

# Molybdenum and Stainless Steel - about Mines and Markets

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Prospects for the development of the Russian  
stainless steel market

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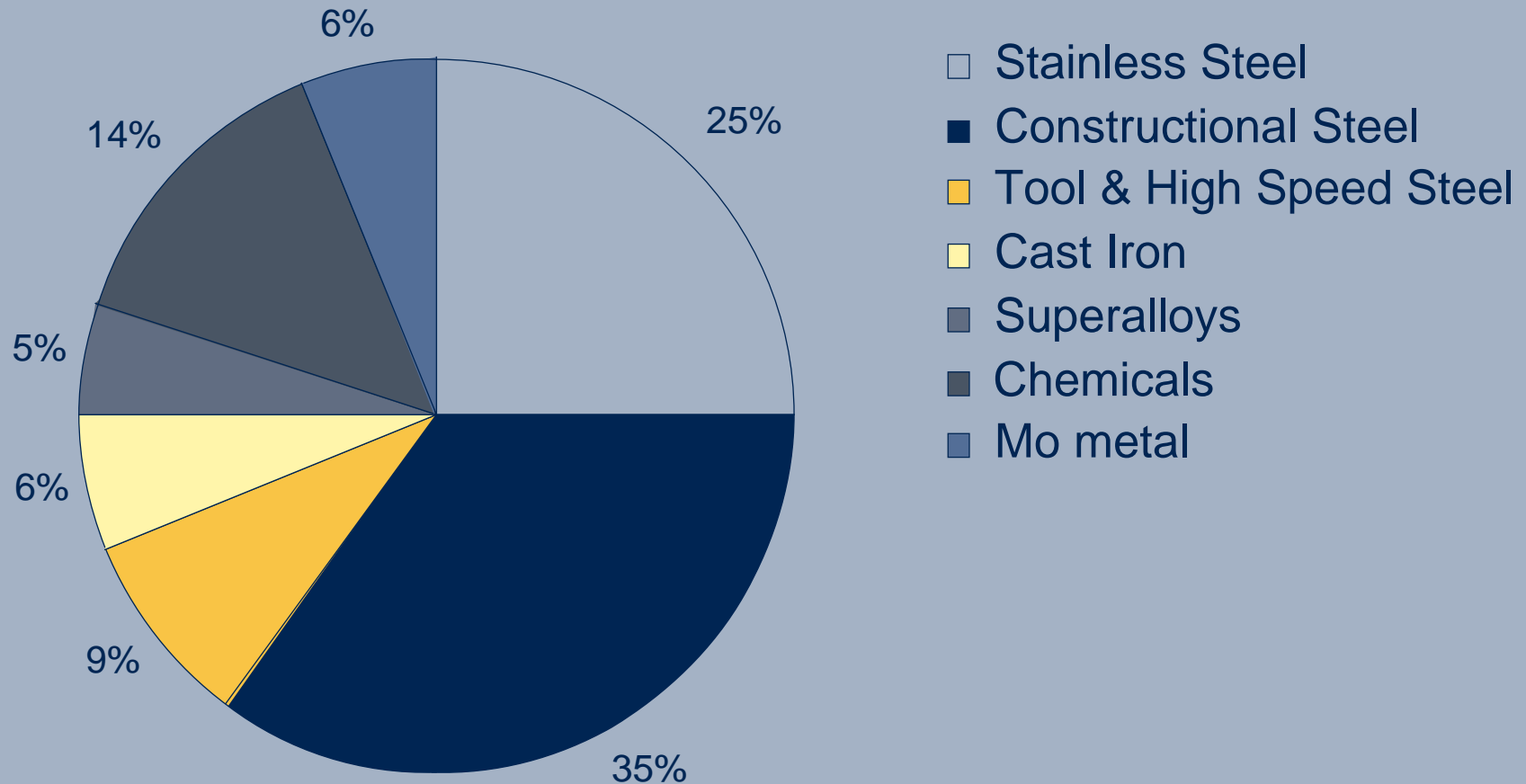
# Molybdenum

- Properties and uses
- Sources
- Market observations

# Molybdenum

- Properties and uses

# First Use of Molybdenum



Total 2006: approx. 425 million lb – 190,000 t

Source: IMO A Estimates

# Molybdenum Metal & Alloys

## Properties

High melting point – 2610°C

- High hot strength
- High wear resistance
- Good corrosion resistance



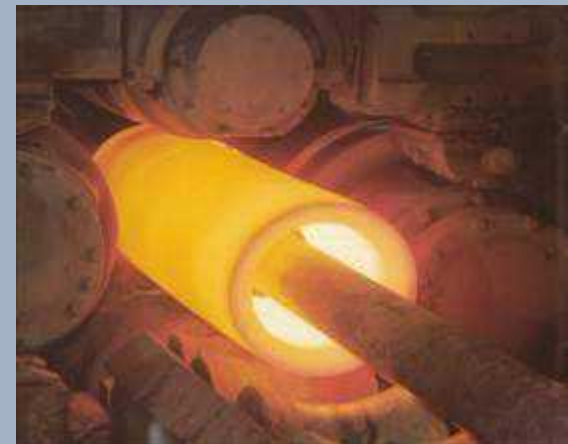
Courtesy of Plansee

High temperature vacuum furnace

# Molybdenum Metal & Alloys

## Uses

- Glass melting electrodes
- High temperature furnaces
- Halogen lamps – sealing and supporting wire
- Electronic industry – high power semi conductor parts
- Mo spray wire and sputtering targets for coating applications
- Metal and plastic forming



TZM piercing plug for rolling stainless steel tubes

Courtesy of Plansee

# Molybdenum in Alloy Steels

Molybdenum is almost always used in combination with other metals including

- Chromium
- Nickel
- Vanadium
- Tungsten
- Niobium

moly grade steels are usually required for high end applications

# Effects of Molybdenum

In tool steels (average Mo 0.8%)  
and in high speed steels  
(average Mo content 5%):

- moly enhances hardenability
- contributes to secondary hardening
- is an important constituent of the primary  $M_6C$ -carbide (hardness > 2000 HV), which confers wear resistance



g33.eps FRÄSER AUS BÖHLER S 500/S 705 – MILL-CUTTER

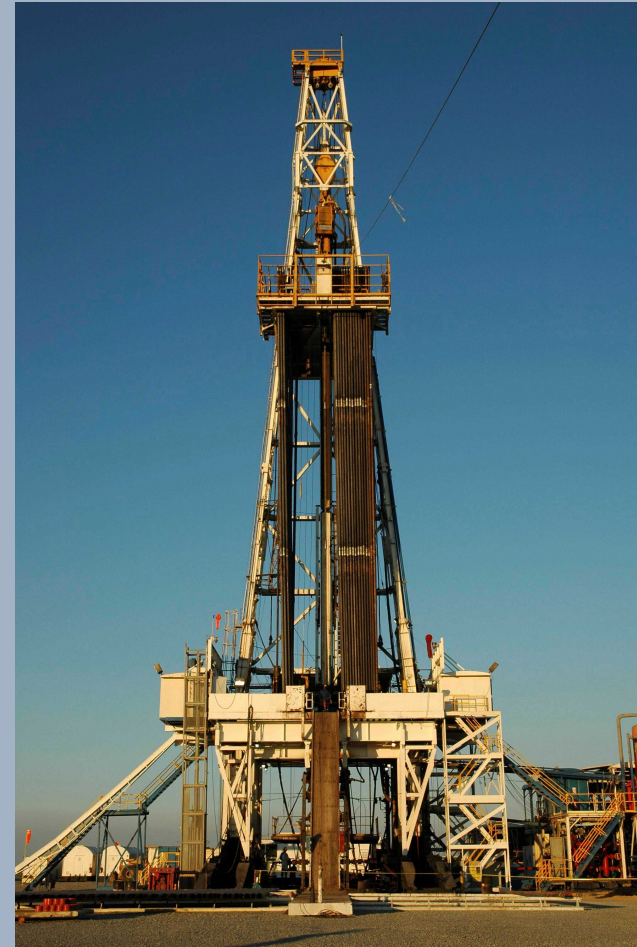
Courtesy of Boehler Uddeholm



# Effects of Molybdenum

in constructional steels &  
high strength low alloy steels-HSLA  
(Mo content 0.1- 1.2%)  
moly enhances

- hardenability
- strength and toughness
- weldability
- elevated temperature strength
- resistance to sulfide stress cracking



Oil rig with drill pipe

Orbis photo

# Uses of moly grade constructional steels/HSLA

Applications cover the whole energy chain from raw material production through end use:

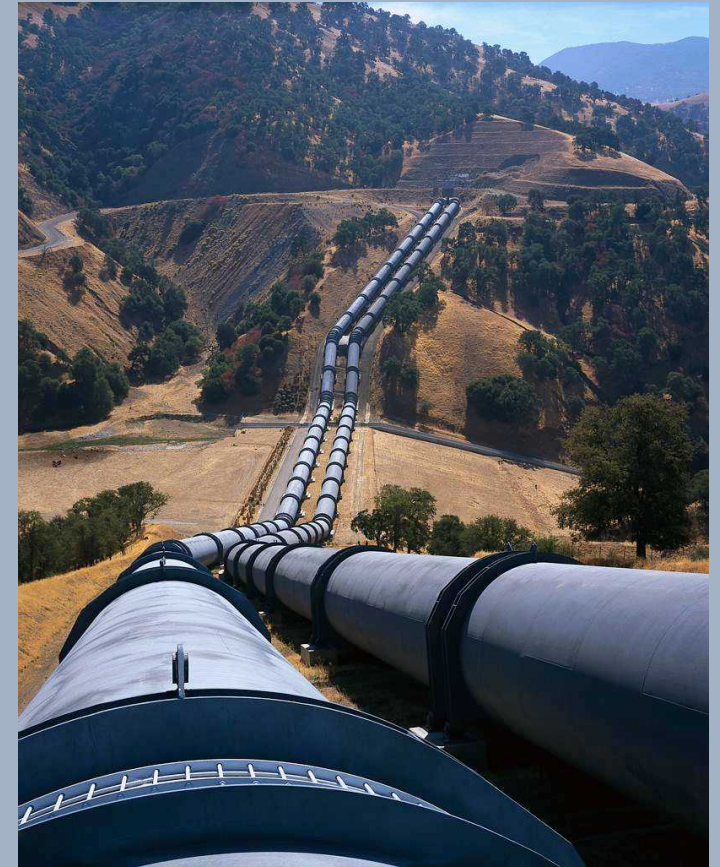
- Quenched & tempered (Q&t) CrMo seamless oil country tubular goods.
- HSLA pipelines for Oil and Gas
- High temperature CrMo and CrMoV grades for petrochemical processing and energy generation.
- Q & t CrMo engineering steels in automotive, shipbuilding, aerospace



# Uses of moly grade constructional steels



Energy generation



Oil & Gas transportation



# Uses of moly grade constructional steels



Gears made of CrMo carburising steel...



