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Mining Futures: Beyond the Headlines

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Abstract

Non-renewable extraction and its future implications have found focus in recent literature from a technical, environmental and social, political and economic perspective. This study uses the six pillars method of future studies to address the futures of mining from multiple aspects. The analysis through this methodology is directed at decision makers and various stakeholders as they evaluate the role of minerals in the economy and intends to inform public policies regarding mineral extraction beyond sectoral silo focus. The conclusions from this study are that mining is more than just technology or economics of pricing and sound policies initiatives are needed to redirect society and re-think current trends in international governance of resource use, and material-intensive life styles.

Keywords: mining, non-renewable resources, future studies, alternative futures

Mining is the extraction of raw materials from the Earth's crust, usually from an ore body, vein or (coal) seam. Mining produces three types of mineral commodities—metals, industrial minerals, and fuels—that all countries find essential for maintaining and improving their standards of living[1]. Mining is basic to the human way of living, as essentially everything we use in modern society (that does not come from a plant) is a product of the mining sector. Mining is a viable part of the economy, as the raw materials necessary for manufacturing, almost everything, utilized in our consumer world, requires raw materials that come from the Earth. However, the direct and indirect contribution that the mining industry makes to human prosperity is often not as well recognized as it should be. Minerals are also unique in the sense of their non-renewable profile, as mineral deposits are finite, either physically or economically. This implies a special concern about their exploitation, and consumption in a way that could prevent or mitigate their scarcity or unavailability for future generations.

While literature abounds on mining and its implications, there are large areas of disagreement and fragmentation within the research community (Kolstar & Wiig, 2008). This diversity takes many forms, some of which are related to the focus on isolated aspects (technology, environment and society, politics and economy) of mineral extraction. Part of the diversity is linked to the linear-

sequential mode of thinking employed from an extractive economy versus mineral-utilization economy perspective. The policy implications from such analysis thereby ignore the global and socio-political implications of this sector leading to misplaced policy interventions. The contribution of this paper to the body of knowledge is the application of six pillar approach of futures studies (developed by Inayatullah, 2008) to the mining industry. The six pillar approach provides a new approach to futures thinking to better understand the processes of change so that wiser preferred futures can be created. The strength of this method is its ability to encompass some of the larger debates on the issue-in-hand, in passing.

The methods and tools used in the six pillar approach are based on the following conceptual framework:

1. History of the issue and how we got there? By mapping time, we become clearer on where we have come from and where we are going.
2. What do you think the future will be like? What is your prediction? Which future are you afraid of?
3. If you change some of your assumptions, what alternatives emerge which challenge your view-point? What are the alternatives to your predicted or feared future?
4. Visualizing the future through deepening and creating alternate futures by identify patterns of change beyond the most obvious and the superficial?
5. What is your preferred future? Which future do you wish to become reality for yourself or your organization?
6. And finally how might you get to your preferred future? What steps can you take to move in toward your preferred future?

Pillar 1- The History of the Issue

Timeline

The development of human kind is directly linked to the applications of mining products at that particular time period. Archaeologists and historians describe early civilizations and periods of human history using terms such as the Stone Age, the Copper Age, the Bronze Age, and the Iron Age, named for their respective predominant tool-making technologies. Such descriptions reflect the fundamental importance of nonfuel minerals, metals, and materials technology and applications. Early civilizations were built to a significant degree using the seven metals of antiquity (in order of discovery): gold (6000 B.C), copper (4200 B.C), silver (4000 B.C), lead (3500 B.C), tin (1750 B.C), iron (1500 B.C), and mercury (750 B.C). Each discovery led to a range of innovations and applications that provided a marked advantage until such time as it was adopted by competing civilizations or overtaken by other innovations. The current Information Age is built around the demands of an ever-wider range of metallic and nonmetallic minerals to perform essential functions in new products such as computers, cellular telephones, and transportation equipment. Today mineral resources are essential inputs into economic activity and fundamental determinants of quality of life in our consumer society. Unless this consumer oriented society, and all of the developing nations in the world, suddenly stop using products we are familiar

with, the demand for raw materials to produce these products in the future will grow with the increased demand for more and newer products.

