EDISON

Avalon Rare Metals

Tin and lithium developments

Tin and lithium projects gain momentum

Metals & mining

In this note we look a Separation Rapids, one of Avalon's (AVL) three main development assets. This project is focused on developing a high-purity petalite resource that could produce both lithium minerals and lithium chemicals for the high-temperature ceramics, glassware and lithium-ion battery industries. Avalon has also announced it will undertake a C$1.3m fully funded work programme on its East Kemptville Tin-Indium Project in Nova Scotia over the summer months. The information gained will aid completion of a preliminary economic assessment (PEA) by year end, thereby marginally de-risking the project from its current pre-scoping study level.

Year end	Revenue (C$m)	PBT* (C$m)	EPS* (c)	DPS (c)	P/E (x)	Yield (%)
08/13	0.0	(8.3)	(8.0)	0.0	N/A	N/A
08/14	0.0	(5.9)	(5.3)	0.0	N/A	N/A
08/15e	0.0	(5.2)	(3.7)	0.0	N/A	N/A
08/16e	0.0	(5.1)	(3.6)	0.0	N/A	N/A

Note: *PBT and EPS are normalised, excluding intangible amortisation, exceptional items and share-based payments.

East Kemptville to start drilling to firm up resources

Work at East Kemptville will comprise 2,000m of diamond drilling, metallurgical process test work and preliminary environmental studies, needed to complete a NI43-101 compliant PEA. Of most significance in terms of de-risking and moving this asset up the value curve is work to firm up the resources and understanding not only how modern process techniques can extract tin from the resource, but also identifying the quantities of indium that can be recovered from a zinc concentrate. Avalon will also test for the presence of other rare metals that could strengthen the project's economics.

Separation Rapids to produce high-purity lithium

Economic deposits of the rare lithium mineral petalite are uncommon and there is only one operational mine called Bikita in Zimbabwe. High-quality lithium minerals products derived from petalite are desirable on account of their very low levels of impurities, notably iron, making them attractive for use in high-temperature ceramics and glassware. AVL is also assessing the potential for a high-purity lithium carbonate or lithium hydroxide chemical for use in the lithium-ion battery sector.

Valuation: Combined tin & lithium valuations C$0.74

We introduce a value for Avalon's lithium asset based on a pre-production peer group analysis of suitable lithium companies generating an in situ lithium resource multiple of US$24.48/t Li_2CO_3. Applying this to Avalon's old NI43-101 resource of 251kt of contained Li_2CO_3 results in a per AVL share value of US$0.04 or C$0.05. We maintain our DCF valuation of East Kemptville based on the February 2015 CRS, adjusted for our in-house metal price assumptions, at a 10% discount rate. We await the East Kemptville PEA in Q116 to update this. Our valuation of Nechalacho remains on hold until the optimised FS is completed.

3 July 2015

Price	**C$0.23**
Market cap	**C$35m**
	US$/C$: 0.81
Net cash (C$m) at 24 February 2015	5.5
Shares in issue	152m
Free float	97%
Code	AVL
Primary exchange	TSX
Secondary exchange	NYSE MKT

Share price performance

%	1m	3m	12m
Abs	(12.3)	(8.1)	(48.2)
Rel (local)	(10.7)	(9.6)	(48.1)
52-week high/low		C$0.54	C$0.20

Business description

Avalon Rare Metals is focused on rare metal and minerals deposits in Canada, with three advanced-stage projects, including its 100%-owned Nechalacho Deposit, the Separation Rapids Lithium Minerals Project and the East Kemptville Tin-Indium Project.

Next events

East Kemptville work programme results	Q116
East Kemptville PEA	Q116

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Company description: Three cornerstone projects

Avalon's project portfolio contains three cornerstone projects: the Nechalacho heavy rare earth (HREE) project in the Northwest Territories, the East Kemptville Tin-Indium Project in Nova Scotia and the large and unique complex-type rare metal pegmatite resource at its Separation Rapids project near the town of Kenora, Ontario. Separation Rapids is a resource-stage project and was brought through a pre-feasibility study in 2000. It was the main focus of the company's activities before it started to develop Nechalacho.