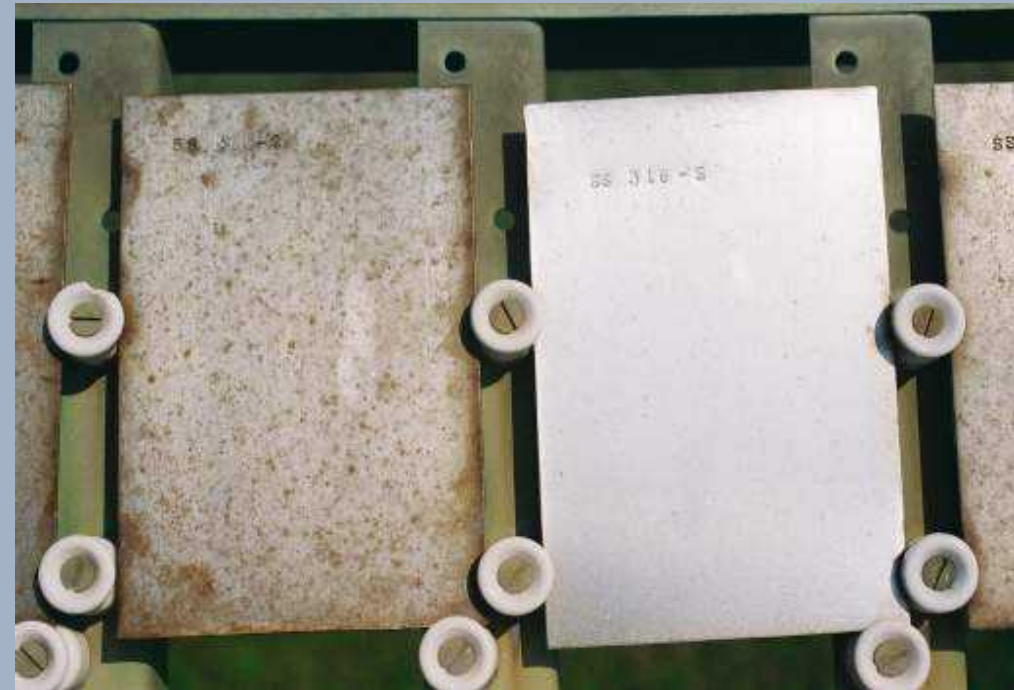
for everything that moves

Courtesy of Plansee

# Effects of Molybdenum

in stainless steels  
(average Mo content approx.  
2.2%)

- moly improves corrosion resistance



# Use of moly grade stainless steels

- About 10 % of world stainless steel production is molybdenum grade with average 2.2% Mo
- Moly grade stainless steels are invaluable in
- industrial processing such as
  - chemical, petrochemical,
  - pulp and paper
  - oil and gas,
  - power generation



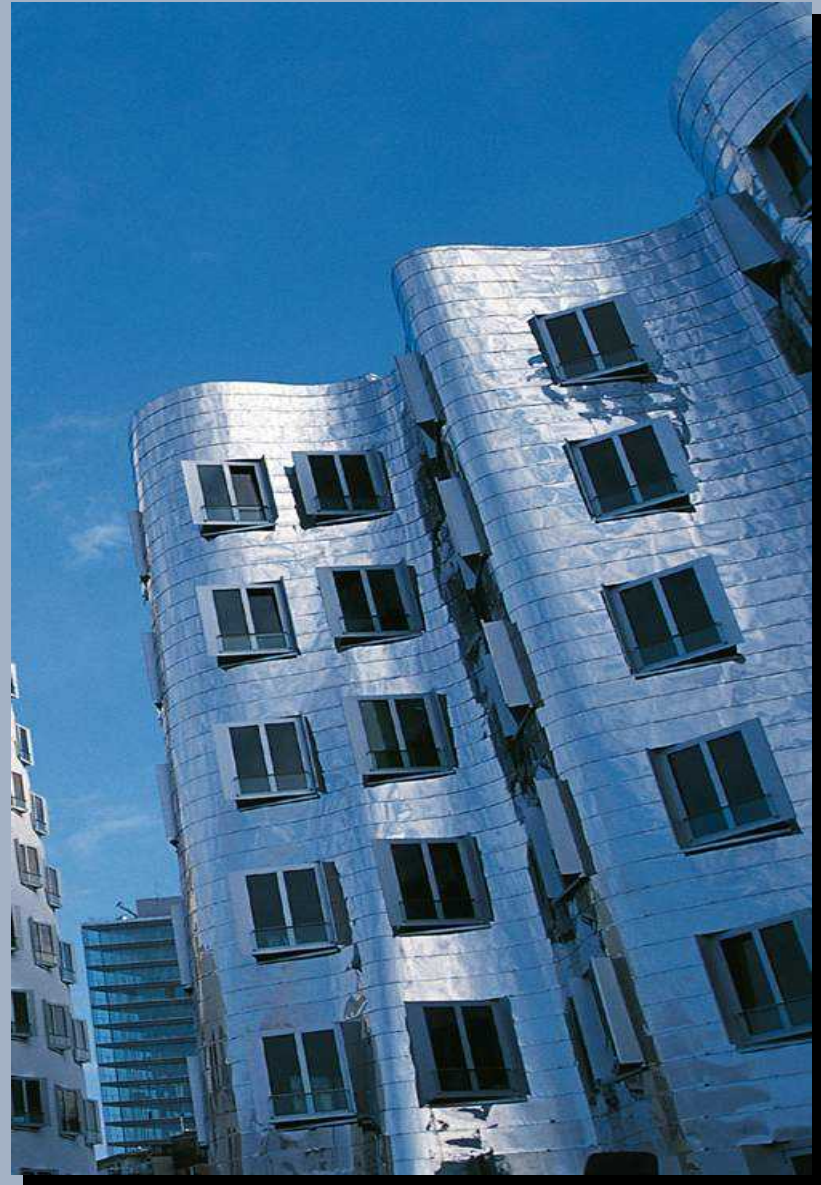
Corbis photo

Petrochemical Processing



# Use of moly grade stainless steels

Stainless steel has become the material of choice for many architectural uses around the world



# Use of stainless steel - grade selection is critical.

Nobody likes stainless steel which is rusting.

Moly-grade stainless steels are resistant to de-icing salt or coastal air attack.





# Use of moly grade stainless steel

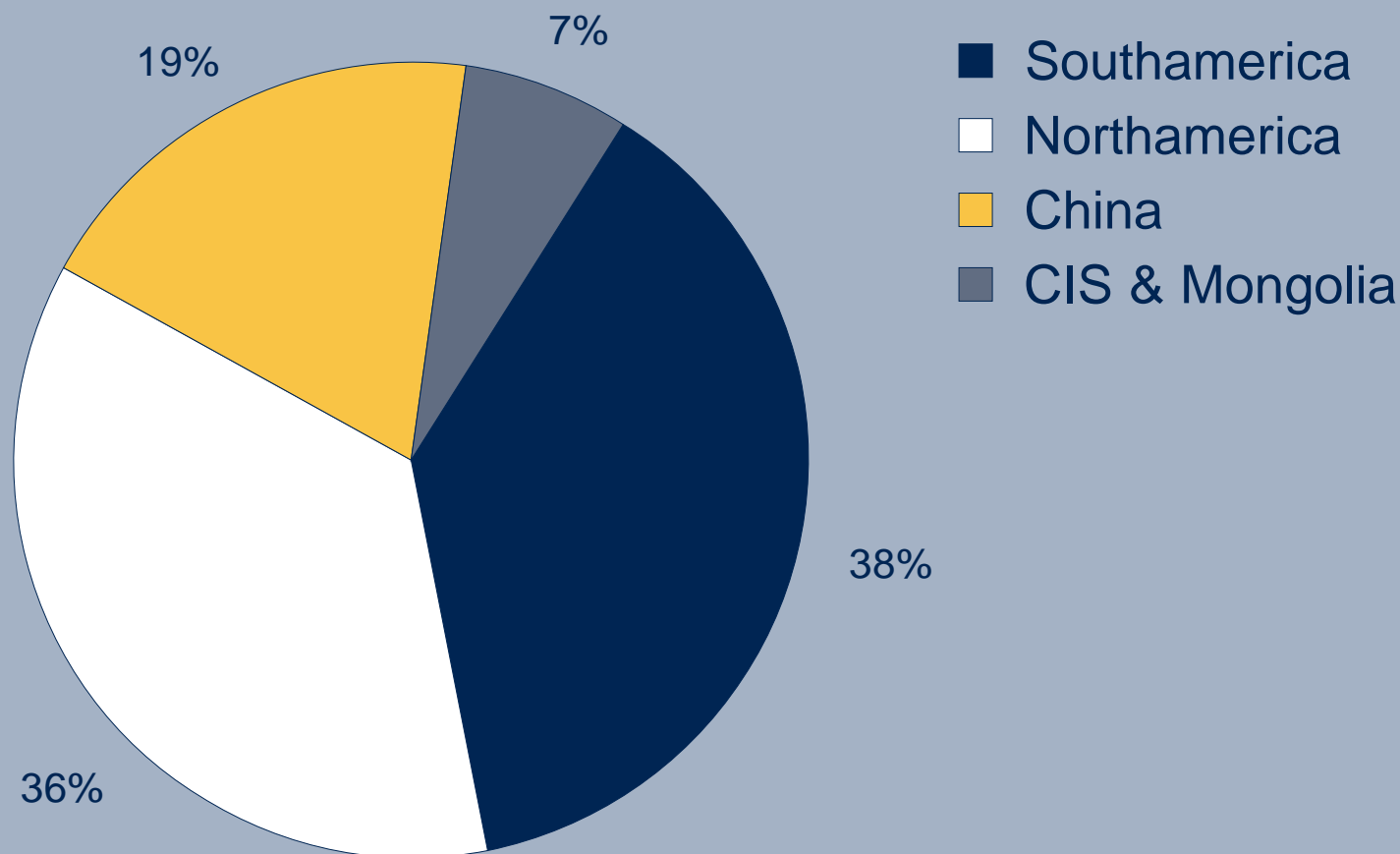
AISI 316 stainless steel with 2,2 % Mo has replaced aluminum at Brussels Atomium.