Significance of mining

Mining is a source of mineral commodities that all economies find essential for maintaining and improving their standards of living. Mined materials are required for construction of roads and houses, building of automobiles and aero planes, manufacturing of computers and satellites, generation of electricity, and to provide the many other goods and services that a consumer society enjoys. In addition, mining is economically important to the producing regions and countries. Mining yields foreign exchange and accounts for a significant portion of a country's GDP (In many poor countries, mining contributes more than 45% of total exports). Mining fosters a number of associated activities, such as mining equipment manufacturing, provision of engineering and environmental services, and the development of world-class universities in the fields of geology, mining engineering, and metallurgy. The economic opportunities and wealth generated by mining for many producing countries are substantial as it provides employment, dividends, and taxes that pay for hospitals, schools, and public facilities. The mining industry produces a trained workforce and small businesses that can service communities and may initiate related businesses. The mineral sector often operates in poor, remote locations that create opportunities of pro-poor service that other private sectors, government or donor initiatives are unable to provide. The International Labour Organization has estimated that the number of people relying on mining, for a living is likely to be over 200 million, worldwide (ILO, 2010).

Pillar 2- Fear of the Future

Concerns over the availability of mineral resources needed to maintain the standard of living date back to the 18th century, when Thomas Malthus observed the land and resources expanding at an arithmetic rate while population grew at a geometric rate. In 1972, a report by the "Club of Rome", a neo-Malthusian think tank, "The Limits to Growth" (Meadows, Meadows, Randers, & Behrens, 1972), issued warning signals that the world was becoming short of those resources badly needed to keep the current lifestyles. The global oil crisis of the mid-1970s fuelled further interest in this topic. While, the Doomsday scenarios of this report have not materialized in 35 years, the report was instrumental in sparking a vigorous debate on the future availability of mineral resources, a debate that is still quite active. A few facts are quite clear:

1. The unifying feature of all mining operations is that the mineral resources being extracted are finite and non-renewable (at least on human time-scales).
2. The rates of consumption of these mineral stocks have accelerated in recent decades far beyond any historical comparison; To be more specific, when use of a resource grows at 5 percent per year, the rate of use will double in fourteen years (Machado & Suslick, 2009). So, if currently known reserves of a mineral are 100 years based on current annual use, such reserves will be exhausted in thirty-six years.

3. The systemic damage like land reclamation, species displacement, environmental degradation and loss in quality of life of local inhabitants is usually lost in economic calculations.

A crisis timeline

Throughout the entire twentieth century, concerns have continually resurfaced about the reliability of supplies of key energy and mineral resources relevant for economic activity. In the decades following World War II, global concerns centered around the adequacy of energy and mineral resources because of their significant use during the war and in postwar reconstruction. The 1970s, witnessed the concerns of the USA and other Western countries in terms of the short- and long-term reliability and availability of foreign sources of oil and other energy and nonfuel mineral resources such as bauxite and cobalt. The ensuing decades also witnessed significant economic growth in North America and Europe, the beginning of the Japanese economic boom, and the emerging global interest in the effects of resource extraction and other human activities on environmental quality. In the twenty-first century, the nature of the concerns over Earth resources has shifted once again, driven primarily by unexpectedly large demand growth in China, India, and other countries.

Given the pivotal role of mineral extraction products in economic activity and as fundamental determinants of our quality of life, it is not surprising that the Committee on Critical Mineral Impacts on the U.S. Economy, noted that, "The U.S. economy could not function without minerals and the products made from them" (National Academy of Sciences, 2008). Similar insights were offered by foresight exercises conducted by the South African Foresight Mining & Metallurgy Report (1994) and the UK foresight study titled Materials: Shaping Our Society (2000). With developing countries demanding more resources each year, to keep up with their ever expanding populations and development, the rate of mineral consumption is bound to skyrocket upwards. (refer to table 1 on mineral consumption and expected known reserves). This raises a very pertinent question that given the technical advances and the globalization of the mineral market, will the necessary mineral resources be available in time and at acceptable costs to meet burgeoning demand for these and other emerging products and technologies?

