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SUSTAINABLE DEVELOPMENT AND INDUSTRIAL MINERALS

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ABSTRACT

Most discussions of sustainable development (SD) in mining relate to metal mines in rural areas. Industrial minerals (IM) are closer to urban areas primarily owing to a high transport-cost component of delivered cost. This visibility to large populations overshadows IMs relatively small operation size and generally lower waste volume and toxicity. The IM industry needs to rethink its way of doing business to fit into the SD paradigm. Society and business in general will also undergo significant change to enable industrial SD along the lines of triple-bottom-line accounting with government pushing everyone. The benefit to IM mining from embracing SD is a renewal in their social license to operate and a rebirth of mining as a positively-viewed force in society. This positive view would lead to lower acquisition costs because society would not fight so hard to eliminate nearby mining. This would ease the current exploration woes of the IM industry by opening up new deposits for exploration and more readily allowing placement of mines nearer to markets. The earlier in the exploration process SD is initiated, the better.

INTRODUCTION

The concepts that would evolve into sustainable development began to appear in the early 1960's, mainly as corporate social responsibility, but the term sustainable development (SD) did not become part of the international lexicon until 1972 (Anderson, 2003). SD become part of the international mainstream upon the publication of "Our Common Future" in 1987, also known as the Brundtland Report, by the UN Commission on Economic Development (United Nations, 1987). The Brundtland definition of SD is activity that "…meets the needs of the present without compromising the ability of future generations to meet their own needs." Formal recognition of SD was achieved at the Earth Summit in 1992, especially in the Agenda 21 action plan, which stated "Governments should adopt a national strategy for sustainable development…for the benefit of future generations."

The Brundtland generality has been interpreted in many ways and more than 300 definitions of SD exist (Anderson, 2003). Intergenerational equity is a key component of all SD definitions. Common to these definitions is the precept that over time human well-being must never decline. Defining well-being is not easy; although the concept of wealth is often used to measure well being. People meet their needs by spending wealth as money. Thus, there is an imperative to create wealth/money to be used and also passed to the next generation, resulting in a call for society to maximize wealth as the best way to attain well-being. Most SD wealth paradigms utilize some variation of current economics and optimality theory.

The current concept of wealth in SD is mainly material and resource based. This is usually not sufficient to characterize SD so various types of non-money capital—natural capital and man-made capital plus subtypes—have been developed. Mining activities such as exploration are a type of man-made capital. Natural capital refers to both renewable resources and non-renewable resources supplied by the earth, water, air and biota of the planet.

Many views of SD exist and range from Strong SD to Weak SD. Strong SD holds that the natural resource base cannot deteriorate, hence no use of non-renewable resources is allowed, while biological resources are maintained at a minimum critical level and wealth is preserved for the future. Weak SD requires sustainability without degrading the overall total of stocks. This allows a more flexible combination of both natural capital and man-made capital under which mining of nonrenewable resources is allowed.

Today society has accepted SD to the extent that its least advantaged members must be included now, along with more traditional stakeholders, in mining and other development decisions. Future generations are considered to have a right to inherit wealth and capital and the undiluted means to acquire both. The current generation has no right to decide what succeeding generations might need or desire. No generation (except the last one before human extinction) should deplete the wealth and capital stocks of the world. The increased total of wealth and stocks handed down to future generations implies that they must be better off (i.e. total human well being never declines). In practice, markets, rather than the government or NGOs, will be the best method to decide how SD unfolds. The trick is to link all markets to SD so that market decisions lead to the desired result without disenfranchising any stakeholder. If markets are not used, intense micromanagement by a central authority will be tried with poor results as predicted by the historical record, such as the failed centrally planned economies of Eastern Europe and the USSR in the last century.

