

## Evidence-based Employment Scenarios

### Mining Employment Scenarios for South Africa to 2024

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# **MINING EMPLOYMENT SCENARIOS FOR SOUTH AFRICA TO 2024**

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## **Executive summary**

Mining has long been an important employer in South Africa. Although still a substantial contributor to employment, its role has diminished since the 1980s. In 1987, total mining employment peaked at 828,773 (DME SAMI, 2006). Two decades later, the mining industry directly employed 455,667 workers, a substantial contraction. The contribution of mining to formal non-agricultural employment fell from 6.3% in 1995 to 5.0% in 2005, according to Statistics South Africa's October Household and Labour Force Surveys.

A global commodity boom has drawn attention to the mining industry as a sector experiencing strong prices, high rates of growth in investment and employment, and attendant skills and certain equipment/consumables bottlenecks. In South Africa there has been a noticeable time-lag in the response of the mining sector, which will require some attention to ensure that the country takes maximum advantage of global demand. The influence of the commodity boom invites research on the mining sector to predict the possible effects of, amongst others, its longevity, technology changes and changes in mining skills requirements, all of which will determine the sector's future contribution to direct employment and its indirect employment effects.

In its reserves of coal and platinum, currently in excess of 100 years at current production rates, South Africa is assured of continued domination, whether in Africa or the world. In contrast, diamonds and gold are constrained by the available reserves. Even though South Africa hosts 40% of the world's remaining gold reserves, these are some of the most expensive ounces of gold, putting South Africa at a competitive disadvantage. In diamonds, the reserves are being depleted faster than they are being replenished, resulting in Mintek predicting a continuous 3% decline in South Africa's diamond output from 2015.

This report was prepared for the HSRC and seeks to investigate potential employment in the South African mining industry. The paper focuses on:

- An assessment of the rate and nature of investment in South Africa's mining industry. This necessarily has to be conducted on a commodity-specific basis and be based on global supply / demand scenarios and planned investments.
- An assessment of the employment drivers in mining, how these relate to mining investment and in particular whether significant technological changes to mining methods amounting to greater mechanisation will be widely adopted.
- An assessment of employment, incomes and occupational skills levels which will be largely determined by the above investment and mining methods drivers.
- An assessment of the inter-sectoral linkages between mining and upstream suppliers, side-stream (equipment, services and consumables) as well the impact on downstream industries.

Scenarios were considered for two periods – seven years to 2014 and 27 years to 2024.

Gold mining has attracted R45.8-billion in capital investment since 1993 and R43.6-billion was invested in platinum mining. Coal and diamonds accounted for R21.1-billion and R4.5-billion, respectively. With the exception of a spike for platinum in 2000 and for gold in 2005, capital spending for all four commodities (a total of R115-billion for 1993-2006) has been averaging close to the R5.4-billion level and probably represents replacements and additions rather than new mines.

This report predicts that the South African mining sector in 2014 will provide between 439,000 and 647,000 employment opportunities. This will be concentrated in the platinum sector (45%-51%) and in the “Other” minerals sector (19%-23%). The mining sector in 2024 will provide between 521,000 and 737,000 employment opportunities, largely focussed in the platinum sector (between 53% and 62%). The gold sector by 2024 is believed to possibly shrink back to between 7% and 11% of the 2014 employment opportunities, down from its current 30%-35%.

South Africa is seeing a trend of greater levels of mechanisation where the mining process is not as labour intensive as in the past, and therefore higher levels of skill will be needed in future. Levels of employment, incomes and occupational skills will largely be determined by the above investment and mining methods drivers. Increased training rates in scarce skills professions will need to be implemented. The environment will need to become more conducive to attracting the skills needed to the sector (for example, attracting engineers towards the mining sector rather than the financial sector). National coaching programmes around Job-Specific Skills and not Generic Skills will need to commence.

The inter-sectoral linkages between mining and upstream suppliers, side-stream (equipment, services and consumables) as well the impact on downstream industries were investigated. Mining inputs into manufacturing will continue to be concentrated in basic iron and steel, alloys production and chemicals where South Africa retains a comparative advantage. These are primary processing stages that are capital intensive, with employment growth held in check by productivity gains. Mining inputs into the numerous other sub-sectors of manufacturing will see little change.

## 1. Introduction

Mining has long been an important employer in South Africa. Although still a substantial contributor to employment, its role has diminished since the 1980s. In 1987, total mining employment peaked at 828,773 (DME SAMI, 2006). Two decades later, the mining industry directly employed 455,667 workers, a substantial contraction. The contribution of mining to formal non-agricultural employment fell from 6.3% in 1995 to 5.0% in 2005, according to Statistics South Africa's October Household and Labour Force Surveys.

A global commodity boom has drawn attention to the mining industry as a sector experiencing strong prices, high rates of growth in investment and employment, and attendant skills and certain equipment/consumables bottlenecks. In South Africa there has been a noticeable time-lag in the response of the mining sector, which will require some attention to ensure that the country takes maximum advantage of global demand. The influence of the commodity boom invites research on the mining sector to predict the possible effects of, amongst others, its longevity, technology changes and changes in mining skills requirements, all of which will determine the sector's future contribution to direct employment and its indirect employment effects.

In its reserves of coal and platinum, currently in excess of 100 years at current production rates, South Africa is assured of continued domination, whether in Africa or the world. In contrast, diamonds and gold are constrained by the available reserves. Even though South Africa hosts 40% of the world's remaining gold reserves, these are some of the most expensive ounces of gold, putting South Africa at a competitive disadvantage. In diamonds, the reserves are being depleted faster than they are being replenished, resulting in Mintek predicting a continuous 3% decline in South Africa's diamond output from 2015.

This report was prepared for the HSRC and seeks to investigate potential employment in the South African mining industry. The paper focuses on:

- An assessment of the rate and nature of investment in South Africa's mining industry. This necessarily has to be conducted on a commodity-specific basis and be based on global supply / demand scenarios and planned investments.
- An assessment of the employment drivers in mining, how these relate to mining investment and in particular whether significant technological changes to mining methods amounting to greater mechanisation will be widely adopted.
- An assessment of employment, incomes and occupational skills levels, which will be largely determined by the above investment and mining methods drivers.
- An assessment of the inter-sectoral linkages between mining and upstream suppliers, side-stream (equipment, services and consumables) as well the impact on downstream industries.

Scenarios are considered for two periods – seven years to 2014 and 27 years to 2024.

## 2. Mining investment and employment in South Africa

### 2.1 Mining investment

Gold mining has attracted R45.8-billion in capital investment since 1993, more than the R43.6-billion invested in platinum mining despite the higher platinum price. Coal and diamonds accounted for R21.1-billion and R4.5-billion, respectively. With the exception of a spike for platinum in 2000 and for gold in 2005, capital spending for all four commodities (a total of R115-billion for 1993-2006) has been averaging close to the R5.4-billion level and probably represents replacement and brownfield additions rather than new mines.

### 2.2 Employment in selected sectors

The mining sector, as an employer, has seen a general employment decline in both absolute and relative employment numbers since the mid-1990s. According to the Department of Minerals and Energy (DME) data, total mining employment fell by 38% over the past decade. The contribution of mining to formal non-agricultural employment fell from 6.3% in 1995 to 5.0% in 2005, according to Statistics South Africa's October Household and Labour Force Surveys.

Historically, South Africa's gold industry was by the far largest single mining employer (Figure 2). In 1994, the gold mining sector employed 68% of all mining sector workers, but this role has diminished substantially so that by 2005 it was employing only 35%. In the same period, coal remained relatively stable (11%-12%) and platinum increased from 9% of total employment in 1994 to 33% in 2005.

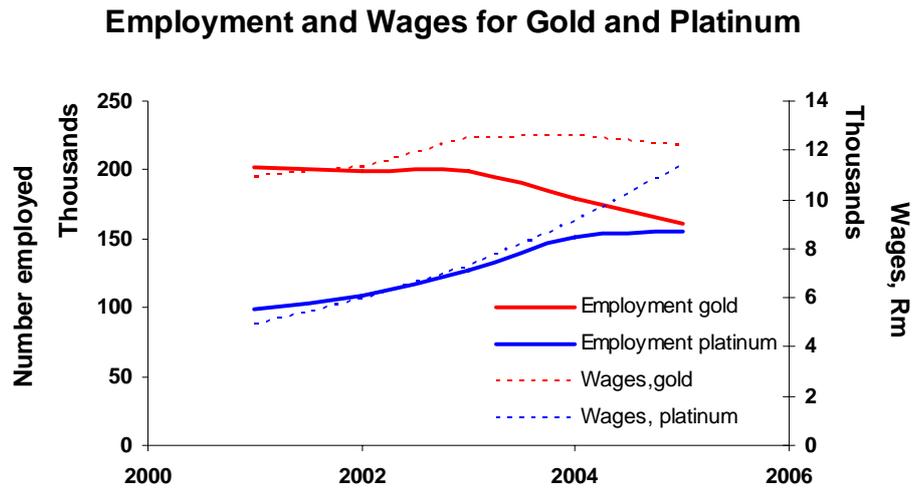
There were 138,000 employees in the *gold mining* industry in 2005, down from 342,000 in 1996. Their wages amounted to R11.8-billion. Deep-level mining of ever-lower grades as it has developed in the South African gold mines has meant that the industry has had to become even more capital intensive to meet the demands of deep underground tunnelling, hoisting, ventilation, cooling and surface processing plants.

