

The sizzling silvery-white Indium heats up for a bull run

Indium (In) – joined at the hip to Zinc: For those zinc bulls amongst us (and my hand shoots up) the received gospel is that that Lead/Zinc supplies are on the wane over the next few years. This is not due to a shortage of the metals on the planet or to potential deposits not being identified but rather due to underinvestment in new mine development on deposits already long-ago identified. This is compounded by a decline in existing production with the closure of big mines such as Century (Australia), Brunswick & Perseverance (Canada) and the zinc mines of Portugal and Ireland heading into their declining years.

The relevance of this for Indium (In) is that this important specialty metal (in the absence of primary mines) is linked to the fate of the Zinc mining industry due to it being a by-product on Zn mining. Zinc mines are not the only source as indium is enriched in sulphidic lead, tin, copper, iron deposits also. Very rarely the element can be found as grains of native (free) metal, but these are not of commercial importance.

The most common extraction process is that the Indium is leached from slag and dust of zinc production. Further purification is done by electrolysis. The exact process varies with the exact composition of the slag and dust.

Some Science: Indium was discovered in 1863 and the metal was first isolated in the following year. Despite the popular conception that its name has something to do with India, it was in fact named for the indigo blue line in its spectrum that was the first indication of its existence in zinc ores,

as a new and unknown element.

Indium is a chemical element with symbol In and atomic number 49. Indium is 61st most abundant element in the Earth's crust making it rather rare, at approximately 49 ppb, approximately as abundant as mercury. It is very soft, malleable and easily fusible with other heavy metals and is chemically similar to gallium and thallium. Fewer than 10 indium minerals are known and none of these occurs in significant deposits.

Applications: The first large-scale application for indium was as a coating for bearings in high-performance aircraft engines during World War II. Afterward, production gradually increased as new uses were found in fusible alloys, solders, and electronics. In the 1950s, tiny beads of Indium were used for the emitters and collectors of PNP alloy junction transistors. In the middle and late 1980s, the development of indium phosphide semiconductors and indium tin oxide thin films for liquid crystal displays (LCD) and touchscreens resulted in a demand surge that, by 1992, resulted in the thin-film application having become the largest end use.

It is widely used in thin-films to form lubricated layers. It is also used for making particularly low melting point alloys, and is a component in some lead-free solders. The chart below from Nyrstar shows the demand by application (net of recycling).



The amount of indium consumed is largely a function of worldwide LCD production. Worldwide production in 2007 was 475 tonnes per year from mining and a further 650 tonnes per year from recycling. Demand has risen rapidly in recent years with the popularity of LCD computer monitors and television sets, which now account for 50% of indium consumption. Increased manufacturing efficiency and recycling (especially in Japan) maintain a balance between demand and supply. Since only 0.5%

to 1% of the production costs of these units is related to the indium content, there is no real incentive to switch away from the metal. The leading producers in Japan suggest that there will be no substitute available within the next five years.

Pricing: Indium demand has increased in line its consumption in LCDs and flatscreen televisions. Meanwhile supply decreased when a number of Chinese miners stopped extracting indium from their zinc tailings. In 2002, the price was US\$94 per kilogram. The recent changes in demand and supply have resulted in high and fluctuating prices of indium, which from 2006 to 2009 ranged from US\$382 per kg to US\$918 per kg. Currently prices are around \$750 per kg.

Production: Some use a rule of thumb that, based on the average content of indium in zinc ore stocks, there is a worldwide reserve of approximately 6,000 tonnes of economically viable indium. It has been estimated that there are fewer than 14 years left of indium supplies, based on current rates of extraction, demonstrating the need for additional recycling (if possible).



However, the US company, Indium Corporation, the largest processor of indium, claims that, on the basis of increasing recovery yields during extraction, recovery from a wider range of base metals (including tin, copper and other polymetallic deposits) and new mining investments, the long-term supply of indium is sustainable, reliable and sufficient to meet increasing future demands. This seems somewhat fanciful and wishful thinking.

