Minerals-based sustainable development – one viable alternative

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INTRODUCTION

Anti-mining sentiments are rife in Europe and North America. Environmental accidents associated with mining activities in numerous countries and resource wars in Africa have triggered harsh criticism, not only of mining but also of the metals industries in general. The purpose of this article is to discuss mining industry practices and responsibilities and to consider the options available for using mineral wealth as a lever for economic, social and cultural development. Our conclusions are that not only are minerals indispensable to such development but possibly the only viable alternative for a better global standard of living.

The article is organised into four parts: Firstly the background to the current situation is reviewed. In the second part the sustainability concept as applied to mining is discussed. Transnational mining companies (mining TNCs) are key players and the target of much of the critique and their role is analysed in the third section. In the final part we consider the issue of poverty reduction and resources development. It should be noted that energy resources are not discussed in this article, although we acknowledge that there are some direct links between the two sectors; fossil fuels extraction represents a significant proportion of the mining sector, while the smelting and refining of all metals requires significant amounts of energy.

A. SETTING

Metal and minerals have been synonymous with power throughout the history of mankind. From prehistoric times societies have flourished economically and culturally whenever and wherever metals have been found and exploited. In the late 19th and early 20th century the transnational companies (TNCs) that now control the global supply of metals and minerals were established. During the past century many big mining companies have seen their fortunes grow and vanish; some are still active while others have long disappeared or been absorbed by corporate takeovers[1, 2]

During the two World Wars and the Korean war demand for metals escalated and consumption outstripped production, amassing huge profits in the corporate coffers. By the early 1970s the sustainability of a high and growing rate of metal production and consumption was questioned in a widely publicized analysis by the Club of Rome[3] , which drew attention to the finite nature of mineral resources[4]. At the same time many of the developing countries, as independent nations emerging from their colonial past, were eager to make use of their natural resource endowment for their own economic, social and cultural development. If the supply of a metal is threatened, as the Club of Rome

claimed, prices and profits for the owners would logically increase. The concept of resource-based development was adopted by many governments and spearheaded by Algeria in the famous UN Declaration of 1974[5]. The industrialised countries became more and more concerned about the security of supply after the oil price shocks of the late 1970s and the potential threats posed by the many "new OPECs" for bauxite, copper, or iron ore [6].The interests of developing and industrialised countries clashed and during the last 20 years history has shown that neither of these scenarios was correct.

With gradually falling metal prices and deteriorating terms of trade for commodities compared to industrial goods, the importing of mineral concentrate or metal for value-added processing has become steadily cheaper. The political and economic fears of disruption in the metal supply chain have also gradually subsided. With growing environmental awareness, concerns about the impact of mining were seriously questioned first in the US and later in Europe. The resulting effect has been an increased metals import dependency.

Seen against this background the strong anti-mining sentiments in Europe and North America become understandable. Recent resource wars in West and Central Africa together with environmental accidents in Europe and elsewhere helped to fuel further concern and suspicion such that not only the mining industry and its practices are under increasing scrutiny but the need for metals as such is questioned.

Where will this type of simplistic and sweeping critique of the mining industry lead? What alternatives will it leave for "the poor" of the world? If the resources of a developing country must not be used for economic, social and cultural progress, what other avenues remain open? Are these alternative avenues, which are not presented and even less discussed, realistic? It is necessary to make assessments of possible options in each specific case.

There was a period during the most intensive IT boom years when it was envisaged that developing countries would not have to pass through the same stages of metal-intensive industrial growth that today's industrialised countries have gone through. Services would become the mainstay of the economy and the demand for traditional mineral resources would no longer be such a powerful economic driver. These ideas are no longer so widely espoused, not only because the IT bubble burst but also because the so-called metals intensity[7] of many economies has failed to show signs of the expected downwards trend. Metals are still needed in the building of infrastructure whether it be roads or global communication networks. China, which is keeping extensive parts of the global economy going, is consuming metals at rates growing by double digit figures annually. While this is certainly not sustainable over the long term, the fact that metals and minerals once again are seen at the heart of rapid economic development, must be taken into consideration when alternative economic development scenarios are discussed.

We believe that there is an urgent need to both broaden and focus discussion about mining industry practices and responsibilities and ways in which countries can use their mineral wealth as leverage for economic, social and cultural development. Is there any

reason why South Africa or Chile or Democratic Republic of Congo should not be allowed to use their mineral resources to try to alleviate poverty? Is there any reason why these countries ought not be allowed to market their metals and minerals to satisfy demand from industrialised countries?

