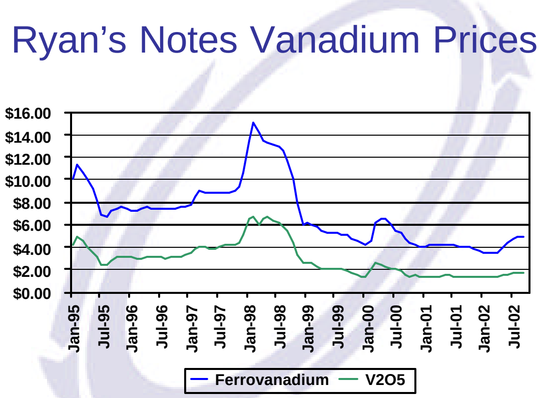
Vanadium 2002

Kevin H. Jones
Bear Metallurgical Company
Ryan's Notes Ferroalloy Conference
October 29, 2002
Boca Raton, Florida

Over the past decade, the vanadium industry, along with many others, has been remarkably resilient, navigating varying economic conditions, the ups and downs of the steel industry and challenges from old and new competitors. Prior to 1999 the industry enjoyed several years of enormous success which led to overconfidence about the future of the industry. The economic downturn, September 11th, and the current state of global financial markets has our world in a state of flux.

This morning I thought I would address some of the challenges facing the vanadium industry in this sobering market environment, issues that are essential to maintaining the confidence of our customers, the steel industry, and our shareholders.

No vanadium paper would be complete without showing the rollercoaster … spike … crash … recovery price history of this industry. So let's start there and get this pre-requisite out of the way.



The price spike that began in October 1997 and lasted until October 1998 was the result of a disruption of supply from Russia. The market had been in relative balance from 1995 until October 1997, this was a period of strong steel production. A big dip occurred in the supply of vanadium from Russia as Nizhni Tagil Iron & Steel Company increased its production of steel sacrificing more than 10 million pounds of vanadium oxide production. Into 1998, Nizhni Tagil reversed their practice and the lost vanadium returned to the market at a time when demand was beginning to weaken and when several other expansions came online.

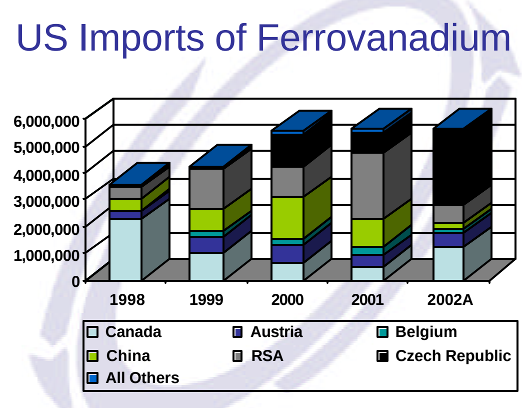
Since this time prices have continued to decline at a steady rate. There had been efforts by some since 1998 to hold back material to support prices but the results as we can see here have been rather short lived.

Since Vanadium prices hit an all time low in April 2002 of $3.45 in the US, prices improved modestly into the second and third quarter of this year. A number of factors impacted positively on market sentiment in the second quarter, with a corresponding increase in price: Chinese exports decreased to notably low levels; the amount of V_2O_5 being offered in the spot market continued to reduce as Rhovan's new integrated ferrovanadium capacity came on stream; and the US market strengthened as a result of the anticipated anti-dumping duty against South African and Chinese ferrovanadium.

In the absence of any further reductions in supply, prices are likely to remain in the current range for the remainder of the year and into next year, as the above factors are unlikely to put further upward pressure on prices. In recent weeks prices have weakened once again.

April's ferrovanadium low of $3.45 represents a V_2O_5 value of less than $1.00 after accounting for conversion, packaging and shipping costs. This is well below the full cost of production, even for the most efficient producers in the world. This indicates that the vanadium market continues to be out of equilibrium at unsustainable price levels.

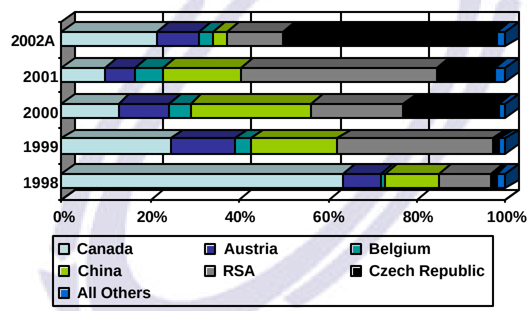
Moving from the past to the present, I would like to discuss the anti-dumping case the US Vanadium industry has initiated against South Africa and China.