MINING AND SD

Mining has one of the stickiest positions of any major Industry relative to SD, as summarized below:

- Mining utilizes non-renewable resources, which is against Strong SD that allows no mining at all because it depletes a non-renewable resource.
- Mining has, in society's eyes, a terrible social and environmental record that must be reversed (quibble all you want, but it is true).
- Over at least the last 25 years, mining in the US has poor performance as measured by return on investment.
- Government subsidies and trade barriers are uniformly considered bad for SD, hence no depletion allowance

for mining would be honored under full SD implementation.

- Some NGO and extreme environmental agendas advocate preservation (nonuse of resources, i.e. no mining) above all else and must be convinced that mining deserves a social license to operate.
- Possible over-reliance on preservation by society and government to achieve SD goals will tend to minimize mining without a fair hearing.
- Difficulty in changing corporate culture to act on SD without requiring a corresponding positive effect on cash flow and profits in the short term.
- End-of-mine-life issues are only partially resolved.
- A proposed mineral services concept (versus the current mineral supply model) that retains ownership of mining products with the mining company for return to the mining company for disposal when the customer is done with them.
- Inability of mining to reflect the full cost of producing, including reclamation and all other SD costs, in the delivered price, especially under the mineral services concept of IM production.
- Triple-bottom-line accounting, described below, has been slow to appear in the operation and reporting of mining companies.

The triple bottom line (TBL) accounting approach focuses companies not only on the economic value they add, but also on the environmental and social value they add— and destroy. At its narrowest, the term 'triple bottom line' is used as a framework for measuring and reporting corporate performance against economic, social and environmental desires of society as a whole. At its broadest, the term is used to capture the entire set of values, issues and processes that companies must address in order to minimize any harm resulting from their activities and to create economic, social and environmental value for the non-mining segments of society. TBL involves being clear about the company's purpose and taking into consideration the needs of all the company's stakeholders—shareholders, customers, employees, business partners, governments, local communities and the public (www.sustainability.com). Some are now calling for a fourth bottom line—cultural (New Zealand National Business Review, 2003).

The situation for mining companies is not as terrible as the above may sound, but much change and work needs to be done. The inescapable fact for society to accept is that mining is essential to present and future well being of civilization. Even if we could return to the Stone Age, we would still be quarrying stone with the result that mining would be the dominant industry in society rather than the few percent of GNP as it is now! Mining is needed and no amount of rhetoric will change that. The negative view that most citizens hold for mining (James, 1999) can be changed, but primarily by the industry radicall**y** altering how it does business. This tack will be far more successful than trying to get society to change its perceptions while mining maintains the status quo—this simply won't happen.

The status quo in mining could be maintained for a time primarily using "greenwash" techniques of achieving environmental whitewash that would do more harm than good. The inescapable fact for the mining industry to accept is that development costs and resistance to mining are rising while availability of mining sites is decreasing—mining is rapidly losing its social license to explore and operate. Mining must stop dodging SD and embrace it to ensure the long-term health of the industry. Yearley (2003) emphasized that mining's "reputation is based not on best practices or contributions to society, but on the human and environmental impact of its worst practices and products."

IM operations—primarily construction aggregate, crushed stone, and clay—comprise about 95% of all mines, pits and quarries in the United States and as much as 75% of the new mined resources used annually (Wagner, 2002). Many of these IM operations are very close to urban centers, or within them, and are operated by small entrepreneurs. Clearly, the overall image of the mining industry for most citizens resides in their experiences with these local IM operations and not in the often distant metal and energy operation. The mining SD initiatives to date have been driven by large metal and energy mining companies not small IM companies. Thus, the mining companies most visible to society have so far bought into SD the least. Considerable work needs to be done to get everyone onboard with some level of SD so image busting activities by clueless mining concerns are minimized.

The mining industry must respond to SD by, at a minimum:

- Acting before they are forced to by government agents of society.
- Involving all sizes of mining operations in SD.
- Changing their adherence to the current business culture, especially in the US, that focusing on immediate returns on investment to the detriment of longer term payoffs.
- Widely adopting TBL accounting.
- Charging government to set a climate suitable for effective SD (also a minimum response for society).

