

Contribution of the Minerals Industry towards Sustainable Development in South Africa

***¹BROADHURST J.L., J.P. ¹FRANZIDIS & ²B. COHEN**

**¹Minerals to Metals Initiative, Department of Chemical Engineering,
University of Cape Town, South Africa**

² The Green House, Cape Town, South Africa

***Email: jennifer.broadhurst@uct.ac.za**

Abstract

South Africa is a leading producer of a number of mineral commodities, and the minerals industry is a key driver of the South African economy. Ensuring that this mineral wealth is exploited in a manner consistent with the principles of sustainable development requires policies and strategies that are underpinned by a well-developed understanding of the challenges, opportunities and trade-offs involved. To this end, this paper analyses the status quo of the primary metal and coal based minerals industry in South Africa according to its performance relative to the five capitals of sustainable development (financial, manufactured, social, human and natural). This survey provides the platform for the identification of opportunities for further research and development in four key areas: technology and processes; resources and the environment; human and research capacity; and the socio-technical sphere. The study shows that the South African minerals industry faces serious challenges in the future, both in developing and implementing the technologies needed to sustain the industry and its significant contribution to economic growth and human development, and in developing and retaining the skills needed for this. These challenges also provide an opportunity for South Africa to leapfrog into a new paradigm in which it recovers and strengthens its global leadership role in the area of minerals exploitation. Realising this opportunity will require partnerships and collaboration between government, industry, local communities and academic institutions to develop the research programmes

and teaching curricula needed to sustain the sector over the long-term.

Keywords: Minerals industry, South Africa, sustainable development

Introduction

Africa, and Southern Africa in particular, is well-endowed with mineral resources and features prominently in terms of the world's supply and reserves of a number of mineral commodities (South African Department of Mineral Resources, 2012, South African Department of Science and Technology et al., 2010, International Council on Mining and Metals, 2012). In accordance with global and national surveys, debates and discussion forums, the general consensus amongst global organizations and national governments is that this mineral wealth has the potential to serve as a vehicle for significant economic growth within the region (South African Department of Science and Technology et al., 2010, Chamber of Mines of South Africa, 2007, Commission for Africa, 2005, United Nations Commission on Sustainable Development, 2010). However, in order to ensure that the contribution of the minerals sector is sustainable, these economic benefits need to be fully realized and extended to all facets of society, especially the host communities, whilst simultaneously preserving the local environment (Citufani, 2013).

This is a significant challenge given the historical environmental liabilities, declining ore grades and increasing socio-economic and political pressures facing the industry, and one that is rapidly becoming more immediate and more complex (World Bank & International Finance Corporation, 2002, Ramphela, 2013, O'Keefe, 2013). Thus, whilst it is widely accepted that the exploitation of non-renewable mineral resources can indeed contribute to sustainable development, good governance and long-term vision within, as well as strong partnerships between, government and the minerals industry sector are critical factors in achieving this goal (Commission for Africa, 2005, Ramphela, 2013, Hermanus, 2003, Aryee, 2010, Bourassa, 2010, Chevalier, 2010). The development and implementation of appropriate policies and strategies must, in turn, be underpinned by a sound understanding of the issues, drivers and trade-offs of key relevance to the mining and minerals sector.

This paper explores the status quo of the primary metal and coal based minerals industry in South Africa within the context of sustainable development and identifies opportunities for sustaining the sector over the long-term, to the benefit of all South Africans.

Industry Strengths and Weaknesses

Consistent with the five capitals model of sustainable development (Porritt, 2007), the strengths and weaknesses of South Africa's minerals industry, as well as the major threats facing it, are analysed below in accordance with the sector's contribution to, and/or impact on, South Africa's financial and manufactured, human and social, and natural capital.

Contribution to Financial and Manufactured Capital

According to data published by the South African Department of Mineral Resources (2012), South Africa features prominently in terms of the world's reserves of a number of metal and energy-based mineral commodities, particularly the platinum-group metals, manganese, chromium, vanadium, gold, titanium, zirconium, and, to a lesser extent, coal and uranium. Whilst South Africa's contribution to the world's mineral supply has diminished significantly over the past 15 years, the country remains a leading producer of Platinum Group Metals PGMs, chromite ore, ferrochromium and vanadium, and is also among the top three producers of gold, manganese ore and heavy minerals (South African Department of Mineral Resources, 2008, 2012, 2013). Furthermore, the mineral resources of the country are still far from fully exploited, with a large number of proven reserves remaining underdeveloped and areas unexplored (South African Department of Mineral Resources, 2012).

