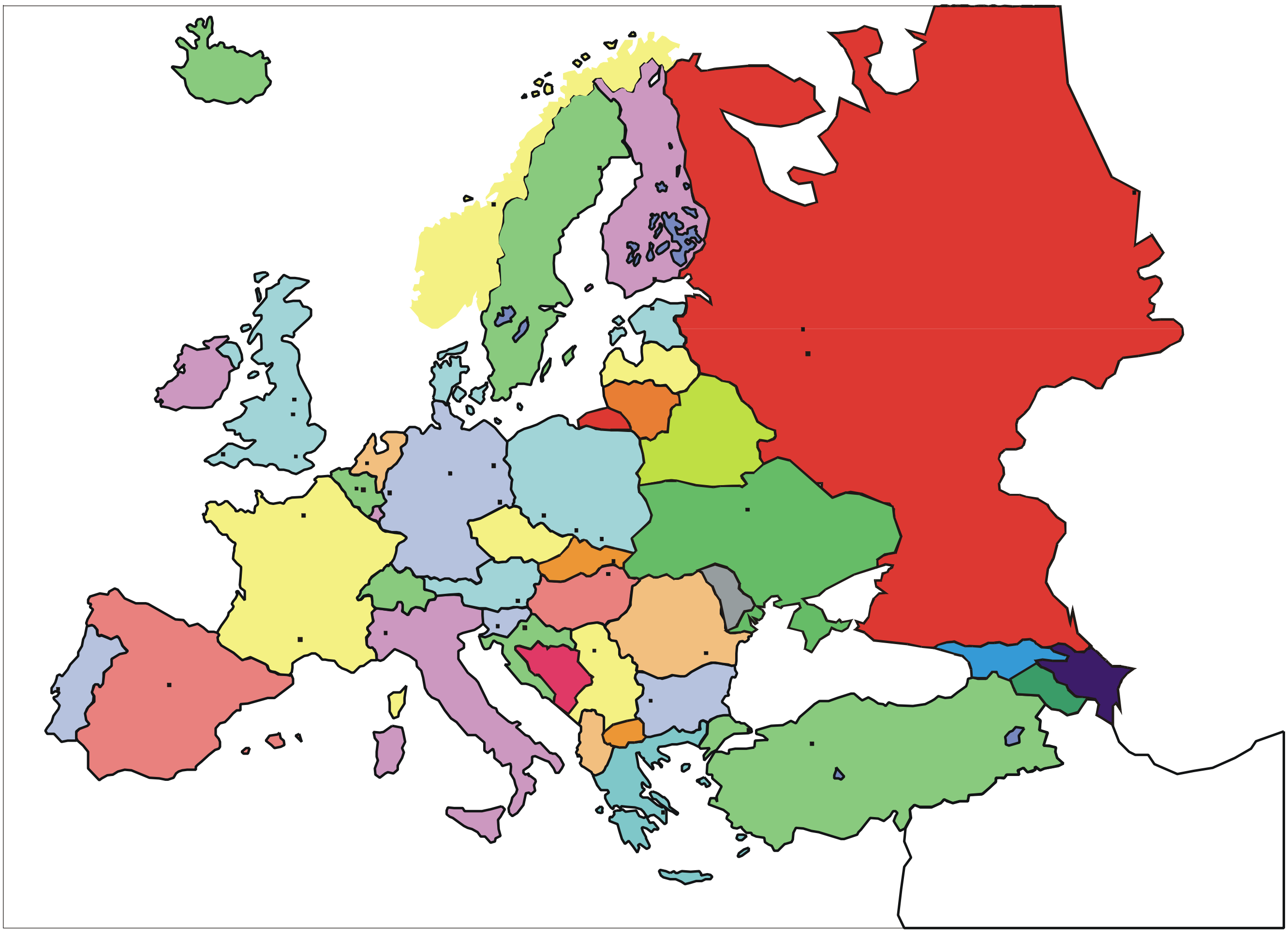
NEWSLETTER

SOCIETY OF MINING PROFESSORS

SOCIETÄT DER BERGBAUKUNDE



Number 14

March 1999

Editorial

I would first like to thank those few of you who have sent me updated versions of the courses that you give in mining engineering at your universities. I am ~~staedily~~steadily upgrading the database, and I hope to have a new version available soon to give out to members. However, most members have not yet taken the time to update their entries and so I urge you to do so. The format can be found on the web site:

http://home.mp.tudelft.nl:80/mineprofs/

Another point I would like to raise here is that the list of members is on the web site and I would urge you all to check the site and see whether we have the correct address for you. In addition, for many of you we do not have an e.mail address. The Society works on a shoestring budget, and it would make things a lot easier financially if we could have an e.mail address for all members. This would mean that I could e.mail you the newsletters rather than having to mail them. Please check your address etc. and let us have any changes.

