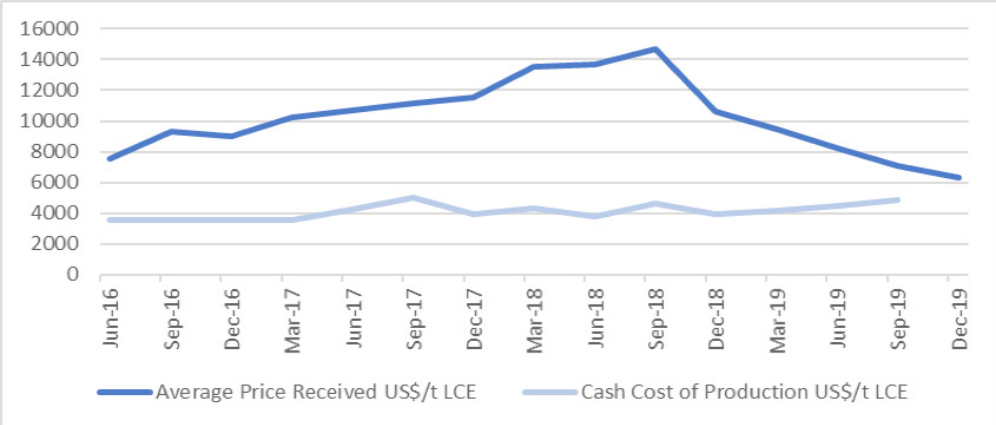
- Olaroz construction began on 21 November 2012 and was completed in October 2014 ie 23 months,
- The nameplate capacity was 17.5Ktpa of carbonate or 4,400t/qtr. Saleable production didn't reach 75% of that level until the June 2016 quarter, ie ramp up took from October 2014 to April 2016, a period of 17-18 months
- Brine projects take time to deliver to market. In this case 40 months in total from construction start.
- Cost of sales into battery grade lithium carbonate in the September 2019 quarter was US$4885/t FOB, so even at current prices, the project is still generating a positive operating cash margin.

Figure 23 Orocobre's Olaroz project capex and production rampup



Source: Orocobre (ASX:ORE) quarterly activities statements

Figure 24 Orocobre's Olaroz quarterly average price received and cash cost of production

