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Centre for Copper and Mining Studies

MOLYBDENUM as a By-PRODUCT

Juan Carlos Guajardo B.
Executive Director

Wednesday 10 September 2008

1.- Molybdenum Supply

2.- Molybdenum as a By-product

3.- Exploring the relationship between Mo and Cu prices

4.- Relevance of molybdenum to the Chilean economy

5.- Molybdenum as a By-product in the Chilean mining industry

6.- Consequences of the current molybdenum market

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1.- MOLYBDENUM SUPPLY

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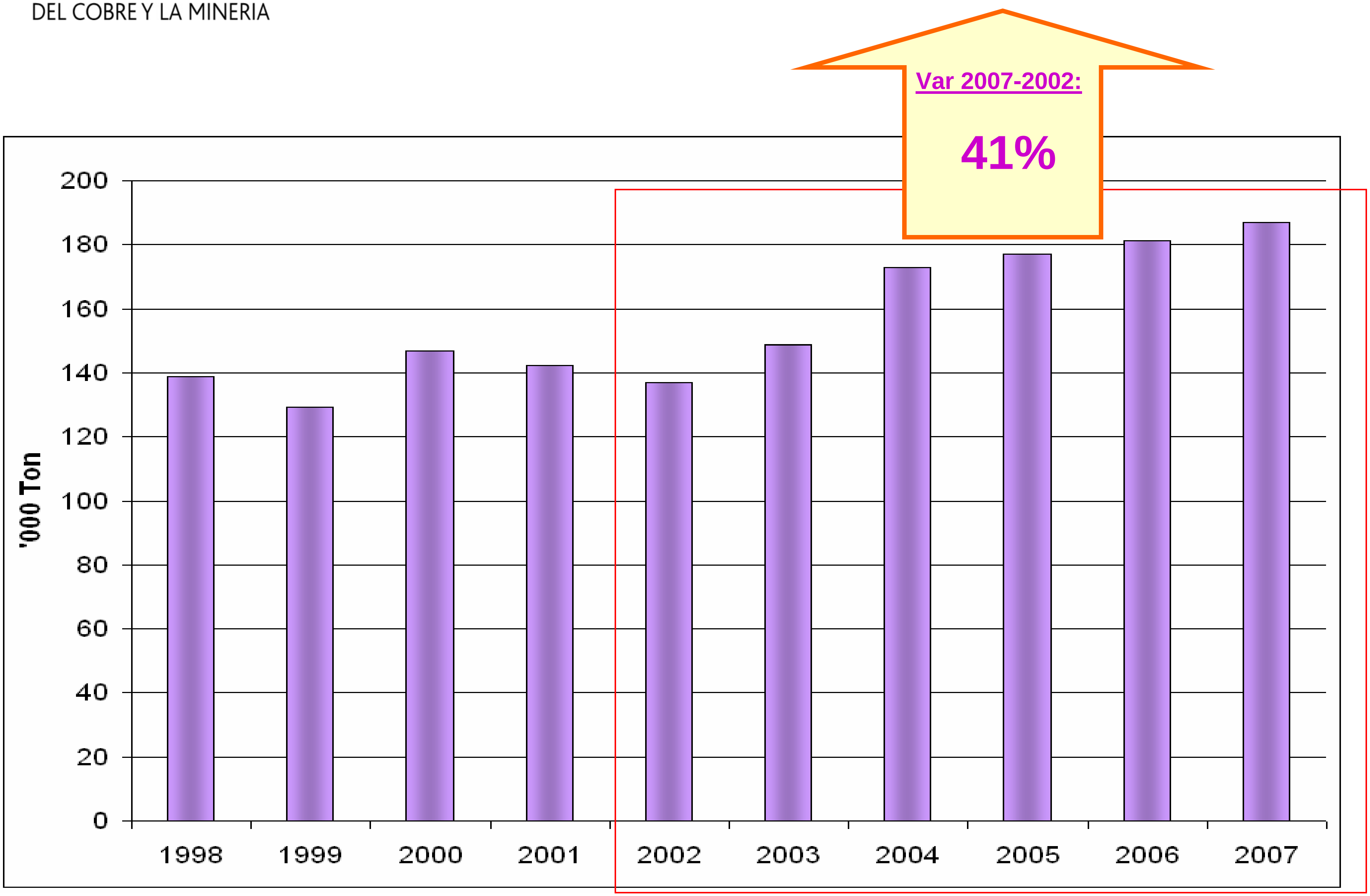
World Molybdenum Production



Source: Based on CPM data

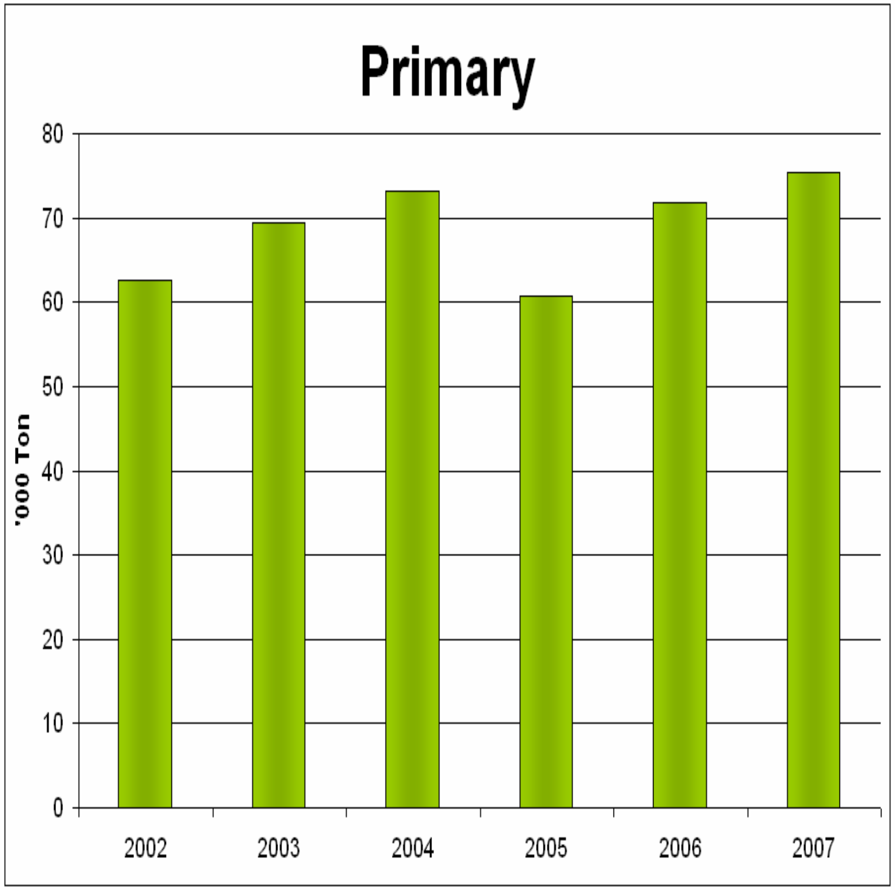
World Molybdenum Production

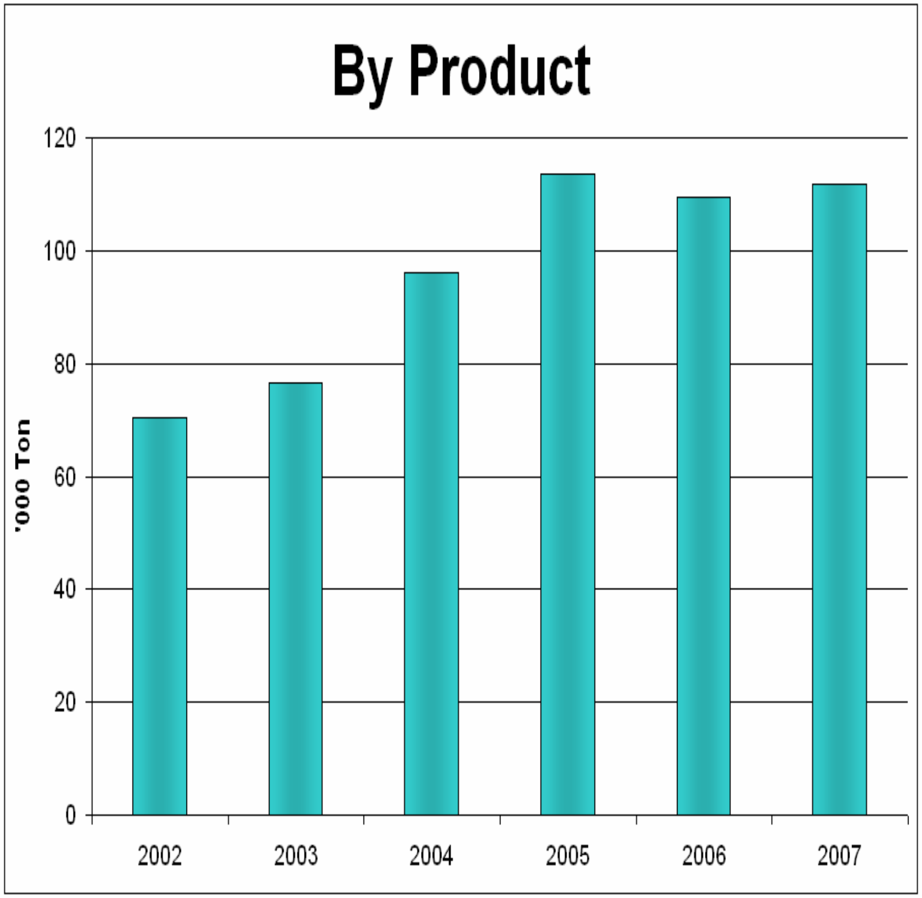
Var 2007-2002:

20%

Var 2007-2002:

59%





Source: Based on CPM data

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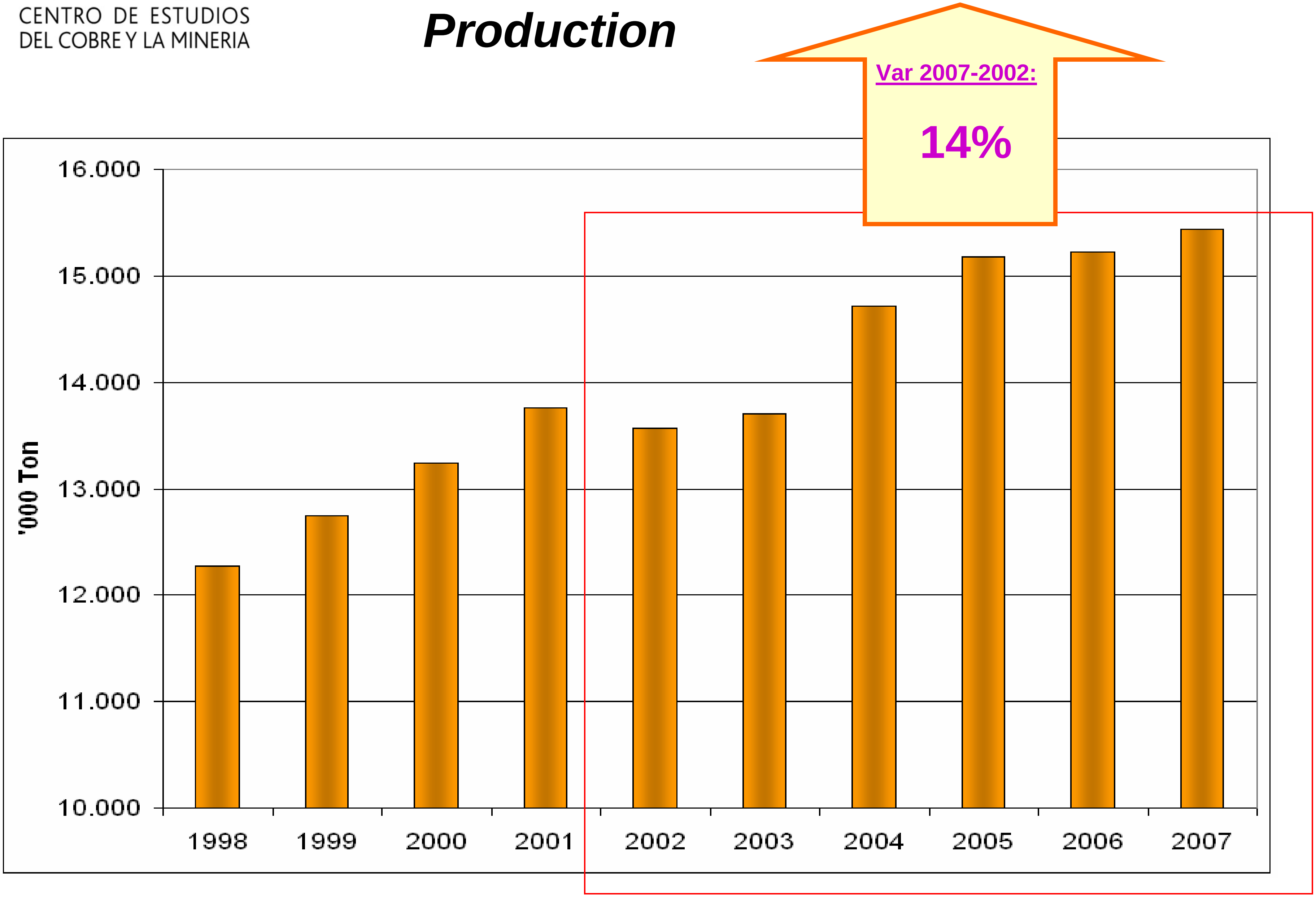
World Copper Production



Source: Based on International Copper Study Group data

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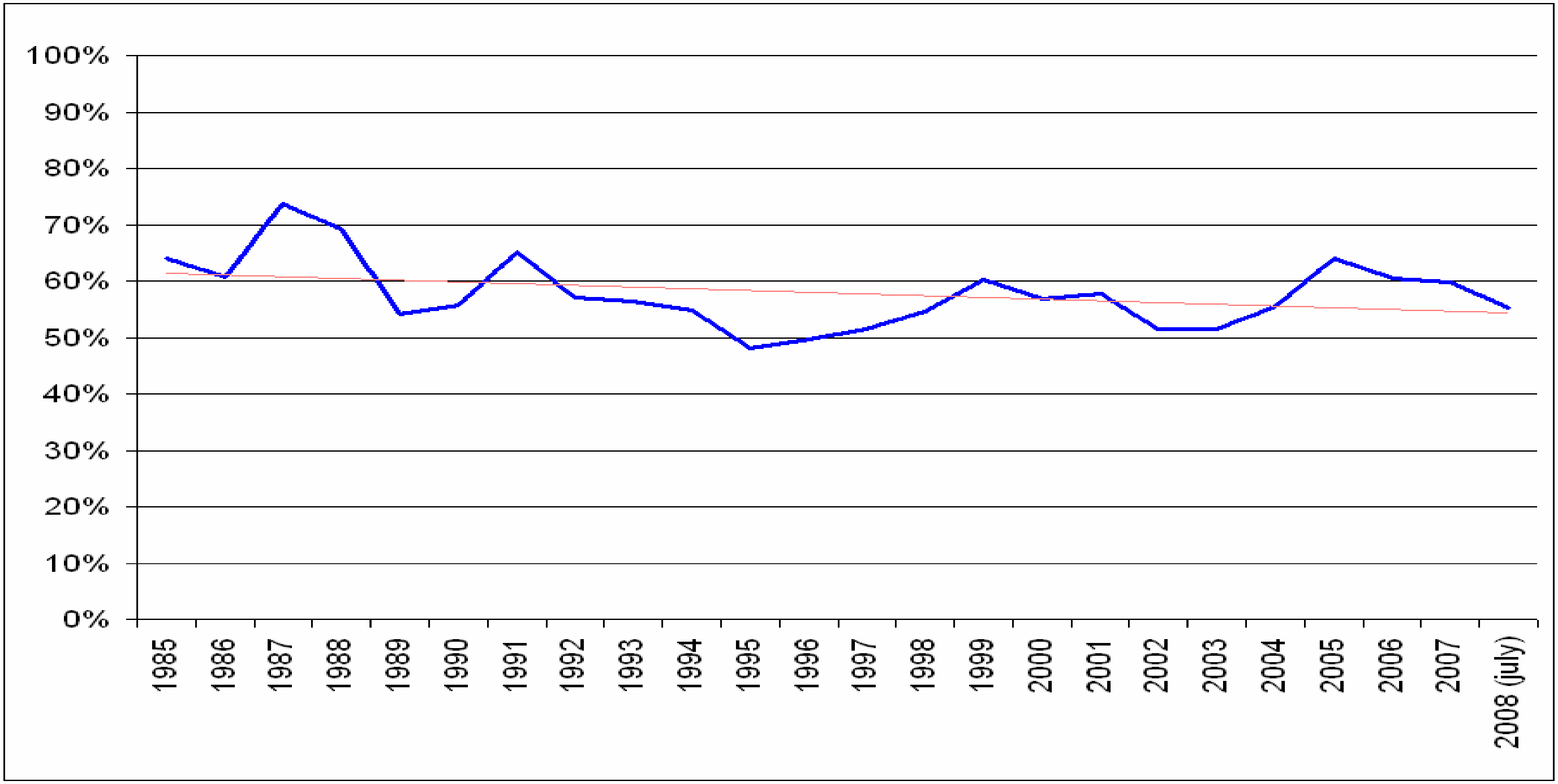
Ratio of By-product output



- **Secondary production reacted faster to the current super cycle**
- **With a consistent downturn between 1985 and today**

Source: CPM Group

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2.- MOLYBDENUM AS A BY-PRODUCT

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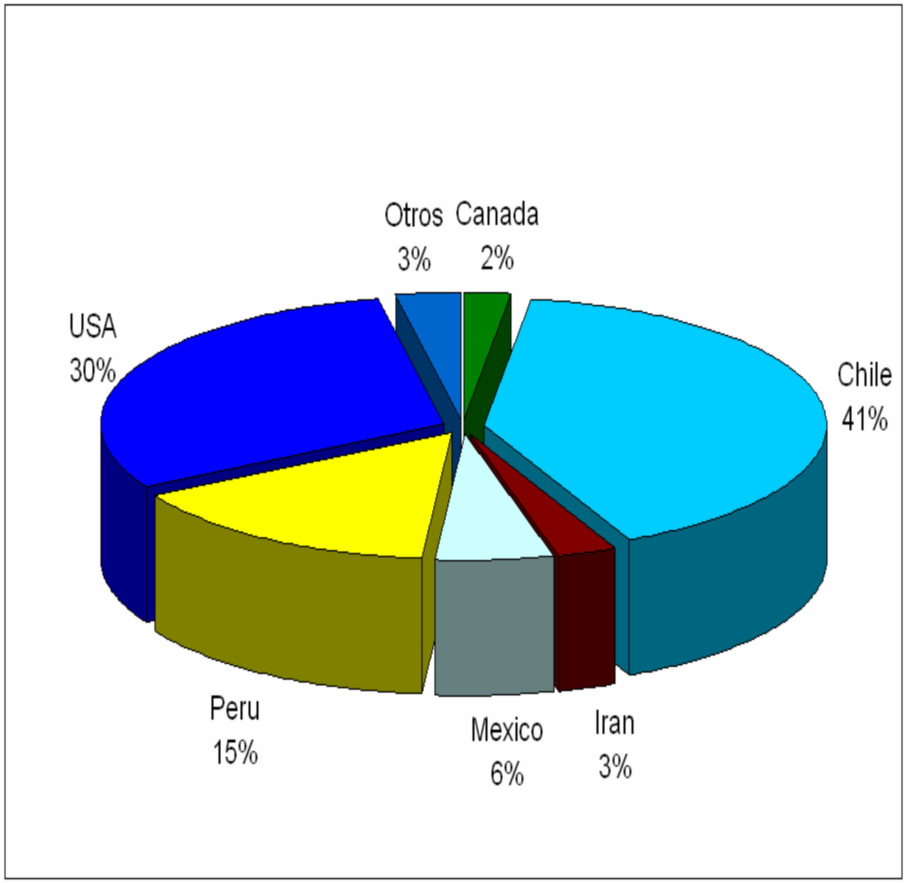
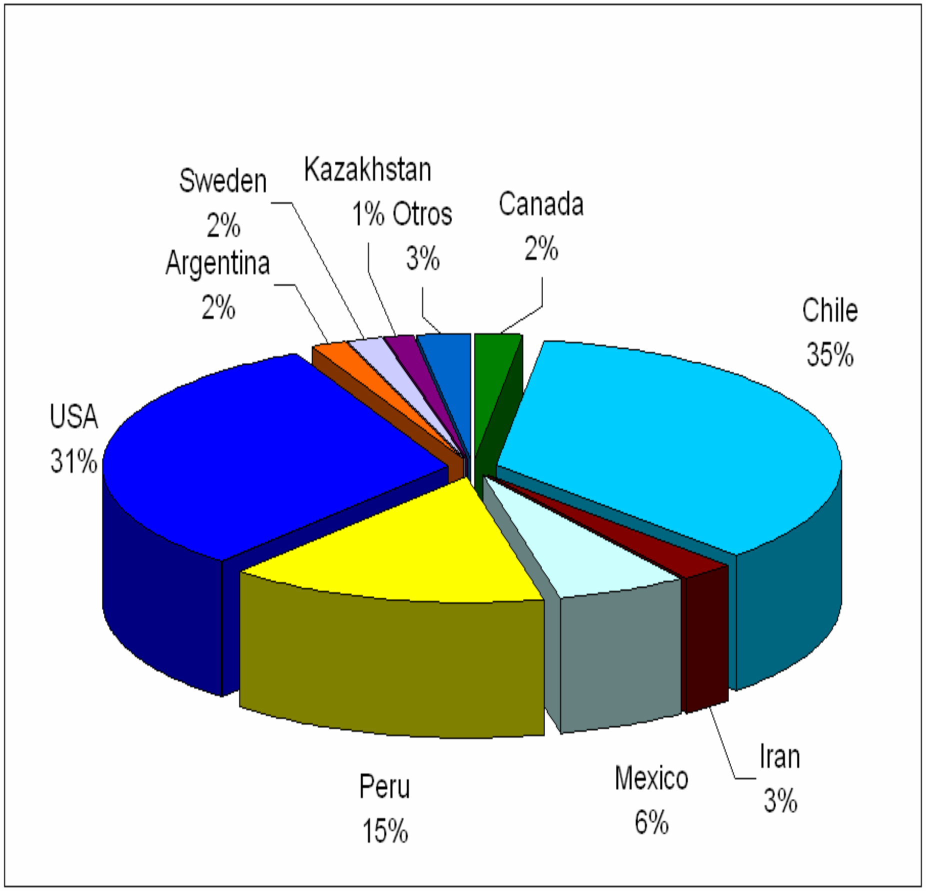
Molybdenum by-product production by country

2007



2015



Source: CRU.

