

# The Next 50 Years – Mining and Metallurgy in Canada at a Crossroads A New Golden Cycle or Decline?

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*“For tomorrow belongs to the people who prepare for it today”, African Proverb*

- *G20 renews fight against global risks*
- *Gold price soars as unrest intensifies*

## Introduction and the New “Super Cycle” for Metals

In early 2011, on the threshold of a new decade, the editors of this commemorative book began compiling information for writing this chapter. The first quarter of 2011 provided a wealth of notable news and business headlines from around the world: significant political changes in the Middle East, Africa and Asia, great shifts in oil prices, a growing worldwide debt crisis, and a catastrophic earthquake in Japan, to name just a few. Taken together, the stories seemed to provide a glimpse into our future world, and indicated the following trends:

- World economy still rocky, showing some improvement but later battered by record-high oil prices and growing sovereign debt
- Population growth, with water and food crisis looming
- Electric cars gaining further attention
- New African opportunities
- Waning of the climate debate, emergence of sensible climate science
- Slow recovery in the U.S. but an overall decline of U.S. world influence
- Surge in the economies of China and India
- Political conflict and unrest
- A sampling of headlines from around the world included (paraphrased):
  - *In a fragile recovery, a storm of rising prices (oil, food)*
  - *Copper touches an all time high on hopes of Chinese demand*
  - *Strong growth seen for BRIC countries*
  - *The only way to get richer (as a country) is to be more productive (According to the OECD, Canada continues to lag behind in many benchmarks including patenting of new products and growth in economic output)*
  - *Ford’s green strategy comes into focus, and a related headline, GM’s Volt electric technology to be used on other GM models*
  - *Europe’s debt crisis roars back*
  - *Surging corn demand is set to fuel widespread price hikes*
  - *African opportunities catch investors’ eyes*

While some of the above news reports indicate future setbacks, we, the authors, believe that the pace of industrialization now underway in China, India, Brazil, Indonesia and other developing countries will be largely unstoppable. With this in mind, we believe the future demand for metals will remain strong and, notwithstanding occasional weaknesses, will continue to rise. The present authors therefore take the view that, in terms of mining and metallurgy, there will be downturns along the way, but a new world “super cycle” will emerge. This view is based on an analysis of the projected commodity demand in many of the developing economies, including China, India, Indonesia, Brazil and the African continent.

The expected rural to urban shift in China (and elsewhere) will potentially become the largest population move from rural countryside to urban centres in the history of mankind – certainly on a much larger scale than anything that took place, for example, in the UK and Europe during the industrial revolution of the 1800s.

A number of commentators support this overall view. For example, Bloomberg staff writer Simon Kennedy (Kennedy, 2011) reporting on the 2011 Davos, Switzerland World Economic Forum noted:

*“For only the third time since the Industrial Revolution, the world may be entering a long-term growth cycle that will lift all economies simultaneously, driving bond yields and commodity prices higher.....*

*.....With the economic and investment outlooks “much better” than in recent years, “people are talking about how to get back to business as normal and what comes next,” said Jitesh Gadhia, a delegate to the conference and the London-based senior managing director at Blackstone Group LP, which runs the world’s largest buyout fund.*

*Global gross domestic product will swell to \$143 trillion by 2030, allowing for inflation and market-exchange rates, from \$62 trillion in 2010—with China and other emerging markets accounting for about two thirds of the rise—estimates Gerard Lyons, chief economist and group head of global research in London for Standard Chartered, which generates most of its earnings from Asia”.*<sup>1</sup>

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<sup>1</sup> Authors’ note: by July 2011, this rosy view was tempered somewhat by the European debt crisis and the gloomy U.S. economy picture. Nevertheless growth in metals is expected to climb.

More recently, Peter Munk, founder and Chairman of Barrick Gold Corporation, the world's largest gold producer, told The Canadian Club in Toronto in June 2011: ".....the world needs hundreds of new mines in the next 20 to 30 years to meet the growing demand for metals driven by the urbanisation of developing countries" (Anon, 2011).

Mr. Munk felt that the relentless demand for metals will continue. The authors believe a correction in China is possible – several commentators have mentioned unrest in the country. For example, in an article entitled, "Can China go green?", and discussing the large tonnages of coal

burned in the country, McKibben (2011) mentioned the large number of demonstrators each year who protest inequities such as low wages and poor working conditions that could interrupt growth. The country's aim, however, is to maintain growth in order to ensure stability.

A huge growth in metals output is anticipated over the next 50 years. Using copper as an example, the current per capita consumption of copper as a function of GDP per capita is illustrated in Figure 1 (International Copper Study Group, 2011). As the GDP/capita rises, so does copper consumption (and the consumption of other metals).