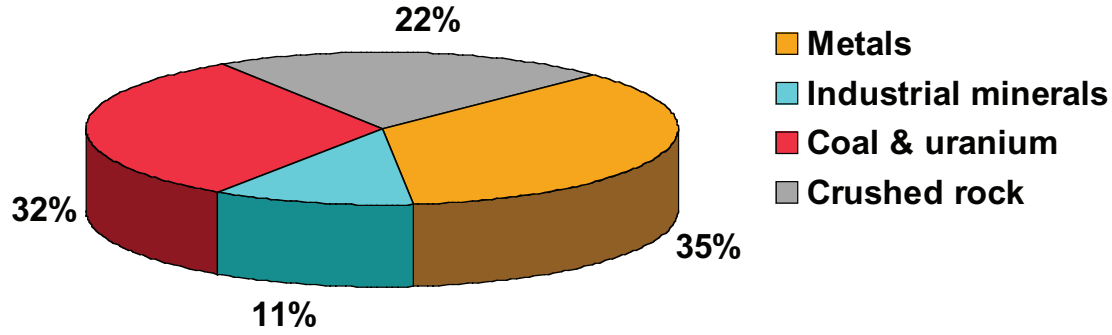

Fig.1. Shares of values of all important commodity groups. World total of all mining except oil and gas values about 350 billion US$ *per annum* (2003). Industrial minerals involve carbonates for cement, phosphate for fertilizers, pyrites, gypsum, etc. Source: Raw Materials Data, RMG, Stockholm 2004.

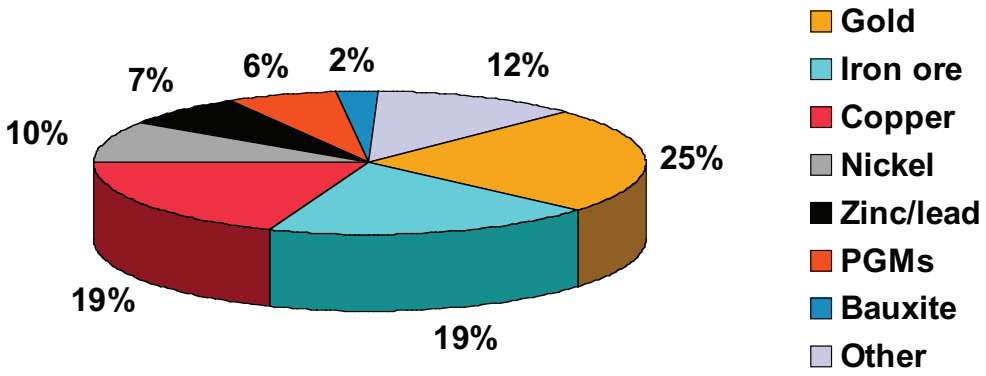

Fig 2. Shares of metallic commodities. World total of all metallic minerals mining (value of metals contained) amounts about 125 billion US$ *per annum* (2003). PGM, sum value of platinum group metals; bauxite value of the major aluminium mineral production. Source: Raw Materials Data, RMG, Stockholm 2004.

B. SUSTAINABILITY

The natural resources or global ecosystem services used by society is worth at least 40 trillion USD a year, which is close to the world's total economic output of 45 trillion USD[8]. Most of the ecosystem services value belongs to air, water, fertile soil and biodiversity. The annual monetary value of all extracted minerals (except oil and gas) is by comparison only 0.3 trillion USD, see Figs 1 and 2. Minerals are, however, indispensable when producing manufactured goods of all kinds and to provide most services, even at a basic level. Also, all "renewable" forms of energy generation, including solar, wind or bioenergy, and forestry and agricultural production are ultimately dependent on utilizing minerals and metals in some form.

Some metal uses have become integrated into human traditions, values and belief systems which influences individual consumer preferences. Gold and precious stones have signified wealth and status throughout history, across continents and in most cultures. Present metal consumption patterns are obviously not always rationally justified.

Mining and smelting of "non-renewable" metals is sometimes considered to constitute the essence of non-sustainable development. Such a simplified description, however, is based on a lack of understanding of the complex interdependence between society and minerals and the character of the development process.

Minerals form the massive rocky crust of the Earth. In an ore deposit useful minerals occur at concentrations, which can be beneficiated under current economic and technological conditions. Is there any truth in the common statement that minerals mined are non-renewable and as such should not be extracted? It is true that they do not renew in that very same mode as they were originally formed[9], but nevertheless there is no danger of depletion in a socio-economic sense as elegantly demonstrated by many authors[10] :

- All elements, particularly metals, are in a physical sense imperishable so that efficient management of spent materials may enable recycling even after centuries A generalized materials-flow cycle is presented in Fig. 3,
- With increasing scarcity, prices will rise and new mineral occurrences, poorer or of new types, will become economic ores. The search for substitutes will also be encouraged as was the case after the "oil crisis" in the late 1970s,
- Many elements occur in common rocks in such enormous quantities that from a human time perspective there is more than enough for everybody even at the highest per capita consumption rates e.g.: iron, aluminium, magnesium, titanium, chromium, not to mention valuable minor elements needed in modern alloys or uranium for energy fuel,
- Improvements in production technologies and in material sciences increasingly enable both transfer of voluminous, currently non-economic deposits to ores and substituting old materials with new, which have better properties and are more easily recyclable,
- Continuous miniaturisation of machinery and equipment and

- "Go without or do with less" has been adopted, for example in trying to minimize use of toxic metals, such as lead or mercury.