Separation Rapids – high-purity lithium resource

The petalite deposit at Separation Rapids is also known as ''Big Whopper'' and comprises a complex-type rare metal pegmatite, which is enriched in the high-purity lithium mineral petalite ($LiAlSi_4O_{10}$). This mineral type is attractive on account of its inherently low levels of contaminants, such as iron. Petalite also potentially allows consumers to buy a premium-grade feedstock for use in high-temperature ceramics and glassware, as well as potentially yielding very high-purity lithium chemicals for use in the lithium-ion battery and specialised lithium application sectors.

Exhibit 1: Separation Rapids (Big Whopper) mineral resource estimate

Indicated mineral resources*		
Mt	Grade Li_2O (%)	Petalite content (Mt)
7.3	1.40	1.2

Source: Avalon Rare Metals' website. Note: *Compares with 11.6Mt global resource at 1.34% at grade Li_2O. At 1% cut-off Li_2O as of 7 February 2002.

We note that the above resource estimate was completed under the original version of the Canadian mineral resource reporting standard, NI43-101. Avalon will need to undertake a review of its existing Separation Rapids data and update them to conform to current NI43-101 guidelines.

The Separation Rapids resource also contains potential by-products of tantalum, niobium, rubidium, potassium feldspar and sodaspar. It also has a spodumene component, which is the more conventional hard rock source of lithium. It is uncertain whether these by-products will be economic to recover alongside lithium end-products. The capability to produce high-purity sodium/potassium feldspar has already been demonstrated.

Avalon has already been successful in the production of battery grade products of both the lithium carbonate and lithium hydroxide forms using established flowsheets and technologies. Further work is underway investigating production of 99.9% lithium carbonate for use in other specialised lithium applications. A third product of value from the operation will be a low impurity sodium/potassium feldspar also of great interest to the glass manufacturing industry

Exhibit 2: Project location (LHS) and view of Big Whopper deposit (RHS)

Source: Avalon corporate presentation

According to Avalon's website, petalite is said to be the preferred lithium mineral (vs spodumene – another key lithium-ore bearing mineral) for use in the manufacture of glass-ceramics on account of its consistently low level of impurities, notably iron. It is also preferred by some glass and ceramics manufacturers for the production of zero thermal expansion glass, cookware and ceramic glazes. The addition of lithium to glass sand during manufacturing also lowers its melting temperature and accelerates the melting process.

The lack of impurities in petalite could also make them attractive for use in high-quality lithium-ion battery manufacture, and Avalon is investigating exactly what type of end-product could be produced – lithium-carbonate or lithium hydroxide; the latter is favoured by Tesla Motors because of the type of cathode its battery type uses.

There are very few occurrences of petalite worldwide and only one operational petalite lithium mine in Zimbabwe (Bikita). In addition to Separation Rapids, other notable occurrences of petalite are found near Kalgoorlie, Western Australia; Aracuai, Minas Gerais, Brazil; Karibib, Namibia; and Manitoba, Canada. However, there is a lack of definitive data on their economic viability.

Low impurities allow for streamlined process flow sheet/possible low capex

The following information has been provided by management and provides the first glimpse at the potential for high-purity lithium chemicals to be produced from a high-purity lithium petalite feedstock. The following are based on initial project test works carried out by Avalon's consultants, SRC:

- Separation Rapids lithium petalite can produce 'battery grade' Li_2CO_3 (>99.5% Li_2CO_3) for use in lithium-ion battery production.
- There is potential to produce an enhanced grade Li_2CO_3 (99.9% Li_2CO_3).
- Importantly, in relation to the potential for the lithium battery technology employed by Tesla Motors, due to the specific cathode design used, Separation Rapids ore allows for production of lithium hydroxide (at 99.1% LiOH or better).

