

Southern Africa Labour and Development Research Unit

MINING EMPLOYMENT IN SOUTH AFRICA,  
1946 - 2000

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CHAPTER ONE :

MINING EMPLOYMENT, 1946-1976

In this section we shall try to identify such historical trends as there have been in South African mining employment in the period since the Second World War. We are interested both in employment trends for the various types of mines and in changes in the overall composition of mining employment.

We shall also ask whether we can explain these trends - knowing that we are unlikely to be able to do so in a fully satisfactory way, both because of the preliminary nature of this work and because we do not have a fully-specified economic model of the 'mining enterprise'. We shall do little more than try to relate changes in employment to changes in output - hoping perhaps to establish some constant relationship between them (for each mineral) or some steady trend in the relationship (i.e. some steady average rate of change of labour productivity in the mining of each mineral). Where we cannot find such regularities in the data we may be able to suggest that 'structural' changes have intervened. However, the preliminary nature of this work needs to be stressed again. As soon as one begins to probe into the highly aggregated data we are using one uncovers a world of great complexity. We wish it had been possible to take more account of, and perhaps explain more of, that complexity.

1. Goldmining employment

It appears that in our period employment on gold mines breaks down very easily into two main phases (with one possible further subdivision). (See Graph 1 on page 10).

1.1 From 1948 to 1961 there is a sharp and unambiguous rising trend in employment. The average number of workers in service climbs from 341 324 (1948) to an all-time peak of 465 688 (1961), an increase of 36,4 per cent - though this does include declines during 1951-52-53 and in 1957.

1.2 After 1961 (and through to 1976) the trend is less sharp but unambiguously falling: however within this overall declining phase the downward trend is clearest to 1967 and thereafter there is some evidence of fluctuation about a relatively stable trend. (It is just possible that when the full 1977 figures are available they will be compatible with the view that during the last decade there have been increasing fluctuations about a slightly rising trend).<sup>1</sup>

1.3 At present we lack a full explanation of why goldmining employment should have fallen into such clearly-defined phases, but there are a number of points that can be made.

1.3.1 It is worth remembering that employment has supply as well as demand determinants. Thus at any time employment may be below the levels that the industry requires. In fact during our period this appears to have been the case for most of the time (speaking very loosely) apart from the decade of the 1960s. However the labour shortfalls of the 1950s (put at 69 000 labourers in 1952)<sup>2</sup> do not really complicate the matter in hand. Employment was expanding from 1948 and the reported labour shortages merely tell us that the expansion would have been faster. Moreover by 1958-59 the shortages were disappearing (as Southern Africa moved into a longish recession), and employment was able to attain desired levels.<sup>3</sup> The true trend is not disguised. It is only in the 1970s that the problem becomes serious. The levels of employment in 1974-76 certainly suggest that the average demand for labour in gold mines is now below its 1970-71 level. However (according to the reports of the Presidents of the Chamber of Mines)<sup>4</sup> Black labour shortages were experienced in

these years,<sup>4a</sup> and this fact plus the employment levels for 1973 and the first 10 months of 1977<sup>5</sup> suggest that the employment statistics alone (at least to 1976) are disguising the trend in labour demand - which is in fact either flat or rising very gently.

1.3.2 What we need to explain then are three phases (or sub-phases) - i) the expansion in labour demand to 1961, ii) the contraction of the 1960s, and iii) the (probable) stabilisation of labour demand (as distinct from employment) in the 425-430 thousand range for the 1970s.

1.3.3 The basic historical 'structural' fact which underlies these phases (certainly the first two) is that in the post-war period four new fields were being developed alongside a substantial surviving part of the older Witwatersrand fields (the East, Central and West Rand fields). The newcomers were the Orange Free State, Klerksdorp, Far West Rand and Evander fields. Certainly by the early 1960s (say 1961-62) the batch of newer mines begun in the late 1940s and 1950s had reached 'full production'.<sup>6</sup> Many of them had been producing gold for some years but had not till then reached full-scale. Not long after this stage had been reached a large number of mines, especially from the East Rand field which was the major producer in the 1950s, began to close down - at least one a year during 1962 to 1971, and as many as five in a single year (1967).<sup>7</sup> The number of major mines in production declined in this period from 55 in 1960 and a maximum of 60 in 1962 to 47 in 1970 (and has since fallen further to 41).<sup>8</sup>

These closures were the result of both geological and economic factors. In particular the long years in which the gold price stayed unchanged while working costs rose took their toll - reducing the payable reserves of ore of mines and bringing the lives of some of them to a premature conclusion.

1.3.4 In these facts to do with the overall expansion and the shift in geographical location of the industry (involving the absolute contractions of historic centres of gold production) must lie the fundamental explanation of the shape of the graph of employment statistics in the post-war period. In the year after the maximum of employment was reached (1962) the President of the Chamber of Mines referred to the attainment of 'full production' by the newer mines. He said that a corollary of this was '... a decrease in development', and continued, 'The industry appears, therefore, to have passed its peak as an employer of labour ... it is likely that the industry's requirements of labour will continue to fall from now on ...'. His prediction was correct in general terms. To flesh out the explanation would require a technical description of the nature of 'development work' (contrasted with work at the stope-face in contact with the gold reef) and (presumably) of the different scales of 'development work' required when a mine is at different stages of its development. However this is beyond us now.

1.3.5 There is also a good deal more that could be teased out of the data - since we have information on tonnage of ore milled, gold output, ore-grade, tonnage milled per worker per year and gold output per worker per year (apart from revenue, cost and profit variables). We shall not attempt to model the relationships between these variables in this paper but a few points of interest may be included here.

1.3.5.1 Gold output rose with only one interruption (1967) from 1952 to 1970 - though the real surge was over by 1965. Output climbed from 368 metric tons at the start of this period to 950 metric tons in 1965; it took the next 5 years to reach 1 000 tons (the all-time maximum).

1.3.5.2 Underlying this increase in production of course was the the development of the new fields and the increase in the number of productive mines (from 43 in 1950 to 60 in 1962). This showed up in increased tonnages of ore being milled and treated every year - tonnages which moreover were of average higher grade throughout most of the 1950s since the newer mines in general had a higher grade than the average of the established industry.

(In 1962 the 'old Witwatersrand' milled 47 per cent of total tonnage but produced 27 per cent of gold output.)<sup>10</sup>

1.3.5.3 This won't quite do for the 1960s - since tonnages went on rising to 1965, and then again in 1969 and 1970, after the number of mines had begun to decline (and employment was also contracting). Ore-grade rose 1960-68 under the pressure of fixed price and rising costs (from 9,93 gms/ton in 1960 to 13,11 gms/ton in 1968) and declined in 1969 and 1970 at the first signs of price increases.<sup>11</sup> The growth of gold output (described in 1.3.5.1 above) is then to be understood as being jointly caused by rising tonnage and rising ore-grade to 1965, and thereafter as the net product of offsetting tendencies viz. falling tonnages and rising grade (1966-68) and rising tonnages and falling grade (1969-70).