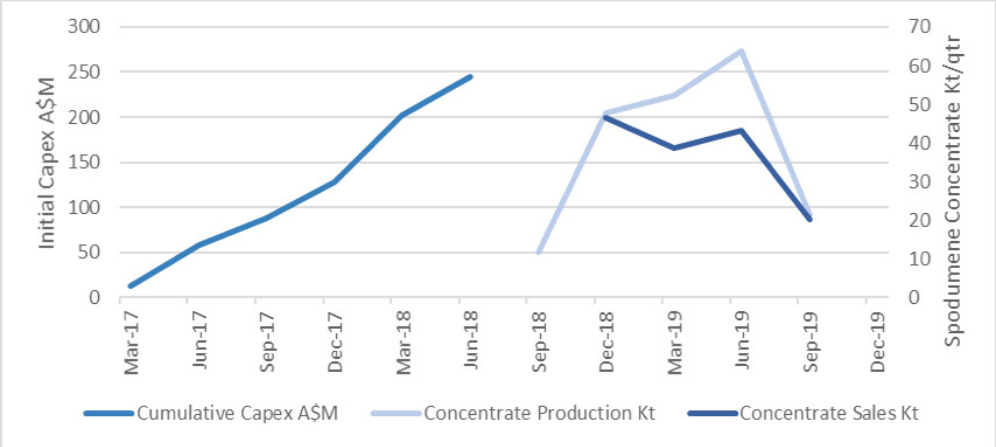


Source: Orocobre (ASX:ORE) quarterly activities statements

Hard rock dynamics – Pilbara Minerals Pilgangoora as an example

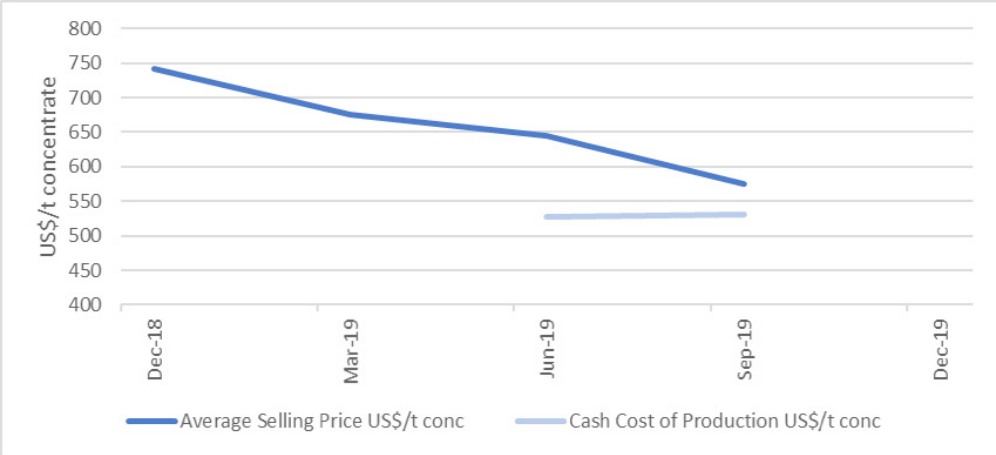
- Construction started on 24 November 2016 and first shipment of spodumene concentrate was on 2 October 2018, a period of 22 months.
- Capacity was 314Ktpa or 78.5Kt/qtr, and the project reached 75% of capacity in the first quarter December quarter 2018.
- Cash cost of production is around US$530/t CIF China, so there is a slightly positive cash margin at current prices, but as discussed above, the converters must be having a very tough time at current hydroxide prices, and are not taking full contract levels of product, so Pilgangoora has reduced output.

Figure 25 Pilbara Minerals Pilgangoora capex and production ramp up



Source: Pilbara Minerals (ASX:PLS) quarterly activity statements

Figure 26 Pilbara Minerals Pilgangoora average selling price and All In Sustaining Cost by quarter



Source: Pilbara Minerals (ASX:PLS) quarterly activity statements

Where does McDermitt and Thacker Pass fit in?

- Thacker Pass and McDermitt are dried out versions of the lake beds the brine producers have to pump, so have a lot in common with the brine deposits in terms of mineralogy and operating cost, but have none of the ramp up delays associated with the removal of water by evaporation. Low cost mining replaces low cost pumping to convey the mineral to the processing plant.
- As a result, these projects blend the faster and more predictable start up of the spodumene producers, with the lower operating cost closer to that of the brines.
- McDermitt and Thacker Pass are scoped to produce lithium carbonate. It would be interesting to see what the economics look like if hydroxide was produced.
- Clay deposits like McDermitt and Thacker Pass are not traditional lithium sources at present, so may require work to gain acceptance from the battery makers, but represent an opportunity for the battery makers to diversify feedstock sources.
- Currently, the bulk of the worlds capacity to convert spodumene into hydroxide resides in China, which may be seen as a source of insecurity in the supply chain for non Chinese industry.
- The bulk of the world's brine sources are in arid highlands of Chile/Argentina. The process involves pumping water into ponds and losing that water to solar evaporation, in a region where water is rare. There are signs that there may be challenges to the growth of this practice, which may present another risk to consumers in the long run.

Brine producers in the arid Chilean brine provinces may have some limitations placed on expansion

- SQM is one of the top three global lithium feedstock producers, The following article was published on 19 December 2019. Source of quote: https://www.business-humanrights.org/en/chile-court-upholds-complaint-from-indigenous-communities-against-sqm-over-water-usage-rights-linked-to-lithium-mining
- *"A Chilean environmental court has upheld a complaint by indigenous communities in the country´s northern Atacama Desert about the use of water by SQM, the world´s No. 2 producer of lithium. The decision by the First Environmental Court in the nearby city of Antofagasta calls into jeopardy SQM´s $400 million plan to expand its lithium carbonate production plant to feed appetite for the ultralight battery metal. Soaring lithium demand has raised questions about whether Chile´s arid northern desert can support current and future levels of lithium production along with the needs of sprawling nearby copper mines, a booming tourism industry and indigenous communities.*
- *The court ruled that a compliance plan presented by SQM in response to a multi-year investigation by Chile´s SMA environmental regulator that found the miner had overdrawn lithium-rich brine was "insufficient." The court said its decision was based on a "precautionary principle," taking into account the "particular fragility" of the Atacama´s ecosystem and the "high level of scientific uncertainty" about the behaviour of its water table. It said SQM had no way of proving that the measures it had proposed were capable of "containing and reducing or eliminating the negative effects generated by the breaches of the company."*