# Molybdenum

- Sources

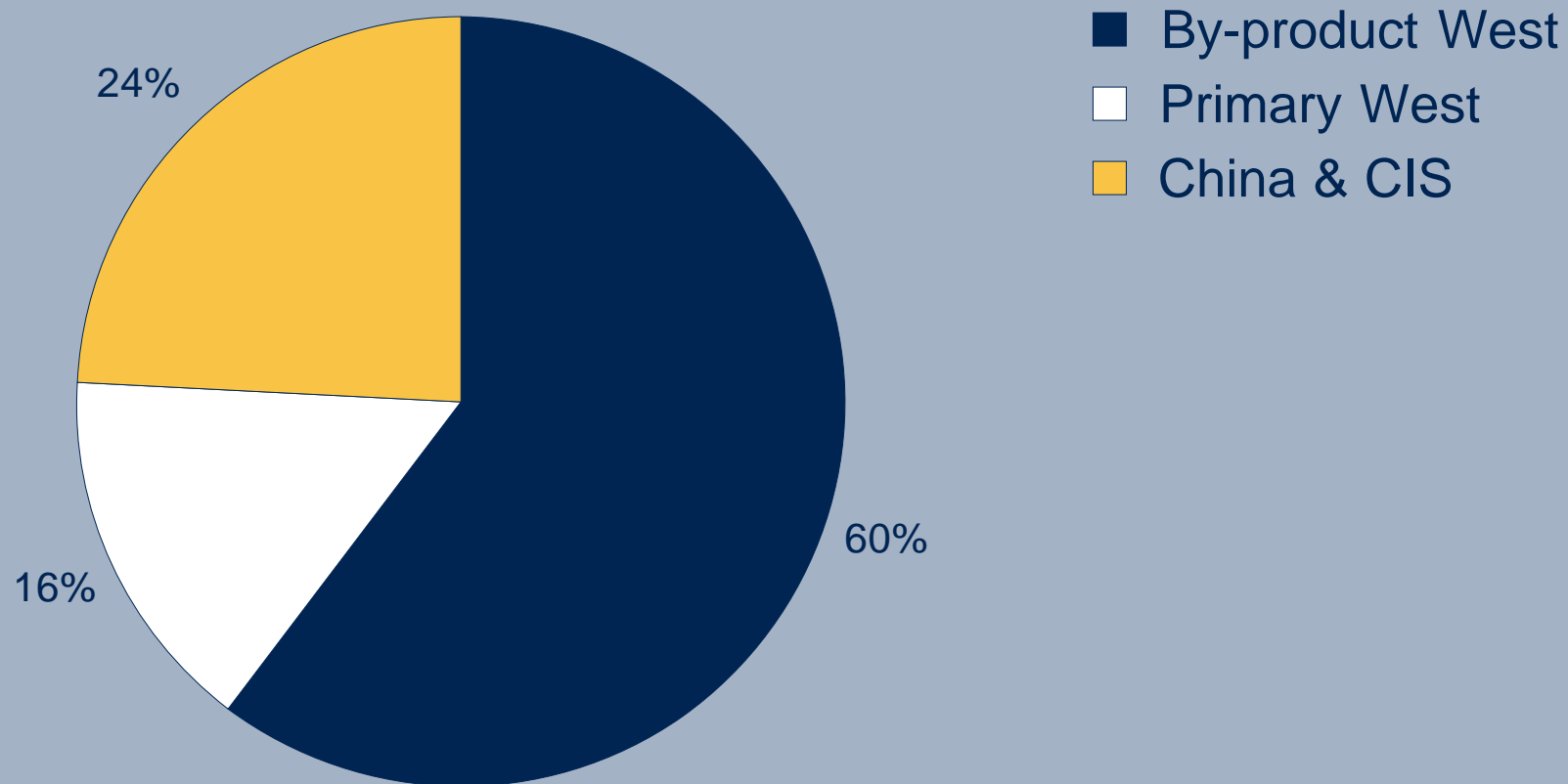
# Global Production - Geographically



Total 2006: 425 million lb – 192,000 t

Source: IMOA; Adams Metals

# Global Production – Mine Types



Total 2006: 425 million lb – 190,000 t

Source: IMOA ; Adams Metals

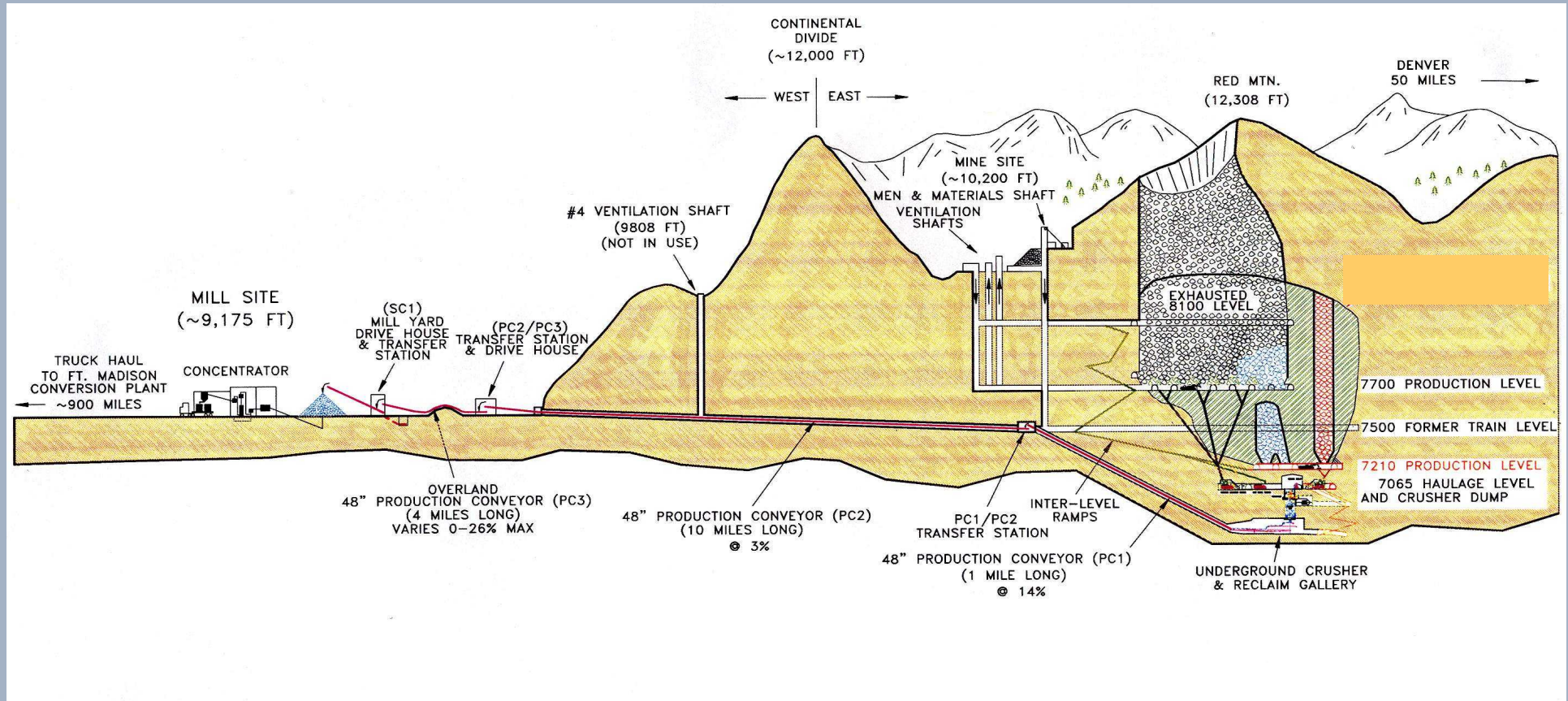
# Molybdenum from Primary Mining

## Calculation example:

- Ore grade 0.2% Mo yielding 1.8 kg/t Mo in concentrate
  - Producing 1 t of Mo ctd requires 550 t of ore
- Annual production of 10,000 t Mo contd. in MoS<sub>2</sub> concentrate requires mining and milling  
5.5 million t of ore (approx. 20,000 t per day)

The initial investment for a primary mine usually requires several hundred million US Dollars.