In recent years there have been interesting developments in the pattern of trade in ferrovanadium worldwide, especially in the United States. As this chart indicates imports have risen steadily since 1998. Most notably you can see the change in imports from Canada to the US during this period where in 1998 the quantity was in excess of two million pounds vanadium. These began declining as production of ferrovanadium destined for the US resulting from South African oxide shifted away from Canada toward European converters and new ferrovanadium capacity in South Africa.

Reciprocal trends can be seen in the statistics for Europe and South Africa. The figures shown for 2002 are annualized statistics reported by the US Department of Commerce through July. From this chart you can also see the rise in South African imports through 2001 which fall off in 2002. Czech Republic imports also show a dramatic climb especially based on the annualized 2002 figures.

US Imports of Ferrovanadium

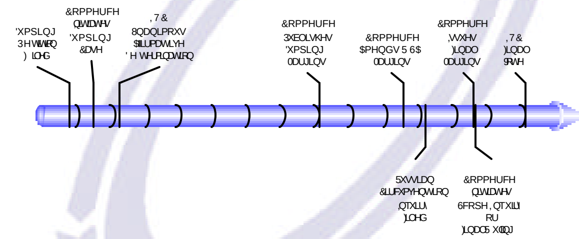


This chart shows each country and its respective percentage of total imports into the United States and more clearly shows the trend I have been discussing. Imports from Canada declined from 1998 when they represented over 60% of total imports to a low of around 10% in 2001. Imports from Canada are again on the increase as efforts to avoid the likely duties on South African ferrovanadium increase. Chinese imports also show a similar trend as they increase steadily though 2000 to over 27% of total imports, decreasing slightly in 2001 and markedly in 2002 as a result of the pending dumping case.

Imports from the Republic of South Africa also show a significant evolution during this period. In 1998 imports from South Africa represented 12% of US imports and increased to 44% in 2001. This year they and have fallen off to 12%, again as a result of the pending dumping case. The imports from the Czech Republic have advanced from less than 2% in 1998 and 1999 to 48% of total imports in 2002. This change is a result of not only the recent shift from the South African oxide but also from Russian vanadium oxide being converted in the Czech Republic for export to the United States.

It must be noted that the 2002 figures shown are annualized July statistics. These annualized numbers may not be representative as imports from China and South Africa have ceased, although it is not unreasonable to assume that in the near term, the same quantity of imports will still arrive but from a different origin.

Dumping Cases



The US Vanadium Committee composed of Bear Metallurgical Company, CS Metals of Louisiana, Gulf Chemical & Metallurgical Corporation, Shieldalloy Metallurgical Corporation and US Vanadium Corporation, filed a petition on November 26, 2001 alleging that South Africa and China were engaged in the dumping of ferrovanadium in the United States. On December 17, 2001 Commerce determined that it would initiate the dumping cases and estimated margins for the purpose of initiation of 91% for China and 116% for South Africa.

On January 10, 2002 ITC issued a unanimous affirmative determination that there is a reasonable indication that the US industry is materially injured by reason of imports of ferrovanadium from China and South Africa.

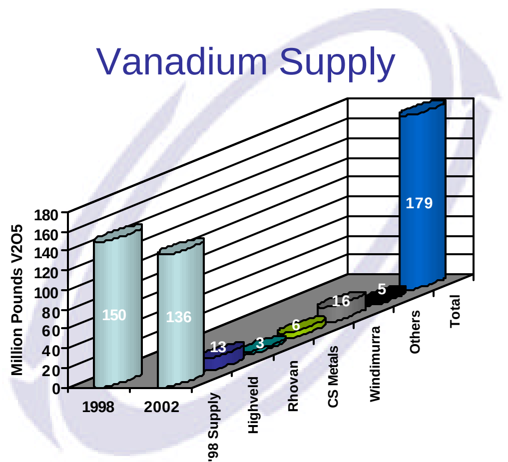
On July 6, 2002 Commerce published affirmative dumping determinations in the Federal Register. Dumping margins that were estimated for China were: Pangang (73.29%) and PRC Wide (78.52%); and for South Africa: Highveld (45.58%), Xstrata (37.29%) and All Other (41.72%) At this point Customs began to suspend liquidation entries of Chinese and South African ferrovanadium and require a bond or cash deposit in the amount of the estimated dumping margins.

