



A century of migrant labour in the gold mines of South Africa

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Synopsis

Our purpose is to record and to explain the widely changing numbers of the huge total of black workers on the gold mines of South Africa over the century from 1896 to 1996. These men were recruited from up to twenty territories, and their contributions are examined. The major areas providing labour over this long period have been Lesotho, the former Transkei within South Africa and Mozambique. From 1989 to 1996, for instance, these three areas accounted for over sixty per cent of the total labour force (tlf).

Our principal Figure 1 shows the tlf fluctuating through time to reach a peak of 480 000 in 1988. Irregular falls are also documented with the most serious in 1995 to 180 000. Based on this graph we consider the political, economic, sociological and historical reasons behind these changing employment opportunities. These have included external world-scale events such as war or depression, as well as internal changes of national economy and policy.

We show the importance for numbers employed of the discovery of gold in the Orange Free State in 1946, the influence generally of the 'Winds of Change' and the firm maintenance by the State of law and order. Varying gold production costs and profitability against high tax rates, allied with increasing wages and a lack of development capital, have led in the last decade to employment falling by fifty per cent, despite an actually higher value of gold output.

Finally, this analysis considers the role of the migrant labour system as it affects, and is affected by, conditions in the gold mining industry, with special reference to its less than humane consequences in the numerically dominant territories of Lesotho and Transkei.

Introduction

The discovery of commercial quantities of gold in the former Transvaal of South Africa in 1896¹ came twenty years after the exploitation of diamonds in the northern Cape. Labour practices followed the existing migratory pattern for domestic and foreign labour in industry, a pattern which exists to this day. Gold miners, like diamond miners, were accommodated in compounds, often segregated by ethnic group, and contracted for 18-month stints with no certainty of re-engagement. The source areas of these miners have for the whole of the twentieth century fallen into three political categories: men from

within the borders of South Africa itself, including former black 'homelands'; men recruited from the former High Commission, now independent territories, Botswana, Lesotho and Swaziland, who were often treated as honorary South Africans; and those from foreign countries, principally Mozambique and from as far afield as Angola, Zambia, and Tanzania. The fact that these miners came from all over southern Africa meant that the migratory system of labour would retard opportunity for men to progress up the ladder of skills and would for a very long time establish that the barrier of colour became also a barrier to advancement².

In 1900 the newly established recruitment centre, the Witwatersrand Labour Organisation (WNLA, popularly 'Wenela') was given wide powers by treaty, including the sole right to recruit in the provinces of Mozambique south of latitude 22°S, which had been one of the principal sources of labour before the South African wars of 1899–1902². In 1899 two-thirds of recruited labour came from Mozambique, the second most important source being the Transvaal (18 per cent), and the Cape (5 per cent).

Co-operative recruiting in South Africa began with the formation of the Native Recruiting Corporation (NRC) in 1912, at which date Mozambique was still the major source of labour, followed by the Cape and other provinces. In 1977 the NRC was amalgamated with the WNLA to form The Employment Bureau of Africa (TEBA), which to this day remains the central recruitment organization for all black mine workers from southern Africa³. Recruitment for gold mining

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took place all over southern Africa⁴, with stringent health checks before miners were accepted. In addition to the inherent dangers of work underground—in 1907 mortality ran at 470 per 100 000 employees per annum²—were the recognized dangers of high pre-existing pneumonia rates. This was the reason that the northern provinces of Mozambique were areas from which no recruits were accepted.

Initially for paternalistic, but latterly for legal and social reasons, mine management has always provided health care for its employees, building, staffing and administering some of the best hospitals in the continent. The excellent medical records of the Chamber of Mines of South Africa have provided a firm basis for research on health and illness in miners. In addition to this, TEBA's huge database contains annual records and the home addresses of the miners at first recruitment—essential for medical-geographical analyses—and many other details of the labour force including recruitment figures for up to twenty distinct territories in South and southern Africa^{3,4}.

Our purpose here is to examine the huge total of black workers by place of origin and to compare the varying proportions through the century provided by these many recruitment zones.

Results

Figure 1 graphs total recruitment of black miners in South Africa together with that from the former Cape Province, Mozambique and Lesotho, traditionally the major suppliers throughout the century.