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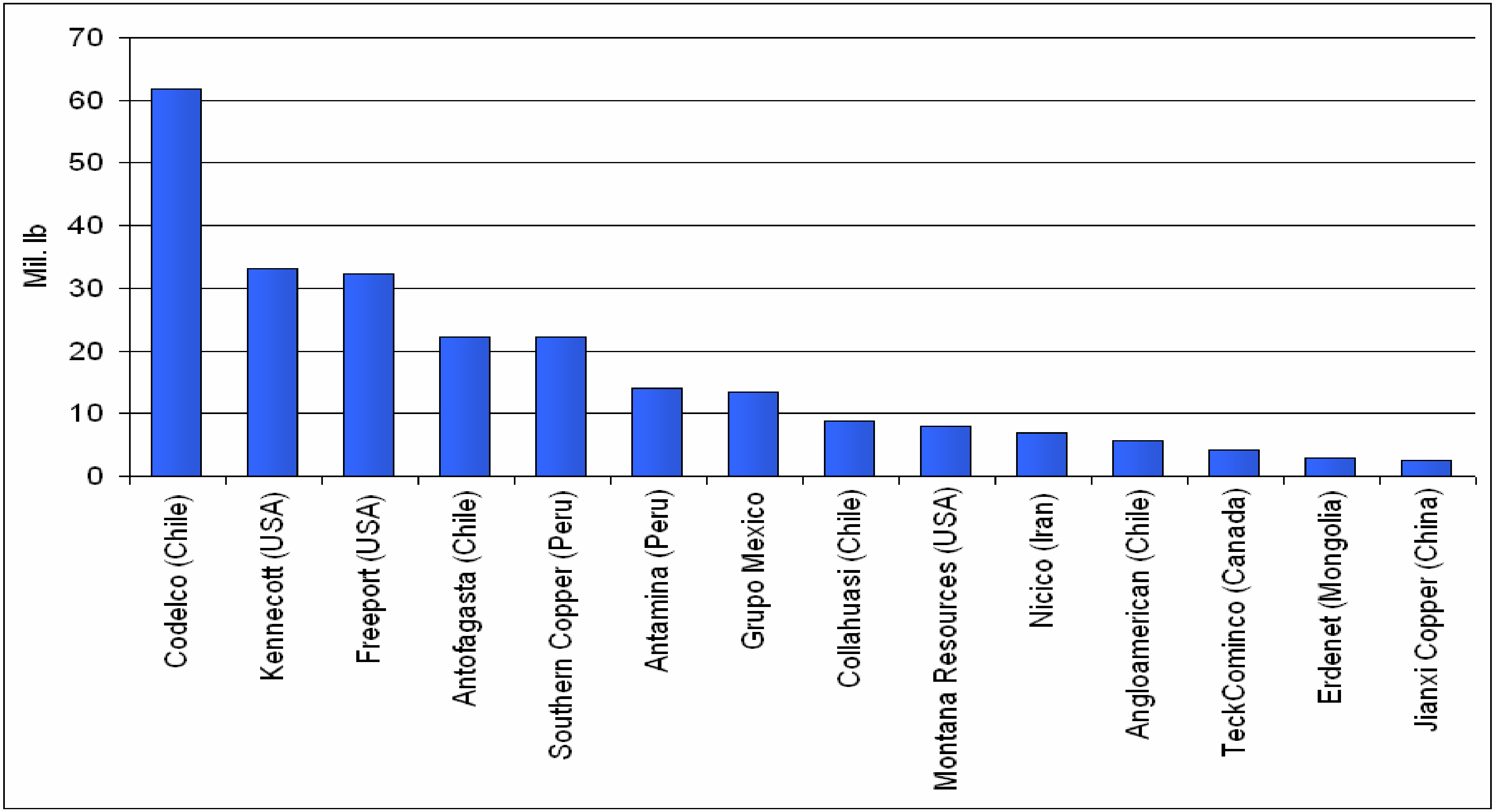
Molybdenum by-product production by company

2007



Source: CRU

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Ranking 2007-2015
By-product Molybdenum Production

	2007	2015	Var.
Codelco (Chile)	1	1	=
Kennecott (USA)	2	3	1
Freeport (USA)	3	2	1
Antofagasta (Chile)	4	7	3
Southern Copper (Peru)	5	4	1
Antamina (Peru)	6	10	4
Grupo Mexico	7	5	2
Collahuasi (Chile)	8	6	2
Montana Resources (USA)	9	12	3
Nicico (Iran)	10	11	1
Angloamerican (Chile)	11	8	3
TeckCominco (Canada)	12	13	1
Erdenet (Mongolia)	13	17	4
Jianxi Copper (China)	14	18	4

Source: Based on CRU data.

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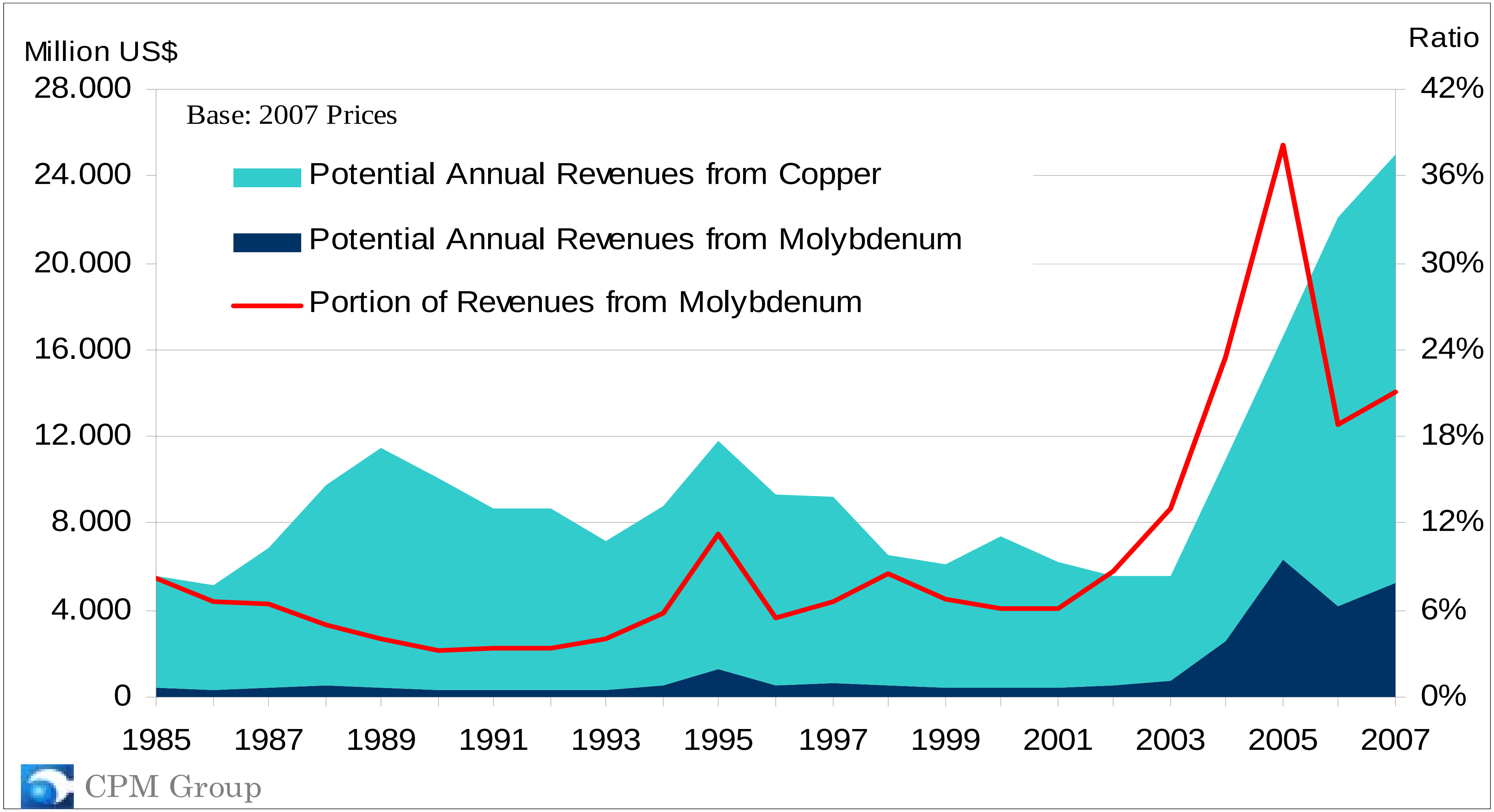
Potential Value of Molybdenum Production for the Top Five Copper By-Producers

Implied using real annual prices & output for Codelco, Rio Tinto, Freeport, Grupo Mexico, and Antofagasta