The decline in employment in the gold mining industry is now being matched by an increase in employment in platinum mining (Figure 1). With the continuing expansion in platinum mining as a result of the strength of the market, more people will be employed there in future. The growth in the platinum sector is often believed to be the best place to absorb the gold mining retrenchees due to similar mining methodology. The Platinum Group Metals (PGM) sector employed 155,030 people in 2005, with a R11.3-billion wage bill. It was the largest sector in the South African mining industry as a result of the continuing high platinum prices.

The coal and diamond industries (Figure 2) are considerably smaller. The diamond mining industry employed 21,976 workers in 2005 and paid out R2.6-billion in wages. The coal industry employed 56,971 in 2005, growing from 50,662 in 2004. The wage bill was R6.3-billion. One of the notable features in the coal sector is that its rate of

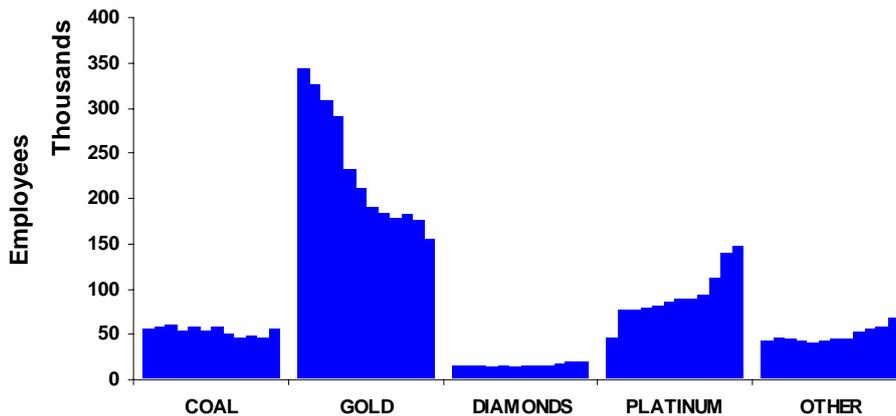
employment changes very little for large increases and decreases in output (see Figure 3).

Figure 1 – Employment and wages for gold and platinum



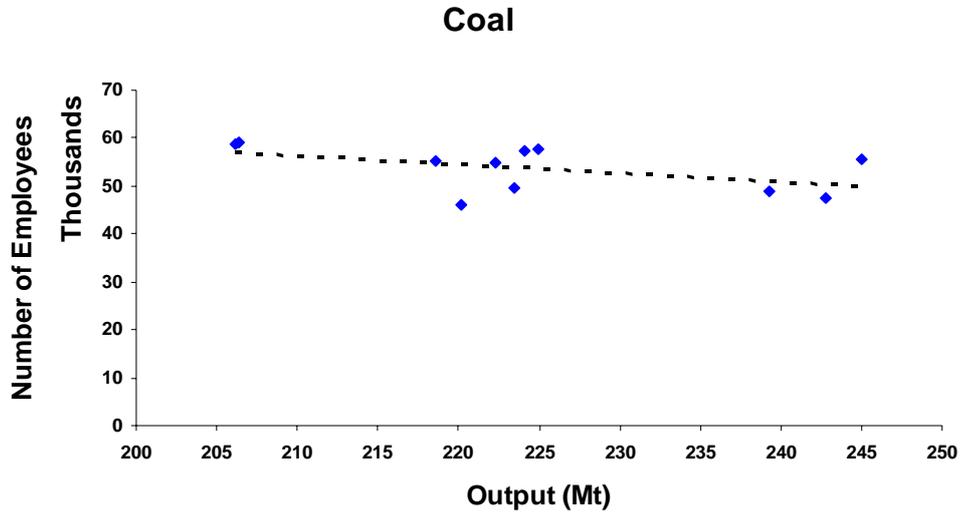
Source: SAMI, 2005/6

Figure 2 – Employment in South Africa’s mining sectors (1994-2005)



Source: DME, 2005/6

Figure 3 – Change in employment with changes in output in the coal sector (1995-2005)



Source: DME labour statistics and SAMI reports

### **3. Some considerations affecting future mining investment**

#### **3.1 Factors influencing employment by commodity**

A number of factors influence investment and its translation into employment. Some are determined externally, say by whether the global commodity boom persists. Other factors may be determined domestically, by the character of deposits, technology choice or labour-related factors.

It goes without saying that not every commodity behaves in the same way. It is well known that even within the same commodity, different sections behave differently. For example, in the coal sector, local coal markets do not behave like export coal markets. Low-grade coal operates in a different domain and with different dynamics than high-grade coal. The same is known in the diamond sector where special stones enter a different marketing dynamic (and price structure) than lower grade diamonds. Different drivers are also evident between different minerals like platinum, gold, coal, diamonds and industrial minerals. External drivers of demand are shown in Table 1.

To assess future employment within the mining sector, the following items are important:

- What will future exchange rates be?
- What will future Rand and Dollar commodity prices be?
- What will be the level of replacement of labour by capital?
- What is the expected level of output?

These are not the only considerations, but within the context of the study these are considered the most influential. The remainder of section 3 considers some external factors, especially the exchange rate and the potential length of the “commodity boom” and high commodity prices. Section 4 considers a wider range of factors, including domestic drivers.

**Table 1 – Significant growth drivers for the commodity in South Africa**

Commodity	Significant driver in South Africa	Factors affecting translation of investment into employment
Gold	Rand price of gold	Restrictions on mechanisation due to geology  Maintain employment in mature mines
	Demand for physical gold	
Platinum	Dollar price of platinum	Feasibility of mechanising <u>some</u> PGM mines, availability of water on Eastern Limb  Likely to rise on environmental grounds
	Demand for physical platinum	
Coal	Local energy requirements	Highly mechanised with limited employment effects  Likely to decrease due to slow diversification away from coal based energy
	Demands in the international steam coal industry	
Diamonds	Availability of rough gem quality diamonds in the international market	Supply constraint due to exhaustion of existing mines
Industrial and Other Minerals	R:\$ Exchange rate	Unpredictable
	These will grow at the GDP rate in the country where it is being consumed.	Low value products thus high transport sensitivity.  Mainly quarrying and highly mechanised

### 3.2 Employment and exchange rates

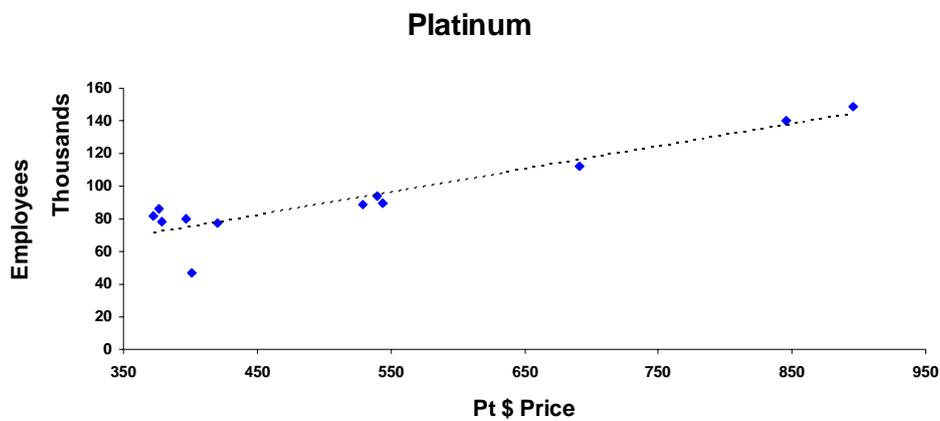
There appears to be a strong relationship between mining employment and the exchange rate, although the precise pattern differs by commodity. Employment in the platinum industry is sensitive to the Dollar price of the commodity to the extent that there is a near linear trend (Figure 4). The same pattern does not exist with gold; however, employment in the gold industry appears to be sensitive to the Rand price of gold, to a limited extent. At a critical threshold in the gold price, R1,750/oz, the decline in the gold price does not lead to a dramatic shedding of jobs (Figure 5). In the coal sector there appears to be a linear trend between the number of employees and the strength/weakness of the Rand. The weaker the rand, the less people this sector employs (Figure 6).

The diamond sector is a small employer (less than 4.5% in 2005). This sector, in South Africa, is largely dominated by De Beers, which is producing in excess of 85%

of South Africa's diamonds. De Beers, though, remain a small employer due to the fact that it tends to mechanise. The diamond market shows similar trends to the platinum sector, namely that it is the Dollar price of the commodity that influences employment. The exchange rate is negligible in influencing whether employment will increase or decrease (Figure 7) and even De Beer's 2005/6 campaign (Thrive at Five) was not aimed at employment but rather productivity. Other studies conducted by Mintek showed that the level of production output was influenced by the Rand/Dollar exchange rate. As the rand weakened during 1995 to 2000, employment declined by 1%; however, as the Rand started strengthening, employment increased by 7% per annum.