On September 19, 2002 Commerce published notice of amended preliminary dumping determination to correct ministerial errors in the calculations for preliminary duties for South Africa. Xstrata margin changed to 19.42% and All Other South African producers and exporters changed to 33.39%, the margin for Highveld remains unchanged at 41.72%

The final dumping margins will be announced by Commerce on November 21, 2002. The expected outcome is that the duty rate for South Africa is likely to be in excess of 100%, and the duty rate for China is expected to remain at restrictive levels. The ITC must have a final injury vote by January 6, 2003

On another front, the US Vanadium Committee on October 8, 2002, filed with the Department of Commerce a request that the agency initiate a circumvention inquiry to determine whether imports of ferrovanadium converted in third countries using Russian V_2O_5 should be subject to the antidumping duty order on Russian ferrovanadium. Commerce now has until November 22, to either initiate a scope inquiry or issue a final scope ruling. If an inquiry is initiated Commerce will have until September 18, 2003 to make a final ruling.

I will now move along to a look at the supply side dynamics driving the current market conditions.



The supply of vanadium continues to increase incrementally. The vanadium industry enjoyed a very good run in the mid 1990's with a relative equilibrium between supply and demand and good prices. This situation led to vanadium producers becoming over bullish about the future of the vanadium industry, the steel industry and the economy. As a result new capacity has been added to the industry since 1998, which unfortunately has significantly exceeded current demand of approximately 155 million pounds vanadium pentoxide equivalent.

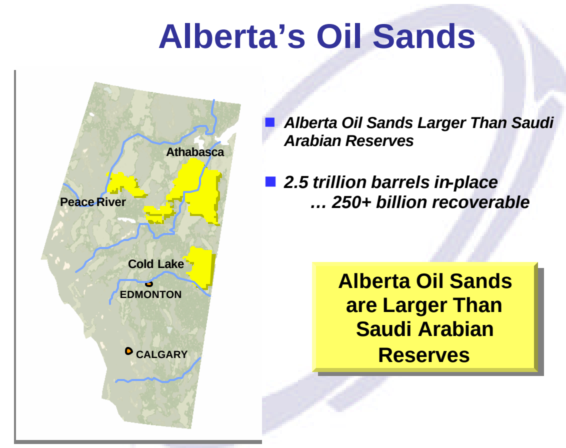
Some of the capacity that existed at that time has been reduced, Stratcor's Vametco facility in an attempt to help ease the oversupply situation has temporarily closed its mine and is substituting slags from Highveld in place of ore, this resulted in a reduction of ore produced vanadium oxide of approximately 10 million pounds. The Crimet spent catalyst processing facility in the US closed in 1999 resulting in another 4 million pound reduction of pre-1998 supply.

Since 1998 there has been another 43 million pounds of capacity added. In South Africa Highveld commissioned a new kiln with a capacity of 13 million pounds and Xstrata's Rhovan plant added incremental capacity of 3 million pounds. In the US, CS Metals of Louisiana has been commissioned with 6 million pounds capacity. In Australia, Xstrata's Windimurra (formerly PMA) was opened with nameplate capacity of 16 million pounds. And other expansions, mostly related to recycling of petroleum residues and catalysts of at least 5 million pounds has been added worldwide.

It is probable that these 43 million pounds of new capacity are not being fully utilized, for example, it is believed that Windimurra is operating at about the 12 million pound rate, and the CS Metals plant has not yet achieved full production and is operating at around 4 million pounds per year. It is not known whether Highveld's new kiln replaced previous capacity or if it was purely an expansion, it could also be a combination of the two.

Petroleum based vanadium production continues to grow from oil residues, ashes and spent catalysts. Recyclers like Gulf Chemical & Metallurgical Corporation have been processing vanadium residues and spent catalysts for over fifty years. This is a testimony to the viability of recycled units as a source to the vanadium industry. It appears that there is a serious misconception by some producers about comparative production costs. One of the items most overlooked in evaluating the economics of recovering vanadium from these residues is that vanadium is not the only source of revenue. Other revenues are derived from molybdenum, nickel, alumina, and tipping fees to the generators. Companies involved in this industry have survived while the other so-called low cost producers generate huge losses trying to displace others and gain market share.

There are good economic and political reasons for the growth in petroleum based vanadium units. Worldwide refining capabilities are generating more spent hydroprocessing catalyst each year. These residual wastes are becoming more heavily regulated and less likely to be landfilled and more likely to be recycled.