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3.- EXPLORING THE RELATIONSHIP BETWEEN MO AND CU PRICES

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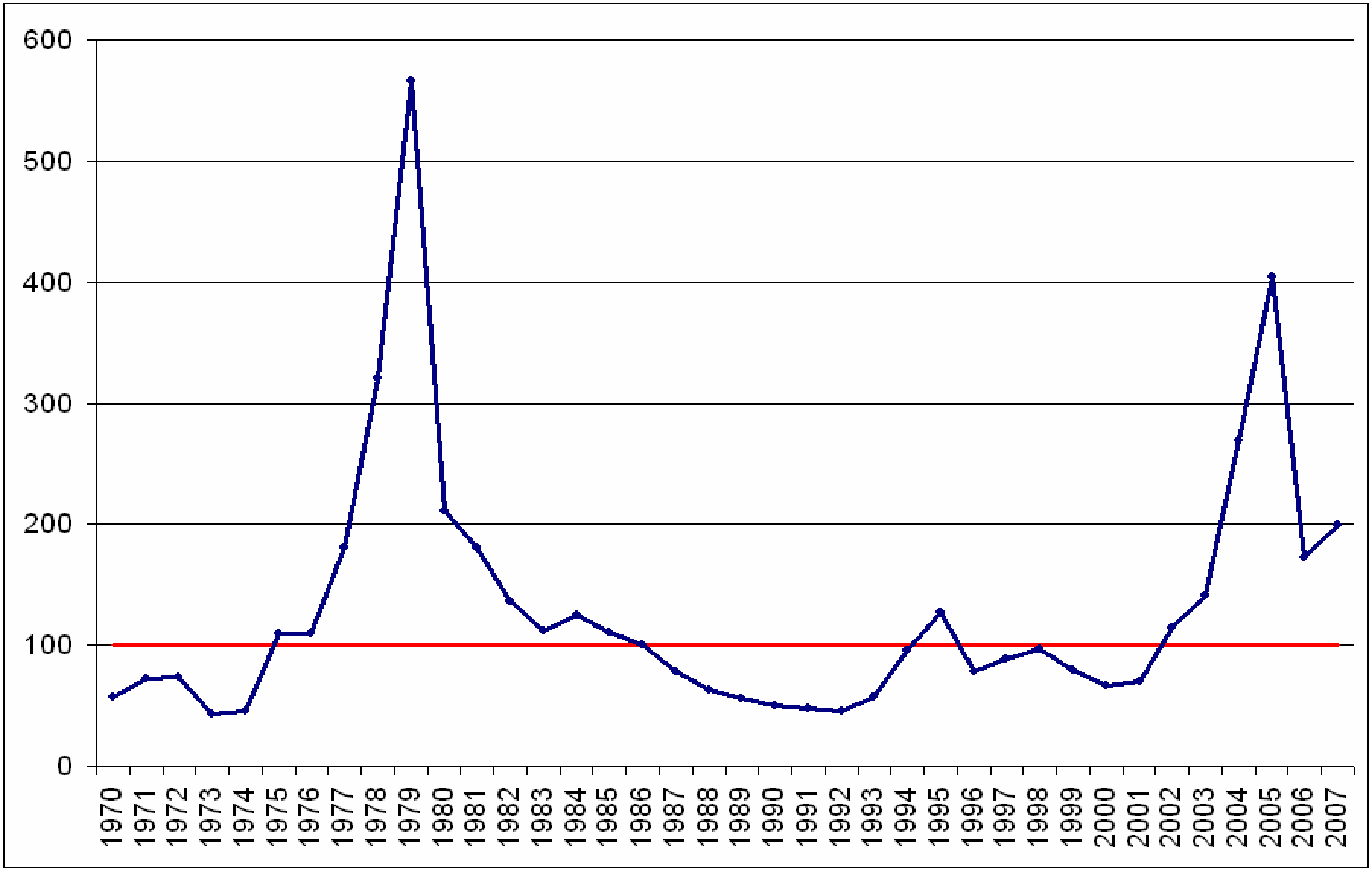
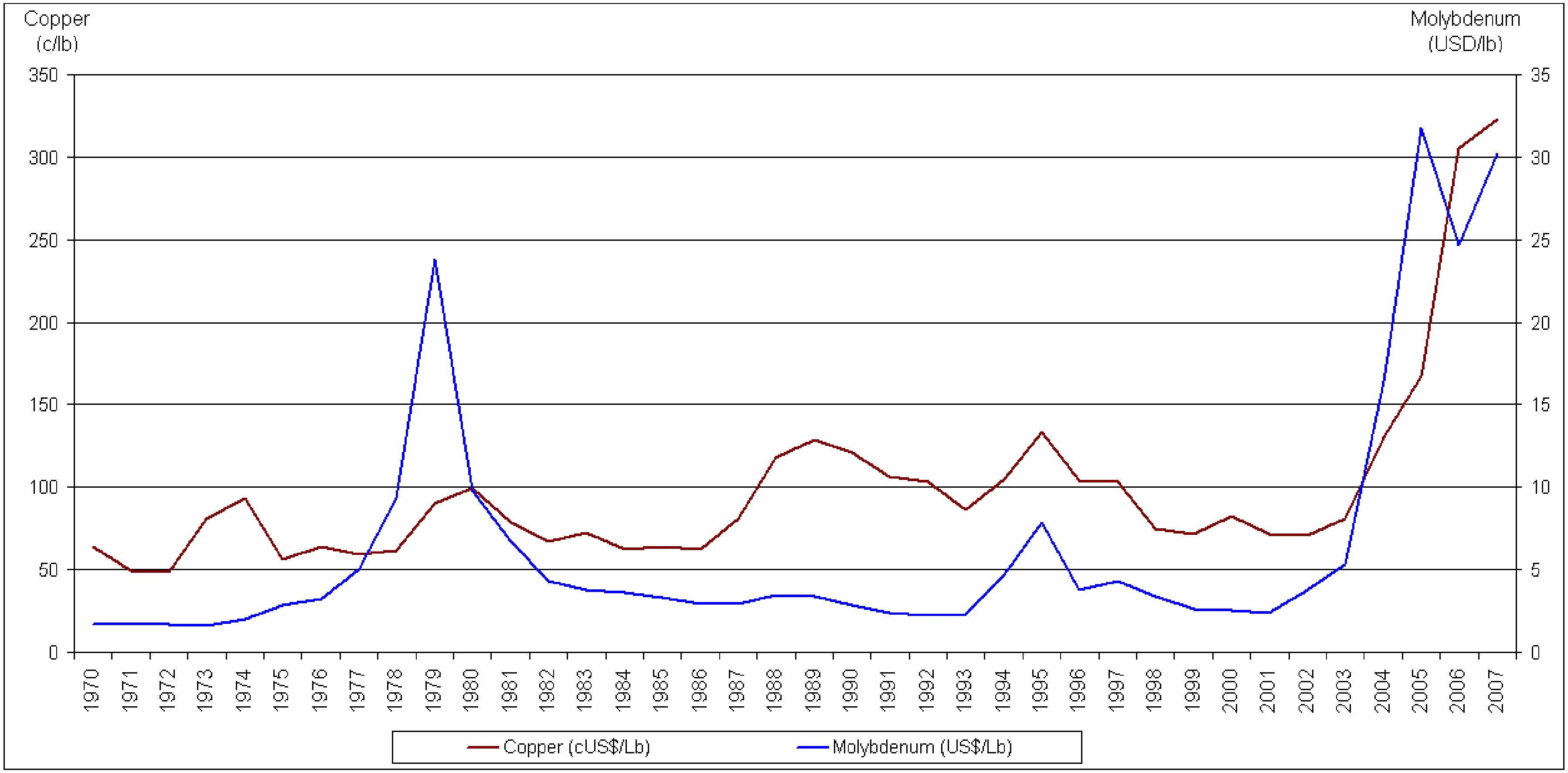
Molybdenum/Copper Price Index

(1986 = 100)



Source: CPM and ICSG data

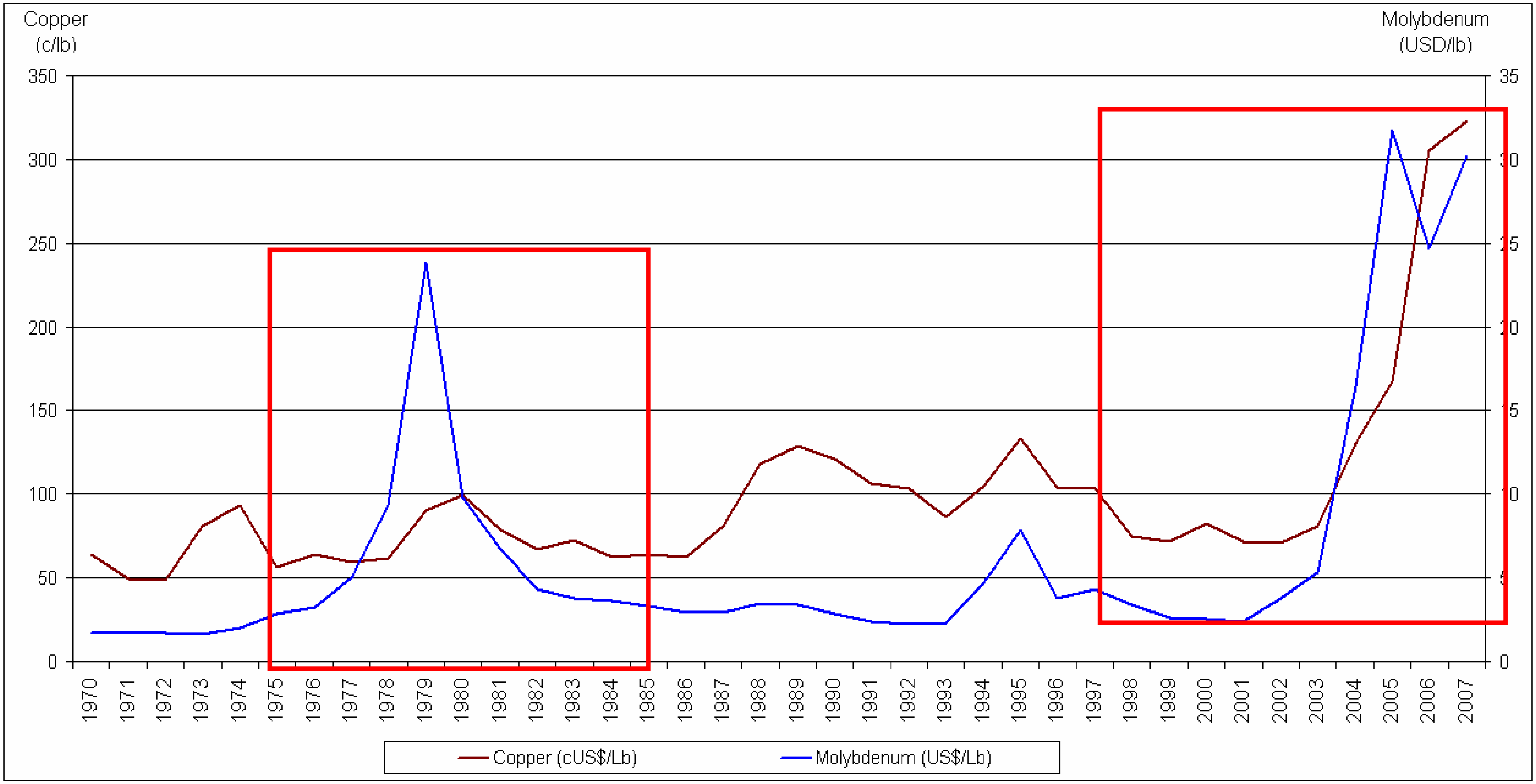
Molybdenum and Copper prices



	Copper	Molybdenum
Standard Deviation	58 cUS$/Lb	790 cUS$/Lb
Correlation coefficient	0,75	

Source: Based on CPM and ICSG data.

Molybdenum and Copper prices



	1975 - 1985	1997 - 2007
Correlation coefficients	0,65	0,85

Source: Based on CPM and ICSG data.