Table 1.
World mineral usage & known reserves[2]

	Annual Usage **(Metric Tons)**	World Known Supply **(Metric Tons)**	Time to depletion at current usage rates **(Years)**
Bauxite	190,000	320,000,000	168
Copper	15,600	260,000,000	16,700
Gold	2,500	90,000	36
Silver	20,200	570,000	28
Tin	300,000	11,000,000	37
Nickel	1,580,000	150,000,000	95
Lead	3,470,000	170,000,000	49

Source: United States Geological Survey (2006)

Environmental and human impact

The authors of "The Limits to Growth" foresaw the collapse of modern civilization not due to mineral exhaustion, but because of the environmental damage arising from the production and use of natural resources. While the core of this argument is misleading, as the geography of production is quite different from the geography of consumption, mining continues to be a hazardous and environmentally devastating exercise. The footprint of mining can usually be managed to limited spatial coverage but when it does occur, it can have significant and irreversible impacts. The negative environmental impacts of mining include energy and water consumption; air, water and land pollution; subsidence; landscape alteration, etc. Impacts from small-scale mining in particular include the silting up of rivers, deforestation, and mercury and cyanide pollution. The consequences of polluted water, land and soils are most visible in deteriorating health, lost agricultural productivity and damaged ecosystems of the mine surroundings.

There is also the issue of clash of interest between mining companies and indigenous population over cultural or local resources. Since mining involves a lot of underprivileged economies, safety, health and environment considerations are frequently non-existent and social dysfunction is rife. At least 5 million of the global total of the small-scale mining sector are thought to be women and over 1 million children (ILO, 2010) and they are typically highly vulnerable. Legal protection is often minimal and the risks for expulsion and human rights violations are high.

Resource wars

While evaluating the role of mining in development processes, a recurring debate has been whether the occurrence of mineral wealth represents a "blessing" or a "resource curse". It might be expected intuitively that mineral wealth and its sensible exploitation would form the basis for economic growth, poverty reduction and sustainable development. Ironically, however, the track record of countries with the opportunity to convert resource abundance into broader development goals is often disappointing and often has not translated into economic prosperity of the masses. Additionally, many resource rich countries are under the shadow of conflict (for e.g.: the oil-rich Middle East) while some of these countries remain amongst the poorest and have the highest levels of poverty, corruption and conflict. Amongst the world's most mineral dependent states, 11 are heavily indebted and five have had recent civil wars. In many mineral-rich developing countries, rent-seeking and corruption tend to be widespread, and in the worst cases the appropriative struggle turns into a full-scale civil war (e.g. Angola's civil war has been greatly influenced over control of precious stones, ironically referred to as blood diamonds). In recent times the Gulf War, the US invasion of Iraq and the Darfur conflict are all grim reminders of the extent to which humanity can fall, over control of mineral fuel resources.

Pillar 3- Challenging the Paradigm of a Feared Future

The biggest challenge to the scarcity view of resource availability lies in the neoclassical economic theory which ignores ecological limits and entropic constraints to

economic growth. Global models generated to understand complex processes and forecast effects have concluded that there are virtually infinite quantities of most materials in the Earth's crust, sufficient to support very high levels of consumption for an indefinite period of time. The question then is not one of physical constraints but rather of the technology to exploit these resources, and the economic, political and environmental limitations on their use.

These canonical views of economist are best summed up by Nobel economist Robert Solow, who once claimed, 'the world can, in effect, get along without natural resources' (McNeill, 2000). Solow, has since moderated his views on this subject (Prugh, Costanza, Cumberland, Daly, Goodland, & Norgaard, 1999), but many other mainstream economists have not. Technology, the handmaiden to industry, is designed and destined to ensure infinite resource availability and remove all constraints to economic development – constraints that are imposed by nature. The future of an individual material varies greatly, depending on the pattern of end-uses, possibilities for substitution and the current distribution of production and consumption. This view further maintains that as technology advances, new resources are discovered as substitutes for scarce resources. The best example of the outfall of this approach has been the confidence of oil companies, in the notion that the possibility of running out of oil is extremely unlikely. A Mobil Corporation advertisement that appeared in the May 8, 1995 issue of Newsweek proclaimed, "Not in your lifetime nor your grandchildren's".