China is a leading producer of indium (390 tonnes in 2012), followed by Canada, Japan and South Korea with 70 tonnes each. Teck's Trail refinery in British Columbia is a large single-source indium producer, with an output of 32.5 tonnes in 2005. We cannot find specific numbers for Trail that are more recent

but one can presume that the largest part of the 70 tonnes of Canadian production reported by the USGS in 2013 would have been from Teck's facility. Nyrstar, as Europe's largest zinc refiner, saw its indium production increase by 154% in 2013, to 33 tonnes, from 13 tonnes in 2012. The company increased capacity at its Auby smelter in France to 45 tonnes per year during 2013.

Potential Production: Adex Mining (TSXV: ADE) has the Mount Pleasant Mine in New Brunswick, which holds a sizeable indium resource. This deposit had previously been mined by Billiton and Lac Minerals. At times the deposit was exploited for Tin and at other times for Tungsten. The main deposit is the Fire Tower Zone where the NI 43-101 resource estimate includes an indicated resource of 13,489,000 tonnes at 0.33% WO_3 and 0.21% MoS_2 , as well as an inferred resource of 841,700 tonnes at 0.26% WO_3 and 0.20% MoS_2 .

The North Zone contains an updated NI 43-101 resource estimate including 12,400,000 indicated tonnes averaging 0.38% Sn, 0.86% Zn, and 64 ppm In, as well as an inferred resource of 2,800,000 tonnes averaging 0.30% Sn, 1.13% Zn, and 70 ppm In. This mine is the most plug-and-play project we have seen with a whole suite of existing infrastructure that was installed by previous owners and consists of a large complex of buildings for administration, management and security; ore processing (crusher-concentrator) and ore storage; warehousing and maintenance. There is a 430-metre-deep mine with thousands of metres of underground development, including a service decline and conveyor decline. It also has a fully functioning tailings pond that is regularly maintained and monitored. The company is at the stage where it has contracted with several consulting and engineering companies to complete a pre-feasibility study and environmental permitting approval in relation to the Fire Tower Zone.

With Tin, Tungsten and Indium all well-priced at the moment,

it would appear Adex has hit the trifecta of specialty minerals with its Mount Pleasant venture. Now to fund it...

Portex Minerals (CSE: PAX) is a Toronto-based mineral exploration which currently has a 100% ownership interest in the Toral (with a NI 43-101 resource estimate) and Lagoa concessions in North West Spain; an 85% interest in the Lagoa Salgada concession in the North West end of the Iberian Pyrite Belt in Portugal; and 24 base and precious metal exploration licenses in Ireland and Northern Ireland. The Irish properties seem too prolific in number for our liking but the real gem is the Lagoa Salgada deposit which is in the general vicinity of the well-known Adjustrel and Neves Corvo mines. While the Iberian Pyrite belt is known for its strong Indium component, Lagoa Salgada is particularly rich in this by-product. This deposit's NI 43-101 resource estimate did not split out the Indium, showing that management were not aware of what they were sitting on here. The deposit consists of a partially defined massive sulphide deposit upon which Tetra Tech Wardrop, in January 2012, prepared a NI43-101 resource estimate including indicated resources of 2.9 mt at 7.2% zinc equivalent and inferred resources of 1.6 mt at 5.5% zinc equivalent. Academic papers on the deposit show readings of Indium as high as 90 ppm (or 90g/t).

With gold, silver and tin in the mix too, Lagoa Salgada has no shortage of "added extras" to justify moving the property towards production in the shorter term.