Below, and based principally on Figure 1, we consider the political, economic, sociological and historical reasons behind the fluctuations in the black labour force. A number of dissimilar events, acting singly, but mostly in concert, was responsible for modulating the numbers of black mine workers over this long period. For an account of the interplay of these events, we have drawn extensively up to 1986 from John Lang's authoritative history of The Chamber of Mines in South Africa².

The discovery of diamonds in 1867 gave black men chances of entering the growing cash economy, as before this

farming was virtually the only employment available. In 1886, gold was found along the Witwatersrand, and this by 1914 was to make the South African gold industry the world's top producer².

The South African War of 1899–1902 forced every gold mine into a virtual shutdown and led to a lowered demand for black labour and the loss of over 100, 000 jobs (a, Figure 1). WNLA was requested to set up a realistic structure to achieve a stable workforce. 'Coloured' (mixed race) labour was considered but never employed to any extent. By 1903 the black labour force was down to half the 90 000 of 1899. Mozambique, the principal source of labour before the war, now through WNLA's efforts, contributed two-thirds of the numbers recruited. Morbidity among black workers, chiefly due to pneumonia, tuberculosis and diarrhoeal diseases, remained generally high. To try to resolve this serious labour shortage, an ill-fated but short-lived immigrant Chinese system was introduced in 1904, reaching its peak in 1907 and failing by early 1910 when the last Chinese worker returned home. The venture failed mainly because of the political shock waves it engendered in England where open hostility was expressed in influential quarters at what were termed the slave-like conditions of employment of Chinese workers².

Since at that time black labour was still hard to come by, WNLA continued to recruit from the southern provinces of Mozambique, south of latitude 22°, and by 1907 to 1909 a big inflow of workers took place, chiefly from that country and the Transkei in the Cape (b, Figure 1), whose work in diamond mining had reduced and the general economy had become depressed.

In 1912 Mozambique provided 48 per cent of all labour force and the Cape 26 per cent (c, Figure 1). By 1930 these figures were 37 per cent and 35 per cent respectively, and other South Africans represented 11 per cent. Thereafter, the long-term trend was for High Commission labour, especially from Lesotho, and also for foreign recruits to play an increasing numerical role. The total number of men employed rose from 318 000 to 371 000 between 1936 and 1969, and the component from within South Africa fell from 160 000 to 131 000.

The violent events of the Afrikaner Rebellion in 1914, the protests of Gandhi, the General Strike in 1914, and an earlier mine strike in 1913 had all disturbed the *status quo* of the total labour force. Grievances were many, and ameliorative recommendations followed, all of this overtaken by the outbreak of the Great War in 1914. For the mining industry the four years to follow were times both good and bad. Number of miners stabilized (d, Figure 1), trade unionism began to strengthen, and the effect of the Great Depression of the 1930s was soon to follow.

'In this scenario of economic tragedy, gold mining staved off total disaster'². The number of black workers in the mines actually rose in each of the Depression years and reached new peaks from 1932 to 1940 (e and f, Figure 1). White labour, too, rose by the year. The demand for gold at its then standard price of £4 4s was 'infinite'². By 1932 South Africa and its highly cost-sensitive gold mining industry were enjoying a windfall. In that year the country departed from the Gold Standard, new gold-bearing formations were found, and the gold price rose. These windfalls gave industry

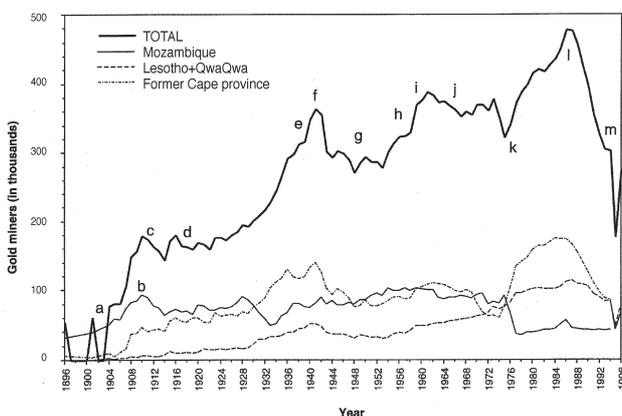


Figure 1—Major areas of supply of black gold miners in southern Africa, 1896–1996

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perhaps its greatest boost ever and 'seven golden years'² of expansion followed. Black employment increased as a result, reaching a new peak of over 360 000 in 1939–40 (f, Figure 1). But World War II brought grave repercussions. Worker dissatisfaction and employees leaving the industry was one symptom and a shortage of supplies another. The peak of mining operations and its labour fell away from 1941 and stayed depressed until the mid-1950s (g, Figure 1). Although South Africa came out of the war reasonably well, the gold price was low and conditions for labour were poor, strikes broke out; one in 1946 involved 60 000 of the 300 000 men in the mines, bringing nine mines to a standstill and partially affecting eight others. At the same time a cost-price squeeze and slender profit margins were seriously impairing the effectiveness of the industry.