1.3.5.4 Of course with tonnages (in general) rising and gold output rising at the same time as employment (from 1962) was contracting, the 1960s see increases in rock milled per worker and in gold output per worker. Put otherwise, it was possible in the 1960s with fewer mines to increase tonnages milled (on trend) without increasing employment because labour productivity in rock-breaking was increased. There was presumably some tendency in that direction because of the reduced amount of basic 'development' work that had to be done, but at least part of the increase must have been due to technical and organisational changes (including 'concentrated mining'). For the whole industry 147,0 metric tons were treated per worker in 1960 and 187,8 in 1970.<sup>12</sup>

1.3.6 This leaves the last 7 or 8 years (c.1969-1977) for comment. It is fairly clear that the fundamental factor at work in this period is the slow and then rapid rise (and vigorous fluctuation) of the gold price - which the gold industry in the 1960s was hanging on for.

1.3.6.1 The 'average value of gold' sold during relevant years changed as follows (R per ounce fine): 25,241 (1968), 26,869 (1969), 25,843 (1970), 28,641 (1971), 39,662 (1972), 65,078 (1973), 107,42 (1974), 111,62 (1975) and 103,77 (1976).<sup>13</sup>

1.3.6.2 In this new economic environment, where 'average value' in 1974-6 was about 4 times its normal level in the 1960s, mines have lowered the ore-grade quite markedly (it is now down to the level of the late 1950s) and have kept up (or tried to keep up) their throughput tonnages. On the demand side, in other words, there has been a strong demand for labour - with, as we have seen, problems on the supply side of a somewhat different variety from the traditional shortages. We are suggesting that the employment levels for 1970, 1971, 1973 and the first 8 months of 1977 give the proper trend. Since in practice tonnages have not risen (or even regained the 1970 level) the lower ore-grade has led to falling levels of gold output.

1.3.6.3 Labour productivity (measured in tons of ore), especially in 1975 and 1976, has risen to a new peak but this may at least partly be a short-run phenomenon having to do with neglect of normal development work in a time of real labour shortage (as apparently in 1975).

1.3.6.4 The underlying strength of labour demand in this 1970s sub-phase is reinforced by the current development of three new mines, as well as new shafts and further development of existing mines.

1.4 It is finally important to emphasise the dominant role of goldmining as generator of employment in the mining sector. This is connected with the labour-intensity of its production processes which result from the peculiar deep-level, hard-rock, narrow tubular character of the gold-bearing reefs - which makes mechanization difficult and expensive. All we need to notice here is the preponderance of gold in the employment statistics. Although its share has been declining on trend since 1946 (78 per cent in that year down to 61,1 per cent in 1976) goldmining still employs roughly 3 out of every 5 workers (of all races) employed in mining. Even relatively small (percentagewise) changes in goldmining employment are capable of swamping in absolute size major developments in other branches of mining employment. (And it is this importance which justifies the detail of the above discussion. We do not attempt to repeat it in the discussions that follow).

TABLE 1: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE GOLD MINES:  
1946-1977

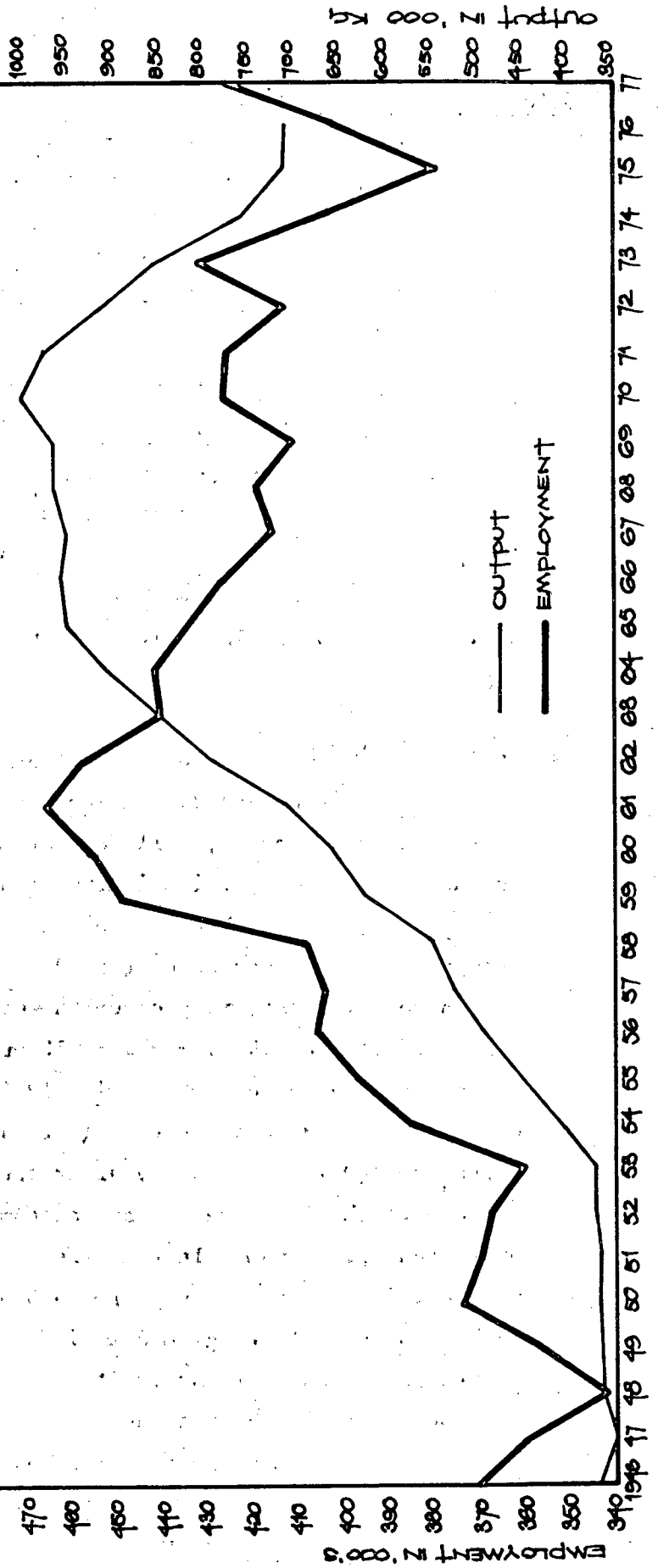
Year	Output (kilograms)	Employment	Output (kgs) per worker
1946	370 972	370 959	1,00
1947	348 359	359 777	0,97
1948	360 334	341 324	1,06
1949	364 067	357 038	1,02
1950	362 792	373 888	0,97
1951	358 188	369 515	0,97
1952	367 613	367 692	1,00
1953	371 407	359 577	1,03
1954	411 717	385 280	1,07
1955	454 143	398 276	1,14
1956	494 453	405 870	1,22
1957	529 724	403 632	1,31
1958	549 164	407 935	1,35
1959	624 123	449 280	1,39
1960	665 086	455 767	1,46
1961	713 576	465 688	1,53
1962	792 890	457 884	1,73
1963	853 231	448 448	1,94
1964	905 485	441 178	2,05
1965	950 336	432 641	2,20
1966	960 445	425 539	2,26
1967	949 683	414 877	2,29
1968	967 132	418 867	2,31
1969	972 949	410 521	2,37
1970	1 000 417	425 871	2,35
1971	976 297	425 163	2,30
1972	909 631	412 494	2,21
1973	855 179	430 463	1,99
1974	758 559	403 996	1,88
1975	713 447	377 924	1,89
1976	713 390	401 907	1,78
1977	699 887	424 992	1,65