Like many countries endowed with abundant natural resources, South Africa relies heavily on its primary minerals sector as a source of wealth and economic growth, with the sector contributing some 9.8 percent to Gross Domestic Product (GDP) in 2011 (South African Department of Mineral Resources, 2012). Apart from this direct contribution, mining also has an indirect multiplier effect on the economy, giving rise to a "real" contribution by mining to GDP of between 15 and 20% (Chamber of Mines of South Africa, 2007). Significant multiplier effects include goods and services provided to the industry; value added beneficiation of mining

outputs; and induced effects through export earnings, consumption multipliers and additional earnings of employees in related sectors.

In terms of directly generated revenue, South Africa's mineral industry remains primarily export driven, with respectively 76% and 82% of primary and processed mineral sales destined for world markets (in 101 countries) in 2011 (South African Department of Mineral Resources, 2012). Commodity prices and export revenue are thus largely dictated by global supply/demand trends, with fluctuations (both booms and slumps) having significant implications on the performance of the industry (in terms of profits as well as safety and environmental practices) and the socio-economic well-being of the country as a whole (Granville, 2001). This situation is aggravated by rising operating costs, declining productivity and the capital-intensive nature of the industry, and is of particular concern in the case of small-scale and/or marginal operations (Chamber of Mines of South Africa, 2012).

The last three decades have seen a substantial shift in the relative contributions of the various sub-sectors in terms of direct employment and export revenue, with the contribution of the gold industry, in particular, decreasing significantly (South African Department of Mineral Resources, 2008, 2012, 2013). Despite the increase in the contribution of processed mineral products (ferroalloys and refined metals) and manufactured /finished goods (stainless steel) over the same period, the South African minerals industry remains dominated by the "big three", viz: platinum group metals, coal and gold (South African Department of Mineral Resources, 2012).

Contribution to Human and Social Capital

Approximately half a million people in South Africa are employed in the mining sector with a further half a million working in related sectors, including downstream (also termed vertical) and side stream (supporting or horizontal) industries. Each of these employees is reported to support between 7 and 10 dependants (Chamber of Mines of South Africa, 2007). This brings the estimated total number of people relying (either directly or indirectly) on the South African minerals industry *within the country* to between 7 and 10 million.

Apart from job creation, the minerals industry also plays a prominent role in socio-economic upliftment and transformation within the country. This is reflected by a number of broad-based regulatory changes since the birth of democracy in South Africa in 1994, which have a significant impact on the South African society. In particular, the Minerals and Petroleum Resources Development Act of 2002 (MPRDA) and the Broad-based Socio-economic Development Empowerment Charter for the South African Mining Industry (the Mining Charter) were specifically developed to ensure that mining houses contribute to the socio-economic development of the areas in which they operate (Rungan et al., 2005).

The introduction of these regulations and policies has been a powerful force for change in the industry. Despite the Mining Charter not having the force of law, most of the major South African mining houses have integrated the Mining Charter roadmap into their social and labour plans to at least some extent. According to the Chamber of Mines of South Africa (2005), industry spending on social issues increased by an average of 27% between 2000 and 2005, with the total annual expenditure on social development exceeding R400 million in 2005. In particular, individual mining operations contribute extensively to initiatives directed at rural development (e.g. improvement or acquiring of breeding stock and the modernisation and improvement of farming methods), and the provision of healthcare facilities and low-cost housing in remote areas. The minerals industry is also actively involved in employment equity and Black Economic Empowerment (BEE). Upwards of R3 billion is spent annually by the sector on procurement from historically disadvantaged South Africans or HDSA-influenced providers (Chamber of Mines of South Africa, 2005), and a number of prominent BEE deals (involving organisations such as Anglo American, De Beers, Gold Fields, Harmony, African Rainbow Minerals, Lonmin, Sasol, Ingwe, the Richards Bay Coal Terminal and Kumba Resources) have been concluded since the turn of the century. However, BEE is still seen in many circles to benefit only a small portion of the black elite, and has been the subject of much criticism within the country (Ramphela, 2013; Rungan et al., 2005). Furthermore, resettlement controversies surrounding Anglo Platinum's Mogalakwena mine in 2008 (Farell et al., 2012), the tragic massacre at Lonmin's Marikana mine on 16 August 2012 (eNews Channel Africa, 2013) and the wave of subsequent strikes across the mining industry, indicate that the relationship between mining corporations and local communities remains fraught with controversy and conflict.