The effect of technology

The available evidence indicates that the effects of new technology have had a major impact in the debate over the availability of mineral resources for future generations. Technology is the mainstay of every industry, including mining, and has altered mineral extraction and its demand in several aspects. Technological innovation has reduced the amount and composition of mineral commodity required in the production of specific products. For example, ceramic materials have replaced metallic minerals in automobiles. Second, new technology can affect the ability to compete in a particular end-use market. For example, the introductions of polyvinyl chloride (PVC) in plastic pipe capture a sizable market share for home building that belonged traditionally to metal minerals. New technology can also change the number and size of end-use markets. For instance, the advent of the automobile gave rise to a major new market for petroleum, steel, and lead. The poster case for impact of technology on mineral demand is recycling. Recycling represents a technological advance having a tremendous implications for energy and mineral resource conservation, waste reduction, saving landfill space and pollution prevention. The flip-side to the coin, is that it will be many years before the technology to recycle elemental compounds from the manufactured items is feasible (cost effective), or even possible.

The greatest impact of technology is perhaps in the way, it has altered the concept of a finite stock of non-renewable resources to a "flow process". Technological innovations have lead to the discovery of untouched deposits not previously known or which were so poor in content that extraction was prohibitive. The result is that the estimates of reserves and identified resources for the last fifty years show crescent growth values for a majority of mineral commodities (see table-2 below). Many

Malthusian forecasters have broadened the mineral availability horizon to over 250 years (Forrester, 1971), (Meadows, 1972), while others have refrained from giving a time span.

Table 2.
Evolution of mineral reserves and identified resources during the period 1950–2000

Mineral commodity	1950 **Mineral reserves & identified resources**	1974 **Mineral reserves & identified resources**	2000 **Mineral reserves & identified resources**	**Growth in 50 years (2000/1950)**
Copper	1.0×10^8	3.9×10^8	6.5×10^8	6.5x
Gold	3.0×10^4	4.0×10^4	7.7×10^4	2.5x
Iron	1.9×10^{10}	8.8×10^{10}	3.1×10^{11}	16.3x
Lead	4.0×10^7	1.5×10^8	1.3×10^8	3.25x
Tin	6.0×10^6	1.0×10^7	12.0×10^6	2.0x
Coal	6.0×10^{10}	6.5×10^{11}	9.8×10^{11}	16.3x
Oil (bbl)	8.0×10^{10}	7.2×10^{11}	1.05×10^{12}	13.1x
Natural Gas (m^3)	4.7×10^{12}	2.2×10^{15}	1.5×10^{14}	31.9x

Source: {USGS (several), BP Statistical Review of World Energy (several), The Petroleum Handbook, Royal Dutch/Shell Group of Companies, Fifth edition, 1966, IEA(several), UN-Statistical Yearbook (several)} as quoted by (Machado & Suslick, 2009).

Looking at just Earth – Extra-planetary & sea mining

Non-conventional mineral sources are those stocks of materials whose utilization by man is far from proven. As technology advances, non-conventional sources of minerals could enter into the marketplace, as shown by current research on seawater, seabed nodules, and ultimately space mining, all of which may occupy some place in the supply of minerals for the future generations.

It is known that seawater contains incredible stores of minerals, with approximately 3.5 percent of seawater is composed of dissolved compounds. However, the available technology for mineral recovery from the sea is, in most cases, prohibitive. Only economics can lead to this mode of extraction, unless some geopolitical factors (war, supply disruption, etc.) could intervene in the decision process.

Space mining was initially conceived as a work of science fiction, dramatically pictured in blockbusters like the block-buster movie *Alien*, but given the changes in the last two decades, space mining is now a concept that far-sighted entrepreneurs can consider. The breaking up of the monopoly on deep-space launches by private launch services, which was once held by Cold War superpowers, has considerably reduced the cost of access to space. Also, technological advances and the transfer of military technology following the Cold War have led to advances in materials, computers, robotics, and deep-space propulsion. Streamlined management of space projects has considerably reduced the costs of space travel, with space missions now costing one-fourth of equivalent projects ten years ago. The icing on the cake is the discovery of

rare and valuable minerals on asteroids that are easier to reach and return with collect material from, than even the moon. So what was mission impossible a few decades ago, is within the realms of practical now!!!