# Molybdenum from Primary Mining



Courtesy of Climax Molybdenum

Henderson operational schematic



# Molybdenum By-product from Copper Mining



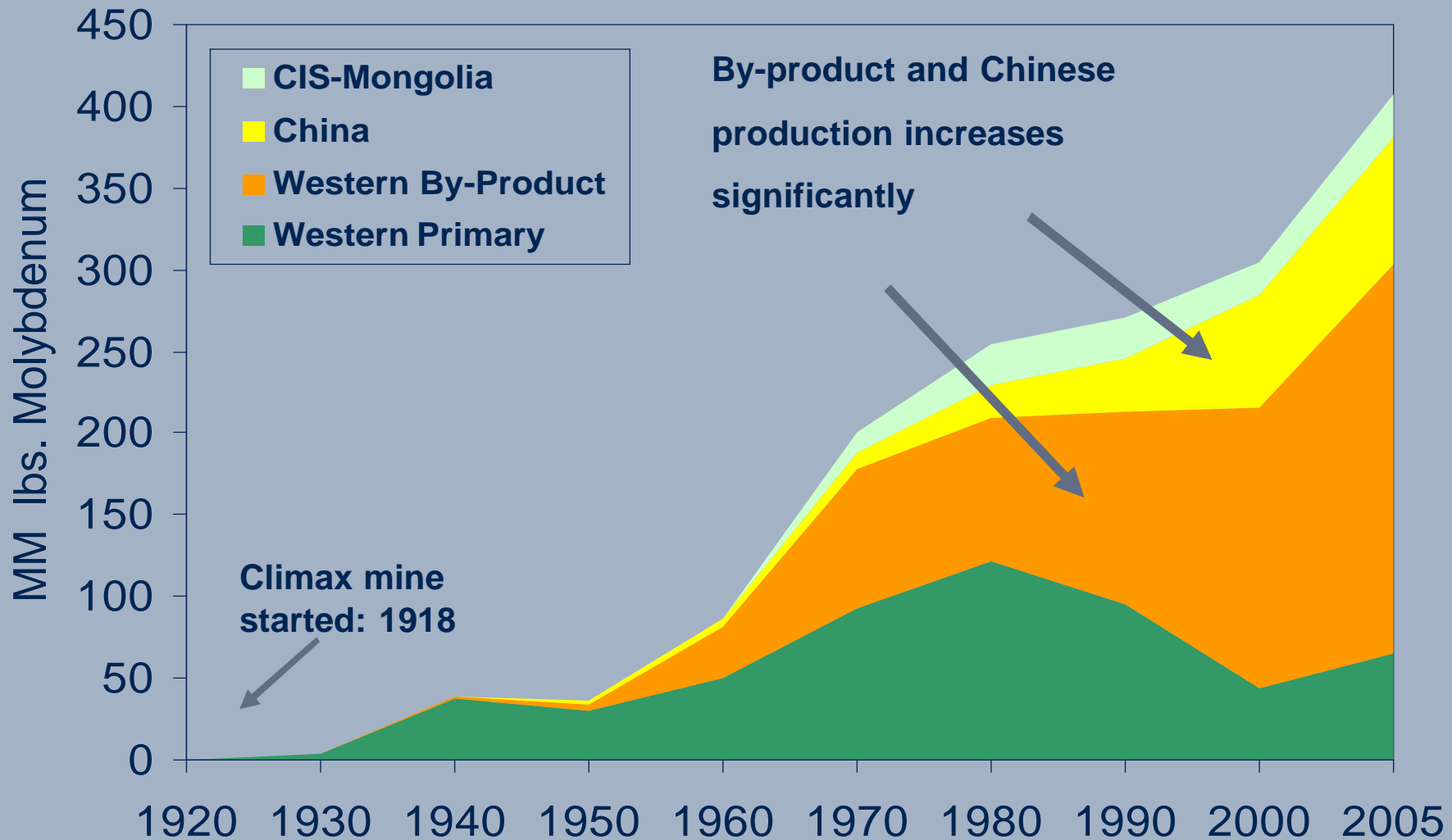
Courtesy of Kennecott Utah Mine Corp.

# Molybdenum By-product from Copper Mining

- Copper mines producing molybdenum as byproduct usually have ore grades falling between 0.5% and 1.5% Cu (5 to 15 kg/t) and between 0.01% and 0,05% Mo (0.1 to 0.5 kg/t).
- Major operations mine more than 50 million tons of ore per year, producing in excess of 200,000 t of copper and between 5,000 and 15,000 t Mo contained in MoS<sub>2</sub> concentrate as by-product.
- The revenues from molybdenum are usually less than 10% of total sales.
- Consequently the moly output of these mines follows the copper market rather than the demand for molybdenum.