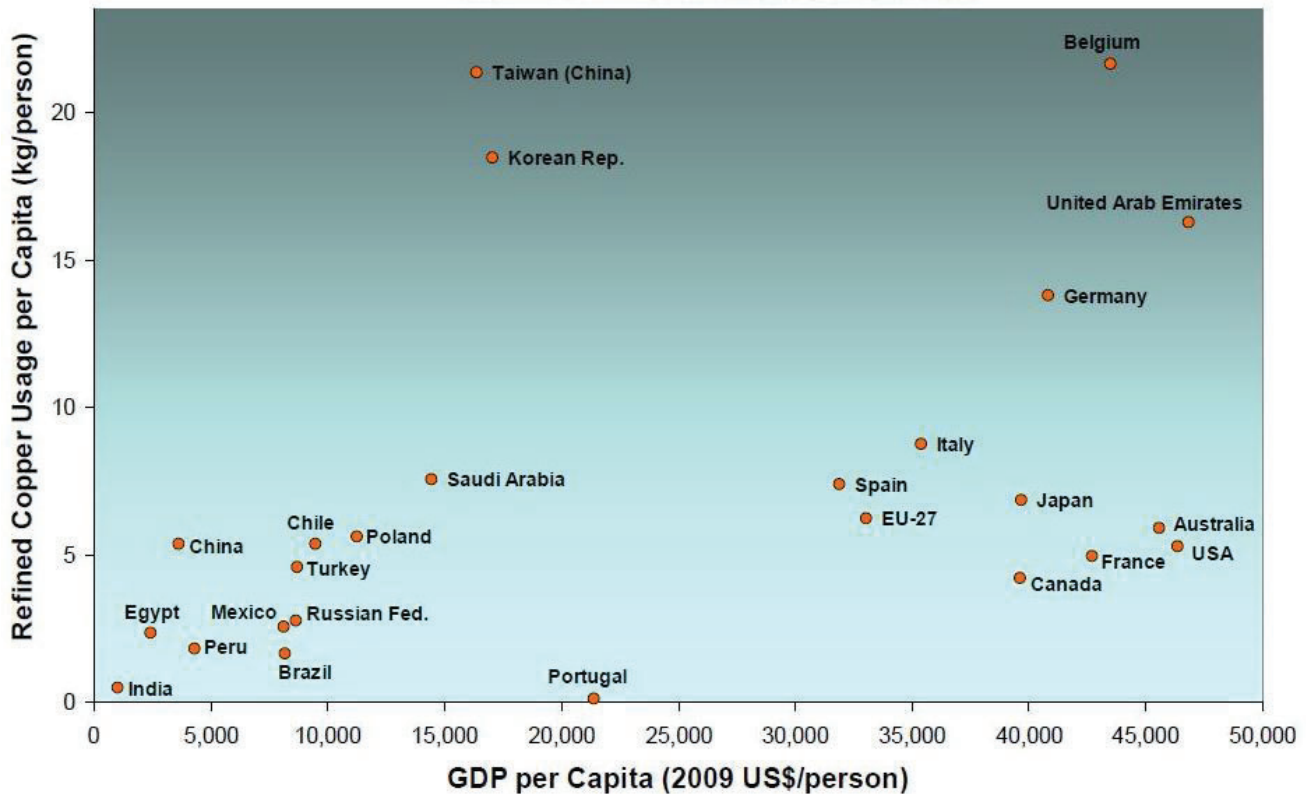


Figure 1. Refined copper usage per capita as kg per person as related to GDP per person (International Copper Study Group or ICSG, 2011), (Courtesy of ICSG)

Current projections for world refined copper consumption up to 2032 are presented in Figure 2. Also shown are the projected requirements in China and India. It is of interest to note that in just over 100 years between 1900 and 2007, the cumulative amount of world refined copper amounted to 608 million tonnes; it is projected that in the 26 years between 2007 and 2032, the required amount of copper will be some 10% more than this, a staggering 680 million tonnes (based on present estimates). Studies show that the per capita consumption of commodities such as copper, nickel, aluminum, etc., increase with per capita income, and then flatten out at a certain level of GDP/capita (when the consumption ratio becomes a constant factor). A seminal study on this topic,

carried out in 1978 and entitled: "World Demand for Raw Materials in 1985 and 2000" (Malenbaum, 1978), illustrated this trend of consumption per capita trending with GDP per capita. Interestingly enough, Malenbaum's projections for the year 2000 for Ni, Cu and Al (0.9, 16.8 and 36.5 million tonnes respectively, numbers rounded) were reasonably close to actual figures for that year. The approach to the percent saturation (the point at which world consumption per capita when related to world GDP per capita tends to flatten out) for four major metals (and also diamonds) is illustrated in Figure 3. Looking into the future, it suggested that, based on present estimates, world demand for these metals will stretch well into the future.

