



Economic Commission for Africa

Minerals Cluster Policy Study in Africa

Pilot Studies of South Africa and Mozambique



Economic Commission for Africa

Minerals Cluster Policy Study in Africa

Pilot Studies of South Africa and Mozambique

ECA/SDD/05/08

ECA/SDD/05/08 - Minerals Cluster Policy Study in Africa: Pilot Studies of South Africa and Mozambique

First printed December 2004

© Copyright Economic Commission for Africa

For this and other publications, please visit the ECA website at <http://www.uneca.org>

Or contact

Publications

Economic Commission for Africa

P.O. Box 3001

Addis Ababa, Ethiopia

Tel: 251-1-44 31 68

Fax: 251-1-51 03 65

E-mail: ecainfo@uneca.org

Material in this publication may be freely quoted or reprinted. Acknowledgement is requested with a copy of the publication.

Layout/Graphics: Seifu Dagnachew

Printed at the ECA Printshop in Addis Ababa.

Contents

Executive Summary	i
Acknowledgements	vii
List of Acronyms	ix
 Introduction	 11
Terms of Reference	11
Resource-based Industrialization (RBI) Strategies	12
Requirements for a Successful Rbi Strategy	14
The Economic Importance of Cluster-based Activities: Canada and Australia	18
The African RBI Scenario	21
 The Cluster Concept	 25
Origin of the Concept	25
Advantages of Clustering	27
Cluster Development in the Context of Minerals	28
Levels of Analysis and Cluster Methodologies	31
 South Africa	 33
The Macro-cluster: The Minerals Industry	33
Industry Structure	34
Contribution to the National Economy	38
Industry Structure	39

Forward Indirect Linkages	55
The Minerals Cluster as an “Engine of Growth”	59
A Meso-cluster: The Gold Mining Industry	65
Geographic Based Sub-clusters: Gold	71
The Need for Technical Innovation	72
Contribution to the Economy	73
Mozambique	103
A Meso-cluster: The Aluminium Industry	77
Qualitative Assessment	80
Quantitative Assessment	85
Summary	89
Conclusion and Policy Implications	98
Overview	103
Meso-cluster: Mozal Aluminium, Maputo	115
Incipient Meso-cluster: Corridor Sands Titanium Project	121
Micro-cluster: The Alto Ligonha Pegmatite Field	131
An Assessment of Cluster Case Studies	134
Overall Conclusions and Implications for Africa	145
References	149

Executive Summary

Overview

This report forms the pilot study component of a broader initiative undertaken by the United Nations Economic Commission for Africa (UNECA) to identify and characterize the role of the minerals industry in selected African countries and to assess the levels of cluster activities associated with them. The objective of the study is to formalize a better understanding of the situation of the mining sector and associated clusters within the overall economy of those countries, with a view to defining development strategies for the local and regional planning of the minerals industry.

This paper explores the mineral resource-based experience of South Africa and Mozambique in the context of economic clustering. It commences with a synopsis of the theoretical underpinnings of the “cluster” concept and its potential use as a strategic tool for guiding industrial policymaking and development strategies throughout the continent. This is followed by a general review of the minerals industry in both countries, and includes an analysis of the extent of the clustering process, the type of spin-offs that have arisen, constraints and interventions, which are boosting or limiting expansion of the minerals sector, and opportunities for future growth in both Mozambique and South Africa. The discussion concludes with a synthesis of the main points raised and suggested policy recommendations.

Cluster Concept

Numerous explanations and definitions abound in the literature for “clustering” and “clusters”. In essence, a “cluster” is a concentration of expertise among closely linked industries and companies in which extensive investment in specialized factors of production catalyzes a growth trajectory. The emphasis is on the linkages that arise as a consequence of mutual interactions between individual industries and with associated institutions. Clusters arise through the flow of information or products between companies that are functionally linked together. The agglomeration of producers, customers and competitors, whether based on geographical proximity or linked by complementary expertise, promotes efficiency and increases specialization. Well-established clusters have the ability

to constantly reinvent themselves, which contributes to ensuring their long-term sustainability. Not only do firms improve the competitiveness of the main activity, but they also absorb new functions and activities and generate technological spillovers. Through such processes, firms and entire industrial sectors can evolve from a position of low-tech to high-tech, higher value activities.

Although clusters can arise spontaneously, the role of government and collective action is critical, particularly in accelerating the process. According to Porter "...government, working with the private sector, should reinforce and build on established and emerging clusters rather than attempt to create entirely new ones".

The clusters studied are classified according to three basic levels:

- National or macro clusters: Emphasize the role of sector linkages in the national economy and which are determined by reviewing the particular international trade and specialization patterns of the country.
- Sector or meso clusters: At this level of analysis, the emphasis is on inter- and intra-sectoral linkages of a specific industry within the economy. Evaluation and analysis is based on reviewing the strategic competitive advantages of the sector.
- Firm or micro-level clusters: These clusters have emerged as a result of interaction, networking, development of strategic alliances, and establishment of associations.

A mixture of quantitative and qualitative data is used to analyze these clusters in the context of South Africa and Mozambique. A modified Input-Output model, developed by Professor Phillip Black of the University of Stellenbosch, was used to establish the direct impact of selected clusters on the economy, as well that of their indirect (or backward and forward linkage) effects.

South Africa

Three minerals based clusters were examined in South Africa: the macro-cluster formed by the minerals industry as a whole and two meso-clusters, the gold industry and the Aluminium industry. The study shows how the South African mining industry has developed into a complex overall cluster with extensive backward and forward linkages, both within the minerals sector and the broader economy. Individual commodity-based clusters, sometimes regionally defined, can be discerned within the overall cluster. Their establishment (in particular the gold mining cluster) was driven predominantly by factor conditions, both internal and external, the most important of which were:

- Characteristics and scale of geological resources;
- Technology improvements;
- The rapid establishment of critical mass;
- Location far from the industrial heartland of European and South African ports;

- International skills mobility; and
- Mineral demand, especially gold.

The study highlighted the important role that government has played in the development of the minerals industry. Many of the major developments would not have taken place without the provision of port, rail and power infrastructure by the government. Historically, the provision of a stable fiscal and legislative environment has been crucial. Currently, the government's role in expediting transformation through dialogue with the industry, backed up by legislation, is creating a new vibrancy in the industry.

Important as the government's role has been, the real development thrust has come from the private sector, with its ability to better assess market requirements and to evaluate risk. Business by nature tends to take a shorter-term view than government. Consequently, the challenge to governments is to guide Industry into developing a collaborative approach that benefits the long-term interest of the country as well as the shorter term monetary interests of the private sector. Human resource development remains a key challenge facing the future success of the industry.

The various case studies highlight areas in which government action is required to ensure future growth and sustainability of the mineral resource clusters/sectors as a whole:

- Facilitating and driving skills development together with industry;
- Encouraging the further beneficiation of minerals wherever possible;
- Upgrading the rail and port infrastructure insofar as it affects mineral exports;
- Promoting measures that encourage cluster development;
- Encouraging industry sectors to collaborate where possible;
- Assisting small and medium size businesses develop export markets; and
- Promoting a collaborative approach to applied Research and Development (R&D).

Mozambique

The Mozambican experience of resource-based industrialization differs significantly from that of South Africa. Mozambique is in the initial stages of economic growth, with development limited to the establishment of industries associated with identified factor endowments, particularly labour and natural resources. Despite this, the Mozambican experience offers a valuable lesson to other developing countries at the edge of the development continuum.

Two examples of meso-clusters are explored: the Mozal aluminium cluster in Maputo and the proposed Chibuto heavy minerals cluster in Gaza Province. The Alto Ligonha artisanal mining micro-cluster, located in Zambezia Province, was also examined.

The drivers of the Mozal development were shown to be very similar to those of the South African clusters, especially the aluminium cluster, with the addition of three key factors:

- The supportive and facilitative role played by the Mozambique Government in reforming its legislative structure and administrative procedures in order to attract international investors.
- The regional cooperation between the South African and Mozambique governments; and
- The ability of Mozal to benefit synergistically from developments at the Richards Bay aluminium cluster.

Furthermore, it is clear that the development of the Chibuto heavy minerals cluster has and will continue to benefit immeasurably from the prior development of the Mozal cluster. It has benefited from the associated legislative and administrative reforms, the upgrading of port, rail and road facilities, and the construction of the Motraco power line to provide power to Southern Mozambique. A separate but equally important driver was the update of the mining title and taxation legislation during the 1990s.

Looking ahead, the chief challenge for the government is to replicate the process in the less developed parts of the country and then prevent 'enclaves' or concentrations of unbalanced economic development from arising. Many of these potential projects, such as the Moatize coking coal project, require the provision of infrastructure, which is beyond the financial capability of the Government to provide, and international funding assistance will therefore be needed. The study again highlighted the importance of implementing skills training programmes. In addition, a conscious effort has to be made to include and involve the local population in the development process. Nationalistic pride has to be stimulated among all participants in order to ensure that the country will 'leap frog' the development process.

Implications for Africa

Sustainable development is not an automatic result of favourable factors and the functioning of markets. It requires the purposeful collective action and coordination of public and private initiatives at all levels as well as a shared strategic vision. Building this vision should be a central goal of any cluster development strategy.

While governments play an essential role in establishing and formulating such a vision, they often encounter difficulties in implementation. In most cases, multi-national and some local businesses are more powerful than national governments and can undermine the development process if they are not drawn into the process in a collaborative manner. This is exacerbated by the inevitable clash between the longer-term view of governments' development initiatives and the shorter term profit driven perspective of companies (private capital). This clash can often manifest itself by the companies exhibiting "enclave" type behaviour, thereby isolating their activities from the broader development of the local economy.

This paper has shown that cluster development strategies orientated around a natural resource base do have the potential to create sustainable economic development and provide a mineral based springboard for enhanced productivity, even in today's technology-driven society. The successful clusters show that their establishment and sustainability was largely dependent on favourable factor conditions, both internal and external, together with specific proactive Government actions.

In summary, the South African and Mozambican clusters, while differing in their economic and mineral based history, share common characteristics that are relevant to the development of clusters elsewhere in Africa:

Establishment of clusters

- Political and economic stability;
- Provision of logistics and power infrastructure;
- Ability to attract needed skills from outside the country; and
- The power of regional cooperation to stimulate development.

Sustainability of clusters

- The importance of promoting cluster development and avoiding “enclave” behaviour;
- The ongoing pro-active development of an appropriate skills base
- The development and maintenance of critical mass by cluster; and
- Cooperation and networking among cluster stakeholders.

With regard to growing and incorporating the micro-cluster/artisanal mining sector into the economy, priority must be given to:

- Provision of infrastructure;
- Human resource development;
- Cluster development; and
- Diversification and innovation.

The development of such clusters contributes to the alleviation of poverty on a local scale.

Acknowledgements

The pilot studies of South Africa and Mozambique were compiled by Dunbar Dales, Marian Walker, Phillip Black, Antonie Botha and Hudson Mteghe under the supervision of Antonio M.A. Pedro, leader of the Natural Resources Development Team of the Sustainable Development Division (SDD) of ECA led by Mr Josue Dione, Director.

Wilfred Lombe, then with the ECA sub-regional office for Southern Africa, in Lusaka, Zambia provided insightful contributions to the elaboration of the terms of reference for the studies as well as helped in monitoring and supervising the work of the consultants. His contribution has been appreciated.

Our gratitude is also extended to Mr George Alibaruho, Senior Policy Adviser with the Office of the Executive Secretary of ECA for having provided funding for the studies, under the Development Account.

The draft studies were submitted to an Ad-hoc Meeting of Experts held in Addis Ababa, Ethiopia from 15 to 17 December 2003 for review of its contents and validation of its main findings and recommendations. The meeting was attended by the following experts: Mr Dick Kruger (Chambers of Mines of South Africa); Professor Stephen Simukanga (School of Mines, University of Zambia); Dr Oliver Maponga (then Chairman of the Institute of Mining Research, Zimbabwe); Dr Brigitte Bocoum (Industrial Engineer, African Development Bank) Tunisia); Mr Magnus Ericsson (Managing Director, Raw Materials Group, Sweden); Mr Estevao Rafael Pale (National Director of Mines, Mozambique); and Mr Arthur Mashiatsidi (Chief Executive, New Africa Mining Fund, South Africa). Staff members of SDD, as well as Messrs Alibaruho and Lombe, were also in attendance. Dr Malaika Culverwell of DfID, UK provided written inputs to the meeting. The contribution of the participants to the meeting in improving the quality of the studies cannot be underestimated. We wish to express our gratitude to all of them. Also appreciated is the assistance provided by Meheret Haileselassie and all support staff of SDD in organizing and servicing the meeting.

We would like to thank Yinka Adeyemi and Maria Thundu of the ECA Communication Team for painstakingly reading all the studies and editing them. Our thanks also go to Teshome Yohannes and Seifu Dagnachew also from ECA Communication Team for doing the layout and graphical work.

LIST OF ACRONYMS

ACR	African Competitiveness Report
ADP	Accelerated Development Programme
AMP	African Mining Partnership
ASSM	Artisanal and Small-Scale Mining
BEE	Black Economic Empowerment
CBD	Central Business District
CGE	Computable General Equilibrium
CPI	Centro de Promocao de Investimentos
DAPP	Downstream Aluminium Pilot Project
DME	Department of Minerals and Energy
DRD	Durban Roodepoort Deep
GDP	Gross Domestic Product
GNP	Gross National Product
ICT	Information and Communication Technology
IFZ	Industrial Free Zone
IDC	Industrial Development Corporation
IFC	International Finance Corporation
IPEX	Institute of Export Promotion
IPP	Import Parity Pricing
MCDT	Mozal Community Development Trust
MEC	Minerals-Energy Complex
MIREME	Ministry of Mineral Resources and Energy
MRMP	Mineral Resources Management Capacity Building Project
NEPAD	New Partnership for Africa's Development
NQF	National Qualifications Framework
NRCAN	Natural Resources Canada
NUM	National Union of Mineworkers
OEM	Original Equipment Manufacture
R&D	Research and Development
RBI	Resource-Based Industrialization
RSA	Republic of South Africa
SACEEC	South African Capital Equipment Export Council
SADC	Southern African Development Community
SAM	Social Accounting Matrix
SASOL	South African Synthetic Oils Limited
SDD	Sustainable Development Division
SMEs	Small and Medium Enterprises
SMEELP	Small and Medium Enterprise and Empowerment Linkages Programme
SSA	Statistics South Africa
SWOT	Strength-Weakness-Opportunity-Threat Analysis
UNCTAD	United Nations Conference on Trade and Development
UNECA	United Nations Economic Commission for Africa
VAT	Value Added Tax

Introduction

This report forms the pilot study component of a broader initiative undertaken by UNECA to identify and characterize the role of the minerals industry in selected African countries and to assess the levels of cluster activities associated with them. The objective of the study is to formalize a better understanding of the situation of the mining sector and associated clusters within the overall economy of those countries, with a view to defining development strategies for the local and regional planning of the minerals industry.

In particular, the studies focus on South Africa and Mozambique. South Africa is examined as an example of a mature minerals industry characterized by a variety of well-established clusters, both commodity and geographically based. Mozambique is studied as an example of a developing mineral industry characterized by a number of potential clusters.

Terms of Reference

The terms of reference of the pilot study specify that the senior researcher (Mintek) will, under the general supervision of Josue Dione, the Director of Sustainable Development (SDD) at UNECA, undertake the following tasks:

1. Review the literature on mineral resource-based growth strategies and define pre-requisite factors to successful cluster development based on experiences from successful natural resource driven economies.
2. Identify and characterize the mining sector in the countries to be studied in terms of the role of the mining sector in the national economy and its contribution to economic growth and industrialization.
3. Assess the levels of cluster activities and sub sectors around the minerals industry, including linkages with the rest of the economy using economic impact measurement techniques, where data permits such quantitative analysis.

4. Undertake missions to the member countries under study as part of the process of defining the level of clustering in the target countries.
5. Undertake a Strength-Weakness-Opportunity–Threat (SWOT) analysis for each country, paying attention to cluster inhibiting and enhancing factors, and the opportunities for cluster development, taking into account the current levels of development of the surveyed countries and any externalities that would inhibit cluster development.
6. Synthesize major findings and draw general lessons and recommendations for the development of mineral resources clusters in Africa, outlining the major success factors specific to the African context and commonalities for each cluster as well as the roles key stakeholders such as government, mining companies, communities and knowledge-generating centres can play.
7. Prepare a draft report for presentation during the Expert Group Meeting on Models for Mineral Resources Cluster Development in Africa to be held in Addis Ababa, Ethiopia in November 2003.
8. Finalize the report for following inputs from the Expert Group Meeting.

Resource-based Industrialization (RBI) Strategies

THE INTERNATIONAL RBI EXPERIENCE

The potential for natural resources, and in particular minerals, to contribute to accelerated gross domestic product (GDP) growth, healthy structural change, and regional development, has been a widely contested issue in development literature for a considerable length of time. Mineral resources are often regarded as being a paradox for development. The possession of mineral resources is generally believed to aid development as they provide the possibility for the state to collect substantial rent to invest in the development of the rest of the economy, provide the foreign exchange for the import of capital goods to develop other sectors and could provide the raw materials for mineral-based industrialization. Several studies that have attempted to characterize developing mineral economies have concluded that they are in fact worse off than non-mineral (agricultural) economies in many respects, and thus mineral endowments are perceived to be a ‘curse’ for development (Jourdan, 1990; Altamirano, 1999; Östensson and Uwizeye-Mapendano, 2000; ECA, 2001; Gylfason, 2001; Wright, 2001). The economist Adam Smith noted as early as 1776 that, projects of mining, instead of replacing the capital employed in them, together with the ordinary profits of stock, commonly absorb both capital and stock. They are the projects, therefore, to which all others a prudent law-giver, who desired to increase the capital of his nation, would least choose to give any extraordinary encouragement...” (Cited in Wright, 2001, 1).

The diverse experiences of mineral- and petroleum-rich countries in Africa and Latin America, which benefited from the oil and mineral booms in the late 1970s and early 1980s, seemed to validate this assertion. Instead of catalyzing economic diversification, increasing the value added of exports, and enhancing employment- and income-generat-

ing opportunities at the local level, what often resulted was a discrepancy between official expectations regarding resource-based projects and the subsequent results (Roemer, 1979; Auty, 1989; 1991; 1995; Davis, 1995). In a study of twenty-eight mineral economies, including 15 petroleum exporters, Nankani (1979) concluded that they suffer from lower marginal savings, higher export receipts and revenue (fiscal) instability, higher unemployment and wage dualism, and poor export diversification performance. Later research conducted by the United Nations Conference on Trade and Development (UNCTAD) and the Harvard Institute of International Development comparing the experiences of these countries with the resource-poor, but economically successful, Asian 'tigers', provided further strong statistical evidence for an inverse relationship between extensive mineral endowments and strong GDP growth (Östensson and Uwizeye-Mapendano, 2000; Gylfason, 2001; Wright, 2001). Auty sums up the results of the various econometric studies in the words "...the mineral economies tend to have a more skewed income distribution than their non-mineral counterparts. They have also had limited success in their efforts to secure an equitable regional distribution of mineral benefits" (1991, 73).

On the other hand, Wright (2001) maintains, "one should avoid jumping to the conclusion that natural resource assets constitute 'negative assets' for the development of a country". Similarly, Roemer (1979, 165) argues that "although resource-based industrialization would perpetuate the pattern of dualism and inequality present in a typically resource-rich country, it might not result in a substantially worse interpersonal distribution than any other industrialization strategy". There are a number of countries whose economies have performed successfully in recent decades despite a reliance on an unfashionable sector such as minerals. Most notably, in Sweden, Finland, the United States, Canada, and to a certain extent Australia, the natural resource sector evolved from a position of low technology based on low-cost labour to one characterized by highly-skilled, knowledge-intensive and export-oriented activities. Such a growth strategy was based not so much on the continued exploitation of a rich natural resource base as increasing the domestic value added associated with such natural resources by prompting the development of those activities which naturally tend to 'cluster' around resource-based processing and extraction industries. These included industries supplying critical 'side stream' inputs (such as capital equipment, consulting services, and consumables), and activities engaged in the further processing or utilization of the outputs ('downstream' industries). Clustering not only enhanced the productivity of the workforce, but also resulted in increased income distribution in the local population and rapid economic growth. More significantly, it prompted a shift to a more dynamic and sustainable growth trajectory (Porter, 1990; Vuori and Ylä-Anttila, 1992; Vuori, 1997; Pajarinen et al., 1998; Karppi, 2001; Mining Weekly, 2001c; Wright, 2001).

According to Porter (1990, 562), there are three distinct phases through which nations have to progress in order to achieve economic prosperity. In the first phase, economic growth is initiated by and limited to the development of industries associated with identified factor endowments (capital, labour, and natural resources). Despite the fact that virtually all countries begin their industrialization process at this state, Porter (1990) asserts that few countries ever move beyond it.

In the second phase, repeated investment and upgrading in these initial competitive industries stimulates the emergence of ‘clusters’ of similar and associated industries. Each cluster assists in broadening the individual base of the economy. In this stage, commitment on the part of the government and firms to improving factor advantages as well as firm strategy, structure and rivalry is key to increasing and maintaining the initial competitive advantage. Porter (1990, 278) asserts that while some countries have been able to upgrade with relative success, (Japan, South Korea, Taiwan, Singapore, Hong Kong, Spain, and to a lesser extent, Brazil) others have been unable to sustain this stage of development.

In the third phase, continual innovation and human resource development within firms and commitment by the government ensures that growth is sustained and the competitiveness of the original resource-base is maintained and embedded in other sectors throughout the economy. A central feature of this stage of development is a gradual reduction in the dependence of the economy on the initial factor endowments for competitive advantage (Porter, 1990). Instead, appropriation and improvement of technology and methods previously imported and the creation of new strategies is of greater importance. According to Porter (1990), increased consumer demand for sophisticated products, rising personal incomes, higher levels of education, and increased levels of competition among local industries characterize countries at this stage of development. Germany, Sweden, Britain, the United States, Japan and Finland are examples of countries that have succeeded in achieving this stage of development.

Although a number of nations with considerable natural resource endowments have been able to enjoy high per capita income levels despite a reliance on resource endowments (Kuwait, Saudi Arabia, Australia and Canada), the unsustainable nature of such an approach is also recognized. Consequently, many resource-rich countries have been forced to seek alternative routes to industrialization. According to Sengenberger (1993, 318), what has also become apparent in the experiences of various industrialized countries is that the effectiveness with which resources are deployed and maximized is often of greater importance than the actual availability of such resources. Likewise, Porter (1990, 15) states “it is where and how effectively factors are deployed that proves more decisive than the factors themselves in determining international success”.

Requirements for a Successful RBI Strategy

It is apparent from a review of the varying developing and developed country experiences that an in-depth understanding of the context and the risks that could arise are critical before a resource-based industrialization strategy can be formulated and implemented. From an examination of RBI strategies implemented by various resource-rich developing countries over the years, three key lessons can be drawn.

First, RBI strategies need to be well managed, well targeted and feasible. RBI should only “be pursued as part of a flexible, broadly-based diversification drive” (Auty, 1986, 325).

Diversification reduces economic risks associated with fluctuating prices and high costs, inadequate market access, external competition, and a declining resource base. Moreover, it is only through economic and industrial diversification that the benefits associated with RBI can be distributed through all levels of the economy and that the attainment of both macroeconomic and industrial objectives can be ensured and achieved. Investment and development, however, need to be both balanced and evenly spread through all sectors of the economy, including the manufacturing and agriculture sectors, and need to complement and uphold the broader development goals of the country. Auty (1988b, 149) maintains that a sound RBI strategy “captures the flexibility afforded by several different projects without straining domestic absorptive capacity, draws on foreign assistance where domestic skill shortages demand, and secures adequate market access”. It is often argued that a precondition of fast and accelerated growth in a region is to shift to less natural resource dependent export activities (light, labour-intensive manufacturing at first, moving on to more complex and eventually ‘high-tech’ industries later on) (Porter, 1990). RBI is therefore a gradual, incremental and long-term process. In order to be successful, detailed investigations and audits assessing the feasibility of proposed projects in terms of available resources must be undertaken. They must also determine the likely impacts at the international, national, regional and local levels. An assessment of the viability of an RBI strategy as opposed to an alternative approach should also be undertaken (Gillis, 1981).

Second, due to the capital-intensive nature of RBI and the limitations this imposes, particularly in terms of multiplier effects, it is imperative that investment projects be linked closely to emerging markets (Auty, 1987a; 1988b). Early export-orientation not only increases the local and international competitiveness of a particular industry and provides the incentive for continuous upgrading, innovation and skills development, but it also generates higher national revenues, which can be reinvested in other industrial sectors or activities. In this way, the development process becomes imbedded in the local economy and the chances for sustainability and long-term economic success increase. Such an approach underpinned the successful evolution of the Swedish, Finnish, Canadian and American economies from factor-based growth to high-tech, knowledge-intensive activities (Armstrong, 1985; Vuori and Ylä-Anttila, 1992; de Ferranti et al., 2002a; Power, 2002). Ensuring the inclusion of a social sustainability dimension is also imperative (Auty, 1998). Success in meeting these various criteria is, however, strongly dependent on the existence of a supportive macroeconomic policy, good governance, and good enterprise management (Auty, 1989; 1991). One of the reasons for the successful RBI process in Sweden, Finland, Canada and the United States was that development occurred within a context of commitment and cooperation at the national and local level, which proved an essential ingredient in ensuring the sustainability of the ‘virtuous cycle of innovation’ in the final stages of growth (Rostow, 1962; Warda, 2001; de Ferranti et al, 2002b; Power, 2002). Moreover, cooperation between the public and the private sectors in the shaping of national science, technology and innovation policy has provided a foundation for a committed and coordinated approach to the long-term development of knowledge and skills in these countries (Vuori and Ylä-Anttila, 1992; Wright, 2001; Blömmstrom and Kokko, 2002).

Third, it is argued that the costs and risks associated with RBI can be reduced through the sequential processing of the product from resource to market and by gradually expand-

ing the capacity of existing plants (Auty, 1988a). Evidence from the developed country experience of RBI attests to the fact that the employment base broadens and the number of income-earning opportunities increases as upstream and downstream industries agglomerate in the vicinity of the core industry (Porter, 1990; Vuori and Ylä-Anttila, 1992; Power, 2002). Furthermore, with each subsequent level of processing intangible assets (such as know-how and expertise) generated in the process provides additional opportunities for growth through the transfer and application of the acquired knowledge into similar activities as well as in non-related, but technologically similar, activities. Taken together, these factors contributed to increased economic diversification and growth, and assisted in raising the productivity, adaptability and skills of the local work force in a number of developed countries (Vuori and Ylä-Anttila, 1992; Ali-Yrkkö et al., 2000; Power, 2002). Roemer (1979), however, cautions that an advantage is only secured if the final output is produced at a lower cost, with lower risk, and with a higher quality. Furthermore, if production is geared to the domestic market, there must be significant demand for the outputs and sufficient revenues should be generated to compensate for the loss of resource assets and to justify the high levels of expenditure involved (Roemer, 1979; Davis, 1995).

Case Studies of the Developed Country RBI Experience

Finland and Norway

Over the past two decades, both Norway and Finland have successfully diversified their economies away from a dependence on natural resources into knowledge-based industries. Faced with a waning resource base, development planners in Norway and Finland were forced to reassess their industrial policies and concentrate investment in alternative economic clusters. Although resource-based industries (petroleum, forestry, and base metals), which provided the impetus for initial economic and industrial development, still feature, downstream diversification has occurred to such an extent that many of the new industries are not even associated with this initial base. Indeed, the Finnish mining cluster flourishes as one of the world's principal producers of equipment and inputs for mining despite the fact that its own mining resources are close to depletion. More significantly, since the early 1990s, Finland has emerged as one of the world leaders in information and communication technology (ICT). Moreover, the ICT cluster is the fastest growing industrial cluster in Finland. The cellular telephone and telecommunication equipment firm, Nokia, largely dominates high-technology developments in Finland. The fact that Nokia exports contribute more than a quarter of Finnish exports and 4% of GDP highlights the success of the ICT cluster. In addition to this, GDP has increased by more than 1% because of the Nokia industry. More than three hundred first-order supplier firms support the Nokia cluster and a total of 3 000 firms are indirectly associated with the company (Rouvinen, 1996; Ylä-Anttila, 2000).

A distinctive feature of the RBI experience in Finland, is that although dependence on traditional, primary-based activities have gradually given way to high-tech activities such as telecommunications, the forestry cluster is still an integral element in the economy and is the third most important economic cluster after electronics and mining. According

to Vuori and Ylä-Anttila (1992, 1), “the forest sector forms by far the most important development block in the Finnish economy and many of the new high-tech, knowledge-intensive industries owe their origins to the forest sector or to forest-related spin-off companies”. Furthermore, Hernesnieme et al. (1996) assert that many internationally competitive and successful Finnish engineering product and service industries (specifically related to mining, information technology and electronics), have backward linkages to the accumulation and adaptation of know-how developed within forestry or the forestry industry. The most important of these spin-offs relate to process control electronics, forestry tractors, boilers for pulp factories, design and planning of the entire production line in paper mills, machinery, training and education systems, and advances in automation (Vuori and Ylä-Anttila, 1992; Ministry of Trade and Industry, 1993; Hernesnieme et al., 1996).

Although Norway lacks a large base company such as Nokia, a number of small companies and leading-edge telecommunication companies exist. The productive use of computer and information technology throughout the economy has resulted in Norway becoming significantly advanced in terms of automation and innovation (Cawden, 1999).

Central to both the Norwegian and Finnish industrial success has been a commitment on the part of their Governments to investment in research and development and nurturing a skilled work force. Finland has invested 3% of its GDP in building high-technology capabilities and its research and development intensity is the second highest in the European Union (Rouvinen, 1996; Ylä-Anttila, 2000). In Norway, literacy levels have reached 99% and 1.8% of GDP is spent on research and development (Cawden, 1999).

Sweden

The factors underpinning Sweden’s economic and industrial success bear many similarities to those of Norway and Finland. In the 1970s, a declining resource base and loss of competitive advantage in resource-based industries (mainly iron ore- and forest-based), due to falling transportation costs and the discovery of new iron-ore deposits elsewhere (Brazil and Australia), prompted a reassessment of the prevailing approach to economic development (Porter, 1990). Development planners and policy-makers adopted a programme of diversification away from resource-based industries into more sophisticated industrial segments and into related and supporting industries such as speciality steels and fine paper, roller bearings, rock drills and fabricated steel products. In addition to this, as the domestic mining sector in Sweden gradually diversified into finished products for the local and international markets, a capital goods industry emerged to service the primary industries (mining equipment and plant machinery). According to Porter (1990), the Swedish economy is essentially an economy made up of clusters of related and supporting industries, many of which have their roots in forestry- or metals-based activities. Overlapping linkages of demand and supply from various sectors have reinforced and propelled cluster growth. For example, forestry offered downstream demand for both paper and pulping technologies, as well as transport products developed by Saab and Volvo in Sweden, which boosted the growth and diversification of two separate clusters (Porter, 1990; de Ferranti et al., 2002a). Over the years, Sweden has developed a strong base of large,

international companies; among them such prominent firms as Volvo, Saab-Scania, Atlas Copco, SKF and Electrolux, as well as many other sophisticated industries (Porter, 1990; Jourdan, 1992; 1994). Sweden's economic success can also be attributed to a supportive and cooperative government. Not only were public services provided, but considerable investment was also made in human resource development and education, particularly engineering. Cooperation and effective information flows between firms within the clusters also played a pivotal role (Porter, 1990).

United States

An abundant resource base (phosphate, copper, iron ore, coal, oil and natural gas) has underpinned the economic success of the United States. It has been asserted, however, that it is one of the few countries that possesses an extensive range of natural resources and has been able to achieve a significant international position in a diverse range of sophisticated manufactured goods as a consequence of this endowment. The economic success of the United States, moreover, can be attributed to sizeable and sustained investments in education, research and development, and infrastructure by all levels of government over a considerable length of time. Constant improvement and investment in initial factors of production served to stimulate the expansion and diversification of the initial competitive advantage and thus broadened the economy. Along with strong domestic and international demand conditions, the geographic clustering of firms, the integration of many industries (such as electronics), minimal levels of direct intervention and public ownership of industries, and the government's free and open trading system and anti-trust policy, the United States has succeeded in becoming world leader in a number of end products, parts, machinery and service industries. Key industrial sectors include, amongst others, automobiles, aircraft, energy, power generation, electronics, mining and construction (Porter, 1990; de Ferranti et al, 2002b; Power 2002).

The Economic Importance of Cluster-based Activities: Canada and Australia

The economic impact and pervasive nature of clustering within the resource-based industrialized countries can be illustrated quantitatively. The mining and mineral-processing sector is an integral component of the Australian economy. According to Hooke (2003, 4), "The Australian industry [mining and minerals] is a leader among other industries in Australia, and a global leader within the sector". The contribution of the sector to the Australian economy is highlighted by Cusack (2003):

- Over the past two decades the sector has directly contributed around \$500 billion to the national economy;
- Mining and mineral processing accounts for around 8.5% of national gross domestic product;

- Direct and indirect macro-economic impacts include payments amounting to \$4.5 billion – \$1.2 billion in mineral royalties, \$1.3 billion in Government port and rail charges, \$1.9 billion in income tax expenses, and \$400 million in indirect taxes.
- The industry generates added value of around \$10 billion annually, around \$8.5 billion of which is exported.
- The industry accounts for around \$43 billion of Australia's current total annual export revenues, representing approximately 37% of total merchandise exports and 28% of Australia's total exports of goods and services.
- Exports of mining technology, equipment and services are worth \$2 billion – 60% of the mining software used in operations around the world is exported from Australia.
- The sector provides direct and indirect employment for 317 000 people – approximately 5.9% of total employment in 2002.
- In 2002, the sector generated around 16% of private new capital expenditure in the country.
- The mining and mineral processing cluster has made a significant contribution to infrastructure development in the country – since 1967, 25 towns have come into existence, 12 ports and additional port bulk handling infrastructure at many existing ports have been established, 25 airfields have been built, and over 2 000 kilometers of railway line laid.
- The sector has critical supply and demand linkages with other sectors in the Australian economy including manufacturing, construction, banking and financial, process engineering, property and transport.

Similarly, the impact of the mining cluster on the Canadian economy can be summarized as follows (Brewer, 1999; Lemieux, 2001; Cranstone, 2002):

- Minerals and metals generated \$36.15 billion in national revenues in 2002, approximately 3.7% of total GDP in Canada.
- Exports from the sector amounted to \$49.5 billion, approximately 13,54% of total exports.
- The mining and mineral processing industries directly employed 361 000 Canadians in 2002: 47 000 were employed in mining, 52 000 in smelting and refining, and 262 000 in the manufacture of mineral and metal products.
- Average weekly earnings in the mining, quarries and oil wells industry in 2002 were over \$1 000, one of the highest levels of any industry in the Canadian economy.
- In 2002, total mining expenditure amounted to \$2.40 billion.
- Exploration expenditure in Canada in 2002 was \$534.1 million.
- There are more than 2 200 firms in Canada that may be called “mining suppliers” of which half depend on sales to mining companies for 50% or more of their total revenues; 24% are from the professional, scientific, and technical services sector such as banking and legal services, and 27% are manufacturers and 45% are located in either Toronto, Vancouver or Sudbury.

- Exports account for between 30 and 50% of Canadian mining suppliers' revenues.
- Almost a quarter of the mining supply firms consist of engineers, geologists, geophysicists, chemists, process engineers, environmentalists or members of related disciplines.
- Canadian suppliers sell in all the major markets. Canada also supplies the majority of equity capital for mining around the world, and has 75% of the world's mining companies (1 447) listed on its stock exchanges.
- Every dollar of additional mining output requires 56 cents of supplies from other sectors of the economy. Each billion dollars of additional mining output creates 4 360 job-years in Canadian supply sectors.

A review of the international experience of RBI outlined above reveals that success was underpinned by a number of unexpected, but highly productive consequences that were stimulated as a result of state investment in various resource-based projects. According to Hirschman (1958), these consequences can be defined as the 'centrality of side effects'. Three 'side-effects' associated with the process of developing the infrastructure and attracting investors in developed countries can be identified and offer lessons to other countries pursuing RBI strategies, including South Africa and Mozambique:

- Linkages - establish an industrial base through backward and forward linkages.
- Bureaucracy -changing the behaviour of the bureaucracy, particularly the local government towards supporting and securing private investment. This is based on the recognition that "government policy at the state and local level has an important role to play in shaping national advantage" (Porter, 1990, 29) and that "government, at all levels, can improve or detract from the national advantage" (Porter, 1990, 73).
- Private Sector -increasing private sector confidence and participation in the development process. Various public-private partnerships were initiated, which helped to facilitate and fund investment projects. Considerable emphasis was also placed on enhancing and developing the skills and capacity of the various enterprises associated with the core industry in order to raise the level of productivity. This was largely motivated by the belief that "a sustained increase in the growth rate can only come from investment in human capital and technology that raise the productivity of other factors of production" (Lall, 1993, 54).

In final assessment, the experiences of the United States, Sweden, and Finland, and more recently Australia and Canada, epitomize and illustrate what can be achieved if the situation, approach and attitude towards resource endowments are right. It is clear that resource-based industrialization will not work and will prove unsustainable if it is undertaken in a context of underdeveloped social, political and economic institutions, where there is undeveloped human knowledge, physical and institutional capital, a lack of technical progress, and inefficient economic and business organization. If there is an over-reliance on the export earnings and other fiscal linkages arising from the resource sector, development is also likely to be negative. To be successful, therefore, resource-based industrialization strategies need to:

- Be flexible;
- Be well-structured and focused;
- Emphasize clustering, networking, entrepreneurship and collaboration;
- Be inclusive of all persons and economic sectors; and
- Embody and reflect a deep sense of commitment and the economic vision of all participants in the economy to the furthering of growth and development.

The African RBI Scenario

Mining and mineral wealth is a more significant economic sector in the African context than traditionally thought. Indeed, the minerals industry has played a pivotal role in the economic development and establishment of infrastructure and manufacturing industries throughout the continent. Agriculture, transport and utilities have tended to follow mining companies into rural areas, providing infrastructure necessary for strip industries to bloom around the mine and along the transport routes. Moreover, rural development has been aided by the repatriation of wages by migrant labourers employed on mines throughout the region. According to the World Bank's Global Development Finance 2003 Report, foreign direct investment and remittances of wages by migrant workers are more important sources of finance for developing countries than private lending. Mining has also contributed to the instability of many post-war African economies, most notably the Democratic Republic of the Congo (DRC) and Angola (Solomon, 2000).

Although limited in nature, the majority of manufacturing activities in Africa have strong backward linkages to natural resources. Although the direct contribution of mining to the economies of Africa has varied during the past 30 years, the importance of manufacturing industries based on a variety of minerals has grown substantially. Indeed, the economies of Angola, Botswana, DRC, Namibia, South Africa, Tanzania, Zambia and Zimbabwe obtain between 22% (Tanzania) and 90% (Angola) of their foreign exchange directly from mining and mineral exploitation activities. In terms of employment, despite the prevailing economic pressure, the minerals industry in the twelve mainland SADC countries formally employs 5.3% of the region's total available workforce, estimated at 68 million. It is estimated that possibly even a larger number are engaged in artisanal and small-scale mining (ASSM), part- (seasonal) or full-time, particularly in Tanzania, DRC, and Zimbabwe.

Africa is endowed with a wide range of mineral resources, many of which remain undeveloped. Moreover, the importance of mining in Africa's economic development is projected to increase in the future rather than wane. The World Bank has identified 25 other (than South Africa) African nations with a vast potential for future mineral exploration, with Ghana, Angola, Namibia, Central African Republic and DRC topping the list.

While both Tanzania and Mali have emerging minerals economies, the full economic benefits associated with their mining industries have yet to be realized. Likewise, in Zambia,

it will be a few years before the full impact of the restoration of the mining sector comes into effect. Although Zimbabwe has a well-developed minerals industry, it is currently in decline (with the exception of platinum) because of the political crisis facing the country. Among the successful mineral-based African economies are Botswana and Namibia, which both have large mining sectors and have tended to outperform other African economies in terms of growth. Sound governance, competent institutions, effective economic management and regulation of the mining sector have underpinned success. Moreover, growth has been largely driven by the private sector. Revenue generated within the mining sector has, furthermore, been reinvested in other areas of the economy, particularly in the public sector, which has boosted overall levels of growth (Solomon, 2000; World Bank, 2002).

Only South Africa, and possibly Namibia, have a truly diversified economy with respect to the coherent supply of goods and services to the minerals industry. Namibia has some vertical and horizontal integration into the secondary sectors, while Botswana has made marked efforts to diversify its economy on the back of its mineral revenues (Solomon, 2001; World Bank, 2002). It is argued that there is ample scope for leveraging broader economic and developmental growth on the continent through the promotion of forward, backward and lateral linkages associated with the minerals sector. Such a potential could be maximized should small- and medium-scale enterprises be encouraged to participate in the development and utilisation of these resources. Artisanal small-scale mining, for example, could be an instrument of rural development and poverty alleviation, especially in the exploitation and processing of industrial minerals (e.g. clays for use in ceramics, fertilizers, mica for use in paints).