# Molybdenum supply structure

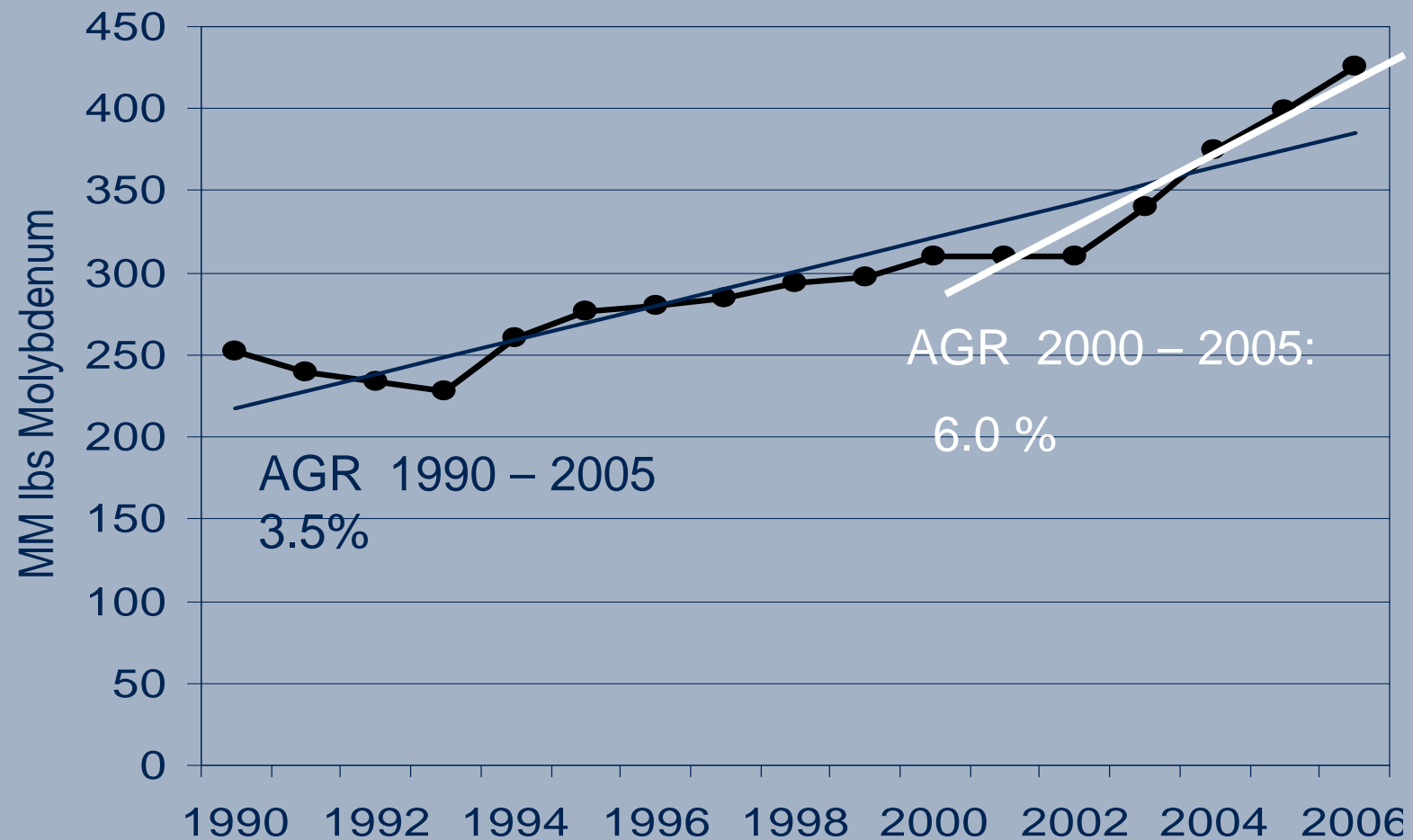


Source: Climax Molybdenum, presented at Ryans's Notes Conference 2005

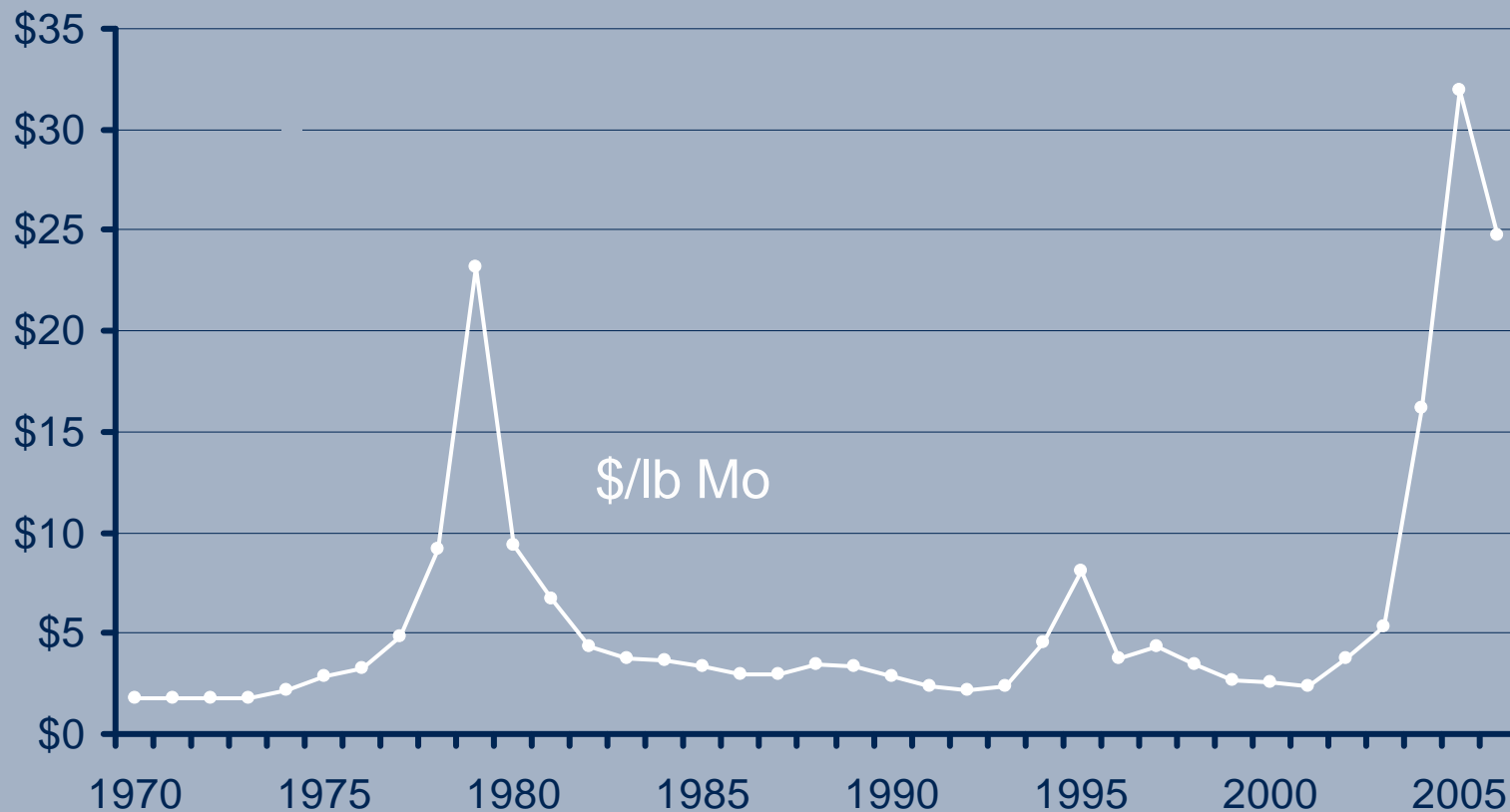
# Molybdenum

- Market Observations

# Global Molybdenum Use

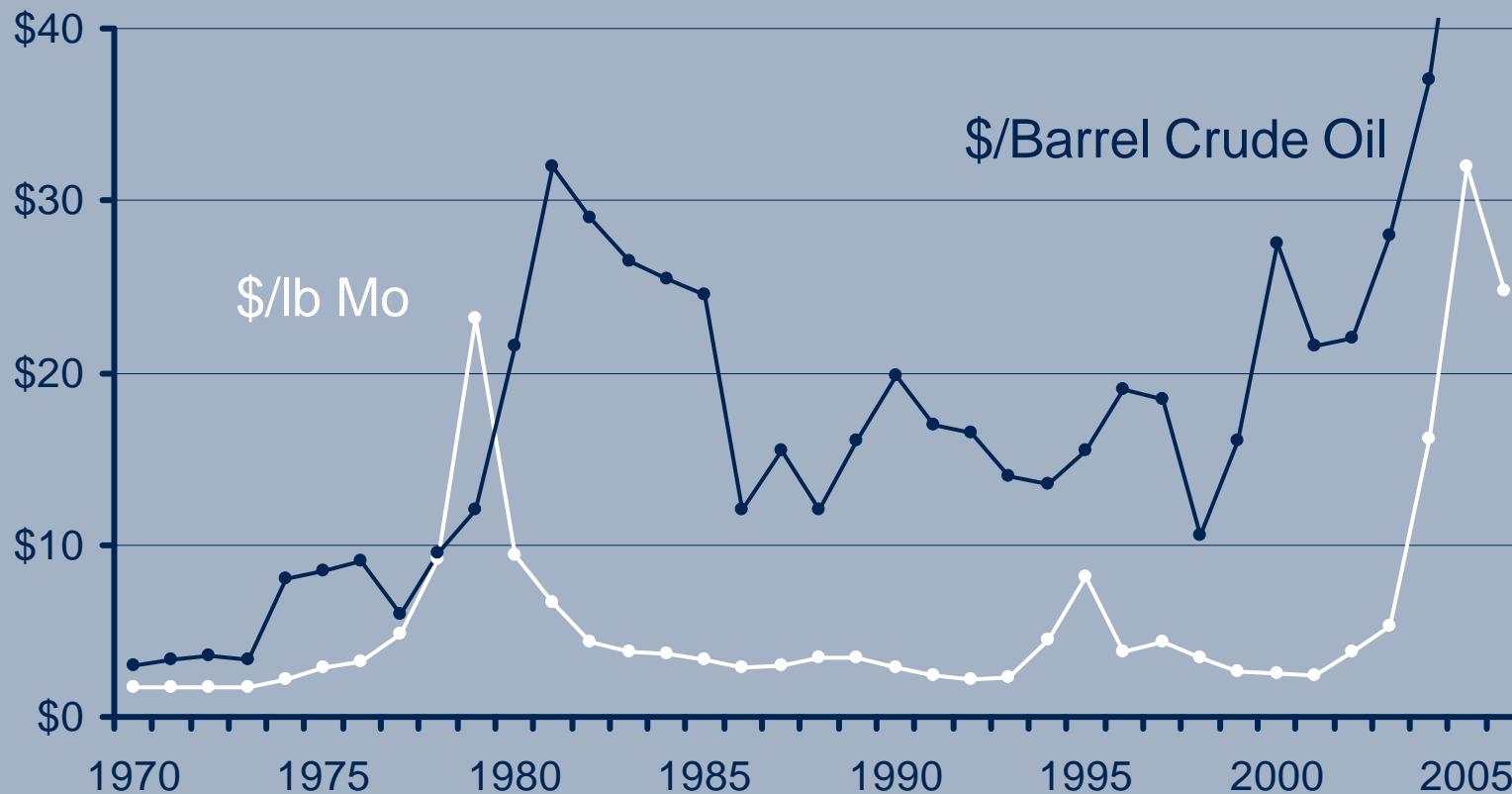