This newsletter gives the information about the next meeting of the Society. It is important to note that for good reasons the dates have been changed slightly from those that were given in the last newsletter. This is to allow the delegates to use the Lufthansa flights to Ekaterinberg, which are only available three days a week. Also, to get the cheaper fares, a Saturday evening must be included. The new dates enable this to be achieved.

This looks to be an interesting meeting and it should be noted that there will be a joint session this time with UNESCO, who will be meeting in Ekaterinberg at the time. It must be noted that the present plan is for this latter session to take place on the 11th, which is a Sunday. As always, I urge you all to come to the meeting. The annual meeting is the only time the members of the Society really have an opportunity to get their views heard and to make suggestions as to the directions the Society should be taking. If you are not there you cannot have any influence on the way things are going.

Also in this Newsletter, is the report of the second meeting of the group which was formed to look into doing something at the time of Minetime '99 in Düsseldorf. This is a joint effort between the Society, Euromines and Eurominerals. As you can see, it has been decided to hold a press briefing at which the importance of the mining and mineral industries will be stressed and advertised. As we go into the new millennium, it is of importance to continue to try and improve the image of our industry and work.

Mike Karmis has produced another very thought provoking look into the future of mining engineering, the mining industry and mining education into the next millennium/century. This is produced with his permission in this newsletter as many will not have seen it. It does, I believe, raise some ~~questions which~~questions, which will help inform our discussions at the next meeting of the Society in Ekaterinberg. In any case it is well worth reading, even if you will not be able to make the trip to the next meeting.

Finally, there are a large number of members, too many, who have not paid their society subscriptions either for last year, or, in many cases for the previous years as well. To those members, particularly the ones who have not paid their subscriptions for some years, I would appeal to your to do so as soon as possible. Due to your arrears in payment, the continued production and printing of the journal Mineral Resources Engineering, which you receive as part of your membership dues is being ~~jeopardised~~jeopardized. The journal's ~~coninuation~~continuation is dependent on my being able to continue pay the publishers your subscriptions, out of the Society dues received. The present situation with the late payment or non-payment of membership dues has reached the stage where paying the journal is not possible for me, and we are now in arrears with the journal. **Please pay up all you owe as soon as possible!**

Press Briefing after Minetime '99 conference

Euromines, Eurominerals and the Society of Mining Professors/Societät der Bergbaukunde are organising a press briefing on Friday June 11th, immediately following the Minetime '99 conference. The location of the meeting will be in Düsseldorf, close to the Minetime '99 area. The event will be between 11.00 and 12.30. The lunch will be in a nearby restaurant (walking distance).

The target audience is a select group of about 20 journalists of the major papers like: Financial Times, Le Monde, etc. Journalists of other journals and papers will be sent a press kit, which they can use for articles.

The program will be as follows:

- European Commission (provided the right person is available): European Mining Policy.
- Euromines (Antero Hakapaa): Importance of minerals in Europe for the society, economics, challenges, transfer of technology into the world.
- Society of Mining Professors/Societät der Bergbaukunde. (Hans de Ruiter): Co-operation in mining education in Europe, development of new technologies.

The meeting will be chaired by Euromines (Professor Luc Segers).

Companies will host the journalists and pay their fares, if necessary. Each company which hosts a journalist will probably have dinner the night before.

Four posters will be displayed: Two from Euromines, showing applications of minerals and economic figures relating to the importance of the industry in the European and national economies. One poster will describe and present the EMC course and the final poster will give information on the Society of Mining Professors Societät der Bergbaukunde, showing the various member universities in Europe (Mr. Neu will send out information about the size of the poster displays).

A press kit will be made available. This kit will include information about the organising organisations.

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A g e n d a
10th Annual Meeting
Mining Professors Society
11-15 July, 1999, Ekaterinburg

8 July, Thursday	Arrival to Ekaterinburg
9 July, Friday	
10.00	Opening Ceremony - Introduction to the Urals State Academy of Mining and Geology (USAMG).
	«Mining and Mining Education in Urals». Rector of USAMG, Prof. I.V.Dementjev.
	«Mining Environmental Problems in Urals». Prof.A.V.Khokhriakov.
	Session on Informative Technology in Mining Education. Paper by Prof. H. Wagner
13.00	Lunch
	Meeting of Society of Mining Professors/Societät der Bergbaukunde
	1. Apologies for Absence.
	2. Minutes of the last Meeting
	3. Matters arising from the minutes.
	4. Annual Report by the Secretary General
	5. Membership matters
	6. Place of next meeting
	7. Election of new President
	8. Any other Business
17.30	Closure
10 July, Saturday	Sight Seeing
11 July, Sunday	
9.00	Round Table discussion with UNESCO
13.00	Lunch
14.00	Closing Discussion Meeting of Society
	Further discussion of future directions of mining engineering education.
15.30	Closing Ceremony
12 July, Monday	Trip to Asbest town, Uralasbest Mining Co. (up to personal desire of the members)
13 July, Tuesday	Departure

(Keynote Address Presented to the 12th International Symposium of ICSOBA Delphi, Greece, September 16-20, 1998)

LOOKING FORWARD: SOME THOUGHTS ON MINING'S CHANGING COMPLEXION

By

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In this truly remarkable place, Delphi, where the Oracle prophesised and predicted the future of the ancient world, it is tempting to follow her example and attempt to foresee the future of the mining industry. Hence, the title of this address is: Looking Forward: Some Thoughts on Mining's Changing Complexion. Let me note that in this presentation I will view the mining industry in its broadest context, without focusing, specifically, on particular commodities.