It has been asserted that the mining and mineral resource sector could play an integral role in bringing about the vision of an 'African Renaissance'. A successful minerals industry would promote significant support sectors, increase the levels of education and skills, provide social infrastructure and generate a strong flow of foreign exchange earnings which will fuel the growth of the competitive industries of the future. Moreover, the funding of resource-based projects is regarded as carrying less financial risk than other large infrastructure projects (such as in manufacturing and tourism) as they are able to operate using the foreign exchange earnings derived from their activities. The development of a mining or mineral sector, furthermore, is less demanding on a country in terms of education, skills and infrastructure, which are often poorly developed in many African countries.

In February 2003, the African Mining Partnership (AMP) was established. AMP is an alliance between African mining Ministers with the principle objective of promoting the implementation of the mining and minerals component of the New Partnership for Africa's Development (NEPAD). There is consensus among African leaders that, in order to ensure that the maximum economic and social returns are achieved from the exploitation of the continent's mineral endowment, priority should be given to a number of essential issues. These include: Beneficiation with an emphasis on mineral cluster development; local value-addition and the fostering of other economic linkages; Localization of resource technologies and the creation of a new (local) knowledge base; Facilitate the formation of indigenous capital, broad-based socio-economic empowerment, and participation in order to prevent the leakage of critical resources; and promotion of human resource and skills development. In addition, emphasis is placed on the importance of standardizing

mining codes in order to encourage inflows of foreign direct investment – traditionally regarded as being risky due to political instability (Bridge, 2003). The challenge facing African countries as they develop input industries related to their underlying mineral wealth is how to develop these opportunity spaces, the capital goods and services industry, and support the adaptation of technologies developed in one area, to another.

This paper explores the mineral resource-based experience of two different African countries, South Africa and Mozambique, in the context of economic clustering. The paper commences with a synopsis of the theoretical underpinnings of the “cluster” concept and its potential use as a strategic tool for guiding current and future industrial policymaking and development strategies throughout the continent. This is followed by a general review of the minerals industry in both countries, and includes an in-depth analysis of the extent of the clustering process, the type of spin-offs that have arisen, constraints and interventions, which are boosting or limiting expansion of the mining sector, and opportunities for future growth in both Mozambique and South Africa. Relevant illustrative examples of clustering will support the discussion. The discussion is concluded with a synthesis of the main points raised and suggested policy recommendations.

2

The Cluster Concept

Origin of the Concept

The increased attention by policy-makers and development planners to the role that cluster-based development strategies can play in national development is largely due to changing global economic dynamics and the emphasis on governments to create competitive advantage. Cluster-based growth strategies have been developed and implemented in various nations/regions to address issues such as cyclical changes in economic conditions, increased global competition, population growth, low growth economies, unemployment, and making the shift from comparative to competitive advantage. According to Singh (2001), in the new economic environment, competitive advantage can be created around natural resources. Clustering provides the means by which to accomplish this.

Numerous explanations and definitions abound in the literature for “clustering” and “clusters”. In essence, a “cluster” is a concentration of expertise among closely linked industries and companies in which extensive investment in specialized factors of production catalyzes a growth trajectory. The emphasis is on the linkages that arise because of mutual connections and interaction between individual industries and with associated institutions. Clusters arise through the flow of information or products between companies that are functionally linked together. The agglomeration of producers, customers and competitors, whether based on geographical proximity or linked by complementary expertise, promotes efficiency and increases specialization. Clusters that are well established have the ability to constantly reinvent themselves, which contributes to ensuring the long-term sustainability of a particular industrial sector. Not only do firms improve the competitiveness of the main activity, but they also absorb new functions and activities and generate technological spillovers. Through such processes, firms and entire industrial sectors can evolve from a position of low-tech to high-tech, higher value activities (Porter, 1990; den Hertog et al., 1999; Roelandt et al., 2000; Singh, 2001).

The cluster concept was initially developed by Michael Porter to account for why certain regions and industries managed to achieve global competitive excellence while others did not. Porter (1990) maintains that in order to foster national competitiveness in a specific industrial activity, five critical elements are needed:

- Advanced and specialized factor conditions;
- Appropriate demand conditions;
- Related and supporting industries;
- Government; and
- Firm strategy, structure and rivalry.

These five elements are interconnected. Through their mutual reinforcing influence over time, domestic competence and international competitiveness is generated. Unfavourable conditions in one element can result in the weakening of the overall cluster. Moreover, competition based on only one element is unsustainable over the long term. National competitive advantage is brought about by the number (and size) of competitive firms in a particular country. Inherited endowments and factor conditions have secondary importance in sustaining competitive strength; national prosperity has to be continuously created by developing more advanced factors of production. Natural resources and an unskilled labour force do not have lasting effects on national competitiveness. As Porter argues, in the long term "...competitiveness [of a country] depends on the capacity of its industry to innovate and upgrade" (Porter, 1990, 73). The fundamental forces behind this ongoing improvement process are domestic demand and fierce rivalry and collaboration between producers. Clusters can occur in many types of industry, and are present in different economic settings and jurisdictional levels (Singh, 2001). Although clusters can arise spontaneously, the role of government and collective action is critical, particularly in accelerating the process. According to Porter "...government, working with the private sector, should reinforce and build on established and emerging clusters rather than attempt to create entirely new ones".

According to Hernesniemi et al. (1996, 158), nine critical factors/preconditions underpin a cluster's birth and growth:

- Time: Often, successful clusters date back to relative advantages or disadvantages, which were present centuries ago. It also takes time to develop an industrial base, customer relations, and brand names.
- Critical mass: An industry has to be fairly large before economies of scale and scope can be fully utilized.
- Entrepreneurs and dedicated people: Most dynamic clusters contain stories of entrepreneurs who significantly influenced the industry.
- Demanding international customers: Cluster studies show that demanding customers are the key source of competitive advantage.
- Rivalry and cooperation: Rival companies are the main feature of a cluster. Lucrative companies, however, often cooperate with their main competitors when necessary and mutually beneficial.

- **Advanced suppliers:** Competitive subcontractors can be a major source of innovations and allow firms to concentrate on their core competencies.
- **Flexible organization and management:** Organizational flexibility is needed especially during periods of excessive turmoil.
- **Continuous knowledge development:** There is no saturation level to cluster innovation. Existing competitive strength will be lost if the upgrading process stops.
- **National pride:** Industries that are nationally appreciated attract the best talent in the country.

Advantages of Clustering

One of the principle advantages of cluster analysis is that it provides a much better tool for understanding the structural evolution and expansion of an industry and identifying future growth areas. This is largely due to the concept's emphasis and focus on linkages and interdependencies among various actors in the value chain. It therefore offers an alternative to the traditional sectoral approach of understanding the dynamics of an economy, which looks at different industries in isolation from each other or linked together through flows of immediate goods and raw materials (Porter, 1990; den Hertzog et al., 1999; Roelandt et al., 2000; Singh, 2001).

Promoting and developing a cluster-based development strategy can engender numerous economic benefits, not only at the macro-economic level, but also at the level of the individual enterprise or corporation. Clusters can generate additional national revenues and foreign exchange earnings through increased exports, produce global competitiveness, enhance productivity, and result in a higher standard of living within the resident population. Moreover, clustering can enhance regional economic stability and improve the image of an area. At the micro-economic level, participating in a cluster provides firms with access to a common supply base of skilled personnel, specialized service providers, and local institutions that offer training and conduct research. Each of these can contribute to improving the efficiency, productivity and overall level of competitiveness within a specific firm. At the same time, operating within a cluster can reduce risks associated with new business ventures, develop new technologies, identify new markets, train skilled workers, and raise capital, particularly among small firms. Many of the costs of specialization are shared or embedded in a dense network of institutions. Furthermore, given the increased tendency of large firms to outsource non-core activities, smaller- and medium-sized firms are in a much greater position to offer support if they are part of an industry cluster. Companies that operate independently of a cluster are less likely to succeed than if there is a pooling of resources and complementing of activities. Perhaps the key advantage of clustering at a micro-economic level is that it forces individual firms to consider the environment in which they operate and how their activities can nurture and advance competitive advantages and foster economic linkages (Porter, 1990; den Hertzog et al., 1999; Roelandt et al., 2000; Singh, 2001).

Cluster Development in the Context of Minerals

As previously mentioned, the ultimate objective for promoting and fostering cluster development in a particular region is to create and generate sustainable competitive advantages. Competitive advantages can be secured by the developing of upstream and downstream industries; increasing the level of competitive inputs (such as services, machinery and equipment); increasing the level of employment in all business activities related to the cluster; increasing the rate and exports of value-added products and services; attracting foreign investment; increasing inter-firm cooperation; ensuring linkages and interactions are high-quality and beneficial; generating new start-up companies; increasing trade performance; and generating higher corporate profits. A rather heterogeneous selection of research techniques is used to assess these various qualitative and quantitative performance measures.

The overall economic impact of a specific mining or minerals processing project, particularly at the local level, is highly dependent on the fullness and depth of the 'cluster' of activities that form and agglomerate around it, for the 'indirect' effects are strongly associated with the degree of 'cluster' maturity. Each direct spin-off from the initial industry provides the impetus for further employment spin-offs either in supporting industries and enterprises or the service sector. These indirect spin-offs, in turn, facilitate the diversification of the economy through the development of additional manufacturing and service activities as employee demands for different products begin to increase. Generally, these indirect effects are derived from four principal sources. Firstly, the fiscal contribution of the plant to local tax revenues. Secondly, the value added originating in inputs, equipment, services and engineering produced by domestic suppliers to the plant ('upstream' and 'sidestream' industries). Thirdly, the value added in the domestic processing of minerals and metals, in products made from such metals and minerals and the transportation and marketing of the same ('downstream' industries). Lastly, value added in local improvements and innovations through integration with technological consultants, suppliers and producers (Ballance, 1987; Porter, 1990; Walker, 2003). Each indirect effect assists in broadening the local employment base and enhancing the skills in the local population.

The development of indirect employment, and thus a secondary industrial sector, around resource-based industries, is strongly dependent on, inter alia, the availability and development of entrepreneurial capacity, skilled labour and supporting technical, design, consulting and engineering services; the effectiveness of the plant's supplier network; the adequacy of the supporting physical infrastructure; the extent of the plant's development facilities and commitment to enhancing productivity; the degree of sub-contracting; and the level of cooperation and coordination between the various participants in the 'cluster'. Lastly, it is also dependent on the national and international competitiveness of the project and the type of products produced (Ballance, 1987; Porter, 1990).

Drawing on the international experience of mineral-based growth and clustering, it is argued that by capitalizing on linkages arising in the production chain, there are three opportunities in which the vast mineral wealth in Africa can be employed to ensure maximum industrial development throughout the continent. Firstly, through the development of

downstream processing and beneficiation activities, secondly through the development of an upstream capital goods and services sector, initially supporting and depending on the resource-based sector, but eventually emerging into an independent sector and generator of economic wealth in its own right. Lastly, the migration of generic technologies from the developed capital goods and services sector to other high-tech industrial sectors – the so-called lateral migration of technology (Vuori and Ylä-Anttila, 1992; Pajarinen et al., 1998).

Mineral Beneficiation

Compared to other manufactured products, there has been a gradual decline in the real price of minerals and mineral-based products. This has largely been the result of a combination of various factors, including: a reduction in the intensity of use of traditional minerals and metals, increasing competition between mineral producers, technical developments lowering the cost of mineral extraction, as well as various economic factors. This has effectively led to a general deterioration in the terms of trade of raw material exporting countries and increasing volatility in export revenues. In line with international debates pertaining to the feasibility of RBI strategies, it is argued that since mining is a primary activity engaged in the exploitation of a national asset, in order to ensure increased export revenues and the sustainability of such an industrialization strategy, further processing of mineral resources through beneficiation prior to export is essential (Jourdan, 1992; 1994; RSA, 1998).

Value-added processing, or beneficiation, involves the transformation of the raw material (through the production process) using local resources (labour or capital), to a more finished product that has a higher value than the sale of the raw material for export. Beneficiation involves a range of different activities including large-scale, capital-intensive activities such as smelting and sophisticated refining plants as well as labour-intensive activities such as craft jewellery and metal fabrication (RSA, 1998). Each successive level of processing permits the product to be sold at a higher price than the previous product or original raw material and adds value at each stage. Beneficiation should aim at creating an integrated industrial 'platform' of feedstocks for component and, ultimately, original equipment manufacture (OEM) exports. Support for increased beneficiation carries both national (increased foreign exchange earnings) and local benefits. In the latter case, it is argued that when more capital is directed into and spent within a particular locality, more money for wages becomes available and local economic opportunities increase as capital and resources are consumed through the construction of a new industry. The opposite effect is the loss of local and national revenues through 'leakage' in local spending (Jourdan, 1992; 1994; Minerals Bureau, 2002). Moreover, mineral-based intermediate and finished products generally do not suffer the same terms of trade decline and volatility that raw materials do. Examples from around the world also attest to the long-term benefits of fostering a diversified and vibrant downstream industry. Mineral-based industries can survive after the exhaustion of the original deposit by importing the necessary ore or concentrate.

Capital Goods and Services Inputs

The overarching objective of fostering the development of linkages between the mineral resource base and the emergence of a 'sidestream' capital goods and services cluster is to provide a base from which sustained diversification can occur. While initially supportive and dependent on the resource-based sector, increased diversification and technological spillovers into new firms results in an expansion of the initial cluster that eventually emerges into an independent sector and generator of economic wealth in its own right.

It is argued that there are numerous opportunities for developing and fostering additional competencies in mining related activities and broadening the existing 'sidestream' cluster. In the first instance, due to the finite nature of mining activities, there is a constant need to establish new ones. According to Natural Resource Canada (NRCAN) (no date, 8), the demand for goods and services required to keep mines operational throughout the world is estimated to be about \$ 200 billion per year. The construction of new mines currently planned around the world is set to trigger an annual demand of approximately \$US 50 billion. The market for goods and services required for mineral exploration, moreover, is valued at \$US3 billion per year. In terms of overall value added, the global minerals industry is estimated to be worth about \$US1 trillion (Chamber of Mines, 2000).

Secondly, given that each ore deposit is geologically unique, demand for goods and services tailored to meet specific country requirements ensures a constant flow of products and supplies and interaction at the global, national and the local level. Once the deposits have been extracted, the ore must be processed and developed on an on-going basis in order to maintain production. Capital equipment, processing plants, consumables, and services are needed in each of these phases. In addition, the mining plant and infrastructure must be repaired and upgraded and, as the ore is exhausted, the mines must be closed. Each of these activities creates a steady need for a variety of direct and indirect 'sidestream' input industries supporting and enhancing the mining sector (NRCAN, no date; Warda, 2001).

Thirdly, very few countries are self-sufficient or competitive in all lines of mining products. In mining, as in other industrial activities, purchasing decisions are largely based on specifications and price. While mining companies purchase locally where possible, they nevertheless are forced to obtain a large mix of products from various sources around the world. Together, these factors contribute to maintaining and enhancing competitiveness within the global mining supplier network (NRCAN, no date; Warda, 2001).

Lateral Migration

The ultimate objective for a thriving mining cluster rests in the 'lateral migration' of the knowledge and expertise embodied in the technologies and products developed to support and sustain local mining and minerals processing sectors. While the development of 'downstream' and 'sidestream' linkages from a resource-based enterprise are critical for initiating a process of sustained economic diversification in a country, the international experience reveals that the real transition from a position as a resource-based economy to a high-technology, knowledge-intensive one requires identifying and developing the more

dynamic linkages that arise in each of these phases of diversification (Porter, 1990; Vuori and Ylä-Anttila, 1992; Vuori, 1997; Pajarinen et al., 1998; Wright, 2001). This means that the mining sector should not only be seen as a source of export commodities (metals and minerals), but also as an engine for the development of its inputs industry and the export of this industry's related services, namely capital goods and expertise in fields such as process control, construction equipment and materials-handling (Chamber of Mines, 2000; Mining Weekly, 2001c).

Levels of Analysis and Cluster Methodologies

In analyzing cluster activities within a particular country, the starting point has generally been to define clusters at various levels depending on the nature and relationships of the elements that make up the cluster and on how their interactions promote competitiveness. The levels of analysis vary from small groups of firms to main sectors in an economy. There are three basic levels of analysis when attempting to classify clusters (According to Roelandt and den Hertog, 1997):

- First, national or macro clusters, which emphasize the role of sector linkages in the national economy and which are determined by reviewing the particular international trade and specialisation patterns of the country.
- Second, sector or meso clusters. At this level of analysis, the emphasis is on inter- and intra-sectoral linkages of a specific industry within the economy. Evaluation and analysis is based on reviewing the strategic competitive advantages of the sector.
- Last, firm or micro-level clusters. These are clusters that have emerged as a result of interaction and networking. The role of strategic alliances, networking and associations is critical at this level.

At the highest level of aggregation, the cluster concept is used to identify the broad areas of specialization within an economy and analyze the relations between and within sectors. At the micro-economic level, the cluster concept is used to identify small groups of firms that are willing to take collective initiatives to produce direct and tangible benefits to each one of the participants.

In this study, while a general review of the mining sector at the macro-economic level is included in the analysis of both the South African and Mozambican experiences, due to the relative paucity of previous cluster-based analyses within the countries and limited data pertaining to the sector, the emphasis is placed rather on the meso/intermediate and micro-levels of cluster development. It is believed that these are the best levels of analysis for the purposes of this study as the formation of agglomerations and economies of scale are most pronounced at these levels. The qualification and quantification of the various upstream, downstream and sidestream linkages associated with a particular mineral/mining-based industry can therefore be traced and reviewed relatively easily.

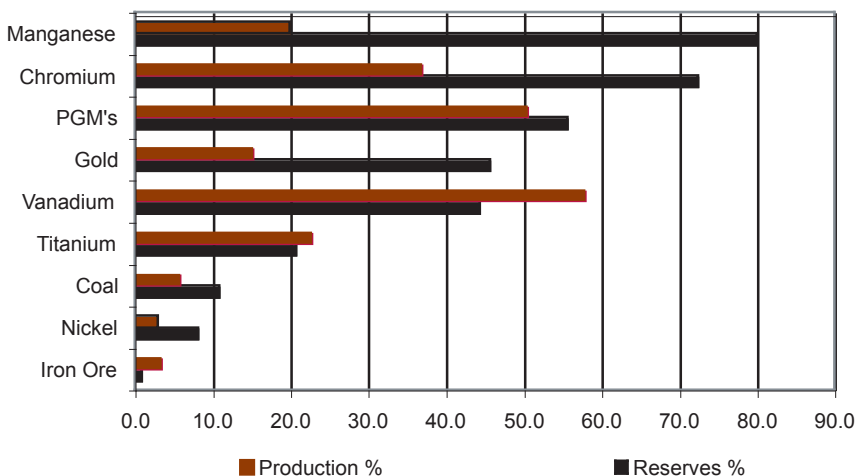
3

South Africa

The Macro-cluster: The Minerals Industry

South Africa can be broadly defined as a mineral economy, with the mining sector accounting for approximately 8% of GDP and close to half of the country's exports (Nankani, 1979, Jourdan, 1992; 1994). South Africa is blessed with an exceptionally large and varied minerals resource base. The country possesses a considerable portion of the world's reserves of alumino-silicates, chromium, gold, manganese, platinum-group metals, vanadium and vermiculite. It is also rich in antimony, fluorspar, phosphate rock, titanium and zirconium (Figure 1).

Figure 1: South Africa's Role in World Mineral Reserves and Production, 2001



Source: Baxter, 2003

This large resource base has enabled South Africa to play a major global role in the production, processing and export of many primary minerals products, for a considerable length of time (Jourdan, 1994; Minerals Bureau, 2002). Not only has the minerals sector contributed significantly to the country's Gross National Product (GNP), providing capital for reinvestment and new developments, but it has also provided the impetus for the development of a diverse secondary and tertiary industrial sector as well as an extensive and efficient physical infrastructure (Davis, 1994; Minerals Bureau, 2002).

There is general agreement that a rich endowment of natural resources, particularly in minerals, has played a critical role in the evolution of the South African economy. It was the discovery of diamonds and gold in the late nineteenth century and their location in an undeveloped interior and their relative inaccessibility that provided the initial impetus for industrialization. The need for heavy equipment, power supplies and large forces of organized labour to extract and process underground ore deposits triggered a series of spin-off activities in a diverse range of goods and services in sectors such as transport (rail system), power generation (coal mining), manufacturing, and commercial farming (Abedian and Standish, 1992; Davis, 1994; Fine and Rustomjee, 1996; Mainhardi, 1997). A more significant legacy of mining and exploration activities in the country has been the emergence of prominent industrial centres and towns, most notably Johannesburg, Kimberley and Richards Bay. The gold, diamond, coal and platinum industries play a key role in the current economy, which is characterized by a high degree of technical expertise, a high capacity to mobilize capital, and global recognition as a reliable supplier of consistently high-quality mineral products.

Despite this favourable economic legacy, and the fact that since 1994 economic and industrial planning has emphasized the growth of sectors and industries in which South Africa has a comparative advantage, particularly those engaged in the processing of mineral resources and energy, it is argued that there has been a historical imprudent use of mineral endowments in the country. The implications afforded by this realization have, and will continue to have, a strong impact on the future trajectory and dynamism of the mining cluster at the macro-economic level. This section provides both a qualitative and quantitative review of the South African mining cluster at the national level. The discussion commences with a look at the current structure of the industry and then shifts to examine the broad economic impacts of the industry at the national and subregional level. The historical contribution of minerals in the South African economy and recent legislative changes with regard to the management and sustainability of natural and mineral resources in the national context is then explored. The section concludes with an analysis of the mining cluster in terms of downstream and sidestream linkage development and possibilities for the lateral migration of inherent technologies (Davis, 1994).

Industry Structure

The structure of the South African minerals industry has changed significantly over the past decade, both in terms of the type of commodities produced, as well as in the internal organization of activities. The process has been driven by a combination of internal socio-

economic pressures and international industry trends. The process of transformation is set to continue in the coming decades.

The South African minerals industry was dominated by gold and diamond production for a considerable period of time. The situation changed in the 1990s as new commodities, most notably platinum, and higher value-added mineral processing and manufacturing activities gradually began to supersede gold as the primary source of national revenue. South Africa has subsequently become a major exporter of processed minerals as opposed to its previous role as an exporter of primary commodities (Jourdan, 1994; Minerals Bureau, 2002). This transition has largely been due to the construction and operation of a number of large-scale capital-intensive mineral beneficiation plants, including Columbus Stainless Steel, Billiton Hillside Aluminium, Namakwa Sands Titanium, Saldanha Steel, and smaller ferrochrome smelters (Financial Mail, 1996, Minerals Bureau, 2002).

In terms of primary activities, South Africa is recognized as a global supplier of a large variety of minerals and mineral products. Approximately 55 different minerals were produced from 713 mines and quarries in 2000. These included 44 gold producers, 11 platinum group minerals, 60 coal, and 74 diamond mines. Mineral commodities were exported to 87 countries (Minerals Bureau, 2002).

Until the early 1990s, the South African minerals industry (and private sector) was dominated by a few core mining houses. Established with the initial objective of providing finance for early industrialists and miners on the Johannesburg reef, they eventually drove the advance of the local diamond, coal, platinum and manufacturing industries. The mining houses contributed directly to the development of South Africa's industrial landscape and important secondary and tertiary sectors, particularly the capital and money market, and at times owned important stakes in the largest banks in the country. Mining houses also functioned as a centralized source of specialized skills to the mining sector and through close collaboration formed a labour oligopoly to increase the supply of labour as a means of managing labour costs (Chamber of Mines, 2000; Minerals Bureau, 2002).

By the early 1990s, however, three factors prompted a re-evaluation and critical assessment of the economic importance and viability of the mining house concept. First, mining houses experienced severe economic pressures due to a drop in the gold price. Alternative strategies and methods of operation were deemed imperative in order to sustain profit margins and reduce costs. Second, due to the extensive period of political isolation, management and workplace practices in South Africa had fallen below international standards. The minerals industry had also gained an image as an exploitative and racially discriminative sector. As the country made the gradual transition to democracy, emphasis was placed on need to ameliorate this negative image. This would only be possible if the structure of the industry was reorganized and the objectives and goals paralleled and upheld those at the national level. Lastly, new foreign investors entering the South African market in the early 1990s found the prevailing corporate and governance structures restrictive. This greatly restricted the opportunities for mining houses to embark on new projects. These factors resulted in a fundamental reorganization of the mining sector at the level of the mining house, the mining company, and the workplace. Mining houses

subsequently became far more focused business units, outsourcing all non-core activities and divesting non-profitable activities.

Mergers and acquisitions of international companies also increased in order to consolidate areas of expertise and ownership and secure international competitive advantage. The purchase of numerous South African mining assets by foreign investors also increased. This era of transformation was further characterized by an increase in the transfer of primary listings (and corporate headquarters) offshore (Chamber of mines, 2000; Minerals Bureau, 2002). In particular, Anglo American Corporation, the largest South African Mining house moved its domicile to London in 1998. In June 2001 Billiton merged with BHP of Australia to create BHP-Billiton and moved its domicile and primary listing to London. Three major gold companies, AngloGold, Goldfields, and Harmony all established secondary listings in New York during this period.

One of the significant outcomes of this period of change was the shift in perception regarding the role of small- and medium-sized businesses in the mining cluster. While large mining companies previously dominated exploration and beneficiation activities, a vibrant junior minerals industry has emerged and numerous smaller groups and companies operate throughout the mining and mineral processing value chain. Many of these companies involve Canadian and Australian junior mining companies working in conjunction with Black Economic Empowerment (BEE) groups. The South African macro-mining cluster therefore now consists of a wide range of firms with widely differing business strategies and ownership profiles, including:

- Multinational global mining entities (e.g. Anglo American);
- World-class single commodity companies engaged in the mining of long-life, high-yield deposits (e.g. Goldfields Ltd);
- Medium-sized black empowered single commodity companies (e.g. Eyesizwe Coal)
- Small companies dedicated to high productivity exploitation of marginal ore from mature operations (e.g. Metorex);
- Small entrepreneurial companies targeting smaller reserves considered too small to be profitably mined by the large companies (e.g. SA Chrome); and
- Numerous junior exploration companies, many with Australian or Canadian links.

In 1999, the National Small-Scale Mining Development Framework was established with the principal objective of providing assistance to junior mining companies and entrepreneurs in South Africa. This was based on the recognition that the sector has a critical role to play in the national economy, not only in terms of complementing larger mining operations, but also in terms of broadening the employment base and enhancing indirect economic spin-offs (Chamber of Mines, 2000; Minerals Bureau, 2002).

From the outset, the Chamber of Mines has been the principal association through which the South African minerals industry has operated. Established in 1889 as a voluntary, private sector-based organization, the Chamber has been the mediating force between the

minerals industry, government and labour. In keeping pace with developments at the local and international levels, the function and role of the Chamber has undergone significant change during the course of the 1990s. The Chamber now acts as the primary advocate of the major policy positions endorsed by mining employers and is responsible for the dissemination of the formalized views of its membership to various South African national and provincial bodies, and to other relevant policymaking and opinion-forming entities, both domestically and abroad. A number of different co-operative organizations serving specific segments of the industry and smaller players have also emerged and complement the activities of the Chamber of Mines. These include the Aluminium Federation of South Africa, the South African Copper Development Association, the Ferro -Alloy Producers Association, the Engineering Industries Federation of South Africa, the Southern Africa Stainless Steel Development Association and the Aggregate and Sand Producers Association of South Africa (Chamber of Mines, 2000; Minerals Bureau, 2002).

State involvement in the South African minerals industry is both complementary and supportive in nature. Not only does it provide a legal and fiscal environment conducive to unimpeded exploration, mining, benefaction and marketing, but is also responsible for ensuring and maintaining social and physical infrastructure. The Department of Minerals and Energy (DME) is the institution through which the government operates, and is comprised of various departments. There are three national research institutes directly linked to the exploration, extraction and processing of mineral resources in South Africa:

- **The Council for Geosciences**, originally called the Geological Survey was founded in 1921. It undertakes geological mapping, carries out studies relevant to the identification, nature, extent and genesis of ore deposits, and is responsible for maintaining the national databases of the country's geo-scientific data and information.
- **Miningtek** was originally established in the 1930s by the Chamber of Mines as a collaborative research body funded by the mining houses to undertake research on common mining problems. In 1990, it was transferred to the control of the Council for Scientific Research as part of the restructuring of the Chamber of Mines, and renamed Miningtek. Since then, it has undertaken collaborative research funded by the Council of Scientific and Industrial Research (CSIR), government and the relevant mining houses. Its initial work focused on addressing the problems faced by deep level gold mining and it completed two projects, Deepmine and Futuremine. The current projects include Coaltech 2020 and Platmine, which address the respective problems that the coal and platinum mining industries face.
- **Mintek** was founded in 1934 with the mandate to serve national interest through research, development and technology transfer that fosters the development of industries in the field of minerals and products derived from them. Some notable achievements include the development of a process to smelt the UG2 platinum ore from the Bushveld Complex, which previously could not be processed because of the high chrome content.

These institutes complement DME's activities and undertake collaborative short-term and applied R&D for the development of technology and application of research findings to the benefit of the industry (Chamber of Mines, 2000; Minerals Bureau, 2002).

The state established the Industrial Development Corporation (IDC) in 1940 by an Act of Parliament in 1940. It is a self-financing national development financing institution whose role is to contribute to economic growth and development through its financing activities. It has carried out its mission with great success and has played a major role in the establishment and development of such major companies as Iscor, Richards Bay Minerals, Alusaf, and Foskor. Since 1994, IDC has evolved into a leading industrial player at regional Southern African Development Community (SADC) levels to being the first South African development funding institution to have its mandate extended to the rest of the African continent.

The IDC helped establish the original Bayside smelter in Richards Bay and played a major role in funding both phases of the Mozal Aluminium smelter operation in Maputo in which it holds a 25% stake. It has also invested in the Corridor Sands heavy minerals project in which it holds a 10% interest. The South African Government envisages the IDC playing an increasing role in the development of the SADC countries.

In essence, since the advent of democracy, the over-arching structure and organization of the South African mining cluster has become far more focused, competitive, internationally active, and inclusive of all types and levels of activity. At the core of the cluster are world-class mining companies producing gold, platinum, diamonds, coal, ferrochrome and base metals. Linked to these extractive industries is a network of downstream refining, smelting, beneficiating and processing industries. World-class engineering and other companies serving the industry support these primary and secondary activities. The minerals industry today provides the base for the country's competitive advantage in electricity, chemicals and related industries. Transformation continues. Future developments within the industry will be driven by legislative pressures pertaining to black economic empowerment and equality in the industry, environmental sustainability, socio-economic responsibility, and corporate best-practice (Minerals Bureau, 2002).

Contribution to the National Economy

This section analyzes the economic impact of the South African mining sector on the economy as a whole. The impact is measured in terms of its contribution to GDP and employment. The mining and metallurgical industry is a well-developed and economically significant cluster in South Africa. Indeed, Menell asserts that, "mining constitutes what is surely the most successful 'cluster' in the country's economy" (Menell, 2000, 1).

The contribution of mining to the economy is not only the result of direct "upstream" and "downstream" activities, but also various indirect activities, particularly "sidestream" supply and support activities, and induced contributions (Chamber of Mines, 2000). A graphic synopsis of the different types of linkages constituting the mining cluster is depicted below.

Industry Structure

The structure of the South African minerals industry has changed significantly over the past decade, both in terms of the type of commodities produced, as well as in the internal organization of activities. The process has been driven by a combination of internal socio-economic pressures and international industry trends. The process of transformation is set to continue in the coming decades.

The South African minerals industry was dominated by gold and diamond production for a considerable period of time. The situation changed in the 1990s as new commodities, most notably platinum, and higher value-added mineral processing and manufacturing activities gradually began to supersede gold as the primary source of national revenue. South Africa has subsequently become a major exporter of processed minerals as opposed to its previous role as an exporter of primary commodities (Jourdan, 1994; Minerals Bureau, 2002). This transition has largely been due to the construction and operation of a number of large-scale capital-intensive mineral beneficiation plants, including Columbus Stainless Steel, Billiton Hillside Aluminium, Namakwa Sands Titanium, Saldanha Steel, and smaller ferrochrome smelters (Financial Mail, 1996; Minerals Bureau, 2002).

In terms of primary activities, South Africa is recognized as a global supplier of a large variety of minerals and mineral products. Approximately 55 different minerals were produced from 713 mines and quarries in 2000. These included 44 gold producers, 11 platinum group minerals, 60 coal, and 74 diamond mines. Mineral commodities were exported to 87 countries (Minerals Bureau, 2002).

Until the early 1990s, the South African minerals industry (and private sector) was dominated by a few core mining houses. Established with the initial objective of providing finance for early industrialists and miners on the Johannesburg reef, they eventually drove the advance of the local diamond, coal, platinum and manufacturing industries. The mining houses contributed directly to the development of South Africa's industrial landscape and important secondary and tertiary sectors, particularly the capital and money market, and at times owned important stakes in the largest banks in the country. Mining houses also functioned as a centralized source of specialized skills to the mining sector and through close collaboration formed a labour oligopoly to increase the supply of labour as a means of managing labour costs (Chamber of Mines, 2000; Minerals Bureau, 2002).

By the early 1990s, however, three factors prompted a re-evaluation and critical assessment of the economic importance and viability of the mining house concept. First, mining houses experienced severe economic pressures due to a drop in the gold price. Alternative strategies and methods of operation were deemed imperative in order to sustain profit margins and reduce costs. Second, due to the extensive period of political isolation, management and workplace practices in South Africa had fallen below international standards. The minerals industry had also gained an image as an exploitative and racially discriminative sector. As the country made the gradual transition to democracy, emphasis was placed on need to ameliorate this negative image. This would only be possible if the structure of the industry was reorganized and the objectives and goals paralleled and upheld those at the national level. Lastly, new foreign investors entering the South Afri-

can market in the early 1990s found the prevailing corporate and governance structures restrictive. This greatly restricted the opportunities for mining houses to embark on new projects. These factors resulted in a fundamental reorganization of the mining sector at the level of the mining house, the mining company, and the workplace. Mining houses subsequently became far more focused business units, outsourcing all non-core activities and divesting non-profitable activities.

Mergers and acquisitions of international companies also increased in order to consolidate areas of expertise and ownership and secure international competitive advantage. The purchase of numerous South African mining assets by foreign investors also increased. This era of transformation was further characterized by an increase in the transfer of primary listings (and corporate headquarters) offshore (Chamber of mines, 2000; Minerals Bureau, 2002). In particular, Anglo American Corporation, the largest South African Mining house moved its domicile to London in 1998. In June 2001 Billiton merged with BHP of Australia to create BHP-Billiton and moved its domicile and primary listing to London. Three major gold companies, AngloGold, Goldfields, and Harmony all established secondary listings in New York during this period.

One of the significant outcomes of this period of change was the shift in perception regarding the role of small- and medium-sized businesses in the mining cluster. While large mining companies previously dominated exploration and beneficiation activities, a vibrant junior minerals industry has emerged and numerous smaller groups and companies operate throughout the mining and mineral processing value chain. Many of these companies involve Canadian and Australian junior mining companies working in conjunction with Black Economic Empowerment (BEE) groups. The South African macro-mining cluster therefore now consists of a wide range of firms with widely differing business strategies and ownership profiles, including:

- Multinational global mining entities (e.g. Anglo American);
- World-class single commodity companies engaged in the mining of long-life, high-yield deposits (e.g. Goldfields Ltd);
- Medium-sized black empowered single commodity companies (e.g. Eyesizwe Coal)
- Small companies dedicated to high productivity exploitation of marginal ore from mature operations (e.g. Metorex);
- Small entrepreneurial companies targeting smaller reserves considered too small to be profitably mined by the large companies (e.g. SA Chrome); and
- Numerous junior exploration companies, many with Australian or Canadian links.

In 1999, the National Small-Scale Mining Development Framework was established with the principal objective of providing assistance to junior mining companies and entrepreneurs in South Africa. This was based on the recognition that the sector has a critical role to play in the national economy, not only in terms of complementing larger mining operations, but also in terms of broadening the employment base and enhancing indirect economic spin-offs (Chamber of Mines, 2000; Minerals Bureau, 2002).

From the outset, the Chamber of Mines has been the principal association through which the South African minerals industry has operated. Established in 1889 as a voluntary, private sector-based organization, the Chamber has been the mediating force between the minerals industry, government and labour. In keeping pace with developments at the local and international levels, the function and role of the Chamber has undergone significant change during the course of the 1990s. The Chamber now acts as the primary advocate of the major policy positions endorsed by mining employers and is responsible for the dissemination of the formalized views of its membership to various South African national and provincial bodies, and to other relevant policymaking and opinion-forming entities, both domestically and abroad. A number of different co-operative organizations serving specific segments of the industry and smaller players have also emerged and complement the activities of the Chamber of Mines. These include the Aluminium Federation of South Africa, the South African Copper Development Association, the Ferro -Alloy Producers Association, the Engineering Industries Federation of South Africa, the Southern Africa Stainless Steel Development Association and the Aggregate and Sand Producers Association of South Africa (Chamber of Mines, 2000; Minerals Bureau, 2002).

State involvement in the South African minerals industry is both complementary and supportive in nature. Not only does it provide a legal and fiscal environment conducive to unimpeded exploration, mining, benefaction and marketing, but is also responsible for ensuring and maintaining social and physical infrastructure. The Department of Minerals and Energy (DME) is the institution through which the government operates, and is comprised of various departments. There are three national research institutes directly linked to the exploration, extraction and processing of mineral resources in South Africa:

- The Council for Geosciences, originally called the Geological Survey was founded in 1921. It undertakes geological mapping, carries out studies relevant to the identification, nature, extent and genesis of ore deposits, and is responsible for maintaining the national databases of the country's geo-scientific data and information.
- Miningtek was originally established in the 1930s by the Chamber of Mines as a collaborative research body funded by the mining houses to undertake research on common mining problems. In 1990, it was transferred to the control of the Council for Scientific Research as part of the restructuring of the Chamber of Mines, and renamed Miningtek. Since then, it has undertaken collaborative research funded by the Council of Scientific and Industrial Research (CSIR), government and the relevant mining houses. Its initial work focused on addressing the problems faced by deep level gold mining and it completed two projects, Deepmine and Futuremine. The current projects include Coaltech 2020 and Platmine, which address the respective problems that the coal and platinum mining industries face.
- Mintek was founded in 1934 with the mandate to serve national interest through research, development and technology transfer that fosters the development of industries in the field of minerals and products derived from them. Some notable achievements include the development of a process to smelt the UG2 platinum ore from the Bushveld Complex, which previously could not be processed because of the high chrome content.

These institutes complement DME's activities and undertake collaborative short-term and applied R&D for the development of technology and application of research findings to the benefit of the industry (Chamber of Mines, 2000; Minerals Bureau, 2002).

The state established the Industrial Development Corporation (IDC) in 1940 by an Act of Parliament in 1940. It is a self-financing national development financing institution whose role is to contribute to economic growth and development through its financing activities. It has carried out its mission with great success and has played a major role in the establishment and development of such major companies as Iscor, Richards Bay Minerals, Alusaf, and Foskor. Since 1994, IDC has evolved into a leading industrial player at regional Southern African Development Community (SADC) levels to being the first South African development funding institution to have its mandate extended to the rest of the African continent.

The IDC helped establish the original Bayside smelter in Richards Bay and played a major role in funding both phases of the Mozal Aluminium smelter operation in Maputo in which it holds a 25% stake. It has also invested in the Corridor Sands heavy minerals project in which it holds a 10% interest. The South African Government envisages the IDC playing an increasing role in the development of the SADC countries.

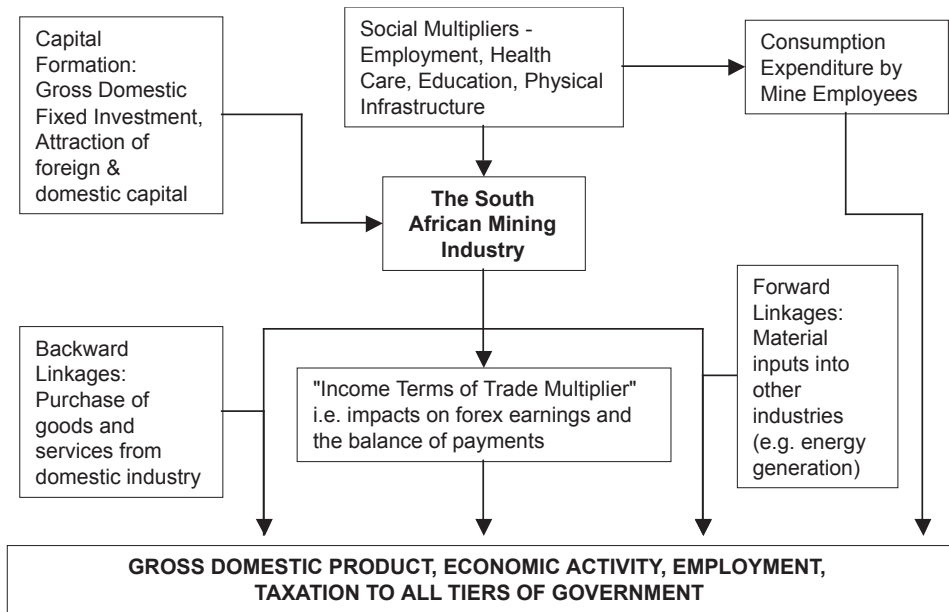
In essence, since the advent of democracy, the over-arching structure and organization of the South African mining cluster has become far more focused, competitive, internationally active, and inclusive of all types and levels of activity. At the core of the cluster are world-class mining companies producing gold, platinum, diamonds, coal, ferrochrome and base metals. Linked to these extractive industries is a network of downstream refining, smelting, beneficiating and processing industries. World-class engineering and other companies serving the industry support these primary and secondary activities. The minerals industry today provides the base for the country's competitive advantage in electricity, chemicals and related industries. Transformation continues. Future developments within the industry will be driven by legislative pressures pertaining to black economic empowerment and equality in the industry, environmental sustainability, socio-economic responsibility, and corporate best-practice (Minerals Bureau, 2002).