Lithium market dynamics

Lithium has a number of unique properties and a broad range of applications. While its use in batteries is well known, only about 30% of lithium produced is consumed in batteries, with c 70% of production applied to applications including glass making, ceramics, lubricating greases, continuous casting powders, aluminium smelting and medical use. Our estimate of current global lithium demand is approximately 160,000 tonnes of lithium carbonate equivalent (LCE) (see below) with 45-55,000 tonnes driven by battery demand.

Lithium used in batteries is processed from brine or ore to lithium carbonate or hydroxide. These are converted to cathode and other lithium-ion battery component materials used in the manufacture of batteries that are higher value-add products. These are usually measured in LCE terms. Lithium carbonate and lithium chloride contain 18.8% Li and 16.3% Li respectively.

Lithium in batteries, the technological edge

Lithium batteries are growing in popularity for a number of reasons, a few of which are provided below:

- **Higher energy intensity, no efficient substitutes:** lithium-based batteries provide substantially higher energy density than is possible from most other technologies. Benefits include compactness and low weight for a given energy density. Under current technology, there are no efficient substitutes. Almost 95% of batteries used in electronic devices are based on lithium. New uses for lithium-based batteries include grid-energy storage.
- **Energy storage advances driven by expanding need:** power storage in batteries has been limited by factors such as battery life and speed of recharging. The need for advances in battery technology is being driven by growing electric vehicle use and increases in power generation from non-continuous sources, such as solar and wind.
- **Broader range of applications driving demand:** battery technology is advancing. The impact of continuous technological progress and possible step changes is expected to lead to broader applications supportive of rising electric vehicle usage and battery solutions that allow intermittent or unreliable power generation sources, such as solar or wind, to be stored.
- **Advances in battery technology include fast charging and extended life:** various researchers are reporting significant lithium-based advances in battery technology. Some of these have the potential to be commercialised, with substantial implications for lithium demand. These include fast-charging capabilities (battery charging time could be comparable to petrol filling time) and an extended life of up to 20 years.

Lithium demand growth and prices

We estimate current annual global LCE demand of around 160,000 tonnes comprising approximately 110,000 tonnes of non-battery lithium and approximately 50,000 tonnes of battery lithium, largely driven by the vehicle market. A number of industry commentators have estimated that LCE demand is growing at a CAGR of 8-12%. While non-battery lithium demand has been growing at GDP/industrial production-type levels, demand for battery-grade lithium is estimated to be growing at a higher 10-15% rate, particularly in the short to medium term. This implies overall demand for lithium is actually accelerating. At CAGRs of 8% and 12% respectively, LCE demand would be around 250,000 tonnes and 315,000 tonnes respectively by 2020. We note that all the lithium demand forecasts given above were made before the collapse in the oil price in Q414; the consequent impact on economic growth may slow projected demand uptake for lithium ion batteries. There is no terminal market; prices are often set between producer and customer. Current LCE prices of around US$6,500 per tonne appear to be well supported at current levels.

For reference, in our other lithium company valuations, we use an LCE price of US$6,500/tonne as our base sustainable price, with an upper case of US$7,000/tonne, given potential future supply tightness.

Lithium batteries vs hydrogen fuel cell technology

It would be incorrect to highlight the forecast growth in lithium demand linked to the advent of electrical vehicle use without some comment on the potential for hydrogen fuel cells to fulfil the same role. Hydrogen fuel cell technology has been under development for years in the automotive industry as a potential leading energy source to power electrical vehicles. A primary reason for interest in hydrogen fuel cell technology is that it provides a significantly higher energy output than lithium per unit of volume and has a much higher energy conversion efficiency rating. However, hydrogen has number of important obstacles in the areas of production, distribution, storage and safety. We briefly discuss these in the following sections.