TABLE 2: EMPLOYMENT ON THE GOLD MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	42 624	328 335	..	..	..	370 959
1947	41 010	318 767	..	..	..	359 777
1948	41 023	300 301	..	..	..	341 324
1949	41 520	315 518	..	..	..	357 038
1950	45 387	328 501	..	..	..	373 888
1951	46 623	322 892	..	..	..	369 515
1952	47 094	320 598	..	..	..	367 692
1953	48 174	311 403	..	..	..	359 577
1954	49 888	335 392	..	..	..	385 280
1955	51 138	347 138	..	..	..	398 276
1956	51 252	354 618	..	..	..	405 870
1957	49 757	353 875	..	..	..	403 632
1958	49 041	358 894	..	..	..	407 935
1959	51 114	398 166	..	..	..	449 280
1960	51 242	404 525	..	..	..	455 767
1961	50 610	415 078	..	..	..	465 688
1962	50 034	407 850	..	..	..	457 884
1963	48 686	395 762	..	..	..	448 448
1964	47 011	394 167	..	..	..	441 178
1965	45 273	387 368	..	..	..	432 641
1966	44 332	381 207	31	422	380 754	425 539
1967	43 121	371 756	30	385	371 341	414 877
1968	41 313	377 554	28	368	377 158	418 867
1969	40 420	370 101	12	355	369 734	410 521
1970	39 386	386 485	20	352	386 113	425 871
1971	38 175	386 988	19	344	386 625	425 163
1972	37 651	374 843	21	353	374 469	412 494
1973	37 598	392 865	19	405	392 441	430 463
1974	37 468	366 528	18	429	366 081	403 996
1975	37 762	340 162	16	466	339 680	377 924
1976	38 697	363 210	16	578	362 616	401 907
1977						424 992

GRAPH 1: MINES EMPLOYMENT AND OUTPUT

GOLD



2. Employment in diamond mining

- 2.1 In the post-1945 years employment in diamond mining has contributed between 4 and (roughly) 2½ per cent of the total for the mining sector - and has involved (again, roughly) 15 000 to 21 000 workers (dealing in annual averages). Despite its modest size we discuss it here partly because of its historical importance. (See Graph 2 p.15).
- 2.2 There do not appear to be any clear trends in employment - except perhaps that in the period 1966 to 1974 employment was consistently above 20 000 workers (peaking at 21 488 in 1970) - whereas in the period 1946 to 1965 employment fluctuated below 20 000 workers (dropping to 15 156 in 1956). This pattern was destroyed in 1975 and 1976 - when employment first went below 20 000 to 19 819 and then fell sharply to 17 415. The decline has not been reversed by August 1977.
- 2.3 It is clear from the graphs of output and employment that output per worker has increased remarkably over the period. Output increased from about 1,3 million carats in 1946 to an historic peak in the region of 8 million in 1970 (and has stayed above 7 million carats a year since then). The increase was reasonably steady - though much of it was concentrated in the period 1958-70. To achieve this 6-fold increase in production employment increased from 19 164 (1946) to 21 488 (1970) - a mere 12 per cent; and in 1976 employment was actually 9 per cent below its 1946 level. To make these figures compatible labour productivity (carats per worker per year) has risen from 60-70-odd shortly after the War to just over 400. This represents the fast average annual compound rate of increase of 6 per cent per annum. In fact there is some concentration of productivity gains in the years 1950-54, 1961-63, 1966-69 and 1976. Without being able to give a satisfactory account of the factors increasing output per worker it is worth recording i) that the development of open-pit techniques and the application of ever-larger earthmoving equipment must be responsible for the general upward curve of labour productivity; and ii) that it may be relevant that before the 1950-54 spurt the Jagersfontein and Premier mines were reopened in 1949 and 1950, and that the 1966-68 spurt was preceded by the development of the Finsch mine in 1966 (which now has a capacity of 2 million carats a year).

2.4 Since 1966 employment has been remarkably constant - with some recent tendency to decline. Fast productivity gains (until the 1970s) and a recent tendency for output to fall off appear to be responsible.

