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FACTORS INFLUENCING THE VIABILITY OF LARGE GOLD OR COPPER PORPHYRY PROJECTS

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Abstract - This paper discusses the influence of political, commercial and economic factors on the viability of copper porphyry and bulk gold projects. Political factors include government policies, social issues and political stability. Commercial factors consider demand and price conditions. Economic factors cover all the technical and environmental issues which mining professionals are familiar with and which, historically, have been the major focus of Pre-feasibility and Feasibility Studies.

1 Introduction

I am going to discuss some of the main political, commercial and economic factors that influence the viability of porphyry copper and bulk gold deposits. I am a geologist; not an economist, trader or politician and most of the delegates here have a geological background. This presentation is, therefore, designed to help geologists to understand some of the complexities of political, commercial and economic factors by examining the broader issues as they affect the development of porphyry and bulk gold projects.

Why am I qualified to give this presentation? I have worked for Rio Tinto for the last fourteen years, based in the UK, Chile and Australia. During this time Rio Tinto has acquired, either completely or in part, an interest in a number of major copper porphyry and large gold mines. Rio Tinto Technical Services of which I am the Managing Director has been involved in the technical assessment of all the acquisitions and has subsequently provided, as appropriate, high level technical expertise to these operations. In addition during the last decade there have been a significant number of investment opportunities for the international mining industry. Rio Tinto Technical Services has taken the lead role on behalf of Rio Tinto in the technical assessment of many of these opportunities.

The acquisitions referred to above include the following significant operations:

- In October 1985, Rio Tinto purchased 30% of the Escondida project in Northern Chile. Construction started in 1988 and the first concentrate was shipped in December 1990. Production since 1996 has been a massive 900 000 tonnes per annum of contained copper.

- With the acquisition of BP Minerals in January 1989, Rio Tinto owns 100% of Kennecott Utah Copper which manages the Bingham Canyon operations. This operation is currently producing about 300 000 tonnes of contained copper and over 500 000 ounces of gold per annum.

- The acquisition of BP Minerals also included the Lihir Gold project on Lihir Island in Papua New Guinea. This project commenced production in 1997. Rio Tinto has a 17.15% shareholding in the project and is the manager.

- Rio Tinto purchased a minority equity interest in Freeport-McMoRan Copper & Gold Inc in May 1995 which today gives Rio Tinto an approx 11% equity interest in Freeport's Grasberg project in Irian Jaya, Indonesia. The agreement between the two companies also gives Rio Tinto beneficial interest in metals produced up to quantities forecast in a plan to produce at 118 000 tonnes per day of ore and an additional 40% interest in metals produced in excess of the quantities produced in the 118 000 tonnes per day plan.

Some of the projects that Rio Tinto Technical Services has assessed, but passed over, over the last decade include a number of major copper porphyry and bulk gold deposits some of which we will be hearing about during the course of this conference. Therefore I have been privileged to gain a broad perspective of factors which influence viability of major gold and copper porphyry projects.

2 Interaction of Factors

This paper is concerned with how political, commercial and economic factors influence the way in which we, in the mining industry, consider major projects rather than how a major mining project influences politics, and national and local economies and commerce. Nevertheless I would like to touch on this very briefly.

2.1 Influence of Mining on Communities

Historically, the attraction of minerals has had a profound influence on the development of the world as we know it today. Spanish influence in South America is linked with the lure of gold and silver from Peru, Bolivia and elsewhere. The gold rushes in the 18^{th} and 19^{th} centuries in North America and Australia accelerated the pace of settlement in many areas. The discovery of gold in South Africa and copper in Zambia have had an indelible effect on the history of these two nations.

These examples and many more illustrate the effect that mining activity can have. Of course each of these developments was influenced by the political, commercial and economic factors of the day.

More recent examples include the advances in Western Australia whose growth has been intimately interlinked with mining and related activities and the growth of the Chilean economy in the last decade or so.

I have seen the effect of the development of Escondida and other mines, such as Zaldivar, on the local economy of Antofagasta in Chile. This city of over 200 000 people has experienced significant changes over the last eight years or so, a major amount due to the increased revenues directly or indirectly from mining projects. Indeed Chile's rapid economic growth during the late 1980s and most of the 1990s has been due in no small part to the mining industry, copper in particular.