Contribution to the National Economy

This section analyzes the economic impact of the South African mining sector on the economy as a whole. The impact is measured in terms of its contribution to GDP and employment. The mining and metallurgical industry is a well-developed and economically significant cluster in South Africa. Indeed, Menell asserts that, "mining constitutes what is surely the most successful 'cluster' in the country's economy" (Menell, 2000, 1).

The contribution of mining to the economy is not only the result of direct "upstream" and "downstream" activities, but also various indirect activities, particularly "sidestream" supply and support activities, and induced contributions (Chamber of Mines, 2000). A graphic synopsis of the different types of linkages constituting the mining cluster is depicted below.

Figure 2: The Direct and Indirect Impacts of Mining



Source: Baxter, 2003

In the analysis that follows, the economic impact of each component of the minerals macro-cluster was analyzed using an input-output based model of the national multiplier and accelerator, developed by the Corporation for Economic Research (the Black Model). The study examines the relative size and importance of the cluster to the South African economy as of the year 2000.

For the purpose of the study, the mineral industry macro-cluster is defined as that group of industries that encompasses:

- All underground and surface mining mineral extraction operations in South Africa, excluding oil and gas production, but including quarrying of lime, sand and aggregate for the cement and construction industry;
- All mineral-processing operations needed to produce a saleable mineral product, including the production of basic ferro-metals;
- All metal smelting and refining operations required to produce refined metal in an unwrought form.
- The restoration, rehabilitation, reshaping, revegetating and reclaiming of areas affected by mining activities; and
- Any administrative, clerical, sales, research or other activities directly related to the abovementioned activities.

The definition excludes the iron and steel and stainless steel industries as well as the manufacture of cement, which, in South Africa, are classified as manufacturing, but includes the production of ductile iron as a by-product of smelting ilmenite.

Some of the more important qualitative issues are raised in the discussions of the minerals industry as an engine of growth sub-regional contributions as well as the role-played by downstream, sidestream and technological linkages (section 4.5).

The same methodology and data sources are used in our estimates of the contributions made by the gold mining and aluminium meso clusters, in South Africa and for the proposed Corridor Sands Titanium project in Mozambique. We also believe that the same methodology, suitably adapted, can be applied to estimating the contributions made by mineral activities to GDP and employment in other parts of the African continent.

Previous Studies

Many studies have reviewed various aspects of minerals- and energy-based strategies as well as the relationship between these natural resources and the South African economy (Davis, 1994; Jourdan, 1994; Mainardi, 1997; Stilwell, 1998). While Stilwell (1998) utilizes the 1993 input-output tables to estimate the overall economic impact of the gold, coal and other mining industries, Fine and Rustomjee (1996) invoke the notion of the Minerals-Energy Complex (MEC) to explain the relationship between natural resources and the economy. They maintain that the MEC “lies at the core of the South African economy ... through its determining role throughout the rest of the economy” (Fine and Rustomjee, 1996, 5). According to them, five key sectors underpin the economy in South Africa: coal, gold, diamonds and other mining activities; electricity; non-metallic products; iron and steel and basic industries; and fertilisers, pesticides, synthetic resins, plastics, basic chemicals and petroleum. Together these sectors constitute the MEC. By exploring and analyzing the input-output linkages between these various sectors Fine and Rustomjee (1996) were able to explain and quantify the direct and indirect dependence of the economy on the MEC, and expose the inherent weaknesses and strengths of resource-based industrialization in the country. Fine and Rustomjee (1996, 10) assert, furthermore, that the MEC should be viewed “not merely as a set of core industries and institutions but also as a set of accumulation”. Not only has the MEC been a source of capital, but it has also been used to fulfil and uphold many of the State’s political and economic objectives. While it is widely believed that the contribution of the mining sector to the economy has been gradually declining, if the MEC is taken as the point of reference, it is argued that the economy’s dependence on these five economic sectors has in fact increased (Jourdan, 1994; Fine and Rustomjee, 1996). Not only did the MEC exports constitute about 80% of total exports (Jourdan, 1994), but it also accounted for approximately one-third of GDP and total employment in 1993 – a contribution which has, in all probability, increased during the past 10 years.

Only limited work has been done on the South African minerals cluster using the input/output analysis. The most notable of these earlier attempts include work done by

Lombard and Stadler (1980) and Stilwell et al (1998). Their studies quantified the role of mining in adding value to national wealth and employment.

The work of Lombard and Stadler (1980) was prepared for the Chamber of Mines of South Africa, with its main purpose being to determine the nature and magnitude of the mining industries' external structural relationships with the South African economy in general (Lombard and Stadler, 1980:1). This relationship is described in terms of backward and forward multipliers, which were calculated from the 1971 input-output tables published by the Department of Statistics. The system of national accounts was used as a framework to calculate the relevant direct and indirect multipliers for the three available mining sector classifications in the input-output tables. Direct and indirect multipliers were calculated using the intermediate inputs and direct and inverse coefficients from the input-output tables. Lombard and Stadler calculated the total GDP multipliers (direct plus indirect) for the gold, coal and other mining sectors to be 1.908, 1.937 and 1.918, respectively. They also found that the direct forward linkage with the domestic economy was relatively weak, which reflected the significant forward leakage associated with the domestic mining industry and hence the low levels of domestic mineral beneficiation. The reliance of the work on the single 1971 input-output table did, however, limit the value of the calculations.

Stilwell (1998) used advanced computing techniques to extend the work done in earlier studies. An important objective of his work was to quantify the economic interdependence between the mining industry and the rest of the economy. He measured the impact that changes in final demand from the mining industry (using the 3 categories of "gold", "coal" and "other mining") have on other sectors of the economy by means of output multipliers. Stilwell (1998) calculated four different types of output multipliers from input-output tables to quantify the linkages between the mining industry and the rest of the economy. He used seven sets of input-output tables published over the period 1971-1993. Even though the static nature of the input-output model used does subject the findings to a number of limiting assumptions, this study provides an interesting view of the changing role of the mining industry over the relevant period. The total GDP multiplier is the first of the four types of multipliers calculated by Stilwell, and indicates the direct, indirect and induced impact on the economy when demand for a specific sector's production increases. The so-called Type 2 total GDP multiplier indicates the impact that an increase in the three GDP elements within a sector will have on national GDP and differs from the total GDP multipliers, as they express the impact on GDP by income generated within a sector. Total employment multipliers related to the number of jobs created in the economy for every R1 million increase in a sector's output. Type 2 total employment multipliers relate the number of jobs created in the economy to every job created in a sector and are a better indicator of the value of a sector as a job creator than total employment multipliers.

Blignaut and Hassan (2001) set out to understand how much of the resource rent is captured and reinvested in other forms of capital wealth. It is crucial for sustainable economic development that at least a portion of the value of depletable natural wealth is reinvested in other forms of capital. Their study endeavoured to derive resource accounting indicators and use them to analyze broader aspects of economic performance and sustainable development of mining in South Africa. They used the formula derived by El Serafy (1989)

to decompose the total resource rent into its capital component, as the proportion that needs to be reinvested, and its income component that can be consumed. Blignaut and Hassan concluded “the share of total taxes and royalties in total rent compares well with El Serafy’s capital component (user cost) that is to be recovered and reinvested. Moreover, the mining industry in South Africa seems to have not only adequately captured user costs, but also succeeded in fully reinvesting the capital component of the resource in alternative forms of capital to compensate for the depletion of mineral assets”

Choice of Input/Output Approach

The Input-Output analysis, the analytical framework developed by Wassily Leontief in the late 1930s, was the approach chosen, as it is an excellent tool for establishing the detailed industrial impacts at a point in time. It provides a good measure of the direct impact of a sector on the economy, as well as that of the indirect (or backward and forward linkage) effects of that sector. This methodology is the principal one employed by international researchers, planners and auditors to assess the economic impact of a particular development at the national, regional and local level and generally uses data obtained from input-output tables. Input-output tables can provide a ‘snapshot’ of the complete economy and all of its industrial interconnections at one particular moment in time.

According to Fatemi (no date, 6-7), there are three reasons why input-output tables can be used to analyze structural change. Firstly, the data are usually comprehensive and consistent. Secondly, the nature of input-output analysis enables an economy to be analyzed as an interconnected system of industries that directly and indirectly affect one another. Structural changes, therefore, can be traced back through the various industrial interconnections. Thirdly, the design of input-output tables allows the factors accounting for structural change as well as the type, scope and magnitude of change to be determined. Despite the benefits associated with the application of input-output tables, however, Fatemi (no date, 7) asserts that there are a number of limitations to such a methodology. Input-output analyses assume that returns to scale are constant; that each industry produces only one type of product; each product within the industry is the same; technical coefficients are fixed; there are no constraints on resources; that all local resources are efficiently employed; and, that input-output data are timeless. Furthermore, it does not provide policy makers and development planners with adequate information regarding the types and nature of employment opportunities that are stimulated as a consequence of a particular investment or activity. By contrast, a qualitative analysis can provide insight into such issues as the type of sectors, the size of firms, and the degree of value-added generated through each direct and indirect employment spin-off, which can be used to validate and assess numerical projections and assertions. This study therefore uses a combination of these two approaches.

The study uses an input-output based model of the national multiplier and accelerator (the Black model), developed by Phillip Black, Professor of Economics at Stellenbosch University (Black, 1981, 1996). Versions of it have been published in several professional journals such as the *Scottish Journal of Political Economy*, *Studies in Economics and Econometrics*, the *South African Journal of Economics* and the *South African Journal*

of Economic and Management Sciences. To date, the Black model has been successfully applied to evaluate several major mining and mineral processing projects in South Africa as well as to many capital investment projects.

The Black model measures the contribution of any sector to the economy by calculating the value added to GDP in the form of wages and profits by the sector itself, and also the (portion of) value added in industries supplying inputs to, or purchasing minerals from, the sector. It then applies a Keynesian spending multiplier to the direct value added (wages and profits inside the sector) and the indirect value added (wages and profits in non-sector industries resulting from the sector's transactions with these industries); the components of which are calculated from the relevant supply-and-use tables. A spending multiplier is then applied to the calculated value added in order to capture the value adding impact of the expenditure resulting from the mining industry's wages, profits and transactions on final demand.

The Black model differs from the conventional Leontief type input-output model, as used by researchers such as Lombard & Stadler and Stillwell, as it does not involve the calculation of multipliers from input-output tables, but uses the supply-and-use tables to calculate value added to GDP instead. In particular, the study uses the latest Supply-and-Use Tables available from Statistics South Africa (Stats SA) (for 2000), which represent an updated version of the earlier (1993) national input-output tables. These Supply-and-Use Tables enable one to identify and quantify the most important relevant backward and forward linkages – a procedure which, in our view, is much more efficient and cost-effective than utilizing the original input-output tables or, for that matter, the one available computable general equilibrium (CGE) model (which is in any case largely based on the 1993 tables).

A second difference is that, in addition to the “direct” and “indirect” (or backward and forward linkage) effects, this study considered the so-called “induced” effect, i.e. the multiplier effect associated with the spending behaviour of employers and employees directly or indirectly working for the sector or industry in question. The induced effect helps give a more complete picture of the “total” impact than the available social accounting matrix (SAM) can do, partly because the latter is also largely based on the 1993 data.

The decision to use an input-output based model of the GDP multiplier and accelerator was motivated by the following reasons:

- Statistics South Africa has not published input-output tables since 1993. This severely limits the use of conventional input-output analysis for the purposes of this study and does therefore not allow us the use of matrix algebra to calculate the familiar matrixes of Leontief inverses, coefficients and multipliers (for any period after 1993) generally associated with these models. It is therefore unreasonable to conclude that the use of conventional input-output analysis based on 1993 input-output tables indicating inter-industry relationships at that time would limit the value of calculations for more recent data years (2000-2002). The unavailability of updated input-output tables would also limit the validity of using techniques based on the existing SAM, or the available computable general

equilibrium CGE model – both of which are based on the old input-output tables.

- The model uses the supply-and-use tables published by Stats SA on an annual basis. These tables include all transactions in goods and services in the economy for a specific year, and use an input-output framework that presents the data in a matrix format, thus representing the only available updated version of the traditional input-output tables. The tables enable us to analyze the link between industrial output and final demand, and show wages paid and profits made in each industry separately. These tables form the basis for Statistics South Africa's National Accounting calculations and show the value added to GDP by each industry classification and for each goods and services category. It is therefore possible to calculate the value added to GDP by the minerals industry, and the minerals industry's transactions with other industries.

A weakness of the input-output approach is that it cannot capture the impacts of the resulting flows of income through the economy or impacts on trade, the exchange rate and financial markets. One approach which could be followed to achieve this, albeit on a hypothetical basis, is to use a macroeconomic model (a computer model of the entire economy in aggregate), together with the input-output system, to perform the hypothetical experiment of removing the minerals sector from the South African economy and observing the results for the key economic indicators such as GDP, the unemployment rate, the exchange rate and government deficits. While the experiment would be hypothetical, the results would constitute the most comprehensive measure of the total “impact” of the sector on the economy. Time and availability of data precluded the adoption of this approach.

Methodology

For any sector or industry, the overall economic contribution consists of three components:

- The primary or direct effect is the value added (in the form of mining sector wages and profits) by the sector itself, i.e. its contribution to the GDP of the country.
- The secondary or indirect effect is the value created by the relevant backward and forward linkage effects that the mining sector has within the country. Backward linkage effects include (the relevant proportion of) value added (wages and profits) in local industries supplying inputs to mining activities in South Africa, whereas forward linkage effects refer to (the relevant proportion of) value added (wages and profits) by local industries purchasing mineral industry outputs.
- The tertiary or induced effect is the value created through the spending multiplier process within the country. It includes all value added in the retail, wholesale, manufacturing and agricultural sectors resulting directly from the fact that a portion of the wages and profits (created by the above direct and indirect effects) is spent in the local economy.

The overall economic impact can be expressed either in terms of additional income generated (i.e. contribution to gross domestic product) or by the number of job opportunities created.

The economic impact of each component was analyzed using the Black model. The findings are expressed in terms of the contribution to gross geographic product and the number of job opportunities created throughout the country.

The model was used to estimate the direct and indirect effects as well as the induced (or spending multiplier) effects for the mining sector. It calculates the total multiplied contribution to the country's income using the following formula:

$$Y_{mr} = k_r(V_{mr} + \sum V_r)$$

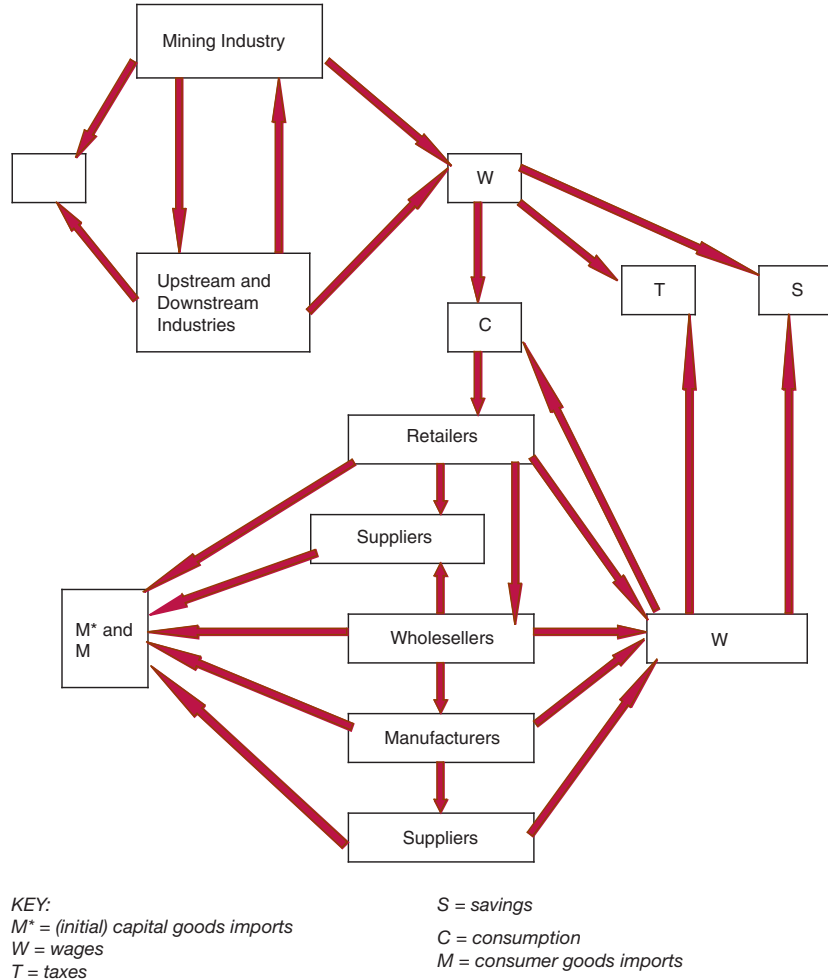
Where:

- Y_{mr} is the total value added or contributed to the GDP of country r by sector m in that country;
- V_{mr} is the value directly added or contributed to the GDP of country r by sector m in that country;
- $\sum V_r$ is the total value indirectly added by upstream and downstream industries ($i = 1...n$) to the GDP within country r , as a direct result of purchases and sales undertaken by sector m ; and
- k_r is the spending multiplier factor, the value of which depends on the marginal propensity to consume net of imports, and on the relevant direct and indirect tax rates.

The equation simply states that the mining sector, net of all intermediate purchases of inputs from within and outside the country, will add value to the country in the form of wages and profits (V_{mr}). The sector will also have certain backward and forward linkage effects on other industries within the region, i.e. purchases from, and sales to local firms. These industries, after netting out intermediate purchases and sales, will also add value in the form of additional wages and profits ($\sum V_r$).

The direct and indirect contributions (net of import leakages) sustain a multiplier process within the country, which results in an increase in incomes exceeding the original contributions. Wages and profits (net of taxes and savings) are spent in the local economy, working their way through the retail, wholesale, manufacturing and agricultural sectors, with some part being lost to imports and the rest adding to wages and profits within the latter sectors. This process repeats itself over several rounds, with the successive additions to wages and profits repeatedly being divided between savings, taxes and consumption expenditure. This multiplier process is illustrated in Figure 3.

Figure 3: The Multiplier Process



Source: Black and Tren: 2000

The total value of the economic impact therefore includes this induced effect and is calculated using a spending multiplier factor (k_r). A value of 1.59 has been used in this report and was estimated using the following formula:

$$k_r = 1 / (1 - (b - m)(1 - t))$$

Where:

- k_r = the spending multiplier factor
- b = the marginal propensity to consume and was estimated to be 0.80 in 2000.

This implies that the average consumer will spend 80% of any increase in their earnings (net of taxes) on goods and services, i.e. they will save 20% of such an increase;

- m = the marginal propensity to import and was estimated to be 0.33 in 2000. This means that on average 33% of any additional consumption expenditure made possible by the project will be spent on imported goods and services; and
- t = the combined effective direct and indirect average tax rate and was estimated at 0.22 in 2000 (i.e. 22%).

The above three parameters are all empirical estimates, made using data collected from the South African national accounts (South African Reserve Bank Quarterly Bulletin, June 2003). The data used in the model were obtained from the latest Supply-and-Use Tables available from Statistics South Africa (SSA), the Chamber of Mines, selected company annual reports and the South African Reserve Bank. The latest available input-output data were for the year 2000.

The 2000 Supply-and-Use Tables are the most up-to-date data available from SSA. The relevant tables contain the value of purchases and sales between industries and show the value added per industry and imports and exports separately. The data was reworked, and the value added calculated per industry on the value of transactions between the mining and other individual industries.

THE MODEL RESULTS: OVERVIEW

The mining sector's value added to GDP and contribution to employment in the year 2000 are given in Table 1 below.

The total economic impact (direct, indirect and induced) of mining in South Africa for the year 2000 was R142, 973 million, which represents 16.1% of the national GDP (R888, 057 million). Consequently, the mining sector directly and indirectly sustains one-sixth of the South African economy.

The total economic impact (direct, indirect and induced) of mining in terms of employment is around 1,27 million jobs. This represents 26.9% of total formal sector employment excluding agricultural workers (4,735,269) and approximately 17.2% of total formal sector employment (7,423,000) (Barker, 2003:80). The mineral industry contributes a greater proportion pro-rata to employment than it does to financial value added by its activities. It is worth noting that the most significant impact in terms of employment is associated with the induced effect. It is also noticeable that the forward linkages are a more significant contributor to GDP than to employment, which is understandable as the downstream industries are less labour intensive.

Table 1: Total mineral industry contribution (2000)

Value Added Area	Value added to GDP		Employment	
	Rand (Million)	% of GDP	No of Jobs	% of Jobs
Direct	54,951	6.2	417,045	8.8
Indirect: backward linkages	20,315	2.3	152,947	3.2
Indirect – forward linkages	14,654	1.65	57,651	1.2
Induced	53,053	5.97	646,183	13.65
Total	142,973	16.1	1,273,826	26.9

Source data: Chamber of Mines 1999, 2001, 2002, 2003b and Statistics South Africa, 2001a, 2001b, 2001c

Note: Jobs described as a percentage of total non-agriculture employment

The Direct Contribution of Mining

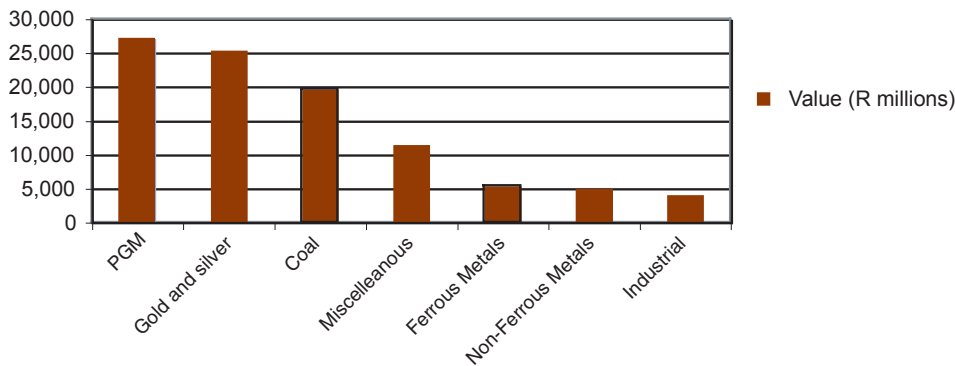
The “direct” contribution of the mining sector to the economy refers to the value-added by the sector itself and in the year 2000 consisted of the sum of wages and salaries of mining employees (R25, 717 million) and gross profits of mining companies (R28, 264 million) and net taxes, being taxes minus subsidies (R 970 million). This totals R54, 951 million and equates to 6.2% of the national GDP. The number of people employed permanently or temporarily by mining companies in South Africa numbered 417,045 in December 2000 (SSA, 2001c).

The direct contribution that mining makes to employment as a proportion of the total impact of mining (32.74%) is about 5.7% less than its contribution to GDP (38.43%). The labour figures are aggregate figures and do not accurately represent individual sectors within the industry, as the degree of labour intensity varies widely within the industry. The deep level mines of the gold and platinum sectors are labour (and capital) intensive whereas the opencast coalmines are capital intensive. Gold mining, for instance, represents only 31.4% of the direct value added by the mining sector, but its employees account for 47.8% of the direct mining jobs (see 6.2.5.1). If the influence of the gold mineral industry is stripped out, then the mining sector is generally significantly less labour intensive than is suggested by Table 1 above.

Mining continues to be the single most important earner of foreign exchange in the economy. In 2002, total mineral sales amounted to R139, 8 billion and exports, R110 billion. Sales of primary mineral products accounted for approximately 34.3% of total export revenue in 2002, of which gold comprised 10.9% (Figure 4). The declining trend in both these indicators since the 1980s have been due to the contraction of the gold mineral industry, increased local beneficiation, and relatively weak commodity prices across the board (Minerals Bureau, 2002). If various processed mineral products, such as ferroalloys, aluminium, carbon and stainless steel, are included in the analysis the contribution is much higher, over 40% (Minerals Bureau, 2002; Baxter, 2003).

The regional impact of mining activities in South Africa differs widely from province to province. Four provinces– Gauteng, Limpopo, Mpumalanga, and Northwest – gener-

Figure 4: South African Mineral Sales for 2002



Source: Minerals Bureau, 2003

ate 79.6% of the total primary income derived from mineral sales, and 81.0% of export sales earnings. Gauteng is characterized by gold production, Northwest is dependent on PGM’s, Limpopo on diamonds and coal, and Mpumalanga on coal.

The Indirect Contribution of Mining

The “indirect” impact of the mineral industry on the South African economy refers to the value added generated through upstream and downstream linkages to the economy. The strength of the indirect effects of a cluster is strongly associated with the degree of cluster maturity, and thus can be used as a measure of the degree of maturity. The greater the indirect linkages, the better developed the cluster.

Backward Indirect Linkages

The product and service sectors, to which the mining sector adds value through upstream linkages, are shown in Table 2.

The transport sector is the largest industry and accounts for 46% of the relevant backward linkage in the mining sector. This reflects the significant reliance of the mining sector on the transport system and industry, and shows the economic impact of transporting minerals on the domestic transport system to ports for export. The R9, 415 million of value added via mineral industry purchases of transport services, implies that nearly 1.4% of the national GDP arises out of transporting minerals within South Africa. Since such a large percentage of South Africa’s minerals are exported, this also represents the only value that the export of raw minerals adds outside the mining sector directly. It also gives an indica-

Table 2: Value added of backward linkages of mining

Products and Services Purchased	Value added		Employment	
	R' million	%	No of Jobs	%
Transport services	9,415	46.3	54,374	35.6
Professional services and Training	2,407	11.8	29,718	19.4
Electricity	2,272	11.2	5,175	3.4
Retails and wholesale trade	1,449	7.1	15,691	10.3
Other business services	708	3.5	4,723	3.1
Other goods: hardware, plastic, rubber and steel products	693	3.4	7,474	4.9
Raw materials: water, coal, cement, basic chemicals, etc	544	2.7	2,376	1.6
Chemical products: mainly explosives	505	2.5	5,950	3.9
Financial Intermediation services	349	1.7	4,301	2.8
Mining machinery	349	1.7	3,795	2.5
Other Services: insurance, communications, etc.	342	1.7	1,763	1.2
Wood products: mainly mining support	325	1.6	7,174	4.7
Other fabricated metal products	280	1.4	2,645	1.7
Civil Engineering: construction and site preparation	276	1.4	4,016	2.6
Machinery: pumps, gears, engines, electric motors	206	1.0	2,142	1.4
Motor vehicle, parts and tires	195	1.0	1,630	1.1
Total Products and services purchased	20,315	100.0	152,946	100.0

Source data: Statistics South Africa, 2001a, 2001b, 2001c

tion of the potential domestic economic impact, if minerals currently exported were to be further beneficiated locally.

The professional services and training sector accounts for 11.8% of the value added through backward linkages. This sector covers a wide spectrum of services and would include all professional, financial and consulting services, as well as training services.

The electricity sector accounts for 11.2% respectively of the value added through backward linkages and reflects the high level of power consumption by South Africa's deep level gold and platinum mining operations. The fact that the gold mining industry, for example, consumes more than 50% of the electricity used by the mining sector, should be kept in mind when interpreting these results.

The number of jobs created, because of mineral industry purchases of goods and services is estimated at 152,947. This implies that 7.5 jobs are created for every million Rand of value added through backward linkages. Jobs created in the transport sector, professional services, and retail sectors account total 99,783 and account for almost two thirds of the jobs created. Industries such as services and wood products are more labour intensive than transport and electricity when their relative contribution to employment is compared to their contribution to value added.

Forward Indirect Linkages

The indirect impacts of the mining sector on downstream business are often referred to as forward linkages. Even though two-thirds of the value of South African produced minerals are exported directly, the remainder is sold to domestic industries, and is used as inputs in the production of goods and the delivery of services, which in turn sustains wages, salaries, profits and taxes in those industries. The relevant wages, salaries and profits in downstream industries sustained by mining business contribute to GDP through forward linkages between the mining sector and these industries.

Table 3: Value added of forward linkages of mining

Major Industries	Value added to GDP		Employment	
	Rand (million)	%	No of Jobs	%
Petro-chemicals	4,768	32.54	8,154	14.2
Iron and steel	3,133	21.38	13,404	23.29
Electricity	2,692	18.37	6,130	10.65
Secondary industry	1,569	10.71	17,366	30.17
Non-ferrous metals	854	5.83	1,565	2.72
Mining	515	3.51	4,155	7.22
Fertilisers	459	3.14	1,283	2.23
Primary industry	308	2.1	1,682	2.92
Services	183	1.25	1,390	2.42
General government	172	1.18	2,410	4.19
Total	14,654	100.0	57,561	100.0

Source data: Statistics South Africa; 2001a, 2001b, 2001c, Auchterlonie, 2003a

The forward linkages amount to R 14,654 million. This implies that 1.65% of national GDP is generated by mining sector sales to domestic companies. Sales to three large industries (electricity, petrochemicals, and iron and steel) account for 72.3% of the contribution to GDP but only 48.15% of the jobs generated. The significant forward linkages to the electricity industry reflect the fact that almost 90% of South Africa's power is gener-

ated by ESKOM's coal fired power stations. This forward linkage effect alone contributes 0.3% to national GDP.

The extensive use of coal to produce synthetic fuels and petrochemicals at South African Synthetic Oils Limited (SASOL) is also very significant and contributes 0.53% to national GDP. Iscor's steel plants are the major local buyers of iron ore and base metals from the mineral industry for the purpose. Iscor produces iron and steel and exports a significant percentage. These sales contributed 0.35% to national GDP in 2000.

These three industries are very capital intensive and therefore their combined contribution to total employment generated by forward linkage is 48.1%, which is much lower than their contribution to GDP. In contrast, the secondary industry sector, which consists of numerous small to medium sized firms, is much more labour intensive. It contributes only 10.71% of the total forward-linkage contribution to GDP, but contributes 30.17 % of the jobs created by forward linkage.

The forward linkages contribute 57,561 jobs to total employment. This implies that forward linkages from the mineral industry account for only 0.8% of national formal sector employment, which is less significant than what might be expected, given the extent and variety of South Africa's mineral resource base, and the age of the mineral sector. This reflects the relatively low levels of mineral beneficiation in the South African economy and the nature of domestic resource use.

For every million Rand in value added, forward linkages associated with the mineral industry added only 3.89 jobs. This is slightly over half the number of jobs created by the backward linkage effect per million Rand spent. This reflects the fact that the majority of the forward linkages are made into capital-intensive industries.

The Induced Contribution of Mining

The "induced" effect of mining on the national economy refers to the role played by the spending multiplier in creating value elsewhere in the economy.

Since South Africa is rich in minerals and energy, industries involved in the processing and beneficiation of these resources have featured prominently and continue to form the basis of the country's industrialization and economic growth strategies (Davis, 1994; DST, 2002; DTI, 2002).

The direct and indirect increases in income and spending also result in a further induced effect of R53, 053 million, which represents 6% of GDP. This is arrived at by applying the national spending multiplier of 1.59 for South Africa to the direct and indirect components of the total impact (as shown in Table 1). This implies that the multiplier effect, which captures the additional value added brought about by (direct and indirect) wages, salaries and profits being spent in the economy, would increase the direct and indirect impact on GDP by another 59% (SARB, 2003).

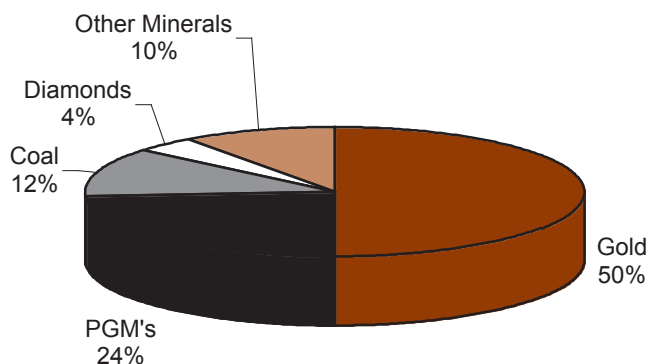
Our estimate of the employment equivalent is based on an incremental job: GDP ratio of 12.18 jobs per R1 million for the induced effect (Voges, 2003). Through its induced impact, the mining sector thus sustains a further 646,183 jobs, which represents 13.65% of non-agricultural formal sector employment and 50.7% of the total employment impact (Voges, 2003). This very significant impact in terms of employment indicates that the largest impact on employment lies outside the mineral industry altogether and gives an indication of the overall significance of the mining sector as a job creator in the South African economy.

Labour and Employment Considerations

Mining remains an important source of employment in South Africa. According to the Minerals Bureau (2002), 2.7% of the economically active population in South Africa is employed in the mineral industry. Almost all gold mines and the majority of platinum operations in South Africa exploit thin tabular ore bodies at great depths. These types of operations are labour intensive. The gold and PGM sectors consequently account for 74% of the total employment in the industry (Figure 5).

Since 1994, investment in resource-based projects has accounted for half the recorded formal sector economic growth. This is likely to increase over the next decade as new projects come on-stream and proposals for expansions and upgrades to current projects are completed. Despite this, however, direct employment in the mining sector has been on a gradual decrease over the past decade. Employment in mining peaked in 1986 (833 000 jobs). Since then approximately 396 000 jobs have been lost. This decline in employment has been attributed to the shrinking gold mining sector and productivity improvements in the domestic minerals industry (Figure 6). The unit cost of labour increased significantly over this period and the wage bill has risen from R3.6 million in 1985 to R24, 409 million in 2001, which equates to 21.1% of total mining revenue.

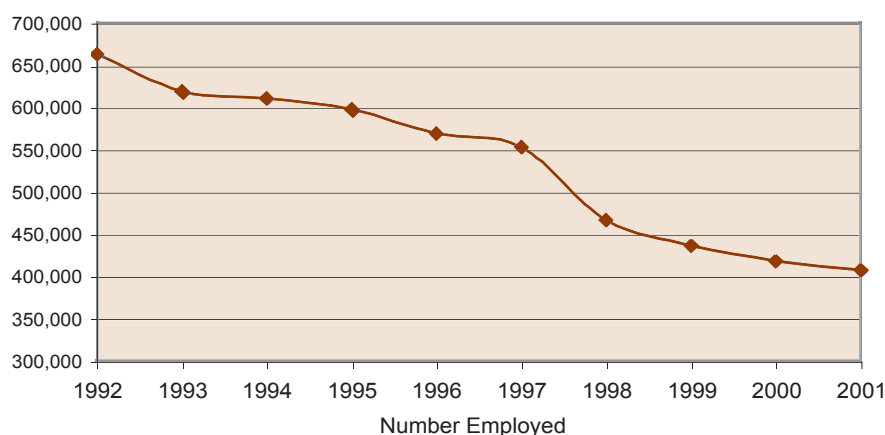
Figure 5: Employment in South African Mines by Commodity



Source, Minerals Bureau, 2002, 13

In response to these changing dynamics in the gold mining sector, a Gold Crisis Committee (GCC) was established in 1998 in an attempt to address key issues critical to the survival of the industry, particularly with regard to the issue of employment. Through a concerted effort, in 2001 actual retrenchments by gold mines have been kept below the 12 000 mark (Minerals Bureau, 2002).

Figure 6: Employment in the South African Mineral industry, 1970-2002



Source: Minerals Bureau, 2002

Nevertheless, the impact of this sustained decline in employment levels has been extensive, particularly if the indirect and induced effects are considered. In 1996, one in seven men with a formal job were employed in the mineral industry. Many of the mineworkers are recruited from rural areas located in some of the poorer parts of the country, and in 56 magisterial districts, mining wages comprised more than one sixth of the aggregate income. Thus, the mining sector is an important conduit for the transfer of money and opportunities into some of the poorest areas of the country. It has also been asserted that for every job created in mining, three additional opportunities are fostered in social activities in those areas.

Historically, the labour force in the minerals industry was characterized by the presence of a rigid statutory colour bar, which prohibited blacks from being employed in most of the administrative, skilled or supervisory posts. The history of the development of the colour bar is one of continual struggle between skilled white workers, trying to safeguard their privileged position against competition from blacks, and mine owners who sought to minimize their costs because of the cost sensitive nature of the industry. At times, the conflict erupted into strikes, which were often violent in nature. In fact the 1922 strike developed into a bloody and protracted confrontation between the white strikers and the army, and the casualties were 153 killed, 687 injured and 4 executed. The effect of this was to entrench the colour bar as thereafter no major white political party could afford to neglect the interests of white workers who claimed to be threatened by labour competition from blacks.

Reflecting the stratified nature of the work force, the trade unions developed along racially separate lines. Right from the early days, there was a high degree of organization of white workers in the industry and their unions played a major role in the formal establishment of the colour bar in the 1920s. In contrast, unions to represent black mine workers effectively only came into existence in the late 1970s and early 1980s, with the abolition of the colour bar as their major objective (Dales, 1984).

By the early 1970s, the white community could no longer satisfy the demands for skilled labour made by the rapidly expanding South African economy. At the same time, there occurred a resurgence of black anger and dissatisfaction, which led first to a widespread outbreak of strikes in 1972/1973 and the Soweto riots of 1976. These events helped convince the business community and the Government of the need for fundamental reform of the South African labour scene. In 1977, the Government appointed a Commission of Enquiry, under the leadership of Professor Nic Wiehahn, to investigate the labour situation. The Commission produced six reports, the sixth of which dealt exclusively with the mining industry, and these opened the way to a complete change in the nature and structure of South African industrial relations. The sixth report, issued in 1979, recommended the complete abolition of the colour bar in the mining industry. Following this, the early eighties were dominated by the negotiations between management and the “new” black unions as they grappled to adapt to developing a more conciliatory less confrontational approach, and to develop a non-discriminatory labour framework. By the 1990s, the Unions’ focus changed to trying to save jobs, as the gold industry in particular faced severe economic pressures as a result of a low gold price and high cost increases. Today the industry is characterized by a world-class labour relations framework, consistent with international norms, and a mature relationship between management and the unions.

The Minerals Cluster as an “Engine of Growth”

Although it is evident that the Minerals-Energy Complex (MEC), and in particular the mining sector, has played and continues to play an important role in the economy, particularly since the early 1970s, it is argued that there has been a historical wasting of mineral resources in South Africa. Davis (1994) asserts that the economy was built on a minerals industry that consumed rather than produced foreign exchange. The use of mineral rents to fulfil political rather than economic goals resulted in a ‘Dutch disease’ of a different type – a booming government sector characterized by large-scale, capital-intensive, resource-based industries (e.g. Sasol, Eskom, Sentrachem, Natref and Iscor) instead of a booming manufacturing sector. Indeed, Fine and Rustonjee (1996, 14) state that the MEC “effectively led to policies which supported its core sectors and precluded the adoption of other industrial policies of diversification away from economic dependence on South Africa’s resource base”.

While it has been recognized that South Africa cannot ignore its basic comparative advantages in terms of its natural resource endowments, the limitations of a too exclusive reliance on the simple export of unprocessed and semi-beneficiated resources is also acknowledged. It has been pointed out that, given the continuing gold crisis in the country

and the fact that most high grade or shallow reserves are close to depletion, an alternative source of exports is required if economic growth is to be sustainable (Jourdan, 1994, Financial Mail, 1996). The severity of the situation is illustrated in Edwards (1996). He points out that while gold comprised half the value of exports in 1980, by 1995 it had fallen to below 20%. Moreover, in 1970, approximately 1 000 tons of gold was produced; by 1996 this had dropped to 500 tons. Employment figures have also dropped. Although retrenchments increased during the last few years, gold remains the largest employer in the minerals sector. The loss of a single job exerts numerous repercussions throughout the economy. In 1996, 400 000 people were employed directly in the industry and 2.5 million were indirectly dependant on incomes generated in the sector. Furthermore, the fact that the supporting industries at a reasonable 3:1 ratio feed into this industry, one may conclude that 10 million South Africans are dependent on the stability and future of the gold mining industry.