AUSTRALIAN EXPLORATION

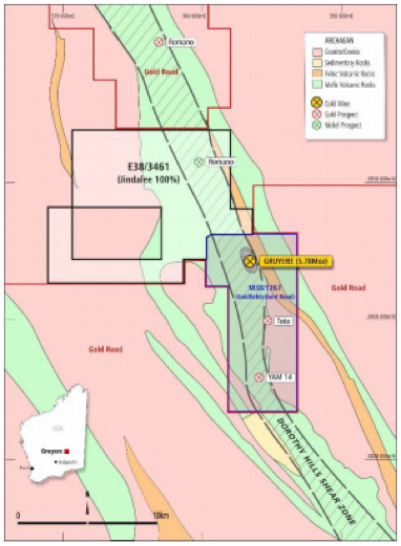
- The company has flagged that its focus in Australia will be on its Widgiemooltha tenements and we would expect North Gruyere to also be a near term exploration focus. The other assets are likely to be partnered or sold if the opportunity to do so arises.

North Gruyere (E 38/3461) – a surprising pickup

- This is a very new acquisition. Jindalee applied for this tenement in December 2019 after it was dropped by Gold Road Resources.
- The tenement appears to contain the full width of the Dorothy Hills Shear Zone which contains the 6Moz Gruyere deposit, but may have had only limited testing, because historically, in maps published by Gold Road, this area was covered by a Heritage Exclusion area.
- Jindalee plans to collate existing exploration information and commence negotiation with the traditional owners with the aim of commencing exploration as soon as E 38/3461 is granted.

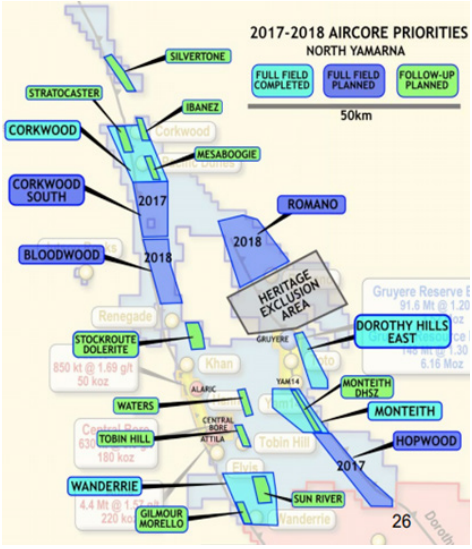
- Gold Road must be having to reduce the size of its exploration licences, as is typically required after the tenements have been held for more than a certain period, and it may be that this ground is highly prospective, but was deemed less prospective than the ground the company has retained.

Figure 27 North Gruyere



Source: JRL release 30 December 2019

Figure 28 Heritage Exclusion Area per Gold Road

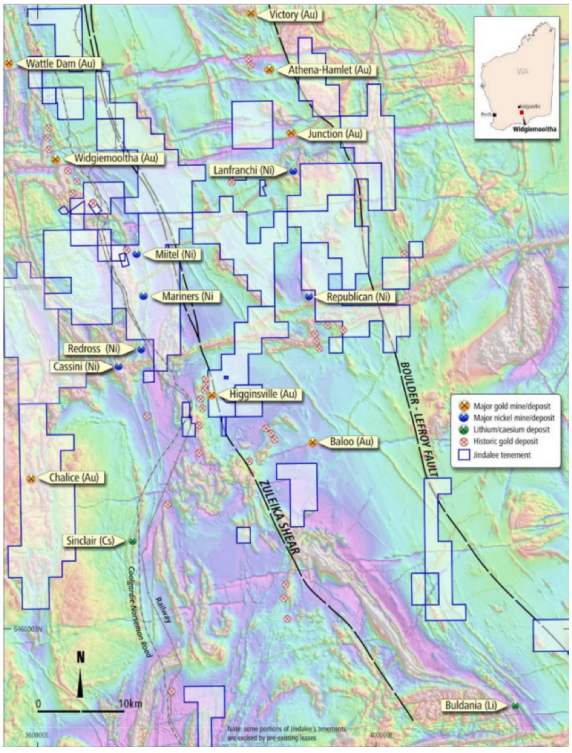


Source : Gold Road release 9 August 2017

Widgiemooltha tenement package prospective for gold and nickel

- Jindalee has been accumulating this tenement package over the last three years. The region is prospective for nickel and gold and the company is conducting a data review, to generate an exploration program.
- Jindalee's tenements are along strike to the north of Mincor's Cassini nickel deposit (1.254Mt @ 4.0% Nickel, and south of Anglo American's Mandilla gold discovery.
- Given the strength of the Australian gold sector, and the positive long term outlook for nickel, this portfolio should add value to shareholders in time.