Substitution of minerals

The ultimate goal of non-renewable resource exploitation is not extraction per se, but the conversion of this natural capital into other forms of manufactured and monetary capital as well as more sustainable livelihood opportunities. In other words, minerals are just a means of reaching the end, not the end themselves. So if a substitute like agriculture could replace the need for extraction, the fears of a mineral-scarcity doomsday may actually be dispelled. In the past we have had petroleum substituting whale oil; optical glass fiber and wireless have replaced copper cables; synthetic fibers are used as a substitute to cotton, wool and silk. Fuels derived from organic sources are a reality now and already coconut oil has been used as an alternative fuel in aero planes. So, the prevalent economic contention is that the limited supply of a resource 'will only occasion the development of new technologies that convert what are now useless materials into tomorrow's resources' (Scherer, 2002).A consequence of this belief in infinite substitutability of materials for production is the rejection of all constraints on growth, even thermodynamic ones (Deb, 2009).

Pillar 4- Beyond the Most Obvious: Visualizing the Future

The content below is partially based on a group exercise on futures of Mining during a Foresight workshop in Islamabad. The multinational group consisted of people from various walks of life as well as experts involved with Earth science. The emerging theme of the discussion was the lack of awareness and public debate on this intrinsic and sensitive issue. The group was also unanimous on the ultimate decline of civilization-as-we-know-today, based on current consumption rates.

The methods and tools used in visualizing the future are based on the following conceptual framework:

1. Mapping the future, using the futures triangle
2. Deepening the future using Causal Layered Analysis and;
3. Creating alternative futures through scenario development

Mapping the future - The futures triangle

The futures triangle maps the future by focusing on three dimensions – the pull of the future (images), the push of the future (drivers) and the weight of the future (barriers to change, as defined by a particular image).

In the case of mining futures, business as usual represents the default future. The push in creating and sustaining it are deep-rooted in current human psyche as the harbinger of change and the reliance on technology as a savior of mankind. However, this also marks the ultimate decline of civilization-as-we-know-today, based on current consumption rates. While certainly an undesirable future, it is complemented by the lack of awareness and public debate on this intrinsic and sensitive issue.

The other major image which serves a counter to the first image is that of a back-to-nature future, and emphasizes the need to prepare for a radically different future. However, the drivers, the pushes of the future are not heading in that direction. The weights against creating such a humanistic future (economic rationalism, diminishing global courtesy, the differences between the geography of production and the geography of consumption) are both broad and deep.