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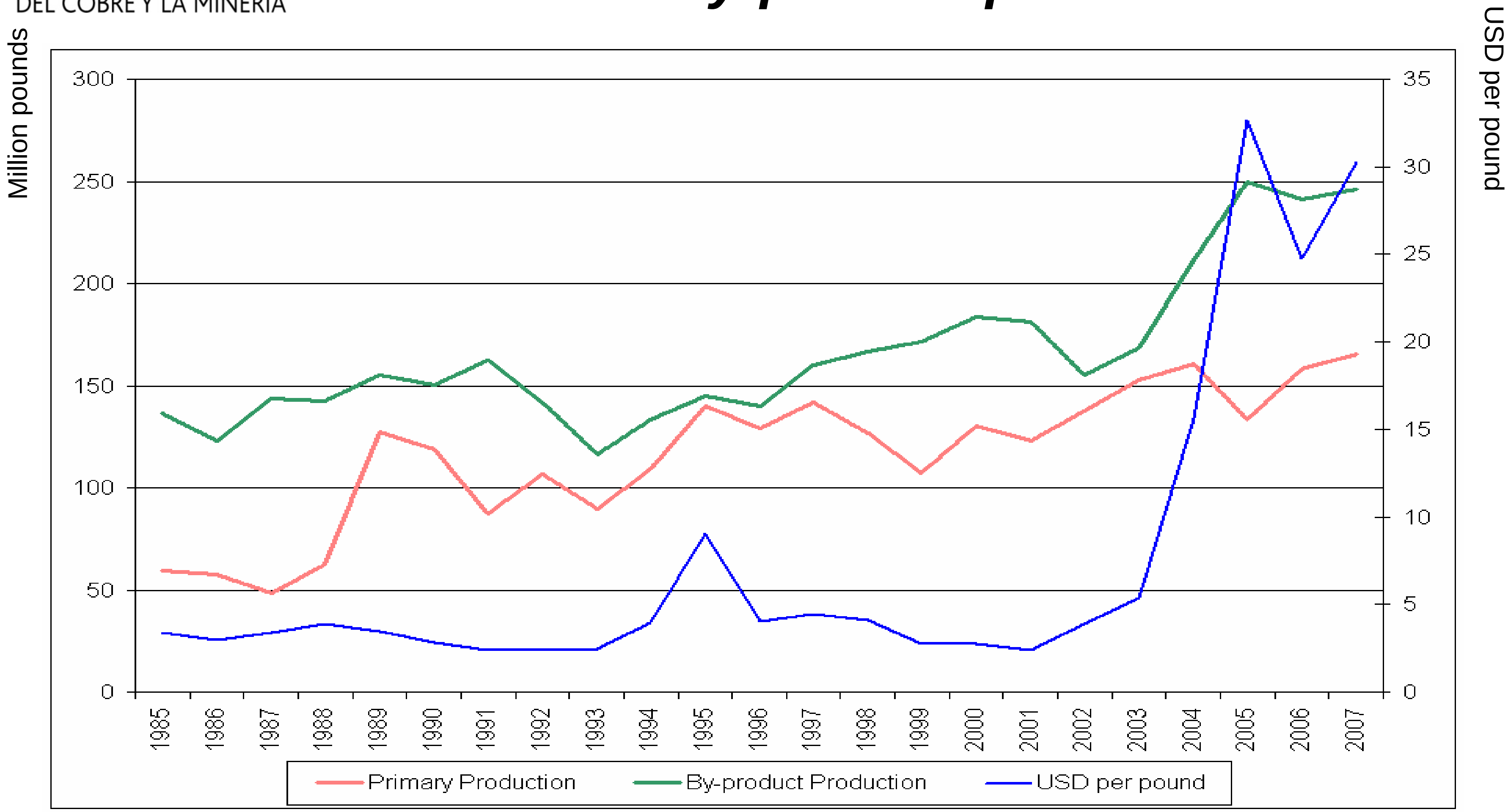
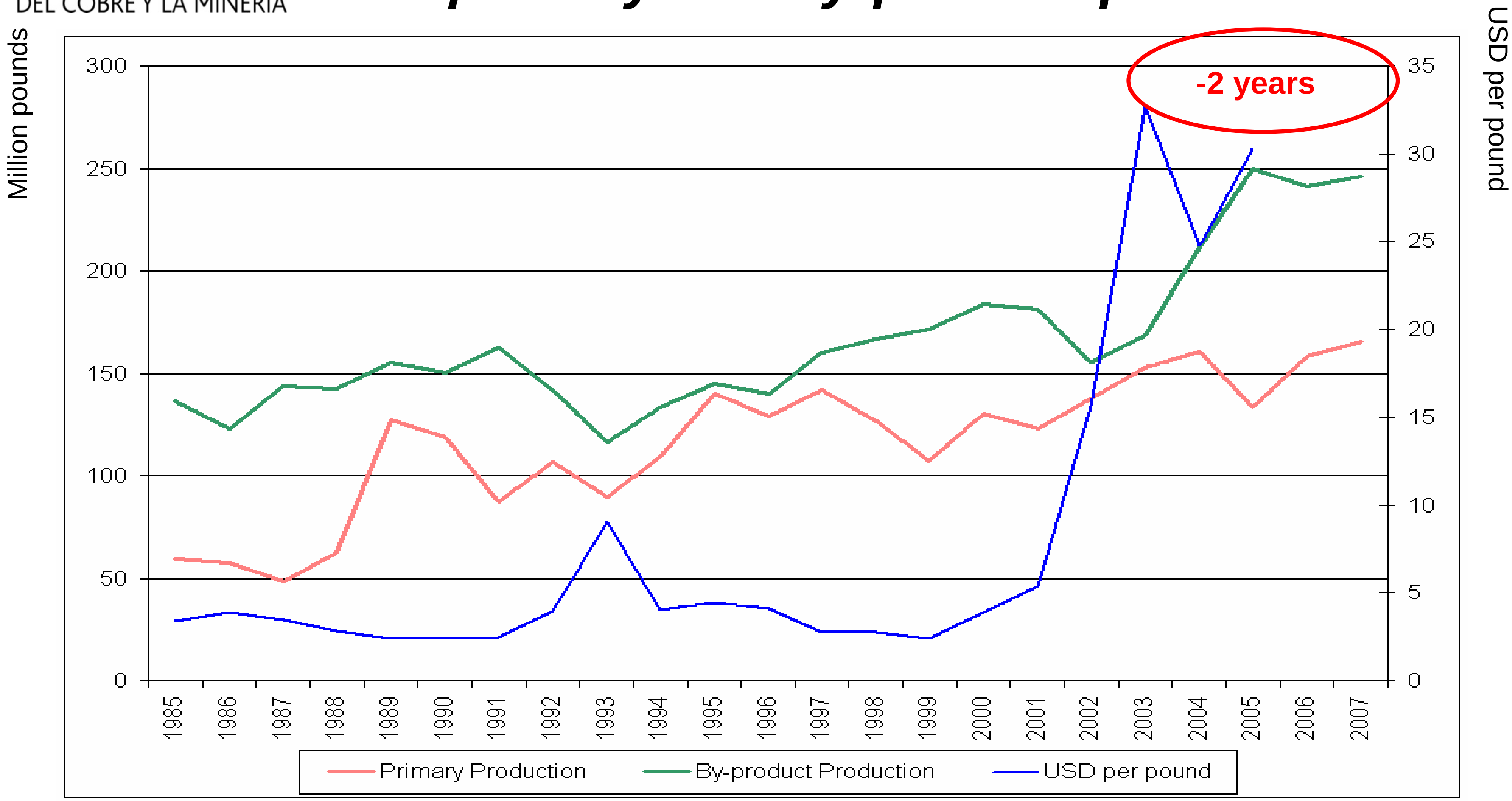
Molybdenum price VS Molybdenum primary and by-product production



Correlation coefficients	1985-2007	2002-2007
Price-Primary	0,517	0,136
Price-By product	0,876	0,981

Source: Based on CPM data

Molybdenum price (T-2) VS Molybdenum primary and by-product production



Correlation coefficients	1985-2007	2002-2007
Price (T-2)–Primary	0,492	0,683
Price (T-2)-By product	0,619	0,394

Source: Based on CPM data

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4.- RELEVANCE OF MOLYBDENUM TO THE CHILEAN ECONOMY

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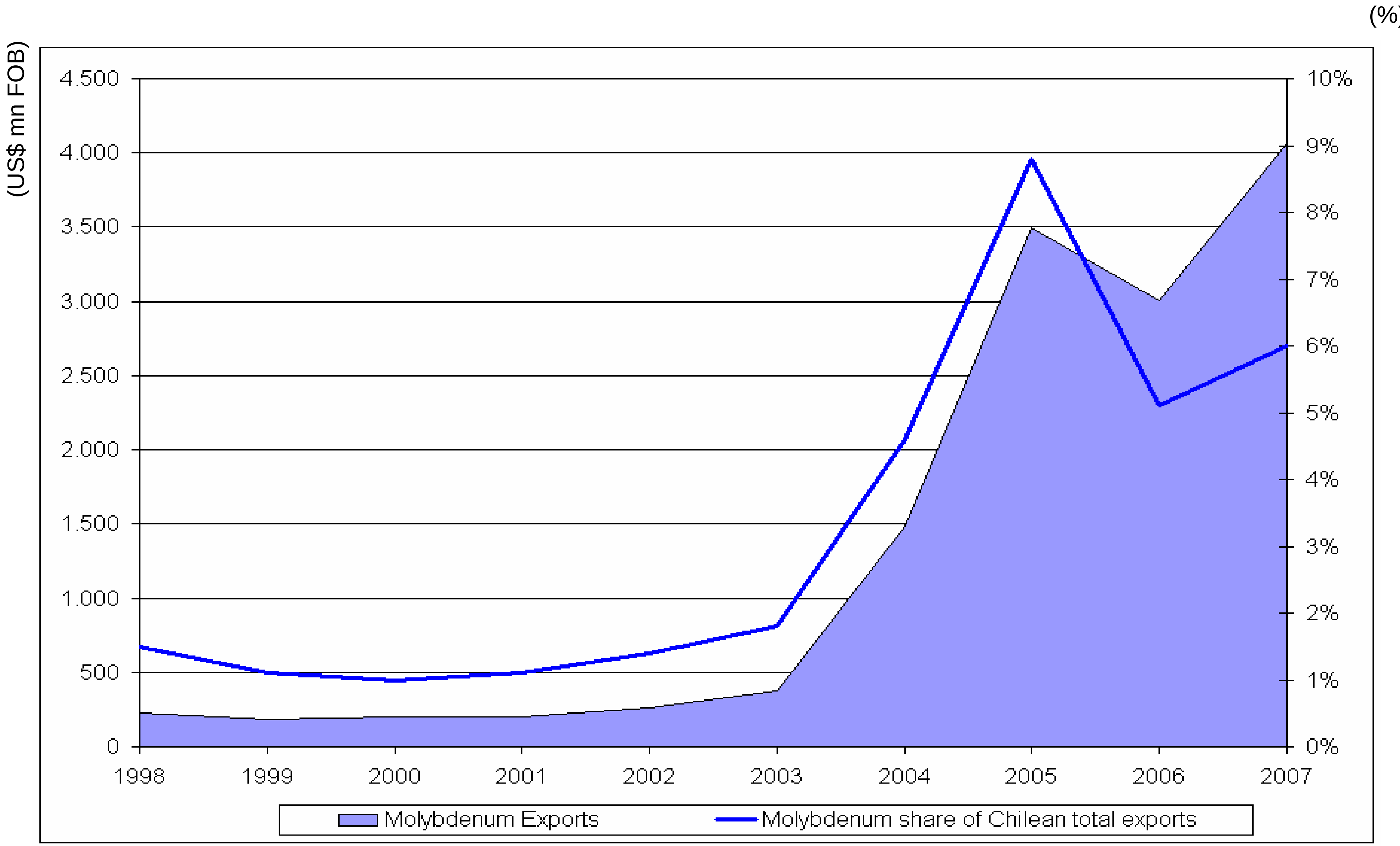
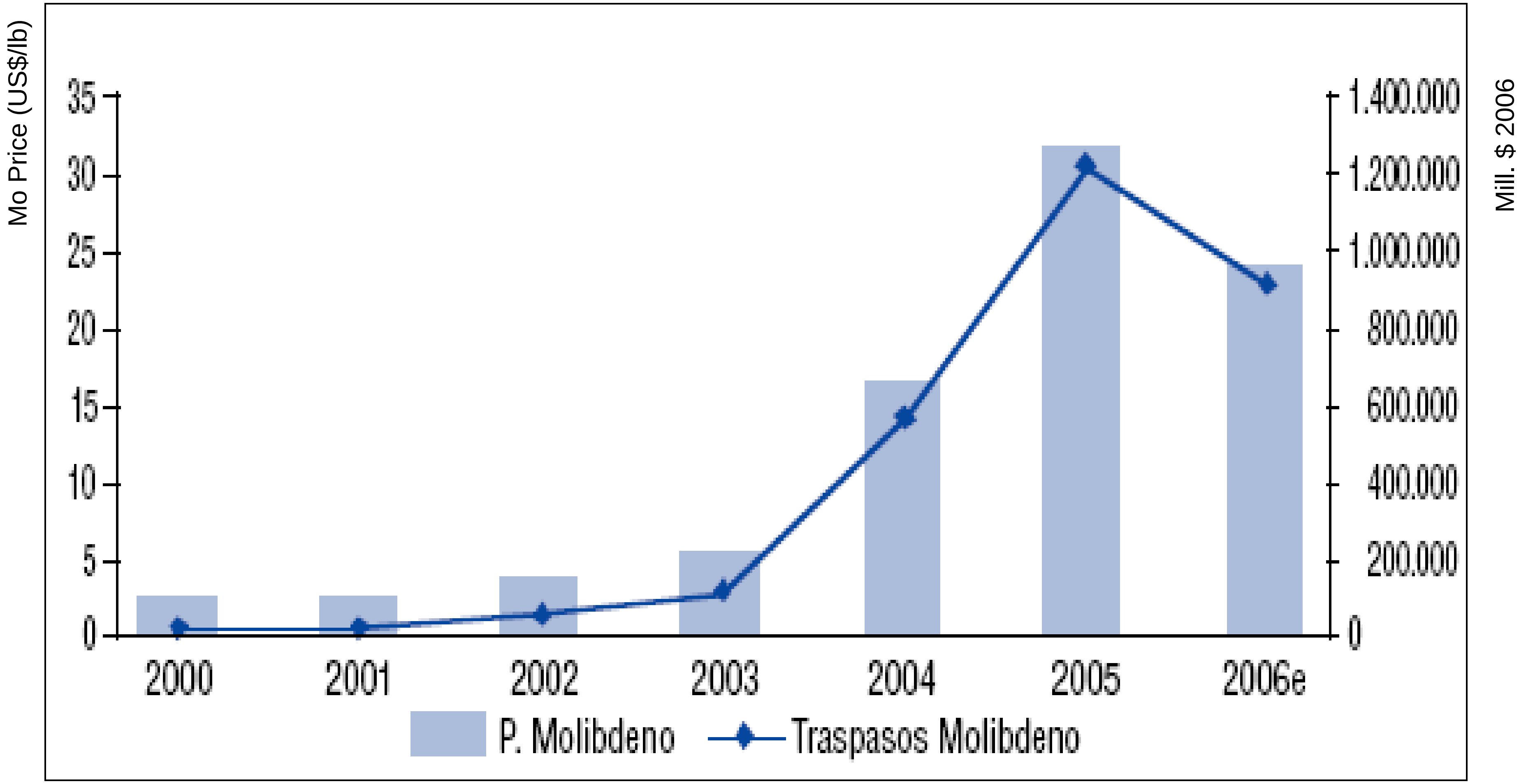
Chilean Molybdenum Exports