Arkwright et al. (1998) maintain that a current impediment to enhanced national and regional trade, in both South Africa and the SADC region, is the lack of an adequately diversified industrial base. Drawing on these debates as well as on the various international experiences, a key feature of the current industrial strategy is its emphasis on speeding the development of linkages between new resource-based investment projects and the rest of the economy. Not only is this an attempt to avoid the ‘enclave’ tendencies of such activities but to gradually shift the South African economy in the same direction as that of the developed resource-rich countries who used their resources as a basis for subsequent development.

According to Menell (2000), “despite it’s maturity, mining in South Africa is emphatically a sunrise industry”. Moreover, it has been asserted that the contribution of mining to the economy must be seen, in its entirety, as coming not only from mining operations, but also from the downstream operations (Chamber of Mines, 2000). The contribution of sidestream and lateral linkages should also be included in the analysis.

Downstream Linkages: Beneficiation

During the 1990s, the South Africa mining sector has undergone a major transformation away from gold into higher, value-added mineral processing and manufacturing, becoming a world exporter of processed minerals, as opposed to its previous role as a primary commodity exporter (Jourdan, 1994; Minerals Bureau, 2002). This transition can largely be attributed to the construction of a number of large-scale, resource-based investment projects (such as Columbus Stainless Steel, Billiton Hillside Aluminium, Namakwa Sands titanium and Saldanha Steel) in various parts of the country (Financial Mail, 1996). Since 1994, investment in resource-based projects has accounted for half the recorded formal sector economic growth. Over the next decade, this is likely to increase as new projects come on-stream and proposals for expansions and upgrades to current projects are completed.

Despite these developments, it is argued that South Africa has the potential to further raise the proportion of beneficiated mineral output. It is maintained that South Africa

is only at the first stage of beneficiation, characterized by capital-intensive plants with low employment levels engaged in the production of intermediate products. In order to progress, it is essential to move beyond this stage to mineral-based product fabrication where levels of employment are significantly greater (Jourdan, 1994). It has been asserted that prior to 1994, the level of mineral beneficiation in South Africa was minimal, as the country's industries were mainly geared to the local market as primary-based products rather than manufactured goods tended to dominate exports. This was due primarily to the small size of the domestic market. In addition, tariffs and pricing policies, a lack of production competitiveness and skills, and protection in the domestic market resulted in a low level of beneficiation (Jourdan, 1992; 1994; RSA, 1998).

The lifting of sanctions, however, has increased the potential for further beneficiation. Jourdan (1992; 1994) asserts that the country has various advantages that favour increased levels of beneficiation. These include a large and diversified resource base; transport benefits accruing to beneficiation close to the resource location; a local skills base in engineering and technology; and low energy costs (Jourdan, 1992; 1994; RSA, 1998). Nevertheless, a number of constraints have been identified that limit value adding initiatives, most notably the large-scale capital requirements needed by most projects; distance and access to international markets; skills shortages in certain technical and managerial categories; and the impact of import parity pricing (IPP) which allows primary producers to charge more for the product locally than they do abroad (Jourdan, 1992; 1994; Engineering News, 2001; 2002).

Since the mid-1990s, the Government has become increasingly committed to ameliorating past inefficiencies and the passing of the White Paper on Minerals and Mining Policy for South Africa in 1998 highlights the Government's commitment to promoting and supporting beneficiation activities. Indeed, it has been pointed out that, the aim of the [minerals and mining] policy will be to develop South Africa's mineral wealth to its full potential and to the maximum benefit of the entire population. Government, therefore, will promote the establishment of secondary and tertiary mineral-based industries aimed at adding maximum value to raw materials" (RSA, 1998, 19).

During 2002, the South African Government promulgated the Mineral and Petroleum Resources Development Act. This Act marks a significant advance in legislation pertaining to the management and administration of mineral resources within South Africa. At its core, the Act has three essential elements. First, it is aimed at aligning the South African minerals industry and policies with those practiced and implemented elsewhere. Second, mineral rights will be controlled by the State. Finally, enforcing the idea of minerals being a "national endowment" – i.e. belonging to the country rather than an agglomeration or corporation. Complementing this is the Broad-based Socio-economic Empowerment Charter for the South African Mineral industry, which was passed by Government in 2002. The Charter and associated Scorecard are aimed at restructuring ownership and participation patterns within the local mineral industry. Emphasis is afforded to the incorporation of previously disadvantaged South Africans into all levels of management and production, socio-economic and environmental accountability, and further beneficiation. Indeed, the vision and goal of the Charter is to create a "... globally competitive mineral industry that draws on the human and financial resources of all

South Africa's people and offers real benefits to all South Africans" (<http://www.dme.gov.za>). The call for increased beneficiation is based on the recognition that "only through beneficiation and downstream development can South Africa become a prosperous and developed country" (Mining Weekly, 2000c). The passing of the Royalty (money) Bill (pending) and Mining Titles Registration Amendment Bill will consolidate the regulatory environment for mining operations and activities (Minerals Bureau, 2002).

These advances in mining legislation have been complemented by policy developments in other areas associated with the management of South Africa's natural resource wealth. In particular, in the Integrated Manufacturing Strategy (DTI, 2002) the Government makes a commitment to continue to study local pricing structures and alternative strategies. The overriding objective of the strategy is to promote knowledge intensity, value addition, and exports, ideally garnering maximum revenue and benefit to South Africa. The strategy will rely on the expansion of knowledge clusters and the continuous generation of intellectual property and new technologies. It also builds on the concept of "value matrices" through the emphasis on upstream, downstream and sidestream linkages and emphasizes that the optimization of value chains have a pivotal role to play in the future transformation of the economy (DTI, 2002). South Africa's new Integrated Research and Development Strategy (DST, 2002), moreover, identifies resource-based technology and knowledge as a critical platform for the emerging national system of innovation. This is a critical component of the R&D strategy, as it will enable the country to build up from one of its main areas of strength: knowledge resulting from the exploitation, handling and processing of resources. Supporting this is the recognition of the role that natural resources can play in the "new economy". Indeed, the fourth technology mission is focused on "leveraging off resource-based industries and developing new knowledge-based industries from them, i.e. mobilizing the power of existing sectors" (DST, 2002).

Sidestream Linkages: Capital Goods And Services Inputs

A recent study commissioned by the Chamber of Mines, in cooperation with Department of Minerals and Energy (DME) and National Union of Mineworkers (NUM) and conducted by the University of Cape Town, illustrates how South Africa has used its mining activities as a base to nurture a cluster of highly competitive mining and mineral processing-related goods and service industries, supporting both the local and international markets. There are three areas in which South African firms have a global competitive advantage: the innovation and development of new technologies; the provision of knowledge-based services; and consultation and specialist mining contractors. South African firms are world leaders in shaft sinking and hoisting technology, cooling of deep mines, rock mechanics design, mining explosives, drilling equipment and abrasives, metallurgical processes and plants, and delivering intellectually based services to mines around the world. This competitive position has emerged largely as a consequence of both the domestic market demand for solving problems of mining at depth and the availability of the 'lab' (i.e. rock-face) for product and technology development (Chamber of Mines, 2000).

The network of related and supporting industries supplying inputs to the South African mineral industry consists of a diverse range of local and international firms of varying sizes

and offering different types of support at various levels. First tier supplier companies consist primarily of project engineering companies such as Bateman, Grinaker LTA and SRK, offering a suite of expertise and management experience. They are usually linked directly to the large mining, extraction and processing firms and are generally involved at the outset of a project's construction until full operations commence. Subsequent involvement is usually linked to plant upgrades, maintenance and repair of technology. While project-engineering firms have R&D facilities in-house, they often enter into alliances and partnerships with other firms, research institutes in the development and commercialization of new technologies. Collaboration and networking with industries is pivotal for keeping abreast of developments, trends and requirements. Competitive advantage is secured through a high attention to quality, timely completion of projects, and knowledge embodied in the products and processes offered. Most are listed overseas and have operations and clients throughout the world. Project engineering companies outsource the majority of their supply requirements to smaller, highly specialized/niche-specific second- and third-tier companies. These extend from shaft sinking, ventilation, drill consumables, conveyor manufacturers, pumps and valve manufacturers and so on.

It is argued that there are numerous opportunities for developing and fostering additional competencies in mining-related activities and broadening the existing 'sidestream' cluster both locally and abroad. A number of local industry conditions, in particular, support the emergence of a capital goods and service export cluster in South Africa. Sybil Rhomborg, Chairperson of the South African Capital Equipment Export Council (SACEEC), asserts that "[South Africa's] mining equipment suppliers, unlike most of the developed world, have the advantage of a local market for their products, which helps to sustain and improve the sector, resulting in improved technology and equipment customization" (Mining Weekly, 2002, 2). With regard to the ICT revolution, the increased globalization of the industry, and concomitant pressures in terms of maintaining competitive prices and quality, South African capital equipment exporters have benefited from a reputation as a world-class source of technology and products" (Mining Weekly, 2000; 2001b; 2002).

While it has been pointed out that many local companies are increasing their technology and R&D budgets in order to take advantage of these local and international opportunities, a number of constraints currently prevent the full potential of the local supplier network from being realized. In particular, pursuing and maintaining an aggressive and successful marketing campaign in a foreign country is costly, and requires highly skilled personnel familiar with the market. It is also time-consuming, taking between two and three years from the initial contact meeting to the signing of the contract. In addition to this, the cost of capital, skills shortages, the HIV/Aids pandemic, difficulty in acquiring funding for development projects at the front end, distance from most export markets, inflation and low productivity, lack of export market knowledge, inefficient infrastructure to support foreign clients, and securing export finance, are other obstacles faced by local exporters. The top South African mining capital equipment exporters at present include Bell Equipment, Multotec, Bateman Materials Handling and Osborn (Mining Weekly, 2000; 2001b; 2002).

While it has been asserted that "success in the export market will save the entire mining-equipment manufacturing sector" (Mining Weekly, 2000, 3), and that exports of mining-

related goods and services have been increasing at an average of 13 per cent per year since 1992, and at 20 per cent over the past few years, reaching a total of R14 billion last year, it has been pointed out that the mining-equipment manufacturing industry is still not doing nearly enough to develop the export markets. Rhomberg asserts that the reasons for this are two-fold (Mining Weekly, 2000, 3). First, there is a general reluctance within South African companies to adopt an international focus and to diversify their export base away from components and sub-components to offering complete solutions and systems. Second, there is a misconception among local manufacturers regarding the potential of the industry – while South African mining equipment is world-class, and usually cheaper than its international competitors, many local manufacturers do not believe this. One of the important objectives of the SACEEC is to assist in overcoming these problems and provide a facilitating environment for the growth of the sector through exports (Mining Weekly, 2000; 2002).

Additional Linkages: Lateral Migration of Technologies

Stimulating lateral migration linkages carry numerous economic benefits. Not only does it assist in generating greater technological competence in the local workforce and increasing the contribution of high-tech exports to total exports, but it also ensures a long-term and sustained approach to the management of a transient resource base – the competitiveness of the original resource base is maintained and broadened as it is gradually embedded into more and more sectors of the economy.

The experience of Bell Equipment, one of South Africa's leading exporters of capital equipment, is a classic example of how technology, initially designed to meet the challenges posed by a single industry, moved laterally into a variety of technologically similar, but sectorally different, applications. Beginning in sugar cane, Bell Equipment moved laterally into developing materials, handling equipment for timber, coal mining and eventually construction activities (Kaplinsky and Mhlongo, 1997). A second example of lateral migration is Lodox, a South African X-ray machine developed initially as a security screening system by De Beers' technical division to detect stolen gemstones hidden on or in the bodies of employees. The system has been modified for use in medical trauma as a digital, full-body, low-dosage X-ray diagnostic-imaging machine. It can scan the whole body in 13 seconds. The economic impact of this lateral migration is apparent in the fact that while only a few diamond scanners are needed on mines throughout the world, virtually every hospital with a trauma unit can benefit from this advance in technology. Moreover, a complete radiography suite incorporating the Lodox is estimated to cost about R600 000, replacing the more expensive CT Scanner, which costs about R4 million. It has been pointed out that South African global expertise and leadership in biotechnology and information and communication technology developed for and through the mineral industry. As these services are currently booming in the world market there is significant potential for South Africa to export such knowledge (Mining Weekly, 2001c, 12).

Given the high-tech and knowledge-intensive nature of mining and mineral processing products and processes, the scope for the development of lateral migration linkages into

knowledge-intensive sectors such as medicine, space, aeronautics and defence, is extensive. There are two factors, however, that are currently restraining the furthering of lateral migration in South Africa. First, there is an element of risk involved in laterally migrating technology, which often involves large companies competing with bigger firms in an unknown field. Second, the local mining cluster is knowledge-based and South Africa is fast losing engineers due to emigration and early retirement. It is argued that further research needs to be undertaken in order to identify strategies capable of resolving these restraints (Engineering News, 2001).

Contribution to Subregional Economic Development

The South African mineral industry, with its depth of managerial and technical expertise, is positioned to be a significant contributor to the government's objectives of employment creation, rural upliftment and regional (SADC) development and, more broadly, to giving an economic underpinning to the vision of an African Renaissance.

South African mining companies are leading the resurgence of mining activity in the region and extensive exploration in Africa is underway. This activity is supported by the activities of South African suppliers of mining capital goods and services, who are in a position to supply goods and services designed for and suited to African conditions and requirements. Johannesburg may reclaim its position as a global centre of mining technology, specialist services and supplies because of this. It is estimated that half the investments made in large-scale projects in southern Africa are returned to South Africa through purchases of services and supplies (Chamber of Mines, 2000).

A Meso-cluster: The Gold Mining Industry

In this section, the impact of the South African Gold Mining Industry is reviewed in terms of its role and significance as the historic core meso-mining cluster in South Africa. The cluster forms a major component of the South African economy and consists of a number of distinct geographically based sub-clusters. They all exert significant direct and indirect impacts on the national economy, as well as the relevant local and provincial economies.

History (1852 - 2003)

Gold mining has a long history in South Africa. The discovery of gold deposits in Krugersdorp in 1852 ushered in the modern era of growth and development in South Africa. In 1869, gold hosted in a greenstone deposit was discovered in the farm Eersteling, near the town of Polokwane, Limpopo Province and in 1871, the country's first formal gold mine, Eerstegoud, was established to mine it. Further, small discoveries of greenstone-hosted gold were made in the 1870s in vicinity of the town of Barberton, triggering the country's first "gold rush". This led to an influx of itinerant prospectors into the Transvaal Republic,

one of whom, George Harrison, discovered the rich outcropping gold reefs on the farm of Langlaagte near Johannesburg in 1886, while passing through en route to Barberton. This discovery, together with the surrounding area being declared “public diggings”, led to the second, much larger, gold rush, which drew in thousands of fortune seekers from the Kimberley diamond mines and from all around the world. This gold rush marked the start of the development of the Witwatersrand, the greatest gold region known to man.

These early mining activities were concentrated along the outcrop of the reef on either side of the farm of Langlaagte. Mineralization could be traced along strike over a distance of more than 30km. The ore consisted of a cemented pyrite-rich quartz-pebble conglomerate, which was heavily oxidized. This ore was easy to dig out and crush in order to liberate the gold particles, which were then recovered using mercury to form an amalgam. The mining operations consisted of numerous small diggings, the bottoms of which were accessed by a complex arrangement of pulleys and ropes. This resulted in dangerous working conditions and inefficient extraction of gold. Consequently, economic pressures resulted in the consolidation of these scattered diggings into mining companies. These companies, in turn, developed into the mining houses that provided the technical and financial resources needed to develop the resources underground.

The gold resource available to the early miners was limited. They were unable to process the unweathered ore located below the base of the weathered zone, as it was hard and refractory. It needed a technical breakthrough. This came with the development of the MacArthur-Forrest cyanidation process in America in 1887, whereby the gold was dissolved from the crushed and milled ore using cyanide. The implementation of this technology led to the second surge in the industry as the major companies acquired ground down dip of the outcrop and sunk shafts to exploit the reef at depth. Ultimately there were three rows of deep level shafts sunk from surface to exploit the reefs at ever-increasing depth. This in turn necessitated the development of new drilling, shaft sinking and hoisting technology.

Mining spread along the outcrop of the Witwatersrand reefs from the so-called Central Rand Goldfield to the west into the West Rand Goldfield, and east into the East Rand Goldfield. This led to the establishment of a contiguous line of mines stretching in an arc from Durban Roodepoort Deep in the west to East Rand Proprietary Mines in the east. Annual gold production reached approximately 120 tons by the turn of the century, making South Africa the leading gold producer of the time. By 1913, production reached 280 tons.

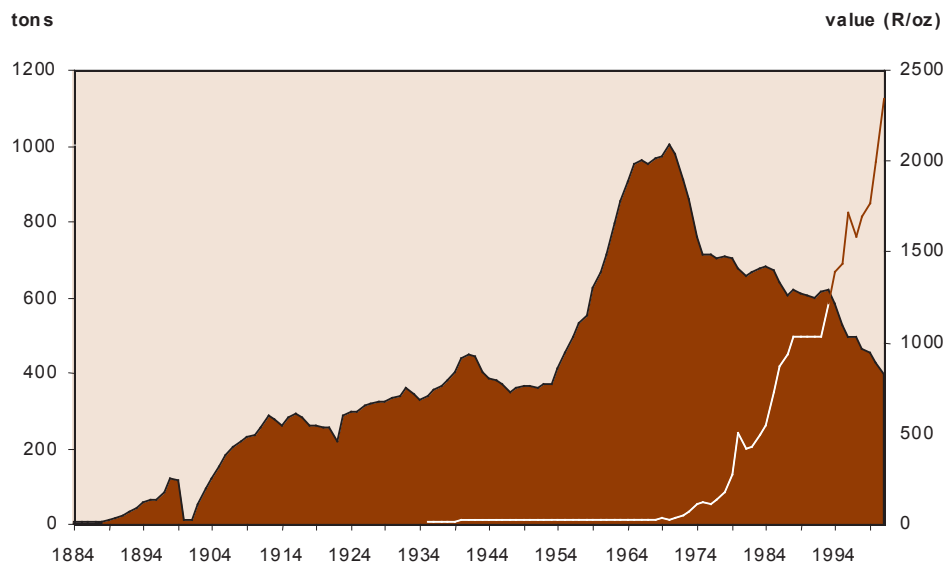
The next important development was the discovery of the West Wits goldfield in the early thirties. This proved that the Witwatersrand reefs extended to the west of Johannesburg at depth under the cover of a thick layer of water-bearing dolomite. The initial discovery was made by a German geophysicist, Krahman, who used a new exploration tool, the magnetometer, which could measure minute changes in the local magnetic field. This enabled him to indirectly trace the extension of the Witwatersrand reefs by tracing the magnetic signature of a strongly magnetic shale bed, which underlies the gold bearing horizons. The development of this goldfield, however, first required another technical breakthrough, the development of the cementation process, which allows the sinking of shafts through water-filled rock. The first West Wits mine, Venterspost, opened in 1939. The development

of the other mines, centred on the town of Carletonville, followed rapidly thereafter. To-day the West Wits line is still the most important gold producing area in South Africa.

The development of the West Wits Line was followed rapidly by the discovery of the Klerksdorp, Free State and Evander Goldfields, where the gold bearing Witwatersrand sediments are also covered by thick layers of younger rocks. The deposits are very deep and the mining of them required the development of innovative approaches in cooling, hoisting, pumping, and shaft sinking technology. The development of these fields took place largely in the late forties through the fifties, which resulted in a dramatic increase in South African gold production, increasing from 390 tons in 1954 to a peak of 1000 tons in 1970. Since then, no new Witwatersrand type goldfields have been discovered. Consequently, gold production has decreased significantly. It initially dropped dramatically over the period 1970 to 1974 as many of the old mines on the Central and East Rand Goldfields were shut. Production decreased more slowly but steadily over the next 20 years, primarily because of declining gold grades.

In the early 1990s the gold mining industry faced a crisis. The mines found themselves squeezed between a low and static gold price and increasing working costs brought on by the need to mine lower grades at increasing depth and by major increases in the cost of labour. Many commentators viewed the industry as being in terminal decline. The industry however responded vigorously to the situation by rationalizing operations, closing unprofitable shafts, and restructuring work practices. This unfortunately resulted in widespread job losses and a significant drop in gold production. Employment dropped from 474 000 employees in 1990 to 201 698 in 2001. Gold production has declined from 611 tons in 1992 and 617 tons in 1993 to 394 tons in 2001.

Figure 7: South African Gold Production, 1884-2001



Source: Minerals Bureau, 2002

Today the South African gold mining industry is in much better shape, having been completely restructured. Two new world-class ore bodies, the Target-Sun orebody in the Free State Goldfield and the South Deep orebody in the Carletonville Goldfield, are being developed into mines. The major mining groups such as AngloGold and Goldfields have committed to large capital expenditure programs to access new deeper resources within their mining leases. This has carried through into the gold production, and the numbers for 2002 indicate that production has risen for the first time since 1993 to 396 tons. The discovery of the new goldfields is clearly reflected in Figure 7, showing South African gold production from 1884 to 2001.

South Africa currently has 39 operating gold mines, producing approximately 396 tons of gold per annum (2002), representing some 15% of global new mine production. Total sales of gold generated some R29 billion in 2001 and the sector employed 202 000 workers at all levels.

Table 4: Gold Production by Goldfield (2001)

Goldfield	Gold Production (tons)
West Wits Line	134.5
Klerksdorp	93.8
Free State	86.7
West Rand	29.5
East Rand	15.9
Evander	13.8
Central Rand	7.8
Greenstone Deposits	6.1
By- products from PGM and base metals mines	6.7
Total	394.8

Source: Minerals Bureau, 2002

The majority of the mines are on the Witwatersrand. The only other significant gold production comes from the greenstone deposits in the historic Barberton/Pilgrims Rest area and the newly developed Kraaipan Greenstone Belt in the Northwest Province, just south of the border with Botswana, where an opencast mine was developed in the early 1990s

Ownership Structure

As discussed in earlier, the South African minerals industry, in particular the gold mining sector, was dominated up until the early 1990s by a few mining houses. By the early 1990s, however, the declining profitability of the gold mining industry prompted a re-evaluation and critical assessment of the economic importance and viability of the mining house concept. Since then, the ownership and management structure has changed

Figure 8: Ownership structure of the South African Gold Industry, 2003



South Africa - The Macro-Cluster: The Minerals Industry | 69

addition, they have all acquired overseas assets from which they obtain a significant proportion of their earnings. There is a second tier of significant sized companies, the most notable being Avgold, JCI, and Durban Roodepoort Deep (DRD). In addition, there are numerous smaller companies operating individual shafts, small mines, or processing old waste dumps.

The process of consolidation and restructuring was driven by the need to restructure the industry in the face of a low gold price and rising working costs. It was facilitated by changes in both the mineral and taxation legislation, which has allowed the consolidation and rationalization of mining operations across pre-existing mine boundaries, which were almost always unrelated to geological boundaries. Individual mines have rationalized their operations, often selling non-core assets in the process.

The process of consolidation and restructuring is not yet complete. The process began in the early 1990s when Harmony, then a stand-alone Mine in the Free State, split off from its parent company Rand Mines, and started purchasing older, high cost, mines from mining houses such as Gencor. This continued when AngloGold sold several of its older mines in the Northwest, and Free State Provinces to Harmony Gold and AvGold sold Hartebeesfontein to DRD.

Further consolidation in the Free State Goldfields occurred during 2001 and 2002, with AngloGold selling its Free State assets to a joint venture (called Freegold) between Harmony and African Rainbow Minerals (ARM). Talks are currently underway between Goldfields and Harmony over some of Goldfields' assets in the Free State. The latest round of mergers and acquisitions has seen the structure of the industry change even more. Ground has been swapped between AngloGold and Goldfields in the Carletonville area to ensure optimum extraction of the orebodies being mined. Harmony has merged with ARM. Avgold's Eastern Transvaal Consolidated has been sold to Metorex Goldfields and is currently finalizing the sale of 15% of its assets to the BEE Resources Company, Mvelaphanda.

The South African gold mining industry now consists of a wide range of firms with differing business strategies and ownership profiles, including:

- **AngloGold and Goldfields Ltd:** Two world-class single commodity companies each operating a few large long-life mines, exploiting high-grade deposits both in South Africa and elsewhere.
- **Harmony:** A world-class single commodity company operating a range of mines of generally mature low-grade operations with a wide spread of remaining life both in South Africa and elsewhere.
- **DRD:** It operates a range of marginal large tonnage low-grade mines in South Africa and some higher-grade operations internationally.
- **Avgold:** It is focusing all its attention on developing the world class Target Gold mine and associated Sun Gold deposit, having disposed of all of its other gold assets.

- **JCI:** It is focusing on developing the world class South Deep Gold deposit in conjunction with its Canadian joint venture partner, Placer Dome Gold.
- **Others:** Small entrepreneurial companies targeting smaller reserves considered too small to be profitably mined by the large companies (e.g. Aflease)

Geographic Based Sub-clusters: Gold

The major gold mines have been concentrated in six geographically distinct areas, the original Barberton Goldfield and seven major Witwatersrand goldfields, namely: the contiguous West, Central, and East Rand goldfields, the West Wits Line Goldfield centred around the town of Carletonville, the Free State Goldfield centred around the mining city of Welkom, the Klerksdorp Gold field, and the Evander Goldfield. This regional but concentrated nature of the gold occurrences has prompted the development, over the years, of focused economic and industrial clusters activity within each area. The sustainability of this development varies from area to area.

The start of mining in the first area, the Barberton/Pilgrims Rest area, led to the development of Eureka City, near the current day town of Barberton, which was developed high in the hills to avoid the malaria-infested lowlands. Clusters of primary equipment suppliers, hotels, banks and other supporting suppliers and infrastructure arose near the mining operations, but were almost as short-lived as the gold rush itself. Today there are a few small-scattered mining operations left, all of which have been consolidated under the control of one company. Barberton has become a primarily tourist town and Eureka City is a ghost town.

In contrast the development of the contiguous West, Central and East Rand Goldfields shortly thereafter, prompted the development of a much larger, more sophisticated and eminently more permanent economic and industrial clustering complex in support of the mining activities. Banks, mining houses (which consolidated many of the early individual claims into larger, more formal companies), engineering works, a school of mines (now the University of the Witwatersrand), a stock exchange (now the Johannesburg Stock Exchange) and other research, economic and service industries, all developed within a fairly short period after the initiation of formal mining on the Reef. Today, though the three goldfields are mostly mined out, Johannesburg and its associated towns spread along the old mining areas remain collectively the commercial, financial, and industrial hubs of the South African economy.

The Evander Goldfield is reaching the end of its productive life, but much of the indirect economic output generated by it has been supplanted by output generated by the nearby Secunda petrochemical complex, which exploits the low quality coal sourced from the Karoo sediments overlying Witwatersrand sediments. The Carletonville cluster remains prosperous as the large mines in the area continue to maintain their production levels by deepening their operations and by mining some of the previously unmined lower grade reefs which can now be accessed cheaply using existing but otherwise redundant shafts

and haulage systems. The fortunes of the local business remain closely linked to the fortunes of the mining operations.

This is also true for the Klerksdorp and Free State Welkom Goldfields. Unfortunately, production in both areas has been cut back significantly over the past 10 years. Many shafts have been either closed or placed on a care and maintenance basis. This has led to a lot of job losses, both in direct employment on the mines and indirect employment in the local supply and service industries, resulting in significant social disruption in these areas, particularly Welkom.

The Need for Technical Innovation

The South African mineral industry was built on the back of the gold mining industry, in particular the gold mines of the Witwatersrand placer gold deposits. The growth, expansion and dominance of the gold mining industry in the country for more than a century has largely been due to the skill, expertise and know-how that has been developed in the sector. The development of this has been necessitated by the unique characteristics of the Witwatersrand gold deposits.

The Witwatersrand gold deposits are thin tabular deposits and most of them occur at depths well in excess of 1 000m below surface, with the deepest mines now operating at depths in excess of 3 000m. The depth of mining has required the development of innovative mining, rock mechanics, refrigeration, ventilation, pumping, and hoisting systems. The waste rock and ore are both exceptionally hard, which makes drilling and blasting difficult. The hardness and refractory nature of the ore also required innovative developments in mineral processing technology.

The technology to exploit such ore bodies did not exist prior to the discovery of the gold on the Witwatersrand. Until then gold mining elsewhere in the world consisted largely of alluvial and vein deposits, neither of which required technical sophistication. Consequently, the lack of available “off-the-shelf” technologies, compounded by the time and challenges incurred transporting equipment imported from abroad from the coast to the interior (approximately 800km) via ox-wagon, prompted the South African gold mining industry to develop new methods and techniques for extracting gold.

Many of the early gold prospectors and miners were foreigners, with a diverse range of knowledge and skills acquired from various types of mining activities throughout the world. In close collaboration with each other, technology transfer occurred and synergies were established which gradually resulted in incremental advances in technology development and application. As mining assumed a more prominent and permanent position in the economy, the mining houses began to invest heavily in R&D, carrying out much of the work in house. Over time, specialist research organizations were established by the industry (e.g. the Chamber of Mines Research Organization) and the Government (e.g. Mintek and Miningtek). Important technological innovations, which propelled the mineral industry forward, encompassed areas such as shaft-sinking, cool air ventilation, hoist-

ing technology, new drilling and blasting techniques, extraction methodologies, waste-treatment facilities and environmental management techniques. Through each phase in the development, testing and application of technologies, a variety of related and supporting goods and service companies emerged in close association with the mining houses.

Several of these service companies that underpinned the historical growth and development of the gold mineral industry now operate internationally. They include renowned companies such as SRK, Bateman, and Boart Longyear. Each of these companies owe their origin to overcoming the technological challenges posed by the specific nature of the South African geological deposits and have all become world players in their respective industries. More significantly, through diversification and product commercialization, the majority of these companies have linkages in other mining sectors as well as other economic sectors including agriculture, construction, food processing, and wastewater treatment. The economic linkages arising from the supply and demand patterns within these companies are far more pervasive and include a multitude of direct and indirect activities (forestry, banking, entertainment, design, retail, manufacturing, etc). Most of these companies' factories are still clustered along the Witwatersrand, following the line of the initial mining operations that mined the outcropping and shallow Witwatersrand gold reefs. Today their head offices are clustered together with the mining companies and supporting financial institutions in business hubs such as Rivonia, Sandton, Central Johannesburg and Rosebank.

This history of innovation has provided the strong technical basis which underpinned the later successful development of South Africa's diverse other mineral resources. Furthermore, the history of technical development in the South African gold mining industry can be closely correlated with periods of growth in the industry. These developments made the exploitation of new gold resources possible.

Contribution to the Economy

This section analyzes the economic impact of the South African gold mining sector on the economy as a whole. The impact is measured in terms of its contribution to GDP and employment.

Model Results: Overview

The gold mining industry's value added to GDP and contribution to employment in the year 2000 are given in Table 5.

The total economic impact (direct, indirect and induced) of gold mining in South Africa for the year 2000 was R34, 479 million, which represents 3.9% of the national GDP (R888, 057 million).

Table 5: Gold Mining Industry Contribution (2000)

Value Added Area	Rand (Million)	% of GDP	Jobs	%
Direct	17,247	1.9	199,259	4.2
Indirect: Backward linkages	4,372	0.5	37,164	0.8
Indirect – forward linkages	66	0.0	874	0.0
Induced	12,794	1.4	155,833	3.3
Total	34,479	3.9	393,130	8.3

Source data: Chamber of Mines 1999, 2001, 2002, 2003b & Statistics South Africa, 2001a, 2001b, 2001c

The total economic impact (direct, indirect and induced) of mining in terms of employment is around 393,130 jobs. This represents 8.3% of total formal sector employment excluding agricultural workers and approximately 5.3% of total formal sector employment (Barker, 2003:80). The gold mining industry contributes more than double pro-rata to employment than it does to financial value added by its activities. It is worth noting that the most significant impacts in terms of employment are associated with the direct effect, closely followed by the induced effect. The indirect effect is much smaller. This is understandable, as gold mining is very labour intensive.

The Direct Contribution of Gold Mining

The “direct” contribution of the gold mining sector to the economy refers to the value-added by the sector itself and in the year 2000 consisted of the sum of wages and salaries of mining employees (R11, 555 million) and gross profits of mining companies (R 5,002 million) and net taxes, being taxes minus subsidies (R 34 million). This totals R 17,247 million and equates to 1.9% of the national GDP. The number of people employed permanently or temporarily by gold mining companies in South Africa numbered 199,259 in December 2000 (SSA, 2001c).

The direct contribution of the mining sector to GDP is 47.3% of its total multiplied impact, which is very similar to its proportionate direct impact in terms of employment (47.8%). The deep level gold mines (as well as the deep level platinum mines) are labour (and capital) intensive. Gold mining, for instance, represents only 31.4% of the direct value added by the mining sector, but its employees account for 47.8% of the direct mining jobs.

Traditionally, gold mining has been the largest single contributor to export earnings. This has changed since the nineties as gold production has declined and the earnings from other mining commodities, particularly the platinum group metals, have increased. It however remains an important earner of foreign exchange in the economy.

The Indirect Contribution of Gold Mining

Backward Indirect Linkages

The product and service sectors, to which the mining sector adds value to through upstream linkages, are shown in Table 6.

Table 6: Value added by gold mining backward linkages

Products and Services Purchased	Value added		Employment	
	R' million	% of Total	No of Jobs	% of Jobs
Electricity	1,332	30.5	3,033	8.2
Professional services and training	787	18.0	9,719	26.2
Other business services	347	7.9	2,318	6.2
Wood products: mainly mining support	290	6.6	6,398	17.2
Wholesale and retail trade	274	6.3	2,968	8.0
Other goods: hardware, plastic, rubber and steel products	223	5.1	2,766	7.4
Raw materials: water, cement, basic chemicals, etc	217	5.0	701	1.9
Chemical products: mainly explosives	181	4.1	2,129	5.7
Other fabricated metal products	148	3.4	1,396	3.8
Machinery: pumps, gears, engines, electric motors	129	2.9	1,212	3.3
Civil engineering: construction and site prep	117	2.7	1,711	4.6
Other Services: insurance, communications, etc.	93	2.1	612	1.6
Mining machinery	81	1.8	879	2.4
Transport services	79	1.8	457	1.2
Financial intermediation services	59	1.4	732	2.0
Motor vehicles	16	0.4	134	0.4
Total Products and Services Purchased	4,372	100.0	37,164	100.0

Source data: Statistics South Africa, 2001a, 2001b, 2001c

The electricity sector accounts for 30.5%, respectively, of the value added through first round backward linkages and reflects the high level of power consumption by South Africa's deep level gold mines. The purchase of electricity by the gold mining industry also has a second round backward linkage to the coal mining industry, which supplies coal for electricity generation and results in a further R145 million contribution to GDP. But this second round effect, as well as the other second and subsequent round effects, is clearly insignificantly small, and we did not therefore include them in Table 6 (though they do indicate, if anything, that the real indirect and total effects are probably marginally larger than the ones shown here).

The professional services and training sector accounts for 18% of the value added through backward linkages. This sector covers a wide spectrum of services and would include all professional, financial and consulting services, as well as training services. The transport sector in the gold mining sector compared to the overall mineral industry, since the final product is a small volume high value item.

The number of jobs created, because of purchases of goods and services by the gold mining industry, is estimated as 37,164. This implies that 8.5 jobs are created for every million Rand of value added through backward linkages. Jobs created in the electricity, professional services, and timber sector total 19,150 and account for about 52% of the jobs created. Industries such as services and wood products are relatively more labour intensive than electricity when their relative contribution to employment is compared to their contribution to value added.

Forward Indirect Linkages

The indirect impact of the gold mining industry on domestic downstream industries is very limited, since the industry exports 98.5% of its production. The value added to GDP via forwards linkages amounts to R66 million only, with an equivalent contribution to employment of 874. The jewellery industry accounts for 78% of local value added, while the gold coin and chemical industry contributes the remainder (Source data: Auchterlornie, 2003b and Stats SA, 2001a).

The Induced Contribution of Gold Mining

The income and expenditure sustained by the direct and indirect impacts also gives rise, via the Keynesian spending multiplier of 1.59, to a further induced increase in GDP of R12, 794 million, which represents 1.5% of GDP. This implies that wages and profits generated by the direct and indirect contributions are spent in the economy and would ultimately add another 59% (in addition to the direct and indirect contributions) in value to GDP. The multiplier calculation is discussed in section 1 and is based on a marginal propensity to consume of 0.80, an import propensity of 0.33 and an average tax rate of 0.22.

The employment equivalent to the induced effect is estimated at 155,833 jobs and is based on an incremental job: GDP ratio of 12.18 jobs per R1 million of induced value added (Voges, 2003). This contribution represents 3.3% of national formal sector employment (other than agriculture) and therefore represents a significant component of South Africa's national employment figures.

Summary and Lessons

The gold industry, though more than 100 years old remains the cornerstone of the South African mineral industry and is a significant component of the economy. The potential for

mining capital goods and services industries serving the gold industry to leverage off their sales into the industry and to follow the South African gold companies in establishing an international presence is large and needs to be encouraged. The industry is, however, faced with major socio-economic issues relating to the likelihood of further job losses and the issues of how to manage the decline of the industry in those mature sub-clusters such as the Free State and Klerksdorp sub-clusters, where many of the mines are approaching the end of their lives.

A Meso-cluster: The Aluminium Industry

In this section, the impact of Billiton's Hillside and Bayside Aluminium plants in Richards Bay together with the downstream operations elsewhere in the country, are reviewed in terms of their role and significance as a meso-mineral cluster in South Africa. Two separate assessments are made: a qualitative assessment and a quantitative input-output assessment.

Overview

Over the past three decades Richards Bay, situated on the North Coast of the KwaZulu-Natal province, has evolved from a small fishing village into one of the major industrial 'hubs' in South Africa. The six large-scale, capital-intensive, resource-based industries dominating industrial activities in the town – Billiton Aluminium, Richards Bay Minerals, Indian Ocean Fertilizers, Mondi Kraft, Richards Bay Coal Terminal and Bell Equipment – are of national economic importance, generating considerable revenues through exports and offering attractive opportunities for foreign investment (Walker, 2001).

An examination of the Billiton Hillside Aluminium smelter in Richards Bay (the largest greenfield smelter in the Western world and the largest new investment project to be undertaken by the private sector in South Africa) is a useful case study for demonstrating the various impacts, both direct and indirect, that a new large-scale, capital-intensive, resource-based project can engender at the local economy in which it is situated, particularly in terms of employment creation. Such analyses are of critical importance when formulating industrial strategies aimed at speeding the development of linkages between new investment projects in a particular country and the rest of the economy. They also assist in ensuring that such impacts are sustainable in the long-term. Four issues are reviewed in this case study. First, activities that are 'clustering' around the smelter, including the supplier network, processors, and services and infrastructure supporting the cluster are identified. Second, the maturity and extent of these linkages are highlighted. Third, the viability of the current initiatives and programmes undertaken by Billiton to maximize its impacts on the local economy are assessed. Last, original predictions regarding the impact of the smelter are correlated with the current situation. It is important to note that, given the size and extent of Hillside Aluminium's operations, only the most notable direct and indirect impacts are reviewed. Moreover, as the purpose of this Pilot Study is to illustrate the various types and extent of linkages emanating from a particular resource

base the method of analysis is more qualitative than quantitative. The discussion commences with a brief review of the aluminium industry in South Africa, and then proceeds to explore the various impacts and spin-offs since the smelter became operational in 1996 (Walker, 2001).

Overview of the South African Aluminium Industry

Over the past three decades, the aluminium industry in South Africa has emerged to become a significantly large and integrated industry of importance to both the national economy and to international aluminium markets. The annual turnover of the aluminium industry in 1998 was estimated to be R7 billion and approximately 15 000 people were directly employed. Overall, more than R15 billion has been invested in the domestic aluminium industry, particularly in the primary aluminium production process (Engineering News, 1998a).

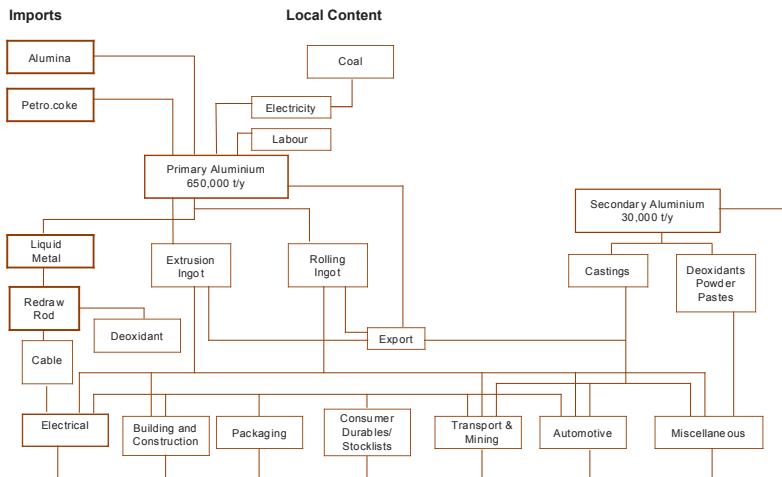
Primary aluminium production is dominated by the two Billiton smelters in Richards Bay (Bayside, established in the late 1960s, and Hillside, which came on stream in the mid-1990s), Zimalco is the principal secondary aluminium producer, Hulett Aluminium and Hulett Hydro Extrusions are the key semi-fabricated and extrusions sectors. In addition, there are a number of fabricators (AEC Fabritech, Alpull), foundries (Murray and Roberts group), downstream manufacturing industries (Gemtech and Astas, Maksal, Welfit Oddy, Malesela Technologies, South African Shipyards) and other contributors, including the Aluminium Federation of Southern Africa (AFSA) and Cascolor (oxidizing and powder coating) (Engineering News, 1999). In 1999, South Africa produced more than 678 000 tons of primary aluminium (Hillside 501 000 tons and Bayside 178 000 tons). Exports accounted for 66% of total sales (Billiton, 2000). Since the late 1980s, local sales and exports of primary aluminium have increased dramatically and with the completion of the Hillside smelter in 1996, primary aluminium production levels in South Africa have almost tripled (Ross, 2000).