Society must also respond to mining by, at a minimum:

- Accepting that mining must be done for the betterment of society (preservation alone will not work).
- Admitting that the mining industry has a right to exist and participate in SD.
- Allowing mining companies to set prices that adequately recapture all costs, including environmental reclamation, recycling and disposal expenses.
- Charging government to set a climate suitable for effective SD (also a minimum response for mining).

The discussion in the above lists suggests that all actors must move in concert if much is to change. The role of government is central in practice to achieving both SD and mining goals and participation by government should be demanded by all stakeholders. Hence the addition of government as the fourth pillar of SD is almost universally accepted. Someone, government it turns out, needs to formulate, push, measure and enforce SD initiatives without harming market dynamics. Waiting for an ad hoc volunteer effort by companies or NGOs generally has been ineffectual. The relative advancement of the environmental pillar (largely via NGO initiatives), compared to the social and economic pillars, was achieved more by government mandates than by corporate social responsibility.

We cannot emphasize enough that doing legally enforced minimums of environmental cleanup, mitigation, remediation, and closure IS NOT SD! These end-of-mine activities are a small part of what is needed to fully engage SD concepts. From exploration to post closure, a mining company will be remembered more for what it did at start-up and during operation than for anything at closure. By closure it is too late to successfully engage the regional stakeholders, but it is not too late to further study mining's name to a wider audience by a botched mine closure. If you are banking on closure activities to prove your SD credentials, you are far, far too late with too little. Remember that mining has a long history to overcome…yes overcome. Simply providing a steady stream of minerals and materials is not enough (Anderson, 2003). Ultimately, the IM company that best implements SD policies can become the mining company of choice by society (Yearley, 2003).

The main objection to implementing SD has been the cost. Many argue that, while it may be a cost in the short term, SD will ultimately prove to be an investment that makes good business sense. Today, low returns on investment, a poor environmental record and geological uncertainty make mining a very risk venture. SD can help minimize costs (Yearley, 2003) by:

- Lowering labor costs—better union relations and increased retention and worker health yield productivity gains.
- Lowering health costs—healthy workers and healthy stakeholders in the surrounding community as a worker pool.
- Lowering production costs—increased energy efficiency and coproduct and byproduct utilization.
- Lowering the regulatory burden—increased trust.
- Lowering closure costs—terminal liabilities more accurately predicted, managed and controlled.
- Lowering borrowing costs—lower risk, lower rates.
- Lowering insurance and surety costs—trust and lower risk.
- Lowering investor dissatisfaction—increasing rate of return and dividends and easing investor social conscience.

INDUSTRIAL MINERALS

What are industrial minerals?

IMs are minerals or rocks or related materials excluding fuels, metals or gems that are natural or man-made and can be sold at a profit. The definition of IMs is very wide ranging and includes solids, liquids, gasses and manufactured products Hundreds of IMs are utilized today including limestone, lime, cement, crushed stone, clay, gypsum, brine, and carbon dioxide.

The price-range between IMs is very large (Table I). Higher value IMs are much more like metals and energy resources because they are so valuable that they can be transported any distance. The need for the correct specifications still applies but is minimized by the inherent high value of these IMs. Lower value IMs can be moved only a few miles before becoming uneconomic.

Table I. Price per Ton Categories for Selected IMs (after: Kuzvart, 2001; Harben, 2002; *Industrial Minerals*, 2003)

US$/metric ton	Industrial mineral, rock or commodity
> $10,000,000	Industrial diamond
> $10,000	Iodine, rare earths
> $1000	Lithium carbonate, silicon, quartz crystal
$100–1000	Alumina, asbestos, boron, bromine, calcium carbonate, corundum (and emery), diatomite, dimension stone, garnet, graphite, kaolin, kyanite, mica, nitrates, potash, rutile, soda ash, talc, vermiculite, wollastonite, zircon
$10–100	Barite, bauxite, bentonite, celestite, feldspar, fluorspar, garnet, illmenite, magnesite, nepheline syenite, olivine, perlite, phosphate, pumice, salt, silica sand, sodium carbonate, sodium sulphate, strontium, sulfur, talc, vermiculite
$1–10	Common clay, gypsum, crushed stone, limestone and dolomites, sand and gravel

IM EXPLORATION

Compared to metals or energy, IMs have two characteristics that bear heavily on SD and exploration:

- Differentiation—what the IM is matters (chemical and physical properties).
- Place value—where the IM is matters (location, location, location!).