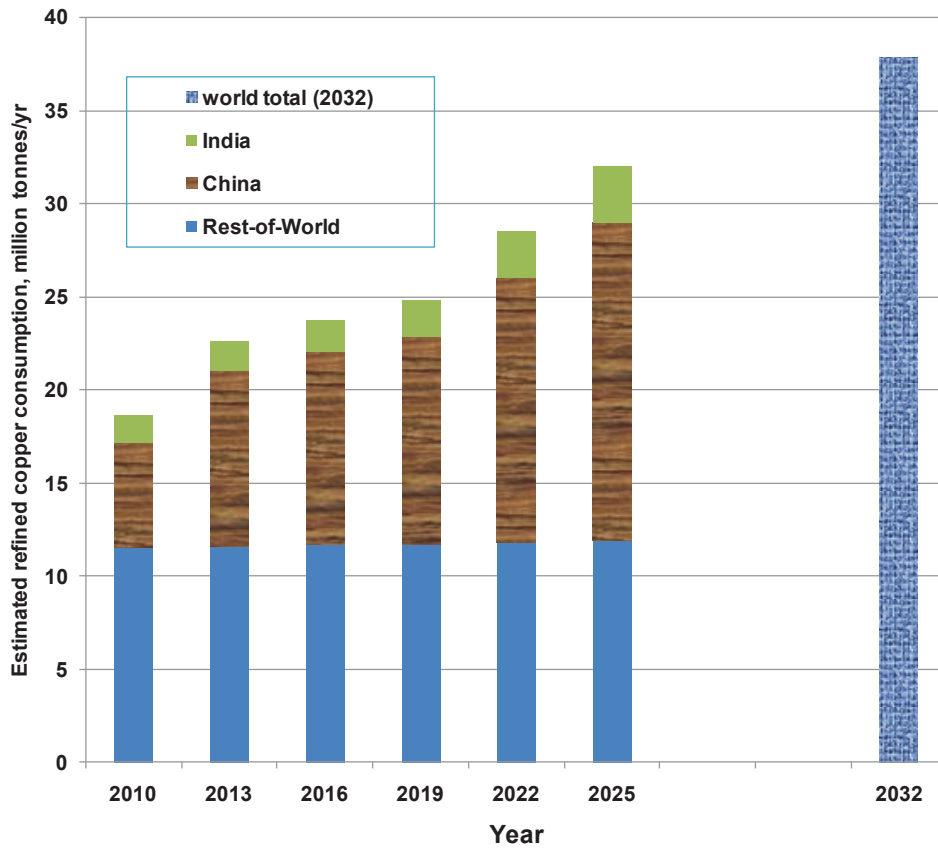


Figure 2. Projected world copper consumption as million tonnes per year to 2032 – Tonnages for China and India also indicated up to 2025 (International Copper Study Group, 2011)

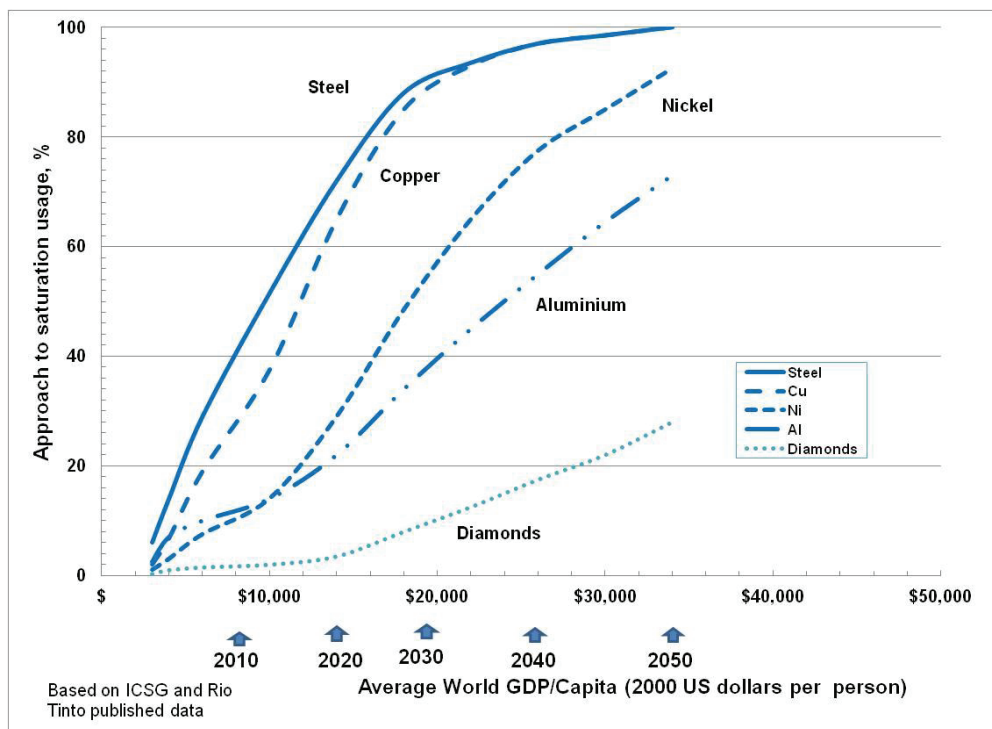


Figure 3. The projected percent of usage saturation (the consumption level at which per capita consumption remains constant with GDP per capita), up to about 2050

Given this world-wide growth in the demand for many of the metals produced in Canada, it can be asked what role can and will Canada play? What policies need to be established to ensure Canada benefits from these vast opportunities? What is the role of industrial research and development conducted by industry, universities and by Government, and finally what is the role of the education system—schools, colleges and universities?