Therefore fixed depletion times or projected life times for commodities based on assumptions of world resource estimates divided by forecast consumption are too simplistic and of little practical value.

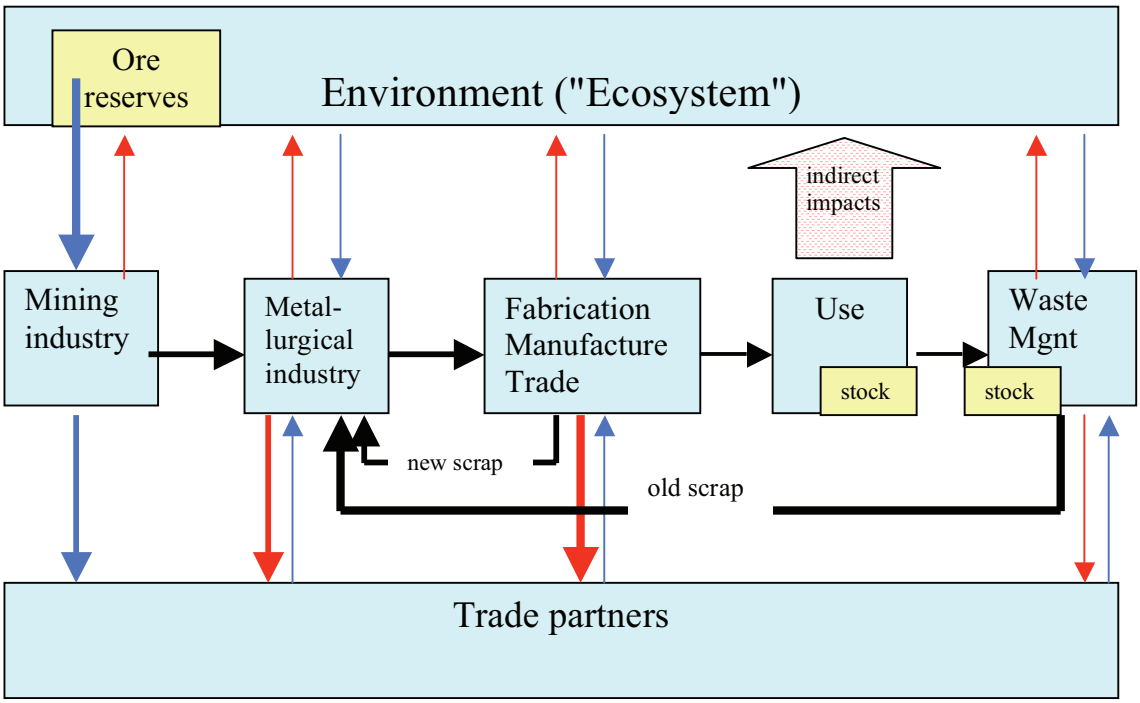

Fig. 3. System of material flows and stocks. Further to recycling scraps the concepts of reuse, remanufacturing of products and landfill "mining" belong to recycling. Even if shown, indirect impacts are due to use of materials enabled services and as such not pertinent to the material flows. Modified from D.B. Muller and T.E. Graedel.[11]

The past has proven that *development is a truly dynamic process and involves much more profound and important change than pure expansion*. The threat to economic and social development is not depletion of metals and minerals, but disruptions in supply due to political unrest or other external factors in the regions of production.

There are however two crucial issues, which need to be discussed: population growth and environmental destruction, firstly due to mining and secondly, most importantly, by the use of minerals and metals in manufactured products and services for consumption.

Poverty, resource demand and capability for global change are intimately linked to **world population growth,** which centres on the developing countries**.** This growth tends to

consume the opportunities for sustainable development, which economic growth could offer. It is estimated that eradication of poverty at present technological level and with today's development goals would require more ecosystem services than the planet Earth can ever provide. Even a decline in annual population growth rate by 1 % in 2001-2015 will undermine most investments in poverty reduction and sustainable development. The key question when strengthening the economy of developing countries is their ability to make efficient use of those transient periods during which demographic age structure is favorable [12].

