



HALLGARTEN & COMPANY

Sector Review

Christopher Ecclestone
ceccestone@hallgartenco.com

Scandium – *Unobtainium* No More?

	Portfolio Call	Ticker	Price	12 mth range	Market Cap.
Australian Mines	Neutral	AUZ.ax	\$0.83	\$0.013 - \$0.155	AU\$223.65mn
CleanTeQ	Long	CLQ.ax	\$0.70	\$0.65 - \$1.78	AU\$525.02mn
Imperial Mining	Long	IPG.v	\$0.08	\$0.05 - \$0.27	CAD\$2.40mn
Niocorp	Short	NB.to	\$0.69	\$0.37 - \$0.78	CAD\$146.52mn
Platina Resources	Neutral	PGM.ax	\$0.09	\$0.073 - \$0.265	AUD\$23.77mn
Scandium Intl	Long	SCY.to	\$0.15	\$0.125 - \$0.325	CAD\$47.2mn

Scandium

Unobtainium No More?

- + The word “Scandium” tripping off the tongue of Robert Friedland in 2017 energised an otherwise unnoticed metal but then also attracted some carpetbaggers to the space
- + Enough serious projects have surfaced that the long-time bugbear of unavailability could be laid to rest
- + Aerospace operators are ready and willing to take up new supply if they can be guaranteed reliable supplies in sufficient quantities at economic prices
- + CleanTeQ has a strategy of stockpiling enough product to give end-users comfort, this will then become an enabler for other contenders
- + Scandium International has low capex costs due to its plans to be a primary Scandium mine
- + Strong potential for expansion of demand based upon increased availability at current or lower prices – applications follow supply
- ✗ Financing environment remains challenging
- ✗ Some of the new projects are predicated by Cobalt as a by-product and that metal appears to have peaked, at least for the moment
- ✗ Niocorp cannot seriously be considered as a North American source of the metal
- ✗ With six Scandium hunters already in the race there is a lot of noise and misinformation but there is also a higher profile for what has hitherto been an obscure metal

On Scandium

Back when the film *Avatar* first came out, its screening coincided with the frenzy of the Rare Earth boom and we wrote a research piece on that sector and likened the Rare Earths, in a tongue-in-cheek manner, to the film’s mysterious sought-after metal, *Unobtainium*. As history was to ultimately show, Rare Earths were all too obtainable and the whole suite of metals fell out of bed and still languish.

At the time, some of the more ignorant of the mining space referred to Scandium as one of the Rare Earths despite it not belonging to the Lanthanide series and rarely appearing in their company in mineralisations. We note with some amusement that the latest swathe of US tariffs against Chinese metals exports targeting Rare Earths, repeat the error and include Scandium in the targeted metals, despite China (to our knowledge) not being a notable producer of Scandium and certainly not an exporter of any note.

Despite this Scandium seems, in fact, to be the closest thing that we have to *Unobtainium* with its very scarcity being its own worst enemy. This is a situation that seems on the verge of being remedied and in this note we shall discuss the how and why.

The Friedland Effect?

Scandium was, until 2017, one of the lesser talked about technology metals. Since last year it has received increased focus and mention, not least because of the peripheral involvement of Robert Friedland in the metal. This interest is despite the fact that the supply situation is severely limited with literally only a few tons of product hitting the market per annum, and even that is as a by-product of the refining and processing of other metals. The applications for the element are known, particularly in aluminium alloys, solid oxide fuel cells and lighting but it's just that manufacturers will not tool up for the metal if they cannot be guaranteed greater (reliable) supply.

Build It and They Will Come?

The absence of reliable, secure, stable and long-term production has limited commercial uptake of Scandium. Despite this low level of use, Scandium offers significant benefits. The potential for substantial expansion in usage and demand clearly exists and to an extent it is one of those "rare" metals stories where the supply could potentially generate the demand rather than the other way around. The most obvious areas where this might happen are in lighting systems, SOFCs and aluminium alloys.

In some ways a good analogy might be Europium. Its application in colour televisions spurred a surge in REE mining (ironically at Mountain Pass) which then made the "rarer" REEs more abundant, lowering the price but moreover accentuating the supply which meant that new applications arose or were employed that spurred the whole evolution of the permanent magnet and laser usages of the other metals in the Lanthanide series.