As chronicled in this volume, Canada dominated the “Golden Age” of metals over the past 50 years. However, looking into the future, a new Golden Cycle can re-occur. It will be up to the current generation of new professionals in the industry to make this happen. The generation who lived through some (or all) of the past 50 years must now pass this “winning baton” to the next generation who must, strengthened by the lessons learned by and from their predecessors, embark on the right path. Should the

wrong path be taken, Canada, to its peril, will certainly get less out of the booming commodity cycle than it deserves. The choice is clearly ours to make.

As evidenced in the MetSoc survey results discussed in a following section, energy consumption in metal production is an important topic, now and into the future. Figure 4 illustrates the unit greenhouse gas (GHG) emission intensity in tonnes of CO<sub>2</sub> equivalent/tonne of metal produced for four metals: steel, copper, aluminum and nickel. The bubble size represents the world industry GHG emissions (refer to scale in figure). It should be noted that the GHG intensity for a given plant depends in part on the particular energy mix for that plant. Due to the large-scale use of hydropower usage, GHG for aluminum production in Canada is lower than, say, if the power was produced by thermal coal. Nevertheless, R&D efforts should continue to be a priority into the future to lower energy consumption.

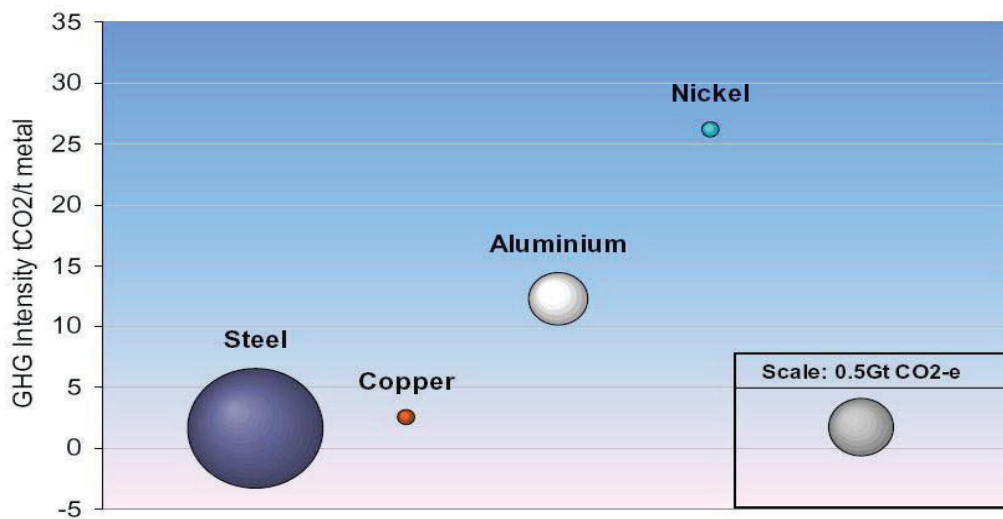


Figure 4. Average greenhouse gas (GHG) emissions intensity for four metals. The size of the bubble corresponds to the present total world industry estimated GHG emissions (Dalvi, 2009)

## The 21<sup>st</sup> Century International Order – Geopolitical Trends

The late nineteenth to early twentieth century saw a gradual inclusion of North America, and specifically the United States of America, as a key player of world power and influence that traditionally had been held by Europe. Following World War II and up to about the present time, the centre of influence gradually shifted from Europe to the United States. A number of recent books have discussed the so-called U.S. decline relative to other countries, and further, some have proposed the required remedies to regain and sustain economic growth in the U.S. for the longer term. The proposals include upgrading the quality of public education, rebuilding aging infrastructure, developing alternatives to dependency on oil, simplifying the tax system, etc. Whether these changes

can be achieved to the degree needed remains to be seen, but it is reasonable to conclude that the decline of the U.S. seen by many is not a given.

U.S. President Barack Obama, in his address to both houses of the British parliament in May 2011 (the first U.S. President in history to do so), decried this notion of western decline. Recognizing that BRIC countries – Brazil, Russia, India and China – are growing rapidly, the President stated:

*“As this rapid change has taken place, it has become fashionable in some quarters to question whether the rise of these nations will accompany the decline of American and European influence around the world. Perhaps, the argument goes, these nations represent the future, and the time for our leadership has passed. That argument is wrong. The time for our leadership is now.”* (National Post, 2011)

What is not clear is whether the corrective actions, needed to ensure that such leadership continues, will in fact occur. The need for job creation – nearly 14 million Americans, or 9.1% of the working population, was unemployed as of May 2011 – and deficit reductions in the United States are huge unsolved problems. Certainly the maintenance of such leadership, called for by President Obama, will require these issues to be tackled head on.

Thus, the extent of the U.S. remaining or declining as a “superpower” will depend on a number of factors, many within its own control. The present editors consider that the U.S. will continue to be a major world power, remaining militarily strong throughout the rest of the present century, but it may decline in “superpower” status. On the other hand, Western Europe, long at the forefront, will likely see a further decline in economic power. This trend will reflect Europe’s decreasing trade with the rest of the world and lower economic strength competitiveness due to high labour costs and a limited appetite for military conflicts. There will be bright spots – Germany for one, likely the U.K., potentially France and to a lesser extent, some of the former Eastern Countries. Russia is unlikely to fill the resulting gap due to its great need to re-build right across the nation. Emerging from these shifts will be the increasing role of South East Asia, particularly China and India, and later followed by Africa.

