Vanadium … Not So “Minor” for Titanium
Vanadium

- Gray, Ductile Metal when Pure
- Naturally Occurring as Oxide
- 22nd Most Abundant Metal on the Earth
- Category: Transition Metal
Vanadium

- Sources
- Production
- Consumption
- Processes
- The Future
Vanadium Sources

2010 Capacity

Primary (Ore) – 23%

Secondary – 77%
Vanadium Sources

2010 Capacity

Primary (Ore) – 23%

Steelmaking Slag – 45%
Vanadium Sources

2010 Capacity

Oil & Coal Residues – 15%

Ore – 23%
Vanadium Sources

2010 Capacity

Spent Catalysts – 13%

Ore – 23%
Vanadium Sources

2010 Capacity

Uranium By-Product – 4%

Ore – 23%
Vanadium Capacity Utilization

Capacity Utilization

Millions of Lbs. of $V_2O_5$

2010

Capacity (342 mm)

Production 284 mm

Steel Slag: 87%
Vanadium Ore: 83%
Oil & Coal Residues: 83%
Spent Catalysts: 85%
Uranium By-Products: 19%
Vanadium Production
2010 by Country

China – 52%
Vanadium Production
2010 by Country

China – 52%

South Africa – 24%
Vanadium Production
2010 by Country

- China – 52%
- South Africa – 24%
- Russia – 10%
- U.S.A. – 9%
- Others – 5%
- U.S.A. – 9%
- Russia – 10%
- South Africa – 24%
Vanadium Consumption
2010 by Country

China – 44%
Russia, Others – 16%
Other Asia – 15%
North America – 14%
Western Europe – 11%
Vanadium Production vs. Consumption

Global 12-Month Moving Average
Annual Rates Through August 2011

Millions of Lbs. of V$_2$O$_5$

Vanadium Production
Vanadium Consumption

Source: Evraz Stratcor, Inc.
Vanadium Consumers

2010 by Industry

- Steelmaking: 93%
  - Improves Strength
  - Improves Wear Resistance
Vanadium Consumers

2010 by Industry

- **Steelmaking:** 93%

- **Ferrovanadium**
Worldwide Steel Production vs. Worldwide Vanadium Consumption

Global 12-Month Moving Average
Annual Rates Through August 2011

Steel Production
Vanadium Consumption

Source: Evraz Stratcor, Inc.
Vanadium Consumers

2010 by Industry

Chemical: 4%

Catalysts, Rubber, Batteries, Pollution Control
Vanadium Consumers

2010 by Industry

Chemical: 4%

Vanadium Chemicals
Vanadium Consumers

2010 by Industry

- Titanium: 3%
  - Increases Strength in Aerospace Applications
Vanadium Consumers

2010 by Industry

- Titanium: 3%
- Vanadium-Aluminum
Worldwide Steel vs. Titanium Production

Steel production has generally increased from 2001 to 2009, reaching over 1,500 million metric tons per year in 2009.

Titanium production has remained relatively stable during the same period, ranging from about 50 to 100 million metric tons per year.

Source: Evraz Stratcor, Inc.
Worldwide Steel vs. Titanium Production

Steel
Titanium

Source: Evraz Stratcor, Inc.
Vanadium in Titanium

- >99% Pure Vanadium Oxide
- Strict Quality Standards
- No W, Mo, Cb
- Audited for Quality
Limitations of Titanium Market

- Half Dozen Qualified Producers Globally

Producer Limitations:

- Capacity
- Feedstocks
Limitations of Titanium Market

- Tightly Controlled Process
- Stringent Quality Standards
- Dedicated Production Required
- Frequent, Vigorous Audits
Vanadium-Aluminum Production

- **High-Purity Vanadium Oxide**
- **High-Purity Aluminum**
- **Aluminothermic Furnace**
- **Chemical Analysis**
  - Of all critical elements, only ingots meeting specifications are further processed.
- **Crushing and Sizing**
  - To Customer specifications.
- **Vanadium-Aluminum Ingots**
  - Shot-blasted, hand-inspected, and broken for crushing.
- **Three 100% inspections to verify product purity and cleanliness**
- **White-Light Inspection**
- **Black-Light Inspection**
- **X-Ray Inspection**
- **Sampling and Packaging**

*EVRAZ*
Vanadium

The Future?
Vanadium Outlook

- Highly Dependent on Steel Industry

- Steel Demand Driven by China

- New Construction Code Mandates High-Vanadium Grade 3 and 4 Rebar
Vanadium Outlook

- Growing Use in Titanium Applications
- Long Term: Balanced Supply / Demand
Projected Growth in Vanadium Demand

Thousands of Metric Tons of Vanadium per Year

Source: TTP Squared
Batteries – Future Wild Card

Two Promising Technologies:

- Vanadium Flow Redox Battery (VRB) -- For Power Grid Load Leveling
- Lithium Vanadium Phosphate Battery -- For Automotive Applications

Could Require as Much as 15% of Total Vanadium Demand by 2015
Vanadium Consumption in Batteries

Source: Byron Capital Markets
New Vanadium Projects

Panzizhua, China

- Source: Steelmaking Slag
- Capacity: 10,000 Tons V per Year
- Due: Late 2011 / Early 2012
- All for Ferrovanadium
New Vanadium Projects

- **Windimurra, Australia**
  - Source: Vanadium Ore
  - Capacity: 6,300 Tons V per Year
  - Due: Late 2011 / Early 2012
  - Mainly for Ferrovanadium
  - Some for Titanium
New Vanadium Projects

Marcas Project, Brazil

- Source: Vanadium Ore
- Capacity: 3,000 Tons V per Year
- Due: 2013
- Mainly for Ferrovanadium
New Vanadium Projects

- Evraz Stratcor, United States
  - Source: Steelmaking Slag
  - Expansion: 3,000 Tons V per Year
  - Due: Early 2013
  - Mainly for Titanium, Chemicals
  - Further Expansion in 2014
Plentiful Vanadium Availability but Most Will Be Used in Ferrovanadium

Additional Vanadium for Titanium Limited Due to Purity and Quality Requirements

Only Small Amount of Vanadium from New Projects Will Be Suitable for Titanium
Summary

- Vanadium Supply / Consumption Should Be Balanced; Possible Price Volatility

- Wild Card: Vanadium Storage Batteries Could Significantly Impact Market
Thank you!