Source: Comisión Chilena del Cobre.

Fiscal Revenues from Molybdenum and Molybdenum price, 2000-2006



Source: Budget Division DIPRES, Ministry of Finance

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Molybdenum and The Structural Balance Policy in Chile

	2001	2006
Fiscal policy based on current fiscal position	Fiscal policy based on medium-term fiscal outlook	Fiscal policy based on medium-term fiscal outlook
Fiscal position strongly exposed to international economy and copper price fluctuations	*"Nets out the cyclical impact of the level of economic activity and the price of copper that affect central government income"*	*"Cyclical adjustment of fiscal income from molybdenum also became necessary"*
	•GDP Potential Output •10-years Copper price	•GDP Potential Output •10-years Copper price **•Long-term molybdenum price**

Source: Cesco based on DIPRES.

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5.- MOLYBDENUM AS A BY-PRODUCT IN THE CHILEAN MINING INDUSTRY

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Companies with Molybdenum as a By-Product

- **CODELCO**
- **ANTOFAGASTA MINERALS**
- **ANGLOAMERICAN**
- **COLLAHUASI**

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Companies with Molybdenum as a By-Product

Company	Production 2007 (MT Molybdenum Content)	Production Value 2007 (USD MM)
Codelco	27.857	1.822
Antofagasta Minerals (Los Pelambres)	10.156	664
Collahuasi	4.039	264
Angloamerican (Sur Andes)	2.582	169

Source: Based on Cochilco data

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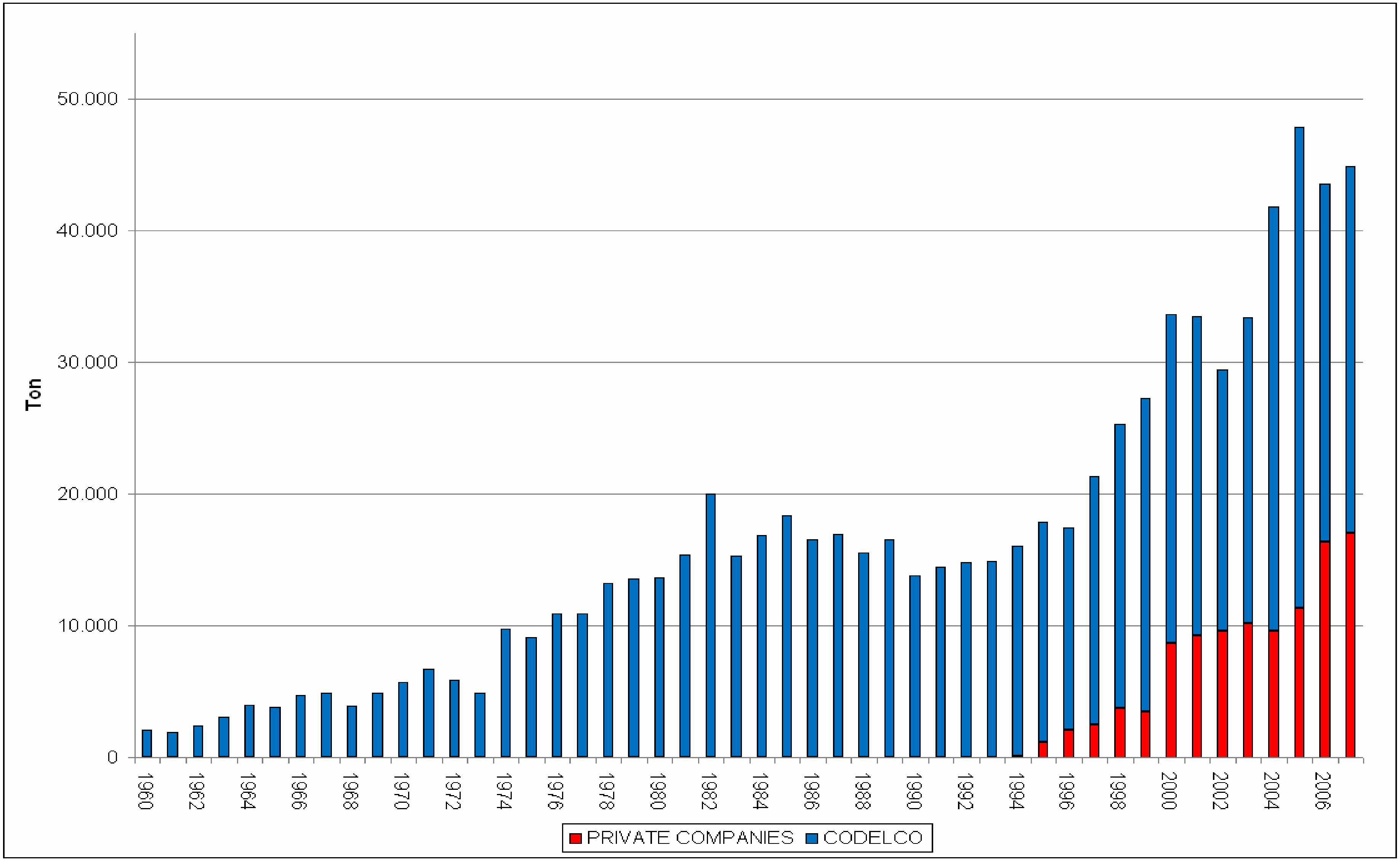
Chilean Molybdenum Production 1960-2007



Source: Based on Comisión Chilena del Cobre.

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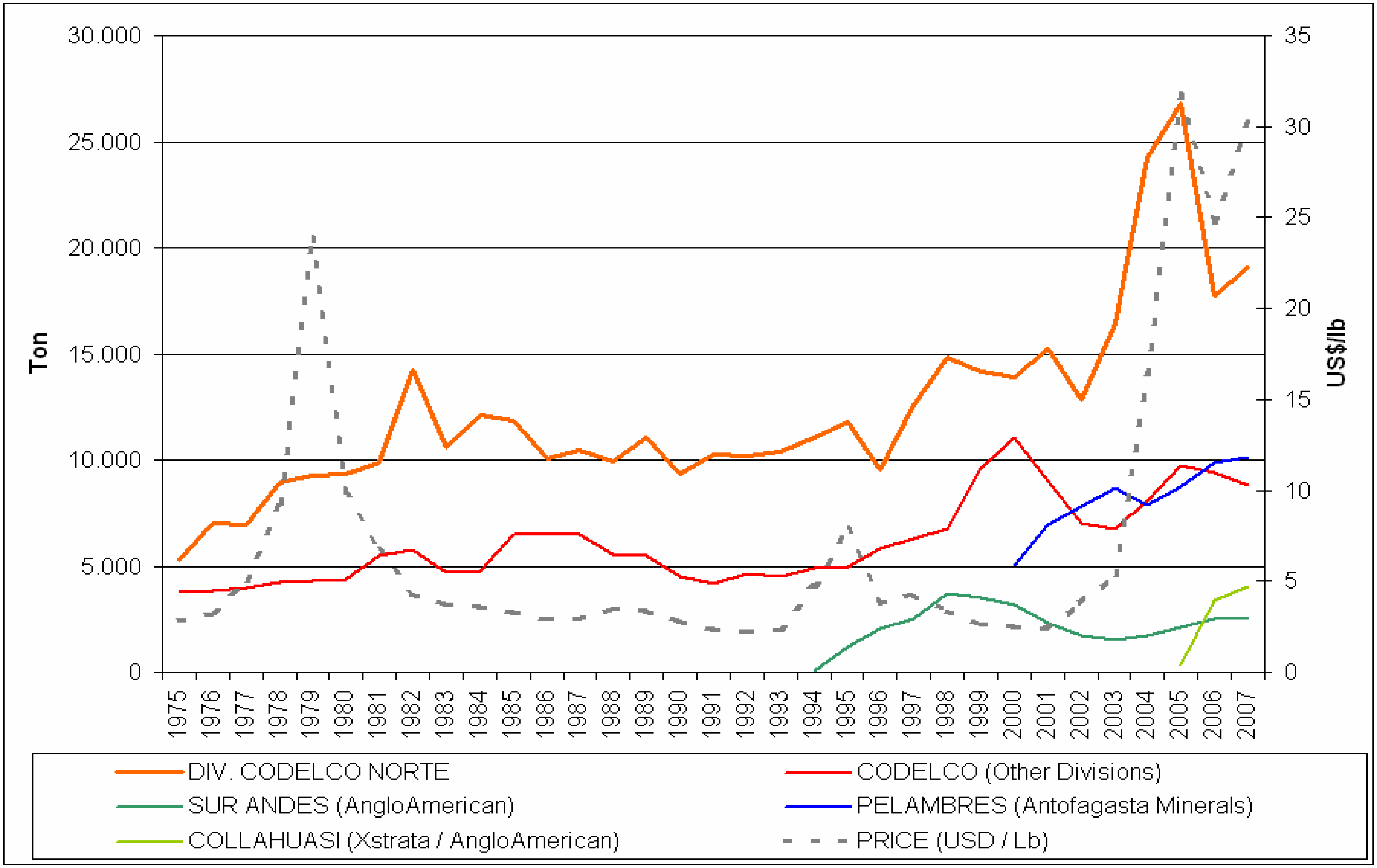
Chilean production by mine
1975-2007



Source: Based on Comisión Chilena del Cobre

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Chilean projects in molybdenum

Planned Start up	Company	Project	Stage	Estimated Investment (US$ millions)
2009	Xstrata	Altonorte	Environmental approval	40
-	Xstrata/Anglo	Collahuasi Expansion	Under study	-
2010	Codelco	Mejillones	Feasibility study	120
2011	Codelco	Recovery improvements (cell expansions, better proc. Timing and additives)	-	15
2010	Antofagasta	Los Pelambres expansion	Expect board approval	50
2015	Antofagasta	Esperanza	Under study	-
2010	BHP Billiton	La Negra plant (5-12 MTT)	Environmental approval. Expect board approval.	120
2010	Molymet	New Mejillones Plant	-	124
		Total Investment in Identified Projects		**469**

Other projects: Los Bronces development project (Molybdenum production will reach 5,400 tonnes from the current level of 2,123 tonnes by 2011), Vizcachitas project (Los Andes Copper)

Source: Based on information from Area Minera and Mineria Chilena Magazines.