It is not too difficult to imagine that greater production will firstly spur the master alloy applications, followed by an expansion in the SOFC demand, lighting and then "new" applications. In aircraft alone the aluminium alloy demand might totally consume the entirety of the extra metal that nascent producers might bring to market. It is interesting to note that Bloom, the California based SOFC manufacturer (and as such possibly the world's major consumer of Sc), currently have an IPO underway and a word search of the prospectus yields no result for Scandium, not even in the risks section.

The Scandium Space

When we first wrote on this metal Scandium International (SCY.to) was quite clearly a lone voice in the wilderness. Since then a number of other wannabes have appeared touting their Scandium virtues as either byproduct kickers or attempts to make unviable and unsexy projects (pardon our cynicism) into viable and sexy propositions to potential investors. In some cases they have attracted investor attention and have had the positive effect of making the metal more high-profile than it has hitherto been. At a recent workshop at the European Space Agency, Scandium was the metal that was most mentioned with Tellurium a very distant second.

Bizarrely the Scandium space is currently being fought over like some ridge in a First World War battle in

Flanders. This might be understandable if the price of the metal was raging higher but price is one of the most obscure elements of this element. We know it is highly valued but that is a product of scarcity. There are few metals out there in which economic models and extant production plans actually guarantee a fall in the metal's price if plan are realized, even in part.

The players in the Scandium space are concentrated in Australian properties, with two claimants that we know of, presenting properties in North America. The six are:

- CleanTeq (the Syerston project in NSW)
- Scandium International (the Nyngan project in NSW)
- Imperial Mining (the Crater Lake project in Quebec)
- Platina Resources (the Owendale project in NSW)
- AusMin (Flemington project in NSW)
- Niocorp (the Elk Creek project in Nebraska, USA)

The players are summarised in this table:

	Ticker	Location	Project	Mineralisation	Sc Grade ppm	Sc Contained Tonnes
Australian Mines	AUZ.ax	Australia	Flemington	Co/Sc/Ni	404	1,091
CleanTeq	CLQ.ax	Australia	Syerston	Ni/Co/Sc	421	19,240
Imperial Mining	IPG.v	Canada	Crater Lake	Sc/Ti/Zr		
Niocorp	NB.to	USA	Elk Creek	Nb/REE/Sc	72	2,266
Platina Resources	PGM.ax	Australia	Owendale	PGMs/Sc	395	13,312
Scandium Intl	SCY.to	Australia	Nyngan	Sc	235	3,976

Firstly, we should remove the US player from contention. **Niocorp** is a niobium project with Scandium credits. Niobium is essentially a monopoly with the Brazilian miner CBMM, controlling over 80% of the market and tolerating Niobec (the producer in Quebec that has an 8-10% market share) so that it does not run into anti-trust problems. CBMM can happily tolerate other miners with tiny Niobium credits being added to the global mix because it can then moderate its own production to maintain price discipline. What it will not tolerate is a new primary Niobium mine of size. This kills dead any prospect of a Scandium by-product flow. Move along...

Next we might look at the stock with the highest “chatter” rating and that is **CleanTeQ**, owner of the Sunrise (formerly Syerston) project, with its now \$525mn market cap (halved from its highs). In reality this is a laterite nickel project with a significant Cobalt kicker. Sunrise has, like many other projects, a “Scandium halo”.

The company published its long awaited DFS in June 2018 with a projected 20-year LoM. The study posited around 20,000 tpa of Nickel and 3,200 to 4,600 tpa of Cobalt with the higher Cobalt production skewed towards the early years.

The average scandium oxide production capacity will be around 80 tonnes per year, which CleanTeQ claims can readily be expanded to 160 tonnes per year, with the DFS conservatively capping sales at 10 tonnes per year for the life of mine. A dedicated scandium refinery with 80 tpa high purity scandium oxide refining capacity is included in the DFS capital cost estimate.

The pre-production capital cost estimate is US\$1.33 billion (AUD\$1.77 billion) which excludes a US\$165mn estimated contingency. This higher capex reflects a significant increase in refining capacity, relative to the 2016 PFS, to provide the opportunity to increase production volumes. Now to raise the funding. Certainly the retreat in the market cap makes that less easy than it might previously have been even with the heft of the Friedland presence on board.