# Molybdenum Price Driven by Energy- and by China Demand

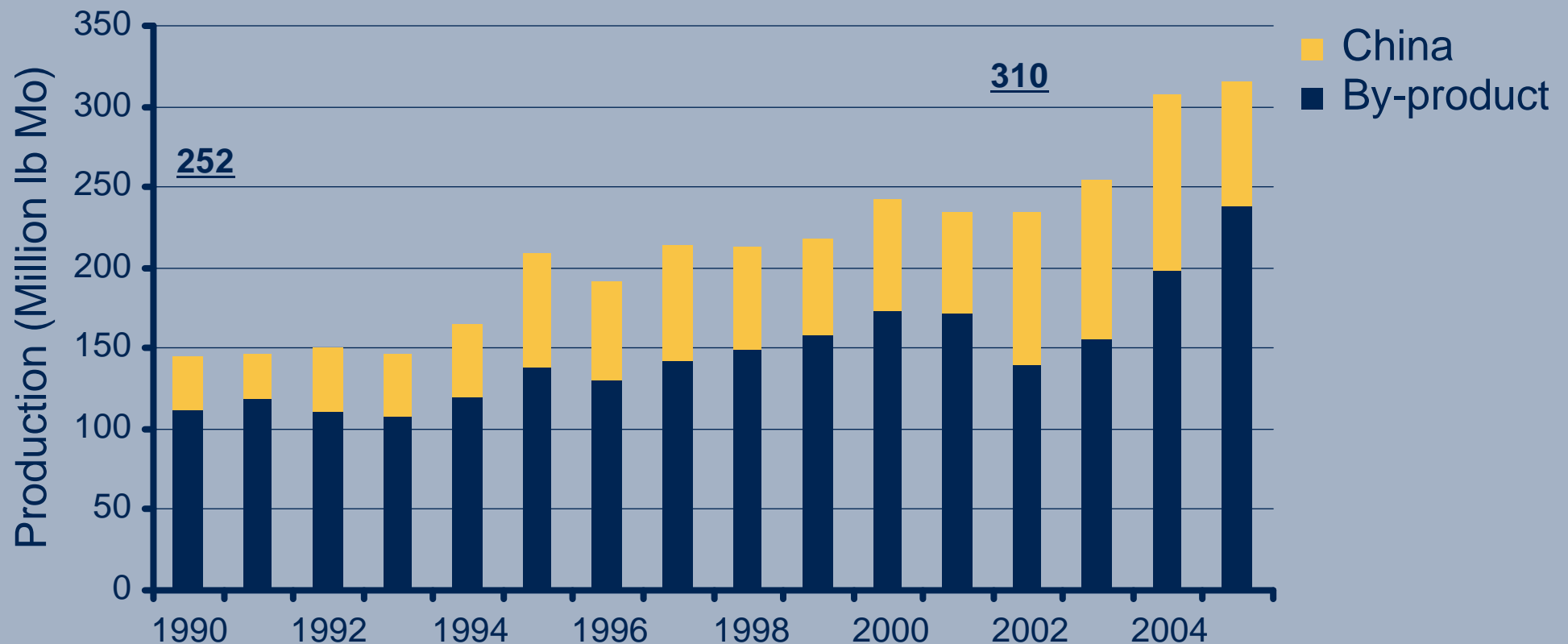


Source: Metals Week Dealer Oxide Price

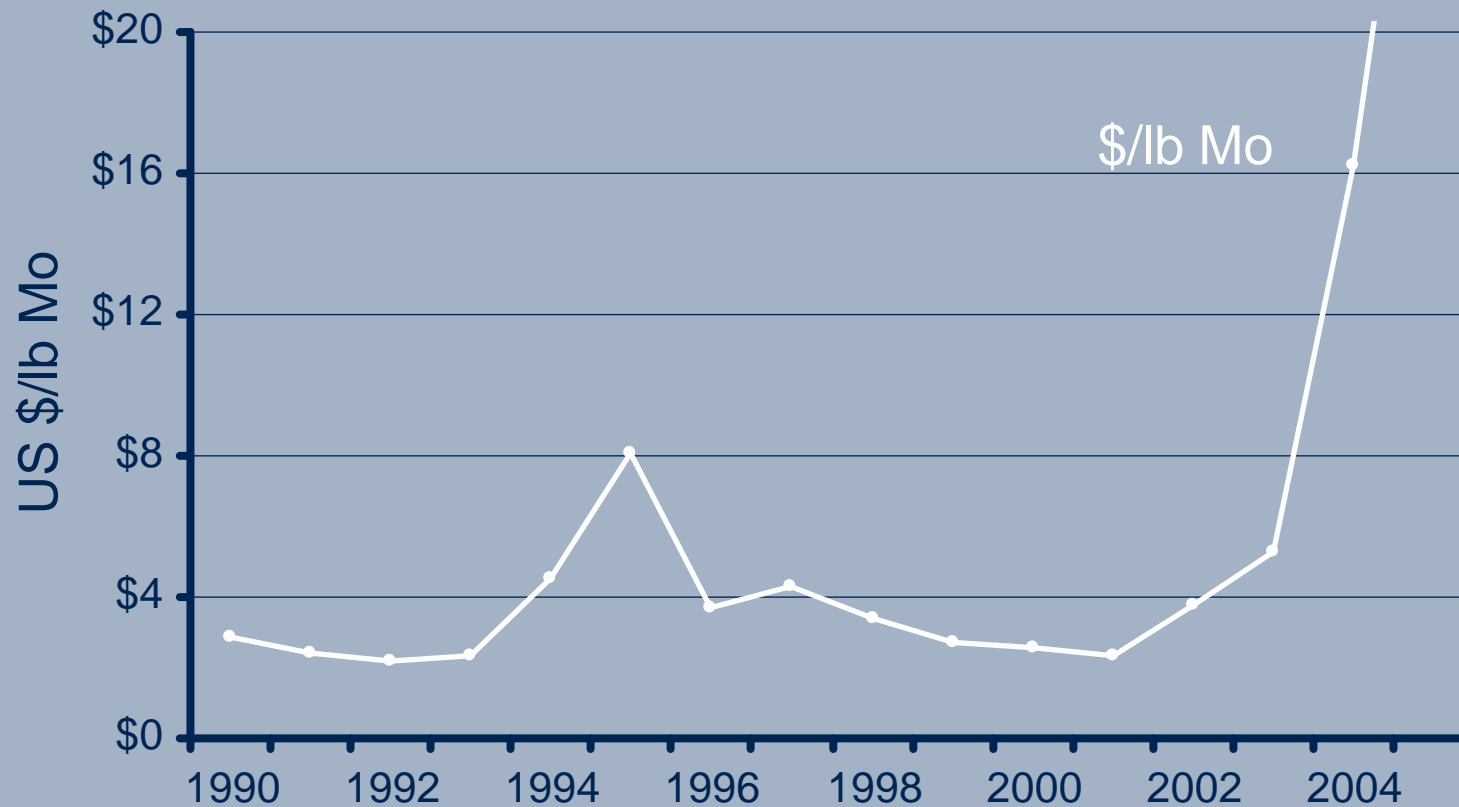
# Molybdenum Price and Price of Crude Oil 1970 through 2005



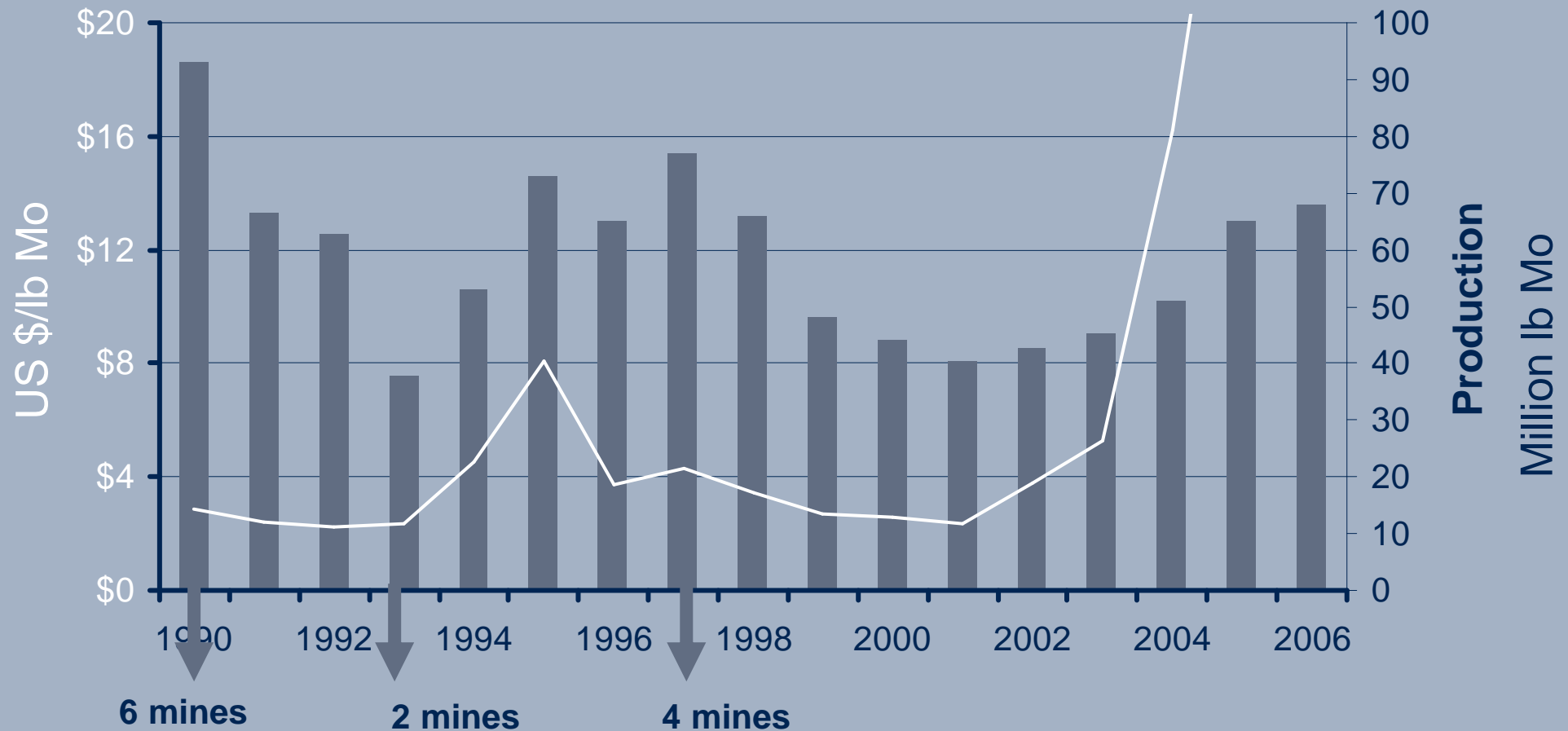
# By-product and China-Production Increased Significantly Since 1990