A further upset occurred in 1948 when D. F. Malan's National Party won the general election by 70 seats to the United Party's 65, and little more than two years later, J.C. Smuts died. Although black-white issues were to be severely affected for decades by these events, ironically for the mining industry, more prosperous days lay ahead, ushered in by a rising gold price and huge worldwide expansion.

The first barely credible sign of this was the startling discovery of gold in the Orange Free State (OFS), at Odendaalsrust, in April 1946. This ranked in importance with the discoveries of diamonds in Kimberley and gold on the Witwatersrand, the major difference being, as Harry Oppenheimer reported, that the OFS field was found by the application of scientific methods of drilling according to geological theory.

The gold price rose substantially and a 15 per cent increase in wages followed although, in the early 1950s, a shortage of black workers resulted from a decline in the purchasing power of gold (h, Figure 1). WNLA again introduced new and cost-effective methods of recruitment and, in 1955, the number of black labourers in the mines averaged 327 000 *p.a.* (i, Figure 1), and output of gold eventually surpassed the 1941 record². Years later, by 1985, Western Deep Levels (now the Savuka mine) reached a depth of 3.6 km with the South Shaft complex operating at about 3.9 km (2.4 miles), about 2.2 km (1.4 miles) below sea level, making this the deepest mine in the world.

In 1954 political events again intervened. J. G. Strijdom succeeded Malan and residential apartheid was instituted. H.F. Verwoerd in turn succeeded Strijdom, and in 1960 the change to a republic was accepted by referendum. Racial turmoil was to follow, with the Sharpeville massacre of 1960 as the first shock wave. In 1961 an accident at the Coalbrook North Colliery led to the death of 435 men. Three days later, the British Prime Minister, Harold Macmillan, arrived and delivered the Winds of Change speech: capital fled the country, foreign reserves fell, and black labour figures again stabilized (j, Figure 1) and devaluation posed a real threat.

Nevertheless, a partial recovery period intervened because of the greater role played by Afrikaner capitalism. Firm maintenance of law and order by Verwoerd restored confidence, and economic growth, interrupted from 1958 to 1961, was restored. In 1966, Verwoerd was assassinated, and was succeeded by B. J. Vorster.

In 1964 the costs of mining were twice those of 1949, although black labour was plentiful for most of the 1960s

with larger proportions coming from beyond the country's borders. Wages were rapidly increasing and job opportunities for blacks expanded accordingly. A major consolation for older and less profitable gold mines was provided by the diversification of the total minerals' industry to some 50 metals and minerals, including antimony, asbestos, chrome, manganese and platinum group metals.

South Africa's market policy in 1973 contributed much to the rapid rise of the gold price to above US\$100 an ounce. This was followed by vigorous trading, which was to usher in the 'renaissance of gold'² in the rest of the seventies, starting with the introduction of the Kruggerand in 1970.

In 1974 the Chamber launched a drive for South African blacks to replace foreigners. TEBA then gradually reduced the foreign component of the total labour force, which fell from 37 per cent in 1966 to 16 per cent by 1979 (Figure 2).

This change had already been initiated by President K. Kaunda in 1967, stopping Zambian labour to the gold mines and was further prompted by a WNLA Skymaster crashing in 1974 with the loss of 74 Malawian miners and the aircraft crew. President H. Banda of Malawi immediately banned further engagement of Malawians in the mines, 129 000 being affected (k, Figure 1). Although recruitment resumed in 1977, numbers employed totalled a much lower figure of about 16 000 men. Within both Zambia and Malawi these changes of policy had major economic and political consequences, with unemployed men and their families becoming virtually destitute.

By late 1974 the gold price had risen from its earlier peak of US\$97.20 to 159.10 but the US policy of demonetization (introduced in 1968) led to lower prices. Nonetheless, by 1979 the price had jumped to \$307.01, settling eventually by 2003 to around \$360, and later even exceeding this.