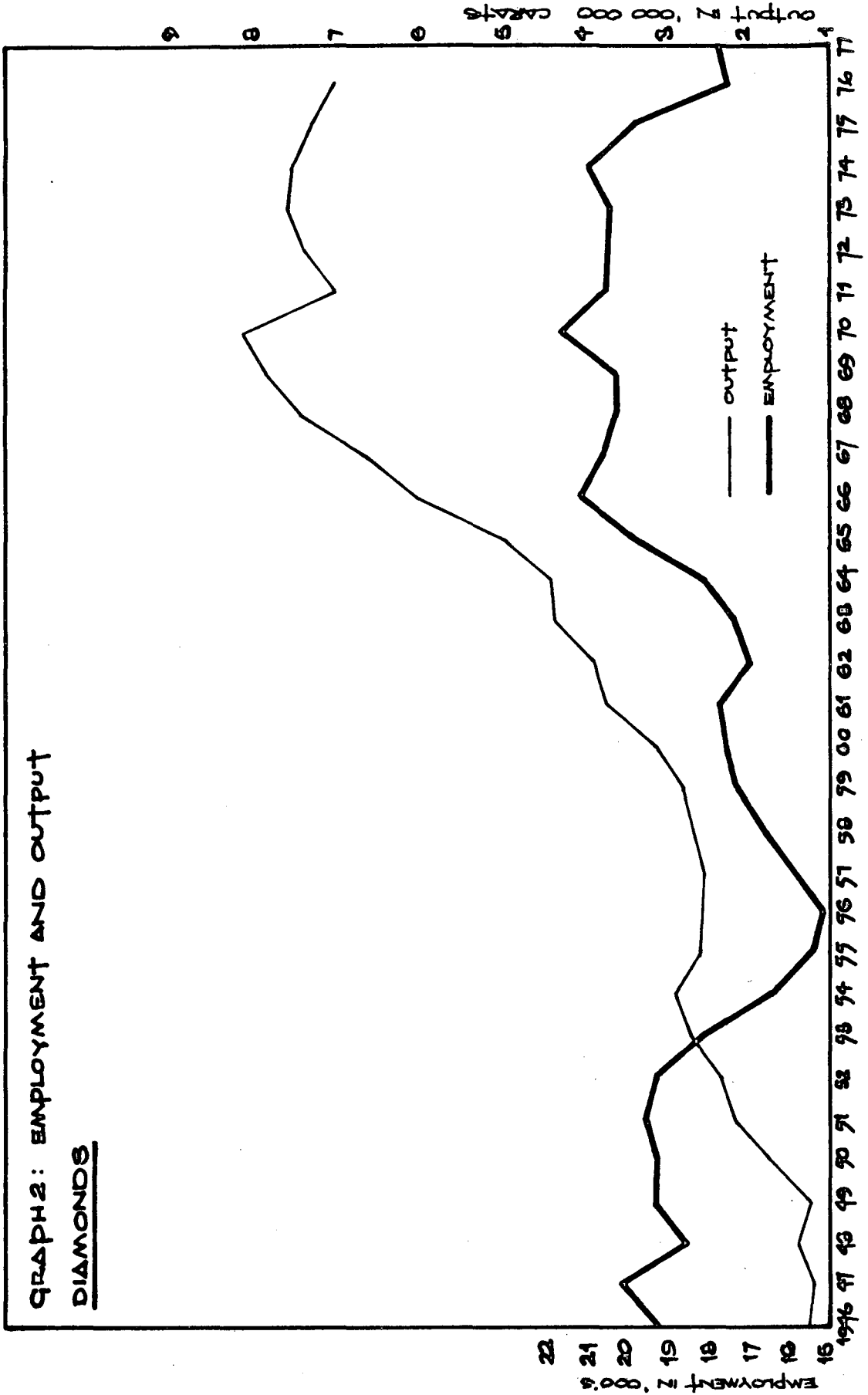
TABLE 3: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE DIAMOND MINES:  
1946-1977

Year	Output (1000 metric carats)	Employment	Output (cts) per worker
1946	1 349	19 164	70
1947	1 242	20 115	62
1948	1 382	18 476	75
1949	1 265	19 332	65
1950	1 732	19 292	90
1951	2 229	19 501	114
1952	2 383	19 295	124
1953	2 718	18 080	150
1954	2 859	16 541	173
1955	2 629	15 458	170
1956	2 586	15 156	171
1957	2 579	15 929	162
1958	2 702	16 714	162
1959	2 838	17 357	164
1960	3 141	17 609	178
1961	3 788	17 682	214
1962	3 918	17 028	230
1963	4 376	17 340	252
1964	4 450	18 125	246
1965	5 026	19 732	255
1966	6 037	21 113	286
1967	6 668	20 645	323
1968	7 433	20 194	368
1969	7 863	20 258	388
1970	8 112	21 488	378
1971	7 031	20 523	343
1972	7 385	20 475	361
1973	7 565	20 421	370
1974	7 510	20 934	359
1975	7 295	19 819	368
1976	7 023	17 415	403
1977	7 643	17 451	438

TABLE 4: EMPLOYMENT ON THE DIAMOND MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	3 231	15 933	..	..	..	19 164
1947	3 442	16 673	..	..	..	20 115
1948	3 243	15 233	..	..	..	18 476
1949	3 327	16 005	..	..	..	19 332
1950	3 126	16 166	..	..	..	19 292
1951	3 358	16 143	..	..	..	19 501
1952	3 361	15 934	..	..	..	19 295
1953	3 201	14 879	..	..	..	18 080
1954	3 148	13 393	..	..	..	16 541
1955	3 158	12 300	..	..	..	15 458
1956	3 135	12 021	..	..	..	15 156
1957	3 239	12 690	..	..	..	15 929
1958	3 264	13 450	..	..	..	16 714
1959	3 416	13 941	..	..	..	17 357
1960	3 491	14 118	..	..	..	17 609
1961	3 575	14 107	..	..	..	17 682
1962	3 435	13 593	..	..	..	17 028
1963	3 457	13 883	..	..	..	17 340
1964	3 429	14 696	..	..	..	18 125
1965	3 497	16 235	..	..	..	19 732
1966	3 606	17 507	3	1 647	15 857	21 113
1967	3 568	17 077	3	1 660	15 414	20 645
1968	3 463	16 731	3	1 726	15 002	20 194
1969	3 450	16 808	3	1 966	14 839	20 258
1970	3 620	17 868	3	2 339	15 526	21 488
1971	3 777	16 746	3	2 185	14 558	20 523
1972	3 835	16 640	3	2 260	14 377	20 475
1973	3 873	16 548	2	2 335	14 211	20 421
1974	3 850	17 084	8	2 632	14 444	20 934
1975	3 685	16 134	11	2 440	13 683	19 819
1976	3 289	14 126	10	2 390	11 726	17 415
1977						17 451

GRAPH 2: EMPLOYMENT AND OUTPUT  
DIAMONDS



### 3. Employment in Coal mining

3.1 In the period under review coal mining has been the second major employer of labour in the mining sector (after gold) - contributing between 10,5 per cent and 13 per cent of the total. Its relative position is now challenged by platinum (assuming that employment in 'other mines' as reported in Mining Statistics is mainly in platinum mines); but there is no question but that any study of future employment trends in mining must look carefully at coal, its projected output levels, and the likely course of technical change in the industry. The potential importance of coal as an employer is suggested by the fact that from 1973 to 1976 annual average employment in coal mining increased from 73 438 to 83 814 - an increase of 14 per cent in 3 years.

3.2 The period as a whole breaks down into 3 phases as regards employment. (On the other hand output seems to march upwards in a remarkably steady fashion throughout the period: from 23 602 thousand metric tons in 1946 to 75 449 thousand metric tons in 1976.) (See Graph 3 p.21a).

3.2.1 During the period from 1946 to 1966 employment increased along a clear trend (from 51 643 to 82 239) with some fluctuations, especially a remarkable switch-back from 1951 to 1952 (up) and 1953 (down again).