The tar sands of Canada are a good example of the foreseen growth in vanadium recovery from spent catalysts. The Alberta Oil Sands are larger than the Saudi Arabian reserves with over 2.5 trillion barrels in place and 250+ billion recoverable.

A new refinery that will begin operations in the fourth quarter of this year, a partnership led by Shell Canada will generate spent catalyst containing nearly 5 million pounds per year of recoverable vanadium pentoxide or close to 3 million pounds vanadium. All of this vanadium will be recycled in the United States as new production. Petrol Canada is another refinery similar in size that is near complete in the design phase and is expected to be operating in 2006 and there will be others right behind them.

Similar units in Mexico are currently land filling nearly 2MM pounds vanadium pentoxide in spent catalyst that could be recycled. They are beginning to have environmental pressure that will ultimately cause this material to be recycled. There are also millions of pounds of vanadium contained in ashes, flexicoke and other residues that should and will likely be recycled in the future as sustainable development emphasis heightens.

The term "Sustainable Development" is concerned with development and environmental issues with a special emphasis on sustainable management of natural resources. The ultimate goal of this issue is to align industrial and social agendas.

What makes sense: the environmental impact of mining vanadium ore to produce vanadium or the avoidance of landfilling hazardous wastes to produce vanadium through recycling and reuse? The answer is very obvious, especially when the cost of producing vanadium from recycling is economically competitive when compared to mining, assuming a level playing field of environmental regulations. The issue of sustainable development will continue to grow as its emphasis throughout the world continues to expand. Industry will have to deal with these issues and consider them when deciding where to buy vanadium in the future. Just as waste minimization issues drive business decisions today as a result of ISO 14000, sustainable development will have sweeping changes upon our mission statements in the future.

We have now made the case by showing significant excess supply of vanadium causing a chronic oversupply since 1998. I will suggest possible moves that could ease this supply side disruption of the market equilibrium.

The question becomes what can be done to cure the oversupply of vanadium? There are two obvious solutions, either reduce production or increase consumption. Adjustments to production will have a more immediate impact on the problem while an increase in demand will not happen overnight and should be viewed as a longer term solution.

The current fantasy on reducing production seems to be the hope that low prices that have plagued the industry will displace some production. Unfortunately, production remains unchanged, resulting in a severe oversupply of vanadium at very low prices. There has been no official indication that anyone has or is considering reducing production, although there are indications that some changes may be afoot in 2003.

In June of this year it was reported by International Mining Consultants, that Xstrata has made a provision for the possible closure of its Vantec facility in 2003, although it is expected that Rhovan will be expanded. It was also indicated that there is a possibility that Windimurra will be shut down and dismantled with some assets going to Rhovan for a strategic expansion and others going to various claimants.

Should early closure of Windimurra be considered there is a risk of damage claims. These may arise from the considerable investments made by suppliers and the Australian government. Allegations and findings related to major production and financial problems at Windimurra can be found in a detailed report delivered by the Western Australia Industrial Relations Commission on May 24, 2002.

If Windimurra is closed this may decrease the likelihood that Vantec is closed. It may be a safe assumption that even though the most cost effective ore to feed Vantec has been depleted, that developing a more distant, higher cost ore deposit would still be significantly more cost effective than continuing to operate the Windimurra plant.

It is interesting to note that in its 2002 interim report, Xstrata reports EBITDA (Earning before interest, taxes, depreciation and amortization) for its vanadium operations of $6.6 million dollars for the first six months of 2002. If we were to adjust this amount by the subsidy resulting to Xstrata for the off take agreement with Glencore this would show a negative EBITDA of $1.4 million instead. The off take agreement provides that Glencore purchase 3,200 tons of vanadium in 2002 at a price of $3.80 per pound V2O5. This would mean approximately 3.5 million pounds of V2O5 was purchased by Glencore in the first six months of 2002 at $3.80, or $2.50 above the current market level providing a subsidy of over $8 million to Xstrata.

It is also interesting that in addition to the apparent losses being generated at the Windimurra plant, there are also royalty payments being made to Precious Metals Australia. And on top of this, Xstrata also has period costs of debt, depreciation and amortization for all three of its plants that are not mentioned in the earlier figures. Xstrata also took a huge write off in 2001, an impairment charge of $45 million related to the Windimurra facility. It would be ironic if the company asserting low-cost producer status were actually consuming more of its shareholder wealth than any other vanadium producer in the world.