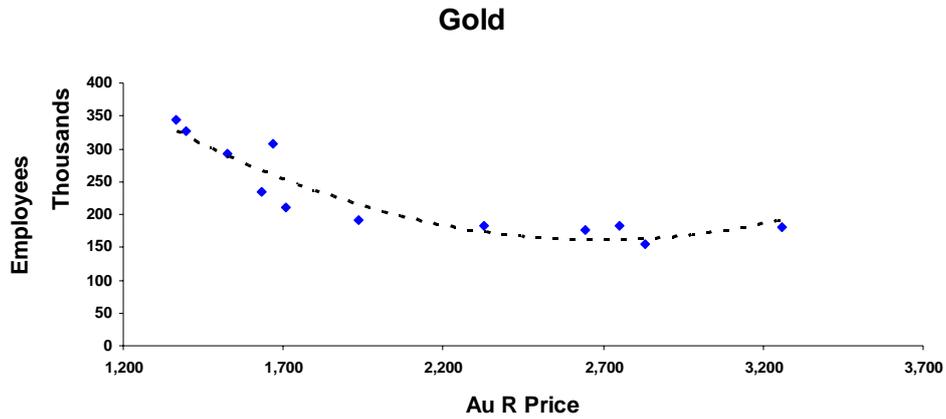
The behaviour of exchange rates, mainly the Rand/Dollar rate, but also to a lesser extent the British Pound, the Euro, the Canadian Dollar, the Australian Dollar and the Japanese Yen, has a dramatic effect on the fortunes of any mineral producer. In essence, it adds to the volatility of the commodity price, at some times exacerbating movements and at others dampening the wild swings.

**Figure 4 – Number of employees versus platinum price in US Dollars (1994-2005)**



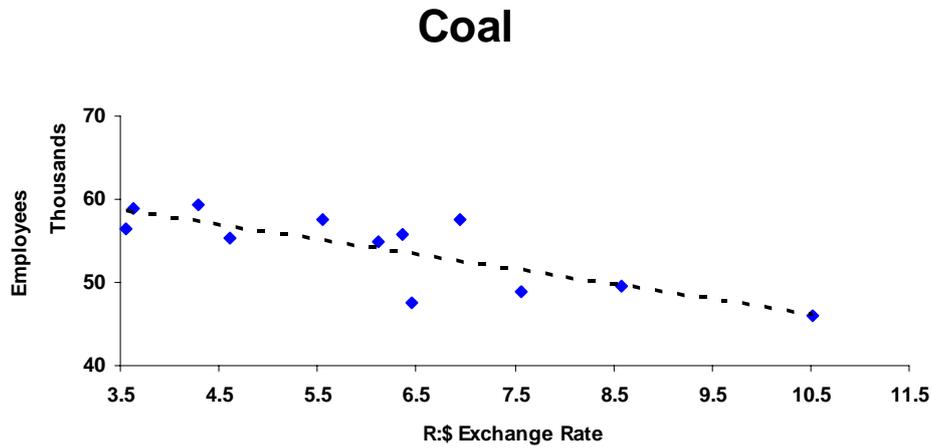
Source: DME labour statistics and KITCO Metal Prices

Figure 5 – Number of employees versus gold price in Rands (1994-2005)



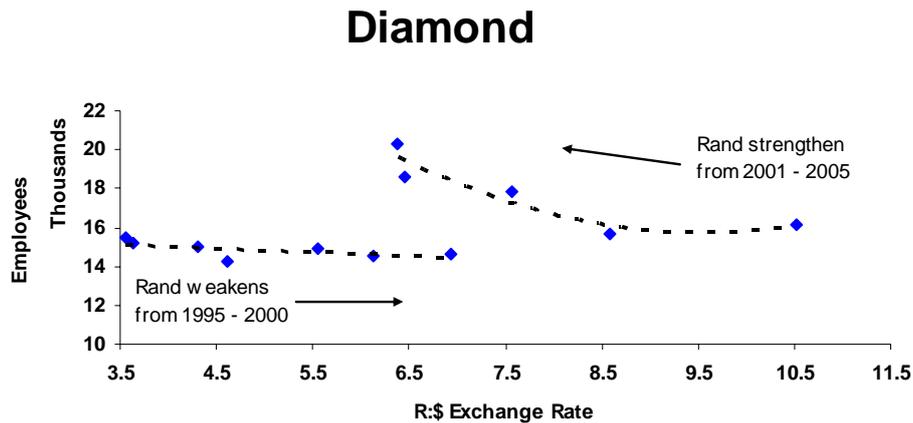
Source: DME labour statistics and KITCO Metal Prices

Figure 6 – Number of employees versus R:\$ exchange rate for the coal sector (1994-2005)



Source: DME labour statistics, South African Reserve Bank (SARB) data

Figure 7 – Number of employees versus R:\$ exchange rate in the diamond sector (1994-2005)



Source: DME labour statistics, South African Reserve Bank (SARB) data

In a steady commodity price scenario, a steadily weakening exchange rate would give producers the confidence to allow for a certain amount of cost escalation in the planning process, as there would be a reasonable chance of getting higher local commodity prices into the future. A strengthening currency has the opposite effect, forcing producers to streamline operations and find new ways of either cutting costs or producing more of the commodity at the same cost, purely in order to survive. This is the situation in which the local gold market finds itself currently. With relatively steady international prices, but with the local economy doing as well as it is, the currency is strengthening against most other currencies, putting pressure on the profit margins and consequently on the available ore reserves.

Currently South Africa is closely linked to the Rand/Dollar exchange rate because most of the commodities sold are priced in Dollars. Consensus forecasts are hard to come by but many commentators believe that the growth of the economy will support the exchange rate. ABSA (2003) forecasts an exchange rate weakening to about R12.71 to R 14.78 to the Dollar by 2017.

### 3.3 The commodities boom

The current boom in global commodity prices is principally due to the industrialisation and commercialisation of China, ably supported by the other 'Asian Tigers' periodically showing signs of slowing down, but many market commentators believe that there is still a fair amount of momentum in the trends. It is very unlikely that this "boom" will continue for another 15 to 20 years. It is in the nature of the commodities business that high demand and the accompanying high prices will have a self-regulating effect via the increased exploration spend for higher value commodities

and the subsequent development of new production capacity, thereby satisfying most if not all demand imbalances, and allowing prices to return to more 'normal' levels.

While it is eminently possible that the current high commodity price scenario could endure to a greater or lesser degree for another five years or so, to project a 'boom' beyond that with any degree of certainty would be overly optimistic.

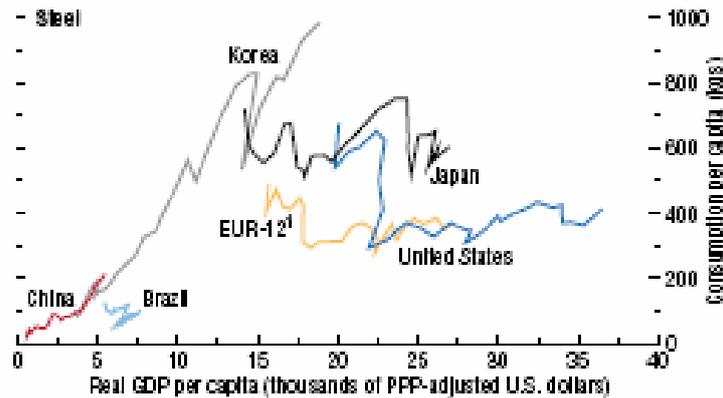
A common concern for many resource economies currently benefiting from the commodities boom is to know how long it will last. Many African economies are depending on a long-run boom because it will provide them with new markets. The boom is also considered the reason for higher prices attained for many commodities and is seen as a shift from the previous traditional markets into a new and hungry Asian market.

An International Monetary Fund (IMF) study (2006) indicated that non-fuel commodities had a greater share in world trade (about 14% during 2000-2004) than fuel commodities (7%). In many low-income countries, a large share of export revenue is generated by just a few commodities. The world is experiencing a period of sustained high prices even though the long-term price trend is largely believed to be downwards. Over the past few decades, commodity prices have fallen relative to consumer prices, at the rate of about 1.6% per annum, and the current volatility in non-fuel commodity markets is not unusual by historical standards.

What remains unanswered is how long this boom will last.

The historical patterns (Figure 8) indicate that consumption of metals (in this case, Steel Intensity) typically grows concurrently with income until approximately the US\$15,000 to US\$20,000 per capita level (in purchasing power parity, or PPP, adjusted Dollars). This reflects a period where countries are going through industrialisation and infrastructure-building. However, at higher incomes, growth typically becomes more service-driven, and as a consequence the intensity of metal use per capita starts to decline. Therefore much depends on whether China, Brazil and India maintain high rates of economic growth, and how consistent these growth rates are over time.

Figure 8 – Steel consumption per capita versus real GDP per capita for the US, Europe and South East Asia



Sources: International Iron and Steel Institute, *Steel Statistical Yearbook* (various issues); World Bank, *World Development Indicators* (2006); World Bureau of Metal Statistics, *World Metal Statistics Yearbook* (various issues); and IMF staff calculations.  
<sup>1</sup> Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.