The future, however, must begin with the present, and the present reflects the experiences, priorities and accomplishments of the past. Let me then start with a historical perspective of mining, embellished somewhat with a small dose of American "folklore" as I deal with the theme of this presentation.

LOOKING AT THE PAST

A toast to the adventurous!
Explorers, miners, engineers!
Who blazed the trail ahead of us,
The pioneers! The pioneers!

Thomas A. Rickard (1905)

This toast reflects the image, spirit, excitement, discovery and purpose that brought together miners, engineers and investors to fuel the mining bonanza, at the turn of the century, in the US. Even the academic institutions of that era joined in this pioneering spirit. The song below, at the turn of the century, became the signature tune of many mining schools, most notably Colorado School of Mines (Spence, 1993):

Now here we have the mining man, in either hand a gun.
He is not afraid of anything, and he's never known a run.
He dearly loves his whisky, and he dearly loves his beer.
He's a shooting, fighting, dynamiting, mining engineer.

The main players of the mining rush were the engineers, the managers, the investors and the owners. It would be easy to present to you here today an account of their contributions and accomplishments. Indeed, they were numerous. Instead, let me give you a rather humorous account of some of their shortcomings!

Let us start with the engineers. Objecting to conditions, and pay, in the western mines, Shockley (Spence, 1993) defined mining, and other types of engineers and geologists working in the mining industry, as follows:

An engineer is a man who can do for one dollar what any fool can do for two.

A lack of financial understanding and business acumen was also attributed to those early engineers. As Ryan (Spence, 1993), a well known mining man in Montana, noted (circa 1916):

If the Anaconda company should do all the good things its engineers recommend, it will never pay a dividend!

It was the mine managers, however, as the appointed spokesman for capital, who incurred the wrath of his workmen if wages were reduced, or if the payroll failed to arrive on schedule. When Charles Bonner (Spence, 1993), in charge of the Gould & Curry in Nevada, was instructed by his company to cut wages to three dollars (circa 1864), irate miners chased him out of his office into hiding, an event commemorated as follows at the local theatre:

Mr. Bonner, the son of a gun
From Virginia City he had to run.
If, we'd 'a got him, before he got away
He's never 'a seen three dollars a day.

R. Stretch (1921)

In the late 1800's debates of scrutiny, accountability and responsibility began to emerge in the mining industry. It was suggested that without such technical scrutiny, managers proceeded as they, and their ill-informed directors, chose! One of my favourite comments is attributed to Alexis Janin, a famous metallurgist educated in Europe and the US, who was recognised as a leading authority of his time (Spence, 1993):

Young men, as we old men know, are generally fools, but it is quite permissible in the young to be fools, provided that they recognise the fact before it is too late... There are sometimes old fools. Directors of a company are generally old and also fools. I have more than once put things over merely because, as an expert, I had the authority to bring about changes which were denied to a superintendent, although he was more capable than myself.

Alexis Janin (1893)

What about the reputation of professors involved in the mining field you may ask? Lamb (1912) published an elaborate chart for providing a graphical solution to "Lamb's Formula" for assessing the prestige and relative standing of an individual involved in the mining industry. In developing his scale, Lamb has assigned a relative worth to a professor of mining marginally higher than that of a used machinery salesman or, that of the lowest of all, a stockbroker!
Mine owners also did not always enjoy a good reputation, as was eloquently described by Mark Twain:

A Western mine is a hole in the ground owned by a liar.

This parallels a statement made years afterward, by oil tycoon Paul Getty, who proclaimed:

The meek shall inherit the earth, but not its mineral rights.

Mark Twain also had this sound advice for investors:

October. This is one of the peculiarly dangerous months to speculate in mining stocks. The others are July, January, September, April, November, May, March, June, December, August and February.

I would like to close this historical note with my favourite verse (Spence, 1993), again devoted to mining investors:

There are mines that make us happy,
There are mines that make us blue,
There are mines that steal away the tear-drops
As the sunbeams steal away the dew
There are mines that have lost the ore shoot faulted,
When the ore's forever lost to view,
But the mines that fill my heart with sunshine,
Are the mines that I sold to you.
Anonymous (1920)

THE CURRENT STATUS OF MINING

Throughout the first six decades of this century the wide range of minerals mined sustained industrial production and provided the basis for industrial growth and development. Then, the position of the industry began to deteriorate rapidly. Escalating labour and general production costs, spiralling environmental costs, over capacity and surplus stocks, diminishing ore grades, depressed mineral markets, progressively more demanding regulatory and taxation policies and the direct or indirect subsidisation of the mineral industries by some governments, all contributed to this decline. During the period 1982-85 the major US copper producers (Phelps Dodge, Asarco, Amax) lost nearly $2.5 billion. Coal prices dropped drastically to about half their 1970s peak level. "The Death of Mining" was proclaimed by Business Week (1984).