Just as the 20<sup>th</sup> century saw a gradual shift in the centers of world power and influence from Europe to North America, the 21<sup>st</sup> century will see a shift eastwards towards Asia and India. The following forces will likely

shape the metals industry over the course of the next 50 years:

- World population increases
- Energy issues
- Demand for minerals
- Food and agriculture
- Climate change debate
- World stability factors
- Water shortages

In a series of papers, Prof. Mudd presented various historical trends for a variety of base metal and precious metals (Mudd, 2007, 2009; Mudd and Glaister, 2009). For example, average gold grades since 1835 are trended in Figure 5. Today, many gold companies typically treat ores that contain 2 to 5 grams per tonne of gold. This decreasing trend towards ever lower gold grades has had a pronounced effect on a multitude of processing variables: energy consumption per unit of gold produced, water usage, and greenhouse gas emissions. As an example, cyanide consumption as a function of gold grade is plotted in Figure 6. As grades decrease, more ore will have to be mined and processed in order to produce the same amount of gold. If the mining and metals industry is to remain competitive, new approaches to processing (e.g. ore sorting) will need to be embraced in order to minimize its environmental footprint.

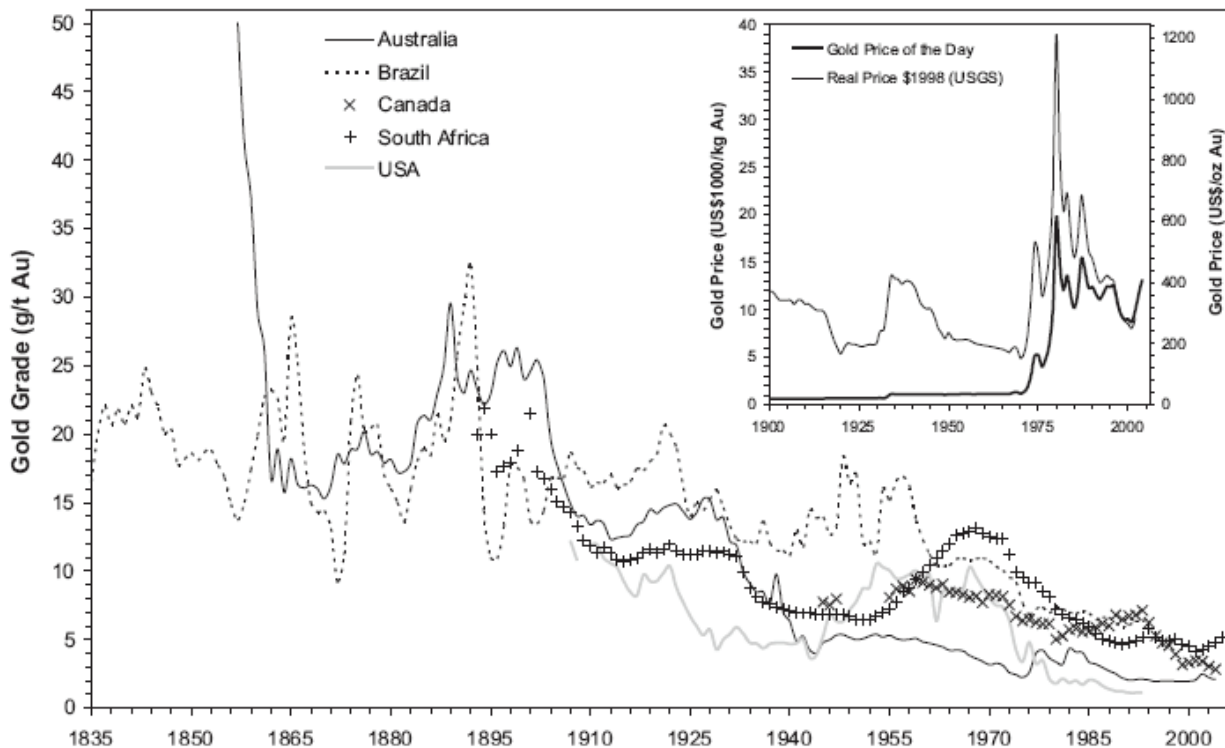


Figure 5. Average gold grades since 1835 (Mudd, 2007)