Hydrogen production and distribution

Hydrogen needs to be produced from the electrolytic separation of water. One of the fundamental and differentiating issues holding back the widespread acceptance of hydrogen fuel cell technology is the ongoing cost of hydrogen production and the currently non-existent (on the scale required by the automotive industry) and potentially costly infrastructure required to adequately distribute hydrogen from source to user. However, we do note recent developments in closed-loop wind powered hydrogen separation from water which could remedy these key production problems.

Hydrogen storage and safety of use

Hydrogen is a very low-density gas, small in molecular size and highly flammable. It is also odourless and burns with an invisible flame, which reduces the easy recognition of leakage in a fuel cell system. It is this lack of odour and ability to burn invisibly that supports the oft-cited (by promoters of lithium battery use) safety implications of hydrogen fuel cell technology. That said, we would argue that, in reality, the storage of benzene (petrol) in an automobile is no more or less dangerous than the use and storage of hydrogen under pressure.

Domestic energy storage – nascent market may provide key demand driver

Domestic energy storage is another potentially significant demand driver for lithium. Tesla has announced it plans to sell a lithium battery, called the Power Wall, for, among other things, electrical energy storage during periods of low demand and therefore pricing. Power Wall prices start at around US$3,000, scaling up depending on battery size and usage requirements. The idea broadly speaking is that consumers could either sell back energy to the grid or use the energy stored during periods of peak demand and pricing. While Tesla has announced pre-order numbers for its Power Wall, shipping will only start in late-2015 and no actual sale data is available to indicate that this new market is sustainable.

Conclusions – fuel cells not for today's market

In conclusion, the positive sentiment currently seen towards lithium is primarily linked to developments in the automotive industry and the advance of electrical vehicle technology. Other conclusions from our brief overview of the lithium space are as follows:

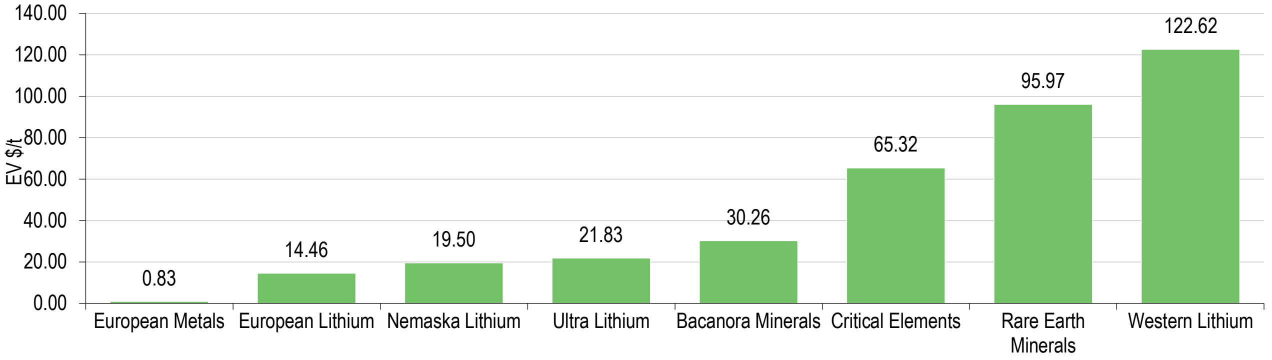
- There is no terminal market for lithium; prices are often set between producer and customer. Current LCE prices of around US$6,500 per tonne appear to be well supported at current demand levels.
- The main driver behind lithium demand is widespread acceptance and growth in electrical vehicle use.
- Non-battery lithium demand (comprising roughly two-thirds of total lithium demand) has been growing at GDP/industrial production-type levels. Demand for battery-grade lithium (comprising the remaining c one-third of total lithium demand) is estimated to be growing at a much higher

10-15% rate, particularly in the short to medium term. The main risk to automotive lithium demand growth is the development of rival technologies such as hydrogen fuel cells.

