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## Veni, Vidi, Vanadium - The Key to Steel

by: Hard Assets Investor

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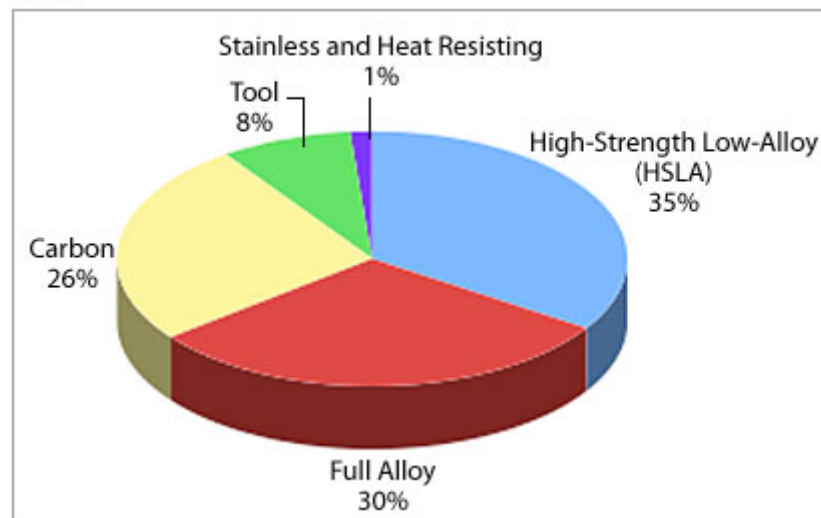
By Tom Vulcan

Back in March 2006, Asahi Soft Drinks, together with Asahi Breweries, Tokyo Medical University and Nihon Pharmaceutical University, announced the results of research they had recently undertaken regarding vanadium and diabetes. Using the results of experiments on mice, the four concluded that "[water that naturally \[sic\] contains vanadium is beneficial to the prevention and control of metabolic syndromes, including diabetes.](#)" Subsequently, Asahi Soft Drinks started to sell Vanadium Tennen Mizu, i.e., natural mineral water with added vanadium. You can still buy it in supermarkets in Tokyo.

Soft drinks aside, vanadium's dominant use, both in the U.S. and globally, is as an alloy for iron and steel - [some 92% of vanadium was used in steel in 2008](#), according to the USGS.

*U.S. Consumption of Vanadium as an Alloy in Steel (2008)*

**FIG. 1**



Source: USGS

In addition, vanadium is used in titanium-aluminum-vanadium alloys, nonsteel alloys, catalysts, pigments, frits and glass.

### Whence The Vanadium?

Vanadium is recovered in three basic ways.

In the first instance, vanadium is recovered directly from vanadiferous ores and, indirectly, from titaniferous magnetite ores, siltstone and uraniferous sandstone, in all of which it occurs naturally.

The main method of recovering vanadium globally, however, is from the vanadium-bearing slag associated with steelmaking using titaniferous magnetite ores, i.e., what's left over when the pig iron has been cast. Depending upon its source, this slag can contain anywhere from 10% to 25% vanadium pentoxide ( $V_2O_5$ ). Recovered by this route, the vanadium is converted either into ferro-vanadium or vanadates and vanadium oxides. Some 60% of the world's vanadium comes from the vanadium-bearing slag left over from casting pig iron.

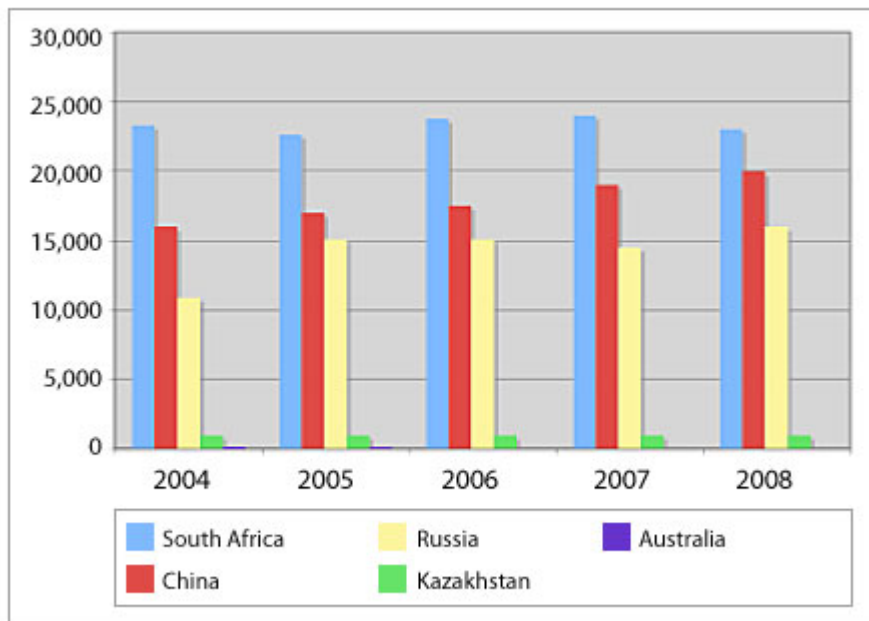
Finally, in addition to being recovered not only both from power plant ashes and spent catalysts, the metal is also recovered from such things as tar sands, oil shale, crude oil and bauxite.