Differentiation means that customers have specifications for their raw materials such that not every deposit of a particular IM can be used. What one end user can run through their plant may be totally unsuitable for another end-user's plant, even though the IM is from the same mine and is identical in every way. The IM industry has moved into a marketing strategy for customizing products for each end user. The result is that exploration for IMs is not as straightforward as it may seem. Not all deposits of a given IM that are found can be mined *and* sold at a profit. Thus, it has been said that the true exploration phase of IMs is marketing or the marketing study (Barker, Austin, and Santini, 1999). The best way to explore for IMs is too do a market study, identify the location of the market to be entered, and explore outward from that market area until the IM deposit with the lowest transportation cost and the correct specifications is found.

Place value means that low cost IMs are limited in the distance that they can be transported (Barker, 1997). Distant IM deposits are often known and of high quality that will be ignored in favor of deposits near to customers, even if they are of lesser quality. This preference for deposits near customers means that IMs are often mined very near to consuming centers that comprise the bulk of society's population. Metals and energy are mined where they are found; IMs are mined where the interaction of transport distance (Table 2), customer specifications, and markets are best integrated. Some IMs are dependent upon specific geologic terrains and are not found just anywhere. These IMs depend upon exploration techniques similar to the metals industry to locate. Some of them are found in metal districts and utilize similar models (McLemore and Turner, 2004).

New industrial products are constantly being added to the consumer markets. Many of these new products require use of IMs not

Table II. Transport Effects on Delivered Cost for Selected IMs (Kuzvart, 2001; Harben, 2002; *Industrial Minerals*, 2003)

Transport cost importance	Selected industrial mineral, rock or commodity
Very low	Industrial diamond
Low	Iodine, rare earths
Low	Lithium carbonate, silicon, quartz crystal
Moderate to low	Alumina, asbestos, boron, bromine, calcium carbonate, corundum (and emery), diatomite, dimension stone, garnet, graphite, kaolin, kyanite, mica, nitrates, potash, rutile, soda ash, talc, vermiculite, wollastonite, zircon
Moderate to high	Barite, bauxite, bentonite, celestite, feldspar, fluorspar, garnet, illmenite, magnesite, nepheline syenite, olivine, perlite, phosphate, pumice, salt, silica sand, sodium carbonate, sodium sulphate, strontium, sulfur, talc, vermiculite
Very high	Common clay, gypsum, crushed stone, limestone and dolomites, sand and gravel

mined currently or in the past. For example, optical fibers are being upgraded and used in computers and communication systems and require new form of silicon and zirconium fluoride. The raw materials needed to produce these intermediate products must be mined.

Sustainable development by mining companies currently is mostly focused (incorrectly) on the closure of a mining operation. In the future, the entire range of mining activities must be included. Thus, SD will span from exploration to post closure activities. SD should be done at the exploration level to insure that as many stakeholders as possible are included at as early a stage as possible. The mere presence of geologists often raises concerns let alone the impact the sudden appearance of an exploration drill rig can have. The land and acquisition department or the exploration department of a mining company should initiate SD activities as soon as, or even before, exploration begins. Determining local concerns and situation early will save much grief later, especially if the project turns out to be large.

CHALLENGES FACING IM OPERATIONS

In many ways IM commodities can set the example for implementing mining and sustainable development. The IM industry is based on a well-integrated network of marketing and transportation infrastructure that provides society with needed raw materials. IM companies have traditionally involved the community more than other mining ventures, because so many IM operations are in close proximity to urban areas, often literally in people's backyards. All that is needed is to energize adoption of SD principles among the thousands of local IM operations.