We must always remember, however, that mining companies are often visitors in a country or region. We not only have a responsibility to mine and process the resource in the best way from the technical perspective to generate the maximum financial benefits for shareholders. We also have to work as closely as possible with our hosts, respecting laws and customs, minimising adverse impacts, and ensuring transfer of benefits and enhancement of opportunities. We should seek to make lasting contributions to local communities and be sensitive to local culture and way of life.

If we in the mining industry do not behave responsibly, we cannot expect local communities or their national or regional governments to always welcome us with open arms.

2.2 Political, Commercial and Economic Factors – An Iterative Process

The consideration of political, commercial and economic factors in mine project valuation is illustrated in Figure 1.

The starting point of any evaluation to support an investment decision is to highlight project objectives, and to describe how the project fits with the company's strategic goals. Every company will have its own mix of objectives and strategies dictated as much by its history, traditions and existing operations, as by its analysis of the industry. Different companies will take different approaches, and there is no uniquely correct strategy for all time.

There are three key groups of factors to be considered in assessing the intrinsic merits of any project, politics, the act of government, commerce or trade and economics which is the study of the careful management of resources to avoid unnecessary expenditure.

- Political considerations include factors such as government policies, mining taxation, provision of physical and social infrastructure, political stability and the extent of community consensus favouring mining.

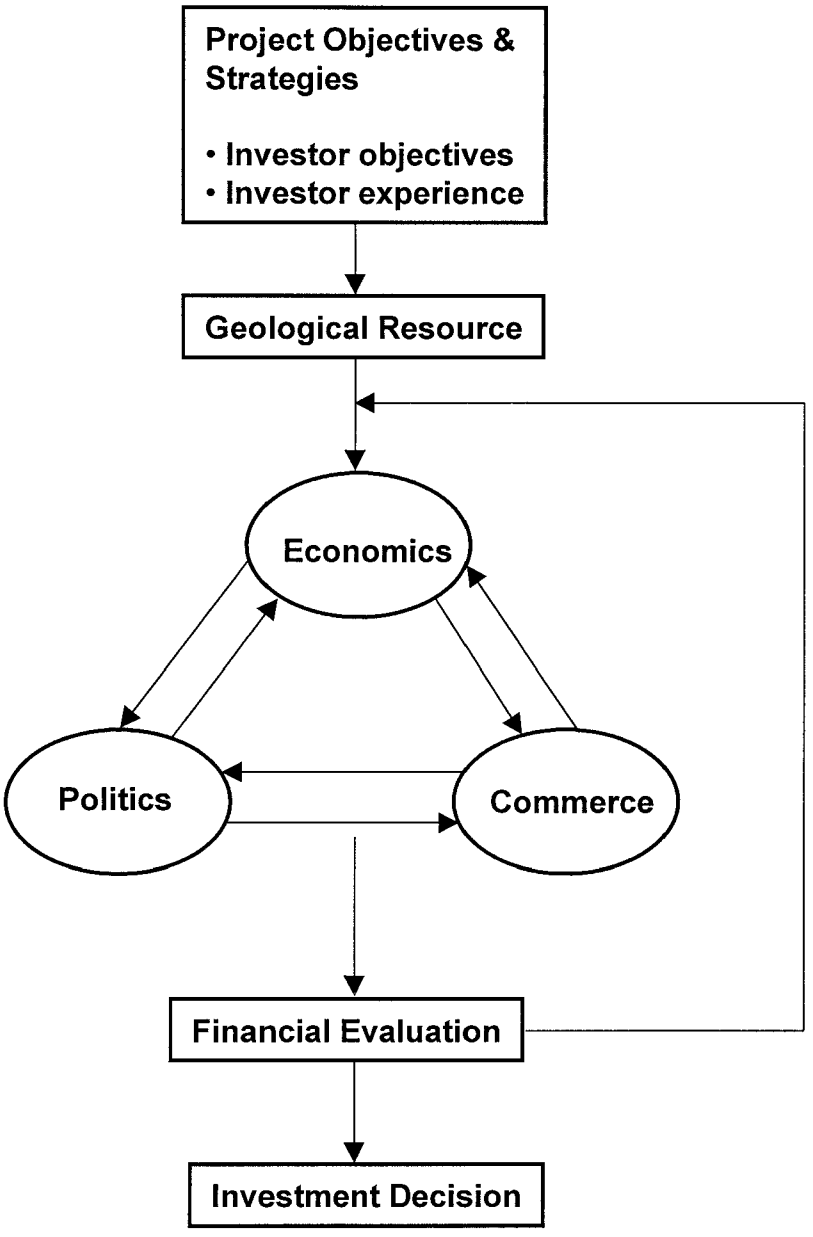
- Commercial forecasts include demand and price conditions, barriers to entry/exit; and