### Geographic Location

South Africa, China and Russia remain the world's largest sources of vanadium. While vanadium has not been mined in the U.S. since the early '90s, there are a number of U.S. companies that produce ferro-vanadium, vanadium pentoxide and other vanadium compounds, with the vanadium for these being sourced, predominantly, from reprocessed spent catalysts, petroleum residues and the fly ash from oil-burning power stations. On occasion, over the last nine years or so, some quantities of vanadiferous slag have been imported into the U.S. and used as feedstock, but slag is certainly not the primary source of vanadium in the U.S. as it is elsewhere globally.

*Estimated World Production: 2004-2008 (Tonnes of Contained Vanadium)*

**FIG. 2**



Source: USGS

Notes: 1) Production from ores, concentrates and slag; 2) China: Estimated 40% of vanadium recovered from vanadiferous slag

### Uses: Steel, Etc.

Rather than being *just* a good general alloying element, vanadium is, for the most part, used in high-strength and specialty steels that require both specific characteristics and properties.

Why vanadium? Back in December 1996, P S Mitchell, then chairman of the [Vanadium International Technical Committee](#) [VANITEC], described some of the [important reasons](#) thus:

Among the reasons for using vanadium in steel are good castability, good rollability, reduced roll wear, relative insensitivity to finish rolling temperature in structural steels, good weldability of structural steels and the ability to use vanadium-containing medium carbon steels in the as-forged state.

Essentially, as an exceptionally versatile alloying element, using vanadium not only imparts to the steels strength, toughness and reliability, it also enables steel to be used effectively at extremes of both high and low temperature. In addition, where it is of vital importance, the strength-to-weight ratios of vanadium-containing steels can be of the highest order.

(As far back as the early 1900s, Henry Ford used the metal in his [Model T Roadster](#), proudly proclaiming in a 1909 sales brochure for the car: "Nobody disputes that Vanadium steel is the finest automobile steel obtainable ...We defy any man to break a Ford Vanadium steel shaft or spring or axle with any test less than 50% more rigid than would be required to put any other steel in the junk pile ...")

The use of vanadium in trucks and automobiles is now just one of its many uses in the transport industry. Others include its use in:

- The manufacturing process of synthetic rubber for hoses and seals
- Airframes and aeroengines
- Steel railway rails
- Railway wagons
- Sheet piling in, for example, docks
- Ships' steel plates
- Marine diesel engines

In the energy and engineering & building industries, vanadium is used, amongst other things, in:

<b>Energy</b>	<b>Engineering &amp; Building</b>
- Steam drums and superheater tubes	- Bridges and buildings
- Turbine castings, rotors, discs and blades-	- Cranes and drag lines
- Transmission towers and poles	- Rolls in steel mills
- Oil and gas pipelines	- Industrial compressor rotors
- Pipeline bends and valves	- Hot formed pressure vessels
- Offshore platforms' legs	- Tools and dies
- Oil storage tanks	- Cutlery

Source: VANITEC

### The Dominant Players

Production of vanadium is concentrated in the hands of just a few public companies.

In South Africa, where around half of the vanadium recovered comes from vanadium ore, there are three major vanadium producers: [Xstrata PLC](#) (**Bloomberg Ticker - XTA:LN**), [Highveld Steel and Vanadium Corporation Limited](#), [Strategic Metals Corporation](#) (Stratcor) (although this latter company's primary mine has remained closed since December 2008.)