Scandium International, that we have covered on several previous occasions in standalone research notes, is the owner of the Nyngan primary Scandium deposit in New South Wales. The revised NI 43-101 Measured and Indicated Scandium resource now totals 16.9 million tonnes at an average grade of 235ppm scandium and Nyngan is the only primary Scandium deposit on offer at the moment. The Definitive Feasibility Study on the project estimates CapEx at a low US\$87mn and projects NPV (at 10%) of US\$177 million and IRR is 33.1%, (NPV at 8% is US\$225 million). Cash costs were estimated at US\$557 per kg of Scandium Oxide, with DFS utilizing US\$2,000 per kg pricing.

Imperial Mining, with its minuscule CAD\$2.4mn market cap, is the holder of the Crater Lake deposit in far-northern Quebec. The deposit is “what it says on the box” a crater with a lake within it and the mineralisation in a halo around the edge of the lake. In 2014, an exploration program intersected a 225m long Scandium- and REE-bearing zone within a thick ferro-syenite layer. Review of the drilling data also returned a 19m long interval grading 0.506% Sc along the western side of the Crater Lake intrusion. A parallel Niobium target showing grab assay results of between 0.20% and 1.42% Nb₂O₅ sits 250 m west of the Scandium target. Clearly more work to be done here, but this is the only North American Scandium play that seems like to get traction.

Australian Mines is essentially piggybacking on Sunrise and claiming “closeology” as its main merit. It is claiming to be the “other half” of the Sunrise deposit, which must be mighty annoying to Robert Friedland. In light of the sexiness of Cobalt at the moment it is primarily touting this as a Cobalt deposit despite the grade being only 0.11%. The project has both a Co/Sc zone and a Sc zone. The latter though has infinitesimal Cobalt grades (0.01%) so a Scandium-only mine would have a grade of 433ppm but only yield 788 tonnes making it only a fraction of the next smallest player. How that would be viable as either a Cobalt or a Scandium mine is beyond our imagination at this point.

We have not met **Platina** since last decade but at that time it was solely a PGM explorer. At the current time it has morphed into a quasi-Scandium stock with an AUD\$23mn market cap (off 60% from its 12-month highs). The company has no DFS yet on the Scandium potential and no process to make PGMs or Scandium. The project is essentially Isoferro platinum at 0.7g/t (+smelter), a less than riveting Nickel grade, Cobalt too small in volume to build a decent size plant and spotty Scandium mineralisation is not where the cobalt or platinum grades are good. There is no mine plan as yet. Still it is one to watch.

There are clearly people with good intentions out there (SCY and Platina), some with serious backers (CleanTeQ), some with the smoke-and-mirrors heavily in evidence (Australian Mines) and some with projects that need an alignment of planets that is scarcely imaginable (Niocorp). If we had to rank these in terms of likelihood to production we would say CleanTeQ first (provided Cobalt stays in such short supply), followed by Scandium International and then Platina.