The exploitation of mineral resources is also recognised as being closely linked to the development of human capacity in terms of skills and knowledge, both in local communities and at national level (Rungan et al., 2005). Historically, the South African minerals industry has been recognised as being a world-leader in a number of areas relating to the primary metal production and coal based power generation sectors. This, in turn, led to a well-developed core of skills and knowledge in specific areas such as deep level mining and precious metal processing. Unfortunately the past 20-30 years have seen a steady but significant decline in the local skills base and the commitment to sector-related research and development (R&D) within mining corporations, educational institutions and science councils, both globally and nationally (Stacey et al., 2008; Upstill and Hall, 2006; Prinsloo, 2012). This trend has been ascribed to a number of factors including high levels of emigration and the poor image of the industry, which is often perceived as being dirty and unsophisticated. Literature reports (South African Department of Science and Technology et al, 2010, Stacey et al., 2008; Reichardt, 2009; Walker and Minnitt, 2006) emphasise the need to urgently address the current shortage of basic technical skills, as well as the high-level skills required to support research and development (R & D) and technology innovation within South Africa. This is seen as a critical issue, with implications in terms of safety, environmental impacts, technical efficiency and development of downstream (vertical) and side stream (horizontal) industry clusters (Walker and Minnitt, 2006).

Impact on Natural Capital

The primary metal production and coal based power generation industries make a significant contribution to the country's economy, and are essential to modern living. However, the operations associated with this industry sector also pose a threat to the natural capital, and consequently the well-being and livelihood of local communities. Historically, the environmental legacy left by the mining and minerals industries has not been a happy one, with hundreds of abandoned mine sites and waste dumps – and the associated acid mine drainage (AMD) problems – providing just some evidence of poor environmental practices of the past, visible in many places.

The establishment of the Global Mining Initiative (GMI) in 1998 heralded a significant change in the industry's response to pressures to improve its environmental performance within the context of cleaner

production and sustainable development. Over the past ten years, this change has been evidenced by the growing number of industry-driven projects (e.g. the Mining, Minerals and Sustainable Development project, MMSD, from 2000–2002); guidelines (e.g. the good practice guidance documents of the International Council on Mining and Metals, ICMM); and voluntary codes (e.g. the international cyanide management codes) aimed at improving environmental efficiency. These global initiatives by industry-led organisations have, in turn, set the standards for national government organisations and mining companies, and the South African mining industry is now governed by a suite of relatively new regulatory acts, government strategies and best practice guidelines. Most of these were developed in the period leading up to and following the World Summit on Sustainable Development in Johannesburg in 2002. These initiatives have made major strides in both identifying and addressing the environmental challenges peculiar to the industry.

Power Consumption and Greenhouse Gas (GHG) Emissions

The minerals industry is energy-intensive, and associated GHG emissions can be attributed largely to the on-site combustion of fossil fuels or the consumption of purchased fossil fuel-based electricity, or both. In 2006, the South African mining and metals production industries collectively accounted for over 20% (equivalent to 562 514 TJ) of the country's total energy consumption. According to the South African Energy Efficiency Accord, the mining industry must show a 15% decrease in energy use, based on business as usual by 2015. Threats of a serious electricity shortage in the future, and the possibility of a carbon tax on electricity consumption, have added further pressures on the industry to assess and improve how it manages and utilizes energy (Sebitosi and Pillay, 2008).

Degradation of Natural Water Sources

Although the mining industry uses less than 10% of South Africa's water (compared to agriculture, which uses more than 50%), the future availability of water of adequate quality poses a serious threat to the minerals industry in terms of its ability to operate or expand existing operations in certain areas. Apart from consuming water, mining and minerals processing operations also frequently result in extensive contamination of local water sources, mainly due to storm water run-off

and seepage from surface waste deposits, open pits and underground workings. The Chamber of Mines of South Africa (2007) has identified prolonged pollution, such as acid mine drainage from previous and abandoned mining operations (particularly coal), as one of the most serious challenges facing the country in respect of water. This issue has also resulted in considerable negative publicity for the industry over the past few years (Cape Times Business Report, 2010; Staff, 2011; Weavind, 2012).

Generation and Disposal of Solid Waste

The minerals industry is characterised by large tonnages of solid waste – particularly in the early beneficiation stages of extraction and concentration, most of which is consigned to land disposal. In 2005, the mining and mineral processing industry in South Africa was responsible for 90% of solid waste production in South Africa (Von Blottnitz, 2005). Historical practices have left a legacy of abandoned and unrestored mining waste disposal sites, and it is now widely recognised that such sites have negative implications in terms of public health and safety; preservation of natural resources, including biodiversity, water and land; and the economic impacts associated with excessive clean-up and site maintenance costs. These waste deposits also represent a loss of potentially valuable mineral resources, in the form of residual target metals as well as minor and trace co-elements. Today, the reworking and extraction of economic minerals from defunct slimes dams and mine sand dumps makes an important contribution towards PGMs and, in particular, gold production in the country.