Initial lithium valuation based on EV per tonne method

Exhibit 3 provides an indication of attributable resource sizes for a random selection of lithium exploration and development companies spread across the world. While Avalon is not solely concerned with Separation Rapids' development (with its other rare and strategic metals projects being assessed alongside Separation Rapids), this peer group analysis can provide a rudimentary value for Avalon's lithium resource, whereas previously we had attributed zero value to it.

Exhibit 3: Lithium (Li2CO3) peer group as of 12 June 2015



Source: Edison Investment Research

As Avalon's Nechalacho and East Kemptville projects are further up the value curve in relation to their future economic viability, we excluded Avalon from the peer group when deriving an in situ lithium resource multiple. The above peer group therefore yields a lithium carbonate resource multiple of US$24.48/t. We have included European Lithium on the assumption that it successfully raises the full £5m as planned via an upcoming IPO on London's Alternative investment Market (AIM), date TBC. We therefore assume its market cap is US$7.65m and that the company has no debt. Using the US$24.48/t resource multiple as described above yields the following in situ value for the current Separation Rapids resource estimate shown in Exhibit 4 below.

Exhibit 4: In situ value of Separation Rapids resource estimate

Contained Lithium carbonate (tonnes)	EV/t avg of peers	In-situ value (US$m)	per AVL share
252,741	24.48	6.15	0.04

Source: Edison Investment Research

The above in situ value of the Separation Rapids resource assumes that it complies with the current version of NI43-101 with no loss of resource on conversion. In reality, we would expect the resource to increase as the previous resource estimate was based on drilling to a depth of only c 200m, with the deposit remaining open at depth. The deposit is also open along strike, although we note that the eastern boundary of the resource is very close to the property boundary. The western, northern and southern flanks are not constrained by a property boundary and provide the easiest lateral directions to delineate further resources.

Combined East Kemptville & Separation Rapids valuation of C$0.74/share

Our C$0.04 in situ resource value for Separation Rapids provides a first-pass indication of value based only on historic indicated resources. Our DCF valuation for East Kemptville is C$0.69 per share. Therefore, a combined value for both Separation Rapids and East Kemptville is C$0.74, with further upside clearly linked to the Nechalacho HREE-enriched project. We await completion of the optimised Nechalacho feasibility study to reinstate a value for this strategically important asset.

Financials

According to Avalon's 2015 AGM presentation, it plans to spend C$4.8m in FY15 on corporate G&A, C$1.5m on Nechalacho, C$1.2m on East Kemptville and C$0.5m on Separation Rapids, since this time a fraction more will be spent on East Kemptville (C$0.1m to increase capex to C$1.6m for this project) and a fraction less on Separation Rapids (C$0.1m to reduce capex for this project to C$0.4m). Nechalacho expenditure is unchanged at C$1.2m. The total capex for all three projects therefore remains at C$3.2m in our financial model. Factoring Avalon's 2015 budget into our financial model and accounting for recent equity raises completed ytd (raising gross proceeds of C$7.6m via the issue of 24m shares – see final paragraph for details of the most recent issue) indicates the company will be able to complete these work programmes. We currently forecast that the company will finish FY15 with cash of C$5.3m (previously C$1.3m).

Based on FY15's capital expenditures totalling C$3.2m and corporate G&A of C$4.8m implies a cash burn rate of c C$0.7m per month. Our end-FY15 cash position of C$5.3m (compared with a stated cash position of C$7.5m at 29 May 2015) therefore supports Avalon for a further seven to eight months, or until March/April 2016.

We point out that the 2015 budget falls short of satisfying the C$4m required to fully fund and complete the Nechalacho pilot plant test programme. We therefore expect the company to return to the market at some point, probably during FY16, to source these funds and complete the critical path work programme.

May 2015 placing details

Avalon raised gross proceeds of C$4.0m (announced on 27 May 2015) via the issue of 6.4m flow-through shares priced at C$0.39 each and 4.4m units at C$0.34 each. Each unit comprises one half of one non-transferable common share purchase warrant. Each whole warrant entitles the holder to purchase one common share at C$0.425 per share until 27 November 2016.