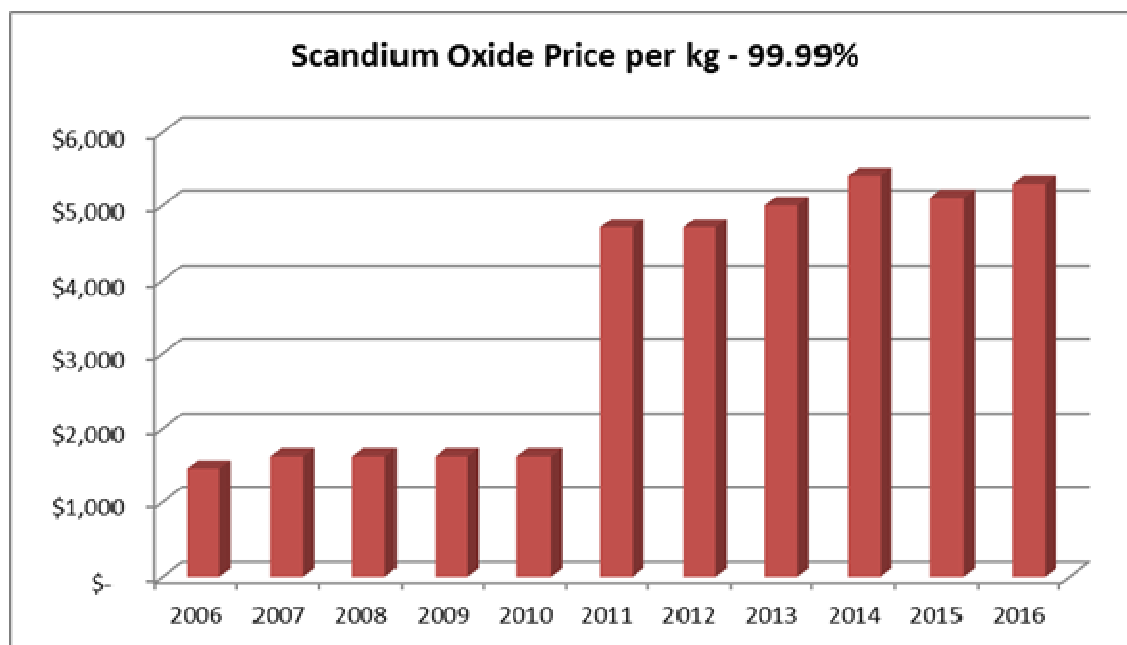
Scandium Volumes – A Relatively Unknown Quantity

The USGS has estimated that global scandium consumption was less than 10 tons per year in 2013. However, as this metal is one of the least intermediated metals around (i.e. most of its trade is directly between end-users and the “producers”, one has to wonder how reliable the USGS numbers are. We have spoken to knowledgeable parties in the Scandium trading space that estimate it at 20-25 tonnes per annum.

Prices & Marketing

The current price of the metal is another murky area (even more so than many of the minor specialty metals) with indications that Scandium Oxide has traded at over US\$5,000 per kg in the middle of the decade. This compares with \$1,620 per kg as recently as 2010.

Speaking to an informed player in the space he noted that Chinese oxide is cheap, maybe US\$1200 or less, however master alloy is priced in a wide range.



Pricing in the metal is somewhat of a “nod, nod, wink, wink” process. One Scandium watcher we spoke to commented that he thought that “\$900/kg was a low-wrong number in 2009, and \$5,200/kg is a high-

wrong number in 2016”.

It is important to note that at \$2,000/kg oxide pricing, there is US\$66 of scandium in one kg of Al-Sc 2% master alloy. There is no reason that Al-Sc master alloy margins should be more than a few dollars premium to other varieties.

Another issue of note is the grade differences in the quotes between 99% and 99.99%. Electrical uses will need 99.9%. Master alloy producers will be content with 98%, and they probably could do with 95% if they adjusted their mixing and gross management techniques. Most material will go into alloys.

In its recent DFS, CleanTeQ made the comment, “While scandium oxide prices have historically ranged from US\$2,000-4,000/kg, the DFS has assumed a forward price of US\$1,500/kg, which is the price at which the company expects significant additional demand growth to be stimulated”.

CleanTeQ Plays God

The De Beers model is well known. After a meeting with the CEO of CleanTeQ in Melbourne in February we came to the conclusion that the De Beers model of ‘enabling’ a market is probably the best way of describing the strategy, and the outlook for the Scandium space at least in the next few years.

The problem potential end-users of this metal have is that a chicken-and-egg-like dilemma arises. Does a major aircraft manufacturer tool up for a switch to Scandium in its aluminium alloy usage when it can be guaranteed little more than scraps in the current scenario? While for potential miners the dilemma is do they build a mine on faith alone that end-users will tool up even when there is a reliable source of Scandium in size? For end-users there is another dilemma. Do you rely upon only one supplier when that miner is more subject to the vagaries of the Nickel price than the Scandium price? If Nickel prices deteriorate for whatever reason then a Scandium source could be shuttered as it is only a by-product.