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6.- CONSEQUENCES OF THE CURRENT MOLYBDENUM MARKET

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Is molybdenum becoming a co-product ?

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Costing Method

Mining industry convention: <u>“normal costing”</u>

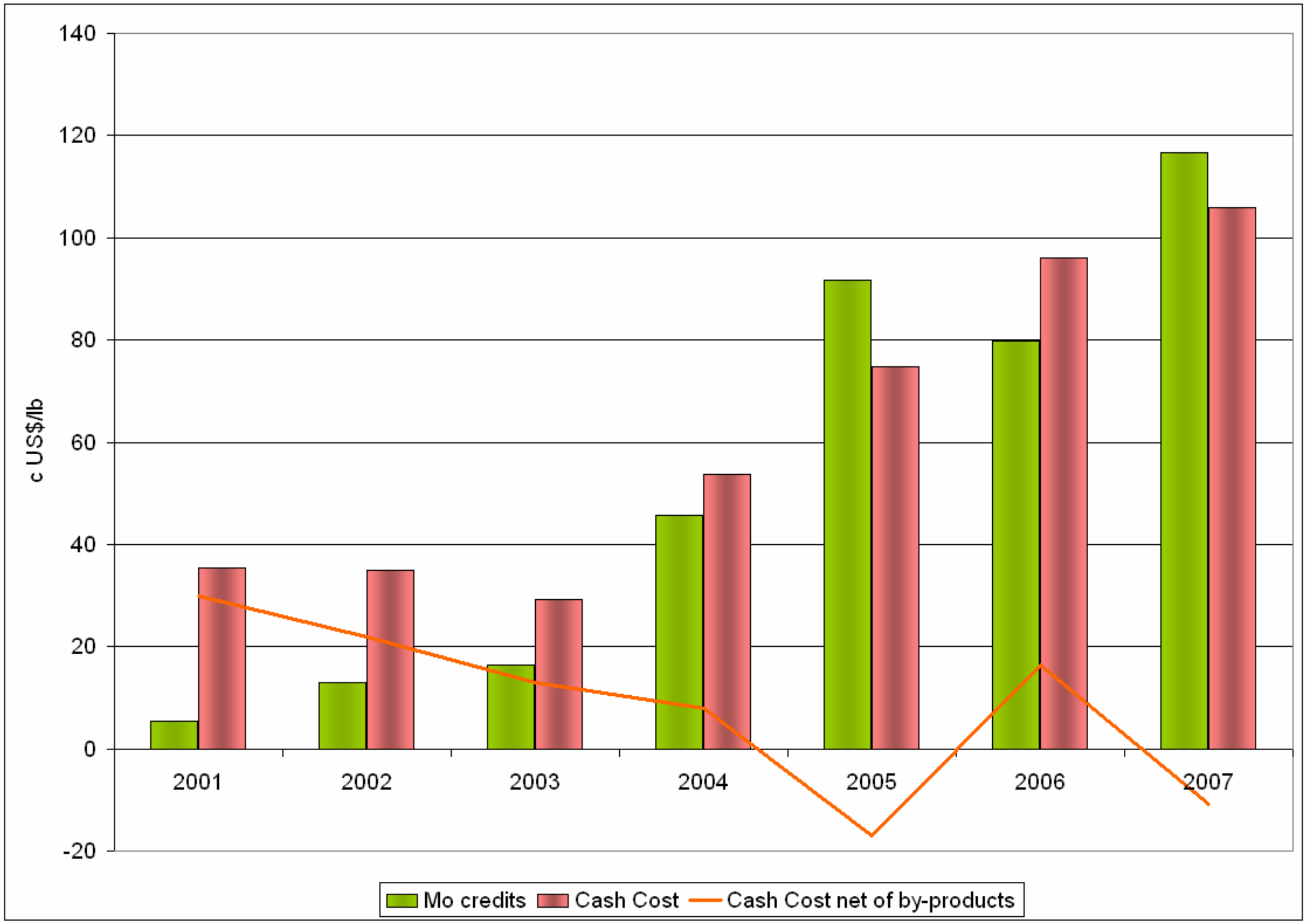
“full costs are allocated to the metal under analysis (copper) and net by-product revenue (moly) is credited against cash operating costs to give a net cash operating cost”.

The alternative: “pro-rata costing”

“the total cost of each process stage is apportioned to the products sharing that process stage, according to their net values at that stage e.g. a metal that contributes 30% of net revenue is allocated 30% of the common costs”.

Moly's role in copper costs

Antofagasta Minerals



Source: Based on company reports

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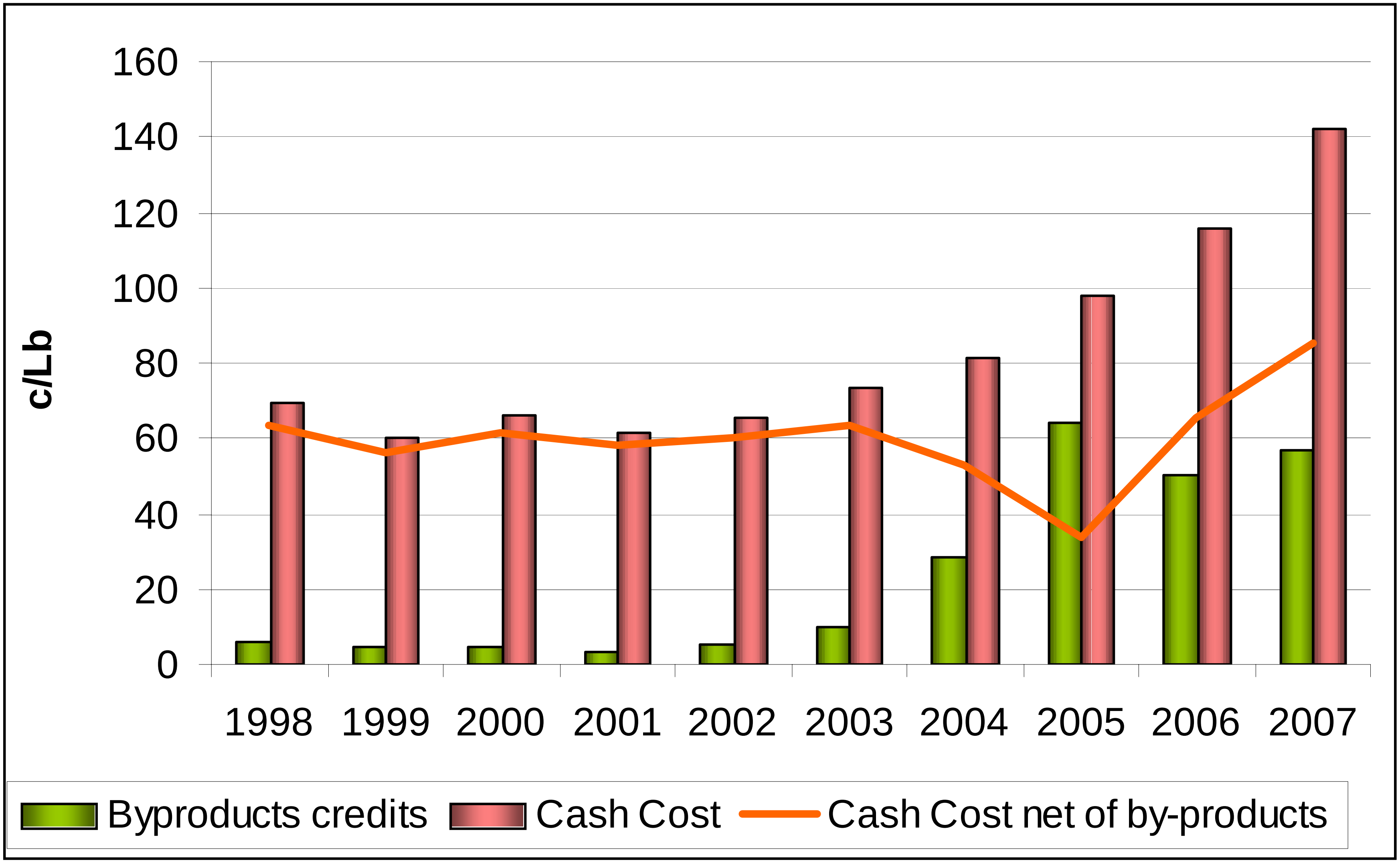
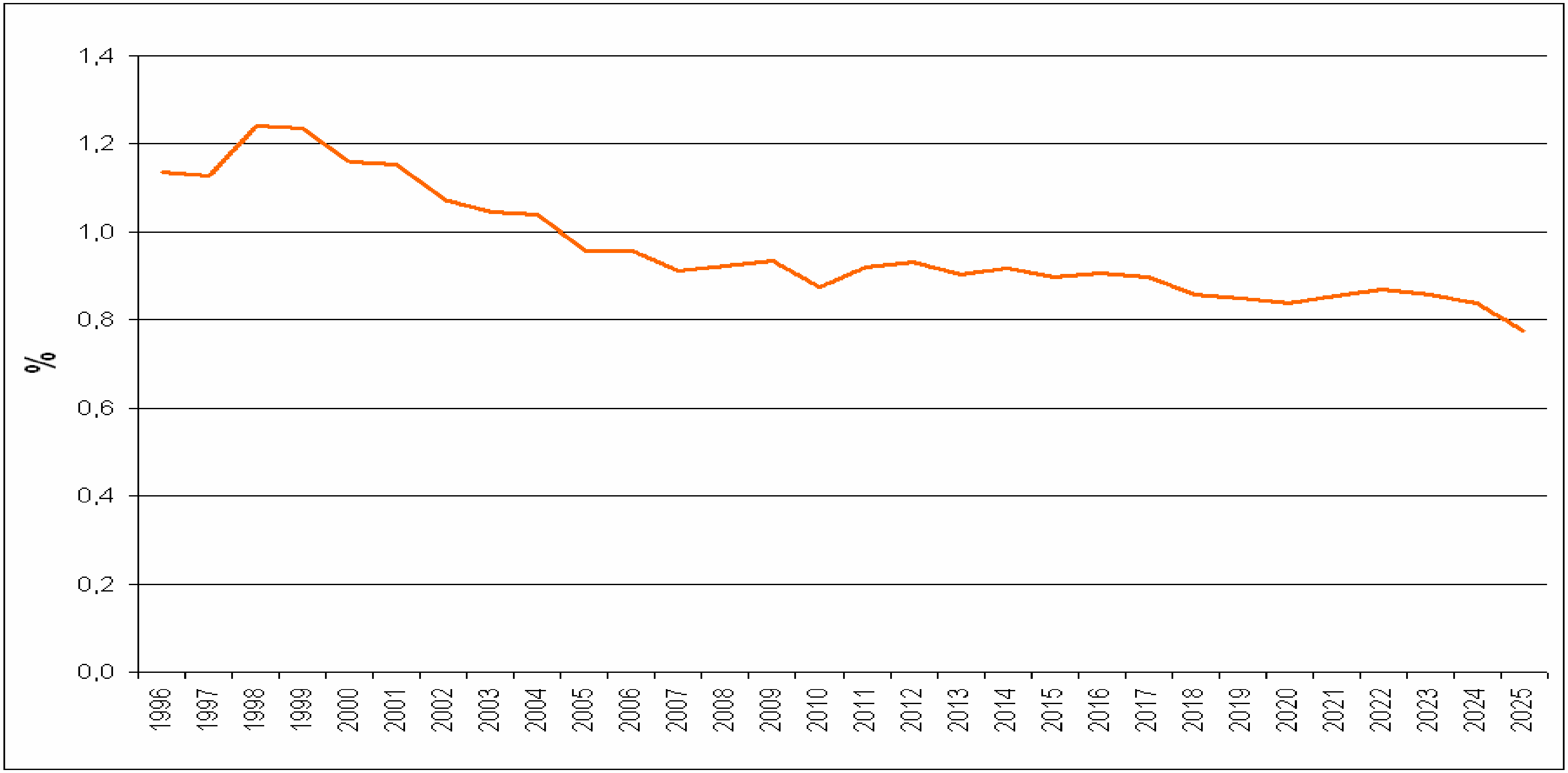
Moly's role in copper costs