As opposed to minerals and metals the **environment** can be regarded a non-renewable resource. The cost of pursuing responsible, sustainable natural resources and environmental management has been estimated at some 10 % of the total economic growth rate of the world.[13] Either by increasing productivity by that much or rather, by changing attitudes and arriving at an international consensus, the required investments could be directed to the care of the environment without stakeholders having to forsake anything crucial in terms of today's living standards. For instance, at least in theory, transfer of some of the downstream revenues generated from the later life cycle of materials back to the miners and smelters would serve to improve their environmental performance. Recent studies already indicate of a significantly positive correlation between the financial and environmental performance of major mining companies.[14] By making more efficient recycling of materials profitable, discharges to the environment would decrease and the demand for virgin materials follow suit. Most of the technology and knowledge necessary to pursue this route is already available or can be developed.

From the sustainability viewpoint it is more appropriate to focus on the use of fabricated products and related services instead of valuing resources in terms of their "renewability". It is misuse, either by using too much or in the wrong application, which leads to deterioration of the environment, rather than direct use of the resources themselves. The primary reason for a non-sustainable use is overpopulation, limited access to information (lacking education), and idealization of a product-oriented consumer life style. Social development cannot take place without raw materials, but our culture allows over-use and/or misuse of products and services. There is a need for a socio-economic and political system, which could define these limits in an equitable way.

Paradoxically (and disturbingly!), the use of many "renewable" resources are currently proving to be less sustainable than the extraction of "non-renewable" commodities. The rate at which some of the "renewable" resources is consumed is exceeding their regeneration capacity. The serious deterioration of the quality of air, water and soil resources is but one example. The decline in fish population in the North Atlantic and the deforestation of the tropical forests are others. Present crops cannot provide the protein mankind need without more cultivated land area and productivity. Improved productivity depends on applying breeding, better production practices, mechanisation and mineral fertilizers.

Ultimately, the limits to growth depend upon political willingness to make decisions and reforms of a structural nature: conducive micro-economy, participation in the global

division of labour, stable macro-economy and, in particular, investments in people and the management of population growth. A fair global economy with international consent on binding laws, regulations and principles and their enforcement is the most promising, if not the only solution.

But would not "zero economic growth" be a solution for sustainable future? No, because such a scenario would clearly undermine opportunities for most poverty eradication plans and even jeopardise environmental achievements in developed countries. Only an economic growth rate, that allows for the population growth and meets the demand for structural adjustments, as discussed above, can support sustainable development. Hopes for a zero growth solution are based on the Club of Rome type of depletion scenario, which has proven to lack the dynamics of the real world development.

"Non-renewability" is not the most relevant criterion for describing the use of mineral resources and rocks. Mining is by definition an environmentally destructive activity but on the other hand is more amenable to monitoring and management than many "renewable" resource sectors. Decisive action to correct the environmental and socio-economic impacts of mining has been implemented in many areas and an acceptable level of sustainability will evidently be reached within the next decades. However the risk to total life-cycle sustainable management of metals increases further down stream from mining. It goes without saying that the use of manufactured products and advanced services enable a better standard of living and a higher quality of life. These very products and services are, however, also a real environmental danger and they can pose a threat to sustainable development in a democratic world.

C. TNC POLICIES

Transnational mining companies are often believed to be at the root of many of the problems associated with mining, in particular in developing countries. Historically it is a fact that mining companies have sometimes replaced states as the governing body and sole economic guarantor of large areas and even countries. Such operators have been able to make huge windfall profits out of high-grade ore bodies without considering the long-term reserve management, environmental and social consequences[15]. But, while this picture might have been true in the mid 1900s it is now mostly history. With economic growth shifting to the service sector and stagnating metal consumption in the industrialised countries, mining companies have become marginalised on the stock exchanges of the world. They are no more *the* engines of economic growth in developed economies.

Individual mining companies may still be in control of local and regional economies and take advantage of the situation to act as if they are above the law. But in general the mining industry has become less concentrated and the major mining companies less powerful over the last decades than they were until the 1960s. This is not only due to

increased competition among them, but also to increasing pressure from the outside world for the industry to conduct its business in an acceptable way.

Transnational companies are in some respect amenable to outside pressure because they depend on their long term funding from diverse shareholders mediated by a number of stock exchanges. In addition to the big players, a mixed group of smaller and state operators have important roles:

- A large number of smaller, often locally controlled companies operating mines and quarries,
- Junior companies tend to be innovative and willing to take greater risks, particularly in early stages of project development, and often in countries and regions where the political situation may be volatile,
- State-owned mining companies acting in emerging market economies and in certain regions of the industrialised countries and
- Artisans and small scale, often informal operators without knowledge and resources to care for the sustainability of their operations.