But the wheel turned again for the mining industry. Economic recovery in most industrialised nations, the emergence of new strong economies in the countries of the Pacific Rim, and population and industrial growth in some regions in the world, particularly Asia, brought strengthening in metals demand. In view of these global economic, social and political changes, a restructured mining industry emerged, based on a new cost-cutting philosophy, utilisation of modern technology and globalisation of exploration, mining and mineral markets.

In his address to the Congress of the Council of Mining and Metallurgical Institutions, then BHP's Chairman Sir Alistair Frame (1986) noted that:

Cost reduction does not always involve capital expenditure or the installation of hardware Essentially, it involves a changed attitude of mind from that which prevailed in the 1960s and early 1970s. The main requirement then was to produce as much as possible, often regardless of cost, prices usually following costs upwards. The present need is to produce at as low a unit cost as possible in order to remain within given market prices. In a sense the mineral industries have rediscovered the basic harsh disciplines of the market place.
Frame (1986)

New technology and the computerisation of many functions have streamlined production, cut costs, improved quality and reduced downtime. Within a decade, from the early 1980s to 1990s, North American metal mining companies raised productivity by as much as sixfold. Overall energy efficiency in the aluminium industry was increased by over 20%. Record coal production was achieved, although the industry's work force declined by 100,000 coal miners. Innovative heap leaching practices allowed Nevada to become a low cost, and the second largest, gold producing, region of the world.

But will the companies of the 1990's survive and flourish in the 21st Century?

OPERATIONAL PARAMETERS AND TRENDS

Let us now examine some important parameters and trends that impact current mining operations and could determine future growth, or even the survival, of mining companies.

<u>Minerals Demand</u>

In the Annual Review of Mining Journal (May 15, 1998), reporting for the United States, Richard Lawson of NMA reported that the nation's GDP rose by 5.8% to $8,080 billion in 1997, while the US population increased by 2.4 million to reach 267.9 million. Demand for minerals grew more in 1997 than in recent years due to strong domestic economic growth. This demand for nearly all commodity minerals is expected to grow modestly to the year 2000. The expectation of low inflation rates, high employment levels, stable wage rates and a gradually expanding domestic economy will contribute to a stable minerals industries. US demand for products in the transportation, construction and agricultural sectors, in particular, is expected to remain strong. US coal production and use is predicted to set records in 1998 and beyond. International trade is expected to increase by 66% in the steam coal market, between 1995 and 2015 (Annual Commodity Review, 1998). However, growth in the metals mining and processing industries could be dampened by falling demand for metals and capital goods in the Southeast Asian economies.

Despite environmental attacks coal, globally, remains the best guarantee for security of energy supply and coal has a proven track record for price stability. The Kyoto summit indicated that no nation (developed or underdeveloped) was willing to ruin its economy by imposing a high CO_2 tax on itself. The meagre compromises that were signed still have to be approved by national parliaments (in the US, the Senate has already declared its unequivocal "no").

Europe's most important role in the mining and metal industry is traditionally on the demand side for the market equation (Mining Journal, June 19, 1998). Europe has a relatively small mining industry, but it is a major processing centre and the world's largest consumer of non-fuel minerals, most of which must be imported. Interestingly the same editorial noted that out of the top three, major, new European mining projects, two were located in Greece, namely: the Kassandra project, a $250million project for a production of 225,000 oz of Au; and, the Skouries project, a $300million venture aimed at producing 275,000 oz of Au and 50,000 tonnes of Cu. Both these projects are undertaken by TVX Gold.

The Mining Journal (June 5, 1998) noted that last year was good for aluminium. Demand was up and 1997 was the 15th straight year of growing aluminium consumption. This growth was more than sufficient to meet the sharply higher production form both restarts and new capacity. Primary aluminium capacity in the west increased 4% (17.39 million tonnes). No green field projects were completed, but several smelters expanded. Western bauxite production rose almost 3% (to 108 million tonnes) and that additional 17 million tonnes were produced in the former eastern block.