The South African economy experienced a long-awaited revival by the end of the seventies, somewhat assisted by P.W. Botha's reform policy, but by 1982, drought, inflation, failing foreign exchange and global recession put paid to further hopes. Major advances for blacks lay in the formation of trade unions, the main one being the National Union of Mineworkers, first established in 1983.

By the mid-eighties, the demand for gold was robust, helped by the weakening South African rand exchange rate. The gold mining industry earned R14 billion in 1985 and paid an estimated R3.4 billion to the state in tax and share of profits. The potential for new jobs was obvious: the total

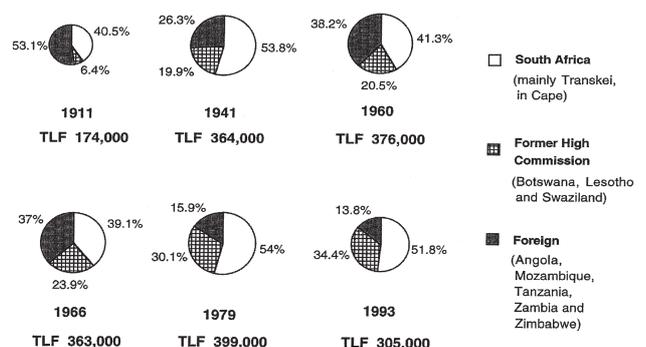


Figure 2—Sources, percentages, and actual total labour force numbers (TLF) of black gold miners working in South Africa at six different periods from 1911 to 1993

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mining industries, gold, platinum, uranium and other minerals earning some R26 billion and having some 700 000 people employed. Within this huge total was the highest peak of black gold mine workers ever attained since the discovery of gold a century before, some 480 000 workers per annum over 1987 to 1988 (l, Figure 1).

The end of the very productive times of 1970 and 1990 was signalled by a combination of circumstances. The 1994 output of gold was the lowest annual production experienced since 1958⁶ and this lowered labour productivity and increased production costs to their highest since 1985. The resultant decrease of the profitability of most mines led directly to a striking fall in the total black labour force over 1985 to 1996, the last year recorded here (m, Figure 1). This was all exacerbated by high general unemployment, a serious crime rate, heavy import tariffs, high tax rates, and the lack of long-term foreign investment. However, the depreciation of the rand against the US \$ helped to cushion some of the impact. In general, many of these changing circumstances over the long period reviewed here related to changes of the international gold price as depicted in Table I below. This shows the relationship of total labour force numbers with values of gold per fine ounce in both rand and US\$ for selected dates, and should be read in conjunction with Figure 1.

In 1984 the black labour force stood at 437 000 men (Figure 1), of which South Africa itself contributed 254 000 (58 per cent), including the Transkei contribution of 133 000 (31 per cent)⁶. By 1994, the last year in which black workers

(Category 1–8 Migratory Miners) were classified apart from whites, the total black force was 303 000, of which 156 000 (51 per cent) were South African⁶. Thus the Chamber's declared policy of 1974, through TEBA, of replacing foreign labour in the mines with South African labour had largely been achieved. In total, however, the gold mining industry, once the country's largest employer, had reduced its black worker numbers from 477 000 in 1986 (1, Figure 1) to 303 000 in 1994⁶ (m, Figure 1), an overall decrease to under two thirds. Between 1985 and 2000, the value of mine output had increased by more than 250 per cent, whereas employment had fallen by 50 per cent⁷.

In recently published data, Figure 3 shows a continued decline of all labour, black and white, to the year 2001.

Components of the black labour force

In Figure 4a, that is showing labour force from the former Cape Province in 1977–1994 period, the Cape is subdivided into Transkei, Ciskei, Bophuthatswana and 'Other Cape' recruiting areas. Bophuthatswana is included with Cape because detailed home records from TEBA show that some 80 per cent of Bophuthatswana gold miners are from within the former Cape Province, although the territory also straddles parts within the former provinces of the Orange Free State and Transvaal.