Of the two primary aluminium smelters based in Richards Bay, the Hillside smelter is primarily export-oriented (100%), whereas only 35% of Bayside's output is exported. The remainder of the aluminium produced at Bayside goes into rod (15%), extrusion ingot (15%) and rolling ingot (35%). Bayside Aluminium is the only producer of value-added primary aluminium products in South Africa and the largest on the African continent (Billiton, 2000). The structure of the local aluminium industry is presented in Figure 9.

Since the South African aluminium industry is strongly export-oriented, it is influenced and affected by developments in the international aluminium market. Aluminium prices are highly volatile. World demand is strongly linked to the world business cycle and is particularly responsive to changes in construction and industrial activity. Supply tends to be relatively unresponsive, due to the sizeable costs associated with shutting down an alumina refinery or aluminium smelter. This volatility is exacerbated by the fact that aluminium smelting is subject to substantial economies of scale. This implies that any new capacity can have a significant effect on the supply-demand balance in international markets. Since the 1970s, there has been a significant decline in real aluminium prices.

Although part of this trend can be attributed to excess capacity, technology and productivity gains have also caused costs to fall in real terms. The implication for smelters is that unless efficiency is continually maintained through improvement programmes and cost reductions, their economic viability will be called into question (Walker, 2001).

FIGURE 9: The structure of the local aluminium industry



Source: Paterson, 2000, 3

In light of these trends, one of the critical challenges facing the local aluminium industry is the need to grow locally and through exports in order to ensure that the maximum gains from the semi-fabricated capacity available (particularly in flat products, profiles and casting) are achieved. While it has been pointed out that local demand can be increased through promotion and education, the local market is too small to absorb all the output and thus large exports of manufactured products are needed (Paterson, 2000, 3). Since primary aluminium outputs in South Africa are considerable (670 000 tons per annum) and can be purchased at world prices, it is argued that there is significant potential with which to realize these objectives (Paterson, 2000). The employment spin-offs associated with increased aluminium beneficiation are presented in Table 7.

The R5.5 billion Hillside Aluminium smelter was completed in June 1996, five months ahead of schedule and R1.4 billion under budget. Gencor, the IDC and a number of other financial institutions financed it. In terms of international competitiveness, Hillside Aluminium is very efficient and several of its activities are used as benchmarks in smelter management elsewhere. Hillside's competitiveness in aluminium smelting is based upon a range of factors including, among others, highly reliable inputs at the world's best quality, favourable input pricing policies, electricity at very competitive prices (mainly due to abundant supplies of cheap coal), high levels of technology enabling the world's best practice in smelter operation, and well developed infrastructure. It also has the advantage of being a new smelter (4 years old) compared to those in the United States that average 44 years and Western Europe, 22 years (Walker, 2001).

Qualitative Assessment

DIRECT IMPACTS

There are two parts to determining the extent and degree of direct value added by Bil-liton Hillside Aluminium to the Richards Bay area. Firstly, it involves identifying the important ‘upstream’, ‘sidestream’ and ‘downstream’ activities arising from the production process and provision of services within the smelter. Secondly, it requires formulating a cost structure detailing the various costs incurred in the production process. Calculating value-added using such an approach is based on the premise that each Rand spent by Bil-liton has the potential to broaden the employment base and increase the range and possibility of future employment opportunities locally and nationally (Walker, 2001).

‘Upstream’ Activities

‘Upstream’ activities refer to the suppliers of the main inputs or raw materials needed in the smelting process. These include electricity, alumina, pitch, petroleum coke and other raw materials (carbon lining materials, cryolite, and aluminium fluoride). In 1999, variable production costs amounted to approximately R2.018 billion. Fixed operating costs in 1999 amounted to approximately R2.31 billion.

‘Sidestream’ Activities

‘Sidestream’ activities refer to the service network, vendors and key contracting firms directly affiliated with the smelter’s operations. Not only is this sector significant in terms of contributing to broadening the local and national employment base and enhancing the potential for further employment spin-offs, but it is also of critical importance to the functioning of all the departments within the smelter.

In 1999, Hillside Aluminium’s vendor spending amounted to R627 million. Of this, R280 million (61%) was spent within South Africa, R240 million (39%) internationally, and R106 million (17%) within the Richards Bay/Empangeni area. Total vendors numbered 1 231, of whom 756 (61%) were located in South Africa, 395 (32%) in Richards Bay/Empangeni, and 80 (6%) internationally (von Gordon, 2000). The local ‘sidestream’ sector supporting the Hillside Aluminium smelter comprises vendors of various sizes, providing either hard or soft services.

Hillside Aluminium, together with other big businesses in Richards Bay, is actively involved in promoting local economic development and sustainable job creation in the area by directly supporting and incorporating SMMEs into their activities. Not only does Hillside view its involvement and support of the Small and Medium Enterprises (SMME) sector as essential in terms of generating a competitive industrial base within Richards Bay, but also as an economic imperative. Hillside Aluminium’s SMME policy was formulated after considerable investigation was made by both public and private

individuals into SMME best practice regarding training, development and support programmes. Approved in June 1998, the Policy identified four issues critical to the successful identification, development and support of a viable SMME supplier sector in Richards Bay/Empangeni:

- Vendor evaluation -Evaluating vendors from the SMME database against approved supplier standards and directly assisting SMMes in order to overcome deficiencies in various aspects of supplier performance, quality, administration and competitiveness.
- Departmental responsibilities - Determining the various departments' responsibilities and the extent to which support and development will/can be provided.
- Entrepreneur development - Contributing to the development of new emerging entrepreneurs through joint ventures thereby facilitating the transfer of skills.
- SMME technical support -Helping SMMes access resources in terms of finance, technology and latest business development information.

At present, Hillside Aluminium has 45 accredited SMME companies on their database. In order for an enterprise to be registered as an SMME, two requirements have to be fulfilled. Firstly, at least 55% of the equity has to be owned by someone from a previously disadvantaged economic background. Secondly, the enterprise must be willing to enter partnerships with larger vendors in order to facilitate a transfer of skills and technology in order to provide a base for the future growth of the business. Hillside Aluminium's shift towards a greater emphasis on incorporating SMMes into their supplier network is also partly due to a reassessment of the nature of business at the smelter. While the senior staff within large industries has traditionally handled requirements in terms of hard and soft services, such an approach, particularly at Hillside, is no longer feasible. It has been maintained that by outsourcing non-core activities to firms (particularly SMMes) in Richards Bay/Empangeni, time, resources and skills within the smelter can be utilized more effectively. Not only does outsourcing assist in reducing corporate costs, but it also contributes to broadening the local employment base.

Employment within the Smelter

Total costs of sales for the 1998/1999 financial year amounted to R3.635 billion. Fixed overhead costs amounted to R558.099 million. Total production costs amounted to R2.394 billion.

Of the total wealth generated by the smelter (R1.241 billion) in 1998/1999, 14% (R187 million) was paid out to the 1, 083 Hillside employees in the form of salaries. Direct employees include those employed on a permanent, temporary and casual basis as well as those in a management or executive position. It does not include contractors.

Employees at Hillside, 70% of whom are from within the KwaZulu Natal province, comprise an operating director, general managers, supervisors/managers, engineers/section heads, administrators, operators, and artisans. Since 1997 there has been a gradual reduction in the number of employees at the smelter (from 1 187 in 1997 to 1 083 in

1999). This has largely been in response to the need to reduce corporate expenditure and to streamline activities in order to remain internationally competitive. The labour force is generally young, with 50.5% falling within the 19-29 age category, and 78.5% in the 19-34 age category. Women constitute approximately 10% of the workforce. There are 212 (19.57%) designated employees (expertise and management personnel). Labour turnover is 8.3% and the level of absenteeism is low.

Hillside Aluminium also places considerable emphasis on employee training and skill development. The successful start-up and operation of the smelter was, in many ways, due to the comprehensive training of all staff beforehand. Approximately R30 million and 50 000 days of training was invested to ensure that each employee was sufficiently equipped to operate and manage the technology and equipment within their designated departments (www.hillside.co.za). A single-class management approach has been adopted at the smelter whereby operators and artisans are paid according to their level of skill and staff according to performance (www.hillside.co.za).

One of the most notable developments undertaken to advance employee skills and employability has been the formulation of a selection of individual training programmes for identified 'high flyers'. Through the Accelerated Development Programme (ADP/ASDP), operators acquire skills and training to enable them to manage and utilize their equipment more effectively. Each training programme is also National Qualifications Framework (NQF) compliant. In this way, the ADP supports the national Skills Development Act, which emphasizes worker training and the simultaneous attainment of accredited and recognized qualifications.

'Downstream' Activities

'Downstream' activities refer to industries and enterprises engaged in the further processing/fabrication of the aluminium produced at the smelter. The majority of the remelt ingots produced at Hillside are exported with very little further value addition within South Africa. Recognizing this, as well as the employment benefits associated with increased beneficiation, Billiton Aluminium (together with the DTI) has investigated the possibilities and viability of fostering the development of a downstream aluminium-based SMME sector in Richards Bay. The Downstream Aluminium Pilot Project (DAPP) is scheduled to commence once the proposed upgrade to the Hillside smelter has been completed (2003). The Project, which will be launched on the site of the construction village established to house workers engaged in the expansion activities, will include a small foundry and will be geared towards the manufacture of aluminium-based tourist items as well as components for the aluminium industry.

National and Provincial Direct Impacts

The macroeconomic impacts of the Hillside smelter in 1998/1999 fiscal year include:

- R187 million paid to employees within the smelter

- R291 million paid to bankers and lenders
- R156 million paid to the government in the form of taxes
- R300 million paid to shareholders in the form of dividends
- R233 million allocated for the depreciation of assets
- R249 million was retained to fund capital replacements and working capital replacement
- R3.365 billion generated through costs of sales

In addition to corporate taxes, each employee is subject to various forms of taxes (personal taxes, VAT, bank/saving charges, levies and rates) each of which contributes to increasing the flow of resources both within the immediate vicinity of the smelter and elsewhere in the country. Each transfer of capital assists in indirectly enhancing the opportunity for improving the livelihoods of residents within the country as well as employment creation.

INDIRECT IMPACTS

A schematic presentation of the direct and indirect spin-offs arising from Billiton's initial expenditure in various production-related activities is depicted in Figure 2. It is important to note that only first stage indirect impacts are presented. Some of the most notable indirect impacts arising from direct employment in the smelter and corporate social investment in the Richards Bay area are detailed below (Walker, 2001).

There is evidence to suggest that the construction and subsequent operation of the Hillside smelter has had a significant impact on employment creation in activities relating to the local housing market. The Hillside smelter has also had an indirect impact on the growth of employment opportunities in the local tourist and retail sectors. Since 1996, there has been an increase in the number of commercial developments in the area, particularly in Richards Bay. The most notable development has been the Boardwalk shopping centre in the Richards Bay Central Business District (CBD). Numerous other smaller retail outlets (Spars, supermarkets, and a mall in Meerensee) have also accompanied this development. The local tourist industry has also flourished. In particular, 3 tourist hotels, 3 small guest lodges, a Formula One hotel, 25 bed and breakfasts (in total between 900 and 1 500 rooms), and 24 new restaurants, have been established since 1995. It has been asserted that these businesses have emerged as a consequence of industrial developments in the area. Given the specialized nature of the large-scale, resource-based plants in the area, and the need to continually upgrade, there is often a constant flow of technicians, consultants, trade delegations and other business visitors from within South Africa and internationally into Richards Bay. With each new tourist enterprise that is indirectly fostered, additional employment spin-offs arise in linked activities (landscaping, marketing, cleaning, catering, management, finance, property development), each of which contributes to broadening the local employment base. With regard to Billiton's corporate social investment activities, during the 1999/2000 financial year, Billiton invested R8 346 364 in community development activities –equivalent to 4.5% of Hillside's earnings returned to employees in the same year, or 2.5% of Hillside's earnings returned to shareholders in the same year.

National, Provincial and Regional Indirect Impacts

There is general consensus that the R5.5 billion Hillside smelter development provided the impetus for a number of proposals to be submitted for expansion programmes to various existing plants (aside from Bayside) and the siting of new ones in the area. In addition to a proposed R500 million dry dock, a proposed container terminal and a multi-million Rand sodium-chlorate plant for National Chemical Plants (a division of Sentrachem and Huston Technical of the United States) were also considered. Proposals were also submitted for the siting of a Blue Circle Cement Plant next to IOF. Perhaps the most significant development, however, has been Iscor's (now Ticom) decision to locate a heavy mineral mining operation near the Felixton sugar mill in Zululand and a smelter in Empangeni. The Iscor development is likely to play an important role in influencing the future industrial dynamic of the region and their go-ahead fostered considerable direct and indirect economic spin-offs throughout the country (The Star, 1996a; 1996b; The Mercury, 2000). The mine started production in late 2002 and the two 125 000 ton per annum ilmenite furnaces were commissioned by late 2003.

Hulett Aluminium

The decision by Hulett Aluminium, in March 1996, to proceed with a R2.4 billion upgrade of its facilities in Pietermaritzburg was a significant indirect impact of the Hillside smelter, particularly in terms of broadening South Africa's downstream aluminium industry. Hulett Aluminium is a key fabricator of aluminium sheet, plate, extrusions, coil, extruded tube, containers, paste, composite panel, roof sheeting and cladding in South Africa and supplies metal to general engineering, building, transport, cookware and electrical firms. The upgrade will result in Hulett Aluminium being one of the most advanced aluminium rolling-plants in the world. (Walker, 2001). The expansion was completed in 2003 and Hulett has grown its sales in step with the increased capacity. The plant utilization is 69% and is expected to grow to 75% in 2004. The increased sales have mainly been in the export market. (Business Report, 18 August 2003).

Once full capacity is reached, it has been asserted that the expansion will increase fabricated outputs from an initial 50 000 to 185 000 tons per annum and foster more than 31 000 jobs throughout South Africa. Hulett's Aluminium is of particular economic importance to South Africa. Not only does it generate sizeable foreign exchange earnings for the country, but contributes significantly to employment creation. Indeed, it has been asserted that for every 6 tons of aluminium fabricated, one job is created. As much as 51% of its products are exported to 34 countries. In 2000 capital employed amounted to approximately R4.5 billion and its turnover was R2 billion. Its annual turnover is projected to reach R5 billion by 2004. Currently, 2 050 people are employed on-site. It has been pointed out that 10% of the material sold by Hulett Aluminium to local customers is used to manufacture value-added exports. In the past two years, exports by these customers have increased by over 50%. The impact of the Hulett expansion programme has also been significant in terms of generating additional employment spin-offs. Indeed, companies who obtain their semi-fabricated aluminium requirements from Hulett Aluminium have been motivated to either proceed with expansion programmes or submit

proposals for new upgrades because of Hulett Aluminium's new rolled products expansion programme. These are all multi-million Rand projects (Walker, 2001).

Mozal Aluminium

It has been pointed out that it was largely due to the success of the Hillside smelter that prompted Billiton to proceed with its decision to establish a similar facility in Mozambique (Engineering News, 1996; Billiton World, 2000). Although only half the size of Hillside, many of the key input suppliers and lessons learnt in the construction of the Hillside smelter have been adopted and utilized in the Mozal development. It can be said that the Mozal project is an indirect effect of the Hillside development. The completion of the Hillside and Mozal Phase II expansions together with the Bayside production has created a Southern African 'aluminium triangle' with more than 10 % of the world's primary aluminium capacity (Business Report 18 August 2003). This cluster has been created in a little over 8 years.

Other Less Tangible Impacts

Equally important, however, have been the less tangible indirect impacts of the construction and operation of the smelter. These include, inter alia, restoring national industrial confidence in a period of economic and political uncertainty, a climate few were prepared to invest in; providing a model for the restructuring of Bayside Aluminium; securing competitive prices for key inputs for both smelters; stimulating a regular flow of international and national investors into the area; serving as an international benchmark in various aspects of smelter management and appearance; and providing local fabricators with competitively-priced and high-quality primary aluminium. Taken together, the direct and indirect impacts of the Hillside smelter on employment creation have, therefore, been considerable (Walker, 2001).

Quantitative Assessment

This section analyzes the economic impact of the South African aluminium smelting industry on the economy as a whole. The impact is measured in terms of its contribution to GDP and employment. The methodology used and data sources are the same as those used above.

Model Results: Overview

The aluminium industry's value added to GDP and contribution to employment in the year 2000 are given in Table 8. The value added and employment calculations were based on estimates, which were derived by adapting the Ferro-Metals Industry figures available from Statistics South Africa's Supply and Use Tables for 2000. These estimates were made

according to local and international aluminium industry norms obtained from the available literature referred to in the relevant data tables. Due to confidentiality issues, the data needed to input into the model could, in some cases, not be accessed directly.

Table 8: Aluminium Smelting Industry Contribution (2000)

Value Added Area	Rand (Million)	% of GDP	Jobs	% of Jobs
Direct	831	0.09	2 750	0.06
Indirect: Backward linkages	1 250	0.14	5 201	0.11
Indirect – forward linkages	2 373	0.27	17 397	0.37
Induced	2 628	0.30	32 007	0.68
Total	7 082	0.88	57 355	1.21

Source data: Statistics South Africa, 2001; Walker 2001

The total economic impact (direct, indirect and induced) of the aluminium industry in South Africa for the year 2000 was R7 082 million, which represents 0.8% of the national GDP (R888, 057 million).

The total economic impact (direct, indirect and induced) of the aluminium industry in terms of employment is around 57 355 jobs. This represents 1.21% of total formal employment excluding agricultural workers and approximately 0.08% of total formal sector employment (Barker, 2003:80). The Aluminium industry contributes more than double pro-rata to employment than it does to GDP. It is worth noting that the most significant impacts in terms of employment are associated with the induced effect, followed by the indirect effects. The direct effect is much smaller. This is understandable, as the aluminium smelting industry is capital intensive.

The Direct Contribution of Aluminium Smelting

The “direct” contribution of the aluminium sector to the economy refers to the value-added by the sector itself and in the year 2000 consisted of the sum of wages and salaries of employees (R375 million) and gross profits of companies (R300 million) and net taxes, being taxes minus subsidies (R156 million). This totals R 831 million and equates to 0.09% of the national GDP. The number of people employed permanently or temporarily by the aluminium industry in South Africa numbered 2750 in December 2000.

The direct contribution of the aluminium sector to GDP is 11.7% of its total multiplied impact, which is a proportionately larger direct impact than its impact on employment (4.8%). This is another indication that the industry is capital intensive.

The Indirect Contribution of the Aluminium Industry

Backward Indirect Linkages

The product and service sectors, to which the aluminium sector adds value to through upstream linkages, are shown in Table 9.

Table 9: Value added of backward linkages of aluminium

Products and Services Purchased	Value added		Employment	
	R' million	% of Total	No of Jobs	% of Jobs
Electricity	825.03	65.98	1879	36.13
Coal	107.0	8.56	779.0	14.98
Other Services: Insurance, communications, etc	88.57	7.08	719	13.82
Other business services	57.34	4.58	383	7.36
Wholesale and Retail trade	34.65	2.77	375	7.21
Other goods: Hardware, plastic, rubber and steel products	30.95	2.47	254	4.89
Financial Intermediation Services	22.47	1.8	277	5.33
Transport services	18.71	1.5	108	2.08
Machinery	18.7	1.5	174	3.35
Chemical products	16.51	1.32	51	0.98
Raw materials: water, cement, basic chemicals, etc	10.58	0.85	71	1.37
Petroleum Products	10.48	0.84	56	1.07
Motor Vehicle Parts	3.25	0.26	28	0.54
Other fabricated metal products	2.11	0.17	20	0.38
Paper products	1.75	0.14	11	0.22
Accommodation	1.35	0.11	6	0.12
Published and Printed Products	0.95	0.077	8	0.16
Total Products and Services Purchased	1 250.37	100.0	5 200	100.0

Source data: Statistics South Africa, 2001a; and Walker 2001

The electricity sector accounts for R825m of the value added through first round backward linkages and reflects the high level of power consumption by the aluminium industry. The purchase of electricity by the industry also has a second round backward linkage

to the coal mining industry, which supplies coal for electricity generation and results in a further R 107million contribution to GDP. This is the only second round backward linkage shown in Table 9. The impact on the electricity and coal mining industries dominates backward linkages and accounts for 75% of the value added through backward linkages. The service industries (other services, other business services, and financial intermediation services) account for 13.4% of the value added through backward linkages. These industries cover a wide spectrum of services and would include all professional, financial and consulting services, as well as training services.

The number of jobs created because of purchases of goods and services by the aluminium industry, is estimated at 5200. This implies that 4.17 jobs are created for every million Rand of value added through backward linkages. Jobs created in the electricity, coal mining and services sectors total 4,034 and account for about 77.6% of the jobs created.

Forward Indirect Linkages

The indirect impact of the aluminium industry on domestic downstream industries is significant, though the industry exports 75% of its production. The value added to GDP via forward linkages amounts to R2 371 million, with an equivalent contribution to employment of 17,396.

The forward linkages contribute 17,397 jobs to total employment, which represents the most significant employment impact of the aluminium industry. This implies that forward linkages from the aluminium industry accounts for 0.4% of the non-agricultural formal sector employment.

For every million Rand in value added, forward linkages associated with the aluminium industry added 7.3 jobs. This is almost twice the number of jobs created by the backward linkage effect per million Rand spent; and reflects the fact that the majority of the forward linkages are relatively labour intensive industries.

The Induced Contribution of Aluminium Smelting

The income and expenditure sustained by the direct and indirect impacts gives rise, via the Keynesian spending multiplier of 1.59 to a further induced increase in GDP of R2 628 million, which represents 0.3% of GDP. This implies that wages and profits generated by the direct and indirect contributions are spent in the economy and would ultimately add another 59% (in addition to the direct and indirect contributions) in value to GDP. The multiplier calculation is discussed in Section 1 and is based on a marginal propensity to consume of 0.8, an import propensity of 0.33 and an average tax rate of 0.22 (South African Reserve Bank Quarterly Bulletin, June 2003).

The employment equivalent to the induced effect is estimated at 32 007 jobs and is based on an incremental job: GDP ratio of 12.18 jobs per R1 million of induced value added (Voges, 2003). This contribution represents 0.68% of national formal sector employment

(other than agriculture) and therefore represents a significant component of South Africa's national employment figures.

Table 10: Value added of forward linkages of aluminium

Major Industries	Value added to GDP		Employment	
	Rand (million)	%	No of Jobs	%
Manufacturing	1,058.2	44.52	9,360	53.8
Non-Ferrous Metals	578.3	24.38	795	4.57
Automotive Industry	263.4	11.11	2,251	12.94
Structural Metal	181.7	7.66	2,420	13.91
Primary Industry	77.6	3.27	887	5.1
Iron and Steel	58.3	2.46	249	1.43
Petro-chemicals	54.7	2.31	352	2.02
Secondary Industry	45.3	1.91	451	2.59
Services	44.1	1.86	524	3.01
General Government	7.3	0.31	102	0.59
Water	2.7	0.12	6	0.04
Total	2,371.6	100.0	17,397	100.0

Source data: Statistics South Africa, 2001; Walker 2001; Castings Industries Directory, 2003; Aluminium Federation of Southern Africa, 2000; Aluminium Association Incorporated, 2003; European Aluminium Association, 2002.

Summary

In the final analysis, two essential insights can be drawn from the investigation of the impact of Hillside Aluminium in the Richards Bay area. Firstly, it is apparent that new, large-scale, resource-based investment projects have the potential to foster significant direct and indirect economic impacts. Moreover, many of these extend beyond the immediate vicinity in which the project is situated. Companies, industries and government officials are generally unaware of the broader positive economic effects engendered by resource-based plants, primarily because the emphasis tends to be on the direct impacts. In determining the magnitude and depth of the impacts fostered by a new investment project, particularly in terms of employment creation and income generation, it is imperative that consideration be given to the indirect impacts as well as a qualitative analysis of the nature of the impacts is undertaken (Walker, 2001).

Secondly, it is evident that investment decisions have a distinct spatial and geographic dimension. A 'cluster' of specialized SMME vendors is beginning to emerge in the greater Richards Bay area. Although it is still in the initial stages of development, as innovation and adaptation of skills and technology increases within local enterprises, their importance to both national development and the aluminium industry will become ever more

apparent. Due to the ‘sidestream’ nature of a number of these firms and the shift towards outsourcing of non-core activities by large industries to SMMEs, a local networking and sharing of services and skills between SMMEs and other big businesses in Richards Bay will gradually emerge, ensuring the indigenization of economic growth. In addition to these developments, Ticor’s decision to locate its new titanium smelter in Empangeni is likely to be a fundamental element in influencing the future spatial reorientation of industry in the greater Richards Bay area.

At a provincial level, the aluminium ‘cluster’ which is emerging in Pietermaritzburg attests to the fact that large-scale, capital-intensive projects have multiple centres of production. Not only is Hulett Aluminium linked to the Hillside and Bayside smelters in terms of supply and demand for primary aluminium, but numerous firms are also reliant on the semi-fabricated products produced at Hulett Aluminium. Hillside’s phenomenal growth, coupled with Hulett Aluminium’s expansion programme, has intensified the downstream processing and beneficiation of aluminium in South Africa. At the national level, the geographic and spatial impact of the Hillside smelter has been of critical importance in initiating subregional economic development in the SADC region. Not only will the Mozal smelter provide the impetus needed for economic growth in Mozambique, but the emergence of the ‘aluminium triangle’ between Richards Bay and Maputo also provides a unique engine for transnational economic growth within Southern Africa. Moreover, the economic development of the ‘aluminium triangle’ is reinforced by the continual flow and exchange of resources, skills and expertise between South Africa and Mozambique (Walker, 2001).

AN ASSESSMENT OF THE CLUSTER CASE STUDIES

This section identifies the common themes running through the three clusters discussed above. First, a Porter framework is used to identify the drivers of the cluster development to assist in “unwrapping” the complexity of various clusters. Secondly, a SWOT analysis of each cluster is undertaken. The section concludes with a brief summary of the assessment and identifies the implications for policy development.

DRIVERS OF CLUSTER DEVELOPMENT

The establishment of the South African mineral cluster (in particular the gold mining cluster) was driven predominantly by factor conditions, both internal and external, the most important of which were:

- Characteristics and scale of Witwatersrand gold reefs: The initial free-milling characteristics and the extended surface outcrop of the reefs allowed the rapid establishment of a large number of geographically concentrated mining operations.
- Technology improvements: The timely development of the cyanidation process in America allowed the mines to continue operations below the limit of weathering and to treat the deeper refractory ores.

- **Critical mass:** The rapid establishment of a large number of geographically concentrated mining operations created a sufficiently large demand for goods and services to sustain the development of a cluster of local goods and services companies. This contrasts with the early gold mining activities in Barberton, which were too small and short lived to result in the establishment of a cluster of support industries around it.
- **Location:** The Witwatersrand is located far from the industrial heartland of Europe and South African ports. The logistics of obtaining machinery and parts from Europe took an unacceptably long time. This provided a key incentive to establishing a local engineering industry (particularly on the East Rand) to supply the mines.
- **International skills mobility:** At that time of the initial establishment of the cluster, there were few government constraints on the movement of skilled people throughout North America and the “British colonial world” and maritime connections were good. This enabled a pool of people with mining expertise to follow the gold rushes from the Klondike in Alaska, to Kalgoorlie in Australia, and finally South Africa. This labour mobility allowed the emerging gold industry to develop despite the lack of any technically advanced mining expertise among the local Boer and African communities.
- **Gold demand:** There was a strong demand for gold during this period from the establishment of the gold mining industry in South Africa during the 1880s until the 1980s, primarily driven by the monetary role of gold.

The subsequent development, expansion (particularly during the 1960s and 1970s) and sustainability of the cluster was driven by a much wider range of drivers, the most important of which were:

Factor Conditions

- **Historical accident:** The Witwatersrand geographic cluster developed into a sustainable mining cluster that has effectively outlived its local mining origins. Mining on a large scale developed on the Central Witwatersrand before any development started on the other major South African goldfields. The support industries already established along the Witwatersrand were able to expand in order to support the development of the other goldfields and mining areas, which further advanced the Witwatersrand mining inputs cluster to the detriment of other local clusters.
- **The availability of large-scale, low quality coal resources:** The gold mining industry and most of the mineral processing industries are large consumers of power. The availability of extensive resources of thermal coal enabled the industry to be supplied with low-cost power.
- **Characteristics and scale of the major non-gold resources:** South Africa is blessed with an almost complete range of the minerals required by the modern world. Many of these occur on a tonnage and grade scale that is unparalleled compared to other deposits elsewhere in the world (such as the platinum group, chromium,

and vanadium resources hosted in the Bushveld Complex and the manganese deposits hosted in the Kalahari manganese field). The country also contains other mineral deposits that occur on a comparable scale to other deposits in the world (such as the diamondiferous kimberlite pipes, marine diamonds, and the Sishen iron ore field).

Demand Conditions

- **Resurgent demand for gold:** The expansion of jewellery and the industrial demand for gold has offset the decline in gold for monetary purposes.
- **Growth in demand for ferrous, base metals and aluminium:** The growth of the Far East economies and decline of European domestic production of base metals and their concentrates has resulted in a significant increase in the demand for South Africa production of such commodities.

Firm Strategy, Structure and Rivalry

- **The role of the mining houses:** The mining houses, originally established with the objective of providing finances for early industrialists and miners on the Witwatersrand, also functioned as a centralized source of specialized skills to the mining sector.
- **Strong industry institutions:** The establishment of the Chamber of Mines early on in the development of the industry and continued operation has provided an effective body to coordinate the activities of the industry, particularly with respect to the industry-government relationship, the diffusion of technology, and labour issues. In particular, the close collaboration of the mining house, coordinated by the Chamber of Mines, enabled the industry to form a labour oligopoly to increase the supply of labour as a means of managing labour costs (Chamber of Mines, 2000; Minerals Bureau, 2002).
- **Technical collaboration:** The exploitation of the Witwatersrand deposits required the development of innovative mining and processing systems and technology. These issues were common to all the mines and required many resources to solve. Consequently the mines had a strong incentive to work together to solve them and this led to the development of a strong culture of sharing technical knowledge. This openness was facilitated by the fact that they all produced the same commodity and effectively did not have to fight for market share. The main areas of competition between the companies were in identifying and tying up prospective new areas.
- **Training and education:** The industry realized from an early stage that it could not rely on an ongoing flow of skilled people to South Africa to supply the skills requirements for the growing industry. Consequently, the industry collectively and individually supported the establishment of the necessary technical training and education facilities (e.g. the establishment of the Witwatersrand University School of Mining). Sadly, the imposition of the apartheid ideology prevented a majority of the population from benefiting from these initiatives and thus set the scene for the skills shortages that today still plague the industry.

Government

- **Security of tenure:** The mineral rights system of the Transvaal Republic and subsequently of the Union and later the Republic of South Africa, provided the mining companies with strong security of tenure, which enabled them to raise finances to develop long life capital-intensive mines. (A new system of mining title was promulgated on 1 May 2004 in terms of all mining rights belonging to the state and incorporating a “use it or lose it principle”. While the effect of this on investment in long term capital intensive mine development in South Africa remains debatable, the new legislation has led to the development of many smaller scale deposits which were previously regarded by the major players as being too small.)
- **Government industrial decentralization policy:** In the post-war years the Government, worried about the concentration of economic power in the Witwatersrand, particularly since it was an area in which its white political opponents were strong, pushed for the decentralization of economic activities. The Government used the provision of good logistics and power infrastructure with the restrictions on the movement of black labour as policy levers to achieve this.
- **Good logistics infrastructure:** Historically, particularly in the 1960s to the 1980s, the South African Government placed major emphasis on the provision of an effective rail and port infrastructure. In the 1960s the Government built a manganese export facility at Port Elizabeth and upgraded the rail line linking it to the Kalahari manganese fields, thereby starting the manganese export industry. Similarly, the Government supported the development of Saldanha Bay Harbour together with the construction of the Sishen-Saldanha railway line by the then state owned Iscor, which enabled Iscor to enter the international iron ore market and subsequently establish the export-oriented Saldanha Steel operation. In the late 1960s to the early 1970s, the Government built Richards Bay Harbour and the heavy-duty coal line linking it to the Witbank coalfield. This enabled South Africa to enter the international coal trade as a major player.
- **Good power distribution infrastructure:** Between the 1960s and the 1980s, the South African Government placed a major emphasis on the development of an effective national distribution grid.
- **Provision of cheap power:** The construction and operation of a number of large-scale, capital-intensive mineral beneficiation plants during the 1990s, including Columbus Stainless Steel, Billiton Hillside Aluminium, Namakwa Sands Titanium, and Saldanha Steel, and smaller ferrochrome smelters, was only viable because of the availability of cheap electric power. In turn, the development of large-scale, low-cost power stations was made possible by the development of technology which allowed for the burning of low calorific value coal produced as a co-product when washing Witbank coals to upgrade them to meet export quality requirements.
- **Threat of oil sanctions:** The development of the coal-based petrochemical industry in South Africa was historically driven by government policy to establish an alternative source of fuel to lessen the impact of potential oil sanctions being imposed against South Africa. This threat has disappeared with the advent of

democracy in South Africa, but the legacy of a world-class, coal- based petro-chemical industry remains. Conversely, the threat of general sanctions hindered the further beneficiation of other mineral as it was felt that that it would be more difficult for a country to apply sanctions if that country was dependent on South Africa for raw materials to feed its own industries.

- **State support for R&D:** The establishment and subsequent funding of the three national research institutes directly linked to the exploration, extraction, and processing of mineral resources – The Council of Geosciences, Miningtek, and Mintek.

Related and supporting industries

- **Economies of scale:** The overall scale of the industry was such that it justified the development of supporting industries in both the goods and services sectors.

An analysis of the cluster reveals a number of essential internal and external conditions, which have contributed to the recent development of the cluster and will effect its future development:

Factor conditions

- **The advent of democracy:** The coming of full democracy in 1994 opened the South African economy to the world at a time when globalization was increasing throughout the world.
- **Lifting of sanctions:** Created increased opportunities to export beneficiated products.

Demand conditions

- **Stagnant gold market:** The low and static gold price that prevailed through much of the 1990s forced the industry to review its operations
- **Growth in demand for platinum group metals:** Demand has quadrupled over the past 15 years due to the implementation of auto catalyst regulations throughout the developed world and the development of the platinum jewellery market.

Firm strategy, structure and rivalry

- **Consolidation and restructuring:** In response to economic pressures due to the low gold price and the need to bring the management and workplaces practices in line with international practices following 1994, the mining houses became far more focused business units, outsourcing all non-core activities and divesting non-profitable activities.
- **Internationalization of the major mining houses:** The two major South African mining houses, Anglo American and Billiton (which subsequently merged with the Australian mining giant BHP to form BHP-Billiton) moved their domicile to London. The rationale behind this was that it would lower their cost of capital

and give them additional flexibility to expand outside of South Africa.

- **Outsourcing:** With the development of the skills base, the mining houses role of acting as a centralised source of specialized skills fell away and it became more cost-effective to outsource many of the specialized technical functions to specialist consultants. This has led to a significant growth in the business of specialized service companies such as Bateman and SRK.

Government

- **Taxation legislation changes:** Changes in both mineral and taxation legislation have allowed the consolidation and rationalization of mining operations across pre-existing mine boundaries, which were almost unrelated to geological boundaries.
- **Mineral and Petroleum Resources Development Act and Mining Charter:** These pro-active Government measures are aimed at restructuring ownership and participation patterns within the local mineral industry. Emphasis is afforded to the incorporation of previously disadvantaged South Africans into all levels of management and production, socio-economic and environmental accountability, and further beneficiation. The effect of them has been to speed up the transformation of the minerals industry and has induced a new dynamism into it.

SWOT ANALYSIS

A SWOT analysis has been undertaken for the overall minerals cluster as well as the gold and aluminium clusters. The results are tabulated in point form for ease of reference. They are not discussed in detail as the points represent a compendium of issues that have been identified and discussed elsewhere in the paper.

The Overall Mineral Cluster

Strengths	Weaknesses
<ul style="list-style-type: none"> • Extent and diversity of mineral resources; • Integrated approach to resource management; • Critical mass of operations large enough to support sustained demand for goods and services; • Well developed physical infrastructure • Depth and extent of management and technical knowledge; • Problem solving culture; • Cheap power (historically); • Local financial sectors good understanding of mineral sector; • Labour relations structure; • Availability of suitable technology; • Historic high level of technical cooperation between the mining companies; and • Priority given to fundamental research together with the countries capacity to undertake fundamental research. 	<ul style="list-style-type: none"> • Mining title uncertainty; • Increasing skills shortages; • Inflexible labour markets; • Fiscal and foreign exchange regulations, which inhibit international and regional capital flow; • Local capital market constraints; • High real interest rates; • Logistic bottlenecks: under investment in rail and port infrastructure over past 20 years is causing major bottlenecks; and • Reducing applied R&D by industry.
Opportunities	Threats
<ul style="list-style-type: none"> • Extent and diversity of mineral resources; • Development of small to medium sized operations by new entrants to the industry because of the "use it or lose it" nature of the mining rights legislation; • Further beneficiation; • International expansion; • Inter-regional integration in Africa; • Sourcing energy from the regional power pool; • Export of deep level mining expertise and equipment; • Export of mining capital goods and services; and • Lateral migration of technology out of mining. 	<ul style="list-style-type: none"> • Currency and price fluctuation; • Cost-push inflationary pressures; • Size of potential royalty payments; • Further major job losses (gold industry); • HIV/AIDS; • Changing focus of top management because of the internationalisation of mining houses; • Loss of specialist expertise from emigration, retirement, and retrenchment; • Loss of intellectual property; • Trade barriers hindering sale of further beneficiated goods; • Decreasing rail and port efficiency and increasing rail and port costs; • Water shortages in some areas; and • Power supply capacity limitations and increasing power costs –post 2007:s

The Gold Cluster

In addition to the general points above, the following aspects were found particularly applicable to the gold cluster:

Strengths	Weaknesses
<ul style="list-style-type: none"> Operational flexibility and robustness of major existing producers; Financial strength of major gold companies; Deep level hard rock mining expertise; Rationalisation of mine boundaries; and Critical mass of operations large enough to support sustained demand for goods and services. 	<ul style="list-style-type: none"> Depth of mining (gold and PGM); Intensive labour requirements; Lack of coherence in gold regulations; and Limited knowledge of gold hosted in greenstone terrains.
Opportunities	Threats
<ul style="list-style-type: none"> Extent of undeveloped gold resources; Further beneficiation; Pro-active marketing of gold; Inter-regional integration in Africa International expansion; Export of deep level gold mining and gold processing capital goods and services; Development of thin seam hard rock mechanized mining equipment; Innovative use of redundant mining infrastructure; and Small-scale mining, retreatment of dumps. 	<ul style="list-style-type: none"> Further central bank gold sales; Cost-push inflationary pressures; Rand gold price decline; Further major job losses; HIV/AIDS; Increasing power costs –post 2007; and Capital cost and time required to bring a new deep level mine into operation.

The Aluminium Cluster

The aluminium cluster as a processing and beneficiation cluster dependent on imported feedstock has certain features particularly applicable to it:

Strengths	Weaknesses
<ul style="list-style-type: none"> • Low cost production; • Single company ownership; • Depth and extent of management and technical knowledge; • Close integration with downstream users; and • Benefits from the synergies provided by forming part of the larger Richards Bay heavy industry cluster. 	<ul style="list-style-type: none"> • Increasing Skills shortages; • Inflexible labour markets; and • Reliance on imported alumina.
Opportunities	Threats
<ul style="list-style-type: none"> • Sourcing power from the regional power pool; • Coega: establishment of a new smelter complex by Alcan – Pechiney; and • Development of synergies with the Mozambican Aluminium industry. 	<ul style="list-style-type: none"> • Cost-push inflationary pressures; • Currency and price fluctuation; • Increasing power costs –post 2007; • International overcapacity; and • Trade barriers.