3.2.2 Employment fell in 1967 and with some fluctuations moved down on trend to 1973. The labour force contracted from 82 239 in 1966 to 73 438 in 1973.

3.2.3 As we have seen there were increases in employment in 1974, 1975 and (especially marked) in 1976. The increases were such that the previous industry peak (achieved in 1966) was passed in 1976. This recent trend of sharp employment growth has been continued into 1977 - with monthly averages of over 90 000 workers in employment.

3.3 Without having any detailed knowledge about the geological and technical aspects of coal mining it seems possible to make some preliminary moves towards 'explaining' the existence of these phases.

3.3.1 Presumably during the first long phase employment increased in order to make possible the sustained growth in production. Output per man-year was increasing but not at a sufficient rate to offset the labour-absorbing effects of increased production. Over the period 1946 to 1966 employment increased by 60 per cent under the impact of a doubling of production. Output per man-year rose from 457 tons to 583 tons for the 20-year period - but that represents the relatively slow rate of increase of 1,2 per cent per annum.

3.3.2 In the post-1966 period down to 1973 technical change in mining - in particular a shift to more open-cast mining and strip-mining as well as various forms of underground mechanisation - speeded up sufficiently for increased output to be compatible with an absolute decline in employment. A 30 per cent increase in production was accompanied by a 10,7 per cent drop in labour inputs. This represents an increase of some 46 per cent in output per head in 7 years - an annual increase of 5,5 per cent per annum which is a considerably faster rate of productivity growth than took place during the first long phase of the post-war expansion of the industry. (Open-cast mining of coal commenced at Hlobane Colliery, Natal in 1964.<sup>14</sup> Of the newer major collieries Usutu got into its stride in 1967, Optimum in 1971, Arnot in 1972: in 1976 the three of them had a combined output of over 16 million tons out of an industry total of 77 million.)<sup>15</sup>

3.3.3 The problem we then face is how to explain the sharp upturn in employment since 1973 - with the 1966 employment peak being surpassed in 1976. In the three years under discussion a 24 per cent increase in output was accompanied by a 14 per cent growth of the labour force - implying a labour productivity gain of some 8 per cent for the period (or 2,7 per cent per annum). This is half the rate of productivity growth of the previous period.

3.4. We are unable at present to explain the important increased labour-absorptiveness of the coalmining industry since 1973. There are some points which may be relevant and are hence worth recording - even though they do not at this stage fit into a coherent picture.

3.4.1 Clearly the long-run status of coal has changed since the dramatic increase in oil prices. This has had something to do with the 35 per cent increase in the (controlled) producer price of coal in 1974 and the revision in 1976 of the pricing formula.<sup>16</sup>

3.4.2 Considerably increased export contracts have been signed in the 1970s - at prices well above the existing domestic prices. (In 1971, for instance, the domestic price of bituminous coal was R1,94 f.o.r., whereas the export price was R4,50 f.o.b.)<sup>17</sup>

3.4.3 It seems possible that part of the very fast increase in output per head in the 1966-73 period came from cost pressures on the industry (as the domestic price was held down). Is this reflected in the decline in the number of mines from 81 in 1966 to 60 in 1974<sup>18</sup> - with the closing down (presumably) of higher-cost (more labour-intensive?) mines and a concentration of production in mines with newer technology, higher output and lower unit-costs? Is it possible that the higher coal prices (including export prices) have reduced this particular economic pressure and caused a re-examination of what the profitable length of life of certain existing mines is?

3.4.4 Clearly the industry is now in an expansionary phase. By mid-1977 the President of the Chamber of Mines could report that since the 1976 undertakings to Government to expand capacity, expenditures on new coal mines and extensions to existing mines in the next 3 to 5 years announced to date exceeded R1 000 million.<sup>19</sup> One would expect that employment is being boosted by the need for very considerable 'development work'.

3.4.5 There are very substantial differences between the geology of various coal deposits - in particular between surface coal and hard-rock, tabular deposits. Output per man-year may be very different - partly in consequence of geological characteristics. In 1976 the output per worker in service in Transvaal and O.F.S. mines was 1 338 tons per year; in Natal mines it was 356 tons per year! What is interesting is that between 1975 and 1976 the Natal mines increased their share of total production: their output increased by 19,5 per cent whereas that of the Transvaal and O.F.S. mines only increased by 8,0 per cent.<sup>20</sup> We do not know why this is the case but it will certainly have contributed to employment-creation.

3.4.6 The effect of labour shortages (as in gold mining) on the reported statistics of employment needs to be investigated.

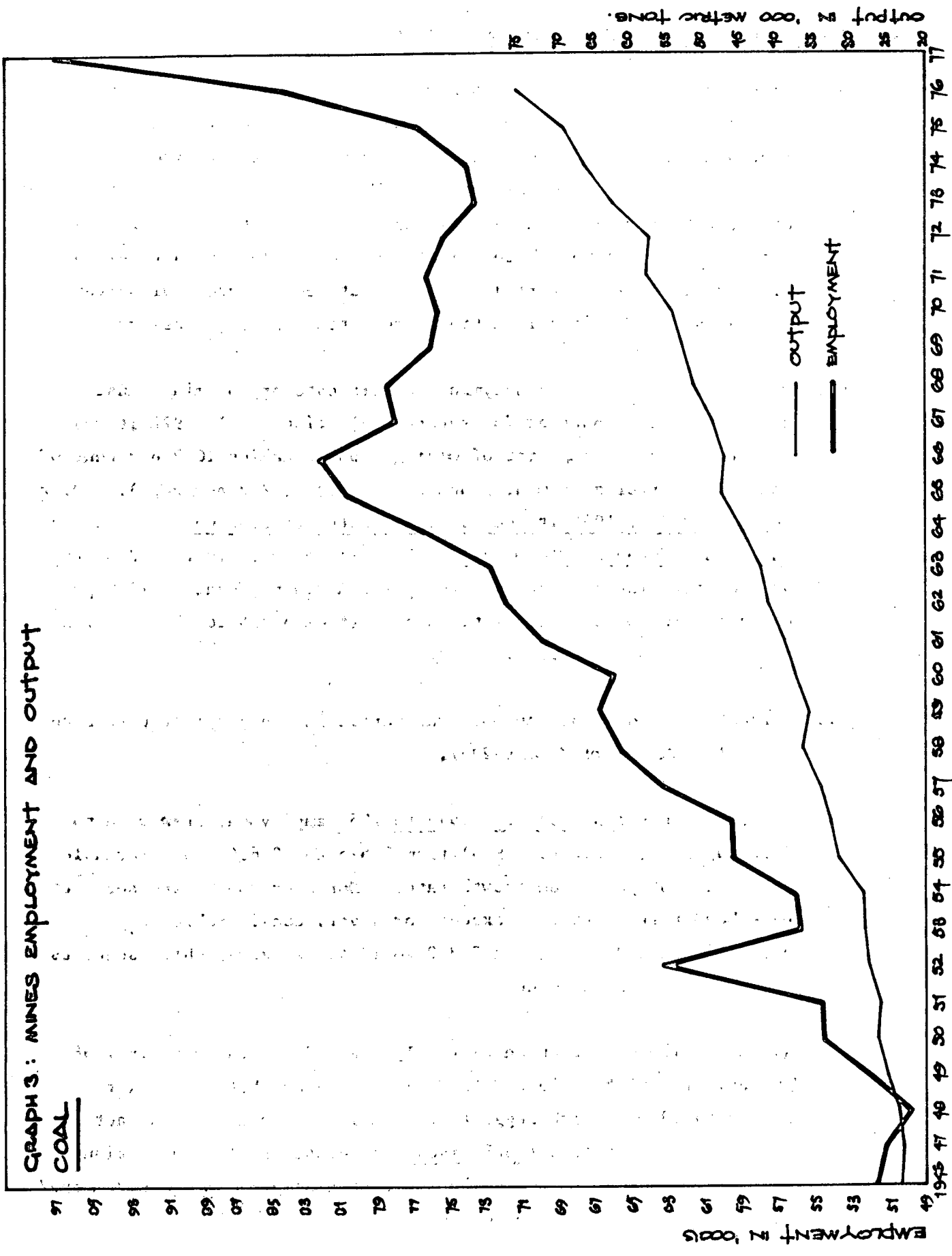
3.5 Coal-mining employment has been growing strongly in recent years after reversing a declining trend associated with very rapid technical change and productivity growth. We need to understand this reversal better before projecting it into the future. (Actual assumptions made in this study about future levels of productivity in coal-mining are specified in Section 2.2.2 on p.61).