Table I
Annual average gold price per fine oz in SA rands and US\$, 1903–1994

Letter in Fig.1	Date	Average total labour force: black miners	SA Rands	US \$	
a	1903	45 000	Not available	18.95	
b	1910	100 000		18.92	
c	1912	180 000		18.93	
d	1918	180 000		-	
e	1938	300 000		34.86	
f	1940-44	360 000		33.85	
g	1950-51	280 000		34.72	
h	1956	320 000		34.99	
i	1960	380 000		35.27	
j	1966	380 000		35.16	
k	1976	330 000		108.53	124.80
l	1988	480 000		993.33	437.09
m	1994	300 000		1363.26	384.05
(-)	2001	176 612 (all employees)	2332.21	271.09	

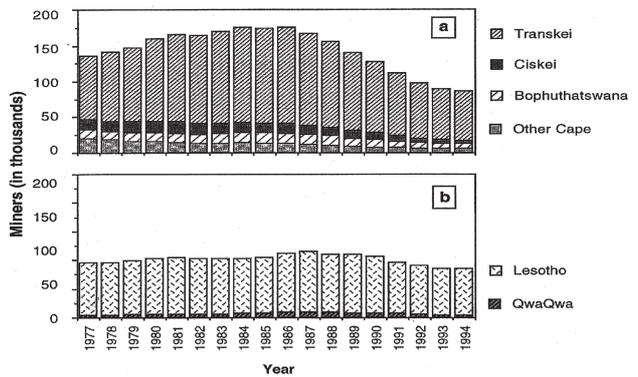


Figure 4—Divisions of former Cape Province and Lesotho areas of supply, 1977–1994

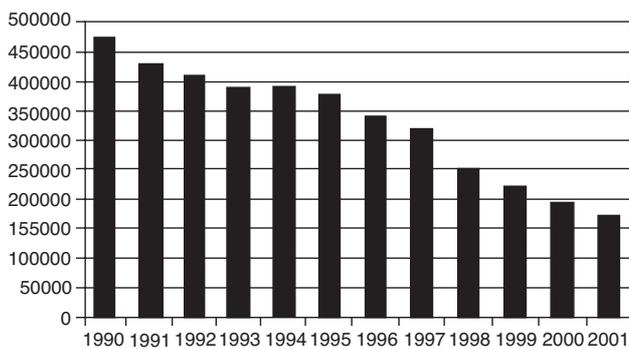


Figure 3—Average number of employees in service on Chamber gold mines, 1990–2001. (Reproduced from Statistical Tables 2001, Chamber of Mines)

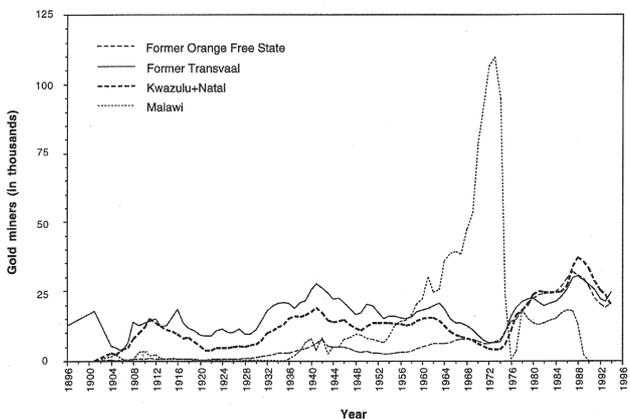


Figure 5—Middle-ranked areas of supply of black gold miners in southern Africa, 1896–1994

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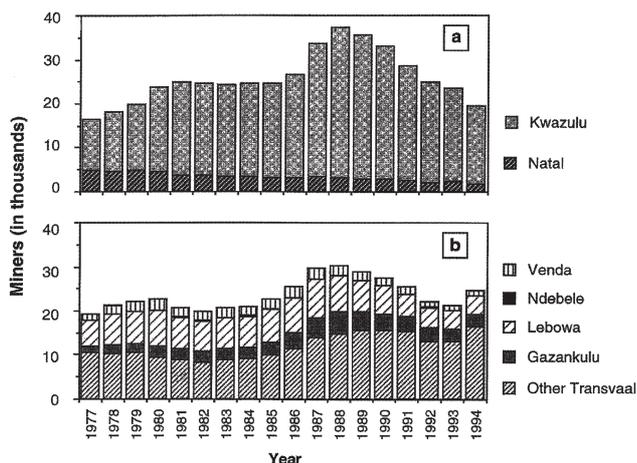


Figure 6—Divisions of KwaZulu-Natal and former Transvaal areas of supply, 1977-1994