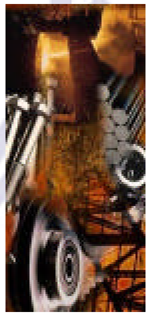
It is not likely that vanadium produced from slag production will decline. The cash cost of producing vanadium from slag is well below one dollar and this source of vanadium is not being fully exploited. This by-product source of vanadium is already out of the ground and has a much higher vanadium concentration than ore. It is not clear whether Highveld is using slags as their primary feed or if they are using ore fines which were the basis for the installation of the new calciner in 1998. Slags are a very economical source of vanadium that supports a sustainable development emphasis.

Reductions from petroleum based units are not likely. As more of these residual wastes are generated, the recycling and reuse of the metals contained in them should continue to grow. There is a significant rate of investment in the refining industry in areas that contain large amounts of vanadium in the crude oil and the focus on sustainable development should assure that the recovery of this vanadium will follow.

In addition to the possible reduction of capacity, the vanadium industry will benefit from an increase in the demand for vanadium.

What is the Solution ?

- Significant growth potential in China and Russia
- Increased production of HSLA steels
  - Benefits V, Cb, Ti
- HSLA products Add Value
  - Higher margins to steel maker
  - Lower cost / better product for steel user
  - Ecological benefits
    - Reduced energy consumption
    - Lower CO2 emissions
    - Sustainable development compatible



Although global crude steel production (which accounts for some 85% of vanadium use) has grown between 2 and 3% per year since 1998, vanadium consumption continues to increase disproportionately, as the vanadium content in steel production rises.

There are vast opportunities to advance the amount of vanadium consumed by the steel industry. For example, China produces roughly twice the amount of steel of the US and uses half the amount of vanadium, or at only 25% the usage rate. If China continues to increase its consumption of vanadium at the rate they have displayed in recent years it is not unrealistic to assume that they could double their consumption of vanadium in the near future which would increase the demand for vanadium by about 15 million pounds of vanadium oxide units. In addition to China, there are major Vanitec promotional efforts taking place in Russia, Europe and in the United States aimed at increasing the demand for vanadium.

According to Mike Korchynsky, Consultant to Strategic Minerals Corporation, the development of microalloyed steels covers the last four decades. During this period, microalloyed, high strength, low alloyed steels, also known as HSLA, became an indispensable class of structural steels. Recent technological developments in steel melting and hot rolling further reduce the cost and enhance the competitiveness of microalloyed steels.

Mr. Korchynsky also explains the ability to satisfy engineering needs with less steel creates economic values. Higher margins for value added steel products increases the profitability of steel producers. At the same time, the steel user manufactures a better, stronger but lighter, product at a lower cost which has a better chance of competing with alternative materials such as aluminum, plastics and composites. This is a "win-win" situation. In addition, a decrease in steel production reduces energy consumption and atmospheric contamination by CO2. As a result this trend will also help satisfy the steel industries need for sustainable development initiatives in the future.

Despite these improvements, the total consumption of microalloyed steel is currently estimated to be less than 20% of the worlds steel production. As a result there is a significant growth potential for microalloyed steels that will benefit the vanadium industry. If microalloyed steel as a percentage of worldwide steel production were to increase by only one percentage point this could mean additional consumption of nearly eight million pounds of vanadium pentoxide units per year. A major jump in the use of microalloyed steels has strong economic benefits for both steel producers and steel users and will benefit not only vanadium but also other microalloys such as Niobium and Titanium.

Savings with High Strength Steels

Higher Profits for Steelmakers
(Dollars per Ton of Steel)

	Carbon Steel	Microalloyed Steel
Selling Price	350	415
Microalloying Cost	-0	-15
Other Production Costs	-300	-300
Steel Maker Profit	50	100

Lower Costs For Users
(Dollars per Ton of Steel)

Carbon Steel (1 Ton x $350)	350
Microalloyed Steel (0.75 Ton x $415)	311
Cost Savings	39

- Because of 25% Weight Reduction, 0.75 Ton of Microalloyed Steel Replaces 1 ton of Carbon Steel
- Vanadium – Offers the lowest cost per unit of strength
- The producer enjoys twice as much profit and the user pays 12 percent less for the material
- Users enjoys additional benefits including: ease of fabrication, improved overall properties (i.e. toughness, ductility), and lower transportation cost.

In this example, the typical benefits that are available to the steel producers and users are shown. The additional selling price of $65 per ton is offset by only $15 per ton cost for the alloys. The result for the steelmaker is twice the profit which increases from $50 to $100 per ton.