- Economic factors include all technical issues, the availability of skilled labour, environmental strategies, and capital and operating costs.

The assessment is an interactive process between these three groups of factors. The process is iterative; the conclusions are not always obvious. A marginally economic project in a high-risk political environment could prove unattractive, whereas a highly attractive economic project could proceed despite high political risk. Different companies or individuals will have diverse views on many of the factors and arrive at differing conclusions. Who is correct can only be judged by success of the company over many years.

Financial analysis is usually tailored to the level of the information available, and it is imperative that those responsible for applying the evaluation techniques or working with the results, realistically accept that Discounted Cash Flow, Net Present Value and Rate of Return calculations are not the only considerations bearing on project viability.

Figure 1
Consideration of Political, Commercial and Economic Factors in Mining Projects



Three or four decades ago mining and mineral engineers, assessing a mining project, would have spent most of their time assessing the technical aspects of development from mining to metal out of the gate. Environmental and community issues, whilst considered, would not have received the degree of attention they do today. Also, today an increasing amount of time and manpower is being spent dealing with the realities of local rules, regulations and other government expectations. When studying a new mining project, the definition of the time required to carry out the technical assessment is easier than attempting to predict timing for legal, permitting and other non technical items. The engineers often have more time to study mining projects due to the time required for non-technical issues. This can result in improved technical assessment.

The mining industry is a global business and the major mining companies are operating in many countries with a wide variety of geographical conditions and differing cultural and political backgrounds. Recent political changes such as those experienced in the Former Soviet Union, or the possibility of foreign investment in countries such as India have meant new opportunities in countries not necessarily accustomed to dealing with multi national companies. This brings with it unknown risks and challenges to be considered alongside potential offers of real rewards and potentially a healthy return to shareholders.

The globalisation of the mining industry has become a way of life. This geographical diversification requires the mining industry to face-up to the commercial, political and economic realities of global investments and we must always ensure our policies are appropriate.

3 Political Considerations

3.1 History

In the 1950s and 1960s, it was not uncommon for multi national mining companies to have a major, sometimes disproportionate, influence in some countries. Peru, Chile, Zambia and Bolivia are examples. This resulted in a wave of nationalisation by the 1970s as concerns were expressed about the distortions and disruptions caused by mining to the economies and social fabric of emerging nations. The presence of large multinationals was sometimes seen as a threat to the economic sovereignty of host nations. These issues will always remain a potential source of concern, but experience of modern mining by companies has limited the negative perceptions of their activities.

In contrast, during the 1980s and 1990s, one of the clearest trends to emerge has been the deregulation, liberalisation and privatisation of economic activity throughout the world. The mining industry has responded positively and enthusiastically to such moves by directly investing in countries containing vast tracts of undeveloped mineral resources. Chile provides the most spectacular example.

One of the most dramatic changes in the 1990s has been the demise of the Former Soviet Union. Potential opportunities opened up which we could not have envisaged 15 years ago. The countries of the Former Soviet Union are still undergoing change wrestling with policies that will attract foreign investment but also look after national aspirations. This process is far

from easy or complete as the cultural change is considerable and regional and local politics are far from straight forward.

3.2 Policies

The adoption of policies of economic stabilisation, a suitable mining code, and an internationally competitive tax regime is a vital factor in the recent upsurge of foreign investment in many mineral rich countries.