Natural Resource Efficiency

Rising global consumption and demand for primary resources, combined with the declining quality of ore bodies, have placed increasing importance on the efficient recovery of economically valuable minerals and metals from ore deposits. It is equally important that the extraction and processing of these minerals is carried out in a manner that minimises consumption of water and energy resources. A recent analysis of available inventory data pertaining to the environmental performance of the local minerals processing (run-of-mine ore to product) sector emphasised the relatively high environmental intensity and low eco-efficiency of the precious metal (gold and PGM) sub-sectors, particularly in terms of water utilisation and solid waste generation (Stewart and Petrie, 2006; Johnston,

2012). In terms of electricity consumption, however, it is the high temperature processes (including aluminium and zinc refining, ferro-alloys production and ilmenite smelting) that are the most inefficient, and which accounted for the majority of electricity consumption by the minerals sector in 1999. The primary metal production and coal based power generation industries make a significant contribution to the country's economy, and are essential to modern living. However, the operations associated with this industry sector also pose a threat to our natural capital, and consequently the well-being and livelihood of local communities.

Industry Opportunities

A host of opportunities present themselves to build on the strengths of the industry and to overcome the weaknesses and threats outlined in the previous section, and in so doing drive the industry towards a more profitable, socially accountable and environmentally sustainable future. These opportunities are explored for the primary metal and coal based resource industry sector in four distinct developmental areas: technology and processes, resources and the environment, human and research capacity and the broader socio-technical sphere.

Technology and Processes

The minerals industry has always been technology driven and has driven the technological and economic development of industrialised countries all over the world. The industry has been amongst the pioneer developers and early adopters of key platform technologies in physical and chemical separation, analytical chemistry, process control and modelling and simulation (Williams, 2003). It is common cause that the success of the minerals industry has depended greatly on the development of innovative and world-class technologies, and will continue to do so to an even greater extent in the future.

Apart from reducing costs and improving process efficiencies, technological advances have the potential to extend the range of ores that can be recovered improve safety reduce environmental impacts; and bring about positive changes in the labour market from being reliant on unskilled, uneducated workers to creating jobs that require technical ability and education (Hermanus, 2003; Granville, 2001). What is of concern, however, is that the vast majority of technologies employed in the primary

mineral industry sector today can be regarded as mature, having been developed over many years of industry practice and research conducted around the world. Recent technological advances have been relatively rare, and the decline in technology innovation is currently seen as a major threat to the industry (Stacey et al., 2008).

This situation also provides the opportunity to sustain a successful and technologically innovative minerals industry in the long-term, through the development and implementation of both process improvements and cutting-edge technologies. In most cases, major improvements in the efficiency of processes with respect to metallurgical and environmental performance can still be achieved by focusing on the inter-relationship between these operations across the entire mine-to-metal mechanistic chain. Development of novel leading-edge technologies through long-term research is, however, required to ensure that the South African minerals sector remains globally competitive in the face of existing and future challenges, as outlined in Section 2. Examples include the use of relatively new technologies such as microwaves and ultrasonics, and flexible smelters with waste heat recovery. Process intensification will provide smaller processing units with high separation intensities that will facilitate the migration of processing to underground sites, whilst the increased use of dry processing and alternative energy sources, such as solar energy, will contribute to reduced energy and water consumption and effluent generation.

Resources and the Environment

Increasing public awareness of the need to protect the natural capital and the upsurge in global communications is placing additional pressure on the mining and mineral processing industry to show that environmental reporting is not just window dressing. The industry must actively demonstrate that its operations are not going to have a negative impact on the local environment and communities in the long-term. This is in the face of historical environmental liabilities, declining ore grades, continuously evolving legislative standards and environmental performance targets, and increasing obligations to local communities in terms of land tenure issues, quality of life, information and consultation, and local economic development.

Opportunities for effectively addressing the key environmental issues and threats discussed above include, but are not limited to the

creation of additional value from by-product recovery, application of dry or less water-intensive technologies and/or processing options, pre-disposal separation of potentially harmful components from large volume wastes, and the use of renewable energy sources, such as solar-generated electricity. In general, the identification of opportunities for improving resource efficiencies and minimising environmental impact and, ultimately, for establishing the business case for effective strategies and activities, will need to be underpinned by reliable process data and information, as well as the availability of adequate tools for the broader-based analysis that extends over the entire mine-to-metals chain and beyond. Motivation for step changes in terms of resource efficiency and environmental sustainability is also likely to require a shift away from conventional cost-benefit based accounting, and the development of a more meaningful concept of the true value of natural resources (water, minerals, and biodiversity).