Figure 29 Widgiemooltha tenement package



Source: JRL 2019 Annual Report p4. Note some portions of the tenements are excised by pre-existing mining and other leases.

Other Australian assets

- Prospect Ridge (Magnesite 100% JRL) located 55km south west of Burnie in Tasmania, containing the third largest magnesite resource in Australia according to www.ga.gov.au. Jindalee has reported a JORC 2012 resource and metallurgical test work, and is seeking partners.
- Aries (Diamonds 100% JRL) located in the central Kimberley 270Km east of Derby, covering the Aries cluster of diamondiferous kimberlite pipes. 95% of the diamonds recovered to date have been gem quality. Jindalee is seeking a partner.
- Joyners (Iron Oxide JRL 20% free carried to completion of BFS) located near Wiluna in Western Australia, with 7.9Mt at 62.2% Fe. This could form part of a bigger project being assessed by GWR Group Ltd.
- North Sinclair and Camel Bore - Aldoro Resources has 80% of non-gold rights, and is looking for nickel.

Australian assets subject to a binding preliminary sales agreement

- On 26 July 2019, Jindalee announced the sale of its minority gold and royalty interests for A$0.5M being A$250K cash and A$250K in a 12 month term convertible note.
- the Assets include New Bore and Kelly Well - JRL 10% free carried to feasibility completion with reversion to 1% royalty. The operator is Dacian Gold Limited.
- Other assets included in the agreement include West Kundana, Kookynie, and Millrose.

CAPITAL STRUCTURE

Table 15 Issues shares and options

	million
Issued Shares	38.49
Options	
30 June 2022 $0.40	3.9
30 June 2022 $0.50	1.7
30 June 2022 $0.60	1.5

Source: JRL release 23 August 2019

- The company has a very clean capital structure, and has not experienced the share bloat that has resulted in many juniors having over 1000M shares on issue. In 2005, the equity on issue totalled 29.4M shares, and 15 years later, shares on issue is only 30% higher.

Table 16 Major Shareholders

Shareholders	Shares M	Share %
Mr LG Dudfield	11.98	34.33%
Kale Capital Corp	3.08	8.80%
Teck Corp	2.05	5.87%
Pillage Investments	1.00	2.90%
Yandal Investments	1.00	2.87%

Source Annual Report 2019

- Founder and director Lindsay Dudfield is the major shareholder, and is probably the main reason why the capital structure has remained so tight and the number of shares on issue is so small.
- Yandal Investments is the investment vehicle of Mark Creasy, the well known West Australian prospector associated with gold discoveries at Bronzewing and Jundee, and the Nova Bollinger nickel discovery of Sirius.
- Teck is the global zinc and coal miner, and has consistently held onto its stake for a number of years.
- Neometals holds 1.65% of Jindalee, joining the register between 17 September 2018 and 17 September 2019. Neometals has been very astute in building low cost lithium exposure early in the cycle, and selling out at the top ie when it exited Mt Marion on 21 December 2018.

BOARD AND MANAGEMENT

Justin Mannolini - Non-Executive Chairman - B.Com/LL (Hons), LLM (Cantab), GAICD, SA FIN

- Mr Mannolini was appointed to the Jindalee Board as a Non-Executive Director in September 2013 and was appointed Chairman in July 2016.
- Mr Mannolini is a partner in the Corporate Advisory Group of Australian law firm Gilbert + Tobin. He was an Executive Director with Macquarie Capital, the investment banking division of the Macquarie Group from March 2016 to May 2016 and was responsible for cross-industry coverage of the Western Australian market. Prior to joining Macquarie, Mr Mannolini was Managing Director and head of Gresham Advisory Partners' Perth office, and before that, a partner in the mergers and acquisitions group of Australian law firm Freehills. In May 2016 Mr Mannolini was appointed to the board of the Northern Australia Infrastructure Facility, a $5B fund set up by the Australian Government to encourage population growth and economic development in northern Australia.
- As a lawyer and investment banker, Mr Mannolini has more than 20 years experience in corporate finance ranging across industry sectors and product lines, including mergers and acquisitions transactions and general strategic advisory mandates for companies in the resources sector .
- Mr Mannolini has a combined degree in Commerce and Law (with Honours) from the University of Western Australia and a Master of Laws from the University of Cambridge (Queens College).