For the steel user, the total cost decreases by $39 per ton despite the increase price per ton as a result of the 25% weight reduction. In addition to these economic benefits, users also enjoy better fabrication properties, improved characteristics such as toughness and ductility, and lower transportation cost because of the weight reduction.

Vanadium Batteries

- Vanadium Redox Battery
  - Expensive
  - Sensitive to V price fluctuations
  - Low O & M costs
  - Long term potential
- Lithium Polymer Battery
  - High Energy Density
  - High Power Density
  - Light Weight
  - Formable to any shape
  - Less sensitive to V price fluctuations
  - Dependent upon UL Listing

In addition to the expected growth of vanadium in the steel industry, chemical applications such as the vanadium battery show promising opportunities to the vanadium industry.

The Vanadium Redox Battery (VRB) technology provides load leveling capabilities and UPS systems for emergency backup where the power grid is unreliable. The potential vanadium consumption in this application has been stated to be up to 20 million pounds per year, with some estimates much larger.

The downside to this technology is that it is very expensive. The cost of this system is at least four times as expensive per kilowatt hour compared to competing technologies such as massive lead acid batteries and newer micro-generators based on fuel cells. This system is also price sensitive to vanadium prices as vanadium is estimated to account for one third of the total cost of the battery. If vanadium prices return to historic price levels this could impact the viability of the VRB. On the other hand, these cells have much lower operating and maintenance costs.

Significant progress has been made in the lithium polymer battery which offers improved energy and power density, meaning it is lighter weight and can deliver a higher volume of power. These batteries also last longer and have a lower maintenance cost than current batteries. These attributes are very important to many applications especially for vehicles. These batteries have many other advantages including the ability to form them to any shape and they have no memory. This system is less sensitive to vanadium prices as vanadium probably accounts for less than 10% of the cost of the system. The cost of these batteries is roughly twice the cost per kilowatt hour compared to lead acid batteries. Acquiring a UL Listing is important to successful commercialization of this battery. The Underwriters Laboratory tests electrical components and equipment for potential hazards. Due to the lithium content of the batteries this will be an important issue. The UL listing is currently pending on this technology.

A factory to produce these lithium polymer batteries has been constructed in Quebec and was commissioned in September of this year. The developers of this project claim that they have solved the issues associated with taking the production to a full scale plant. It is expected that this plant will consume 4 million pounds vanadium oxide in the near future and could be scaled up beyond this level.

Ample capacity exists to supply the battery industry with the vanadium units required. Although battery applications require high purity vanadium, it would be much more economical to convert existing low grade capacity than to install new capacity. It could be done faster and incrementally as market demand expands, rather than building new capacity for an unproven technology.

Conclusion and Outlook

- HSLA Steel and Battery applications will increase consumption of Vanadium
- Short term demand is not expected to increase
- Longer term demand could reach 165 to 180 million pounds V_2O_5 within 5 years
- Oversupply continues to dictate market
- Vanadium Slags and Petroleum Residues are more economical
- Foreseeable vanadium demand can be met economically by existing capacity, at least through 2010

There are promising opportunities for vanadium consumption in steel as the trend toward lighter and stronger steel continues. Batteries also present a significant potential for the industry if some of the technical and commercial hurdles can be overcome to bring these technologies to the market.

In the near term, the present recessionary trend worldwide continues to linger and the likelihood of an imminent recovery is fragile. The current consumption rate of 155 million pounds vanadium pentoxide is not likely to change rapidly and could potentially fall. Longer term it is not unreasonable to forecast consumption of between 165 and 180 million pounds annually in the next five years depending upon the economic cycle and the advancements in HSLA steels and in the commercialization of the VRB and Lithium Polymer batteries.

Worldwide oversupply will continue to dictate the market until a reduction of supply is implemented. This will likely be in the form of reduction in vanadium produced from primary ore. As I have discussed earlier, these units have the highest cash cost when compared to slags and petroleum residues that are already out of the ground and have a vanadium content significantly higher, 20 to 100 times, than the vanadium content of ore. These non-primary units will continue to be produced irrespective of demand or price.

Capacity exists to supply the projected growth in the steel and battery industries with the vanadium units required at least through 2010. Under all rational forecasts there are no scenarios where current production capacity cannot meet demand both in terms of quantity and quality. The current capacity to produce vanadium from slags, ashes, residues, and primary ore is almost twice the current world consumption.

Perhaps once the heat moves away from the dumping issue, minds can move on and turn to other issues undermining the world vanadium industry. The industry might concentrate on the root cause of the problem – the disruption to normal patterns of world trade caused by an excess of global vanadium capacity.