# Moly Price Was Below \$ 4.00/lb in 10 of the Last 15 Years

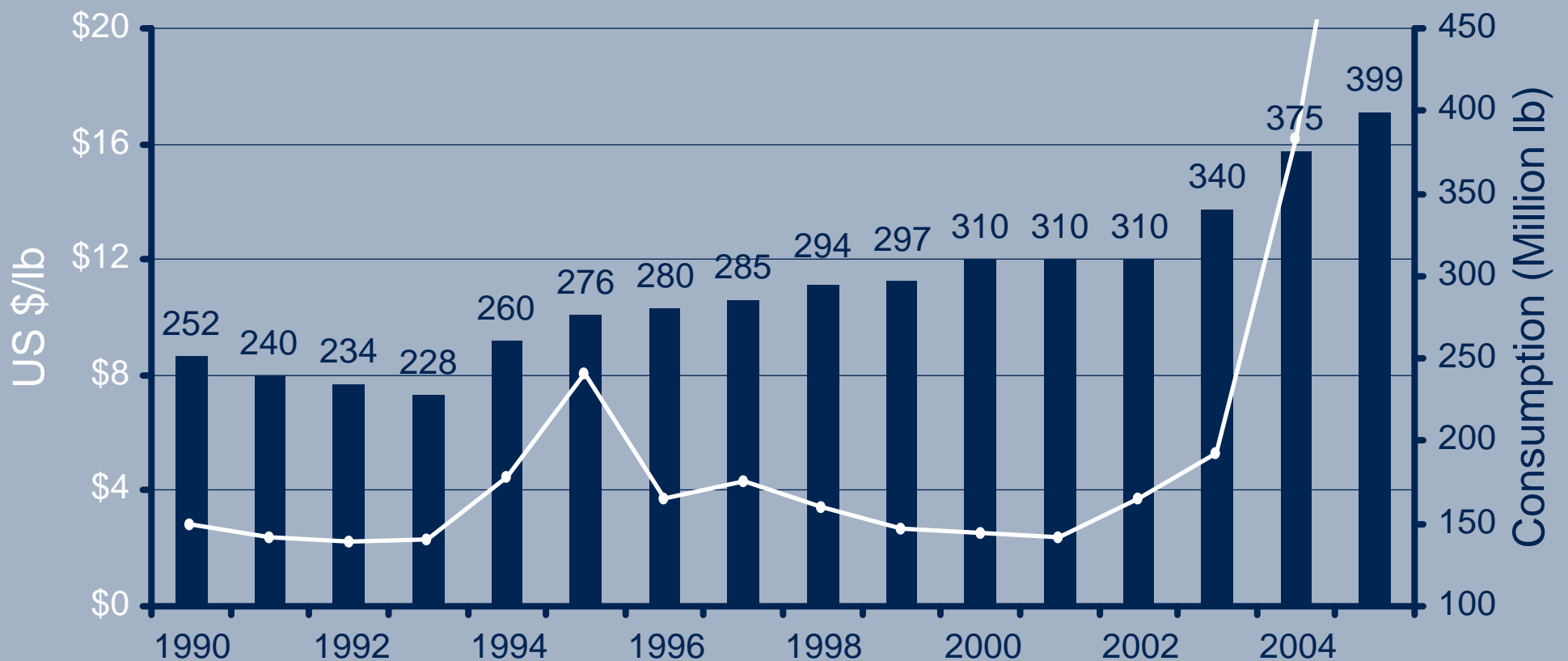


# Molybdenum Price and Western Primary Production

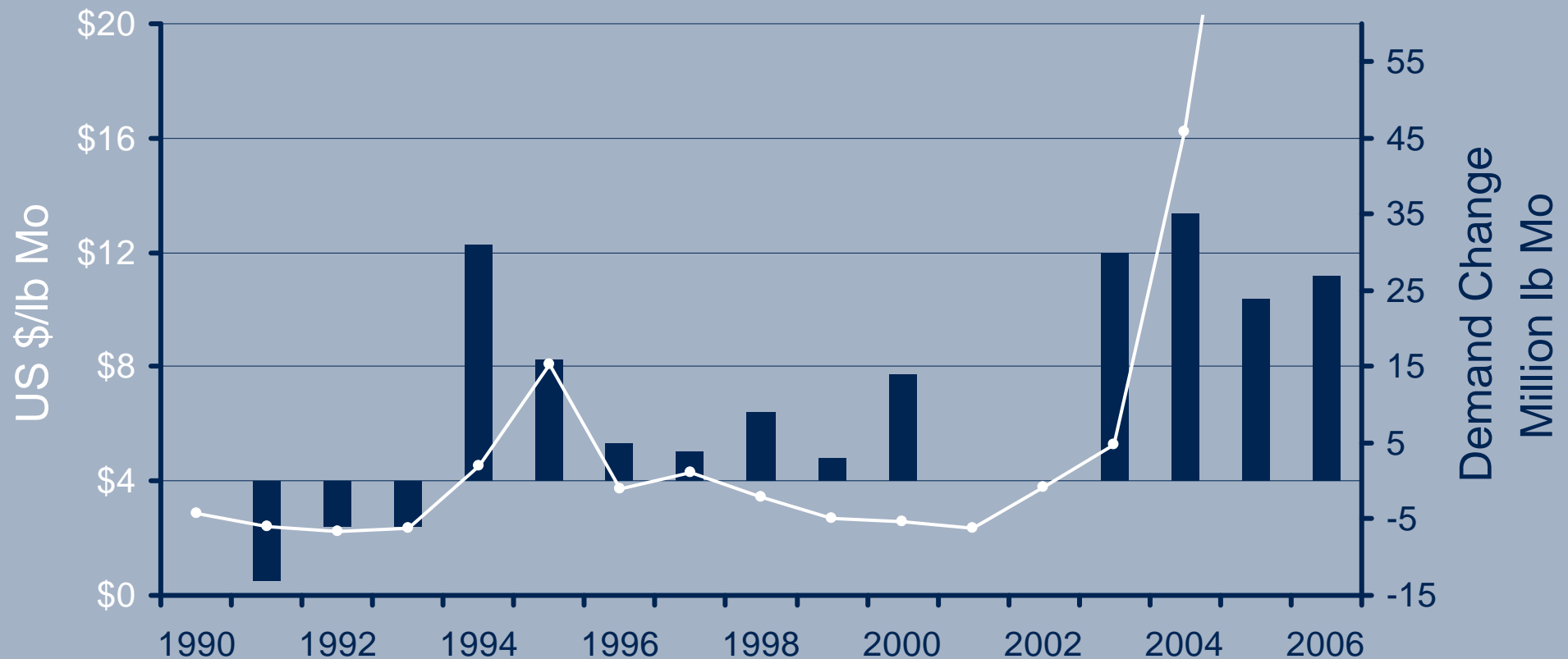




# Molybdenum Market: Demand and Price



# Molybdenum Market: Demand Change and Price

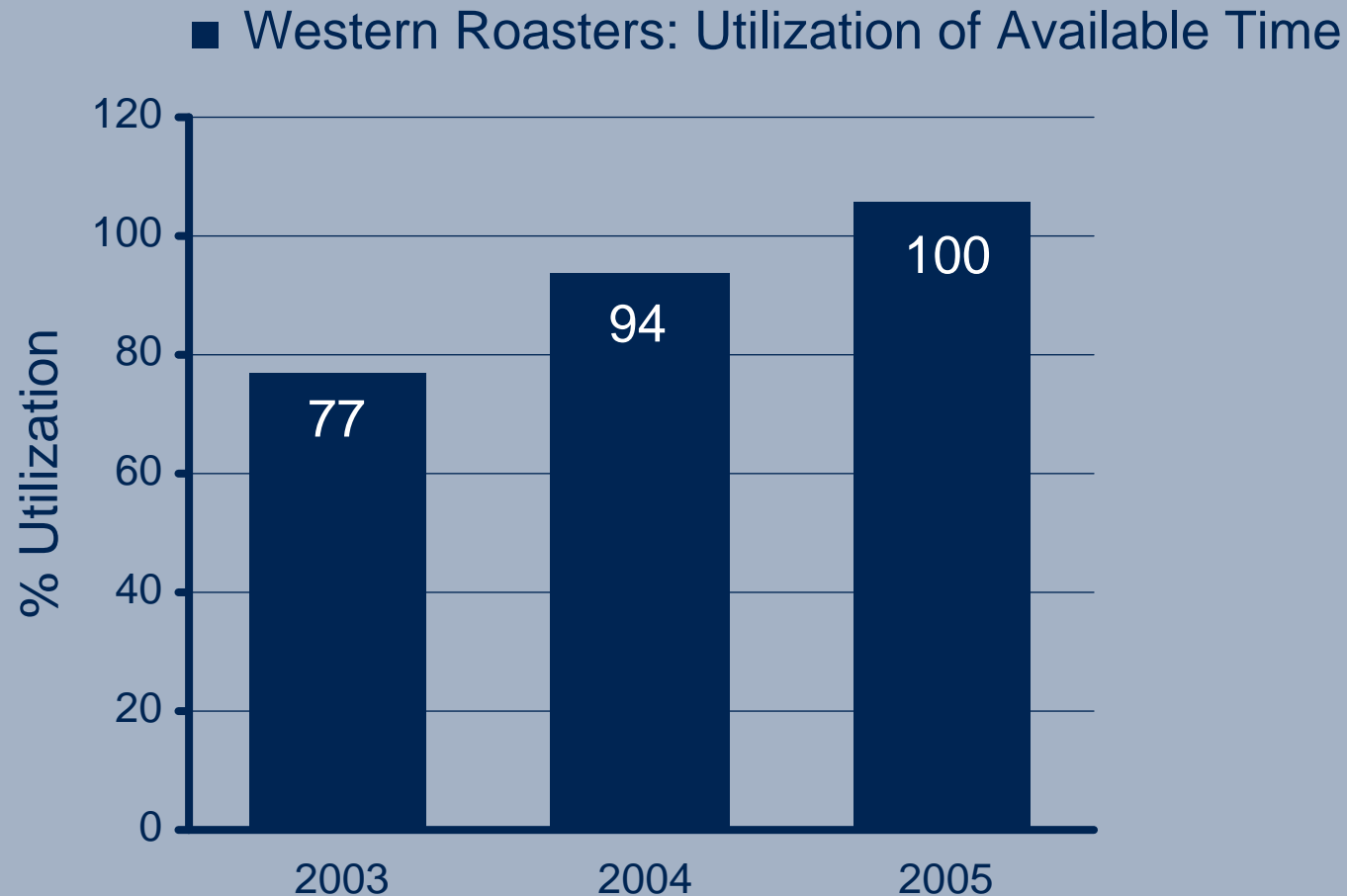


# New Primary Molybdenum Mine Projects

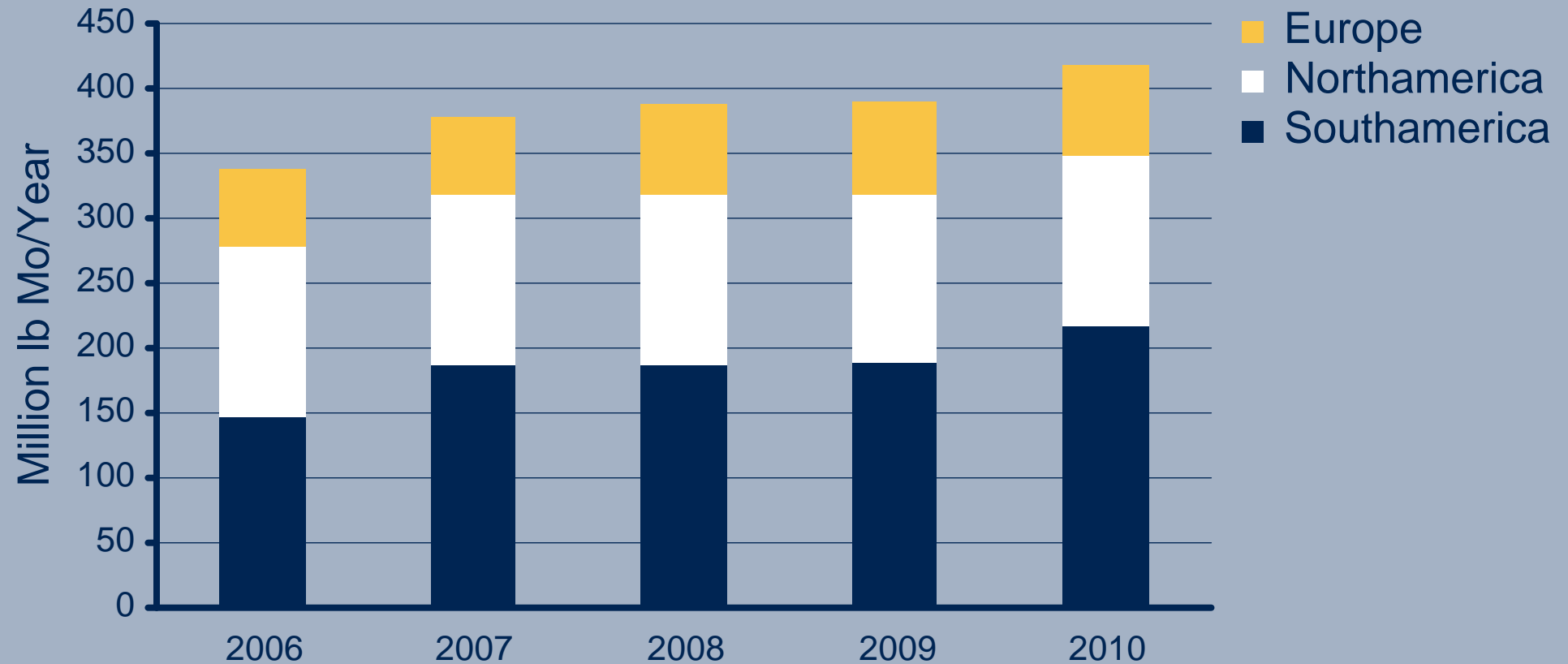
Mine		Expected Annual Capacity (Million lb Mo)	Status	Production Start Indicated
Roca Mines - Max Moly	Canada	2.5	Under construction	???
Bluepearl Davidson	Canada	5 to 10	Feasibility study	end 2007
PD Climax mine	USA	20 to 30	Conditionally approved	2009
Mt. Hope Nevada	USA	35	Currently being permitted	2009
Adanac - Ruby Creek	Canada	10	Feasibility study	2009