Human and Research Capacity

Achieving the technical advances required to realise the opportunities pertaining to techno-economic and environmental performance will require a sustained programme of research and development (Hermanus, 2003; Prinsloo, 2012). This will provide the means to build research capacity at the universities and science councils, and to drive the changes needed in the industry itself (Hermanus, 2003; Prinsloo, 2012; Williams, 2003). The outlook in terms of skills in South Africa is not positive at present (see discussions in previous section), and major opportunities for the sector lie in rectifying this situation.

In particular, opportunities exist for attracting high quality young people from all social backgrounds into technical disciplines such as engineering in the mining industry (Stacey et al., 2008). Of critical importance in this regard is the need to promote competent research activities and generate highly-skilled people at historically disadvantaged tertiary institutions, and to attract postgraduate students from South Africa and other African countries. In this way, the creation of human capital can be extended beyond South Africa's borders and, in turn, contribute to the economic development of these countries.

It is also becoming increasingly important that the universities respond to the need to develop curricula that are sensitive to current trends

towards systems thinking and the concomitant integration of technical skills, ethics and global citizenship (Petersen, 2010). Ensuring that the mining industry contributes to development that is sustainable involves a complex set of inter-relationships between safety, health, the environment, sustainable development and proactive stakeholder management. This requires that employees in the minerals sector, specifically those operating in strategic operational positions, should have an overall understanding of these issues and sensitivity on how to project such in the context of different stakeholders (Petersen, 2010).

Repatriation of existing skills to South Africa as a result of the current global financial crisis can also be seen as an opportunity. South Africa has weathered the crisis better than many developed countries and there are opportunities to attract skills back to the country. There are also opportunities to attract high-level technical skills from industry back into academia as many academics left for higher paid industry positions during the commodity boom (Stacey et al., 2008).

Partnerships between government, industry and educational institutions are considered essential in improving the skills situation (Stacey, 2008; Prinsloo, 2012). Similarly, closer collaboration between industry and academia with respect to graduate training and continuing professional development is seen as an important opportunity (Petersen, 2010).

Socio-technical

As discussed earlier, the minerals sector is a significant contributor to the economy of South Africa, through job creation, contribution to GDP and social upliftment. However, there is increasing consensus that the current relationship between the mining industry and society is failing to deliver expected development benefits, and that there is a need for the industry to develop new business models which take cognisance of the inter-related nature of the economic, social and political systems (Citufani, 2013; Ramphele, 2013; O'Keefe, 2013). Research in this sphere will contribute to transforming the role of the industry in regional development that goes "beyond mining" (Ramphele, 2013). This will include working with government and business to build other sectors of the economy, both vertically down the value chain and horizontally in terms of growth of

suppliers to the sector, particularly small and medium enterprises (SMEs) (Walker and Minnitt, 2006; Morris et al., 2012).

Opportunities in this area include: moving towards increasingly sustainable mining communities (mining with the community rather than for the community); up-skilling local communities and building entrepreneurs on the fringes of the mining industry for the supply of goods and services; increasing the inherent safety of mining operations; increasing recycling of metals and mining products; and more effective planning for mine closure – both from an environmental and post-mining community point of view.

Conclusion

This analysis of the status quo of the primary metal and coal based minerals sector in South Africa has identified the industry as a significant contributor to both the economy and to social upliftment. However, the sector is under threat from socio-technological pressures and a shortage of skills. The former include rising costs and declining ore grades, as well as increased pressures to reduce the impact on the environment, develop a more synergistic relationship with local communities, and play a more transformational role in regional development, particularly over the long-term.

If South Africa's minerals industry is to continue to thrive and underpin the socio-economic development of the country in a manner consistent with sustainability principles, it is essential for the country to increase its human and research capacity. This will, in turn, ensure that the industry has access to leading-edge technologies, inherently safe processes and high level skills to enhance its profitability whilst simultaneously minimising its impacts on the environment and enhancing benefits to local communities.

There is a strong indication that this will require active partnerships between government, industry and educational institutions in developing research programmes and teaching curricula that target the future needs of the South African minerals sector. Collaborative research and teaching models will further provide the opportunity for up-skilling of academics and building of research facilities in historically disadvantaged institutions, and for attracting graduates from other African countries. In this way, the

creation of human capital can be extended both within and beyond South Africa's borders.

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