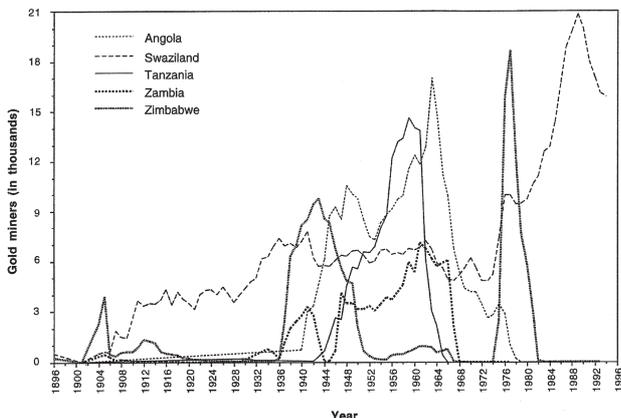


Figure 7—Minor areas of supply of black gold miners in southern Africa, 1896-1994

In Figures 1 and 4b, Lesotho and QwaQwa are combined. QwaQwa is a very small territory centred on Witsieshoek and bordering Lesotho, the Free State and Natal. It is peopled by Sotho and so is ethnically akin to Lesotho. Politically it was a 'homeland' under the previous regime but is now administered as part of the Free State Province.

Middle-ranked areas, Free State, Malawi, KwaZulu-Natal and Transvaal are shown in Figure 5 and sub-divided (for the latter two areas) in Figures 6a and b.

Minor suppliers to the gold industry are shown in Figure 7. (Note the widely differing values on the vertical axis and the wide swings of recruitment illustrated by these graphs).

Discussion

Figure 1, with its sharp rises to over 150 000 men p.a. by 1910 and subsequent peaks in 1942, 1962 and 1986, emphasizes the enormous employing power of the gold mining industry but also its fragile liability to forces quite outside the influence of the Chamber of Mines. The effects

throughout its history such as the economically and socially disastrous fall in employment (Figures 1, 2 and 3) have been consistently linked to the falling world price in the US \$ (Table I). The proportions of labour shown for each of the three main areas of supply (Cape (dominantly Transkei), Lesotho and Mozambique), see Figures 1 and 2, reflect the pattern for the total, with each supplying many workers from the inception of gold mining, and Lesotho building up numbers steadily to World War II and since. In all cases the cash flow from the miners to their families at home has been, and remains to this day, a crucial input to the economy of the areas of labour supply, and as a result, the effects of major shifts of employment opportunities and the absolute dependence on mine payments have far-reaching and often serious consequences^{5, 8-10}.

Figures 1 and 4 a and b show the breakdown of former Cape and Lesotho/QwaQwa employees for the years 1977-1994. Numbers of miners from the former Transkei homeland (over 130 000 p.a. in the mid-1980s) have always made up a dominant proportion of the industry's labour force but have recently dropped by nearly a half. Inevitably this implies great hardship of unemployment in the home areas. Lesotho, as the other major area of supply, has not lost as large a proportion (105 000 in 1987 to 80 000 in 1994).

In Figure 5 are shown the middle range (by number) of areas of supply. Two major anomalies are demonstrated. In the earliest years of gold mining, 1896-1902, the majority of workers came from nearby areas of the former Transvaal. Word of opportunities to earn reached Mozambique quickly and, after a decade or so, men from further afield, Zulus and Xhosas, were also volunteering. The subdivisions of men from KwaZulu-Natal and the separate homelands within former Transvaal are given in Figures 6a and b for 1977-1994. The downturn in numbers in the 1990s has affected KwaZulu-Natal recruiting but not as much as that of men from the former Transvaal. For much of the century miners from north and north-west of South Africa and from Swaziland to the east have not been numerous (Figure 7) and also have varied greatly with other political events, generally reflective of disillusionment with apartheid and disgust at the conditions, mainly of accommodation, for the miners.

The migrant labour system in the gold mining industry

The widespread use of this labour system in mining, in agriculture and in other industries, its consequences in the major industrial centres and the rural areas, and above all, to the workers and their families, both domestic and foreign, have been exhaustively described over a period from 1972 to 1993 by a succession of authorities^{2,5,8-10}. The data all support the contention that the migrant system is untenable, pervasive and regrettable, certainly not a temporary system, but an entrenched and fundamental one with serious social costs. It has become a permanent feature of life for millions of workers, as the above references and the Figures in our paper clearly show.