Source: IMF, 2006

In addition, there are numerous motivations for high commodity prices to persist. Some are worth close consideration if one tries to establish the expected duration of the current boom.

- 3 China has driven up metal prices due to its growing demand and in doing so has merely amplified a growing supply-side deficit.
- 4 Because China is consuming so much, other nations are prepared to pay a security premium so that they can be assured of supply.
- 5 Speculators are driving the prices up.
- 6 The recent energy price increases (of 20%-50%) are reflected in the commodity prices (passing on input costs to the consumer).
- 7 Fewer discoveries of new deposits have meant that known, higher cost deposits have to be mined. This is linked to a previous low investment in exploration, which has caused a supply-side constraint.

By contrast, the commodities futures markets indicate that the current high prices may not be sustained in the medium term. Price reversals are anticipated to commence in the short term (2010-2012).

The reasons for this are as follows:

1. Supply will increase as new producers of the various metals come on stream, decreasing the demand-supply gap and causing prices to reduce.
2. The security premium will be eroded when nations become more assured of supply.
3. The higher energy price that has manifested itself in the sell price will mean that if it declines, commodity prices will also decline.
4. Exploration spend has been increasing and as new discoveries come on stream, demand will be less of a driving force in the commodity price.
5. Future prices for numerous commodities (including oil as a proxy for energy and copper as a proxy for industrial metals) are in decline.

While it is highly plausible that the current commodity boom will be completed by about 2012, future additional booms, possibly driven by China or even Brazil, will probably follow. Many analysts make the assumption that China wants to urbanise a large part of its population during the current boom cycle.

## **4. Future investment and employment scenarios**

Prosperity, increased employment and improved social conditions will usually accompany the successful exploitation of valuable mineral resources in the current regulatory environment, not only for the country but also for the local communities in which the development takes place. Job opportunities will be created directly where the capital investments to develop mines are made, and indirectly throughout the entire value chain incorporating all aspects of the exploration, development, operation and eventual closure of the mining entity. The placing of the deposits within South Africa has allowed certain regions almost to 'specialise' in certain commodities.

In the following sections the four main sectors are examined – gold, platinum group metals, diamonds and coal. For each sector, the recent history of the sector is sketched, followed by future best- and worst-case scenarios.

### **4.1 Gold**

#### *4.1.1 Current scenario*

For the past century and more, South Africa's gold production has been closely associated with the deposits of the Witwatersrand Basin. The gold mines of the Wits have stretched from the Free State Province through North West and Gauteng and into parts of Mpumalanga Province. South Africa's gold output has been steadily decreasing since 1971; apart from the development of the Kalgold project in the Kraaipan Schist Belt of the North West Province, the majority of new projects are largely extensions along strike or down-dip of current or mothballed operations. Only two new mines have been established – the Target mine near Odendaalsrus in the northern Free State and the South Deep mine between Carletonville and Randfontein in Gauteng – although these are also technically extensions of existing known mineralised zones.

#### *4.1.2 Nature of investment*

The potential for new investment in gold mining in South Africa is waning rapidly in the face of an overwhelming rush to find, develop and exploit new platinum deposits. While the large gold mining companies are certainly spending a fair amount of capital on exploration, they are also spending a reasonable amount of money in their own backyard. For the 2006 financial year (although different companies have different year-ends), the three top gold producers – AngloGold Ashanti, Gold Fields and Harmony – spent some R4.2-billion on their South African operations, approximately R2.0-billion of which was on expansion projects and the balance on ore reserve development and equipment replacement.

Over the next five-year period, it is likely that this level of expenditure will continue, as the current expansion projects at all of the major producers will only be coming fully onstream within that period. Beyond that there is the potential for a collaborative

venture to access the ultra-deep areas of the Witwatersrand Basin, as well as accessing certain partly-mined areas in the Central Rand Area, currently underwater.

So, while there is unlikely to be a spate of new mines springing into existence, there exists reasonable potential for gold production to increase from current levels back to the 350 ton level and above, depending on the behaviour of the gold price, cost inflation, exchange rates, labour productivity and new methods in both gold extraction and gold utilisation.

#### *4.1.3 Employment scenarios*

We believe that there are two main scenarios for the local gold mining industry, looking specifically at the South Africa-based operations and excluding any corporate activity, including take-overs, mergers, acquisitions by foreign companies, etc. While this may have a particular effect depending on the location and corporate philosophy of the external partner, they would still have to comply with South African laws and regulations.

The first scenario is a continuation of the current trend in South African gold mining, that is, declining gold production, albeit at a much slower rate than over the past 10 to 15 years, and a normalisation of firm boundaries between companies to take whatever advantage is available of the existing ore reserves. In this scenario there could well be another 10 or more years of high levels of capital expenditure before the older, deeper mines begin to run out of economic reserves. There is unlikely to be any major move in the gold industry away from a majority of production based on conventional mining. Very few of the remaining exploitable ore reserves lend themselves to bulk mechanised mining, and even if some did, it would be prohibitively expensive to redesign an existing mine to cater for mechanised mining. Therefore, staffing levels in this scenario should remain at or marginally below current levels, with natural attrition being the main factor in reducing staffing levels, the effects of HIV/Aids<sup>1</sup> notwithstanding.

The second scenario would allow for a slow but steady increase in gold production as the new areas are accessed and prices and exchange rates support the allocation of capital to new shafts and/or mines in extension area, providing additional production rather than just replacement tonnage. In this scenario, ore reserves, buoyed by a positive trend in prices, would increase and allow a much longer capital expenditure

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<sup>1</sup> Companies spend in the region of R220-00 to R480-00 per annum per employee on workplace HIV/Aids programmes. This budget covers issues such as awareness campaigns, formal training of employees, peer educator training, sexually transmitted infections (STI) treatment, voluntary testing and counselling (VCT), wellness programmes and home-based care. Each operation is expected to augment the budget with local community programmes and budgets are allocated separately for community partnerships, of which Mothusimpilo, Bambisanani, Lesedi, Powerbelt and Carletonville home-based care programmes are some examples. Where companies are introducing antiretroviral treatment programmes as part of their comprehensive HIV/Aids programmes, separate budgets are allocated. <http://64.233.183.104>.

profile for current mining producers. Even in this scenario, it is unlikely that new areas would be found that would be ideal for mechanised mining, and the same logic applies to this scenario in terms of the expense of refitting an existing mine to cater for mechanised production. Staffing levels in this scenario should at least remain constant and possibly even rise, depending on the extent and level of additional production.

The general decline of gold output in South Africa results from the fact that no new mines are being built. South Africa can experience a resurgence in employment in this sector if the Rand price of gold increases to a point where old mines can be re-opened or operating mines be extended (for example, by deepening). A second reason for increased employment in South Africa would be if gold mined elsewhere in the world becomes increasingly expensive to mine and the South African operations become viable once again from a cost perspective.

The ability to switch to mechanisation is generally limited in the gold industry unless it is for greenfield projects. In this case employment will be low and high-level skills will predominate. If brownfield expansion occurs, mechanisation may become a viable option and once again employment will decline.

Employment levels in the gold sector are currently delinked from the Rand price of gold. This means that the strongest factor controlling gold sector employment is available resources. If gold output is used as a proxy for gold then the sector may already provide a guide for where employment is headed. Currently South Africa's gold output is declining by 4.5%, but employment is declining slightly faster – closer to 6.8% per annum. Our scenarios are therefore that employment will decline within a 3% to 8% range (Figure 9).

Indications at present are that even when circumstances change and South Africa becomes a new gold target (currently it hosts 40% of world gold reserves, however, this is high cost gold) the future projects will be more mechanised and less labour intensive.

It could transpire that the industry hits a base and continues to drift along for many years at an employment level between the ranges reflected in Table 2.

Figure 9 – Gold employment scenario

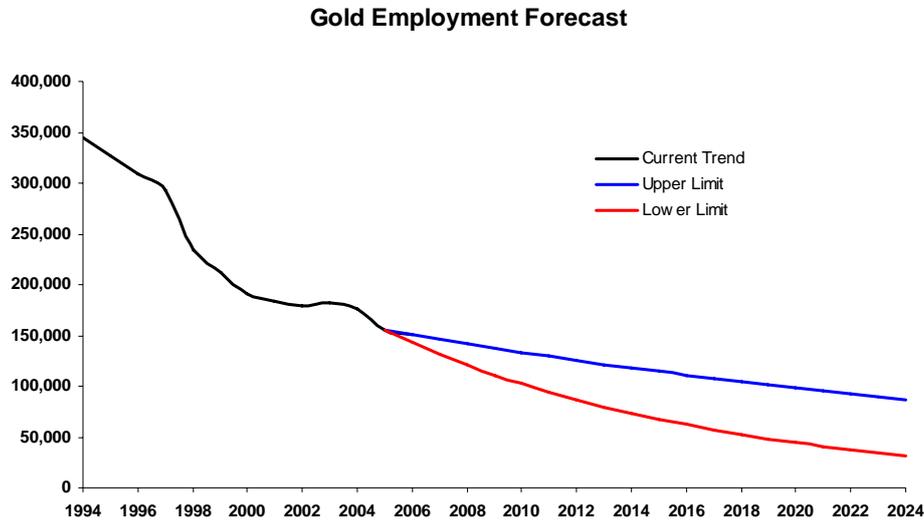


Table 2 – Gold sector employment estimates (2014 and 2024)

	2014	2024
3% decline per annum	118,000	87,000
8% decline per annum	74,000	36,000

## 4.2 Platinum group metals

### 4.2.1 Current scenario

Platinum Group Metal (PGM) mining in South Africa is largely focused on the Bushveld Complex, situated in the North West, Limpopo and Mpumalanga Provinces. Minor occurrences of PGMs are contained in other deposits (as in the base metal deposits in the Northern Cape which have platinum credits).