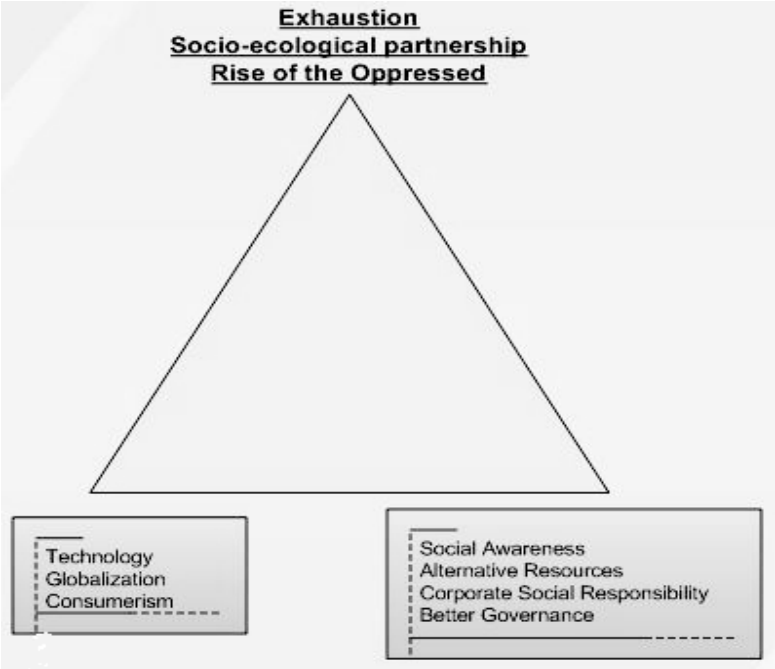

Figure 1. The futures triangle

Another plausible image of the future is the awakening of mining economies and their realization of the ability to challenge the conventional route to globalization. This would significantly include rallying developing countries' support for the development of a significant developing country economic bloc as well as strengthened national identity and focused governance plans. Interestingly, the weights for change are clearly and more easily articulated. Developed country intervention, a fractured vision of developing countries and fear of the unknown were all identified as weights that mitigate against such a positive future.

Deepening the future - Causal layered analysis

Derived from theories of poststructuralist discourse, and developed by Inayatullah (1998), Causal Layered Analysis (CLA) provides a basis for critiquing the social construct of the 'real' and offers a layered approach with which to analyse the results and provide a framework for the discourse from the key focus areas of this research. The CLA method assumes four levels of analysis: The **first level** is the **litany** representing

quantitative trends and problems, which is the most visible and obvious level, requiring little analytic capabilities and the assumptions are rarely questioned. The **second level** is the **systemic view** concerned with social causes, including economic, cultural, political and historical factors. The **third deeper level** is concerned with **structure and the discourse/worldview** that supports and legitimates it. The task is to find deeper social, linguistic, cultural structures that are actor-invariant (not dependent on who are the actors). The **fourth layer** of analysis is at the level of **metaphor or myth**. These are the deep stories, the collective archetypes - the unconscious and often emotive dimensions of the problem or the paradox. This level provides a gut/emotional level experience to the worldview under inquiry. The CLA method attempts to discern the irrational for the purpose of discerning the deeper story being played out at the litany levels. These four levels are used to find the full panoply of stories, both from the conscious, unconscious and emotive perspectives on the issue (Inayatullah, 2004).

Box 1- Causal Layered Analysis on the Futures of Mining
Year: 2060
Pushes/Drivers: Demand, Lifestyle, competition, Marketing/media, Efficiency (Technology), MNC's (profit)
Litany/Headlines: "Profits from mining hit all-time high"
Systemic View: Governance, Alternate Mineral Resources
Dominant World-view: Consumers (Improved Quality of Life), MNC's (Boom Time), Governments (Better Economic Management), NGO's (eyewash, end is near)
Story/Metaphor: "The Silence before the Storm", "Make Hay while the Sun Shines"

The emerging map from the CLA exercise mirrored a shared perspective on the long term deterioration of the mining situation. At the litany level the causes were multifold: profit mentality, disregard by developed countries and Multi National Corporations for foreign user-space, disregard for problems and issues in the geography of extraction. The solutions at this level are mutual respect, effective issue discussion and Corporate Social Responsibility.

At the systemic level, the issue was of extracting economies governing their resources and affiliates responsibly and effectively and not being a pawn to the powers. Another aspect of this level is of providing alternatives to mineral usage. This could be both in terms of less consumerism as well as technology solutions. The solutions here are partnering with industries, enhanced infrastructure and a commitment towards consumer minimization.

At the worldview level, the issue assumes different proportions from different view-points. The end-consumers want more and cheaper materials, with an insight towards a better quality of life. The MNC's are interested in their profits and empires and wish to make the best of boom times. The governments of extraction areas are stuck in a quagmire of reaping what they never had to sow (extractive minerals are a free gift of nature). On the other hand of the resource trap are resource-hungry coun-

tries locked into a prisoner's dilemma of inaction, as reluctant to deal with the responsibilities that accompany power. The final piece of the jigsaw are NGO's which are pressurizing corporations and governments for peripheral issues like environmental policies and for problems that just do not matter very much for the extractive economies. The solution is applying pressure on policies towards better governance and transparency.

At the myth level, mining in the 21st century is about "make hay while the sun shines". The solution is to transform the opportunistic mentality to a "Silence before the Storm" approach.