In a nifty move, Lithic Resources changed its name to InZinc Mining (TSXV: IZN). We suspect most viewers of the change would not get that the "In" is actually Indium. The company completed a preliminary economic assessment for its West Desert (which it has owned since 2005) zinc-copper-indium project in Utah just now in April 2014. The assessment concluded that the deposit would be developed as an underground mine with an onsite mill that would produce zinc-indium and copper-gold-silver concentrates. The newest PEA

foresees a low-cost, long-life zinc mine at West Desert. An underground mine with conventional mining and milling methods is projected to produce an annual average of 107.9 million pounds of zinc, 1 million tonnes of iron concentrate (magnetite) and 9.9 million pounds of copper over a 14.8 year mine life. As of November 2009, indicated resources at West Desert totaled 283 tonnes of indium, but the latest PEA using a Gross Metals Values cutoff value of \$50/tonne counts on an indicated resource of 433 tonnes and an inferred resource of 1,102 tonnes. The problem is the hefty capex at this time which comes in at US247mn.

We might also mention Geodex Minerals (TSXV: GXM) which holds the Mount Pleasant West Project. This consists of five claim blocks east and west of the aforementioned Mount Pleasant mine (owned by Adex Mining) and located south of Fredericton in southwestern New Brunswick. The property includes claims acquired by staking and through option/ joint venture agreements with other companies. The project area is in an area with excellent logistics and infrastructure. Since 2006, Geodex has conducted exploration programs on the property, including multiple diamond drilling programs but there is no resource as yet.

Finally, in the "outside the box" category there is 5Nplus (TSX: VNP). This stock is truly for the cognoscenti. It is not however a miner. The company draws its name from the purity of its products – 99,999 % pure (5 nines, or 5N) and more. It specializes in the production and purification of minor metals such as bismuth, gallium, germanium, indium, selenium and tellurium as well as inorganic chemicals based on such metals and compound semiconductor wafers. Many of these are critical to industrial applications such as solar, light-emitting diodes and eco-friendly materials. Its history goes back to 2000 when some employees of ANRAD Corporation, formerly Noranda Advanced Materials, decided to start their own company through a management buy-out of certain assets. It

currently employs nearly 700 people worldwide and operates manufacturing facilities and sales offices in several locations in Europe, the Americas and Asia.

It was actually a conversation with one of their traders, at the recent Antimony conference, about Indium which prompted us to write this piece.

Malku Khota – An Object (Abject?) lesson to us all

You don't need a particularly long memory to recall the fate of South American Silver Corporation and its Malku Khota property in Bolivia. This was a large resource of Indium with an indicated resource of 1,481 tonnes and inferred resource of 935 tonnes. For the cheap seats however it was marketed as a sizeable silver play. The problem the company had was that it quite correctly decided that it's Indium (and 15 tonnes of Gallium) component were also sexy and represented icing on the cake. By some estimations its Indium resource represented 25% of the global resource of the metal. However this clearly came to the attention of parties for whom silver didn't matter a damn but for whom these other two metals were strongly sought after. In particular the Chinese with total dominance of the Gallium space had NO interest in having anyone outside China with any capabilities in the metal. These are both metals that the Chinese seek to dominate so that they can control the value-added chain in the technologies that use them (gallium-arsenide chips in the case of Gallium and flat screens in the case of Indium).

Well, may we ask whether the grab of Malku Khota in August 2012 by the Bolivian government on some feeble grounds did not presage a transfer of this asset to the Chinese eventually? How long before we hear this land-grab "closes" with the Chinese walking off with the prize of 25% of global Indium reserves and some Bolivian functionary's Swiss bank account bulges just that little bit more?

Conclusion: Attempts to put together an ETF of physical Indium several years ago, utilizing a vehicle called SMG Indium, came to grief. The website can still be seen online and we have a yellowing copy of the prospectus on file but clearly Indium was a bridge too far at that point in time when investors were just wrapping their brains around Rare Earths (and then shortly afterwards licking their wounds). However Indium is not going away (even if the Bolivian government thinks it can take some out of circulation). The demand is strong and unless the seemingly ubiquitous LCD screen disappears in the near future, demand would seem to be set for an upward path for some time. Recycling potential from broken or redundant screens would seem to be set as a constant, as in an algebraic equation, despite whatever boosters in the trading community might like to say (seemingly hoping to talk down prices).