The North West Province is currently the dominant producer of PGMs; however, most of the long-term projects are located in the Eastern Limb of the Bushveld (Limpopo Province). A critical problem faced by the Eastern Limb operators is that they cannot source enough water in the short term. As projects like the building of the De Hoop dam come onstream, water supply will become less of a problem. This is anticipated to occur from 2010 and 2013.

Water usage is regulated in terms of the National Water Act No. 36 of 1998 (NWA). Only public water is recognised. The State issues licences for its various uses, including those activities associated with mining. The use must be specified in an

environmental impact assessment (EIA), which precedes licensing. Since it is technically public water, even the re-use of 'dirty water' pumped out of mines to enable mining to take place in the first place will also be subject to licensing. The mine owners will have to get agreement for this from the Department of Water Affairs and Forestry (DWAF) before the licence can be issued.

Unlike the gold sector, the PGM sector is booming. Apart from the traditional 'Big Three' – Anglo Platinum, Impala Platinum and Lonmin Platinum – numerous smaller operators are well established in the local industry, such as Northam, Aquarius and African Rainbow Minerals. Over the past three to five years, as the demand for platinum has consistently outstripped supply, numerous local and foreign exploration companies as well as new black economic empowerment (BEE) participants have fuelled an increase in ore reserve generation, which has already resulted in a dramatic increase in PGM production.

#### *4.2.2 Nature of investment*

South Africa is certainly the premier destination for new and aspiring platinum companies, especially with the recent developments in processing technology which allow for the expanded processing of UG2 ore, which traditionally caused numerous problems in the existing furnaces, forcing producers to blend Merensky Reef with UG2 Reef ores in order to treat UG2 at all. Technical developments now allow UG2 to be processed separately (partly due to technology developed at Mintek), effectively opening the UG2 Reef for complete development, a situation that was not feasible only 10 years or so ago.

Capital expenditure into the PGM sector has experienced a quantum leap over the past five to six years to a level in financial year 2006 where the top five producers (Angloplats, Impala, Lonmin, Northam and Aquarius) spent a total of R10.7-billion, the majority of which was earmarked for new projects, expansion and access development.

The exploration and development spend from the junior platinum companies is a little more difficult to quantify. It would appear to be in the region of R150-million to R250-million per annum at present.

What must be borne in mind is that the Bushveld Complex hosts a wide variety of commodities in addition to the mainstream PGMs, namely gold, copper, nickel, chrome, vanadium, cobalt and a host of minor metals. Large resources of iron-bearing rocks that could reasonably be exploited in bulk exist in the Eastern Limb of the Bushveld.

It is not difficult, given the vast measured, indicated and inferred resources already calculated by the major companies, to assume that PGMs and associated minerals and metals will still be mined in large quantities from the Bushveld 50 years from now.

### *4.2.3 Employment scenarios*

Given the current trends in platinum supply and demand (and other PGMs, although some of the sector dynamics differ quite dramatically from platinum), it is reasonable to assume that over and above the global commodities boom, the market dynamics for platinum would be particularly robust. Johnson Matthey has indicated for some time now that the platinum market has been in deficit, with demand for platinum for new applications in electronics, high-temperature alloys, jewellery and automobile catalysts outstripping new mine supply and with only the recycled material from scrapped electronics and autocatalysts bringing the market back into some semblance of balance. Ever-tightening emissions controls for cars and trucks, especially diesel vehicles in Europe, have provided a solid underpinning to an already tight market and it is unlikely that this will change dramatically in the short term.

The increasing level of mechanisation in the platinum sector reflects the overall drive for greater productivity and efficiency within wider-bodied ore deposits. In certain areas, mechanisation is also a strategy to reduce the exposure of shift workers to unstable ground conditions following a blasting cycle. While the gold sector has experimented with trackless and mechanised mining methodologies over the past decade or two, most attempts to convert operations from conventional to trackless/mechanised mining have proved expensive failures. The only real situation where mechanised mining is working relatively well (although not without many teething problems) in the gold sector is at Target mine (now part of Harmony) where a unique geological phenomenon has resulted in almost perfect conditions for massive mechanised underground mining.

The platinum mines, however, especially, but not exclusively, on the flatter-lying and wider-bodied Eastern Limb, are more conducive to accommodating mechanised mining methods. Impala Platinum, for instance, is currently (for the 2006 financial year) mining at a rate of approximately 14% from mechanised sections, compared to less than 1% in 2002. Production over the same period has increased from 1895 moz PGM to 2003 moz, while employment has declined from 27,900 to 26,900.

So this again provides the basis for two scenarios, the first of which, similar to gold, provides for a stabilisation of the current markets, with the continuation of the status quo, and a steady increase in the levels of production until all the expansion and development projects have been completed, and the markets once more fall into balance. Even if this should occur, we believe that the market would remain buoyant for at least five to eight years before showing any real signs of tapering off, barring a total meltdown of the global economy. In this scenario, employment should certainly not decline and may well increase until all expansion projects have been completed.

The second scenario is much more of a 'high road' situation where new applications and uses for PGMs continue to be discovered, emissions controls continue to be tightened in Europe and the US, and the Chinese market follows the West in terms of emissions legislation. This would provide for continued growth in demand well past 2015, and the continued efforts of South Africa to provide adequate supply into that market. In this scenario, employment levels would continue to grow in the mainstream production sector as well as in the downstream industries which industry and government are currently identifying as priorities.

Indications at present are that the platinum boom currently under way is also a consequence of an inability of the major platinum producers to match markets needs. It is also evident that this inability has seen the increase in the number of platinum companies able to commence mining in time to meet market demand. However, as the number of platinum companies increase, failure and consolidation will occur with the emergence of fewer large producers. The potential for one more primary producer in South Africa seems possible.

In 1995 there were nine countries producing platinum. By 2005, this had only grown to 10 countries. The opportunities for more countries to become active in the platinum sector are limited by their geological endowment. In this same period, South Africa increased its market dominance, from 68% market share in 1995 to 77% market share by 2005, peaking as high as 82% of world market share in 1999 (USGS, 2006).

Platinum is expected to be in constant demand and its long-term future is assured. With deeper level mining and South Africa's 200-year reserves (at current production levels) it means that platinum will become South Africa's new mining bastion, much like gold was in the mid-1900s.

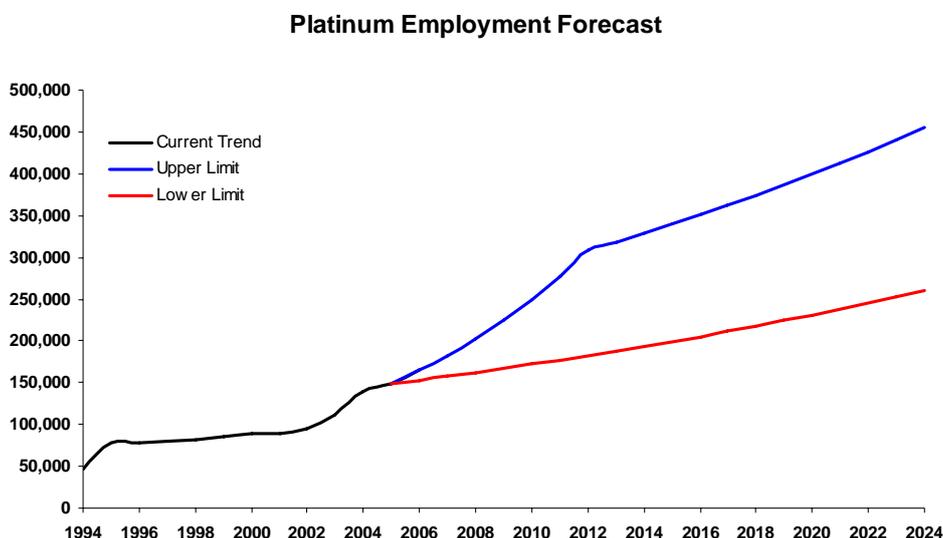
In the seven years from 1996 to 2002, the platinum sector experienced a 3% per annum growth in employment. From 2003 to 2005, this had increased to 17% growth per annum. This supernormal growth means that platinum has the capacity to absorb labour from declining sectors like gold (and to a lesser extent diamonds).

With estimates of employment growth of between 3.3% and the modified growth (Table 3) more likely (supergrowth is expected to be for a limited time only before productivity declines and mechanisation is instituted by all three primary platinum producers), the employment scenario for this sector is shown in Table 3 and Figure 10.