What do these supply-demand trends indicate? Sustainable development studies clearly show that the world's fundamental challenges remain the same: population growth and the need to improve many people's quality of life and standard of living. World population is likely to double over the next fifty years. This will need increased use of basic products, such as food, energy, and materials, all of which are based on mineral resources production. Conservation, recycling and energy savings may offset some of this growth. However, these reductions will not be sufficient. According to a recent article (Editorial (a), 1998):

> ***"quantum leaps of technology, productivity and eco-efficiency are required."***

The well known British scientist and commentator Tom Burke, who also serves as an environmental policy advisor to RTZ, commenting on the need to integrate technology and ecology, said (Editorial (b), 1988):

> ***"we are not fundamentally short of the resources, capital or technology to offer twice our present population a decent quality of life, without undermining the ecological foundations of the economy. But putting them together in a sustainable manner is not a task for governments alone."***

Global Issues

There are four topics that I would like to discuss under this section, which are impacting the development of mineral resources, namely: mergers and acquisitions (M&A), industrial privatisation, electricity deregulation and, the rather disturbing topic, after the Bre-X saga, due diligence.

Mergers and Acquisitions

Globally more than $ 18 billion was spent on mergers and acquisitions in the metals mining and refining industry last year, 50% more than in 1996. This trend is continuing, and in the first four months of 1998, $ 15 billion have already been spent on M&A. Gold is the metal on which most capital has been spent through mergers, acquisitions and initial public offerings (IPOs). The total spending of some $20 billion on gold was about 1/3 of the total spent on all other metals, for the January 1995 to April 1998 time frame. Spending on aluminium/bauxite over the same period totalled $7.6 billion, but almost most of this ($5 billion) was spent during the first four months of 1998. During the last year well over 100 ownership changes were recorded, involving costs ranging from $11 million to as much as $3.8 billion, the later figure concerning Alcoa's take-over of its fellow US aluminium producer, Alumax, early this year.

As a result of this activity, global corporate structure and the pattern of ownership have changed drastically since the early 1970's. Although more than 8,000 companies are involved in western-world mining, the bulk of global mine production is controlled by just a handful of companies. According to the Stockholm-based Raw Materials Group (RMG), there are fifty top mining companies controlling more than 60% of world mineral production (Mining Journal, May 29, 1998). In fact, the top three, Anglo American Corp. of South Africa, Rio Tinto of the UK and BHP of Australia, control 18% of the total value of all non-fuel mineral production.

The RMG report also noted that the increase in M&A is particularly significant when waited against an anticipated decline in exploration activity during 1997 (Mining Journal, May 29, 1998). This may indicate that M&A are now preferred as the most favourite means of expansion within the mining industry. This trend also reflects the increasing share of exploration activity now conducted by junior companies, who lack the capital resources to develop a potential mine. Recognising that finds remain difficult, juniors are still the key to successful finding activity. Big companies are focusing on exploring or acquiring large, long-lived properties. At the same time, majors are willing, and interested, to sell their smaller properties (e.g., Barrick, Placer Dome). Financing is reasonably available and developing countries have now a hospitable climate for mining investors. Nevertheless, the primary drivers on acquisitions are: Resources / reserves, sales contracts, cost improvements and diversification.

I must stress, however, that:

> ***"Exploration first adds value to a company - acquisitions are a distant second (Schwab, 1997).*** "

Shareholders of large companies, spending huge amounts on acquisitions should be asking - will the acquisitions generate sufficient profits and cash flows, and will the managements of the new, enlarged companies be able, to realise the planned benefits and cost reductions arising from the merger or acquisition? Or the enthusiasm for M&A is because this avenue is perceived as a way of avoiding the costly, risky and lengthy exploration phase of the typical mine-development project?

Industry Privatisation

Privatisation has changed the structure of the global mining industry (Schwab, 1997). However, it is continuing at a slower pace and the remaining privatisation opportunities are becoming more difficult to carry through, since the best assets have already been sold. During the first four months of 1998 two significant privatisation projects were identified, notably: Alcoa's \$410 million take-over of Inespal of Spain and the increased stake by Union Miniere of Belgium in the Bulgarian copper smelter MDK.

The earlier attempt this year to auction Venezuela's aluminium assets failed, after the three major bidders withdrew, because of onerous sales terms and an excessive base price of \$2.1 billion. Venezuela's privatisation agency (FIV) indicated that two major consortia were to be involved in the July 15th auction, on a base price of \$1.55 billion. This was again postponed and interested companies are re-grouping yet again. On the other hand, the "landmark" accord reached in Jamaica recently, between government, industry and the unions, will improve labour relations and resolve the issue of taxation on productivity enhancement schemes. These developments will be discussed in detail, by more knowledgeable speakers, later in the program.