CODELCO by-products



Source: Based on company reports

Copper head grades 1996-2025



Average	0,963%
Standard Deviation	0,126%

Source: Codelco based on Brook Hunt data

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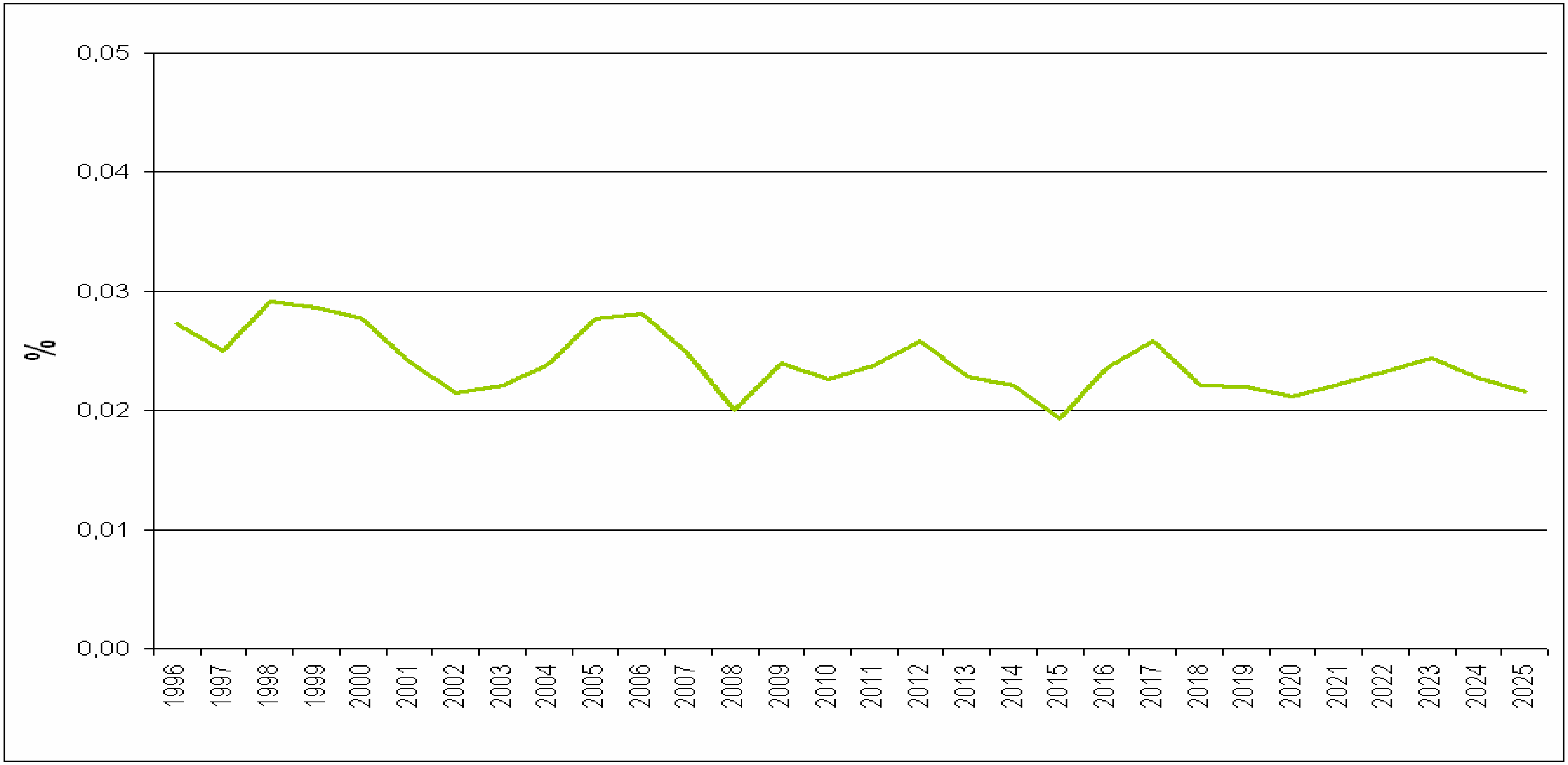
Molybdenum head grades 1996-2025



Average	0,024%
Standard Deviation	0,003%

Molybdenum head grades more stable than copper head grades!

Source: Codelco based on Brook Hunt data

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What is changing due to the molybdenum market?

- Joint consideration of both moly and copper in mining (equivalent price rather copper price)

- Recovery decisions: Trade-off decisions between copper and molybdenum not necessarily favoring copper

- Recovery improvements

- Mining models demand more molybdenum information in order to improve decision making. Particularly relevant in new mines.

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Exploration expenditure Molybdenum and Copper

Molybdenum

Year	Nº Companies	USD millions	Year on year increase
2006	73	65-75	~ 200%
2007	126	200	

Copper

Year	USD millions	Increase
2006	1.346	49%
2007	2.000	

Source: Based on Metals Economic Group data

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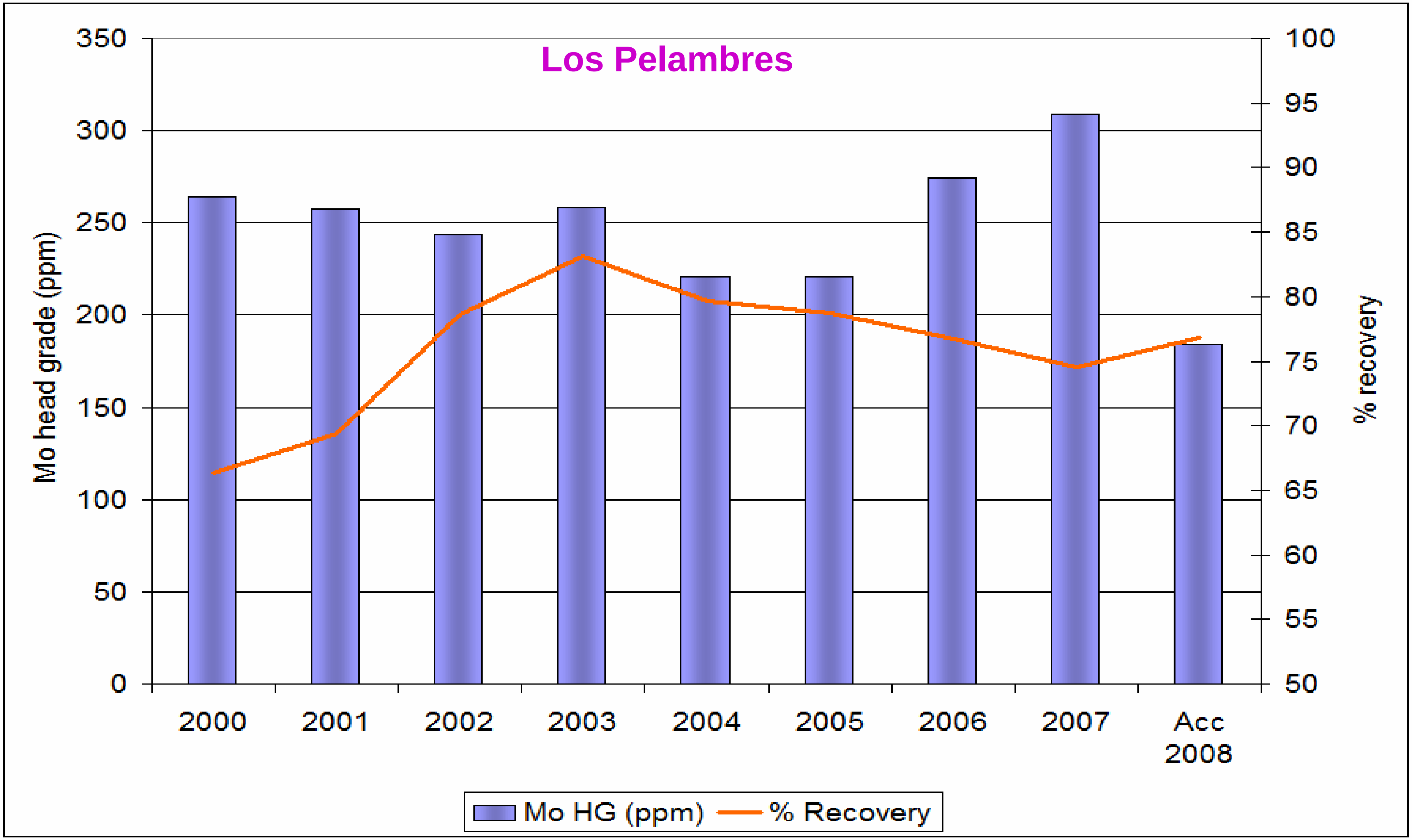
Mo Recovery rates and head grades 2000-2008



Source: Antofagasta Minerals

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Why flexibility is important in the planning of copper-molybdenum mines

- Relative price of molybdenum and copper is a relevant driver in mining decisions
- Flexibility is important to mining managers. More information is useful (testing mine and plant data) along the entire mine life
- Molybdenum is fully considered in development of new mines: Codelco: Inca de oro, MM, Expansión Andina, Chuqi Subterránea. AMSA: Esperanza, expansión Pelambres
- Molybdenum is in the way of being jointly considered with copper in every copper company producing Mo. Only a few companies take operative decisions solely driven by copper today

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