**Table 3 – Platinum sector employment estimates (2014 and 2024)**

	2014	2024
3.3% growth per annum	194,000	260,000
11% to 2012, thereafter 3.3% growth per annum	329,000	455,000

Figure 10 – Platinum employment scenario



## 4.3 Coal

### 4.3.1 Current scenario

South Africa’s coal reserves are mainly bituminous, with relatively high ash content (about 45%) and low sulphur content (about 1%). Three fields (Waterberg, Witbank and Highveld) hold 70% of total recoverable reserves, estimated at 33.5 billion tons in 1998. At the current extraction rate, this translates to about 40 to 50 years of production. South Africa’s coal reserves are dominated by Karoo region sediments, which cover most of Southern Africa and are also responsible for the coal deposits mined at Wankie in Zimbabwe and Maamba in Zambia.

Three major coal producers and exporters currently dominate the coal sector: Anglo American Coal (Amcoal), BHP Billiton South Africa (Ingwe) and Duiker Coal. Amcoal operates coal mines in Mpumalanga and KwaZulu-Natal. Amcoal’s Bank, Goedehoop, Kleinkopje, Landau, Greenside and New Clydeside coal mines produce coal destined for the export market, while production from the Arnot, Kriel, New Denmark, New Vaal and Matla mines is generally sold to the South African electricity company, Eskom. Ingwe produces coal for the local and export markets from its Delmas, Douglas, Ermelo, Glisa, Khutala, Koornfontein, Malta, Middleburg, Optimum, Rietstruit, Welgedacht and Zululand coal mines. Ingwe also has a 37.43% share in the Richards Bay Coal Terminal (RBCT).

Coal is the primary fuel produced and consumed in South Africa, and most of the coal mined is used to produce electricity. Other major steam coal-consuming sectors include gold mining, the cement industry and the brick and tile industry. The power generation and synthetic fuel industries use 85% of domestic coal consumption. The

remainder is used in the metallurgical industry and for domestic use. Mittal Steel (previously Iscor Ltd.), a South African steel company with steel plants throughout the region, is the main consumer of domestic coking coal in South Africa. Mittal also utilises imports of coking coal and supplies from other local producers to satisfy the remainder of its requirements.

#### *4.3.2 Nature of investment*

It is difficult to say how the coal industry will actually develop over the next five to 10 years because of the electricity demand increasing every year on the back of both increased industrialisation and the success of the rural and community electrification programme. This, in turn, puts pressure on the national grid to supply the electricity required, to the extent that additional capital is currently being spent to refurbish and bring onstream previously mothballed power stations such as Majuba and Driefontein.

It is very likely that the Waterberg coalfields in Limpopo will provide a significant proportion of the coal for power generation over the next 15 to 20 years, but this will also be a finite supply, and our opinion is that the smart money over this period will be earmarked for research and development of power generation technologies such as fuels cells and the Pebble Bed Modular Reactor.

#### *4.3.3 Employment scenarios*

The coal industry in South Africa is far from eventual closure. Certainly some of the older collieries are nearing the end of their productive life, but with the utilisation of low-grade coal for power generation and a significant ore resource of metallurgical coal that still exists, future usage is assured.

We see only one main scenario, with potential diversions *en route*. The very nature of coal mining, especially large, open-pit mining operations is that there is very little to be done about the methodology and scheduling of mining – the overburden must be removed before the upper seams are mined, and these have to be extracted and either used or discarded before the next lower seams may be mined. What is very evident is that any major extensions to existing mines, as well as the development of new mines will be focussed mainly around a high level of mechanisation. So even if the Waterberg and other operations are large and the life-of-mine extends beyond 25 years, there will be no major job creation spin-offs, although on a short-term basis, local communities would be able to take advantage of the construction and development phase, and to a certain extent the production phase, depending on the skills are available.

South Africa's coal is largely for domestic consumption, although it is also ranked fourth in the world as a coal exporter. South Africa is seeing a trend whereby levels of mechanisation in the coal sector are high and the mining process is not as labour intensive as the deeper level mining operations. Coal is therefore expected to play a small role in South Africa's employment future compared to the metals.

In 1995, the coal sector in South Africa employed 58,802 people. At the end of 2005 it employed 55,720 people (a 5% decline). Over the same period, coal production in South Africa increased from 206.2 Mt to 245.0Mt (SAMI, 2006).

Considering that this sector focuses on innovation to increase production there is no realistic expectation that significantly more jobs will be created. Alternatively, it is possible that jobs could be lost.

In Table 4, scenarios for coal industry employment losses are put forward, based on possible sector growth rates.

Table 5 creates scenarios for coal industry employment based on possible Rand / Dollar exchange rates. These differ quite substantially, and Mintek believes the lower employment scenario based on possible exchange rates to be the more likely outcome.

**Table 4 – Coal sector employment estimates using growth trend data (2014 and 2024)**

	2014	2024
0.2% growth per annum	57,000	58,000
0.3% decline per annum to 2012, thereafter growth at 2.7% per annum	60,000	78,000

**Table 5 – Coal sector employment estimates using exchange rate trend data (2104 and 2024)**

	R:US\$	2014	R:US\$	2014
Upper case	11.21	45,000	16.57	35,000
Lower case	13.90	40,000	20.55	28,000

*Note: This is the case Mintek considers most likely.*

## 4.4 Diamonds

### 4.4.1 Current scenario

South Africa’s diamond deposits were long concentrated in the Northern Cape where the first diamondiferous kimberlite discoveries were made. Over the years the diamonds were mined close to exhaustion but the De Beers replacement for these in South Africa was the Venetia diamond mine located in Limpopo Province. Venetia produces in excess of 70% of De Beers’ total diamond supply and is expected to remain a significant producer to a least 2025. At the same time as De Beers is closing or down-scaling its Northern Cape Mines, it is opening up new operations, including the Voorspoed Mine in the Free State (expected LOM of 10 years or to 2017) and the South Africa Sea Areas Mines (also called the SASA concessions, which are the marine deposits along South Africa’s West Coast).

Ultimately these two new operations will be highly mechanised and Cape Town (Western Cape Province) will be the beneficiary of the SASA operations where the port facilities are located. Voorspoed Diamond mine will be serviceable from Gauteng (located ~180km southwest of Johannesburg, close to the N1).

South Africa's future diamond prospects will thus be focused on the Limpopo, Western Cape and Gauteng Provinces.

#### *4.4.2 Nature of investment*

Although the focus of the local diamond business is to manage the majority of ageing deposits still producing, there seems to be significant interest in surface operations in the Barkley West area near the confluence of the Vaal and Harts Rivers, as well as renewed interest in the Northern Cape along the Orange River. A relatively large amount of exploration has been undertaken by companies such as Monroe, Diamond Core, Moonstone and others, although the only real success story of the past few years has been the Letseng deposit in Lesotho, for some time part of the troubled JCI stable but now mostly in the hands of Lonrho Africa.

Unfortunately, the South African environment for diamond prospectors has not been particularly enabling to foreign companies wishing to spend exploration capital, especially with the long delays to date in granting of the various prospecting, exploration and mining licences. A number of Canadian, Australian and other companies have therefore elected to seek exploration properties elsewhere, such as Botswana, Namibia, Mozambique, Angola, Zambia and the DRC. Although these problems are currently being addressed, it will be difficult to entice the foreign companies back, and it would appear that encouragement needs to be given in some form or another to local BEE entrepreneurs to enter the risky business of exploration.

#### *4.4.3 Employment scenarios*

The one opportunity for job creation in the diamond industry is the formalisation and regulation of the artisanal and small-scale mining operations present on the fringes of every major operation or exploration property. It has been speculated that anywhere up to 100,000ct every year are recovered by these 'diggers', but this may well be a conservative estimate.

There would obviously be a fair amount of reluctance on the part of diggers to be formalised, bordering on illegal as most of their operations probably are. Surface diamond exploration and mining are two of the least technical of the commodity markets to enter, and if regulated, assistance of both a financial as well as an advisory nature could form the basis of regenerated community prosperity in some of the most desperately poor areas of our country.

Employment on a large scale would probably not occur, unless the bigger miners discover a new diamond field and bring in manual labour to exploit the deposit. What could be of value is the organisation of communities into co-ops to co-ordinate the

efforts of ‘diggers’ in a certain area, for example, Douglas or Barkley West, where these activities could provide a reasonable living for the local communities.

South Africa’s diamond sector sees production increasingly waning. It is becoming clear that De Beers cannot be expected to keep driving the market. Divestitures have taken place and will continue for the short term. What is expected to happen is that as smaller operators take over the mines and open smaller mines or even commence mining smaller deposits, more labour-intensive methods will be required to support these. In the period 1995 to 2000, employment in South Africa’s diamond sector shrunk by 1% per annum. However, in the period 2001 to 2005, there was a significant rebound in employment and employment increased by 7% per annum. The new mines being planned by De Beers are believed to be more capital intensive and labour growth within De Beers is expected to shrink, and so affect the entire industry. Mintek estimates that employment in the diamond sector will grow at between 1% and 3% per annum for the medium to long term. However, the reserves assessment suggests that this will fall back in about 2015 to 2018 when many of the newer projects start closing and other mines close down. From then a decline of 5% to 8% is assumed (Table 6). The estimates following the exchange rate trend are given in Table 7.