Conclusion and Policy Implications

The review of the international experience of the development of resource-based economies in Section 1 clearly showed the importance of developing clusters with up and downstream linkages as a critical step in the process of transforming an economy driven by “enclave” -type mineral operations, into one that is sustainable and broad-based. The South African mining industry has developed into a complex overall cluster with extensive backward and forward linkages. Individual, commodity-based clusters, sometimes regionally defined, can be discerned within the overall cluster.

The analysis of these South African clusters confirms the importance of Hernesniemi et al. (1996, 158) statement that nine critical factors/preconditions underpin a cluster’s birth and growth. The industry quickly developed the critical mass due to the size and nature of the Witwatersrand orebodies.

The development of the industry was driven by entrepreneurs, who competed fiercely for ground but collaborated on areas of common interest and benefit, such as labour procurement and mining technology. This cooperation was made easier by the fact that the companies produced the same product, gold bullion, which was all refined at a jointly owned purpose-built refinery, the Rand Refinery Ltd, from 1921 onwards. Furthermore, from 1926 until 1998, when the Harmony Group were granted permission to operate its own

refinery and to directly market a portion of its production, all South African gold was sold to the South African Reserve Bank after refining who then marketed it internationally.

The cluster developments have all been characterized by the ongoing involvement of entrepreneurs. The state has had and retains an important role in providing an environment in which entrepreneurs can flourish. In particular this relates to providing a legislative and fiscal environment that encourages risk taking. The industry has been characterized by an ongoing rivalry between companies, who at the same time have cooperated closely on issues of mutual benefit. Many of the companies have shown themselves capable of adapting their organizational structures and management processes in times of change. This was shown during the early 1990s when the companies had to adjust to the low price high-cost environment then prevalent in the gold industry and currently as they adapt to the government's transformation drive. Those companies that failed to adapt have been taken over or have disappeared. The specialized and demanding requirements of the industry have led to the establishment of sophisticated suppliers of both capital goods and consumables. Furthermore, the restructuring of the mining houses and outsourcing of key technical services has led to the development of an extensive network of locally based service companies with the skill and expertise that well equips them to undertake work elsewhere in the world.

It is also clear that the first cluster to develop retains a strategic advantage over its successors, provided it can develop a critical mass. This is illustrated by the successful evolution of the Witwatersrand into a sustainable economic hub that has developed far past a reliance on its mining roots. In contrast, many of the other gold and other mining geographic sub clusters face a bleak future when their mines run out, and this remains a worry for the Government.

The development of the aluminium cluster also serves as a good example of Hirschman's (1958) concept of "side-effects" stimulated by state investment in resource-based projects. The South African Government initially developed Richards Bay Harbour and coal rail line in the late 1960s to enable the local coal industry to compete in the export coal market. At the same time, the Government was pursuing a decentralization policy aimed at establishing industrial development nodes outside of the established industrial clusters and had introduced incentives to industrialists to encourage such developments. The government's core action taken to develop the coal export industry, supplemented by its decentralisation policy, induced three side effects. Firstly, it laid the basis on which an industrial base with forward and backward linkages could be established at Richards Bay. Secondly, it changed the bureaucratic mindset so that it worked to support and encourage investment. Thirdly, by its positive actions, the Government increased private sector confidence and participation in the development process. In particular, the State owned IDC worked together with Rio Tinto to establish Richards Bay Minerals to exploit and process the nearby heavy mineral deposits. Collectively these triggered the development of Richards Bay into becoming a heavy industry cluster. This then provided a suitable base in terms of infrastructure, logistics, power supply, and skills availability to support the establishment and growth of the aluminium cluster and other heavy industries such as Indian Ocean Fertilizers.

These lessons are important as they provide guidance as to the type of actions that need to be addressed to ensure the further development and sustainability of the various mineral clusters. This is particularly important in South Africa, where evidence suggests that the industry will not be able to resume the importance that it occupied in the economy in the 1980s. Bigger companies are continuously shedding marginal operations and transferring wealth and control outside South Africa. This has important implications for the future growth and development of the industry.

The analysis has highlighted the important role that the Government has played in the development of the minerals industry. Many of the major developments would not have taken place without the provision of logistic and power infrastructure by the Government. Historically, the provision of a stable fiscal and legislative environment has been crucial. Currently, the Government's role in expediting transformation through dialogue with the industry, backed up by legislation, is creating a new vibrancy in the industry. Important as the government's role has been, the real development thrust has come from the private sector with its ability to better assess market requirements and to evaluate risk. Business by its nature tends to take a shorter-term view than government. Consequently the challenge to Government is how to guide the industry into working in a way that benefits the long-term interest of the country without damaging the shorter-term interests of the private sector and thus unintentionally dissuading them from investing in the future. In addition, human resource development remains a top priority, both to meet the needs of industry and to overcome the dreadful legacy of the past.

The implications for Government are:

Skills development: While the Government needs to pro-actively address the issue of skill development, it needs to address the issue of how to retain existing skills to bridge the gap until new suitable experienced people have been developed. In addition, immigration regulations need to be revised to make it easier to bring in specialist skills. Furthermore, incentives need to be provided for private companies to invest in skills development.

Beneficiation: As discussed above, beneficiation is a critical step in expanding the value chain. While significant progress has been made over the past decade, much more can be done. Furthermore, it is an important component of the new mining charter. This will require comprehensive negotiations in good faith by Government with industry so that the most optimal areas for further beneficiation can be identified

Upgrading of the logistics infrastructure: Maintenance of existing levels of output and an expansion of minerals exports requires the continuous upgrading of the rail and port infrastructure. This, in turn, will require major capital investment and injection of operational skills. The government needs to make this a high priority. The task may be made easier by the privatization of the important port and rail operations, as is being done in Mozambique.

Promotion of cluster development: International experience has shown that the development of clusters is an important driver leading to sustainable development. The studies have also shown that government, at both a national and local level, plays a major

enabling role. National government's attention should be directed towards developing and implementing policies that encourage the development of clusters. Important policy levers include fiscal incentives for training and applied R&D and focused investment in the provision of major infrastructure. Local government structures play an important facilitative role as key implementers of many of the incentives and as providers of local infrastructure and bulk services. Local government often needs to be "educated" about the implications of the cluster concept so that it can take a more pro-active role in creating a cluster enabling environment in its area of jurisdiction; in many cases this requires a change of the bureaucratic mindset. Government can play a supportive role to local authorities by contextualizing the importance of cluster development within the overall national development priorities and, in certain cases, providing funding for local infrastructure development. Local infrastructure can also be developed in partnership with private capital; incentives enabling this are required.

Industry sector cooperation: International studies on cluster development all emphasize the importance of industry cooperation and networking. While the overall minerals industry has been characterized by a reasonable level of cooperation on technical issues, most of this has taken place at the core production level and has not closely involved the suppliers of goods and services. Significant synergistic benefits could be obtained if more groups of specialized suppliers were to collaborate and network more. In particular, the government should encourage groups of suppliers in distinct product sectors of the industry to establish their own focused industry associations to look after their common interests and provide a platform for collaborative research (e.g. The Conveyors Manufacturers Association of South Africa and the Shaft Sinkers Association of South Africa). Policy levers could include providing initial start-up funding through the DTI matching the private sector contributions.

Export market development: Many of the suppliers of goods and services to the industry are small to medium sized enterprises. They do not have the resources to develop an international presence on their own. The Department of Trade and Industry has limited measures in place to support the initiative. They include financial support for such companies to attend international trade fairs and support for the establishment of export councils, such as the South African Capital Goods Export Council. The resources allocated to the initiatives are limited and the whole approach needs to be reviewed. International experience of countries such as Canada and Australia show a far greater level of cooperation and coordination between the state and the private sectors in marketing the country and thus its technology and services. The DTI should put more emphasis on acting as an initiator and driver. The concept of export councils is good but needs to be extended and better resourced. The companies forming export councils must allow the councils to take a more pro-active approach in marketing their member's products collectively. This has been successfully done by the Electro-mechanical Products Export Council, which has established a permanent showroom in Melbourne, Australia, by playing an effective role promoting sales into Australia.

Research and Development: As the local mineral industry becomes more international, the incentive to carry out research locally becomes weaker. The government, through the Department of Science and Technology is actively trying to work with the various

stakeholders to ensure that R&D expenditure becomes focused on the long-term national interest. The danger of the R&D that is directed to incrementally improving operations will be neglected.

At the meso- and micro-cluster levels, effective communication and cooperation among all component stakeholders of the cluster must be encouraged. There are three possible ways of achieving this:

Information: Develop an IT based system of providing mining firms with information regarding local and regional supply, existing and potential, of goods and services. This should be established on an industry wide basis with the involvement of all the important stakeholders. Such a system would lower the cost of procurement and therefore lower the cost of mining, thereby extending the life of the operations. It will also make it easier for new suppliers of goods and services to enter the market.

Trade fairs: Local suppliers should, in collaboration with existing trade fairs, be encouraged and assisted in participation in those fairs, as a step to becoming more internationally focused. An electronic information sharing system should be created for local procurement and supply.

Research: A collaborative approach needs to be encouraged between private sector mining companies. For this to work, an understanding has to be developed among the companies from which they will benefit by adopting a common approach to dealing with technical problems common to the industry. Such an approach will help lower the cost of operations and help place the mining sector supplier in a stronger position to compete internationally. The example of Finland provides a good practice of the benefits of this type of approach (Walker, 2003).

Mozambique

Overview

This section of the report provides a review of the mineral industry in Mozambique. The Mozambican experience of resource-based industrialization differs quite significantly from that of South Africa. While in South Africa, mining triggered the growth of the manufacturing and tertiary sectors in the economy and has a century-long history, in the case of Mozambique, the Government's decision to leverage the inherent mineral wealth to initiate development is a relatively recent phenomenon. Mozambique is, in many ways, in the initial phase of economic growth, with development limited to the establishment of industries associated with identified factor endowments, particularly labour and abundant natural resources. Despite this, the Mozambican experience offers a valuable lesson to other developing countries at the edge of the development continuum with regard to the proaction and receptiveness of both the Government and private sector to fostering an environment conducive to economic growth.

In order to understand the dynamics and extent of economic clustering associated with the extraction, processing and export of mineral resources in Mozambique, this section commences with a review of the prevailing macroeconomic context and economic history of the country. The discussion then shifts to a synopsis of the structure of the mineral industry, the mineral resource base, the key role players in the industry, and the economic significance of the sector to overall national growth and development.

Two examples of clustering at the meso-level are explored, and consideration is afforded to the impact that future, large-scale, capital-intensive, resource-based activities will have at the national, provincial and local levels. An example of an artisanal mining cluster at the micro-cluster level is examined as the small-scale mining sector is often overlooked in economic analyzes of clustering activities and its importance in poverty reduction is underestimated. However, in the case of Mozambique, the artisanal mining sector is a clear example of micro clustering with important direct and indirect economic spin-offs at the local level.

Although every attempt has been made to include both a qualitative and quantitative dimension in the analysis of linkage development and clustering, the parameters of the study have been influenced by the relative paucity of data and the short time frame. Nevertheless, the Mozambican experience offers a valuable set of lessons relevant to other countries in the SADC region, as well as the rest of the African continent.

The Mozambican economy has experienced a considerable boom in the past few years. Indeed, since 1992 the country has recorded an average annual growth rate of 8% and is one of the fastest growing economies on the continent. In the 1998 African Competitiveness Report (ACR), economic prospects for Mozambique's future were documented as being highly positive. The ACR listed Mozambique among the leading countries in the region in terms of economic improvement and optimism. Furthermore, UNCTAD's World Investment Report 1999 listed Mozambique as one of the top 10 business-friendly countries in Africa. Despite this growth and sentiments expressed by analysts, Mozambique remains one of the poorer countries in the SADC region, and the world, with a GDP per capita of \$ US 220.00 in 2001. Thus, growth is off a very low base (Pretorius, 2000; Sunday Times, 2003b).

The objective of obtaining increased private sector involvement in the sector, notably by Mozambican owned firms, has failed to materialize during the 1990s because of lack of technical skills, lack of access to financing, and limited support by the public mining institutions (National Directorate of Mines and the National Directorate of Geology). Furthermore, the low domestic savings that characterize the present structure of the Mozambique economy implies that the main source of capital for large-scale investment in the mining sector can only come from foreign direct investment (NDM, 2002).

A distinctive characteristic of the recent economic growth and investment in Mozambique has been the role played by geographical proximity and cultural factors in influencing the pattern and location of inter-regional FDI flows. The Mozal smelter would not have been established in Mozambique had the access to cheap electricity and the existence of a successful aluminium industry in Richards Bay not been present. Pretorius (2000) suggests that regional economic cooperation among countries in the SADC region, such as that undertaken between South Africa and Mozambique, may be a possibility with which to stimulate further intra-regional FDI and economic gains from efficiency seeking restructuring of industry. However, this may not always be a favourable approach as businesses in countries such as South Africa are generally larger and more powerful than some governments and most producers in the region, and therefore may actually undermine the development process through exploitation. Furthermore, while large-scale investments by multinationals such as BHP-Billiton do contribute to growth and development in their host countries, it is not always sustainable. Technology- and knowledge-intensive activities are developed and housed in the more industrialized countries, so the opportunities for knowledge transfer and continuation of R&D at the local level are limited. When the smelter is eventually closed down, there may be very few lasting industries from which to stimulate lateral migration linkages and high-tech input clusters (Pretorius, 2000; Sunday Times, 2003a).

Although an increase in FDI will undoubtedly contribute to an increase in the overall GDP per capita in Mozambique, such an increase in GDP may actually perpetuate income inequality given the lack of labour - absorbing economic activities in the country.

Investment in infrastructure (e.g. roads and ports) does not guarantee an egalitarian distribution of income; neither does the construction of a large resource-based investment project automatically result in the integration of the poorer members of the population into the economy (Pretorius, 2000).

Pretorius (2000) cautions that the involvement of the private sector in the establishment of large-scale, capital-intensive anchor projects in developing countries such as Mozambique should not be regarded as a panacea to all development problems. The private sector's ultimate objective is to ensure return on investment. Private-public partnerships are essential for ensuring the viability and long-term sustainability of such ventures. The involvement of the public sector is critical for ensuring that the revenues generated through the project's commercial activities are distributed and reinvested into the economy in a fair and equitable manner and to avoid the emergence of "enclaves" of economic activities. Moreover, public sector involvement is critical for providing political and commercial guarantees to the project financiers, ensuring community participation and environmental sustainability, and most importantly, providing macro-economic stability and good governance.

History and Macro-economic Context

Vasco da Gama's arrival in Mozambique in 1498 heralded Portuguese involvement in the area. Driven by territorial and commercial objectives oriented around the trade of gold, ivory and slaves, initial development in Mozambique concentrated around the coastal areas. The Portuguese showed little interest in investing in and developing Mozambique beyond the status of a trading station and only a few permanent settlements emerged. In the 18th century, an initiative was undertaken by the Portuguese Government to attract settlers to the interior of the country through the provision of land grants. However, as the commercial significance of the area was still based on the trade of slaves this incentive failed to trigger the expected development impulses. In the late 19th century, Portugal leased peasant farmlands in the northern part of Mozambique to British companies who converted the land into plantations and exercised complete, quasi-governmental authority.

Reaction to colonial rule commenced in 1964 with the formation of the Frelimo Liberation Movement, which launched a guerrilla campaign from bases in Tanzania. The ensuing war ended in 1974, following a coup in Lisbon that brought to power a new Portuguese government that pursued rapid decolonization. Mozambique was granted its independence in June 1975. The Frelimo Government began to establish a Marxist-type state, nationalizing industry and creating agricultural collectives. These developments were accompanied by the mass emigration of mainly white Mozambicans – the predominantly skilled, manual, technical, and professional class – that severely weakened the nation's economy.

In the late-1970s, the Frelimo Government supported the liberation movement in Zimbabwe (then Rhodesia) by permitting it to use bases within Mozambique. In retaliation, Renamo (the then Rhodesian Government had supported the establishment of Renamo) carried out guerrilla raids against Mozambique. In the 1980s, conflict erupted into a brutal civil war. Health and education systems collapsed and agricultural production throughout the country ceased. The economic crisis was compounded by a severe drought in the

mid-1980s, which led to widespread famine. By 1990 close to a million people had died, 1.3 million had fled the country and 4 or 5 million were displaced within Mozambique. The civil war ended following the signing of a peace accord in October 1992.

Since 1996, the Mozambican Government has accelerated the implementation of market-based policies, using privatization and price liberalization to substantially reduce the role of the public sector in the economy. Particular emphasis has been placed on the development of export-oriented industries and the creation of an investment-friendly environment through the provision of tax incentives and government guarantees. The shift away from Marxist principles combined with the political stability that has prevailed since the 1994 multi-party elections have led to dramatic improvements in the country's growth rate, which has been boosted by foreign and domestic investments and donor assistance. Fiscal reforms, including the introduction of a value-added tax and reform of the customs service, have improved the government's revenue collection abilities. Nevertheless, despite these gains, Mozambique is still dependent upon foreign assistance for much of its annual budget, and the majority of the population remains below the poverty line (EIU Report 69, 2001). A substantial trade imbalance also persists, although it has diminished with the opening of the Mozal aluminium smelter, the country's largest foreign investment project. Additional investment projects in titanium extraction/processing, agro-processing and garment manufacturing should further close the import/export gap.

Owing in some measure to the successful resettlement of war refugees, the low base from which the country started, and these institutional reforms, Mozambique has registered one of the highest growth rates in Africa in the past decade. The average growth rate from 1993-1999 was 6.7%, and between 1999-2002, 7-10%. Sustaining and increasing this level of economic growth over the short- and long-term is a major governmental concern.

Although the Mozambican economy is reasonably diversified in terms of GDP, employment is still heavily concentrated in agricultural-based activities. More than 80% of the population is engaged in the agricultural sector, which contributes 35% to the GDP. The largest economic sector is the service sector, which accounts for 52% of GDP due to increased government spending in the civil service. Industrial and mining activities only contribute 13% to the GDP. Until recently, a major source of household income was derived from remittances from mineworkers employed in South Africa. However, this has declined in importance, owing to the changing employment structure in the South African minerals industry.

Mozambique's physical infrastructure remains underdeveloped by world standards, despite the major upgrading and expansion programmes embarked on after the cessation of the civil war. Areas of major concern are the road network, the telecommunications system, power generation and the provision of water. Fixed telephone and fax services are available in all cities, and cell phone and Internet services are widely available. Mozambique is also endowed with a large, easily trainable, productive and inexpensive labour force.

Against this background, any new large-scale investment project in the country will contribute significantly to the diversification of the economy, stimulate further growth, and boost recent growth trends. In addition, it will boost investor confidence in the country and generate critical foreign exchange earnings to help ease the debt burden. At present, it

is estimated that (excluding the impact of Mozal) only 1.1% of Mozambican export trade value comes from ore and metals, with coal being the leading product.

The Mineral Industry

Mozambique is a natural resource-rich economy, with a diverse and relatively untapped endowment of minerals including coal, natural gas, titanium, gold, rare earth minerals, and various non-metallic minerals. Oil reserves and opportunities for diamond mining also exist. Despite this inherent wealth, commercial mining activities have only recently started to play an important role in the Mozambican economy. Growth of the sector has been historically constrained by incomplete geological data, an undeveloped legal and business environment, and a lack of internal and external financing with which to catalyse the sector (Raphael. 1999). Indeed, prior to independence in 1975 the mining sector was regarded as the “forgotten sector of the economy”, with only one third of the country covered by 1:250,000 scale geological maps; 10 small- to medium-sized mines in operation (mainly coal and tantalite), an outdated Mining Law (enacted in 1906), a shortage of critical skills, training facilities and institutional structures, and a non-existent hydrocarbons sector.

Since then, however, the Mozambican Government has embarked on a gradual process of transforming the mining and minerals processing sector so as to harness the full economic benefits embodied within the transient and static resource base to the maximum benefit of the country. The Government has assumed a primary role in facilitating this process and has instituted three important measures to achieve its goals. First, the coverage and quality of the national geological database has improved. This has largely been driven by various exploration programmes undertaken by both foreign and local companies (mainly focused on heavy mineral sands, gold and tantalite) and via bilateral and multilateral aid programmes. The latter initiatives mainly focused on improving the quality of the geological database at a regional scale, mapping the geological resources, and in some cases, associated geophysical surveys were conducted. Second, initiatives to improve training and human resources have been explored. Third, in the late 1980s, the legislative framework governing the sector was amended in order to make it more attractive to foreign investors and since then exploration activities in Mozambique have increased significantly.

Although only one exploration license was granted in 1990, by 2002, this figure had increased to 628 (Table 11). Initial interest in mineral activities mainly involved local companies and was oriented around gemstones. However, during the mid-1990s a large number of foreign investors began to undertake exploration in various metallic minerals including gold (e.g. Ashanti, Trillion Resources) and heavy mineral sands (Billiton, Kenmare, Southern Mining). Foreign companies are currently exploring a diverse range of other minerals in Mozambique including base metals, nickel and coal.

The Mineral Resource Base

The Mozambican mineral resource base is both diverse and extensive and comprised of metallic metals, industrial minerals and hydrocarbons.

Table 11: Exploration Expenditure and Licences Issued

Year	No of Licences Issued (Cumulative)	Exploration Expenditure (\$)
1997	313	13 184 981
1998	361	12 988 475
1999	394	17 959 020
2000	463	16 806 187
2001	514	18 745 676
2002	628	4 616 040

Source: MIREME

Gold deposits are located in three main greenstone belts located in the provinces of Niassa, Tete and Manica. The latter greenstone belt is the largest, offers the greatest potential for exploitation, and is currently being re-examined. A number of small alluvial gold deposits are found throughout Tete, Manica, Niassa, Zambezia, Nampula and Cabo Delgado and are largely the domain of the artisanal mining sector.

Mozambique houses a significant proportion of the world's known and accessible mineral sands deposits. The most important deposits that have been identified and reviewed for extraction and processing include:

- The Corridor Sands deposit, situated near the town of Chibuto in Gaza province, and owned by the Australian mining giant, WMC Resources Limited.
- The Moma deposit located along the Nampula coast and owned by Irish junior exploration company, Kenmare Resources.
- The Moebase deposit situated in Zambezia along the coast and owned by BHP-Billiton.

Feasibility studies have been completed for the Corridor Sands and Moma deposits and it is likely that both projects will come into operation during the current decade (Industrial Minerals, Jan 2003).

The most significant reserves of pegmatites are found in the Alto Ligonha region of Zambezia province. The three most important pegmatite bodies within the reserve are the Muiane, Morrua, and Marropino pegmatite bodies together with associated occurrences nearby. Prior to the outbreak of the civil war in the 1980s, the mining of these pegmatites made Mozambique an important producer of tantalite. After years of closure, the Morrua and Marropino mines have resumed operations and the Muiane mine is forecast to start up operations early next year. In addition to tantalum bearing minerals, the pegmatites also host numerous other minerals including caesium and lithium minerals, gem quality quartz, beryl and tourmaline, topaz and kaolin. As these can all be recovered as by-products, there are numerous economic opportunities to further exploit these reserves. While other smaller pegmatite bodies are scattered throughout Mozambique, they have mainly been worked by the small-scale mining sector. Gemstones such as aquamarine, rose quartz, emeralds, hard rock and alluvial garnets are the main products recovered by artisanal mining methods.

Mozambique is relatively richly endowed with coal reserves. The most important deposits are the Moatize-Minjove and Mucanaha-Vuzi coalfields located in the Tete province. The Moatize deposit is one of the largest resources of coking coal left in Africa and has the potential to support a large-scale operation. It is currently mined on only a very small scale. No meaningful development of the deposit can be contemplated until the Senaa railway line, which connects the area to the port of Beira, has been rebuilt.

Mozambique also possesses a variety of industrial minerals. These include bentonite, small deposits of bauxite, dimension stone, ornamental stone, and graphite.

Industry Structure and Organization

At the macro-level, private-sector-mining activities are characterized by eight small operating mines and one large-scale, resource-based beneficiation plant. These activities are complemented by a large, relatively unskilled artisanal small-scale mining sector.

There are currently no large-scale mining operations in Mozambique. Formal mining sector activities are limited to the operation of eight small mines and a number of small-scale gravel and crushed stone operations scattered throughout the country. Mines currently in operation are listed in Table 12.

Table 12: Operating Mines, 2003

Mine	Commodity	Province
Mina Alumina	Bauxite	Manica
CDM	Bentonite	Maputo
Moatize coal mine	Coal	Tete
Milamor	Dumortieritic Quartzite	Tete
Marmonte	Marble	Cabo Delgado
Marropino	Tantalite	Zambezia
Morrua	Tantalite	Zambezia
Muiane	Tantalite	Zambezia

Source: MIREME

The production of these mines is shown in Table 13. Current mineral sector beneficiation activities are limited to the operations of Mozal, a world-class aluminium smelter. The future development of the Mozambican formal mining sector rests principally on the development of two world-class heavy mineral sand operations, the Corridor Sands project in Gaza province and the Moma project in Nampula province. There are also several smaller development projects underway, primarily for the mining of black granite and niobium-tantalite.

Table 13: Mineral Production and Exports 2002

Mineral	Unit	Production	Exports
Bauxite	Ton	9 119	9 119
Bentonite	Ton	16 174	19 040
Tantalite	Ton	47	45
Beryl	Ton	54	18
Granite	M ³	670	607
Gold	Kg	17	21
Aquamarine	Kg	26	7
Tourmaline	Kg	124	70
Limestone	Ton	1 301 232	0

Source: MIREME

Mozambique has a large artisanal mining sector that is estimated to provide a means of livelihood to about 50,000 persons in the country. It is a people-initiated and direct poverty alleviation measure for the country as a whole, with little cost and limited intervention on the part of the Government. It thus forms an important part of the country's economy, particularly the informal sector, though its contribution is hard to quantify. This sector is dealt with in section elsewhere in this study.

Legislation and the Management of Mineral Resources

Since the cessation of hostilities, the Mozambican Government has assumed a far more proactive approach towards the promotion and attraction of industrial activities in the country. A number of important initiatives have been fundamental in heightening awareness of the country's economic potential and opportunities for development. These include amendments to the mining legislation and the establishment of numerous incentive structures such as the Matola Investment Development Zone.

Mining Legislation

The original Mining Act in Mozambique was passed in 1906. However, during the 1980s, the government realized that in order to attract investors to help develop the sector, the prevailing legislation needed to be drastically amended. In 1986, a new Mining Law was passed which, together with the associated Mining Law Regulations, opened the mining sector to the private sector. In 1994, the Mining Certificate Regulations Act was passed to accommodate the needs of the informal mining sector, and the Mining Fiscal Regime Law was introduced. The latter piece of legislation took cognisance of the high-risk capital-intensive nature of mining and introduced a number of special incentives to aid the growth of foreign investment and domestic industrial expansion. The Minerals and Precious Metals Law was passed in mid-1995, with the primary objective of promoting the trade of precious metals, precious and semi-precious stones through normal channels. In

February 1998, the Mozambican government reviewed the legislation passed since 1988 and adopted a new mining policy.

Essentially, the policy outlined the key goals and vision of the Mozambican mining sector and reinforced the constitutional assertion that natural resources located in and beneath the soil of Mozambique are the property of the State and should be developed to the benefit of the broader economy. The policy, moreover, took cognizance of some of the key constraints hindering the growth of the mining sector in Mozambique and identified factors needed to boost development, in particular:

- The importance of having a stable legal environment;
- Shortcomings in terms of infrastructure;
- The need for an incentive structure to help offset disproportionate infrastructure costs for all investors; and
- The need for the further beneficiation of the country's mineral resources.

The new policy also affirmed the Government's intention to continue with the restructuring and privatization of state-owned mining operations. With regard to mineral rights, the new Law sought to:

- Provide greater transparency in the awarding of mining rights,
- Reduce the scope of discretion by the regulatory authority, and
- Provide greater security to the holders of rights, from initial reconnaissance to the mining stage.

A five-year plan extending from 1998-2002 which aimed at increasing the production and export of mineral products, promoting geological mapping, and increasing capacity within the sector's institutions was subsequently developed.,

In order to further facilitate the development of the mining sector, the government launched an in depth review of the sector in 1999. This culminated in the issue of a new Minerals Law in 2002, which replaced the previous law. The new Mineral Law "regulates the terms for the exercise of the rights and obligations related to the use of and exploration of mineral resources, respecting the environment, with the view of their rational utilization and for the benefit of the national economy, prospecting for, and optimal exploitation, processing and utilization of minerals". As such, it recognizes the important role that the Government has to play in ensuring a complementary and supportive approach to the management and use of the Mozambican mineral endowments. Furthermore, it highlights the importance of a sound legal and fiscal environment for exploration, mining, mineral processing, beneficiation, and marketing-related activities (Levy and Caldeira, 2001).

The ministerial body responsible for fulfilling the Government's objectives with regard to the mining and energy sector is the Ministry of Mineral Resources and Energy (MIREME). A number of other ministries provide oversight in specialized areas including, the Ministry for the Coordination of Environmental Affairs (MICOA), the Ministry of Finance and the Ministry of Agriculture. Despite a deep commitment to furthering growth of the minerals and energy sector, activities and overall levels of efficiency within

MIREME (especially with regard to the artisanal mining sector) are constrained by a lack of critical resources, particularly adequate equipment, financial resources, and qualified and trained staff. In order to encourage the expansion of private investment in mining in a socially and environmentally friendly way, the World Bank has funded the Mineral Resources Management Capacity Building Project (MRMP) in order to build capacity both within MIREME and associated institutions. The project has several sub-components and commenced in 2002, and is scheduled to end in mid-2006. In particular, the aims of the Project are to:

- Build institutional reform capacity in public institutions in order to strengthen policy-making, regulatory and sector management capabilities, and improve the legal framework;
- Develop the country's geological infrastructure in order to complete the coverage of geological maps and airborne geophysical data as well as facilitate access to information through the computerized Minerals Information System;
- Develop an Environment Management System which will include the realisation of environmental audits to improve the level of knowledge of the current situation and the development of a computer-based system and databases to assist in the environmental administration of the sector; and
- Develop a sustainable small-scale and artisanal mining sector by improving technical, social, environmental and economical conditions.

Investment Incentives

A number of programmes and interventions have recently been undertaken by the Mozambican Government in an effort to create a business environment conducive to foreign investment. These include:

- Implementing a range of direct investment incentives including exemption from indirect taxes on equipment, cars and raw materials for first production cycle; significant reductions in corporate and indirect taxes for up to 10 years for new entities; and regional tax allowance.
- Establishing special institutions to provide investment and trade support, including Centro de Promoção de Investimentos (CPI), the Mozambique Institute of Export Promotion (IPEX), the Business Associations Working Commission (CTA), which aims to improve the business environment by facilitating dialogue between the public and private sectors and the local Industry Development Institute (IDIL), which attempts to further rural development by promoting the establishment of agri-industries and other industries.
- A programme to reduce administrative barriers to trade and investment, which is being managed by the Ministry of Investment and Trade, but involves all relevant Ministries.
- Introduction of more flexible exchange controls
- The passing of the Investment Law of 1993, which offers a range of investment guarantees relating to security of property rights, repatriation of capital and profits, and so on.

The Government also passed legislation for the establishment of Industrial Free Zones (IFZs). The “IFZ Decree” (Decree No 62/99) defines an Industrial Free Zone and sets forth the benefits available to operators of such a zone and the companies licensed to operate in them (Levy andCaldeira, 2001). Beneficiation activities are eligible for IFZ status, although mining activities are excluded. There are two types of IFZ and their eligibility criteria are based on the number of workers employed and the percentage production exported:

- Multiple-use IFZ: The delimited area must contain qualifying firms that collectively employ at least 500 Mozambicans and every qualifying firm within the area must employ at least 20 Mozambicans. The Beluzone Industrial Park, which was built next to Mozal in Matola, is the first example of this type.
- Stand-alone IFZ: A stand-alone IFZ must employ at least 250 permanent Mozambicans. The CSL operations in Chibuto, together with its jetty facility at Chongoene, will be stand-alone IFZs. Such licences are only granted to projects costing more than \$500 million.

Firms in both type of IFZ must export at least 85% of their production to qualify for IFZ status. Companies situated within the IFZ enjoy a number of benefits. These exemptions for IFZ companies include:

- Industrial Contribution Tax (corporate income tax) and the applicable rate is generally 35%, though this is lower in certain sectors, such as agriculture;
- Customs duties on imports;
- Value added tax (IVA VAT?), which is currently levied at a rate of 17%;
- Specific consumption tax (tax on certain defined high value goods. The exemption does not apply to luxury goods such as liquor and tobacco); and
- Property tax and property transfer tax.

Other special privileges enjoyed by IFZ companies include:

- Non-exemption from the supplementary tax (withholding tax on dividends, capital gains and other distributions such as interest paid to shareholders, interest on bonds issued by the company). For other companies, the tax is levied at a flat rate of 18%;
- Liability, for multi-use IFZs, beginning in the 7th year after their certificates were issued, to pay a turnover tax equal to 1% of their respective quarterly invoices (sales);
- Individual negotiated tax regimes for stand-alone IFZs, the details of which form part of the company’s agreements entered into with the government and formalized by the issue of an Investment Project Authorization (IPA) by the government;
- Foreign workers may comprise up to 15% of the labour complement;
- IFZ enterprises are permitted to open, maintain and transact foreign exchange accounts with the country and abroad; and
- Sales of goods and services by local suppliers to licensed enterprises within the IFZ for use in their operations are considered exports.

In order to encourage investment in the Zambezi valley, the Mozambique Government has also implemented a special tax regime for projects to be developed in districts falling within the Zambezi valley.

The legislative and administrative changes discussed above are largely focused on large companies and projects and have established an investor-friendly environment for such companies. The same is not true for small- and medium-sized enterprises (SMMEs). They continue to operate in a very bureaucratic and permit-driven environment. This significantly increases the cost of doing business and increases the risk associated with establishing new enterprises. In many cases, particularly outside the major centres and in the north, the difficulties are compounded by the lack of capacity in governmental institutions to implement policies. The reforms in many cases have yet to be implemented.

The Contribution of Mining to the National Economy

Historically, mining has played a very small role in the Mozambican economy. At independence in 1975, mining accounted for less than 1% of the GDP. Since independence, the Government has implemented a number of reforms and capacity building activities to transform the mining sector so that it could become a major contributor to the economy. To date these have shown limited results.

After a period of decline due to the civil war, the value of the mineral production has increased since 1990 when the small-scale miners resumed production of gold and bauxite in Manica province to a modest figure of about \$9 million in 1998, being \$8 million from industrial minerals and the balance from gold and gemstones (Raphael, 1999). The contribution of the sector by 1999, excluding the impact of Mozal, to GDP, had increased to approximately 3 and 4% of exports. However, the activities of the artisanal miners cause significant leakage of revenue from the economy. It was estimated that some \$10 million of gold and \$30-40 million of precious and semi-precious stones are illegally exported from Mozambique each year.

The successful commissioning and operation of Mozal has had a dramatic effect on Mozambique's small economy. Thanks to the smelter, the country's exports in the first quarter of 2001, the Mozal's first quarter of full production, were 172% higher than the equivalent quarter of the previous year. Furthermore, the deficit between export revenue and import costs improved to about 50%, instead of over 75%. However, even with the improved earnings, Mozambique remains dependent on aid money for its balance of payments support.

Employment in the formal mining sector is very limited, with direct employment estimated at less than 3,000 persons (Raphael, 1999). The establishment of the Corridor Sands and Moma operations will increase this by some 1500, as they are capital-intensive operations with limited employment requirements. The multiplier effect on indirect employment will be much more significant. In contrast, the artisanal mining sector is a significant employer because of its intensive use of manpower. The sector thus provides one of the few forms of self-employment and income generation in the rural areas, providing seasonal occupation for as much as one third of the active population in such mineralized

areas. It is estimated that the number of people involved in the artisanal or small-scale mining sector in Mozambique number more than 50,000. This number could be as high as 100,000 if seasonal workers and farmers who combined agricultural activities with mining in some periods of the year are included (NDM, 2000).

The future of the minerals industry is linked to the development of industrial heavy mineral projects such as mineral sands as well as, in the longer term, the rehabilitation of the Moatize coalfields. In 1999, the Mining Policy Dialogue Seminar entitled “Attracting foreign mining investment to Mozambique”, organized by the National Directorate of Mines, set a target for the mining contribution to reach a level of 10% of annual exports and 6% of GDP by 2005.

Overview of Mining Cluster Activities

Given the relative ‘newness’ of mining activities in Mozambique following the end of the civil war, it is still too early to talk meaningfully of a national integrated mining cluster in the country. What is particularly interesting in the Mozambican experience, however, is the emergence of distinct meso-clusters. The most impressive example of such a cluster is the whole development complex established around the Mozal aluminium smelter in Maputo. The planned heavy minerals sands development in Chibuto, with its integrated mining, mineral beneficiation and smelting operations, is likely to engender a similar economic impact. While traditionally not considered to be of significant national economic importance, the small-scale mining sector is often overlooked in economic analyses of clustering activities. However, in the case of Mozambique, the artisanal mining sector is a clear example of micro-clustering, with important direct and indirect economic spin-offs at the local level. Each of these three examples of clustering will be explored in turn in the sections that follow.

Meso-cluster: Mozal Aluminium, Maputo

OVERVIEW

Billiton’s \$1.3 billion Mozal aluminium smelter is the largest private investment project of its kind in Mozambique. Billiton’s decision to locate the smelter in Maputo was largely motivated by the availability of cheap electricity from South Africa and Maputo’s favourable position on the south-eastern coast of Africa in terms of accessibility to markets and raw materials. The 250 000 ton per year smelter is the result of a joint venture between Billiton, the Mitsubishi Corporation of Japan, IDC, and the Government of Mozambique. More broadly, it is the result of a joint regional industrial project initiative between the Mozambican Government and South Africa to foster growth in “development corridors”, along major highways linking manufacturing nodes along the corridor with a port. The Mozal aluminium smelter is the key anchor project of the Maputo Development Corridor, which links Maputo, and its Port, with major South African cities along the N12 highway. The success of the development corridor is dependent on foreign

investment in the form of infrastructure provision and establishment of major industries (Pretorius, 2000).

The smelter came on-stream in 2000, six months ahead of schedule and \$100 million under budget, and reached full production in the first quarter of 2001 (Engineering News, 1996a; Billiton World, 2000a; Sunday Times, 2003c). Billiton, together with the other shareholders, viewed the establishment of a world-scale smelter as being a ‘catalyst’ for further economic growth in the SADC region. According to the Engineering News (2000), “Mozal and its unique public and private partnership would be a powerful catalyst for economic development in the region ... In the years to come, Mozal is anticipated to present significant employment benefits to Mozambicans and provide a powerful boost to the Mozambican economy by developing the industrial base and export potential of the region”.

In this section, some of the most notable direct and indirect impacts resulting from the construction and subsequent operation of both Mozal I and II at the local and national level, will be presented.

Qualitative Analysis

Direct Impacts

The Mozal smelter is situated in the Beluluane Industrial Park, 20km from Maputo. During the initial construction of the smelter, the workforce peaked at 4 000 people and 920 permanent positions were created once full production commenced. In terms of ‘up-stream’ impacts, the smelter consumes 600 000 tons of raw materials in the production process. Alumina is sourced from the Worsely Alumina Refinery in Western Australia, electricity from South Africa, and liquid pitch (used in the electrolytic process) from the Japanese company Nippon Yusen Kaisha (NYK). Mozal consumes more than 450 megawatts of electricity each year – approximately twice the power consumption of the rest of the country. In terms of ‘sidestream’ activities, BHP-Billiton spends about \$US 35-40 million each year on the purchase of goods and services required for maintaining operations at the smelter from Mozambican companies (this figure excludes water and electricity supplies). Besides access to technology and expertise (from the Hillside smelter), all the critical inputs (raw materials, electricity, transport, labour, and finance) are accessed at low cost, which gives Mozal a considerable cost advantage over its competitors (Pretorius, 2000).

At any given time, the smelter has between 200 and 250 contracts with local suppliers. Key local ‘sidestream’ suppliers and service providers include Motraco (the transmission company formed to deliver power from South Africa to Mozal and Maputo), the Maputo Port Development Company and CFM, responsible for discharging the alumina ships from Australia and loading the aluminium ingots for export to Europe.

The completion and operation of the Mozal aluminium smelter doubled Mozambique’s exports, generating an annual excess of \$US 400 million in foreign exchange earnings for the country and adding more than 7% to GDP. The construction and operation of the

smelter has resulted in Mozambique emerging as an important exporter to the European Union. Indeed, when Mozambique first started exporting ingots to the EU in 2000, the value amounted to EUR22, 1 million. However, by 2001, this had increased to EUR391.6 million (an increase of 1 672%). In 2001, aluminium accounted for 73% of Mozambique's exports to the EU (www.mozal.com; Sunday Times, 2003c).