The number of mines operated by the members of this mixed group is much greater, while, production is less and environmental and socio-economic performance is typically lower than that of the TNCs. For various reasons the mixed group is not as sensitive to outside pressures as is the major transnationals.

Intense and mostly well-founded critique over the years from many stakeholders, ranging from trade unions to environmentalists was necessary to start the processes which led to recent landmark reports such as “Breaking New Ground: Mining, Minerals, and Sustainable Development” (MMSD, 2002), the “Extractive Industries Review” (EIR, 2003) and the "Extractive Industries Transparency Initiative" (EITI, 2003)[16]. In a long and elaborated participatory process these reports analysed the current performance of the industry and proposed improved practices for industry and other stakeholders. Such practices are often not entirely new but adaptations of what has already been implemented by the most progressive of the mining TNCs. Most important, however, local and state government, industry and labour and NGOs worldwide are becoming committed to the new performance criteria. A complete change in practices will certainly require years, but the objectives and substance of sustainable mining are agreed to by most of the major stakeholders including many mining TNCs originating from and operating in the developing world.

While united action by direct and indirect stakeholders can obviously exert some influence even over the major mining transnationals it also requires an increasing degree of accountability and responsibility on behalf of the pressure groups. The observation that “thoughtful political science analysis is increasingly being taken hostage by journalistic interpretations and NGO reporting and "expert commissions” has poignantly been made in connection with the resource war in the Republic of Congo[17]. The point is that “The functioning and evolution of the international mining sector is …. often overlooked". This sector has gone through fundamental changes over the last two decades …. It

operates primarily according to economic logic, which explains why it is much less involved in Central Africa than many local actors tend to believe". An analysis of the problems created by mining must carefully and without prejudice determine what has really happened and establish who the perpetrators are at each level of accountability, in order to adequately address the problem.

Many mining companies, and not only the majors, are attempting to comply with four objectives:

- to be socially acceptable,
- environmentally sustainable,
- economically affordable and
- apply technologies, which serve to achieve the first three objectives.

Social acceptability involves principles of community responsibility such as respecting local people's values, and allowing stakeholder groups to contribute to and participate in mining related development. Sharing of economic benefits generated by operations and taking the opportunity to develop social and institutional structures are encouraged. Another dimension is to respect human rights and to adhere to ethical business practices not only in government-business relations but also in business-business relations, as well as in relationships with trade unions. **Environmental stewardship** involves protection of nature as well as worker and community health, which are based on corporate environmental management policies. This plan integrates policies, programs and practices for minimising the adverse impacts during and after the mining or smelting operation is shut down so that performance complies with or exceeds government requirements. All conceivable emergency situations must also be planned for and the resources to deal with them in case they develop must be available. **Economical viability** is crucial not only from the investor's point of view, but also for ensuring security of employment, continued generation of public revenues and successful environmental management. The **technological dimension** involves producing and processing of minerals by methods, which enable environmentally safe operation and recyclability and economic recovery of materials. Commitment to continuously search for cost-environment-effective technologies and even to use Best Available Technology (BAT) is often required by corporate policies. Responsible operators also encourage all contractors and suppliers to follow these corporate practices. The real challenge to industry is to work towards all four objectives simultaneously, while making all stakeholders satisfied with the results.

One example of the gradual progress in this stepwise process of making the mining transnationals more sustainable is the recent adoption by the International Council on Mining and Metals (ICMM) of ten fairly strict MMSD based principles and commitments against which to measure their performance. Further, ICMM has agreed with the Global Reporting Initiative (GRI) to generate a GRI Mining and Metals Sector Supplement.

Governments of resource-rich countries and front runners among the mining TNCs are gradually directing some of their efforts towards taking increasing responsibility for the

sustainability of the mining industry. Whether the results of these efforts will meet the expectations of all stakeholders, including local communities remains to be seen. It is however unquestionable that when mining TNCs find that their environmental investments improve their bottom line results their commitment to the environment will be strengthened. This is a powerful sustainability driver and it should be used when drafting new laws and regulations.

D. POVERTY REDUCTION AND RESOURCES DEVELOPMENT

History abounds with examples where nations have based economic development on locally available natural resources, be it fertile agricultural land, high grade metal deposits or vast forests and powerful streams and rivers. Often financial resources and technological expertise had to be imported but nevertheless some of the benefits of mineral production stayed in the host country, which in some cases was pivotal to subsequent economic development. Examples could include Sweden, Finland, the USA, USSR, Australia and South Africa.