Simply being resource abundant country does not by itself bring about investment by mining companies in their search for the broadening of the global production networks. In the period 1955-1975, mineral investment contributed to the successful development of many countries, with the star performers being Australia, Canada and US. On the other hand, the GDP of countries such as Chile and Cuba were stagnant or declined during this period of political instability.

Political stability and attractive policies have transformed Chile since the mid 1980s. The GDP has grown at 5% annually, largely due to attractive investment policies which has been accompanied by an explosion of foreign investment in its mining and other industries. This has been the major catalyst in the opening of many new copper and gold mines since 1985, increasing copper production from approximately 1Mt/y to over 4Mt/y today. Unlike the situation before 1970, there are now many foreign mining companies involved with projects, not just one or two dominant players as was the case before 1970. The mines that were nationalised in the 1970s remain under state control as Codelco and Codelco often works in co-operation with the foreign mining companies in exploration, etc.

Other Latin American countries have also experienced the benefits of a stable political environment and the adoption of attractive investment policies. The challenge for mineral rich countries is to establish sustainable fiscal and regulatory policies that will foster mining investment.

Notwithstanding the outstanding growth performance of mineral exporting countries in recent years, residual political risk remains an issue. Policies may change, political pressure may be used on mining companies, for example, and there is naturally a desire in many countries to construct perceived value adding downstream operations and to not be treated as a raw materials supplier.

Therefore, despite the political and legislative changes of recent years, the mining companies contemplating investment in countries seeking to attract capital must carefully assess and take a view on the bonafides of an apparently welcoming government and the foundation of their new policies.

Many politically stable developing countries that have recently altered their mining and tax regimes could still prove unlikely to be attractive for mining investment because of some deep-seated cultural, social, structural and environmental problems. These problems are often neglected or given scant attention in the conventional assessment of political risk, but experience suggests they should figure more strongly.

3.3 Community Affairs

Mining companies need to create and maintain links with local communities, understand their concerns over local environment and work with them to preserve traditional cultures. This is especially true when considering major projects which is invariably the case when we are considering copper porphyries or bulk gold.

A paternalistic approach, which usurps the function of local or national government, creates a culture of dependency. A cautionary example is the Zambian copper industry of the 1930s to 1970s where the companies were directly responsible for the health, housing and advancement of the local communities, thus creating an enclave culture divorced from rest of the economy. The declining competitiveness of the industry, and an obligation to carry social costs meant the mining companies were unable to invest adequately to maintain competitiveness in the 1970s and 1980s. In this regard, the experiences of Rossing Uranium are refreshing. Rather than follow the paternalist model of the Zambian copper industry, and create an enclave culture, a percentage of profits were contributed to an independent foundation whose objective was integrated community development. This model has been adopted by other parts of the Rio Tinto group in different parts of the world.

The success of Lihir Gold, a large bulk mining gold project in Papua New Guinea is largely due to the time and effort devoted by the operating company and the national and provincial governments to accommodate the concerns and aspirations of local Lihirians. Extensive negotiations over six years with the landowners led to the approval and adoption of an integrated compensation, relocation and benefits package. Pursuant to this agreement, the national and provincial governments agreed to share royalties with the landowners and the local development authority, and provide government infrastructure and services on Lihir Island. The operating company, as part of its commitment to overall community development, also agreed to fund general social infrastructure such as roads, health, education and training. This is in addition to the establishment of a trust fund to facilitate the development of business opportunities for the local people.

4 Commercial Realities

4.1 Restructuring

Much has been written about the structural and cyclical problems facing the mining industry since the 1960s. The distinction between either set of influences can at times be artificial. However, the incessant drive towards cost reduction and more efficient production, in order to survive, is part of a broader trend towards liberalisation, deregulation and privatisation. While each decision on cost reduction or efficient production has its own unique drivers behind it, there are several overriding themes behind restructuring of the mineral industry and the changing commercial front.