In contrast to IMs, exploration in the metals industry is geology driven in remote areas and only recently are metal mining companies beginning to understand and implement principles of sustainable development in an integrated industry-wide manner. In fact, metal mining companies are leading the way for all of mining. IM operations face challenges today that are different from any others the industry has ever faced, but many are no different from what metals and energy mining operations have faced and each can help the other to achieve SD (McLemore and Turner, 2004). Some of these challenges are:

- Mining is a global market, even for many IM operations, with global competition for resources, land access, funding, and markets.
- Many people have little if any understanding of where products they use everyday come from or where real new wealth comes from (mainly mining, fishing, logging, ranching and farming). IMs are a major component of most products used everyday by society.
- Local and national governments depend upon the revenues generated by mining to be sustained far into the future and yet these same governments impose and enforce strict and costly health, safety, and environmental regulations, even for small-scale IM operations.
- Local communities expect that IM companies will provide employment, infrastructure, and other benefits and will leave them better off due directly to the mine's activities. Rio Tinto Borax is one of many examples of companies that are responding to community needs (Mining Engineering, 2001).
- The world expects IM companies, like metal and energy mining companies, to adhere to much higher standards of performance. The IM industry must avoid ecologically and culturally sensitive areas. The phosphate industry in Florida is an excellent example of how industry can reclaim mines into wildlife refuges and play and integral part in protecting the Everglades (Florida Phosphate Council, 2001).
- Investors expect higher returns and dividends.
- IM companies, like metal mining companies, are expected to protect and enhance biodiversity. Many people believe that the benefits of mining are not enough to justify the perceived negative impacts on biodiversity (IIED, 2003).
- IM companies must establish specific targets based on long-term environmental and community interests.
- Areas with favorable economic geology are limited so mineral deposits are found in specific locations not always compatible with society's needs and desires, especially near urban areas. The major delivered-cost factor for many IM companies is transportation. The closer the mine is to the urban area, the cheaper the commodity as delivered to urban sites. Yet the public generally does not want any mining operation near their homes, schools, recreational areas, and businesses. Intel, an IM end-user, when schools were an issue near a proposed fabrication plant, built schools in the surrounding community at no cost to local stakeholders and effectively, using SD, eliminated opposition to the plant.
- New industrial uses can require unconventional raw materials, generally IMs. Successful IM companies must keep up-to-date on these new, unconventional needs. The successful company will be able to quickly supply these materials to a fast-paced industry.
- Some IMs actually help solve environmental problems. Other IMs are coproducts from meeting environmental regulations (i.e. sulfur from copper and other mines with high sulfide minerals, Wagner, 2002).

INDICATORS OF EFFECTIVE IM SD

Indicators are used to measure performance towards SD. Some of the suggested indicators for IM industry towards sustainable development are summarized below.

- Mine life increases (better utilization and fewer community attacks).
- Tons per acre increases (better utilization).
- Distance from population centers as new operations are permitted (mining is trusted to operate closer to society).
- The amount of mined land reclaimed and returned to beneficial use.
- Reserves/resources of specific commodities increase.
- How early and widely stakeholders are contacted in the mining development process.
- Mines are offered lucrative packages to operate near municipalities.

SUMMARY

Industrial minerals are irrevocably intertwined with modern society. Their use pervades the modern economy. The transport cost sensitivity of most IMs means that they tend to be produced near population centers unlike metals and energy that are produced wherever they are found. Exploration for IMs thus is often conducted near a sensitive population. By engaging in effective SD activities such as TBL accounting, IM companies can reaffirm their social license to operate while opening up areas for exploration now closed to them owing to the poor reputation of mining in society. Overcoming this reputation requires full engagement of SD from exploration to post closure over many years for mining to regain some the prominence it has lost since the early 1900's. Most discussions by mining concerns about SD emphasize various environmental activities, mainly at closure, that alone are not nearly enough. SD must begin with exploration and follow throughout the entire mining process to post-closure activities.

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