In China, where practically all the vanadium comes from steel production, the two major vanadium producers are [Panzhuhua New Steel & Vanadium Co., Ltd](#) (Pangang) (**Bloomberg Ticker - 000629:CH**) - the largest in China, and third largest in the world -- and [Chengde Xinxin Vanadium and Titanium Stock Co., Ltd.](#) (**Bloomberg Ticker - 600357:CH**).

In Russia, the leading player in the market is Russia's leading steelmaker, the [Evraz Group](#) (**Bloomberg Ticker - EVR:LI**).

The above spread of five vanadium-producing concerns belies the fact that Evraz is very much the leading, if not dominant, player in the market. Evraz not only owns Highveld in South Africa, but it also owns [Strategic Metals Corporation](#) (Stratcor), one of the largest vanadium product companies in the U.S.

Following Evraz's acquisition of Highveld, the European Commission, in an attempt to prevent Evraz from monopolizing the vanadium market, ruled that the group was obliged to separate off, and sell, various of Highveld's vanadium-related assets, including Vanchem, Highveld's vanadium division. Late in 2008, after a number of delays, Evraz eventually sold Vanchem to Swiss-based Duferco Investment Partners Inc, a consortium including Japanese investors and the steelmaker Duferco.

That said, even if one puts aside rumors circulating in early 2008 to the effect that, whilst under pressure from the EC over South Africa, Evraz was consolidating its position in Russia even further through some form of involvement in the acquisition of [Tula Vanadium](#) by SGMK-Metal, the group's position in the vanadium market remains exceptionally strong.

According to [The TEX Report's](#) general review of vanadium in 2008, published in February this year, the "total output of vanadium by Evraz in 2008 has been assumed to have shared 27-28% of the world market." However, if joint ventures were included the figures would be "... approximately 35% of the world demand for vanadium."

Interestingly, Evraz Group is effectively controlled (through his holding in Millhouse LLC) by Roman Abramovich, the Russian billionaire currently residing in London and the proud owner of the Chelsea Football Club.

### The Prospects For Vanadium

With well over 90% of the world's vanadium going into steel, it is hardly surprising that its fortunes are tied closely to that of steel production in general. And right now, that means China.

Because whatever the prognosis may be for Japan and the Western economies, it seems likely that, despite current economic conditions, development in China is set to continue. And that development will continue to need steel (most probably increasing amounts of China's own steel), which in turn, needs vanadium.

It also seems likely that, in addition to consuming more of its own steel, China will also seek to export more of its domestically produced steel. In the past, of the major steel-producing nations, China has used the least vanadium in each ton of steel it has produced - U.S. usage has, historically, been the highest. If, therefore, China is going to go after a greater share of the steel export market, in order to ensure that the quality of its steel matches (and is competitive with) what is currently out there, it is going to have to increase the vanadium content of its export steels. According to a [recent presentation](#) by the industry expert Robert M. Bunting of Stratcor, there are already signs that this is happening.

With vanadium's importance in the production of high-strength and specialty steels, as use of these grows, so too does demand for the metal itself. Initiatives like the [Vanadium Technology Partnership](#), a "cooperative relationship between the vanadium microalloyed steel industry and the U.S. Army" that seeks to exploit, in weapons systems and infrastructure, amongst other things, the exceptional strength-to-weight ratios of vanadium-alloyed steels, attest to the importance of these steels - not least in the defense industry.

Outside the defense industry, some of the potentially important roles for vanadium "in the twenty first century" (as identified by VANITEC) include its use in:

- Vanadium steels for high-energy, high-speed autogenous welding
- Vanadium steels in electric generating plant of the future
- Large-scale energy storage systems
- Fusion reactors
- Ultra-light, ultra-strong complex alloys for aircraft
- Metal matrix composites for aeroengine components
- Vanadium high-carbon gray cast irons for disc brakes and drums

Of special interest currently are the "large-scale energy storage systems," in particular vanadium redox-flow batteries, not least because these last are environmentally friendly. Developed at the University of New South Wales back in the '80s, these batteries exploit vanadium's chemical properties to make very large electric batteries. Not only can these batteries store charge for very long periods (and, with little ensuing damage, be left discharged for very long periods), they are also easily scalable - just by increasing their size or number.

Over and above all these, as Peter Nicholson, trading director at [London Chemicals & Resources Ltd](#) in London, says of

the metal: "Being more difficult to isolate than many other industrial metals, vanadium has only been in large-scale commercial production relatively recently (20<sup>th</sup> century). Its properties and applications are still being researched and new applications continue to be discovered."