The Figures here are also a quantitative reflection of this system in a single industry over a century of enterprise. The historian De Kiewiet¹¹ in 1978 remarked that modern South

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Africa is built not on gold and diamonds alone but on the availability of cheap black labour. In 1890 the number employed was 14 000. By the end of that decade this number had increased sevenfold (see Lang² and Figure 1), and by 1998 the total stood at 255 000, a drop of 42 per cent from its peak of 534 000 in 1986¹². In essence, the labour policy required sufficient and stable numbers over regular periods. The only alternative to this mass movement was the large-scale resettlement of the miners and their families along the Reef, but this was economically suspect to the mine owners and politically unacceptable to successive South African governments². Consequently, the attainment by the mining industry of its desired ends in labour numbers depended on men migrating continuously back and forth from several countries in southern Africa, notably Mozambique and Lesotho, as well as from all over South Africa itself¹³.

It must be said that to some extent the mining industry in recent years is slowly reducing its almost complete reliance on migrant labour. For one thing, the South African labour force is steadily becoming more stabilized, living near mine properties or commuting weekly from homes nearby⁸⁻¹⁰. The proportion of South African workers to foreign and ex-High Commission ones has nevertheless remained remarkably stable. Over 1989 to 1996, for instance, South Africa itself contributed numbers slightly above those of ex-High Commission territories taken together with those from foreign countries (Figure 2). Another factor affecting complete reliance on migrant labour has been the quite drastic shrinking of the importance of gold mining as the 'staple' industry^{11,12}.

The vulnerability of migrant workers arises less from migration *per se* than from living conditions and way of life on the mines. For instance, single men are usually crowded together in their employers' 'hostels' and married migrant men work far away from their families⁸⁻¹⁰.

Another corollary lies in the reality that the miners are mostly illiterate and innumerate and have low levels of competency in any one language in common. Over the years, this cheap source of labour has earned as much as 30 per cent of South Africa's foreign exchange income, but now the industrial situation is much altered. The rigidly structured and the anachronistic modes of the workplace were used to produce 70 per cent of the world's gold. At present that figure is down to less than 25 per cent¹² and formerly cheap production has become expensive. At the same time, world gold prices have fallen (in 1998 to a 20-year low of US\$294, 11 per cent less than the average in 1997¹²) and share values have dropped accordingly. Major producers are closing poorly performing mines and in some cases diversifying to new gold sources in other parts of Africa.

In the face of these circumstances, quite outside the influence or the understanding of individual miners, what do the disastrously falling employment prospects now mean in the villages of traditional recruitment? In many rural areas in the Transkei or Lesotho, more than half of the local GDP came from remittances from absentee miners. Young men grew up confident of being able to earn cash and to support families at home by going to the mines and, as a result, the home villages had populations markedly lacking in adult males. In addition to child care, women did all the farm and

domestic labour in an environment usually lacking water, electricity and educational and health services. The 1980s especially saw an increased reliance on labour migration from rural areas to the mines, even to provide for money to plant the appallingly unproductive crops. In fact, a general shortage of money made improved modes of land use impossible, even in the areas of government introduced 'betterment' schemes¹⁴.

Lesotho, for example, which from 1989 to 1996 supplied more gold miners than did Transkei¹², illustrates the indispensable contribution made to that society by mining employment. In Lesotho, work is scarce. About half the active adult population works in South Africa, mainly on the mines. Their earnings are an important source of income. Estimates¹⁵ put this at about 75 per cent of the country's gross domestic product. Apart from this income, wool, mohair, maize and wheat help to sustain a poor economy. Only 16 per cent of the land is arable and even that is under severe threat of erosion¹⁴.

A similar picture exists in the former Transkei and Ciskei (the present Eastern Cape), now devastated by the legacy of migrant labour, which robbed the area of its economically active men and left women to eke out a dismal living from subsistence farming¹⁶.

The 1990s brought further swarms of disgruntled and unemployed miners back to their villages in vast and unexpected numbers *pro rata* to the loss of mining opportunities documented in our paper. Land erosion and deterioration, and consequently further falls in agricultural productivity, are already seen as results of this newly induced population pressure¹⁵. Furthermore, social disruption and lack of personal security almost inevitably lead to crime, when to have no income is itself the major crime.