A comprehensive list of new molybdenum projects, including a number of by-product expansions, can be found under [www.infomine.com](http://www.infomine.com)

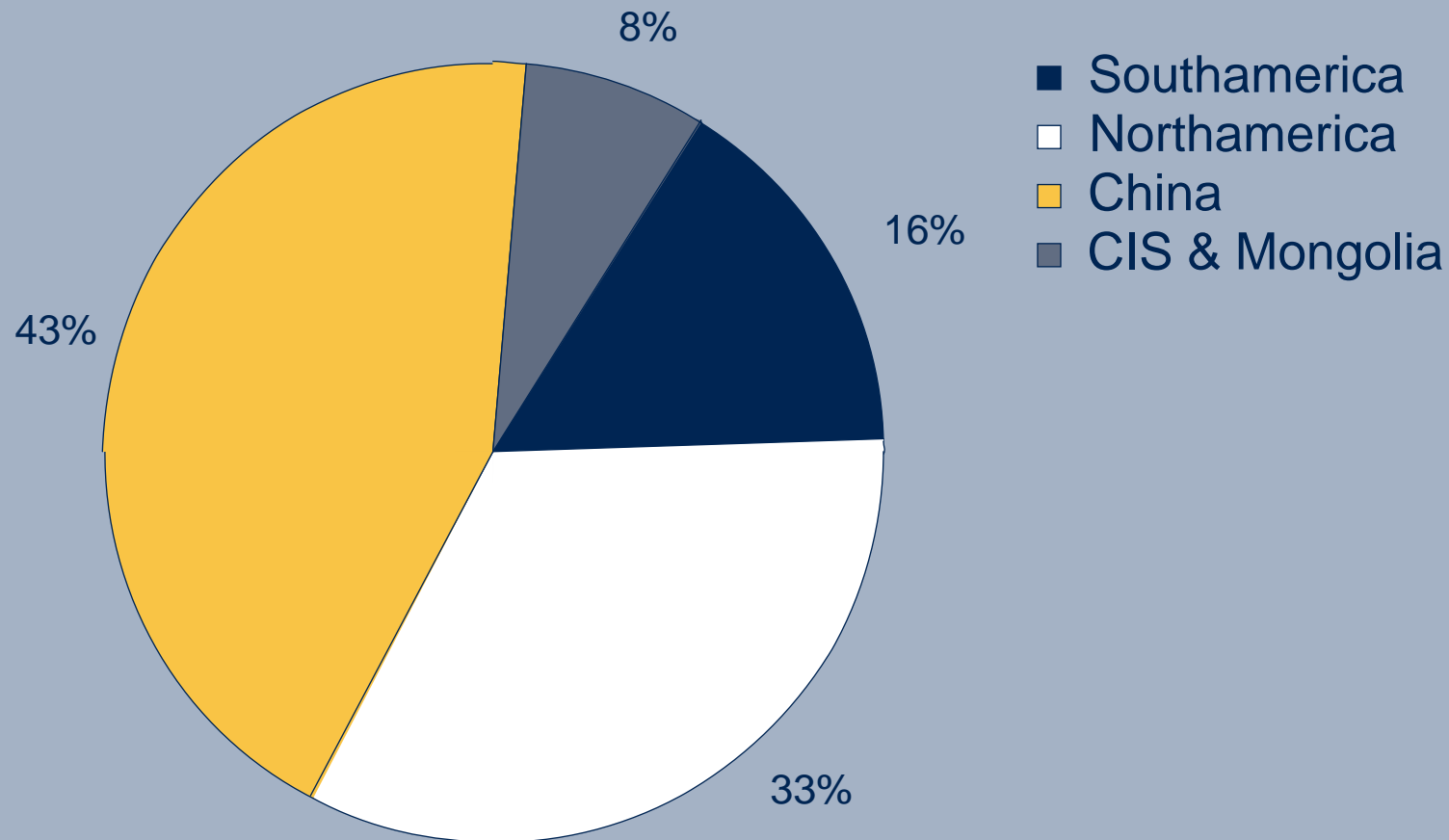
# Estimated Western Roaster Utilization Rates



# Projection of Western Roasting Capacities



# Global Molybdenum Reserve Base

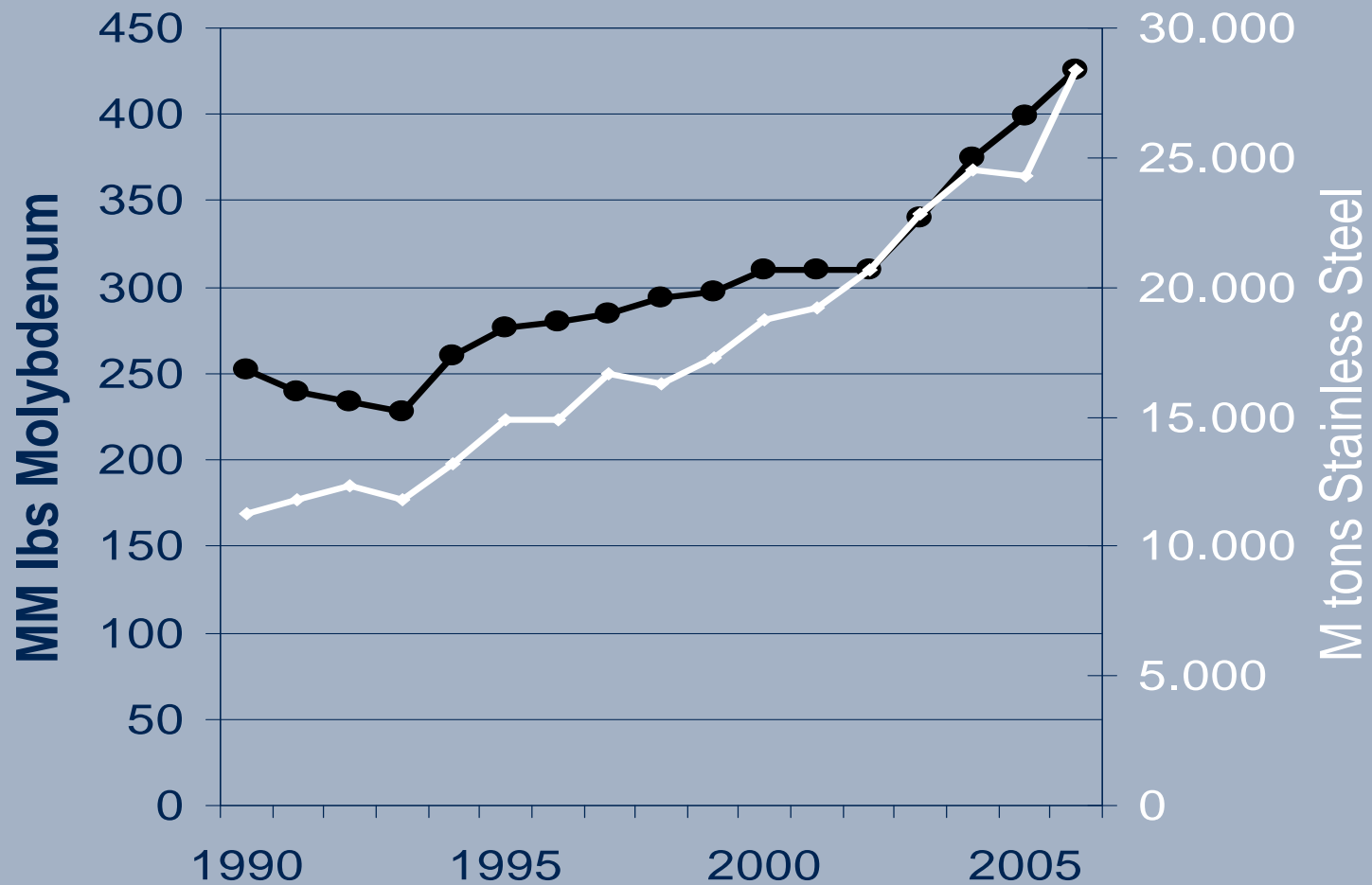


Total 19 million metric tons Mo ctd. – worth 100 years of present use

Source: US Geological Survey 2006



# World Stainless Production & Molybdenum Use



Source: IMOA; Adams Metals

Everything that glitters is stainless –  
and moly is happy to be part of it.

Thank you .



Courtesy of Outokumpu