Exhibit 5: Financial summary

C$000s	2012	2013	2014	2015e	2016e
August	IFRS	IFRS	IFRS	IFRS	IFRS
PROFIT & LOSS					
Revenue	0	0	0	0	0
Cost of Sales	0	0	0	0	0
Gross Profit	0	0	0	0	0
EBITDA	(12,071)	(8,483)	(5,566)	(5,177)	(5,177)
Operating Profit (before amort. and except.)	(12,303)	(8,694)	(5,733)	(5,323)	(5,177)
Intangible Amortisation	0	0	0	0	0
Exceptionals	45	(2,880)	218	0	0
Other	0	0	0	0	0
Operating Profit	(12,258)	(11,573)	(5,515)	(5,323)	(5,177)
Net Interest	1,106	374	(216)	90	79
Profit Before Tax (norm)	(11,197)	(8,319)	(5,949)	(5,233)	(5,098)
Profit Before Tax (FRS 3)	(11,152)	(11,199)	(5,731)	(5,233)	(5,098)
Tax	0	0	0	0	(300)
Profit After Tax (norm)	(11,197)	(8,319)	(5,949)	(5,233)	(5,398)
Profit After Tax (FRS 3)	(11,152)	(11,199)	(5,731)	(5,233)	(5,398)
Average Number of Shares Outstanding (m)	103.2	103.7	112.7	140.4	151.6
EPS - normalised (c)	(10.8)	(8.0)	(5.3)	(3.7)	(3.6)
EPS - normalised and fully diluted (c)	(10.0)	(7.4)	(4.9)	(3.5)	(3.4)
EPS - (IFRS) (c)	(10.8)	(10.8)	(5.1)	(3.7)	(3.6)
Dividend per share (c)	0.0	0.0	0.0	0.0	1.0
Gross Margin (%)	N/A	N/A	N/A	N/A	N/A
EBITDA Margin (%)	N/A	N/A	N/A	N/A	N/A
Operating Margin (before GW and except.) (%)	N/A	N/A	N/A	N/A	N/A
BALANCE SHEET					
Fixed Assets	84,043	100,214	109,444	112,498	112,498
Intangible Assets	0	0	0	0	0
Tangible Assets	84,043	100,214	109,444	112,498	112,498
Investments	0	0	0	0	0
Current Assets	40,038	11,632	7,393	6,671	1,376
Stocks	0	0	0	0	0
Debtors	640	389	417	417	417
Cash	38,300	10,314	6,018	5,295	0
Other	1,098	929	959	959	959
Current Liabilities	(5,464)	(1,463)	(1,099)	(1,099)	(1,202)
Creditors	(5,464)	(1,463)	(1,099)	(1,099)	0
Short term borrowings	0	0	0	0	(1,202)
Long Term Liabilities	0	0	0	0	0
Long term borrowings	0	0	0	0	0
Other long term liabilities	0	0	0	0	0
Net Assets	118,618	110,383	115,738	118,070	112,672
CASH FLOW					
Operating Cash Flow	(6,192)	(6,309)	(5,089)	(5,177)	(6,577)
Net Interest	1,106	374	(216)	90	79
Tax	0	0	0	0	0
Capex (incl. Exporation expenditure)	(28,849)	(22,265)	(10,071)	(3,200)	0
Acquisitions/disposals/strategic partner buy-in	0	0	253	0	0
Financing	1,524	210	10,847	7,564	0
Dividends	0	0	0	0	0
Net Cash Flow	(32,411)	(27,990)	(4,276)	(723)	(6,497)
Opening net debt/(cash)	(70,859)	(38,300)	(10,314)	(6,018)	(5,295)
HP finance leases initiated	0	0	0	0	0
Other	(147)	4	(20)	0	0
Closing net debt/(cash)	(38,300)	(10,314)	(6,018)	(5,295)	1,202

Source: Company accounts, Edison Investment Research

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