With the impending crunch in Zinc/Lead production and the sparse pipeline of new projects, well might Indium supplies track lower with the production of these household name base metals. It is only those deposits with outside Indium grades that will provide some solace that a zinc-induced supply crunch may yet be mitigated. Indium is clearly not the word of the moment amongst mining's chattering classes but like so many other specialty metals the years of blithely ignoring brewing supply problems could have this metal becoming an obscure object of desire faster than one might imagine.

Mining Finance in Capital Markets for Antimony Miners

I was a guest speaker this week at the 2nd World Antimony Forum in Madrid. My topic was Mining Finance in Capital Markets for

Antimony Miners. More on that later (because I was the ultimate speaker).

The crowd was a select one indeed with key players from the European and Asian regions with a smattering of North Americans and even some parties from Central and South America. Definitely the forum had the heavy-hitters in attendance. I would also note that composition was more than 90% "Buy Side" (traders, processors, refiners, end-users) versus less than 10% being "Sell Side" or the miners. We were the salutary finance industry presence, and then there were staff of the International Antimony Association (I2A) to represent the regulatory state of things.



Of course the chief source of tension between the buy and sell-sides in any metal is over price... particularly in metals with industrial applications. The users want lower prices and sellers want higher prices. In Antimony the price is well off its 2010 highs and even gave back a little more in the last year taking it under the \$10,000 per tonne mark but, most were in agreement that the price going under \$8,000 would hamper profitability at the few Western producers and any lower and they would shut down leaving the Chinese as almost exclusive producers (with some artisanal operators in LatAm and South East Asia thrown into the mix).

The Burmese Mystery

However this would be bad news for the Chinese as well because China has gone from being an 80% plus market share of end-product, which was almost all its own ore, down to the low 60% area in terms of share of global mine production with its 80% plus share of end product coming from it being the largest importer of concentrates, particularly from Burma/Myanmar. The latter was the true revelation of the conference because it doesn't figure in global production statistics and doesn't

merit attention in the USGS survey of where the global reserves are and yet it is supposedly producing between 14-40,000 tonnes per annum. No-one really knows as most of it is smuggled by the rebel tribes in the north of Burma that mine it and then send it into China for processing. The pundits with a good calculator take the difference between what China supposedly mines, what it officially imports and then what it supposedly exports and the difference is the widely differing X factor of Burma. This may also be subject to faulty algebra as well because China is a big clandestine exporter of end Antimony Trioxide. This theory is explained by Vietnam's hefty exports when the country has scarcely any production! The rationale behind this furtive movement is to avoid the Chinese export tax on Antimony. In theory China is not fulfilling its export quotas and yet several countries in Europe are reporting imports from China that are greater than the whole quota... Something is clearly awry.

Lie, Damn Lies and Statistics

The lesson from all this is that the waters are muddy indeed. And in our perception this helps the Chinese. If one thing is clear it is that everyone else is but a small asteroid circling the Chinese sun in the Antimony solar system. Eschew the gravitational pull and one floats off into outer space. Well, at least that is the way things work at the moment. The big thing the Chinese should fear is the creation of a "parallel universe" of miners and roaster/smelter operators outside China that divert product direct to Western consumers without the product ever entering the swirling mass of the Chinese "system". One of the speakers at the event was Emin Eyi, of the AIM-listed Tristar Resources. This company was originally a Turkish Sb mining play. Then it hooked up with the sovereign wealth fund of Oman and came up with the idea of a 20,000 tpa roaster/smelter producing a Antimony Trioxide product with the cheap energy in that locale. Such a development would move maybe 15% of roaster capacity out of

the Chinese orbit. It would provide capacity to roast (potentially) the entire output of the three largest non-Chinese mines (Consolidated Murchison in South Africa, Mandalay's Costerfield mine in Victoria, and Hillgrove in New South Wales, the latter two both in Australia). Such a "break for freedom" would throw a cat amongst the Chinese pigeons. Western companies would scramble to source from non-Chinese production just to feel safe from over-concentration on the Chinese, even though there may also be shipping economies from buying closer to Europe. Then if a few other smaller roasters entered the fray (we met someone who ran one in Turkey at the conference) then they could also cater to other smaller Western mine start-ups (without forgetting the US has US Antimony's processing facility in Montana). In that scenario the Chinese might be left with the zero sum game of being the larger producer and consumer with these two cancelling each other out in an autarkic outcome. The world would divide into two markets...