Electricity Deregulation

During the next few years, industrial and domestic consumers will be profoundly impacted by the deregulation of the utilities industry. The question of how electricity deregulation will affect a particular company and, in this case the overall market for aluminium, is absolutely critical to the strategic future of every aluminium company. Electricity remains one of the major differentiating factors between smelters (Editorial (a), 1998). According to Alcoa of Australia:

> ***"Australia's ability to encourage the industry to grow is clouded in particular by the competitiveness of electricity prices in the light of deregulation, and by concerns over perceived linkages of fossil fuel power stations with possible future climate change. In light of these circumstances it is important for Alcoa to take advantage of the window of opportunity secured by the government at the Kyoto climate change conference, and develop an effective future strategy for dealing with these uncertainties."***

Due Diligence

Finally, the Indonesian Busang gold fraud scandal, involving Bre-X, has focussed the technical professional community's mind on the need for effective due diligence. As noted by Hanchek (1998):

> ***"Busang was more than an ordinary gold scam with a few zeroes added It was an extraordinary popular delusion."***

Busang was a humble beginning to what was to become the world's largest, most daring and best-engineered salting scam. Silver (1997) noted:

> ***"(Bre-X) has all the ingredients of Hollywood - power, money, greed, glamour and intrigue."***

Without any new drilling Bre-X estimated annual production capability of 2 million tons for Busang.

> ***"It's never a good sign when geologists go "missing" at such critical times,"***

commented Hanchek (1998) on the "accident" involving the company's chief geologist!

Because of Bre-X, 1997 will be remembered as the year that:
- the market's appetite for geological resources and exploration evaporated;
- the role of mining consultant would be redefined;
- and, the year that Canadian market regulators and investors, globally, begun searching for new guidelines on reporting.

In Canada, at least, 1997, will be the year that most mining executives, shareholders and mining analysts will want to forget (Martin, 1997). The post Bre-X impact on the market was:
- depressed gold shares;
- severe impacts on junior companies;
- cancellation of deals;
- and, problems in raising financing.

The lingering effects, both reputational and financial, of Bre-X could alter the conventional view of the Canadian stock exchange as the exchange of choice for mining companies (Klimley, 1997).

Economic Trends

The growth rates of the latest metal industry leading indicators remained low and continued to point to slower growth or, possibly, even some declines in metal industry activity in the coming months (USGS, 1998). Declining economic activity in East Asia (and the recent problems in Russia) may hold down price growth for most metals. According to the same report, the leading and coincident aluminium mill indexes appeared to be pointing to declining growth for aluminium mill products activity in the near term.

The monetary crisis in East Asia may impact global mineral development in different ways. Future large-scale mine developments in the region most likely will be delayed, until the economy improves; overall exploration activity in the region will decrease, as the internal cash flow of the majors feels the pinch; gold demand, in particular, will soften as disposable capital within the Asian economies dries up.

Gold still fascinates investors and explorers alike! The Gold Field Minerals Service (GFMS), presenting its gold statistics for 1997, stated that the relentless price decline was a clear sign of an oversupplied market. The average price of $331/oz in 1997 was a 12 year low, even in nominal terms, and in real terms, was the lowest level since 1972. Surprisingly, mine production also increased by almost 5% to a new record level 2,464t. This increase in production was due to start-up of new mines, which were under development during the past few years. GFMS calculates that the average cash cost of gold production dropped 7% last year to $250/oz. Nevertheless 42% of Western producers still had total costs which were above last year's average spot gold price!

According to most observers, the most damaging aspect to gold prices was the official statements by the European Central Banks to engage in some form of mobilisation of previous sterile gold reserves. The reaction of the market was to sell borrowed gold. Thus, although the impact of central banks sales was a negative factor on price, it was mainly the negative sentiment and rhetoric, which were primarily responsible for the price weakening last year.

According to Forbes Magazine (McCormack, 1998) the extraction industry has seen prices fall near or below average production costs and the result has been profound restructuring. Copper producers have cut back on their output and slowed growth capacity. Two industry giants - Cyprus Amax and Phelps Dodge - each have shattered 10% of their domestic capacity. As I was preparing this paper, I noted with interest that the stock of the major US mining companies, in July 1998, was valued at 1/2 to 1/3 of the corresponding 1997value. The magazine, however, notes that two decades of unrelenting pressure have transformed the mineral resources sector. Producers have been forced to become more efficient and weak companies have folded. The impact was to have companies squeeze more money from existing operations, rather than from increasing production. As a result, some investors now pick gold on their investment strategy. With prices currently around $300/oz it was suggested that the wave of central bank selling that sent prices into a tale spin has largely passed. A manager of a major fund was looking for a price of $350/oz by 1998 year-end.

During the past 20 years the economic emphasis in the mining industry has gradually shifted away from the traditional philosophies of production levels and resource sizes, which are rather meaningless from a cash flow perspective. Mining companies must now embark on programs that emphasise earnings and profits, rather than production levels. Companies must focus on the economic reasons for their existence.

Technical Developments

Significant technical developments contributed to the recovery of the minerals industries in the past 20 years. However, despite these technical advances, few conceptual changes have been made in the way we mine mineral deposits. According to Cohen (1994), apart from some massive increases in the size of equipment and mechanisation, if Georgius Agricola was visiting a mine today, more than 500 years after his birthday, he would recognise most processes and would find little change of principle or method in the industry!