Scenarios

Scenarios are stories about possible futures, about what could happen, not what will or should happen. Unlike predictions or forecasts, scenarios are rich, multi faceted stories that capture the unpredictability as well as possibilities of the future. The scenarios for mineral extraction futures have been developed through divergent futures approach as categorized by "best case," "outlier," and "business-as-usual." The following scenarios were explored.

1. Exhaustion scenario

This represents the default scenario as an extension of the present day. Many of the 20th century minerals have completely disappeared or only exist as low-level ore material (too poor in quality to be extracted). They have been replaced by newer materials, farmed from earth or derived from asteroids. Space mining now is the dominant method of mining. While the 20th century characterized the exploitation of only the top 1 km of the Earth's crust, the exploitation of the rest 99.9% is the norm, which represents mankind's march into the future.

This scenario represents MNC's and developed country governments dominating developing countries, for their control over resources. Conflict and chaos is the norm in countries which are at the mercy of MNC's and developed countries, for their sustenance and advice. The Earth is littered with orifices and looks like a perforated sphere from outer space. The view from outer space also reveals, green in developed countries and the utter brown waste of third world countries.

Science and Policy have become increasingly driven by short-term, ad hoc government objectives and MNC expansion programs. Low skilled labor which once was representative of mining and its pro-poor advantage has disappeared. Mining is now a highly mechanized sector, with MNC’s vying for man-less mining operations. The manpower is highly skilled, representing the elite few and mining engineering and its off-shoots have taken over major engineering fields like mechanical and civil engineering.

2. The triumph of the tree huggers scenario

This is a best case scenario, depicting the triumph of the environmentalists and back to the basics movements. People have realized that if exploiting 1% of the earth has resulted in the environmental and socio-economic chaos of the world in the 20th century, then what hell would break loose if the remaining 99% is exploited. People

the world over have realized the futility of leading consumer lives and have reverted to cave-man lives. Ironically this is an aspect that has not been deemed worthy of discussion in any foresight exercise on mineral extraction as development is considered a moral obligation, an unquestionable social goal, to be achieved by rapid industrial growth

A huge role in this scenario is of population, which has dwindled considerably, ultimately resulting in fewer products and resulting in minimal usage of minerals. Substitution of minerals has been done by agro-mining and recycling of the metallic junk left over by the 20th century. Science and policy is directed towards betterment of the bottom billion of the Earth. War and conflict have become virtual unknowns due to the peace and harmony among the people of the world.

3. Rise of the downtrodden

This is an outlier scenario depicting the efforts of economies of mineral production. Mineral extraction economies have finally found the faith in their ability to challenge the conventional route to globalization by rallying developing countries' support for the development of a significant mining economic bloc. The result is isolation from the developed world, strengthened national identity and focused development planning and governance.

This would lead to limited integration into the world economy and, as a result, isolation from technological developments elsewhere. These loner policies would encourage self-sufficiency, such as import substitution while decreased foreign investment would result in limited economic growth. There would be no broad regional political alignment, but rather focused relationships with specific countries as well as intensive regional co-operation in exploration and exploitation. On the flip side, limited access to the frontiers of technology would result in less cost-effective exploration and exploitation as well as limited likelihood of discovering major new deposits.

Pillar 5- The Preferred Future- The Way You Want the Future to Look Like

Based on the above scenarios and by literature review, a preferred future was articulated. Such a future would avoid worst-case scenarios and would materialize around at least the following two themes:

1. Future generations don't get into a quandary

The topic in itself represents a quandary and gears towards a more "technology for solving the problems created by technology" solution. Some elements discussed in the tree hugger scenario also require serious thinking and action. The question then becomes one of redirecting society and reversal of current trends in population growth, resource use and material-intensive consumer life styles. A re-think is also required on a concept that has become accepted as gospel: the idea that all economic growth benefits humankind and that the greater the growth, the more widespread the benefits. The result has been that in developed countries, educational institutions and media vigorously uphold and support the gluttonous consumption of the earth's

resources, as being good for the economy and that consumerism is a civil duty. This is then preached to the developing world as a model to imitate and a utopia for all. As a Western scholar acknowledges,

> *If the world is to save itself from ecological disaster, the redemption cannot begin among the poor, however satisfying that idea may be for the missionaries. Only the wealthy few – that is, nations such as ours – have the power and the wherewithal to rescue us all from the impending consequences of mass consumption on a global scale. (Greider, 1999, p.27)*

Ironically, while the environmental aspects of this scenario have been discussed in various national foresight exercises, the consumer aspect as a long-term solution has not been addressed by any of these foresight exercises.