TABLE 5: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE COAL MINES:  
1946-1977

Year	Output (1000 metric tons)	Employment	Output (tons) per worker
1946	23 602	51 643	457
1947	23 498	51 184	459
1948	24 024	49 865	482
1949	25 497	52 457	486
1950	26 474	54 827	483
1951	26 632	54 780	486
1952	28 065	63 161	444
1953	28 459	56 026	508
1954	29 314	56 474	519
1955	32 111	59 428	540
1956	33 602	59 723	563
1957	34 769	62 372	557
1958	37 085	65 848	563
1959	36 453	66 997	544
1960	38 173	66 307	576
1961	39 565	70 294	563
1962	41 275	72 073	573
1963	42 454	72 777	583
1964	44 917	76 449	588
1965	48 460	80 858	599
1966	47 942	82 239	583
1967	49 300	78 186	631
1968	51 655	78 561	658
1969	52 752	76 201	692
1970	54 612	75 742	721
1971	58 666	76 307	769
1972	58 440	75 338	776
1973	62 352	73 438	849
1974	66 056	73 992	893
1975	69 440	76 897	903
1976	77 059	83 814	919
1977	85 411	96 919	881

TABLE 6: EMPLOYMENT ON THE COAL MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	3 029	48 614	..	..	..	51 643
1947	3 168	48 016	..	..	..	51 184
1948	3 096	46 769	..	..	..	49 865
1949	3 150	49 307	..	..	..	52 457
1950	3 290	51 537	..	..	..	54 827
1951	3 306	51 474	..	..	..	54 780
1952	3 420	59 741	..	..	..	63 161
1953	3 409	52 617	..	..	..	56 026
1954	3 970	52 504	..	..	..	56 474
1955	5 327	54 101	..	..	..	59 428
1956	5 480	54 243	..	..	..	59 723
1957	5 768	56 604	..	..	..	62 372
1958	5 954	59 894	..	..	..	65 848
1959	5 971	61 026	..	..	..	66 997
1960	6 029	60 278	..	..	..	66 307
1961	6 416	63 878	..	..	..	70 294
1962	6 651	65 422	..	..	..	72 073
1963	7 024	65 753	..	..	..	72 777
1964	7 977	68 472	..	..	..	76 449
1965	8 587	72 271	..	..	..	80 858
1966	8 560	73 679	381	73	73 225	82 239
1967	7 737	70 449	370	67	70 012	78 186
1968	7 846	70 715	354	70	70 291	78 561
1969	7 613	68 588	319	64	68 205	76 201
1970	8 173	67 569	274	46	67 249	75 742
1971	7 220	69 087	263	47	68 777	76 307
1972	7 495	67 843	255	48	67 540	75 338
1973	7 276	66 162	249	337	65 576	73 438
1974	7 504	66 488	258	47	66 183	73 992
1975	8 144	68 753	288	71	68 394	76 897
1976	9 168	74 646	327	65	74 254	83 814
1977						96 919



4. Employment in 'Other Mines' (mainly Platinum)

4.1 In this study we are going to assume that in recent years this category of mining employment is almost entirely employment on platinum mines. This view is based on statistics provided by Professor R.P. Plewman for 1970 (see Table 34, Note 3 for details). We do not know how close the identification was further back in time - nor for that matter whether it has uniformly continued to be so close in the 1970-76 period. At this stage of historical survey however a precise identification across time is not necessary.

4.2. What is clear is that employment in this category of mines must be regarded as important for future projections. In 1976 it was the third-largest employer of mining labour - taking 10,9 per cent of the total, after gold mining and coal mining (12,7 per cent). Over the period from 1946 its employment growth has been more spectacular than that of any single mineral - both in terms of increased share of the total labour-force in mining (from 0,8 per cent to 10,9 per cent) and in terms of absolute numbers (from 3 575 to 71 999, with a peak in 1974 of 86 892).

4.3 A rough break-down of the post-war period into employment phases seems possible. (See Graph 4 on p.24a).

4.3.1 In the period from 1946 to 1957 employment grew with no interruption (except for 1955) from 3 575 to 19 630 - a remarkable 16,8 per cent per annum growth rate. Moreover the growth seems to have been fairly steady - except for a very considerable jump between 1951 and 1952 (from 7 882 to 13 494 workers) which suggests the opening of a new mine.