Minerals and mining as levers for economic development have however been challenged in recent years. Some point to the TNCs and their negative role[18], others compare general economic development of countries well endowed with mineral resources to those without and find that the former group has not done better than the latter[19]. Some voices even claim that the more minerals intensive, the weaker the economic development. These views have strongly influenced thinking in the international development community and mining is in wide circles not considered a lever for economic and social development under any circumstances.

These views have however recently been challenged by others.[20, 21] They refer to and analyse the experiences of industrialised countries such as the USA, Canada, Australia, UK, Sweden, Finland, which have to a large extent built their economic growth on domestic natural resources. Metals and minerals formed the backbone of the Soviet Union's leap from a backward agricultural state to one of the two superpowers in the cold war era. The key driver of Russia's present growth is likewise natural resources.

Iron and steel production based on domestic iron ore is another important example. Economic development when moving from self-supporting agriculture to manufacturing is reflected in an increase of the consumption of iron and steel. The present Chinese economic explosion is fuelled by vast amounts of iron and steel, which is used for infrastructure construction such as roads, bridges, railways, buildings, and electrification, and also for consumer goods for wealthier Chinese homes and exports.

A citizen of a poor country annually utilizes about 125 kg of iron in one form or another, while the comparable figure for developed countries is 400 kg. As an economy matures, the overall consumption of steel *per capita* starts to decline, while use of coated and alloyed steel and later, stainless steel will increase. [22]Development involves continuously

growing use of longer lifetime products manufactured from quality steels, which are recyclable i.e., relative sustainability of materials use increase by economic growth.

In our view, to simply and a-priori dismiss the possibility of socio-economic development based on minerals is unjustified and may lead to serious mistakes in prioritising development routes for some countries and/or regions. The potential for resource-based sustainable development should be evaluated without prejudice as one potential driver of economic growth.

Minerals production would not only supply necessary raw materials for domestic use but could become the first industry sector and seed further, non-mining related industries. The additional requirement for services both up-stream and down-stream could potentially form a sustainable, and viable cluster.[23]

The positive economic impacts of mining industry can be summarized as:

- GDP growth,
- Direct and indirect export and tax revenues,
- Direct employment (typically at 100-300 per mine, 70-90% local labour force),
- Indirect economic spin offs (downstream investments by a factor of 2 to 4) and
- Direct contribution to health, education, food security, transportation, water supply services, energy, information and telecommunication, small business and vendor and supplier partnership programs.

Investing in and operating a mine is principally a private sector undertaking although the fortunes of a company depend not only on whether it is privately or state-owned, but rather on management capability. The Swedish iron ore producer LKAB, Finnish former basemetal miner and smelter Outokumpu and the Chilean copper giant Codelco demonstrate that companies, in which government has a majority stake, can still be profitable and successful on a global scale. To create an enabling business environment is government's exclusive task while at the same time ensuring that the public benefits of mining are safeguarded. Governments of developing countries may need technical assistance in attaining this objective.

When considering policies aimed at using minerals for economic growth it is obviously necessary to adopt a holistic approach that covers all relevant vertical and horizontal factors, rather than restrict analysis to minerals sector alone.

The *vertical* improvement of the minerals sector involves for example training at all levels, the formation of professional organisations, setting up legal and regulatory systems (mining code, specific environmental and fiscal regulations), in addition to collecting and disseminating geological information, market studies and investment promotion and marketing. One such example is the African Mining Partnership that was launched in 2004 to drive the NEPAD mining and minerals related initiatives[24]. Over 20 African mining ministers gathered in Cape Town and brought up the important role to be played by minerals in poverty alleviation across the continent. Another, global example is

the Intergovernmental Forum on Mining, Minerals and Metals and Sustainable Development, which will become operative after 25 countries from all continents have confirmed their membership in early 2005.[25] However, experience shows that even countries with good mineral potential and supportive taxation regimes do not necessarily attract investors if the proper horizontal factors are not in place. These *horizontal* factors are among others: good governance, development of physical and social infrastructure, convertibility and transfer of funds, proper use of fiscal revenues, measures to mitigate political risks, including government intervention and political violence.

Deregulation and liberalization to enhance the country's competitiveness for mineral investments must not however limit the capacity to enforce socio-economic and environmental standards and development strategies.[26] A "competitiveness" based on limiting local benefits of mineral exploitation is not in the long-term interests of local people, host governments or investors. If taxes and royalties paid are too low to ensure an adequate and improving standard of education and health care, a mining company will in time face serious problems in recruiting skilled workers. To create an enabling and competitive environment some aspects are crucial:

1) Strengthening national laws and regulations to ensure that a larger part of revenues are entering the host country economy and that environmental standards are improved and enforced. Capacity building to efficiently monitor and enforce laws and regulations is urgently needed in a number of countries.