This is particularly true in the case of underground mining techniques. That industry has been forced to cope with environmental and health and safety regulations, eroding metal prices, difficult geologic and mining conditions, economic limitations, just to name few of the challenges. The gains in productivity derived through mechanisation, technical advances and improved labour efficiency have not always offset the detrimental changes in cost and recoverable ore value. In the USA (Miller and Hrebar, 1995) this is reflected in the dramatic plunge in the number of operating underground mines (-74%) and in total employment (-73%), between 1962 and 1995. As a result, as a percentage of total metal production, underground mines have lost prominence to highly productive surface operations in most major commodities. This is particularly glaring in the precious metals. Industry observers also note that, while a number of new underground mines have been developed recently, most grass-root exploration and drilling programs are targeting shallow deposits rather than those amenable to underground mining methods.

Underground mining must make major technological strides in the development of new, low-cost, high efficiency mining systems. These changes need to extend beyond advances in equipment design and/or integration of mechanisation. Revolutionary changes are needed, which can encompass large-scale changes in the traditional way that deposits are mined and developed. Otherwise, the recoverable metal value per ton of ore, mined by underground methods, will decline significantly.

In a recent article, Ellis (1998), current Chairman of BHP, referring to technology said:

"the challenge in resources industries is continually to reduce costs and increase margins and returns. This means using advances in technology, both to optimise existing businesses and to develop better ways of finding new resources and delivering the derived products to the marketplace more cheaply. High technology is a prime avenue for adding value in this way."

Environmental Impacts

The environmental politics have a well-known agenda: air and water quality, waste and recycling, noise and nuisance, chemical and radioactivity, endangered species. The OECD countries have made, in the past decade, significant progress in these issues. It is in the developing world that these problems remain unchecked, especially Asia. According to a report by the Asian Development Bank, these problems are now so serious that they are undermining economic prospects for the region. According to Burke (Editorial (b), 1988):

"The environmental footprint of mining operations is relatively small and a very high Ievel of rehabilitation can be accomplished rather rapidly... Human impacts on the environment will grow - and with them public anxiety about the effects of those impacts."

In the US, The President's Committee of Advisors on Science and Technology, consisting of industry and academic leaders, noted in its Teaming with Life Report (1998):

"Over the last few decades, a new paradigm has emerged: Improving and protecting our environment is compatible with growing the Nation's economy. As part of this paradigm, we have come to recognise the essential linkage between the economy and the environment."

Mining and sustaining development can be compatible, but the honest participation and contribution of all stakeholders is necessary (Ackerman, 1998). Beyond environmentally assessments, mining companies must be involved in a social assessment, which acknowledges the legitimacy of all stakeholders prospective.

Equally important is the need for sound operational practice. Accidents such as the recent tailings impoundment failures in the Philippines, Guyana and Spain attest to risks associated with mining. One solution is to promote the continuous review of risks and the implementation of environmental manage-ment systems. Companies must recognise that environmental and social responsibility - and an open information policy - convey competitive advantage and economic benefits.
The mining industry has a strong case to make for playing a central role in the transition to sustainable development. Environmental compatibility and sustainability have become important concept in the global marketplace. But for that case to be believed in the court of public opinion, Burke stresses that mining must rid itself of its outmoded image of being dumb, dirty and damaging. This will require the industry to demonstrate continuous improvements in environmental performance at every stage, from exploration to closure. That performance record can then supply the foundation for a systematic effort to change perceptions of the industry by ensuring that the reputation benefits of each improvement in per-formance are fully captured. Burke concluded that: Success in the mining industry of the 21st century will go to those companies that get this equation right.

THE SURVIVORS OF THE FUTURE

So, what are the main requirements for a mining company to survive in the future? Let me emphasise the following three.

Innovation

There is a need to think radically and to view mining as a "customer satisfaction" process, rather than a collection of functioning operational units (Campbell, 1994). Often, a continuous improvement initiative is not enough, when a fundamental redesign - a paradigm shift - is needed for a performance breakthrough. According to O'Neill (Campbell, 1994), then Chairman of ALCOA:

"Continuous improvement is exactly the right idea if you are the world leader in everything you do. It is a terrible idea if you are lagging in the world leadership benchmark. It is probably a disastrous idea if you are far behind the world standard. We need rapid quantum-leap improvement."

It is important to note that an increasing number of companies are now focusing on benchmarking and "best-practices" approaches. A number of professional and industrial groups are currently attempting to develop procedures and guidelines for these concepts. Benchmarking, simply (Geist, 1998),

"is the practice of being humble enough to admit that someone else is better at something and being wise enough to try to learn how to match and even surpass them at it."

According to Loton, past chairman of BHP, (Mining Journal, June 26 1998):

"The goal for a producer is improved competitiveness that translates into the higher margins and greater returns."