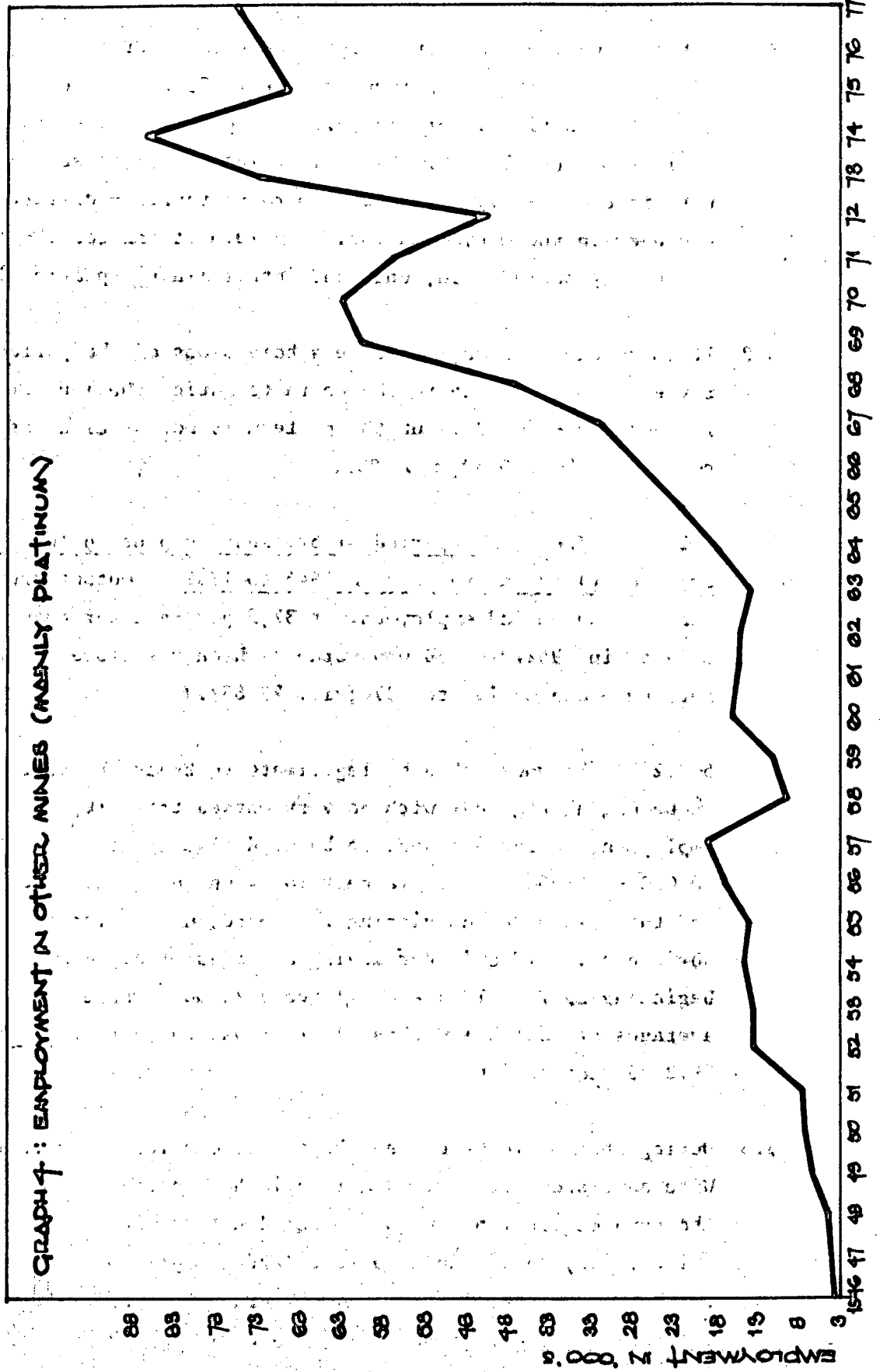
4.3.2 There is then an extremely sharp downward break in 1958 (employment fell from 19 630 to 9 675 in a year, but was back to 16 044 by 1960 - which suggests cyclical influences). In fact the years 1958 to 1964 (inclusive) show considerable fluctuations and no growth - at least in the sense that only in 1965 was the 1957 level of employment improved upon.

4.3.3 In 1965 trend growth (in the above sense) recommenced - though 1964 was also part of this 'upswing - and has been sustained, though with rather more fluctuations than in the 1946-57 period. Two new producers (Impala and Atok) in 1969, a further one (Western Platinum) in 1971 and the new Amandelsbult Section of Rustenburg Platinum (the largest producer) in 1973,<sup>21</sup> have provided the productive capacity and the employment demand. Such expansion (with output rising from 40,4 metric tons in 1970 to the region of 100 tons in 1976) raises the possibility that some of the extra employment in recent years may have been connected with development work rather than regular mining. At any rate, smoothing the employment growth for the period from 1965 to 1976 (inclusive) gives an average growth rate of 11,2 per cent per annum.

4.4 It turns out that platinum is the mineral with the geology most similar to that of gold and hence (see p.7 above) with relatively small potential for mechanisation of the labour-saving variety. Given the size of South African platinum reserves and the assumed rate of growth of world demand for the metal (and other metals in the related group), Professor Plewman has argued that it will assume an increasingly important place in maintaining (or increasing) employment totals in mining (see Chapter 2).

TABLE 7: EMPLOYMENT ON OTHER MINES: 1946-1977  
(MAINLY PLATINUM)

Year	White	Black	Asian	Coloured	African	Total
1946	..	..	..	..	..	3 575
1947	..	..	..	..	..	3 982
1948	..	..	..	..	..	4 689
1949	..	..	..	..	..	6 668
1950	..	..	..	..	..	7 567
1951	..	..	..	..	..	7 882
1952	..	..	..	..	..	13 494
1953	..	..	..	..	..	13 558
1954	..	..	..	..	..	14 669
1955	..	..	..	..	..	14 270
1956	..	..	..	..	..	17 376
1957	..	..	..	..	..	19 630
1958	..	..	..	..	..	9 675
1959	1 104	10 541	..	..	..	11 645
1960	1 463	14 581	..	..	..	16 044
1961	1 414	14 060	..	..	..	15 474
1962	1 406	13 912	..	..	..	15 318
1963	1 435	12 300	..	..	..	13 735
1964	1 665	16 158	..	..	..	17 823
1965	1 912	20 402	..	..	..	22 314
1966	2 159	24 242	4	346	23 892	26 401
1967	2 933	28 621	1	569	28 051	31 554
1968	3 770	38 392	3	552	37 837	42 162
1969	4 523	55 832	13	516	55 303	60 355
1970	5 379	57 075	6	525	56 544	62 454
1971	5 172	51 461	12	442	51 007	56 633
1972	3 966	39 833	5	349	39 479	43 799
1973	5 116	67 694	4	536	67 154	72 810
1974	6 194	80 698	2	414	80 282	86 892
1975	5 479	62 723	3	438	62 282	68 202
1976	4 339	67 660	2	316	67 342	71 999
1977						75 632



5. Employment in Asbestos Mining.

5.1 Asbestos mining has been a significant employer of labour for some time. The industry maximum to date is 23 687 workers in service on average during 1966; in 1976 average employment was lower but still substantial at 21 504. In relative terms asbestos mining has since the early 1950s been third -, fourth - or fifth - largest employer in the mining sector. In 1976 it was fourth-largest, a long way behind gold, coal and 'other mines' (platinum).