Currently, even though the prices both of ferro-vanadium and vanadium pentoxide may have rebounded markedly since the beginning of May (not least because of tight supply in the nearby months), the market in general is still oversupplied. With the downturn in steel consumption, there has certainly been a buildup in vanadium product inventory, but there may, also, have been a buildup of stocks of unprocessed vanadium-bearing slag from steelmaking operations, particularly in China.

### Investment Opportunities

Are there any possibilities in vanadium? The major publicly traded producers are possibilities, but, as so often with the minor metals, vanadium is just one small fraction of their overall businesses.

Indeed, pure plays in the metal are hard to find.

The Windimurra vanadium mine northeast of Perth in Western Australia was actively operated by Xstrata until, in early-2003, the company placed it on a care-and-maintenance basis and, subsequently, sold it to [Windimurra Vanadium Limited](#).

Whilst a pure vanadium play, unfortunately, the company fell into receivership (with administrators and managers having been appointed) in February this year, before any of its plans to get the mine back up and running came to fruition. There may, however, be hope for the mine yet, as, in early May, [Reed Resources](#) was said to be [considering a bid](#) for the collapsed company.

Any such hope should, however, be weighed against the words of Marc Gonsalves, executive general manager of Corporate Affairs at Xstrata, in his opening statement at a public hearing held by the Economics and Industry Standing Committee of the Legislative Assembly of Western Australia on August 24, 2004, when he said: "[It has cost our shareholders over AUD186 million to find out 'with the benefit of hindsight' that Windimurra is not profitable going forward.](#)" If Xstrata, with its size and experience, couldn't make it work then, one must consider carefully the ability of anybody else to make it work now, especially in these economic conditions.

In Canada, [McKenzie Bay International Ltd](#) was, for a time, enthusiastic about developing its Lac Dore vanadium deposit, rumored, after Highveld in South Africa, to be the world's second-largest vanadium deposit. In the end, the company's wholly owned subsidiary, Lac Dore Mining, Inc., announced the sale of its mining claim to the uninspiringly named 6945295 Canada Inc on September 9 last year.

Unfortunately, too, even in the exciting (and expanding) sector for recycling spent catalysts to recover V<sub>2</sub>O<sub>5</sub> (many millions of pounds of such catalysts are now coming into the U.S. from Canadian tar sand operations), there are no pure vanadium plays. All the major operators are subsidiaries of larger concerns. [Bear Metallurgical](#) is owned by [Gulf Chemical & Metallurgical Corporation](#), which is, itself, owned by the French [Eramet Group](#) (**Bloomberg Ticker - ERA:FP**). [Metallurg Vanadium](#), in its turn, is owned by [AMG Metallurgical Group NV](#) (**Bloomberg Ticker - AMG:NA**). And, Stratcor is, of course, owned by Evraz.

Since vanadium is also often recovered as a co-product by primary uranium producers, a watching brief should also, perhaps, be kept on the likes of the Canadian companies [Denison Mines Corp.](#) (**Bloomberg Ticker - DML:CN**) (owner/operator of the White Mesa facility (the only working uranium mill in the U.S.) near Blanding in Utah) and [Energy Fuels Inc.](#) (**Bloomberg Ticker - EFR:CN**).

While, in addition to uranium, Denison Mines produced some 1.2 million pounds of vanadium pentoxide in 2008, Energy Fuels, having decided to build its own uranium/vanadium mill, is currently in the early stages of trying to license its [Pinon Ridge Mill](#) in southwestern Colorado, not least in an effort to take advantage of the shortage of milling capacity in the area. If, and when, completed, the mill will, in the words of the company, be "the first facility of its kind to be built in the U.S. in over 25 years."

Finally, Canada-based [Rocky Mountain Resources Corp](#) (**Bloomberg Ticker - RKY:CN**), is looking both to exploit the vanadium it has on its Gibellini property located in Eureka County, Nevada, and the vanadium and phosphate it has found on its Paris Hills property located in Bear Lake County, Idaho. If successful, Rocky Mountain will be pretty close

to a pure vanadium play.

In conclusion, some exposure to vanadium can be gained indirectly through either the major quoted producers or, even, catalyst recyclers. There are, currently, no pure vanadium plays in either activity. And, even if there were, in current market conditions, the fates of Windimurra and CS Metals (a major player in the catalyst recycling market in the U.S. that closed up business in December 2004 following estimated losses well north of \$150 million) should give potential investors in stand-alone operations considerable pause for thought.

That said, the long-term future of the metal might not be so bleak.