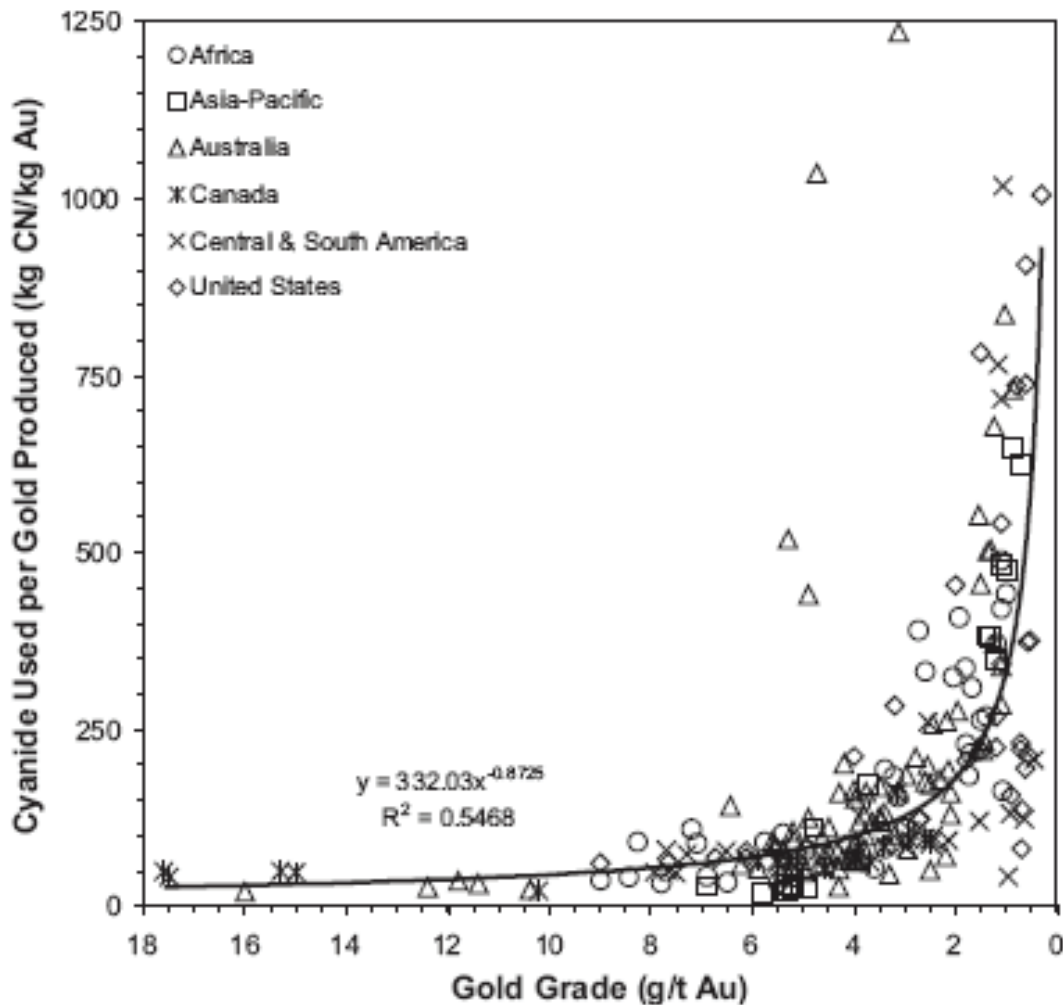


Figure 6. Cyanide consumption as a function of gold grade (Mudd, 2007)

## The Next 50 years: Results of the MetSoc Survey on the Future

*“In these matters the only certainty is that nothing is certain”, Pliny the Elder*

(23-79 AD, *Historia Naturalis* (37 volumes) – included are early descriptions of mining and metallurgy)

During the spring and summer of 2011, a group of MetSoc members were sent surveys to seek their opinions regarding the next 50 years. The group surveyed included MetSoc Past Presidents as well as members at large – members from industry and academia, junior and senior members. About 90 surveys were sent out; the editors received 42 responses. These responses form the basis of the following discussion. The authors would like to point out that this survey was only intended to “gauge the pulse” of the membership.

Responses were received from members with ties to industry, academia and government labs. At the time of

printing this book, the CIM has a total membership of approximately 12,900. MetSoc currently has about 1,700 “known” members. The number of responses received (42) is greater than the square root of the MetSoc membership (41), so the authors feel that the number of respondents is deemed adequate to express the views of our members. The results are presented in a series of charts for selected survey questions. It is noted that the results will be presented in more detail during the Management Symposium at COM2011. Plans are underway to prepare a more complete paper on the survey results. The following is a brief overview of the survey responses.

One of the questions focused on energy usage in our industry. The question read as follows:

*“Considering just energy usage in metal production (say as energy units/tonne of metal) and desirable improvements therein, what reduction in energy consumption do you think should be realistically targeted over the next 50 years assuming reasonable levels of R & D activities are carried out, including the potential of achieving a breakthrough*

technology?”

The results were very clear (see Figure 7). Members felt that energy consumption in metals production was quite important. Two thirds of respondents felt that a 25% reduction in energy usage in metal production would be a realistic target over the next 50 years. 14% felt that the target should be 50% reduction. Certainly this is an important area for R & D in the future. Clearly these types

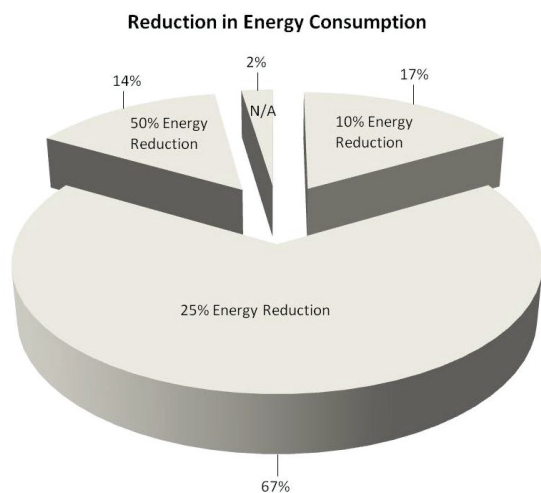


Figure 7. Responses on energy matters

of reductions will not happen by themselves. Will energy inefficient operations such as ball mills be replaced by technologies such as EPD (electric pulse disaggregation)? Will “dry” operations such as ore sorting gain a greater foothold in the industry? Will companies and governmental agencies put in the effort to develop new unit operations? Will industry and engineering firms embrace and promote these technologies?