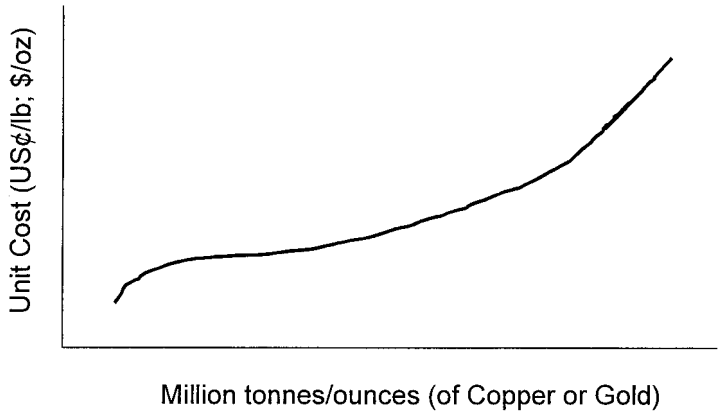
The takeover of mining companies by major oil producers in the 1970s and 1980s, followed by their withdrawal a few years later, left the industry much leaner and fitter, often with little debt. Companies threatened by deteriorating competitiveness resorted to mergers, defensive rationalisations and diversification.

During the 1980s and early 1990s there was a major shake out of labour. Today trade in most minerals is freer from interference. Cyclical factors affecting the mining industry has largely eliminated any excess capacity. Deregulation and liberalisation in the West is being matched by restructuring in the East, with beneficial effects for the mineral industry.

4.2 Cost Curves

An indicator of industry attractiveness is the slope of the commodity cost curve. The distribution of mines on the cost curve is continuously changing.

Figure 2
Idealised Cost Curve



If the curve is steep, as per Figure 2, that is the ratio of costs between bottom and top producers is high, those on the low side of the curve can exploit their cost advantage. Competitiveness is, however, a dynamic aspect, because competitiveness at a fixed point does not imply future success. This is evident from the near terminal decline of US copper industry in the 1970s and 1980s, and shows that ignoring technical and commercial changes elsewhere could be at ones peril.

4.3 Price Conditions

Investment decisions are naturally influenced by prices. Rising prices encourages investment and dropping prices have an opposite effect, notwithstanding the clear evidence of cyclical price behaviour over the previous decades.

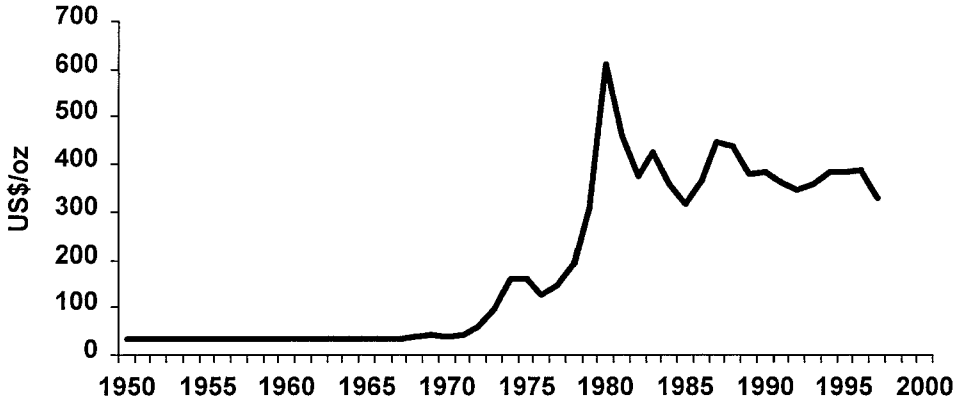
Copper and gold are traded daily in all forms and in substantial volumes in trading centres such as London, New York and Singapore. The prices are usually determined by transactions on the LME and COMEX, and is a reflection of the perceived balance between demand and supply, rather than production and realisation costs. In contrast, prices for industrial minerals tend to take into account not only the cost of production but the competitive position and the technical service and support provided in tailoring products to customers needs. The pricing for bulk commodities such as iron ore and coal is a consequence of direct negotiations between the buyer and the seller. In establishing prices, the buyers and sellers attempt to balance each other's requirements resulting in the use of long term contracts. This is not the case for metals such as copper and gold which are traded using the auction system practiced on the commodity exchanges.