2) **Binding international protocols** on the conduct of business and social responsibility, such as the UN´s "Draft Fundamental Human Rights Principles for Business Enterprises"[27],OECD´s ″Guidelines for Multinational Enterprises" [28]and EU´s ″European Enterprises Operating in Developing Countries"[29] should be enforced. Abuses should be dealt with by national courts.

3) **Self regulation** by the mining industry itself, such as the ICCM´s commitment to ten principles[30] and individual corporate policies on social responsibility should be encouraged. An environmental certification of the type used by the forest industry has also been suggested to the mining sector and should be considered. [31]

In addition to the main players, namely companies and host governments, the home countries of transnational companies, creditors, stock exchanges, international development cooperation agencies and NGOs should each be assigned a well-defined role in ensuring compliance with accepted standards. For example, a company's commitment to implement the OECD guidelines or the Equator Principles adopted by some banks could be the condition of eligibility for credit guarantees. There are however already too many individual sector initiatives, guidelines and principles. Many of these have similar contents but none of them are legally binding. Each industry should be regulated through a single or at least a minimum number of segment specific protocols, that are equally binding for all concerned. The recent Extractive Industries Review[32] recommend the World Bank Group to adopt as a prerequisite for the financing minerals sector projects good governance, democratic institutions, functioning judiciary and, in

particular, specific actions to ensure that the benefits of mining to flow back to local communities and the poor.

There are certainly many problems associated with this route of development, such as the necessity to take a long-term perspective of more than ten years. With proper planning however and by taking both positive and negative experiences of the more distant past as well as more recent results of minerals-based economic development from countries such as Botswana, Chile, Papua New Guinea, Australia, Argentina and South Africa into account many of the blatant misuses of mineral resources so cruelly obvious from the crisis in, for example, the Republic of Congo could perhaps be avoided.

A holistic approach and clear assignment of responsibilities to stakeholders is necessary for creating a minerals industry, which over the long term will be beneficial to all stakeholders and not a merely a privileged few. In the global economy international development cooperation should be the prime agent to support the strengthening of horizontal factors of the industry, such as good governance. Vertical factors should be principally developed by government using funds created from revenues of the resource based industry.

E. CONCLUSIONS/SUMMARY

Metals, minerals and other earth resources are indispensable for economic growth and to long term social and political development. Non-fuel minerals are generally available in such qualities and abundance that their depletion is not a threat to mankind in the foreseeable future. Developing geological science and systematically collecting geological data from under-explored parts of the globe, improving materials technology and increasing recycling, in combination with adequate development policies have the potential to increase global mineral reserves at the pace of economic growth. This should however not be taken to mean that sustainability can be taken for granted. On the contrary, a crucial, difficult and necessary task over the next decades will be to bring ecology and economy closer to each other by applying mechanisms to encourage earth-sustaining forms of economic development and discourage earth-degrading growth.

Minerals production is but the first phase of the materials life-cycle. Whether the manufactured goods and services, made from minerals and other raw materials, are designed, produced and consumed in a sustainable manner will at least partly depend on the degree to which consumers are informed about the impacts of their choices. To manage a systematic transformation towards sustainability in each link of this long and complex chain and to change the behavior and values of companies, consumers and governments towards more sustainable choices will be a prolonged, yet necessary task.

Minerals-based sustainable development is not just a possibility, but the only viable alternative for a better standard of living on a global scale. Many of the negative effects of mining stem from ignorance and misleading policies and a lack of democracy and proper governance. Sometimes poverty may be at the root of the problem, but this is

definitely not always the case. It is a lack of capacity in public administration and the tendency of mineral projects and mining companies to aggravate bad policies and corruption that needs to be rectified, not mining as an activity in itself. Research into the complex relations between mineral projects and mining TNCs on the one hand and public policy making and economic and social development on the other hand is necessary and urgent.

Resource-based sustainable development should be evaluated without prejudice, on a case-by case basis, as one potential route to progress in socio-economic development for all countries and regions where favourable geological conditions are at hand.

Mineral resources have given and will give a competitive edge to a number of resource-rich countries. Minerals are however *not* a panacea for national prosperity. For mining to become something more than just digging the earth and leaving a hole behind, forward-looking economic policies should be based on investments in useful minerals expertise and technological development combined with policies aimed at balancing societal needs and a conducive but regulated business environment. The socio-economic and environmental framework for mineral production needs legally binding regulatory regimes, both nationally and internationally, supplemented with producer self regulation.