Based on this initial economic success, an expansion programme was proposed by BHP-Billiton and approved in June 2001. The \$US 665 million, 253 000 ton per annum Mozal II aluminium smelter effectively doubled the production of primary aluminium in Mozambique. Full production capacity was reached in September 2003. A cost saving of approximately \$US195 million was achieved against the original budget and the project was completed 7 months ahead of schedule (Ricks, 2003). The Maputo province benefited considerably from the construction and operation of the expansion project. In terms of permanent employment opportunities, 318 positions were created within the smelter. Furthermore, during the expansion project, over 5 000 local people were trained in construction skills and about 70% of labour required during the construction came from local communities. The total local direct spend in Mozambique for the project amounted to \$US 94 million and approximately 60 Mozambican firms benefited from the expansion programme. Of this, approximately \$ US 88 million was spent fulfilling local empowerment objectives. Some companies were awarded more than one contract and included companies such as Agro Alfa, Soradio, Kanex, and Padilha Construções. Additional economic impacts include the fact that electrical power consumption in Mozambique rose from 200mW to 1100mW, export earnings increased from \$ US 220m to \$1 billion, and about 5% of Mozambique's 15% rise in economic growth is due to Mozal (www.mozal.com; Sunday Times, 2003c).

Indirect Impacts

The investment of \$ US 1.34 billion used to build Mozal 1 significantly boosted the economy of Mozambique as well as the country's industrial base and opportunities for downstream manufacturing. It was the first major industrial project to be implemented in Mozambique over the past 50 years. The development of Mozal also boosted the economies of Mozambique's major trading partners, South Africa, Swaziland, and Australia through the sourcing of raw material inputs and labour.

The construction of both Mozal I and II generated a number of indirect economic impacts at the community level. One of the most notable impacts was the establishment of the Mozal Community Development Trust (MCDT) in 2001. The Trust is the main body through which BHP-Billiton's community-based projects are undertaken and managed. More than 1% of Mozal's pre-tax profits have been allocated for use in developing the community near the smelter. Although the Trust is primarily focused on projects within a 10km radius of the smelter, it is not limited to this area. Flood relief donations, support of governmental schoolbook distribution programmes, HIV/AIDS campaigns and other national crises and more have drawn them to provinces beyond the target area. During the last year, the MCDT spent approximately \$ US 2 million on 47 initiatives in five key areas: small business development; education and training; health and environment; sports and culture; and community infrastructure.

An important area of support has been in education. Between 2000 and 2003, the MCDT built 25 classrooms in six different primary schools, all within a 10km radius of the smelter and attended by more than 4500 children. The Nelson Mandela Secondary School, which will eventually offer secondary education to 2400 students and employ 30 teachers, is currently under construction. On completion, the school will have 12 classrooms and 2 laboratories. The balance between scholastic development and social development will be addressed with the building of additional facilities, including a sports gymnasium, an auditorium, and a social centre. Three other secondary schools have been completed in order to ensure that the quality of education at other secondary schools is at the highest level. The Matola Secondary School has a fully equipped library and Josina Machel has a computer facility housing 20 workstations connected to the Internet. In total, 8 000 students have benefited from these upgrades. The Matola Industrial School offers training in technical fields and is now in a position to offer more substantial courses due to a donation of welding equipment (www.mozal.com).

Another significant indirect impact has been the development of the Small and Medium Enterprise and Empowerment and Linkages Programme (SMEELP). SMEELP is a joint initiative between the Mozal expansion team, the Mozal operations team, Africa Project Development Facility of International Finance Corporation (IFC) and the Investment Promotion Centre (CPI). It was officially launched on 18 July 2001 with the principal objective of assisting in the uplifting of local businesses by linking local small- and medium- enterprises (SMEs) to the Mozal expansion project's supply chain. This initiative was in accordance with Mozal's broader empowerment policy, which stipulates that management is committed to "maximizing sustainable benefits to the local community using a combined strategy of development and use of local goods, services and personnel, without compromising project objectives". The programme was designed to ensure the successful awarding of at least 25 contracts to local SMEs through four methods: the creation of SME contracts; pre-selection of SMEs; training; and mentorships. In total, 28 project contracts were awarded to the value of \$US5 million. It has been pointed out that the capacities of Mozambican SMEs have increased due to the activities of SMEELP, and many are capable of providing high standards of service to both local and international companies and projects. The established methodology is currently being re-implemented at BHP-Billiton's Hillside aluminium smelter expansion project in Richards Bay (www.mozal.com; Mining Review Africa, 2003).

An additional indirect impact that has arisen in the Beluluane area as a consequence of Mozal has been the construction of local public infrastructure including a residential complex, landfill site, access roads, water supply and telecommunications systems and the formation of the Beluzone Industrial Park.

The Beluzone Industrial Park

Beluzone is the outcome of an initiative initially proposed by the Mozambican Government, through the CPI and Chiefton, an Australian facilities management company, to develop an industrial park in the Beluluane area. The aim was to develop a cluster of suppliers around Mozal in order to accommodate and promote industrial growth and to encourage international investment. Beluluane is located 16 km from Maputo City and is

in close proximity to the Maputo harbour and the main highway leading to South Africa. Beluluane, part of the Matola region, is characterized by a mixture of urban development, small- to medium-sized businesses, and rural areas producing staple crops for local sale. Further urban development is planned for the region and plans are under way to build housing close to the Beluzone as the area develops (<http://www.beluzone.com/>)

The leading enterprise in the area is the Mozal Aluminium Smelter, which occupies 140 hectares in the middle of the Beluzone Industrial Park. Beluzone encompasses the area surrounding it, covering an area of 660 hectares. This area is being targeted for further industrial use and lot sizes range from 3 500 m², averaging approximately 10,000 m². Areas have been set aside for general industry, light to heavy industry requiring several hectares, and large-scale heavy industrial usage. As much as 80% of the land is designated as a Free Trade Zone.

Industries that are envisaged for the area include:

- Companies servicing Mozal;
- Downstream aluminium manufacturing;
- Heavy manufacturing plants (e.g. automotive, engineering);
- Light manufacturing/production (e.g. garments);
- Services industries;
- Value-adding industries;
- Manufacturing primarily for export;
- Training providers: Beluzone technical school;
- Industrial linkages companies;
- Professional services (e.g. health, legal, insurance, accounting, business services etc.);
- Raw material stockpile facilities; and
- Packaging and labelling companies.

CPI acts as the marketing agent for Beluzone and provides potential investors with a one-stop-shop where they can obtain answers on questions about investment, licensing, fees, and customs exemptions (<http://www.beluzone.com/>).

Purchase from South Africa

It has been pointed out that it was largely due to the success of the Hillside smelter that prompted Billiton to proceed with its decision to establish a similar facility in Mozambique (Engineering News, 1996; Billiton World, 2000). Although only half the size of Hillside, many of the key input suppliers and lessons learnt in the construction of the Hillside smelter have been adopted and utilized in the Mozal development. The reliance on South African companies for specific inputs was largely due to the fact that critical infrastructure (roads, bridges, houses, electricity, telecommunications, and a dedicated harbour berth) and skills essential to the functioning of the plant were either lacking or poorly developed in the country. Each contract signed with a South African company not

only resulted in increased capital flows into the country, but also increased the potential for additional employment spin-offs to be created. It can be said that the Mozal project is an indirect effect of the Hillside development.

Although it is not possible to list all the South African companies that benefited from outsourcing contracts, a few have been selected to illustrate the extent and diversity of the indirect impacts of the construction of the smelter on South Africa. It is important to note, furthermore, that many of the firms were also involved in the construction of Hillside Aluminium (Walker, 2001).

- SNC Lavalin-EMS – Responsible for the engineering, procurement and construction management (Engineering News, 1999b).
- Eskom – Constructed a \$100 million, 400 kV transmission system linking the South African power network with Maputo. Eskom provides 435 MW to the Mozal smelter (Engineering News, 1998i; 1998g; 1998h).
- Deloitte Consulting and Isis as well as its subsidiary Keops – Provided the business management system (BMS) and the shopfloor technical management (STM) system for the smelter. The design, development and integration of the various systems took place in Gauteng.
- Kentz South Africa – Provided electrical and instrumentation for the two-gas treatment centres (contract valued at R22 million) (Engineering News, 1998h).
- Reef Industrial Painters – Provided blasting and painting contracts for steelwork. The company was involved in the Hillside development, blasting and painting more than 6 000 tons of steelwork, piping and platework (over a million square metres of surface area was coated on-site) (Engineering News, 1998j).
- Bayside Aluminium and Hulett's Aluminium – Supplied various forms of extrusions and fabricated products (such as busbars) to the smelter (Engineering News, 1998e).
- The 12 000 tons of steel; 3 000 cubic metres of concrete; 600 tons of mechanical items; and, 170 tons of cable required during the construction of the plant were also sourced from South Africa (Engineering News, 1998f).
- Civil contracts, including concrete works, structural steel works, mechanical and platework, as well as electrical implementation was supplied and erected by various South African companies (Engineering News, 1998f).
- South African resources were used in the project management, procurement of services, quality control, quality assurance, inspection, expedition and planning (Engineering News, 1998f).
- In terms of on-site activities, a number of South African firms and individuals were employed in site administration, site supervision, industrial relations, planning, and document and materials control (Engineering News, 1998f).
- South African firms also provided things such as multichoice satellite dishes and vehicles.

The completion of the Hillside and Mozal phase II expansions together with the Bayside production has created a Southern African 'aluminium triangle' with more than 10 % of the world's primary aluminium capacity (Business Report 18 August 2003). This cluster was created in a little over 8 years.

Summary

The Mozambique Government, by open attitude, facilitating legislation and administrative reforms has made major equity and debt investors welcome in Mozambique. This strong encouragement right from the outset of the project, including the attractive tax regime in the surrounding industrial free zone, has made the world take note of Mozambique as an investor-friendly environment. The Mozal project is not only a success for Mozambique, but also a success the whole of southern Africa and as an illustration of what can be achieved through synergistic partnerships and collaboration. The southern African aluminium industry will soon supply around 7% of the world's aluminium production. Moreover, the success of Mozal has acted as a spur to further investment in mega-projects in Mozambique. Many achievements at Mozal II came from some of the experiences and lessons learned from Mozal I, including an improved understanding of how to get the most from the symbiotic relationship between Mozambique and the Mozal team. Commenting at the opening of Mozal II, President Chissano of Mozambique said, "...through partnerships, such as we have on Mozal with BHP Billiton, Mitsubishi and IDC, our country can continue progressing and developing for the well-being of the Mozambican economy and our people" (www.mozal.com).

Incipient Meso-cluster: Corridor Sands Titanium Project

Overview

The Corridor Sands Project (CSL) is based on mining and beneficiating the immense deposits of titanium dioxide minerals located near the town of Chibuto in the Gaza province of Southern Mozambique. The project site is about 190km north of Maputo, and about 50km inland from the Indian Ocean. The deposits were discovered in late 1997, and are one of the largest known resources of titanium dioxide and associated minerals in the world. The size and quality of the mineral deposits are such that the eventual scale of the operations should rival that of the largest in the international titanium feedstock industry and enable operations to continue into the next century.

The project concept envisages building an integrated mining, beneficiation, and smelting complex near Chibuto with an ultimate capacity of 1 million tons of titanium slag per annum. This will include the mine itself and an associated, two-stage mineral processing plant to recover the valuable heavy minerals from the sands. The minerals are ilmenite (iron-titanium dioxide), rutile and leucosene (both nearly pure titanium dioxide) and zircon (zirconium silicate). A smelting complex, located next to the mining and mineral processing operations, will upgrade the ilmenite to produce an 85% titanium dioxide slag and a high-purity iron product. The smelter will start with three furnaces, each with a capacity of 250,000 tons per annum of titanium slag, and build up to eight furnaces by adding one every two years thereafter (Southern Mining, 2000).

The project development will necessitate the construction of a variety of infrastructure. This includes the construction of a 193Km 400-kVa power line, a large-scale water supply system, housing, water purification plants, sewage treatment plants, and an associated general infrastructure. In addition, provincial and national roads linking Maputo to Chibuto will have to be upgraded. The project products will be exported down a purpose built private haul road linking Chibuto to the Indian Ocean coastline, where a finger jetty and bulk cargo loading facility will be constructed, and loaded directly onto ocean-bound ships.

A bankable feasibility study completed in July 2003 confirmed the technical and financial viability of the project. Since then, WMC Resources (WMCR), a major Australian mining house, purchased 100% of the project from Southern Mining Corporation, a South African junior exploration company who found and evaluated the deposit. WMCR is currently finalizing the project structure and anticipates that the project financing will be put in place during 2004, together with the award of the EPCM contract to build the mine and plant. Construction will start in early 2005 and it is estimated that it will take 29 months to complete the construction and commissioning of the three initial furnaces (WMC, 2003).

The project represents the next major beneficiation plant to be built in Mozambique following the success of Mozal. It will involve an initial investment of \$US500 million for a production level of some 375,000 tonnes of titanium dioxide slag per year. This capital amount covers site processing and smelting facilities, an allowance for contingency, and all costs for the electrical power and product export infrastructure. To reach its planned full production level of one million tonnes of titanium dioxide slag per year the project will require a total capital investment of approximately \$US800 million (Corridor Sands Information Brochure, WMC 2003).

The development will take place in the area immediately adjacent to the town of Chibuto, which is a small regional town with a population of approximately 55,000. Both the town and the surrounding area are poorly served in terms of infrastructure. There is very limited formal employment and much of the local income is obtained from remittances.

Contribution to the Economy

This section analyzes the estimated impact of the Corridor Sands project on the Mozambican economy as a whole and on the provincial Gaza economy. It is based on the work done by Black and Tren in 2000 as part of the environmental impact assessment for the CSL project. The study concluded “the Corridor Sands Project will make a significant contribution to GDP in Mozambique, creating many new job opportunities in the process, and ultimately encouraging new investments in many other sectors within the local economy” (Black and Tren, 2000).

The impact is measured in terms of its contribution to GDP and employment and was analyzed using an input-output based model of the regional multiplier and accelerator. The methodology used to estimate the impact of a new project – in this case the CSL project – is essentially the same as that used for an existing sector or industry (e.g. the

macro-mining and meso gold mining clusters in South Africa), as set out in section 5.1.3 above. The chief difference is that for a new project, one has to distinguish between the construction and operational components of the project. The construction component represents a temporary impact only, but often has significant backward linkage effects in the local economy. In contrast, the operational component represents a permanent net injection of wealth into both the provincial and national economy.

As before, a distinction is made between the direct (V_{mr}), indirect ($\sum V_{jr}$) and induced effects (determined by the multiplier, k_r) during both the construction and operational phases, and the total effect is expressed in terms of both additional income generated (or contribution to GDP, Y_{mr}) and the number of new job opportunities created.

The spending multiplier factor (k_r) differs from that used in the South African analyses referred to in 5.1.3, as the economic parameters in Mozambique differ significantly from those of South Africa. A value of 1.8 was used in this report and was estimated using the following formula:

$$k_r = 1/(1 - (b - m)(1 - t))$$

Where:

- k_r = The spending multiplier factor
- b = The marginal propensity to consume and was estimated to be 0.9. This implies that the average consumer will spend 90% of any increase in their earnings (net of taxes), i.e. they will only save 10% of such an increase;
- m = The marginal propensity to import and was estimated to be 0.38. This means that on average 38% of any additional consumption made possible by the project will be spent on imported goods and services;
- t = The combined effective direct and indirect average tax rate and was estimated at 0.15 (i.e. 15%).

The above three parameters are all empirical estimates, made using data collected from the Mozambique national accounts.

Construction Phase

For the purposes of this study, construction on the project is assumed to start on 1 January 2005 and the construction phase has been broken up into two phases:

- The Initial Construction Phase. This phase covers the first 42 months of construction during which time three furnaces will be erected; and
- The Subsequent Expansion Phase. This phase covers the next 10 years during which time a further five furnaces will be erected, one every two years.

The total impact and number of jobs created by each phase, in both Gaza and Maputo Provinces, are shown in Tables 14 and 15 below.

The construction impact is significant. It differs from most other major capital projects in that the construction input continues over a long period of time (14.5 years), because

of the stepped build up in production. Analysis of the forecast construction expenditure showed that the value added or wages (and profits) component generally varies between 6.25% and 9% of total capital expenditure. A figure of 7.55 percent rather than the median of 7.63 %, was assumed for the model in order to allow for a small initial wage/salary leakage. It was assumed that for the non-wage component (i.e. the remaining 92.45%) that some 92% of it will leak from the Gaza Province in the form of capital and materials imports. This large leakage is because there are no industries in Gaza Province able to supply any of the required products.

The construction phase will result in the direct expenditure of \$US102 million over a 14 and a half-year period in Gaza Province, and a further \$US33 million for the rest of Mozambique. Backward linkages (indirect economic benefits) add \$US76.7 million or \$US5.3 million per year of benefits to the country during the same period. Induced benefits result in a further \$US170 million, which will make a significant indirect contribution to the gross domestic product of Mozambique.

Table 14: Construction impact (Phase 1)

Area		Gaza Province	Maputo Province	Mozambique
Value Added to GDP	Direct	39.1	12.9	51.9
	Indirect	0.003	29.4	29.4
	Induced	31.3	33.7	65.0
	TOTAL	70.4	76	146.3
Jobs created	Direct	2,300	275	2,575
	Indirect	0	481	481
	Induced	1,840	605	2,446
	TOTAL	4,140	1,362	5,502

The direct impact of the initial construction phase will be greatest in Gaza Province. The construction will be labour intensive and the company intends for the large proportion of the semi-skilled labour force will be recruited locally. The Chibuto area is traditionally a major recruiting area for the South African gold mines and is therefore characterized by a pool of workers experienced in working in large, mining-related environments. It is also envisaged that skilled construction workers, who developed their skills during the construction of Mozal, will be attracted to Chibuto from Maputo.

The local indirect backward linkages will be negligible during the initial construction phase, as there are no industries in Gaza province able to supply the necessary goods and services. The majority of the backward indirect impact will occur in Maputo Province where a cluster of firms has been established as a result of the construction of Mozal. These firms range from suppliers of professional services to small engineering-support companies.

The induced effects will be strong in both provinces. The presence of a large, well-paid (in a relative sense) group of workers will lead to a strong induced effect on the Chibuto economy. In Maputo province, much of the induced effect will be driven by the fact that initially the local Mozambique suppliers of goods and services are based in either Maputo or Matola. In addition, all equipment and supplies will come via Maputo, some via Maputo Harbour and others by road from South Africa.

The picture is similar for the second phase though the indirect effect is somewhat larger for both provinces.

Table 15: Construction impact (Phase 2)

Area		Gaza Province	Maputo Province	Mozambique
Value Added to GDP	Direct	63.1	20.5	83.6
	Indirect	0.7	46.7	47.4
	Induced	51	53.7	104.7
	TOTAL	114.8	120.8	235.6
Jobs created	Direct	1,152	139	1,291
	Indirect	5	244	249
	Induced	926	306	1,232
	TOTAL	2,083	689	2,772

Although Mozambique will be the main beneficiary of the long-term impacts of the construction of the mine and smelter in terms of foreign exchange earnings and investment flows, South Africa will benefit significantly from the construction of the smelter, particularly in terms of the procurement of goods and services. It is expected that about 50% (R3 billion) of the plant's capex will be spent in South Africa, subject to the receipt of competitively priced tenders from local suppliers, engineers and contractors. Thus, huge regional benefits should flow.

As with Mozal, the reliance on South African companies for specific inputs is largely due to the fact that critical infrastructure (roads, bridges, houses, electricity, telecommunications, and a dedicated harbour berth) and skills essential to the functioning of the plant are either lacking or poorly developed in the country. Each contract signed with a South African company will not only result in increased capital flows into the country, but will also increase the potential for additional employment spin-offs to be created.

The establishment of the Corridor Sands Project will necessitate the addition of several other capital investment projects, including:

- A new residential area in Chibuto;
- A new potable water plant to supply portions of the town;
- A new sewage reticulation system to supply portions of the town;
- A 400 kVa power-line from Matola to Chibuto;

- Bulk cargo export facility at Chongoene; and
- upgrading of the existing Chibuto airstrip.

These projects will have a huge impact on the Mozambique economy, making direct, indirect and induced contributions to GDP in a manner similar to the other components of the project. Although no specific details on the number of jobs created are available, it is clear that the additional expenditure of approximately \$100 million will result in considerable indirect and induced value added benefits to the national economy. However, most of the new jobs would be for the construction phase, and therefore of shorter-term duration than employment benefits during the operational phase of the mine and smelter.

Operational Phase

The Corridor Sands resource is large enough to sustain production at full capacity (eight furnaces) for more than 100 hundred years. However, the financial evaluation of the project is based on a 22,5-year period with initial production commencing 18 months after the start of construction activities, which gives a production life of 21 years. The reason that the life of the operation is restricted for the purposes of the financial model is because discounting any cash flow from beyond 23 years in the future becomes virtually meaningless.

The economic analysis in this report assumes the same project life as that used in the financial evaluation of the project. The cumulative effect of the value added to GDP and to employment over the 21-year period of the operation is shown in Table 16.

Table 16: Production impact over life of operation (21 Years)

Area		Gaza Province	Maputo Province	Mozambique
Value Added to GDP	Direct	530. 9	110. 5	641. 4
	Indirect	90. 1	190. 9	281. 1
	Induced	496. 8	241.2	738. 3
	TOTAL	1 117. 9	542. 7	1 660. 6
Jobs created	Direct	1 179	321	1 501
	Indirect	475	608	1 083
	Induced	1 325	743	2 067
	TOTAL	2 979	1 672	4 651

Once operational, the project will result in considerable direct benefits at provincial and national levels. The value added to the Gaza Province will be in the order of \$US531 million, and for the rest of Mozambique in the order of \$US110 million, giving a total contribution of \$US641 million. The operations will also generate a substantial amount of indirect and induced economic benefits at both provincial and national level. Indirect and induced benefits of approximately \$US1 000 million for the country as a whole (\$US587

million for Gaza Province and \$US432 million for the rest of the country. The operation phase will result in permanent (over 21 years duration) jobs for 4 651 people.

The total contribution of the production phase to Mozambique's GDP comes to \$1.7 billion, or \$79 million per year, giving rise to the creation of an estimated 4 651 new job opportunities. The latter estimate, as before, is the weighted average annual number of job opportunities for the two components of the production phase.

The total value added figures as shown in Table 16, as calculated by Black and Tren, have been adjusted to reflect the annual impact of the operation for a three-furnace operation and an eight-furnace operation for Mozambique as a whole. The results are shown in Tables 16 and 17. In both tables, the % of GDP figures represent the value added measured against the Mozambique GDP for the year 2000, which was \$ US 3.6 billion. The percentage of jobs added are measured against the estimated number of formal jobs in 2000, excluding the agricultural sector, and were estimated to be 1,380,920.

Table 17: CSL Initial Operation (3 furnaces)

Value Added Area	\$ (Million)	% of GDP	Jobs	%
Direct	19.3	0.54	885	0.06
Indirect: Backward linkages	5.8	0.16	411	0.03
Indirect – forward linkages	0	0	0	0
Induced	14.7	0.41	1,037	0.08
Total	39.8	1.11	2,333	0.17

As expected, the direct impact of the operations will be greatest in Gaza Province. The operation is however, capital intensive, and labour only forms a small component of the operating cost (12.2%). Mining will be done by a specialist contractor and accounts for 23.4% of the total operating cost, but most of this will be accounted for by equipment amortization, fuel, and maintenance costs as very large-scale, earth moving equipment will be used. The majority of staff needed on the plant and by the contract miner will consist of semi-skilled to skilled artisans. The company intends that a large proportion of the semi-skilled labour force will be recruited locally. As discussed above, the Chibuto area is traditionally a major recruiting area for the South African gold mines and as a result, it is characterized by a pool of workers experienced in working in large mining related environments. It is also envisaged that skilled artisans trained by Mozal will be attracted to Chibuto from Maputo.

As discussed earlier, the indirect effects of a project are strongly associated with the maturity of a cluster. Consequently, the indirect linkages for the incipient CSL cluster are proportionally smaller than those of an analogous cluster in South Africa. The local indirect backward linkages will remain smaller than an equivalent project in South Africa as there are limited firms able to supply the necessary goods and services.

Like Mozal, there will be a high level of leakage to South Africa. Electricity, anthracite, and electrodes collectively account for 38.1% of working costs and will all have to be sourced from outside Mozambique. The electricity (23.1% and electrodes (6.6%) will be sourced from South Africa. The mining equipment consumable and most of the ongoing capital goods, such as mining machinery will be sourced from South Africa. Anthracite (8.4%) will be sourced from Vietnam. The majority of the backward indirect impact will occur in Maputo province, where a cluster of firms has been established as a result of the construction of Mozal. These firms range from suppliers of professional services to small engineering-support companies.

The project, as envisaged by the developers, will have no forward linkage effects. The four products, titanium slag, ductile iron, rutile, and zircon will all be exported, mostly to Europe, the USA and the Far East. There are however, some limited opportunities for further beneficiation and these are discussed below.

The induced effects will be strong in both Provinces. The presence of a large, well-paid (in a relative sense) group of workers will lead to a strong induced effect on the Chibuto economy. In Maputo province, much of the induced effect will be driven by the fact that initially the local Mozambique suppliers of goods and services are based in either Maputo or Matola. In addition, all equipment and supplies will come via Maputo, some via Maputo Harbour and others by road from South Africa.

Table 18: CSL Full Operation (8 furnaces)

Value Added Area	\$ (Million)	% of GDP	Jobs	%
Direct	61.8	1.72	1, 565	0.11
Indirect: Backward linkages	18.6	0.52	1,155	0.08
Indirect – forward linkages	0	0	0	0
Induced	47.0	1.31	2,176	0.16
Total	127.4	3.54	4,896	0.35

Enclave or Cluster?

The CSL project is a robust, long-life project that will make a significant impact on the Mozambican economy, albeit off a small base. Given the immense size of the Chibuto heavy mineral sands resource, this impact is likely to remain for many years past the time reflected in the above section. The challenge facing Mozambique is how to optimize the linkages between CSL and the rest of the economy.

The nature of this project as a capital-intensive, one-site integrated mining, mineral processing and smelting operation exporting all its production through its own jetty facility, is that it could easily become another example of a classic mining enclave. The project promoters in their planning, are aware of this danger and have attempted to alleviate the

problem by proposing action in three areas: employment, training and provision of local infrastructure. In addition, quasi-governmental organizations, such as the Limpopo Valley Spatial development Initiative, have commissioned studies to investigate the possibility of further benefiting the products before export.

Employment and Training

The developer has a policy of employing as many local residents as possible. The implementation of this will require the investment in training and education. In this regard, the project will learn valuable lessons from the Mozal experience. Furthermore, the company is limited by law in the number of expatriates it employs, and the proportion of expatriates is expected to decrease.

Planning and Infrastructure

The project developer has worked in conjunction with the local and provincial government to draw up an integrated development plan with the objective of maximizing the socio-economic and developmental benefits to be derived from the implementation of the CSL project at Chibuto (DINAPOT, 2002). The planning process was informed by a development vision, accepted by all-important stakeholders, which states:

“To ensure that Chibuto, by capitalizing on the development of the CSL project, establishes itself as an important economic and business centre within Gaza province, which is capable of addressing the infrastructure, social, economic and cultural needs of the broader community in a socially, financially and environmentally sustainable manner such that it leads to improvements in the quality of life for all the stakeholders of the town and surrounding area. This will be based on Chibuto’s growing urban and industrial economy, reinforced by a strong and diversified regional economy, underpinned by mining, eco-tourism and agriculture, and Chibuto’s role as the eco-tourism “gateway” to Gaza province.”

The outcome of the process was the creation of an integrated development plan, which provides the broad framework to accommodate the multiple land-use demands that will follow the development of the Chibuto district. The projects supporting infrastructure requirements are incorporated within the plan. The project developer has established a policy that it will not become a permanent provider of housing and associated services to its employees. Rather it will assist in the development of additional housing and associated infrastructure which will be available for renting/purchase at market related levels by any person, whether a company employee or not. These developments will fall within the municipal boundaries of Chibuto and will assist in the development of the town. Modular water purification and sewage treatment plants to service these areas will be built by the developer on behalf of the municipality, which will operate them and, over time, extend them to serve the rest of the town.

The general principle that the developer has laid down, with the support of the authorities, is that wherever possible:

“Facilities provided by the project should be common user facilities managed by the relevant government department, with initial assistance from the developer” (DINAPOT, 2002).

Downstream Beneficiation Opportunities

These opportunities are limited as the ilmenite will have to be beneficiated (roasted and smelted) to produce a saleable titanium dioxide feedstock suitable for use in the pigment industry or for titanium metal production.

There is no commercial benefit to be derived from establishing a pigment plant to process part or all of CSL’s production. In fact, the establishment would jeopardize the entire Corridor Sands project. The project will be unable to proceed without long-term off-take agreements, which are required by the project financiers in order to mitigate the commercial risk. Under these circumstances, it is hard to imagine that the key pigment producers, given the oligopolistic nature of the pigment industry, would countenance the establishment of rival capacity by or in close association with an essential raw material supplier.

Titanium metal production is unlikely to be viable given the worldwide surplus production capacity and the industry high-cost structure based on current technology. However, this could change dramatically should a new, low-cost, process be developed which would enable Titanium to displace other cheaper but lower performance metals. Such a development is still a long way away. The Cambridge process still has to progress from bench scale test to pilot plant work. In addition, the initial evaluation of the process is that it will still be too costly to significantly lower the price of titanium metal.

There could be a good opportunity to further beneficiate zircon, thus adding significant value. CSL will produce a significant quantity of good quality zircon with relatively low radioactivity, and this should provide a good, easy-to-process feedstock for further processing. In particular, consideration should be given to establishing a plant to produce a very pure zirconia. High purity zircon with sub-micron spherical particles has excellent low temperature application potential in areas such as electronics, oxygen sensors and catalysts. The technology to do this is available in South Africa. An alternative, somewhat lower technology route would be to establish a zircon grinding plant to supply milled zircon to the ceramic industry. The value addition in this route would be limited. Both opportunities would create a few skilled jobs.

The high purity pig iron (HPPI) offers some potential, as CSL will produce large volumes of high-quality HPPI, but have to rely on agents to sell it into a geographically wide range of customers. The prime market for HPPI is as a feedstock to the ductile iron-casting industry, where it competes with low residue scrap. A production foundry located next to the CSL iron plant could benefit from receiving hot metal and thus would save on melting costs. The downside is that such a foundry would have to be a continuous operation, with long production runs. Most such foundries serve the automotive industry and are located close to their customers.

The process of recovering the heavy mineral products from the ore will also produce a large quantity of fines that will be sent to the tailings dam. These fines were produced by the weathering of the amphiboles and consist of a mixture of silt-sized silica fragments and clay. The suitability of making bricks from this material should be investigated, as the Gaza province suffers from an acute shortage of brick-making material and, consequently, local construction costs are very high. This has the potential of generating a large number of jobs at a SMEE level.

Micro-cluster: The Alto Ligonha Pegmatite Field

While large-scale, capital-intensive beneficiation activities are concentrated in the southern provinces of Mozambique, small-scale mining activities are widespread throughout the country. One of the most distinctive examples of micro in Mozambique is found in the Zambezia province and is linked to the Alto Ligonha pegmatite field.

Over 95% of the country's 52,000 miners are small-scale artisans, extracting gold, silver and gems from Manica, Zambezia, Tete and Niassa. It also has many negative consequences to the very people and communities involved, as well as to the general environment (Bugnosen, 1999). There is widespread agreement that artisanal mining causes extensive environmental damage and social degradation and there are major problems associated with trying to formalize and regulate this activity (Meredith Sassoon, 1999). The Mozambique Government is fully aware of both the positive and negative contributions to the economy and therefore has acted accordingly. It has established a department of small-scale mining within the National Directorate to provide the required support and technical assistance. In addition it has instituted a licensing system, which is issued at provincial level, making it more accessible to the miners.

The artisanal mining sector in Mozambique consists of numerous small-scale gold and gemstone diggings, scattered throughout the country. In particular, they are concentrated in the Alto Ligonha pegmatite field, which stretches from northern Zambezia into southern Nampula province, where local peasant farmers mine the majority of the gemstones. In addition, artisanal miners mine and pan for alluvial gold in the Tete, Manica, Niassa, Zambezia, Nampula (Marrupula alluvial gold diggings 70km from Nampula) and Cabo Delgado provinces.

Some of the gemstones are further processed in the small but successful Mozambican lapidary industry. There are presently two facilities, one belonging to Gemas e Pedras Lapidadas (GPL), a formerly state-owned company privatized, located in Maputo, which processes raw gemstones as ornamental stones and then exports them as finished products. In recent years, there have been attempts to increase competition in the sector by allowing other competing cutting and polishing companies to be established, like PALOMA and Tecnominas.

Micro-economic Context

Older Precambrian terrains dominate the Zambezia province. The dominant geology is granite, interspersed with limited areas of meta-sediments. Alto Ligonha lies within this zone, which gives it an economic mineral resource base centred on pegmatite bodies, typically found close to the interfaces between granites and older rocks. The region hosts many minerals, including columbite, bismuth, manganese-apatite, beryl, gold and radioactive minerals. Little wonder three larger-scale mines of Morrua, Marropino and Muiane were developed.

With a population of approximately 3,402,237 people, Zambezia is the second most populous province in Mozambique – after Nampula. The province extends from the mouth of the Ligonha River in the north to the Zambezi delta in the south. The low-lying coastal areas are conducive to the cultivation of rice, maize, cassava, sugar cane and cashew trees and the coastal waters are rich in prawns, lobsters, fish and coral. Along the coast, mangrove swamps flourish and semi-deciduous humid forests and evergreen forests characterize the inland and high-lying areas. Economic activities in Zambezia province are based mainly on agriculture, contributing approximately 50% of the provincial GDP in 2000. Principal exports from the province include prawns, timber, copra, cotton and vegetable oil. There is little or no industrial activity in the province (NDM, 2000; 2003).

Mining is the principal means of cash generation for inhabitants in the Zambezia Province and is primarily of the small-scale or artisanal type. Mineral activities are dominated by the production of tantalite, coloured stones and some gold. The bulk of production occurs in the area bordered in the north by the Ligonha River and in the south by a line between Marropino and Morrua. Output is mainly artisanal, although the tantalite price boom in 2001 resulted in the construction and re-furnishing of three mines. Only two of these, Marropino and Nakasupa, are operational following a subsequent collapse in the price of tantalum. An estimated 50t of tantalite is produced by the artisanal mining sector each year. Coloured stones, mainly aquamarines, tourmalines and gold are mined in the area. In the latter case, output is approximately 10kg and activities usually take place in the dry season, between May and October (NDM, 2000; 2003).

While most of the children in the province attend school, the level of absenteeism is high. Many children participate in mining activities after school. In terms of education, it is estimated that the gross primary school enrolment rate in Zambezia in 2001 was 76%. Most children discontinue school after Grade 5 due to a lack of schools and teachers offering tuition above that level. The adult illiteracy rate is higher than the national average at 75%. The female illiteracy rate in 2001 was estimated to be 89%. Illnesses such as tuberculosis, sexually transmitted diseases (STDs), eye disease, bilharzia, malaria, cholera, and measles are common throughout the province. This is largely due to the lack of clean potable water and sanitary facilities. Only an estimated 17% of the population in the province have access to safe drinking water and 6.6% to sanitation facilities. In 2001, approximately 62% of children under 5-years old were chronically malnourished and according to 1997 statistics, 68% of the population live under the poverty line. In 2002, an estimated 78,000 (26.1% of the national average) maternal Aids orphans were living in the province (NDM, 2000; 2002; 2003) (Appendix 1).

Direct and Indirect Impacts

Mining is mainly undertaken during the dry season, when agricultural activity is low. Mining settlements are well established. Women are equally involved in mining. The men generally work in the extraction process, while women transport the ore away for panning/processing. Children also help with small tasks. Women and men are also both involved in the harvesting of maize and groundnuts. Men prepare the land for planting and the women are involved in the planting, weeding and harvesting. Local miners will engage in agricultural activities in the early morning and then proceed to mining in the mid-morning or at mid-day. In general, between 3-8 people work together in groups at the mining site. Occasionally, the number of individual groups can form a cluster of more than 100 individuals (NDM, 2000; 2003).

As noted earlier, the mining sectors a major source of cash income and employment to rural dwellers in the province. Miners earn approximately twice the average level of earnings in the area. There is a ready market for products extracted at the mine sites. Buyers generally arrive in the afternoons to purchase minerals and gemstones extracted and processed that day. Tantalite can be stockpiled for a later date as the drop in commodity prices has resulted in a low demand for the product. Prices are determined by buyers, many of whom own their own weighing scales. Furthermore, there is an inadequate knowledge of ruling prices, inadequate valuation techniques/methods of gemstones and general lack of tools to quantify the daily output, which result in marketing being a rudimentary affair. Consequently, levels of distrust between buyers and sellers regarding the fixing of prices (for both gemstones and gold) are quite high and a distinct characteristic of activities in the sector. Gold miners receive approximately \$US6.25 per gram against a market price of about \$US11 per gram. This is largely due to the quality of the gold (around 80% Au) being purchased and the buyer's profit margin. Each artisanal miner produces about 33 grams annually, which equates to roughly \$US198 per year. While this level of income does not substantially alleviate poverty, it does contribute significantly to raising the general livelihood of individuals. Income derived from these activities is generally used to purchase clothes, non-agricultural foodstuff and to pay for health services and schooling (NDM, 2000; 2003).

While some artisanal miners have worked on small formal mines, overall levels of training in mining and associated skills are low. Mining activities are also poorly organized and many manual methods of excavation are used. The lack of prospecting skills is evident from "pig-rooting", where mining follows visual occurrences of the ore. Processing of gold and tantalite ends with panning, while gemstones end with cobbing. Mercury is not used in the extraction process and measures are needed to prevent its introduction. Secondary activities related to the small mining sector include equipment such as the manufacture of wooden panning pans (used in the panning of gold and tantalite) and sluice boxes. In general, due to the high cost and unavailability of materials, agricultural and household equipment and tools are used in the panning and extraction process. There is a high degree of sharing and collaboration in the distribution of work and sourcing of equipment. There are no local suppliers of mining equipment (such as hammers, chisels, hoes, etc) or service providers such as repair or sharpening, or lapidary facilities. Apart from informal

retail stalls, there are no permanent retail outlets around the mining sites. There is also a lack of banking facilities to fund entrepreneurial activities (NDM, 2000; 2003).

Miners pay taxes, both the local country reconstruction tax and VAT, at the rate of 17% on non-food items purchased from the barracas. A miner in possession of a bicycle has to pay an additional 30,000 Meticaís per annum in taxes. Similarly, those who drink or who travel in a vehicle have to pay additional duties on alcohol and fuel. These taxes are strictly levied. Depending on the level of income earned, it is estimated that between 10% and 20% of a miner's disposable income accrues to the state in the form of taxes and duties (NDM, 2000; 2003).

There is a general perception from many government authorities and others that small-scale miners are illegal and therefore a nuisance, especially when viewed from an environmental perspective. In some instances, police have been used in an attempt to flush out illegal miners and buyers. Miners are therefore distrustful of authorities and buyers. Alleviating this environment and culture of mistrust is essential if meaningful coexistence and collaboration is to result (NDM, 2000; 2003).

An Assessment of Cluster Case Studies

This section identifies the common interlinked themes running through the two Mozambican meso-clusters discussed above. First, a Porter framework is used to identify the drivers of the cluster development to assist in “unpacking” the complexity of various clusters. Secondly a SWOT analysis, of each cluster is undertaken. A similar analysis is done for the artisanal micro-cluster. The section concludes with a brief summary of the assessment and identifies the implications for policy development.

Drivers of Cluster Development

Meso Clusters

The successful establishment of the Mozal Aluminium Cluster was largely due to favourable factor conditions, both internal and external, and specific Government actions:

Factor conditions

- Political stability: The end of the civil war in 1992, followed by multi-party elections in 1994, opened the Mozambique economy to the world at a time when globalization was spreading throughout the world.
- Regional aluminium Cluster: The Mozal Aluminium Smelter can be seen as an extension of the South African aluminium cluster. The proximity of Maputo to Richards Bay enabled Mozal to utilize the pool of companies supplying goods and services to Bayside and Hillside aluminium plants.

- Access to South African skills pool: The construction and initial operation of Mozal was greatly assisted by Mozal's ability to recruit staff from the Richards Bay Aluminium cluster. This labour mobility allowed the emerging Mozambique aluminium industry to develop despite the lack of any technically advanced construction and smelting expertise in Mozambique.
- Construction of the N4 highway: This provided an easy linkage between the Witwatersrand, where the South African heavy engineering and construction industry is based, and Maputo.
- Access to cheap, reliable power: Aluminium smelting is energy intensive. Maputo's location close to the large power generation capacity of the Eastern Transvaal where there was a surplus power generation capacity (which is forecast to end in 2007), enabled Mozal to lock in the supply of power at a competitive rate.

Demand conditions

- Sustained demand for aluminium: The worldwide demand for aluminium grew strongly during the 1990s and is forecast to continue its growth trajectory into the next decade.

Firm strategy, Structure and Rivalry

- Synergy with the Alusaf: The ability of BHP-Billiton, the major shareholder of the South African (Hillside) and Mozambican (Mozal) projects, to use the same project team for both smelters and their subsequent expansions, helped to significantly reduce both the construction time and cost.