Grappling with the challenge that this presents CleanTeQ came to the conclusion that “seeing is believing” for Scandium end-users. The promise of sufficient metal is not sufficient but they must be, quite literally, able to eyeball it. Due to the happy concurrence of events that Nickel is satisfactorily priced and that Cobalt is very well-priced (and the market disposed to fund Nickel-Cobalt to production) a strategy was devised that the Scandium can essentially be stockpiled until enough of the product exists that end-users will have comfort that they will have future supplies. The news release for the DFS stated “Financial model assumes scandium oxide sales of only 10 tonnes per annum with surplus to be stockpiled on site for later processing as the market develops. Scandium hydroxide will be refined into scandium oxide on site”. Ergo, the actual sales will be something like the “known” current global consumption. So this strategy rather than “build it and they will come” might best be described as “stockpile it and they will use it”.

As a result, Clean TeQ has existing agreements with companies including Airbus Group and Chinalco, to develop new light-weight aluminum scandium alloys for the aerospace and automotive sectors. This is not the same as sales but it is definitely the start of a mating dance between the aerospace industry and

the putative Scandium miners.

One thing that has become clear to us is that for end users to tool up for a shift to Aluminium-Scandium alloy use in serious quantities (ergo the aerospace industry) there will need to be at least two producers. One alone will not give them comfort of supply. CleanTeQ for instance might start producing but if Nickel (or Cobalt) prices tank such a mine would be shuttered for the duration and the Scandium by-product users would be hung out to dry. This is the point that other primary mines for Scandium are “enabled” (such as Nyngan and Crater Lake) to give end-users diversity of supply and a source decoupled from the vagaries of the Nickel market.

Thus the evolution we would see would be a by-product producer making several tens of tons per annum and then escalating, with a primary producer probably then joining the fray. Scandium in that circumstance goes from being an “obscure object of desire” in high-tech industries to being a conventional specialty metal like Tungsten or Tellurium. It will also create a supply-chain almost totally outside the Chinese orbit (despite the Chinese position in CleanTeQ).

Risks

It is important to highlight some of the risks in for Scandium players. At least with most players located in the well-known and long established mining jurisdiction of NSW, it is unlikely that any problems should present themselves on that front. However one should consider:

- ✘ Financing difficulties
- ✘ Scandium price fluctuations in what is an opaque market
- ✘ Price fluctuations for other metals that are primary drivers in some projects (i.e. Nickel & Cobalt)
- ✘ Failure of demand to match rising production (i.e. build it and no-one comes)
- ✘ Excessive number of competing projects could crowd the scene and hog capital

The chief advantage that CleanTeQ and Scandium International have in minimizing these risks is that they are so far advanced compared to other potential players, while in the case of Scandium International its bite-sized capex makes it eminently more buildable than some of the other contenders.

Conclusion

Scandium has gone from being obscure a couple of years ago to be name-checked frequently in recent times. The irony is that on the production and consumption front nothing, as far as we can tell, has actually happened. The *Wundermetall* remains as unobtainable as ever. However the situation is changing. End-users want it but aren’t prepared to back projects to make it happen. They are happy to talk but talk doesn’t put metal on the table. Ironically it might be an obscure linkage to the fortunes of Cobalt and the rise of EVs that might fire up the production prospects even though Scandium (thus far) has had nothing to do with the EV revolution. Cobalt becomes an enabler of Scandium.

Excepting Scandium International as the only primary Scandium player, the others are all viewing

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Scandium as a by-product for projects. Certainly, for a while there, the heat generated by Cobalt meant that projects with that metal could promote their virtues while overlooking the fact that Nickel had improved but not to levels where laterite Nickel projects would stand on their Nickel merits alone. At the moment Cobalt is going through what we might politely call a “pause” and this has pulled back the stock prices of the putative Ni-Co-Sc plays. At least the main play, CleanTeQ has the added zest provided by having Robert Friedland on board and this might overcome whatever other obstacles there might be.

If this hubbub of arm-wavers has any usefulness it is in making Scandium the word of the moment amongst the chattering classes of the mining world. Unfortunately the average (or even the sophisticated) investor finds it difficult to discriminate between the good, bad and the indifferent. The more information that is available on the metal, and the dynamics, then the sooner this fog shall lift.

Scandium’s potential for much greater penetration of the technology metals space is well-known to any with more than a passing knowledge of the applications to which it can be applied. The space of the next five years will prove whether Scandium can make the jump for being *Unobtainium* to being a commonplace specialty metal even if not in everyone’s home or garage.

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