**Table 6 – Diamond sector employment estimates (2014 and 2024)**

	2014	2024
6.9% growth to 2012, thereafter -0.9% decline per annum	32,000	21,000
2.6% growth per annum	26,000	25,000

*Note: This is the case Mintek considers most likely. This scenario increases to 2014 and then declines from 2016.*

**Table 7 – Diamond sector employment estimates using exchange rate trend data (for 2014 and 2024)**

	R:US\$	2014	R:US\$	2014
Upper case	11.21	17,000	16.57	35,000
Lower case	13.90	23,000	20.55	63,000

## 4.5 Summary

The summary for the commodities is detailed in Table 8.

**Table 8 – Summary of employment scenarios**

Commodity	Case	2004	2014	2024
Gold	Upper		118,000	87,000
	Lower	177,000	74,000	32,000
Diamonds	Upper		32,000	21,000
	Lower	19,000	26,000	25,000
Platinum	Upper		329,000	455,000
	Lower	140,000	194,000	260,000
Coal	Upper		45,000	35,000
	Lower	48,000	40,000	28,000
Other	Upper		123,000	139,000
	Lower	58,000	100,000	157,000
Total	Upper		647,000	737,000
	Lower	442,000	434,000	502,000

## 5. Future skills

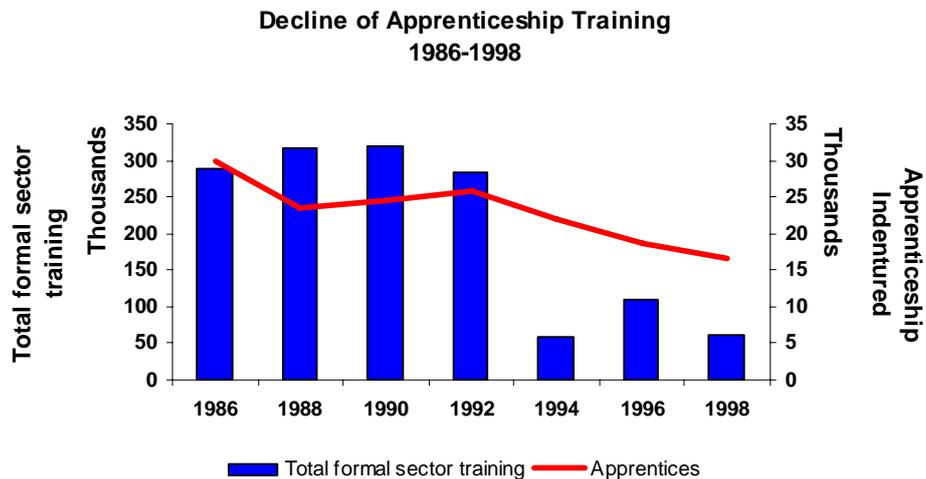
### 5.1 Skills requirements

At present, there is a serious lack of skilled professionals at all levels within the mining sector. The lacklustre performance of the commodities sector during the 1990s and early 2000s resulted in a dearth of new entrants into the professional and technical arenas of the minerals business, as there was limited funding available for new students and restructuring occurring within the professional levels as the country moved out of the *apartheid* era into the realm of BEE. A large number of graduates from a broad base of mineral-related disciplines sought jobs in other countries where the security of tenure within a company was more dependable than that experienced locally. In addition, the movement of school-leavers in this and other countries away from ‘unglamorous’ careers such as geology, mining engineering and metallurgy towards high-end professions in the medical, legal and commercial sectors resulted in the curtailment or even closure of many mining schools and related institutions across the globe. As the levels of technology increase in the mining industry and the local pool for the technical grades (highly educated, with maths/science, and able to pay for an education) dry up, it will have to be supplemented from abroad in the short-term by the ever-increasing army of suitably-qualified itinerants. More creative approaches to drawing in alternative sources of skilled personnel will be needed, such as career pathing workers within the industry, or attracting those that might not otherwise have access to tertiary studies and internships.

This state of affairs, together with the discarding of the apprenticeship programmes traditionally applied on the mines in South Africa in favour of the Sector Education and Training (SETA) approach, has also had the end-result of creating a gap in the provision of technically-qualified artisans and technicians without which a complex entity such as a mine cannot hope to function. This is starkly represented in Figure 11. This situation is presently being addressed, but not at a rate sufficient to cope with the average operational expansion occurring both locally and abroad. The lure of foreign work at higher rates in stronger currencies is also depleting the local labour market of qualified people almost as soon as they are qualified.

This factor will be one of the most critical to address if any of the goals mentioned within the report are to have any chance of success. For the purposes of some of the scenarios presented, we have assumed that skills will be available when required, although this may well not be the case.

Figure 11 – Decline of apprenticeship training (1986-1998)



Source: Department of Labour, 2005

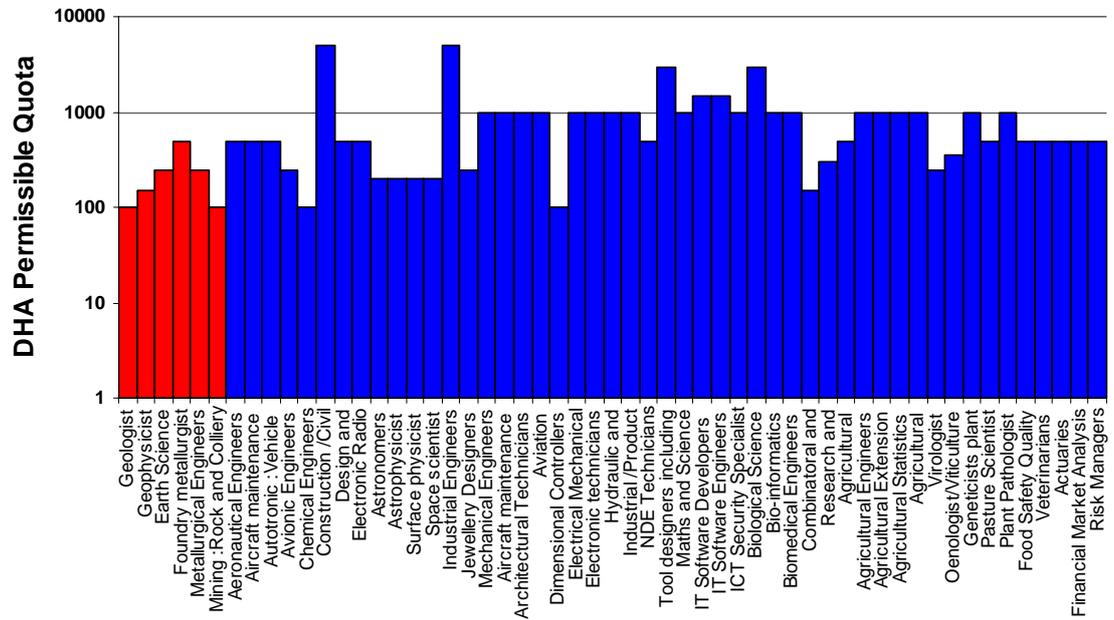
## 5.2 Considerations of skills shortages or people shortages

An Australian study (MCA, 2006) which also reported on the skills shortage in that country, reported a rising trend where it was not so much a skills shortage being experienced as a people shortage. A people shortage implied that skills were obtainable in that country but that the mining sector could not attract people to that particular sector.

In South Africa there is a rising trend amongst the younger generation of graduates to be less inclined to live in mining towns and environments. They are therefore not attracted to those areas, preferring to live in more urban settings and choosing service-sector employment (for example, preferring to work for the banking sector rather than for the mining sector).

Based on the Department of Labour's *State of Skills in South Africa – 2005* report, the Department of Home Affairs (DHA) quantified the skills it would permit (Figure 12) to be 'imported' into South Africa (in Davids, 2007).

Figure 12 – Department of Home Affairs: permissible skills ‘imports’



Note: Mining sector in red

### 5.3 Training needs

To deal with the current skills shortage, a multi-faceted approach is needed:

- Increased training rates in scarce-skills professions;
- Create environments that attract the skills to the sector (for example, attracting engineers towards the mining sector versus the financial sector); and
- Create national coaching programmes around Job-Specific Skills and not Generic Skills.

## **6 Indirect linkages in mining employment**

### **6.1 Indirect employment contribution of mining**

Employment generated by inter-sectoral linkages to and from the mining sector is examined below. Statssa Supply and Use tables for 2002 have been analysed in order to determine the share of employment attributable to mining that is generated in industries supplying goods and services to the mining sector (upstream linkages) and the share of employment attributable to the use of mining output (downstream linkages). Condensed supply and use data were used to match sectoral employment data covering nine principle sectors. The results obtained provide a picture of the employment linkages of mining and quarrying that is accurate for 2002.

The discussion has been simplified by using an aggregated mining sector. However, in order to record the sub-sector impacts on employment linkages, attention is drawn to major differences where they arise in the strength of linkages reported for coal, gold and all other mining activities.