Government

- Mozambican Government investment policies: These created an investor-friendly environment for major projects, primarily through the passing of the IFZ legislation together with the implementation of the programme to reduce administrative barriers to trade and investment.
- Mozambique – South African Government cooperation: Both Governments share a common vision regarding the need to establish a major industrial development in southern Mozambique that would act as a catalyst to the economic regeneration of the region. This led to the two Governments working together to facilitate the provision of power to Mozal sourced from South Africa and the development of the Maputo Corridor to provide an effective link between South Africa's industrial heartland and Maputo.
- The active involvement of IDC: the IDC, with its extensive knowledge of southern Africa and the aluminium industry, played a major role in assisting Mozal to raise finance in the international capital markets. In addition, IDC took an equity stake in both Mozal I and Mozal II and provided export guarantees to many South African contractors and suppliers involved in both construction phases.

The successful establishment of Mozal has created a number of strong drivers that will encourage and assist the further economic development of Southern Mozambique. In particular, the drivers favouring the establishment of the Chibuto heavy minerals cluster include:

Factor conditions

- The availability of large-scale heavy mineral resources: Mozambique hosts the largest known undeveloped heavy minerals resource in the world.
- Critical mass: The rapid establishment of the Mozal smelter complex in Matola has created a sufficiently large demand for goods and services to sustain the development of a cluster of local goods and services companies in the Beluzone Industrial Park.
- Human resource development: A pool of skilled construction workers and plant operators has been created by the training activities of Mozal and its associated companies.
- Local supporting industries: The establishment of the Beluzone Industrial Park and the proactive procurement policies of Mozal (as required in terms of its agreement with the Mozambican Government) have led to the establishment of a small supply cluster around Mozal.
- Community health: The establishment of Mozal has led to a major programme to control malaria in the Matola area. This programme forms part of a larger cross-border initiative between South Africa and Mozambique.
- Improved transport infrastructure: The Mozal development triggered the rehabilitation and upgrading of the Maputo harbour and road and rail links with South Africa.

Demand conditions

- The long-term demand for titanium feedstock is closely linked to the world GDP growth. In particular the demand for titanium slag will increase as the other sources of titanium feedstock become depleted, thus providing a favourable market entry for Corridor Sands.

Firm strategy, structure and rivalry

- The original developers of the Corridors Sands Project recognized early on that in order to be successful the operation needed to be developed as an integrated large-scale operation that included further beneficiation of the ilmenite on site. This required the full-scale involvement of a major mining house possessing a depth of technical skills and a strong balance sheet, as well as the involvement of a major financial institution with experience in funding mineral related developments in Africa. This was achieved in 2003, and the project is now owned and managed by SMC Resources, a major Australian mining house, with IDC as a significant minority shareholder.

Government

- Business-friendly environment: All projects that follow on from Mozal will benefit from the practical implementation of the Government's reforms.
- Concessioning of port and rail systems: This process is providing a much-needed rejuvenation of the overall transport system in southern Mozambique, which had suffered from years of under-investment.
- Security of tenure: The revised mineral rights system has simplified the system of obtaining mineral rights.

Related and supporting industries

- Motraco: Corridor Sands will be able to draw power through the Motraco system, built to transmit power from South Africa to Mozal.
- Local supporting industries: The establishment of the Beluzone Industrial Park and the proactive procurement policies of Mozal (as required in terms of its agreement with the Mozambique Government) have led to the establishment of a small supply cluster around Mozal.

The sustainability of the Mozal and Chibuto clusters will be primarily dependent on:

- Power: The continued availability of cheap power.
- Training: The continued and further development of a local skills base.
- Cluster development: The further development of local supply and services companies
- Good governance: The continued development of the country into a mature democracy underpinned by a culture of good governance.

Micro-Clusters

Factor conditions

- The easy availability of resources amenable to small-scale mining: Mozambique hosts the largest known undeveloped heavy minerals resources in the world.
- Human resource development: A development of a pool of trainers with the ability to provide basic skills training.
- Community health: The establishment of community clinics in the areas where the diggers congregate with the provision of basic health education.
- Improved transport infrastructure: Easier road access will stimulate the development of clusters around the diggings.

Demand conditions

- Improved demand: the establishment of effective marketing channels will improve demand.

Firm strategy, structure and rivalry

- Collaboration: The diggers generally work in small independent groups. The establishment of local associations under the guidance of the Department of Small Mining, to provide training and technical assistance would assist in developing a more efficient, healthy and environmentally acceptable artisanal sector.

Government

- Artisanal, mining-friendly environment: The Government needs to ensure all relevant government departments understand the role that artisanal miners can play in poverty reduction and that they should be viewed as legal workers, provided they obey the general regulations.
- Concessioning of port and rail systems: This process is providing a much-needed rejuvenation of the overall transport system in southern Mozambique, which had suffered from years of under-investment.
- Security of tenure: the revised exploration and mining licence structure recognises and provide for a simpler system of licensing small and artisanal miners.

Related and supporting industries

- Critical mass: The establishment of sufficient small diggings in a region to create a sufficient demand for good and services to sustain the development of a cluster of local suppliers of goods and services.

The sustainability of the Artisanal mining clusters will be primarily dependent on:

- Training: The continued development of the local skills bases
- Cluster development: The further development of local supply and services companies
- Good governance: The continued development of the country into a mature democracy underpinned by a culture of good governance.

SWOT ANALYSIS

A SWOT analysis has been undertaken for the overall formal sector meso-clusters. The results are presented in three tables; the first sets out points that are common to both cases studied and the next two deals with point of particular relevance to Mozal and Chibuto clusters respectively. The artisanal mining micro-cluster is treated separately. As done for the South African cases, the results are not discussed in detail as the points raised in them represent a compendium of issues that have been identified and discussed elsewhere in the paper.

The Meso-clusters

Strengths	Weaknesses
<ul style="list-style-type: none"> • Investor friendly business climate for large investors; • Good reputation with international investors following success of Mozal • Cheap power (potential); • Extent and diversity of potential mineral resources; • Good mining title legislation; • Government focus on improving national geological database and resource management capacity; • Willing labour force. 	<ul style="list-style-type: none"> • No local capital market • Reliance on foreign capital • Country risk premium • Poor physical infrastructure; • Poor logistics infrastructure; • Skills shortages; • Capacity constraints in key government departments; • Reliance on expatriates for skills, and technology; • Inadequate national geological database; • No meaningful local R&D capacity; and • No industry representative body.
Opportunities	Threats
<ul style="list-style-type: none"> • Development of a support industry cluster around each major mineral development: Mozal, Corridor Sands, etc; • Development of mining/power generation cluster around Tete coalfields; • Further large scale beneficiation operations e.g. the Beira Iron Plant • Development of the Moma heavy mineral deposit; • Regional cooperation and integration • Supply additional power into the Southern African power pool; • Draw power from the Southern African regional power pool; • Utilisation of natural gas as alternative energy source for beneficiation; and • Development of human resources. 	<ul style="list-style-type: none"> • Currency and price fluctuation; • HIV/AIDS; • Increasing energy prices; • Projects creating "enclave" type operations; • Insufficient availability of specialist skills needed to run new developments; • Social disruption caused by growing wage gaps as mega-projects such as Corridor start up; and • Political disruption because loci of the major developments lie in the south of Mozambique.

The Mozal Cluster

In addition, the following aspects were found to be particularly applicable to the Mozal Aluminium cluster

Strengths	Weaknesses
<ul style="list-style-type: none"> • Strong government support; • Strong shareholder body; • Part of a major international group; • World class operation; • Cheap robust power; • Willing labour force; and • Good import export logistics. 	<ul style="list-style-type: none"> • Skills shortages; • Capacity constraints in all key government departments; • Reliance on RSA for skills, technology, and power; • Supporting industry cluster still poorly developed; and • No meaningful local R&D capacity
Opportunities	Threats
<ul style="list-style-type: none"> • Development of Mozal/Beluzone industrial cluster; • Development of Chibuto cluster; • Utilisation of natural gas as alternative energy source for beneficiation; • Draw power from the regional power pool via Motraco; and • Regional cooperation and integration • Development of human resources. 	<ul style="list-style-type: none"> • Currency and price fluctuation; • HIV/AIDS; • Increasing energy prices; • "Enclave" type behaviour around Mozal; and • Labour rate inflation resulting from development of other mega projects such as Corridor Sands.

The Proposed Chibuto Cluster

The following aspects were found to be particularly applicable to the proposed Chibuto cluster:

Strengths	Weaknesses
<ul style="list-style-type: none"> • Worldclass heavy mineral resource; • Willing labour force; • Good reputation with investors following success of Mozal; and • Cheap power (potential). 	<ul style="list-style-type: none"> • Capacity constraints in local and provincial government departments; • Poor physical infrastructure; and • Poor logistics infrastructure.
Opportunities	Threats
<ul style="list-style-type: none"> • Development of the Chibuto/Xai Xai cluster Mozal/Beluzone industrial cluster; • Possibility of developing facilities to further beneficiate zircon and pig iron; • Utilisation of natural gas as alternative energy source for beneficiation; and • Development of human resources. 	<ul style="list-style-type: none"> • HIV/AIDS; • Increasing energy prices; • Enclave type behaviour by mining developments; • Insufficient availability of specialist skills needed to run new developments ; and • Social disruption caused by growing wage gaps as mega-projects such as Corridor start up.

The Alto Ligonha micro-cluster

With regard to the development of Alto Ligonha and other small-scale mining clusters, the following aspects were found to be applicable:

Strengths	Weaknesses
<ul style="list-style-type: none"> • Extent and diversity of mineral resources amenable to small mining; • Specific legislation focused on small scale mining; and • Establishment of a Department of Small Scale mining within the National Directorate of Mines. 	<ul style="list-style-type: none"> • No training facilities; • Lack of prospecting and mining skills; • Poor logistics infrastructure; • Poor physical infrastructure; • Capacity constraints in key government departments; • Inadequate marketing mechanisms; and • Culture of distrust between the authorities and miners.
Opportunities	Threats
<ul style="list-style-type: none"> • Creation of micro-clusters around the small scale/artisanal mining centres, supplying training and basic equipment; • Development of human resources; and • Poverty reduction. 	<ul style="list-style-type: none"> • Currency and price fluctuation • Inadequate public health and HIV/AIDS; • Inefficient exploitation of resources; • Environmental degradation; • Insufficient availability of specialist skills needed to run new developments; and • Social disruption caused by friction between diggers and peasant farmers.

Conclusions and Policy Implications

Meso-clusters: Large-scale Beneficiation Activities

The Mozal/Beluzone development, is to date, the most successful example of the Mozambique Government's attempt to secure the growth dynamic within the national economy. This process has to be duplicated/replicated in every subsequent large-scale investment project in order to prevent 'enclaves' or concentrations of investment and unbalanced economic development from arising. Mentorship programmes, on-site training, and ABET courses need to be implemented at the start of the project. Conscious effort has to be made to include and involve the local population in the development process. Nationalistic pride has to be stimulated among all participants in order to ensure that the country will 'leap frog' the development process.

Micro-clusters: Artisanal and Small-Scale Mining Sector

In general, the promotion of the mining sector in developing countries tends to be biased towards large-scale mining activities given its ability to generate foreign investment and revenue for the host country. However, there is an urgent need for governments to match this with policies specifically aimed at developing the small-scale, artisanal mining sector

in an economically and environmentally sustainable manner, due to the extraordinary number of people deriving a living from such activities. In rural areas, where poverty prevails and few or limited options for economic diversification exist, strategies aimed at promoting the artisanal mining clusters can provide a means by which to gradually resolve both poverty and the employment crisis.

A number of constraints limiting the growth and expansion of economic activities in rural poverty-stricken areas such as those around the Alto Ligonha pegmatite field require policy intervention:

- **Provision of infrastructure** - Attention needs to be afforded to the provision of critical physical and social infrastructure such as capital, schools, roads, health services, employment and potable water. Provision of these (apart from employment) through a multi-sector approach would ease problems of the miners and communities. One possibility is to establish an Inter-ministerial Coordination Committee and NGO/Donors Forum to help in the provision of infrastructure. An Inter-ministerial Coordination Committee (of relevant ministries) would be responsible for debating issues affecting small-scale mining sector and approving national and annual programmes. The NGO and Donor Forum, in turn, could assist in capacity building in mining communities, while interacting with the Coordination Committee. In addition, the Small-scale Mining Secretariat could provide management and co-ordinate activities. The private sector should also be included in the process of service provision and planning.
- **Human resource development** - Low skills and lack of training facilities restricts the possibilities for diversification and concomitant increases in income. There are numerous opportunities for broadening the linkages associated with the artisanal mining sector. For example, gold and tantalite could be further purified, which will fetch higher prices. Gemstones could be tumbled, cut, polished and possibly mounted. Since tantalite needs to be in larger volumes for export, warehousing could be built to get the minimum quantities. These activities require the involvement of several service providers and could thus broaden the local employment base. An increase in skills in extraction activities, furthermore, will invariably lead to greater productivity and opportunities for processing lower grade ores, thereby extending the life of a mine. In general, the acquired technical skills should be applicable in other sectors of the economy, especially life skills, e.g. investments and savings.
- **Cluster development** - An environment conducive to the building of clusters and networks needs to be established. The pervasive culture of mistrust and lack of cooperation between miners, buyers, and public officials currently acts as a deterrent to growth. One way of approaching this issue is to foster the development of associations and/or co-operatives to facilitate the provision of services. Furthermore, groups as aggregates have a tendency to increase the demand for inputs and equipment, which spurs the growth of clustering. Associations or groups could form the basis of pilot projects, forming nuclei of training and service nodes.
- **Diversification and innovation** - Diversification and hives of innovation need to be fostered to broaden the impact of the sector. Due to the interconnected-

ness of mining and agricultural activities in the Zambezia province, an increase in income levels generated within the mining sector will create a concomitant increase in agricultural output levels. Suppliers of mining equipment will also benefit from an expansion of activities within the agriculture sector. This will provide the impetus for the development of a secondary-manufacturing sector. The tourism sector could also be boosted through the promotion of locally produced, finished jewellery under the banner “made in Mozambique” or “uniquely Mozambique”.

- **Taxation** - Lastly, the mining law exempts artisanal miners from paying local land taxes royalties. With increased production operations, the Mining Passes must be converted to Mining Certificates. Certificate holders must pay levies to the local authorities for local development. These permits generate economic development from local resources.

The draft report of a World Bank funded study (MEPC, 2003) on artisanal mining in Mozambique made some recommendations that may be considered among measures to promote growth of clusters. Some of these initiatives include:

- **Working groups** - Establishing broad-based interdepartmental/NGO/Donor working groups to address the full scope of rural development issues that are raised by baseline studies.
- **Legal review** - Reviewing laws and regulations, if need be, in light of their applicability on the ground.
- **Training programmes** - Establishing training programmes and facilities for small-scale miners; and the relevant government officials and NGOs who visit mining operations to provide advice, support services and guidance to miners in mining and recovery techniques.
- **Support systems** - Establishing specific technical, social, economic, environmental support systems.
- **Local fabrication** - Providing appropriate equipment and encouraging local fabrication
- **Public health** - Providing clean water, basic health services and establishing a general awareness of public health issues.
- **Marketing channels** - Assisting in establishing alternative distribution channels to increasing competition in buying of mineral products
- **Gender and youth issues** - Addressing the role of women and children in artisanal mining

5

Overall Conclusions and Implications for Africa

Sustainable development is not an automatic result of favourable factor conditions and the functioning of markets, particularly in developing countries. It requires the purposeful collective action and an adequate coordination of public and private initiatives. All this stems from a shared strategic vision among all agents in the region regarding how to build a better future and to build this strategic vision should be a central goal of any cluster project.

Governments play an essential role in establishing and formulating such a vision, but may often find it difficult to implement. Both multi-national and local businesses in countries such as South Africa are often larger and more powerful than some governments and most producers in the region, and therefore may actually undermine the development process by carrying out activities that are geared to the good of the company rather than that of the nation. This is exacerbated by the inevitable clash between the longer-term view of governments' development initiatives and the shorter-term profit-driven perspective of a company. This can often manifest itself by the companies exhibiting "enclave" type behaviour thereby isolating their activities from the broader development of the local economy.

This paper has shown that cluster development strategies orientated around a natural resource base have the potential to create sustainable economic development and provide a springboard for enhanced productivity, even in today's technology-driven society. The successful clusters in both South Africa and Mozambique (meso and macro) show that their establishment and sustainability was largely dependent on favourable factor conditions, both internal and external, together with specific, pro-active Government actions.

In summary, it is clear from the examination of the South African and Mozambican clusters that, while differing in their economic and mineral based history, they share common characteristics that are relevant to the development of clusters elsewhere in Africa:

Establishment of clusters

- Political and economic stability - Public sector involvement is critical for providing political and commercial guarantees to the project financiers, ensuring community participation and environmental sustainability, and most importantly, providing macro-economic stability and good governance.
- Provision of logistics and infrastructure - Provision of logistics and relevant infrastructure by the State in a public-private partnership is an essential element in the initiation and development of large scale projects
- Availability of skills – The establishment of major projects in developing countries require the importation of technology- and knowledge-intensive skills. While aware of the long-term need to develop those skills locally; it is essential that governments create an environment that will attract such skills and also support local skills development through understudy programmes. This usually requires changes to the immigration and residency regulations as well as personal tax incentives.
- Regional co-operation – Regional economic cooperation among countries in the SADC region may be a possibility with which to stimulate further intra-regional FDI and economic gains from efficiency-seeking restructuring of industry. The example of Mozal confirms this, as it would not have been established in Mozambique had there not been good regional cooperation between Mozambique and South Africa.

Sustainability of clusters

- Promoting cluster development and minimizing prospects of “enclave” development: While the construction of a large resource-based investment project will undoubtedly contribute to an increase in the overall GDP per capita in the host country, it may actually perpetuate income inequality due to the “enclave” nature of mining activities. The development of a cluster of companies supplying goods and services to the anchor project will work against the enclave tendencies of the anchor project and help facilitate the integration of the poorer members of the population into the economy.
- Maintaining skills developments: The operation of major projects requires persons with technology- and knowledge-intensive skills. Local capacity needs to be developed so that the reliance on expatriate skills can be lowered with time. Unfortunately, these activities are often developed and housed in the more industrialized countries, so the opportunities for knowledge transfer and continuation of R&D at the local level are limited. Moreover, much of the underlying skills are proprietary to the developer, usually a large multi-national company. Government pressure is needed to affect the necessary skills transfer. The major policy lever to achieve this is the steady reduction in the number of work permits granted and a simultaneous tightening of the criteria governing their issue. In addition, individual training programmes must be developed for identified ‘high flyers’, in conjunction with the private sector, to allow them to acquire the relevant skills and training to enable them to manage and utilize their resources

more effectively. These programmes must address the training requirements of the supplier companies as well as the anchor project.

- **Critical mass:** Not all clusters are sustainable, as is illustrated by the differing future facing the five regional gold mining clusters in South Africa. International experience of cluster development highlights that while governments alone cannot ensure clusters, they can play a major role in initiating and sustaining them through timely interventions to redirect development strategies. The challenge for African governments wishing to develop cluster strategies is to identify when fundamental change in the dynamics of a cluster is needed and formulate appropriate strategies. Such clusters must be encouraged to integrate into the economic activities of the designated growth clusters and prevented from becoming “enclaves” drawing their goods and services from companies based outside the country/region.
- **Cooperation and networking:** An essential component of successful clusters is the informal communication between the cluster components and the high level of cooperation between the stakeholders when addressing issues of common interest. The government therefore needs to encourage the establishment of industry and trade organizations to provide a structured environment to encourage communication. This could include establishing local Chamber of Business/Mines and supplier associations through which issues of concern could be channelled to Government.

With regard to growing and incorporating the micro-cluster/artisanal mining sector into the economy, priority must be given to:

- Provision of infrastructure;
- Provision of financial support for the development small scale mining supply companies;
- Enhancement of the skills base through targeted human resource development programmes;
- Facilitating Cluster development in small scale mining areas; and
- Diversification and innovation by the miners and related industries.

The development of small-scale mining clusters contributes to the alleviation of poverty on a local scale and has potential to enhance regional development through linkages.

References

Abedian, I. and Standish, B., 1992: The South African Economy: An Historical Overview, in I. Abedian and B. Standish (eds.), *Economic Growth in South Africa: Selected Policy Issues*, Oxford University Press, Cape Town, 1-24.

AFSA (Aluminium Federation of Southern Africa)., 2003: *Statistics Review 2000*, www.afsa.org.za.

Ali-Yrkkö, J., Pajja, L., Reilly, C. and Ylä-Anttila, P., 2001: NOKIA - A Big Company in a Small Country. ETLA Ser. B 162, ETLA, Vantaa.

Altamirano, N., 1999: Sustainable Development and Exhaustible Resources: The Dutch Disease is Not a Disease at All, IR/PS Research Report, No. 99-08, Graduate School of International Relations and Pacific Studies, University of California, San Diego.

Aluminium Association., 2003: *Aluminium Statistical Review for 2002*, Aluminium Association Incorporated, Washington DC

Arkwright, D., de Beer, G. and Mmatli, R., 1998: Spatial Development Initiatives in South Africa: Progress Achieved and Future Objectives, Unpublished paper presented at SAPES Trust Annual Colloquium, Harare, September.

Armstrong, W., 1985: The Social Origins of Industrial Growth: Canada, Argentina and Australia, 1870-1930, in D.C.M Platt and G. di Tella (eds.), *Argentina, Australia and Canada: Studies in Comparative Development, 1870-1965*, St Anthony's College, Oxford, 76-94.

Auchterlonie, A., 2003a: South African Beneficiation Scenarios for Platinum, Unpublished Report, Minerals and Energy Policy Centre, Johannesburg.

2003b: South African Beneficiation Scenarios for Gold, Unpublished Report, Minerals and Energy Policy Centre, Johannesburg.

Auty, R.M., 1986: Resource-based Industrialization and Country Size: Venezuela and Trinidad and Tobago, *Geoforum*, 17 (3), 325-338.

1987: Backward Versus Forward Integration in Resource-based Industries: Malaysia and Indonesia, *Tijdschrift voor Economische en Sociale Geografie*, 78 (2), 82-93.

1988: Internal Constraints on Prudent Oil Windfall Deployment for Resource-based Industry: Nigeria and Cameroon, *Geoforum*, 19 (2), 147-160.

1989: The Internal Determinants of Eight Oil-exporting Countries' Resource-based Industry Performance, *Journal of Development Studies*, 25 (3) 353-373.

1991: Third World response to global processes: the mineral economies, *Professional Geographer*, 43 (1), 68-76.

1992: Mineral Beneficiation: Some Reflections on the Potential for Resource-based Industrialization in South Africa, Economic Trends Research Group, Working Paper No. 14, University of Cape Town School of Economics, Cape Town.

1995: Patterns of Development, Policy and Economic Growth, Edward Arnold, London.

Ballance, R.H., 1987: International Industry and Business: Structural Change, Industrial Policy and Industry Strategies, Allen and Unwin, London.

Barker, F., 2003: The South African Labour Market, Van Schaick, Pretoria.

Segal, N., 2000: The South African Mining Industry in the 21st Century, Chamber of Mines, Johannesburg

Billiton World., 2000: Together We Make a Difference, Billiton World, 3 (3), 3.

Billiton., 2000: Billiton: Annual Report, 1999, Billiton Plc, Westerham Press, London.

Black, P.A., 1981: Injection Leakages, Trade Repercussions and the Regional Multiplier, *Scottish Journal of Political Economy*, 28 (3)

1996: A Theory of the Regional Accelerator, *Journal for Studies in Economics and Econometrics*, 20 (2).

2000: Corridor Sands EIA: Specialist Reports: Economic Impact Assessment, Vol. 2, Coastal and Environmental Services, Grahamstown.

Blignaut, J.N. and Hassan, R.M., 2001: A Natural Resource Accounting Analysis of the Contribution of Mineral Resources to Sustainable Development in South Africa, *Southern African Journal of Economic and Management Sciences*, Supplement Series No3,

Blomström, M. and Kokko, A., 2002: From Natural Resources to High-tech Production: The Evolution of Industrial Competitiveness in Sweden and Finland, Stockholm School of Economics, Stockholm.

Brewer, K.J., 1999: Economic Clusters: A Vision for Mining and Mining Suppliers, Presentation prepared for the EXPONOR '99 Mining Conferences, La Minería del Siglo XXI – Mining in the XXI Century, Antofagasto, Chile, 23 November.

Cawden, R., 1999: A New Generation in Touch with Global Technology Changes: Cellular Telephones and Internet Penetration Single New Market Niches, Washington Times, Special International Report on Norway, 29 November.

CMSA (Chamber of Mines of South Africa), 2001: South African Mining Industry: Statistical Tables 2000, Chamber of Mines, Johannesburg.

CMSA (Chamber of Mines of South Africa), 2003a: Annual Report 2001/2002, Chamber of Mines, Johannesburg.

2003b: Gold Mining Industry: Value-added Statement, Unpublished Report, Chamber of Mines, Johannesburg.

2003c: South African Mining Industry: Statistical Tables 2002, Chamber of Mines, Johannesburg.

Coastal and Environmental Services., 2000a: Environmental Impact Assessment: Corridor Sands Project, Summary Report, Vol.5, Coastal and Environmental Services, Grahamstown.

2000b: Corridor Sands Chongoene Export Facility EIA: Scoping and Terms of Reference Report, Vol. 1 Coastal and Environmental Services, Grahamstown.

Cranstone, D.A., 2002: A History of Mining and Mineral Exploration in Canada, Natural Resources Canada, NRCAN, Ottawa, Ontario.

Cusack, B., 2003: Australia's Mineral Resources, Presentation to the 2003 Resources Industry Dinner, Hyatt Regency, Adelaide, 30 May.

Dales, D., 1984: Attitudes to Black Advancement and Trade Unions Held by Shift Bosses on Selected Mines, MBA Research Paper, The Graduate School of Business, University of Cape Town, Cape Town.

Davis, G.A., 1994: South Africa's Managed Trade Policy: The Wasting of a Mineral Endowment, Paeger, Westport.

1995: Learning to Love the 'Dutch disease': Evidence from the Mineral Economies, World Development, 23 (10), 1765-1779.

De Ferranti, D., Perry, G.E., Lederman, D. and Maloney, W.F., 2002a: Comparative Advantage, Diversification, and Intra-Industry Trade: Determinants and Consequences, in D. de Ferranti, G.E. Perry, D. Lederman, and W.F. Maloney (eds.): From Natural Resources to the Knowledge Economy Trade and Job Quality, The World Bank, Washington DC, 13-48.

De Ferranti, D., Perry, G.E., Lederman, D. and Maloney, W.F., 2002b: It's Not Just What You Produce, But How: Lessons From Comparative History, in D. de Ferranti, G.E. Perry, D. Lederman, and W.F. Maloney (eds.): From Natural Resources to the Knowledge Economy Trade and Job Quality, The World Bank, Washington DC, 49-74.

Den Hertog, P., Leyton, J., Limpens, I. and Whalley, J., 1999: Approach to Cluster Analysis and its Rationale as a Basis of Policy, Report published for the RISE project, University of Brighton.

DINAPOT (National Directorate of Land Use Planning, Mozambique), 2003: Integrated Development Plan for Chibuto and the Surrounding Area, Province of Gaza, Mozambique, BCP Engineers (Pty) Ltd, Pietermaritzburg.

DST (Department of Science and Technology), 2002: South Africa's National Research and Development Strategy, The Department of Science and Technology, Pretoria.

DTI (Department of Trade and Industry), 2002: Accelerating Growth and Development: The Contribution of an Integrated Manufacturing Strategy, The Department of Trade and Industry, Pretoria.

ECA (Economic Commission for Africa), 2001: Enhancing Africa's Competitiveness: Policy Issues in Natural Resources and Science and Technology, ECA, Notes from the Secretariat, June.

EIU (The Economist Intelligence Unit), 2001: Mozambique, Country Profile 2001, The Economist, No 69, Intelligence Unit, London, [PAGES].

Engineering News., 1996: First Symbolic Sod set to be turned today, Martin Creamer's Engineering News, 14 June, 17.

1998: Expansion on Track, Martin Creamer's Engineering News, 19-25 June, 20.

1999: Window of opportunity for primary producer, Martin Creamer's Engineering News, 25 June-1 July, 32.

2000: Plant upgrade: now on track with R261 million now committed, Martin Creamer's Engineering News, 30 June-6 July, 37-38.

2001: Neutralise import parity pricing to advance lateral migration, Martin Creamer's Engineering News, 18-24 May, 10.

2002: State to study import parity pricing issue, Martin Creamer's Engineering News, 3-9 May, 12-13.

EAA (European Aluminium Association), 2002: Market Report, European Aluminium Association, Brussels.

El Serafy, S., 1989: The proper calculation of income from depletable natural resources”, in Ahmad, Y., El Serafy, S. and Lutz, E (eds) *Environmental Accounting for Sustainable Development*. Washington, D.C: World Bank

Fatemi, A.S., no date: Input-Output Economics (article), <http://www.fatemi.com>

Financial Mail., 1996: Exports: industry comes of age, *Financial Mail*, 21 June.

Fine, B. and Rustonjee, Z., 1996: *The Political Economy of South Africa: From Minerals-Energy Complex to Industrialization*, Witwatersrand University Press, Johannesburg.

Gillis, M., 1981: *The Effects of In-State Investment: Lessons from Oil-fired Development in Other Parts of the World*, Paper prepared for the Permanent Fund Trustees, HIID and Department of Economics, Harvard University, Cambridge Massachusetts.

Gylfason, T., 2001: *Lessons from the Dutch Disease: Causes, Treatment, and Cures*, Institute of Economic Studies Working Series W01:06, University of Iceland, Reykjavik.

Heeks, R., 1998: Small enterprise development and the ‘Dutch disease’ in a small economy: the case of Brunei, IDPM Discussion Paper Series, Discussion Paper 56, Institute for Development Policy, University of Manchester, Manchester.

Hernesniemi, H., Lammi, M. and Ylä-Anttila, P., 1996: *Advantage Finland: The Future of Finnish Industries*, ETLA/SITRA, Sarja B 113 Series, Taloustieto Oy, Helsinki.

Hirschmann, A O., 1958: *The Strategy of Economic Development*, Yale University Press, New Haven.

Hooke, M.H., 2003: Policies for Growth, Presentation for “Minerals Week”- Annual Seminar, Minerals Council of Australia, Canberra, 3 June.

Huggins, G., Rodgers, G. and Spitz, A., 2000: *Corridor Sands EIA: Specialist Reports: Social Impact Assessment*, Vol. 2, Coastal and Environmental Services, Grahamstown.

Humphreys, D., 2000: *Mining as a Sustainable Economic Activity*, Paper prepared for an informal seminar on the Mining and Metals Industry, OECD, Paris, 9 February.

Jourdan, P.P., 1990: *Strategies for the Regional Planning of the Minerals Industry In Southern Africa: The Case of the SADCC*, Unpublished PhD Thesis, University of Leeds.

1992: *Mineral Beneficiation: some Reflections on the Potential for Resource-based Industrialization in South Africa*, Economic Trends Research Group, Working Paper No. 14, University of Cape Town School of Economics, Cape Town.

1994: *South Africa’s Mineral Beneficiation Industries and the Potential for Mineral-based Industries*, Unpublished Masters Thesis, University of the Witwatersrand, Johannesburg.

Kaplinisky, R. and Mhlongo, E., 1997: Infant industries and industrial policy: a lesson from South Africa, *Transformation*, 34, 57-85.

Karppi, I., 2001: Competitiveness in the Nordic Economies: Assessment and Structural Features, Working Paper 2001:2, Nordregio, Stockholm.

Lall, S., 1993: What will make South Africa internationally competitive?, in P.H. Baker, A. Boraine, and W. Krafchik (eds), *South Africa and the World Economy in the 1990s*, Rustica Press, Cape Town, 50-70.

Lemieux, A., 2001: Canada's Global Mining Presence, *Canadian Minerals Yearbook 2001*, Natural Resources Canada, NRCAN, Ottawa, Ontario.

Levy, S.J. and Caldeira, J.M., 2001: The legal framework for mining and beneficiation in Mozambique, SAL Consultoria e Investimentos, Lda, Maputo

Lombard, J.A. and Stadler, J.J., 1980: The Role of Mining in the South African Economy, Study Prepared for the Chamber of Mines of South Africa, University of Pretoria, Pretoria.

Mainardi, S., 1997: Mineral resources and economic development: a survey, *Development Southern Africa*, 14 (1), 61-77.

Menell, R.P., 2000: Key challenges for the 21st century – finding a common base, Address given by the president of the Chamber of Mines at the Mining Summit, Pretoria, 25 February.

MEPC (Minerals and Energy Policy Centre)., 2003: Artisanal Mining Baseline Study, Draft Report, Unpublished Draft Report prepared by the MEPC for the Government of Mozambique, Johannesburg.

Minerals Bureau., 2002: South Africa's Mineral Industry 2000/2001, Minerals Bureau, Department of Minerals and Energy, Pretoria.

Mining Review Africa., 2003: Record breaking Mozal 2 bodes well for Hillside 3, *Mining Review Africa*, 5, 15-16.

Mining Weekly., 2000: Equipment makers lack oomph, *Mining Weekly*, 2 September -5 October, 3.

2001a: Research to promote more use of downstream resources, *Mining Weekly*, 24-30 August, 4.

2001b: The globalization of South Africa's mining industry, *Mining Weekly*, 7-13 September, 38.

Mining Weekly., 2001c: Fighting the 'natural-resource curse', *Mining Weekly*, 9-15 November, 12.

Mining Weekly., 2002: SA's top five mining capital equipment exporters, Mining Weekly, 17-23 May, 2-3.

Ministry of Mineral Resources and Energy., 2000: Mineral Resources Development and Investment Opportunities, Ministry of Mineral Resources and Energy, Maputo.

Ministry of Trade and Industry., 1993: National Industrial Strategy for Finland, Publications 3/1993, Ministry of Trade and Industry, Helsinki.

Nankani, G., 1979: Development Problems of Mineral Exporting Countries, World Bank Staff Working Paper 354, World Bank, Washington DC.

NDM (National Directorate of Mines)., 2000: Artisanal Mining Baseline Survey, Mozambique, National Directorate of Mines, Ministry of Mineral Resources and Energy, Maputo.

NDM (National Directorate of Mines)., 2002: Annual Report 2002, Ministry of Mineral Resources and Energy, Maputo.

NDM (National Directorate of Mines)., 2003: Artisanal Mining in Mozambique: Second Baseline Survey Report (Zambezia and Cabo Delgado Provinces), National Directorate of Mines, Ministry of Mineral Resources and Energy, Maputo.

NRCAN (Natural Resources Canada)., no date: Canadian Suppliers of Mining Goods and Services, NRCAN, Canada.

Östensson, O. and Uwizeye-Mapendano, A., 2000: Growth and Diversification in Mineral Economies, Draft paper prepared for the regional workshop for mineral economies in Africa, Cape Town, 7-9 November.

Pajarinen, M., Rouvinen, P. and Ylä-Anttila, P., 1998: Small Country Strategies in Global Competition: Benchmarking the Finnish Case, ETLA Discussion Document, B144 Series, Taloustieto Oy, Helsinki.

Paterson, A.E., 2000: Globally competitive value-added aluminium: a review of the current position, South African Buyers and Exporters: Aluminium Guide and Yearbook, Millennium Issue, Aluminium Federation of Southern Africa (AFSA), Isando, 3-10.

Porter, M., 1990: The Competitive Advantage of Nations, MacMillan, London.

Power, T.M., 2002: Digging to Development? A Historical Look at Mining and Economic Development, A report prepared for Oxfam America, Oxfam, Boston.

Pretorius, L., 2000: Regional Integration and development in Southern Africa: A case study of the Mozal Project and its implications for workers, Report compiled for the International Labour Resource and Information Group (ILRIG), March.

Raphael, E., 1999: The Mozambique Mineral Sector, Paper prepared for the Mining Policy Dialogue Seminar entitled Attracting foreign mining investment to Mozambique, National Directorate of Mines, Maputo.

Ricks, B., 2003: Mozal II brought on stream ahead of budget schedule, MiningNews.net, 23 October.

Roelandt, Th.J.A., Gilsing, V.A. and van Sinderen, J., 2000: New Policies for the New Economy: Cluster-based Innovation Policy: International Experiences, Paper presented at the 4th annual EUNIP conference, Tilberg, The Netherlands, 7-9 December.

Roemer, M., 1979: Resource-based industrialization in the developing countries: a survey, *Journal of Development Economics*, 6, 163-202.

Ross, A., 2000: Base metals, aluminium, <http://www.dme.gov.za/minerals/part2c.html>.

Rostow, W., 1962: Some Lessons of History for Africa, Paper presented at the Third Annual Conference of the American Society of African Culture, University of Pennsylvania, Philadelphia, 22-26 June.

Rouvinen, P., 1996: Advantage Finland: The Future of Finnish Industries, The Research Institute of the Finnish Economy/ The Finnish National Fund for Research and Development (ETLA/SITRA), Helsinki.

RSA (Republic of South Africa)., 1998: White Paper: A Minerals and Mining Policy for South Africa, Department of Minerals and Energy, Pretoria.

Sengenberger, W., 1993: Local development and international economic competition, *International Labour Review*, 132, 313-329.

Singh, I., 2001: Natural Resource Based Clusters in the New Economy: Theory and Reality, Paper prepared for the 4th Annual International Conference of The Competitiveness Institute, Tucson, Arizona, October 28 – November 2.

Solomon, M.H., 2000: Growth and Diversification In Mineral Economies: Planning and Incentives for Diversification, The Mineral Corporation, 9 November.

SARB (South African Reserve Bank)., 2003: Quarterly Bulletin, SARB, Pretoria, June.

Southern Mining Corporation., 2000: Annual Report, Southern Mining Corporation, Johannesburg

Southern Mining Corporation., 2001: Annual Report, Southern Mining Corporation, Johannesburg

Southern Mining Corporation., 2002: Annual Report, Southern Mining Corporation, Johannesburg

SSA (Statistics South Africa)., 1999: Census of Mining – 1996, Statistics South Africa, Pretoria

SSA (Statistics South Africa)., 2000: Selected Industries, Statistics South Africa, Pretoria.

SSA (Statistics South Africa)., 2001a: Comparative Labour Statistics: Survey of Employment and Earnings in Mining, Statistics South Africa, Pretoria.

SSA (Statistics South Africa)., 2001b: Mining: Financial Statistics, Statistics South Africa, Pretoria.

SSA (Statistics South Africa)., 2001c: Supply and Use Tables – 2000, Statistics South Africa, Pretoria.

SSA (Statistics South Africa)., 2003: Mining: Production and Sales, Statistics South Africa, Pretoria.

Stillwell, L.C., 1998: The Impact of Mining on the South African Economy – An Empirical Review, Unpublished PhD. Thesis, University of the Witwatersrand, Johannesburg.

Sunday Times., 2003a: Playing with the big boys, Sunday Times, Business Times, 26 October, 21.

Sunday Times., 2003b: Country boasts huge growth in key sectors, Sunday Times, Business Times, 26 October, 21.

Sunday Times., 2003c: Mozal's success a boost for economy, Sunday Times, Business Times, 26 October, 21.

The Mercury., 2000: Investor confidence sparks growth, The Mercury, 21 November, 21.

The Star., 1996a: Iscor likely to approve R2bn titanium plant for Richards Bay, The Star, Business Report, 29 July.

The Star, 1996b: Iscor favours Richards Bay for processing plant, The Star, Business Report, 3 September.

Vouri, S. and Yla-Anttila, P., 1992: Industrial Transformation in Finland – From Factor Driven to Technology-based Growth, ETLA Discussion Document, No. 413, ETLA, Helsinki.

Vuori, S., 1997: Technology Sources and Competitiveness – An Analysis of Finnish Industries, ETLA, Taloustieto Oy, Helsinki.

Walker, M, 2001: Unpacking New Investment Projects: the Impact of Billiton Hillside Aluminium on the Richards Bay Area, unpublished research report for the national Department of Trade and Industry (DTI), Pretoria, April 2001.

Walker, M, 2003: Resource-based Industrialization: The Finnish Experience, Unpublished report, MINTEK, Johannesburg

Warda, J., 2001: Investing in Innovation in the Resource Sector: Industry Needs, Barriers and Opportunities for Action, Innovation and Knowledge Management, Conference Board of Canada, Ottawa, February.

World Bank., 2002: Treasure or Trouble? Mining in Developing Countries, World Bank and International Finance Corporation, Washington DC.

Wright, G., 2001: Resource-based Growth Then and Now, Paper prepared for the World Bank project "Patterns of Integration in the Global Economy", June.

Ylä-Anttila, P., 2000: Nokia and Oulu – National and Regional Growth Drivers in Finland, Paper presented at the seminar Verdiskaping, kompetanse og innovasjon, mot en ny politikk for nyskaping og næringsutvikling, Oslo, May 8, 2000.

Internet References

www.beluzone.com - The Beluzone Industrial Park

www.hillside.co.za - The Billiton Hillside Aluminium Smelter, Richards Bay, South Africa

www.mozal.com - The Billiton Mozal Aluminium Smelt