Lindsay Dudfield - Executive Director -B.Sc.

- Mr Dudfield is a geologist with almost 40 years experience in multi-commodity exploration, primarily within Australia. He held senior positions with the mineral divisions of Amoco (1977-1979) and Exxon (1980-1987) and was closely involved with the delineation of the Scuddles zinc-copper mine at Golden Grove, WA.
- In 1987 he became a founding Director of Dalrymple Resources NL and spent the following 8 years helping acquire and explore Dalrymple's properties, leading to a number of greenfields discoveries. In late 1994 Mr Dudfield joined the Board of Horizon Mining NL (JIndalee's predecessor) and has been responsible for managing Jindalee since inception.
- Mr Dudfield is a member of the Australasian Institute of Mining and Metallurgy, the Australian Institute of Geoscientists, the Geological Society of Australia and the Society of Economic Geologists. He is also a Non-executive Director of Energy Metals Limited and Alchemy Resources Limited.

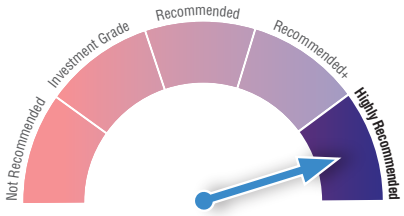
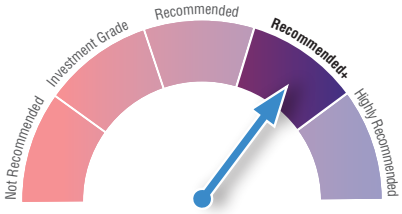
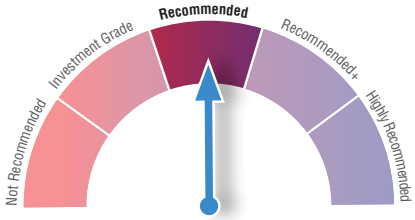
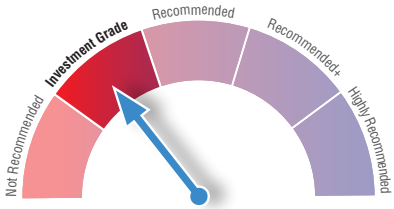
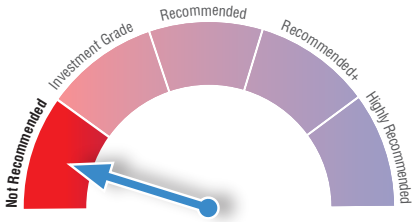
Patricia (Trish) Farr - Executive Director/Company Secretary - Grad Cert ProfAcc., GradDipACG., GAICD, FGIA/FCIS

- Ms Farr joined Jindalee when the Company listed in July 2002 and has been closely involved with the growth and development of the Company since listing.
- Ms Farr is an experienced Chartered Secretary with over 20 years experience in the resources sector having provided company secretarial services to several ASX listed companies including Musgrave Minerals Limited and prior to that Energy Metals Limited and Fox Resources Limited.
- Ms Farr is a graduate member of the Australian Institute of Company Directors and Fellow member of Governance Institute of Australia (formerly Chartered Secretaries Australia) and the Institute of Chartered Secretaries & Administrators. Ms Farr was appointed to the Jindalee Board in 2008.