Supply and Use tables provide a useful snap-shot of the economy at the time of their construction. This provides the ability to dissect the inter-sectoral linkages obtained at that time; however, their predictive power is limited as the key question becomes one of speculating about how structural change in the economy will present itself and consequently how employment will be affected.

In 2002, the relative contribution of mining to the national economy and share of fixed investment peaked due to the coincidence of significant expansion in the platinum sector with dismal public sector investment. Table 9 shows the variability in mining's share of fixed investment and especially its declining share since 2002, which needs to be taken into account when considering the implications of interpreting how linkages may have changed since that date.

**Table 9 – Contribution of mining and quarrying to value added and fixed capital formation, 1996-2006**

Year	Share of value added	Share of fixed capital formation
1996	6.9	8.0
1997	6.5	8.5
1998	6.8	8.9
1999	7.1	9.2
2000	7.6	9.9
2001	8.3	10.3
2002	8.7	11.3
2003	7.4	10.7
2004	7.0	7.9
2005	7.0	6.1
2006	7.8	6.5

*Source: SARB, 2007*

The focus in this discussion is on first-order secondary or indirect effects of value created by the use of inputs in the mining sector, together with the use of mining output in each of the other sectors. The report avoids attempting to quantify tertiary effects by means of a spending multiplier. Tertiary effects from the value added by any economic activity and its effects in turn on wages, profit, savings and investment throughout the economy are indeed real; however, there is a risk of double accounting and consequently inflating the spending multiplier that can be attributed to mining. Here we adopt a conservative approach and confine the examination of indirect effects to secondary impacts only.

### 6.1.1 Upstream linkages

Consumption of the output of the nine principle sectors is shown in Table 10. Here the share of products and services purchased by mining for each sector is shown along with its attributable share of employment. These are referred to as upstream or backward linkages.

Transport is the principle input to the mining sector, totalling 35% of the total value of inputs into mining. Mining consumes 11.2% of the supply of transport services and is second only to trade as a user of transport services. It is stating the obvious to observe how dependent mining is upon road, rail and port infrastructure and transport services to move mined product to domestic and export markets. Sub-sectoral differences here are highly significant, as coal mining consumes 28% of the total transport services and gold mining an insignificant 1%, but other mining – comprising the metals iron, chromite, manganese and industrial minerals – absorbs a massive 71% of this input.

Electricity consumed by mining absorbs 8% of the sector's output; however, the limited share of employment contributed by the electricity sector reduces the employment significance of the high rank that electricity has in the upstream linkages.

Again the sub-sectoral differences are significant as gold mining consumes 54% of the total supply to mining.

**Table 10 – Share of sector output consumed by mining and attributable employment**

Sector	Share of sector output	Sector employment share
Transport	11.15%	23,193
Electricity	8.01%	3,766
Manufacturing	2.25%	28,132
Community services	1.95%	33,290
Construction	1.46%	5,095
Business services	1.12%	13,773
Trade	0.79%	10,247
Mining	0.21%	863
Agriculture	0.02%	240
<b>Total</b>		<b>118,600</b>

*Source: Statssa 2003, 2006a, 2006b*

Manufacturing supplies 2.3% of its output to the mining industry, which accounts for some 28,000 jobs. Under manufacturing fall the major categories of chemical products, mining machinery, pumps, petroleum products, wearing apparel, fabricated metal products, wood products, motor vehicles and components, electrical equipment, textiles, plastics and tools.

Community services provide almost 2% of its output to the mining sector, since education and professional consulting services fall into this category. A large share of the services consumed are engineering and scientific services contracted on a per-project basis by mines. The skills requirements of employment generated in this category is high level and of a technical nature.

Mining absorbs only 1.5% of the construction sector's output. This value appears low in relation to the 8% to 10% contribution that mining makes to gross capital fixed formation in the economy and is explained by the extensive use of engineering management, procurement and contracting firms to carry out capital works for mines.

Mining's secondary employment effects through first-order backward linkages is estimated to be 1.6% of the formally employed workforce for 2002, numbering some 118,000 jobs.

#### *6.1.2 Downstream linkages*

The mining sector's share of inputs into the nine principle sectors is shown in Table 11. Here the share mining products make up in the purchases of each sector is shown, along with its attributable share of employment. These are referred to as downstream or forward linkages. Recognising that 70% of total mineral production is exported directly in a saleable form that involves limited post-mine processing, the limited scale

of downstream linkages highlights the large share of precious metals in South Africa's mining mix. Transport, energy and labour cost advantages are negligible factors influencing the location of further processing close to the mining source in the case of precious metals.

**Table 11 – Mining inputs consumed and attributable employment**

Sector	Share of sector inputs	Employment
Electricity	12.98%	6,102
Manufacturing	5.45%	68,162
Construction	1.74%	6,097
Agriculture	0.24%	2,356
Mining	0.21%	863
Community services	0.13%	2,225
Transport	0.10%	215
Trade	0.04%	565
Business services	0.02%	233
<b>Total</b>		<b>86,817</b>

*Source: Statssa 2003, 2006a, 2006b*

Forward linkages to the electricity industry are the most significant, given that coal-based power generation provides 90% of the power provided. Again the employment effects of this strong forward linkage are limited due to the capital-intensive nature of the power-generation industry.

Manufacturing as a whole obtains 5.5% of its inputs from the minerals industry, spread across numerous sub-sectors, the most important of which follows here. The largest share mining output is absorbed by the petroleum and chemical industry for conversion into fuel and basic chemicals, representing some 31% and 36% of domestic sales of coal and other mining products, respectively. Employment effects are low in this capital-intensive sector. The second-most important downstream linkage is the conversion of coal and other mining products in the basic iron and steel industry, which both supply some 30% of their domestic sales into basic iron and steel and ferro-alloy sectors. Again this is a capital-intensive sector with low direct employment in the primary steel-making stage. Non-ferrous metals absorb 2% of coal and 6% of other mining's domestic sales, respectively. Each of the above-mentioned feedstock has a greater employment effect in subsequent stages of process and fabrication of final goods.

Metals and industrial minerals are directly consumed in significant proportions in sub-sectors of the manufacturing industry, comprising metal fabrication, equipment, coatings, paper, cement, glass and transport equipment.

Industrial minerals directly make up 1.7% of the inputs into the construction industry.

Mining's secondary employment effects through first-order forward linkages are estimated to be 1.2% of the formally employed workforce for 2002, numbering some 87,000 jobs.

## **6.2 Future indirect employment contribution of mining**

Upstream and downstream linkages to and from mining will change as the structure of the economy changes, therefore the following remarks draw attention to employment changes that are expected to follow from anticipated changes in the minerals, energy and minerals-related manufacturing sector.

### *6.2.1 Possible changes in upstream linkages and associated employment*

Transport remains the most critical upstream linkage for the mining sector. Based on the fixed location of the Kalahari manganese and iron ore fields, Mpumalanga and Waterburg coalfields, the Bushveld complex and sources of industrial minerals in relation to domestic and export markets, transport remains the most important upstream linkage. The relative decline and rise in gold and PGM precious metals mining respectively will not alter this picture, as precious metals have negligible transport requirements.

Mining's share of electricity sales will decline due to faster rates of growth in the secondary and tertiary sectors and further contraction of the gold mining sector, which absorbed 50% of all electrical inputs in 2002. Increased power consumption for deeper level mining in the PGM sector does not offset the decline in sales to the gold sector.

The consumption of manufactured inputs by mining will remain a function of the rate of domestic investment to maintain and replace current capacity. Changes will occur in the source of supply of the required equipment inputs, which will be determined in the main by the success or failure of South Africa to retain its existing industrial base.

### *6.2.2 Possible changes in downstream linkages and associated employment*

Government's announced shift in the energy carrier mix in power generation away from coal will not lead to a contraction in domestic coal demand. Domestic coal sales will continue to grow in line with the rest of the economy. New coal-fired power plants will increase domestic off-take.

Mining inputs into manufacturing will continue to be concentrated in basic iron and steel, alloys production and chemicals where South Africa retains a comparative advantage. These are primary processing stages that are capital intensive, with employment growth held in check by productivity gains. Mining inputs into the numerous other sub-sectors of manufacturing will see little change as these are manufactures produced for the domestic market.

## References

Chamber of Mines (2007) The Chamber of Mines of South Africa. <http://www.bullion.org.za>

Dauids, R.C. (2007) Skills Shortages in South Africa: A Literature Review. Development Policy Research Unit. DPRU Working Paper 07/121 ISBN: 978-1-920055-44-8

Department of Labour (2005) State Of Skills in South Africa, 2005. Department of Labour

International Monetary Fund (2006) The Boom in Nonfuel Commodity Prices: Can it last?. [www.imf.org](http://www.imf.org)

Mineral Council of Australia (2006) Staffing the Supercycle: Labour Force Outlook in the Minerals Sector, 2005 to 2015. Mineral Council of Australia

Nedbank (2007) Nedbank South Africa. Capital and Expenditure Project Listing 1 Jan 1993 to 30 December 2006. Accessed 6<sup>th</sup> February 2007

South Africa's Mineral Industry 2005/2006 (2006) Directorate: Mineral Economics, Department of Minerals and Energy, Pretoria, Republic of South Africa.