2. Justified and equity based distribution of mining profits

The bringing up of this topic in a best case future is a reminder that perhaps the ills associated with the "curse of mineral resources" are not inevitable, and can be addressed through good global governance. Mining was an important driver of growth in the USA, Canada and Australia in the early 20th century and recently, Botswana and Chile have achieved economic development powered through mineral exploitation. To realize the economic potential for pro-poor growth and ensure more equitable distribution of benefits, good governance, and corporate social responsibility by MNC's, effective legal frameworks, and meticulous environmental and social regulations will be needed.

Once again, the developed world has a big role in ensuring that international standards of transparency and good governance get adopted, through peer pressure. It will also matter greatly what ordinary people in the developing world think about resource-extracting corporations. It will be the accumulated effects of teenagers in the backseat of the family car, saying, "No, Mom and Dad, not that petrol pump / jewelry shop — did you hear what XYZ corporation is doing in Nigeria / Angola?", that brand names and corporations will try to clean up their acts. Interestingly, this aspect has also not found discussion space among various national foresight exercises on mining.

Pillar 6- Getting There - Policy Recommendations

Based on the above analysis, it is the view of the author that any attempt to use traditional public policy to create preferred futures is likely to be counterproductive. It is important that various stakeholders be brought to the table if we want future generations to be better off than the current generation. Sound policies initiatives are also needed to redirect society and current trends in resource use and material-intensive life styles. The following policy guidelines are a step towards that effect.

1) Conversation on mining futures across stakeholders, with different worldviews built into this conversation. It is important that in these dialogues, the traditional Western assumption of perpetual happiness and limitless prosperity, equated with acquisition of commodities is not kept universal and that alternatives are prospected.

2) Implications of smart and green technologies on mining futures, for eg. A mineral-footprint card. Similar to the carbon-foot print plan, a mineral footprint plan can be evolved and designed into houses, communities and lifestyles.
3) The usage of anticipatory action learning (asking questions of desired and probable futures through iterative cycles) as a policy research methodology. This means ensuring that mineral extractive economies are not just the object of research but are part of a mutual dialogue on desired mining futures. An example can be given of Saudi Arabia, which has a per capita annual income of nearly $15,000, yet its true unemployment rate is estimated at up to 25 percent, mostly concentrated among youth (Beattie, 2009). A big reason for this job-light model is the Dutch-disease effect caused by oil, which causes diversification into other economic activities and sectors, economically unfeasible. Yet any steps by Saudi Arabia towards diversifying its portfolio or pumping less oil, would equate to a nightmare, worst-case scenario for the developed world. Ironically, every time the advice from developed countries, is more investment in higher education, research and universities, which eventually results in youth dissatisfaction, brain-drain and recently as fodder for radicals. Hence the need for looking beyond currently preached policies.
4) Role of voluntary corporate codes, by MNC's especially in places where enforcement of laws and regulations is weak and sound policies are absent. Under initiatives like the Extractive Industries Transparency Initiative and organizations like International Council on Mining and Metals (ICMM), the mining sector's contribution to sustainable development has made several advances.
5) Transparency and good governance in developing world bureaucracy will enable a country's civil society to hold its government accountable for the development and revenue-spending of national mineral assets. Where corrupt and dictatorial governments rule, pressure from civil society and shareholder groups in both developed as well as developing countries, can play a major role.

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Notes

1 While discussing the minerals sector, it is important to differentiate between two distinct parts of the sector, namely Mining and Metallurgy. Mining usually includes exploration, mining operations and equipment, while Metallurgy includes mineral processing and 'added value' primary products. While close cooperation with the mining and metallurgy sub-sectors is essential for any plausible future, our study only looks at the mining aspect of the mineral sector.

2 All identified reserve estimates are based on estimates; these figures are not based on proven ore deposits.

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