Prices of copper and gold have exhibited considerable volatility over the years usually in line with the unpredictable shifts in balance between demand and supply. The copper price has fallen by about 1% per year in real terms for at least two hundred years. The fall in real prices over time provides a strong need for mining companies to not only select low cost operations but to force down their costs. Faced with this reality, copper producers are exploring for near surface low cost ore deposits and continually seeking to invest in technological improvements to reduce their costs.

This decade has seen a major growth in new copper porphyry projects with high entry prices often being paid to secure a stake in the industry. To some, these high entry prices seemed reasonable two years ago but since late 1997, when the South East Asian economies collapsed, they now appear expensive. The combination of copper price and political factors provided a very attractive "cocktail".

I often reflect on whether the copper price would be at current levels if Chile had not been such an attractive place to invest from the mid 1980s. The increase in copper production from Chile from 1985 to today could not have occurred through the endeavours of Codelco alone. The correct political and economic policies to attract foreign mining companies provided the catalyst. I don't believe a similar quantity of "new" copper could have been supplied from anywhere else. Indeed, the Chilean success shows how the greatest obstacles to mining are not in fact, geological, but generally institutional.

Figure 3
History of Gold Prices



In contrast to copper, gold has had an unique history. The 1970s rally, when gold price climbed from US$35/ounce in 1974, after being held fixed at this level for four decades, to the giddy levels of over US$800/ounce in early 1980, drove gold mining profitability to mouth-watering levels. The rise in price, illustrated in Figure 3, improved the economics of previously marginal deposits, resulting in heightened exploration, and opening of the new goldfields of Western Australia, and many mines in the Americas. The investment in large scale open pit bulk gold mines has also been a consequence of the gold price since the mid 1970s. Some of these projects like Lihir have long lead times, having been discovered in 1982 and only brought into production in 1997. Recently, commercial reality has set-in and the returns have been driven down to the industry average levels, commensurate with gold prices falling to around US$300/ounce. Just like the porphyry projects, large scale operations which can control or decrease their operating costs can weather such price cycles.

Fortunately, the gold price pendulum swings, and that of copper too, do not always have a lasting effect on the investment decisions but they are a pervasive force affecting stocks of mining companies. Perhaps the collapse of political barriers in recent years and the employment of new technologies in exploration, development and production has made our industry more competitive and at the same time lowered the entry and investment barriers.

5 Economic Analysis

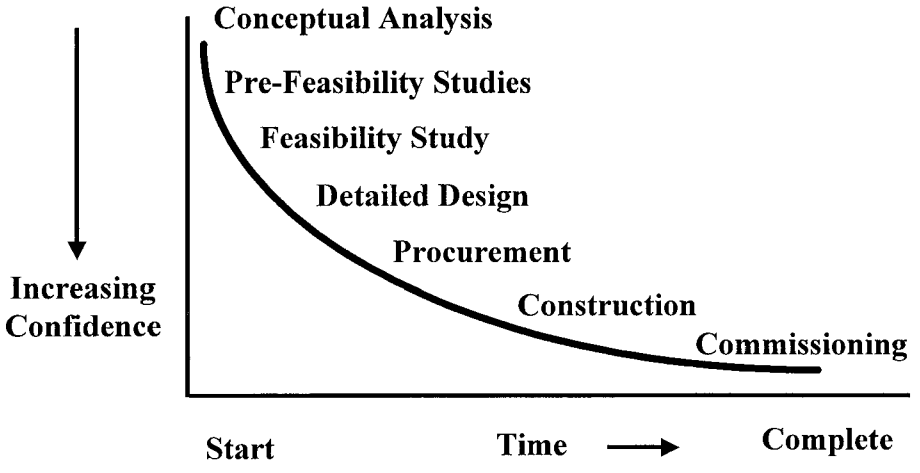
5.1 Economic Factors

I have included all technical and fiscal factors under the heading Economics. This includes all the considerations that would be included in a Prefeasibility and Feasibility Study except the political and commercial factors. Having found or acquired an ore body, numerous non geological factors come into play in the vital process of determining whether a geological resource can be accepted as a viable mineable reserve. These include environment, mining, processing, infrastructure and so on, which contribute to the estimation of capital and operating costs for inclusion in financial evaluation including tax and royalties. I am not here referring to the overall political framework that establishes fiscal policy, but the understanding of the mechanisms of tax and royalty payments for inclusion in any financial evaluation.