Resource Security

No one has much problem with Chinese dominance at the moment, as the large Chinese contingent at the event showed, but still in these days of rattling sabres no-one also wants to be too dependent. Japan in particular must wonder (as the world's second largest user at 10,000 tpa) as to whether tensions over islands could produce supply disruptions as happened in Rare Earths a couple of years back. There was a Russian contingent (Geopromining) who spoke of their own mine and two others (one owned by Norilsk) in that country. Curiously all the Russian production now goes to China for processing.. how the mighty are fallen.. It would seem logical though that Russia will at some point have at least one roaster in operation to corral local production and keep the value added in the country. We also met the people behind the UK-headquartered private antimony mine developer Rasant. They will be producing from a mine near the Chinese border by late summer and have a

concentrator up and running also. It will be interesting to see if this heads to the AIM, giving London its first listed Antimony play.

Off the Beaten Track

Interestingly the talk on Antimony away from events like this is on the known locations to the mainstream mining community, such as Australia, Canada and South Africa. However the focus amongst the miners present at this event was on different territory. There were two companies with (between them) three past-producing properties in Spain, there were two players with mines in Honduras, there was a roaster owner who had a stake in a Turkish producing mine and there was the owner of the largest mine in Tadjikistan. This was on top of the aforementioned Russians. The party that was scheduled to appear and didn't was the crew from Hillgrove, the mine that was recently sold by Straits Resources (SRL.ax) to a Hong Kong group, Bracken Resources. This Sb-Au mine, which I spoke about in my presentation, was last producing as recently as 2008 when it shut for financial and process reasons. It will apparently be back humming again soon, but with its product heading off to China, much to the disappointment of those that had hoped for an alternative Western source of supply. Other chatter related to Consolidated Murchison, the largest Sb mine outside of China. This South African mine is owned by Village Main Reef, the JSE-listed miner that has had the asset up for sale for a few months now. Speculation is rife that the Chinese might be the buyers, which would be bad news for the big trader Traxys that takes the product to India to roast. However there was also some possibility that Traxys (in which the PE investor, Carlyle Group, has just taken a chunky stake) might end up being the buyer. The lips of Traxys contingent were hermetically sealed on the issue. The people from Village Main Reef had been scheduled to appear and then did not...

Conclusion

So the speech I gave ended up as the last item on the program (we shall not call it the high point, though some did..). It was interesting that so many on the buy-side knew so little about what was going on with the mining side of their business. It reminded us of Churchill's comment on the British and the Americans, "two nations divided by a common language". Many end-users at least in Antimony do not think about "where their next meal is coming from". China has long been there as the bottomless supplier of cheap and abundant product. As many have realized in the Tungsten space, such a situation can quickly turn nasty and so we have seen end users in W (e.g. Sandvik and GTP) move towards securing non-Chinese supplies via direct stakes. I think if nothing else I was a bit of a wake-up call on this front. I also managed to show that Sb projects that are investable are not in short supply but that depressed mining finance markets in recent years necessitate end-users and traders showing a commitment to the metal via investment in new projects that are more than just a token 5% to 15% stake in a project or the listed vehicle. The buy-side need to become real partners in the sell-side's projects to make them happen before it's too late.

The outlook though is good for stable to moderately higher prices with less chance of the price spikes (and plunges) of the past. This lays down an environment for project developers that mean they are not in a boat in high seas, but one with smoother sailing.