REFERENCES

[1] Martin Lynch, Mining in World History, London 2002.
[2] Carl-Wolfgang Sames, Anaconda - Berichte aus der Rohstoffwelt, München 1986.
[3] ref. D.H. Meadows, D.I. Meadows, J. Randers, W.W. Behrens. Limits to Growth 1972.
[4] This was not a new thought even in the late 1960s. Similar worries had been discussed for example by the Swedish Nobel Prize Laureate Svante Arrhenius, Kemin och det moderna livet, (in Swedish) Stockholm 1919 or by the British historina J. D. Bernal Science in history, London 1969.
[5] United Nations Declaration on New International Economic Order No. A/RES/3201.
[6] In 1973 the Non-Alligned Movement led by Algeria presented their proposed New International Economic Order to the United Nations. This new agenda focused to a large extent on the use of natural resources as a lever for economic and social development. Fair and reasonable prices for raw materials formed an important part of the proposal.
[7] Amount of metals consumed per unit of GDP. See for example Astride mining, issues and policies for the minerals industry, Phillip Crowson, London 2003.
[8] World Development Indicators 2003, The World Bank, Washington DC.
[9] That metals are formed also today and in considerable quantities is demonstrated by the so-called black smokers and the nodules in deep seafloor environments. There was a surge in interest in the submarine mineral resources as a result of the oil price shocks in the late 1970s. Gradually this interest faded but the International Seabed Authority (ISA) under the aegis of the United Nations was set up in 1994 to deal with commercial issues of these resources. The first commercial exploration permits covering black smokers at a depth of some 5 000 m were given by Papua New Guinea to an Australian junior in the early 2000s. See Minerals other than polymetallic nodules of the International Seabed Area, ISA Kingston 2004.
[10] See for example John E. Tilton On borrowed time? Assessing the threat of mineral depletion, Resources for the Future, Washington D.C. 2003.

[11] Daniel B. Muller and Thomas E. Graedel. Model Development for the Global Cycles of Iron and Its Alloying and Coating Elements, Workshop Report, Yale University, 6-8 February 2003.
[12] "demographic windows". World Development Indicators 2003
[13] based on the estimation of Nordhaus 1992
[14] Innovest Strategic Value Advisors, 2001. Sector Report Miming – Base and Precious Metals, www. innovestgroup.com
[15] One example is given in United Nations Reference Book on major Transnational Corporations operating in Namibia, New York 1985, p. 25 discussing the Tsumeb copper mine in northern Namibia. ".. the average annual return on original investment in TCL (Tsumeb Corporation Limited) over the period between 1950 and 1970 as 348 per cent."
[16] www.eirtransparent.org
[17] Erik Kennes, Footnotes to the Mining Story, Review of African Political Economy, vol 29 pp 601-607.
[18] But one example of this type of arguing was presented in The Courier No 196 p 38.
[19] Richard Auty, The Political Economy of Growth Collapses in Mineral Economies, approved for publication in Minerals & Energy – Raw Materials Report, Stockholm 2004.
[20] Gavin Wright and Jesse Czelusta, Mineral Resources and Economic Development, Paper prepared for the Conference on sector reform in Latin America, Stanford Center for International Development, November 13-15 2003.
[21] Paul Stevens, Resource Impact: How to maximize the benefits and minimize the negatives: The contribution of the companies, paper presented at the International Mining Seminar: Global investment, local challenges, Centre for Energy, Petroleum and Mineral Law and Policy, University of Dundee, Scotland June 2004.
[22] as given in Fig. 3.
[23] UN ECA, Mining Policy Pilot Study, Case studies of the South African and Mozambican mining clusters", Addis Ababa 2004.
[24] NEPAD, New Partnership for Africa´s Development, see http://www.uneca.org/eca_resources/Conference_Reports_and_Other_Documents/nepad/NEPAD.htm
[25] The forum got its final two signatories, Guinea and Swaziland, to reach the minimum number of 25, at the 2005 African Mining Partnership meeting held in Cape Town early February 2005. The Forum operates under paragraph 46 of the Johannesburg World Summit Plan of Implementation, see www.globaldialogue.info.
[26] Bonnie Campbell editor, Regulating Mining in Africa, for whose benefit? Nordiska Afrikainstitutet Discussion Paper 26, Uppsala 2004.
[27] http://www1.umn.edu/humanrts/links/principles11-18-2001.htm
[28] http://www.oecd.org/department/
[29] http://cei.sund.ac.uk/EU/codeofconduct.cfm
[30] International Council on Mining and Metals, http://www.icmm.com/icmm_principles.php
[31] Mining Certification Evaluation project: Independent certification of environmental and social performance in the mining sector a project of WWF-Australia and Placer Dome Asia Pacific. Paper prrepared by Michael Rae, WWF-Australia for the MMSD workshop "Possible structures for progress towards sustainable development", May 7th 2001, Johannesburg South Africa.
[32] EIR, 2004