Cutting staff and mining higher grades are mining industry's responses to low metal prices. When staff has been cut and higher-grade ores are being mined, operators look for additional waste to cut costs that may be specific to individual operations. Innovative practices to reduce capital requirements, cut operating costs and improve recoveries are now urgently needed

In my view, the continuous decline in minerals-related research and development is dangerously depleting the stockpile of expertise and knowledge in the field. There is undeniably a direct link between state ownership, political control, or - at least - mere public interest in major mining operations, and government sponsored research organisations. As the political involvement subsides, the sustainability of these centres diminishes, at the very time when they should be contributing even more to the rapid change required in the minerals producing industries. The demise of organisations such as Bretby, in the United Kingdom, Chamber of Mines, in South Africa and Bureau of Mines, in the U. S., exemplifies this trend (Karmis (b), 1998). On the other hand, minerals industries research activities are usually focused on improving short- and long-term profitability. Such research projects are usually the victims of budget cuts when funds are short. According to Cohen (1994), as a result of such cuts and bottom-line economics,

> ***"research and development in most parts of the industry have either disappeared or shrunk to mundane ad hoc tasks."***

It is also important, at this point, to suggest strongly that the mining industry should try to play a more prominent role in the establishment of national research agendas. Take the example of US coal. The past 25 years have been a remarkable period of achievement. Production up 76%, productivity up 150%, safety improved by 80%, while prices have been reduced by 65%. A remarkable success story! Yet, instead of focussing research efforts in our most abundant and cost effective fuel, coal, millions of dollars have been devoted to renewable and other energy sources which, at present, are nothing more than a vague promise. Of the billions that the federal government proposes to spend in the US on fighting global climate change, most funding will focus on developing energy saving technologies and on developing renewable resources. Relatively little will be spent on areas such as carbon sequestration or the improvement in combustion efficiencies at coal-fired power plants. Yet, in the US last year solar and wind produced less than 1% of the total generation of electricity versus coal's 57%!

Unless the mining community, i.e. industry, academia, government, develops an aggressive and innovative research agenda, it is in danger of stagnating in terms of technology and, therefore, may prevent itself from exploiting deposits and seams that are uneconomical or impossible to mine with current technology (Karmis (b), 1998). In the opinion of the author, to develop and sustain the R&D necessary for such revolutionary innovations, a significant infusion of public and private funding is required and, now, urgently needed.

Community

Most companies realise today that a general "license to operate" from society is in practice as essential as official authorisation. In essence, success lies in "partnership" not in "ownership."

Providing education, environmental responsibility, community and infrastructure development, employment and good communications are just some of the requisites of good neighbour partnership between mining corporations and the communities, regional and national, in which they operate. This was strongly supported by the CEOs of the major mining companies, during an international convention in Peru this year (Chadwick, 1998). Typical of today's responsible mining company, Rio Tinto has the slogan: ***Global partner - Local neighbour***. According to the same company's community policy, its major principle is: ***mutual respect, active partnership and long term commitment.***

Leaders vs. People

Progress and leadership depend on people who understand the need for innovation and how to apply it to useful ends. Without an energised and innovative workforce high tech is high risk, noted Ellis, 1998. Essentially, leadership is about change not managing the status quo. Recognising this, an increasing number of companies subscribe now to the simple axiom***: To improve a company fast, develop people fast*** (Pierson in Geist, 1998).

What about the role of the academic institutions in developing and fostering leadership? The engineering professionals, required to lead the minerals industry into a competitive position in the next century's international resource markets, will emerge from innovative educational processes and environments (Karmis, 1998 (a); Gentry, 1998). Institutions must provide students with an education and a desire for leadership in the minerals and energy industries, through the design and introduction of new technologies that address the changing social, political, economic and philosophical issues facing these industries.

I must stress, however, that, with few exceptions, the mining schools around the world are currently suffering from decreasing enrolments, reduced institutional support and, most importantly, lack of research funding and graduate support (Karmis (b), 1998). These problems are even more significant if we accept the new educational mission explained above. It is imperative that the mining community demonstrates its support to these mining programs, and prevents further attrition and erosion to the academic infrastructure. These programs collectively represent, even now, a sub-critical mass of effort that may deny the industry and the community proper technical support and professional manpower within a few short years (Hackett, 1996).

CONCLUSION

So, what is the complexion of the successful mining company that will emerge in the 21st Century?

According to Ellis (1998):

> "***A high-tech resources company will differentiate itself and be a different and better place to work. It will have a culture of innovation, a global approach, international perspectives and many opportunities. Such a company will expand the earth's resources, operate economically and sustainably, tread softly on the environment and be based on optimism, not pessimism. Technology will play a big part in this.***"

We are also reminded that the stakeholders expect the mining industries to operate in a framework governed by economic prosperity, environmental quality, social justice or responsibility. Generally, they don't want us to go out of business; they want better business, notes Loton (1998).

In my view, the successful mining companies in the coming century will be sensitive and responsive to the expectations of all stakeholders. These companies will be populated with visionary leaders, capable of embracing change and adopting innovative technologies. And, finally, the successful companies will continuously seek new and creative ways for the global exploration, mining and processing of ore deposits.

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