The solution to this dislocation caused by migrant labour is by no means straightforward. In 1972 Wilson⁵ referred to the 'acute urgency of the situation', words echoed almost exactly by Webster¹⁰ twenty years later.

In the heyday of gold mining in the 1960s and 1980s it was estimated that each absentee miner supported ten dependants and six others at work in supportive roles. Thus the cold lines in our graphs of reduced employment of miners-at-work imply a quite enormous task in job creation additional to the harsh estimates of underemployment faced by the South African government today. A further complication lies in the devastating inroads made into the labour force (and the gold mining economy) by HIV/AIDS. A 33-year study¹⁷ of the cancer experience of 12.8 million man-years of black miners working on the goldfields of South Africa from 1964 to 1996 draws attention to this and includes reports of five cancers related to HIV infection.

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MINEGEM™ automates CAT underground mining loaders*

Caterpillar underground loading machines can now be fitted with the latest automated mining system.

Called MINEGEM™, this new-generation underground loader automation system is one of the first sophisticated autonomous navigation systems that can operate at the same level as human operators, a particularly attractive solution in extremely harsh environments.

The product has been developed over a seven-year period and manufactured by Australian company Dynamic Automation Systems (DAS), a joint venture between Caterpillar Elphinstone and Lateral Dynamics.

According to Chris Gibbs, managing director of Barloworld Equipment Mining, the southern African dealer for Caterpillar underground mining machines (formerly Caterpillar Elphinstone), the company's strategy for underground automation follows a stepped approach.

'This enables our customers to choose at what level they wish to participate, while maintaining the option to upgrade to the most advanced systems as the mine becomes more familiar with automation technology,' explains Gibb.

'A diminishing skills base, high HIV infection rates, a strong focus on safety, and the drive for a lowest cost per ton through improving productivity all point towards the necessity to look at technological innovation within our dealer region.'

MINEGEM™ has strong synergy with Caterpillar's MineStar, an integrated mining information system for surface mining machines, also available from Barloworld Equipment, which has already revolutionized productivity on mines.

Elphinstone marketing director Bob Calvert says, when it comes to the South African market, automation is mine and site specific.

'Although the complete package might not be suitable for every mine, it is particularly significant for typical large-scale underground mining methods,' he explains. 'It will definitely enhance production in large cycle applications. Because the system is highly modular, machines can be easily semi-automated to automatically adjust the steering in teleremote mode, making it highly flexible for small operations.'

By removing operators from the locality of consistent machine operations, MINEGEM™ has greatly enhanced safety and efficiency.

Tim Macpherson, managing director of DAS, says: 'This is the culmination of more than seven years of development, with support from the CSIRO, a consortium of Australian mining companies.'

The MINEGEM™ system is 'bolt-on' and can be fitted to a loader either at the factory or in the field, enabling semi- or full automation.

Co-pilot mode is the next logical step up from teleremote with automatic steering of the machine.

'Autopilot mode allows the operator to load the bucket, either manually or automatically via AUTODIG™, using the integrated digital teleremotes,' explains Macpherson. 'It then sends the loader on a mission consisting of a series of goals to automatically tram dump and return to the draw point.'

Using Autopilot, several machines can be controlled by one operator. Traffic management, production statistics capture, and data sharing are all available options.

'This is a significant step for the industry,' says Macpherson. 'It is the first time that the materials movement cycle can be precisely controlled and implemented—and in real time. It closes the quality loop for mobile fleet materials handling.'

Thanks to MINEGEM™, a loader can now be operated from the surface without compromising production or the condition of the machine. As the system is reactive, it responds to changes in the environment and the condition of the loader. The result is an extremely robust and adaptable solution capable of maintaining production under variable conditions and at planned rates.

'These benefits are available now, with minimal risk to production,' says Macpherson, 'and unlike technologies adapted from factory Autonomously Guided Vehicle (AGV) systems that operate in controlled predictable environments, the MINEGEM™ solution was developed in operating mines accruing some 3 000 hours of field follow trials.'

In Australia, DAS has automated 11 loaders on four different models (and another brand) to date and, during development, has operated field follow units at WMC Resources Olympic Dam and Rio Tinto's Northparkes in the last quarter of 2002, with excellent results under normal operating and production conditions. The system operating at WMC Resources Olympic Dam mine in South Australia is currently targeted to produce 10% of the mine's production.

Visit www.DASCAT.com for more information. ◆

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