I am not going to list all the economic factors that mining professionals consider in the flow of a project from conceptual analysis through to Feasibility Study prior to an investment decision. These factors are well known to this audience and are covered in other publications. The Australasian Institute of Mining and Metallurgy is producing a publication which covers these factors in some detail called Towards 2000 AusIMM Mineral Resources and Ore Reserves Estimation Monograph.

Figure 4 illustrates the process from conceptual analysis to commissioning of a project with the increasing level of confidence as each stage is completed. I might add that this is an idealised picture, where politics, environmental controversy and community dissension do not, for the purpose of the discussion, intrude!

Figure 4
Improved Confidence during Project Development



5.2 Techno-economic Trends

Some of the recent techno-economic trends in copper porphyry and bulk gold deposit projects are:

- An increase in the scale of the operations using acid heap leaching of oxide ores and thin layer bacterial leaching of chalcocite ores to produce cathode copper near to the resource. Some of the major copper oxide heap leach operations which are planned or have recently started operations are El Abra (220 000t/y cathode), Escondida oxides (125 000t/y cathode). The large projects using thin layer bacterial leach of chalcocitic ores are Cerro Colorado (92 000t/y cathode) and Quebrada Blanca (75 000t/y cathode). All of these operations are in Chile.

- Major efforts towards resolution of potential generation of acid rock drainage, the most critical potential being from waste and low grade dumps.

- Separate storage and consideration of subsequent processing of low grade dumps, particularly in areas with dry climates.

- Investigation of major copper underground block cave operations to ultimately replace some of the major open pit operations such as Chuquicamata, Bingham Canyon and Grasberg.

- Increasing attention to detail of the geological models, data from which is vitally important for environmental considerations, control of mining and processing costs, decisions on tailings disposal, commercial consideration if concentrates are produced, and so on.

- Consideration of working conditions such as camp or other accommodation and shift rosters. Increasingly, operations are adopting fly-in, fly-out to avoid the need to build major infrastructure such as towns, etc.

- More emphasis on closure planning and rehabilitation during mine life. Closure planning is now an integral part of a Feasibility Study.

6 Resumé

It is apparent that the time taken to study the economic factors is usually easier to gauge than the time it will take to resolve a number of political issues. In the mining industry, we are accustomed to resolving technical issues and producing technical Feasibility Studies. That is not to say that we always get it right, but at least we are familiar with the process. This includes environmental considerations as it is now second nature to integrate these factors in all the technical decisions and studies.

Project lead times are, however, tending to increase. This is not because we are taking longer to carry out the Feasibility Studies and construction / commissioning stages of a project. It is because of the increasing time taken for gaining permission to proceed with a project from various external interested parties and also the emphasis put on non techno economic issues.

Given that there is an attractive overall political environment to underpin mining investment, the industry still has to proceed with sensitivity in dealing with all parties who will be affected in one way or another by a mining project. There will be significant financial benefits to the local community and the broader community, but we must not lose sight of the fact that there will also be considerable change. This change will not be welcome by everyone and the sensitive management of such change is vitally important. It is up to us in the mining industry, in conjunction with community representatives at all levels, to work with the communities and ensure all parties benefit, not only during the life of any mining venture but, if practical, by generating sustainable development after the mine closes.

In this complex world, politics, commerce and economics all influence the development of mining projects. The bulk gold and copper porphyry projects are invariably very large and attract international attention. Mine developers have to be aware of this and ensure that adequate attention is given to all these influences. The non technical issues will become increasingly complex and time consuming, but it will be increasingly important that we address these factors correctly. Leon Davis, the Chief Executive of Rio Tinto, has christened this dimension "The New Competencies". My final word is that we must become as expert at the new competencies as we have become at the old ones.

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