APPENDIX A – RATINGS PROCESS

Independent Investment Research Pty Ltd "IIR" rating system

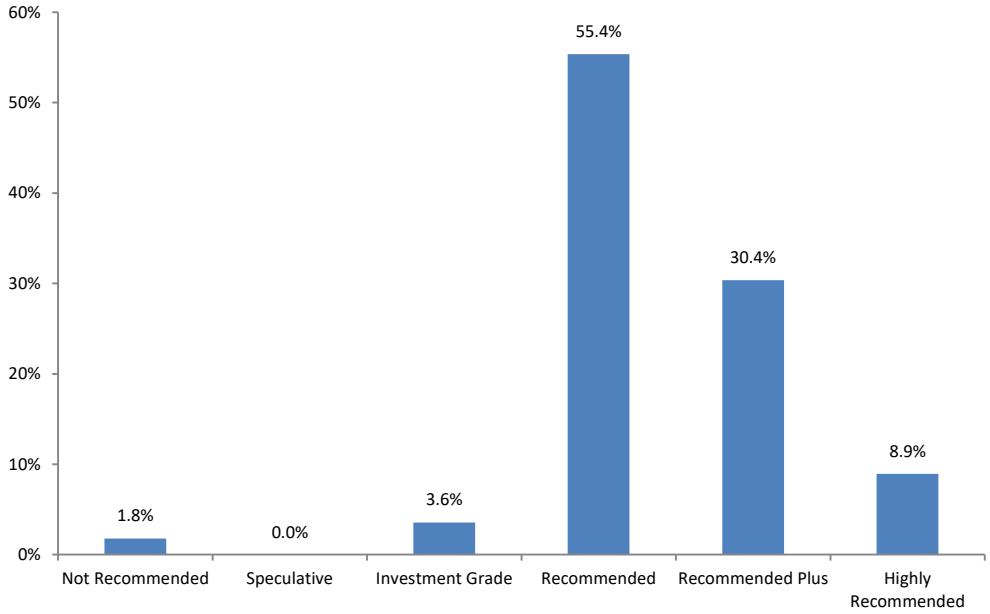
IIR has developed a framework for rating investment product offerings in Australia. Our review process gives consideration to a broad number of qualitative and quantitative factors. Essentially, the evaluation process includes the following key factors: management and underlying portfolio construction; investment management, product structure, risk management, experience and performance; fees, risks and likely outcomes.

LMI Ratings	SCORE
Highly Recommended	**83 and above**
	This is the highest rating provided by IIR, indicating this is a best of breed product that has exceeded the requirements of our review process across a number of key evaluation parameters and achieved exceptionally high scores in a number of categories. The product provides a highly attractive risk/return trade-off. The Fund is likely effectively to apply industry best practice to manage endogenous risk factors, and, to the extent that it can, exogenous risk factors.
Recommended +	**79–83**
	This rating indicates that IIR believes this is a superior grade product that has exceeded the requirements of our review process across a number of key evaluation parameters and achieved high scores in a number of categories. In addition, the product rates highly on one or two attributes in our key criteria. It has an above-average risk/return trade-off and should be able consistently to generate above average risk-adjusted returns in line with stated investment objectives. The Fund should be in a position effectively to manage endogenous risk factors, and, to the extent that it can, exogenous risk factors. This should result in returns that reflect the expected level of risk.
Recommended	**70–79**
	This rating indicates that IIR believes this is an above-average grade product that has exceeded the minimum requirements of our review process across a number of key evaluation parameters. It has an above-average risk/return trade-off and should be able to consistently generate above-average risk adjusted returns in line with stated investment objectives.
Investment Grade	**60-70**
	This rating indicates that IIR believes this is an average grade product that has exceeded the minimum requirements of our review process across a number of key evaluation parameters. It has an average risk/ return trade-off and should be able to consistently generate average risk adjusted returns in line with stated investment objectives.
Not Recommended	**<60**
	This rating indicates that IIR believes that despite the product's merits and attributes, it has failed to meet the minimum aggregate requirements of our review process across a number of key evaluation parameters. While this is a product below the minimum rating to be considered Investment Grade, this does not mean the product is without merit. Funds in this category are considered to be susceptible to high risks that are not reflected by the projected return. Performance volatility, particularly on the down-side, is likely.

APPENDIX B – MANAGED INVESTMENTS COVERAGE

The below graphic details the spread of ratings for managed investments rated by Independent Investment Research (IIR). The managed investments represented below include listed and unlisted managed funds, fund of funds, exchange traded funds and model portfolios.

SPREAD OF MANAGED INVESTMENT RATINGS



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INDEPENDENT
INVESTMENT RESEARCH

Independent Investment Research (Aust.) Pty Limited

SYDNEY OFFICE
Level 1, 350 George Street
Sydney NSW 2000
Phone: +61 2 8001 6693
Main Fax: +61 2 8072 2170
ABN 11 152 172 079

MELBOURNE OFFICE
Level 7, 20–22 Albert Road
South Melbourne VIC 3205
Phone: +61 3 8678 1766
Main Fax: +61 3 8678 1826

HONG KONG OFFICE
1303 COFCO Tower
262 Gloucester Road
Causeway Bay, Hong Kong

DENVER OFFICE
200 Quebec Street
300-111, Denver Colorado USA
Phone: +1 161 412 444 724

MAILING ADDRESS
PO Box H297 Australia Square
NSW 1215