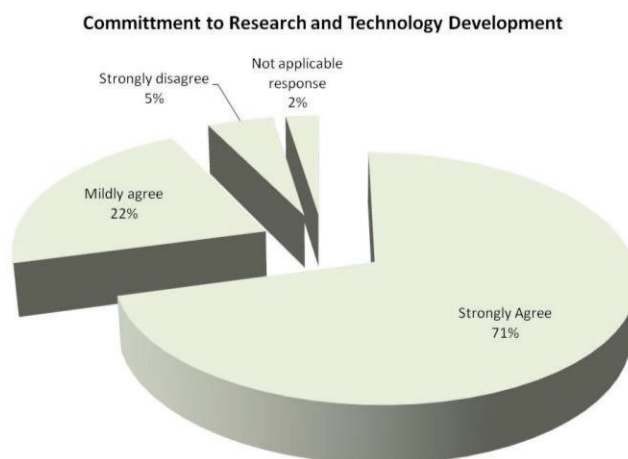


Figure 8. Responses on R&D needs

Another question that had a clear response focused on R&D efforts. Recipients were asked to comment on the following statement:

*“To make Canada more competitive in the future will mean committing more effort than at present by both industry and Governments to research and technology in mining/metallurgy”.*

The responses are shown in Figure 8 and are very telling as well. Overwhelmingly, members felt quite strongly that to make Canada more competitive in the future, more effort must be committed by both industry and Governments to research and technology development in mining and metallurgy. This is an important result that the editors would like to take up with MetSoc and the CIM. The words of Dr John Convey, Director of the Mines Branch (of the then Department of Mines and Technical Surveys) and the General Chairman of the first Conference of Metallurgists held in 1962, in discussing the outcome of the very first Conference of Metallurgists are relevant here: *“The first Conference of Metallurgists was a success because of its contribution to the promotion of research consciousness.....unless we are concerned with research, the country will falter”.*

Perhaps hidden here are some important links to the strength of the mining and metallurgical industry, and perhaps to the Canadian economy.

One survey question that was somewhat left to the discretion of the members read as follows:

*“What will be the ten top issues that mining companies worldwide will face in 50 years?”*

The results are shown in Figure 9. The authors tried to combine the responders’ words into common themes (y-axis) and the x-axis represents the relative frequency of identification. The top issues resolved around: Environmental Issues (legislation, mine closures), Manpower (retaining and attracting staff), Energy (availability, GHG), Political Issues, Social Concerns, and Production (costs, reserves, ore grades). How the industry responds to these challenges will in great part determine how strong our industry will be in the future.

When asked; *“What top six words immediately come to your mind that characterize the Canadian mining and metallurgical industry today?”*, the respondents had the following to say (see Figure 10):

The top responses were: challenged, foreign, successful and dynamic. Lower down on the list were items like: independent, safety, competitive, R&D leader. Whether or not this is gloomier than it should be, the editors are not sure. In any case, this seems to be a long way from the era of the “Golden Age” as discussed in this book. Perhaps some lessons from that successful age need to be re-evaluated?

### Question 13

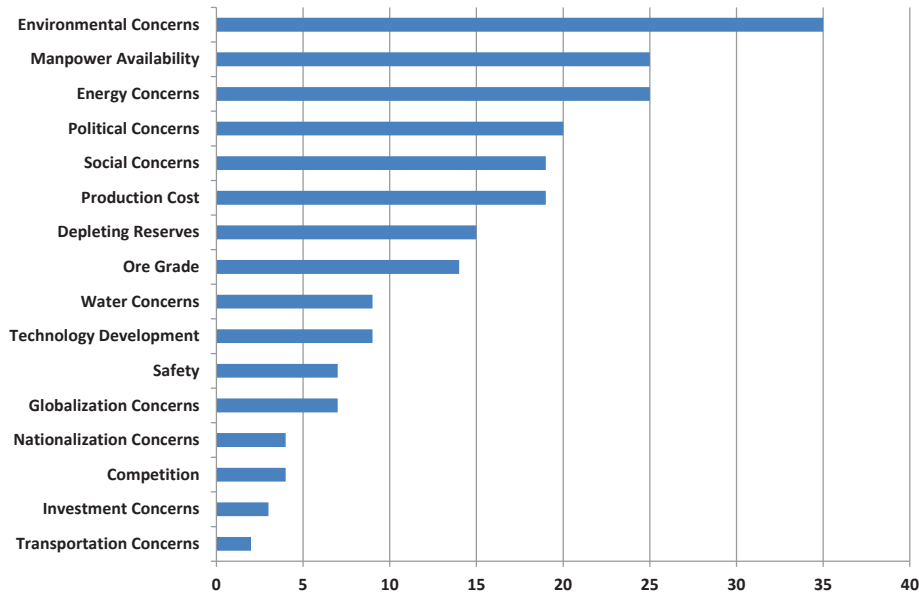


Figure 9. Responses for top issues that mining companies worldwide will face in 50 years

### Question 11

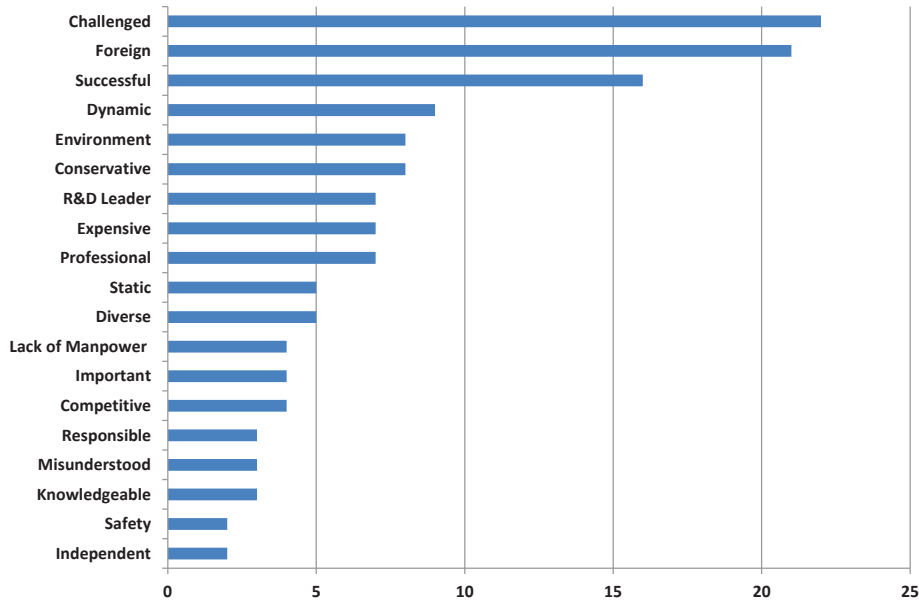


Figure 10. Responses for top six words that immediately come to your mind that characterize the Canadian mining and metallurgical industry today (in 2011)

## Closing Thoughts

*"I never think of the future - it comes soon enough."*  
Albert Einstein (1879 - 1955)

*"The future will be better tomorrow."*  
Dan Quayle (1947 - )

*"The future ain't what it used to be."*  
Yogi Berra (1925 - )

From the time of the first Conference of Metallurgists held in 1962 up to the present day, Canada and the world have seen enormous political, societal, economic and technological changes. The extent of those changes is so vast that it would have been virtually impossible for those first delegates to predict them. There is every reason to believe that the next 50 years will similarly see big events and transformations, not all possible to predict today. Nevertheless, the present authors believe that, overall, world demand for metals will continue. Given this belief,



the past teaches us that the new generation will need to continue on the path towards continued innovation and technical contributions to our industry. That way, whatever changes do occur, we will all stand to benefit.

One thing is certain – when trying to predict the future, you will be wrong! Where will the industry be in 50 years? Will we be mining and processing minerals on the moon using robots? Will we be extracting gold from seawater? Which new technologies will be available for us to use?

Over the years there have been a number of excellent review papers. For example, the entire issue of the February 2007 Journal of Metals was dedicated to looking back at trends in the metallurgy and material fields (JOM, 2007). Very few papers try to predict future trends. The authors, however, are reminded of one brave soul, Professor Bill Davenport, who in 1980 wrote a paper that tried to predict trends in copper smelting 20 years into the future (Davenport, 1980). For the most part, his predictions were extremely accurate.

During the first COM in 1962, the gold price was \$35 per troy ounce. How many of the then delegates would have predicted the recent rise in metal prices (gold touched \$1900 on September 5, 2011)? It is interesting to note that in 1961 Americans were forbidden to own gold at home as well as abroad. How many of those delegates could have foreseen some of the greatest developments of the last 50 years: the personal computer, Global Positioning System (GPS), DNA fingerprinting, etc.

Will the industry be strong and vibrant in the future, or will we see a sharp decline? Will our universities be preparing students for exciting careers in the mining, metallurgical and material industry or will these curricula be expunged? Which topics will the editors of the 100<sup>th</sup> COM Commemorative Book be writing about in 50 years time? The front page of the December 17, 1984 issue of Business Week screamed out the headline: "*The Death of Mining?*" (Anon, 1984). As the Mark Twain quote goes, we strongly hope that "*The reports of my death are greatly exaggerated.*" We strongly believe that the future will bring many challenges and opportunities, but we also sincerely believe that those bold enough to choose a career in this industry will be extremely satisfied.

## Acknowledgements

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