5.2 It is possible to suggest some subdivisions of the period under review with reference to the characteristic behaviour of employment in those sub-periods, but the pattern is not as clear as would be convenient. (see Graph 5 p. 29).

5.2.1 There is a period of breakneck expansion (of output and employment) in the years from 1946 to 1952. Output grew at 37 per cent per annum and employment at 32,5 per cent per annum - reaching a level in 1952 (viz. 23 039 workers) which was close to the maximum for the whole period to 1976 (viz. 23 687.)

5.2.2 It would then be legitimate to treat the rest of the period as belonging together with no very marked trend (up or down) in employment. There appear to be mild fluctuations in the range 18 000 - 22 000 workers (except for 4 unusual scattered years), and there seems no convincing reason for not taking the trend as horizontal. (The 5-year moving averages of employment in the years beginning 1957 to 1963 are all above 21 000, whereas subsequent similar averages are all below this figure - but they are climbing to 1972-76, not falling).

5.3 During this period there has been very considerable growth of output. With some short-term fluctuations it has increased from 18,3 thousand metric tons to 369 thousand metric tons - a 20-fold increase while employment expanded 5-fold (and its plateau-level already reached briefly in 1952). Clearly there has been a considerable increase in labour productivity - and almost all of it has been achieved in the post-1952 period. Roughly, output per worker has trebled

during these years (from 5,3 tons per worker per year to 17,2 tons) - and, although it is not very marked, there is probably some acceleration in the rate of increase of labour productivity as the period proceeds.

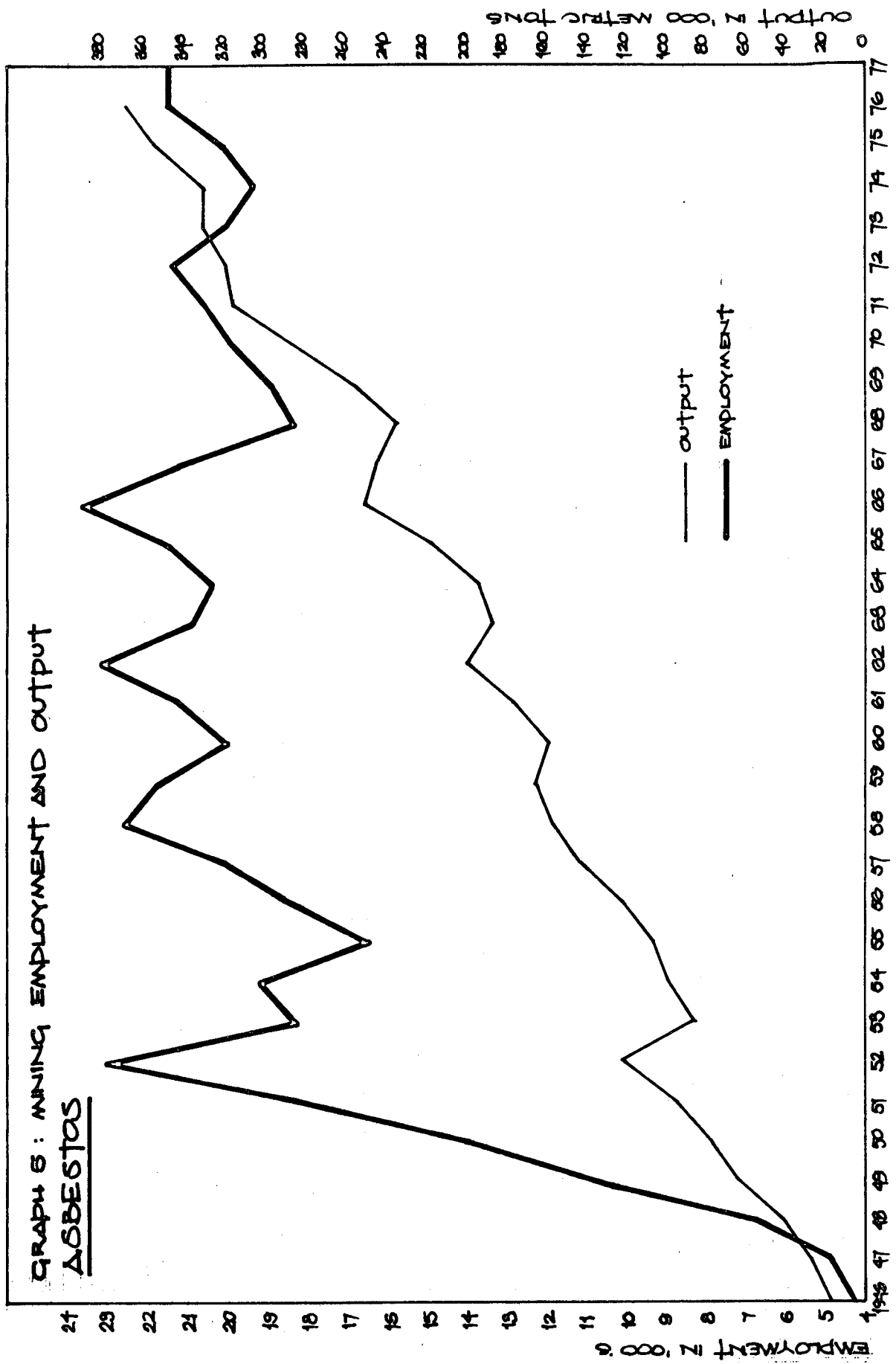
5.4 The evidence suggests then, that in asbestos mining productivity improvements (which we are not yet able to specify technically), running at the rate of about 5, per cent per annum since 1952, have been substantial enough to check the growth of employment - despite fast growth of output - and even during the last decade to cause it to fall below earlier average levels.

TABLE 8: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE ASBESTOS MINES:  
1946-1977

Year	Output (metric tons)	Employment	Output (tons) per worker
1946	18 300	4 263	4,3
1947	27 300	4 925	5,5
1948	41 500	6 785	6,1
1949	64 100	10 957	5,9
1950	79 300	14 102	5,6
1951	97 400	18 027	5,4
1952	121 400	23 039	5,3
1953	86 000	18 330	4,7
1954	99 100	19 166	5,2
1955	108 600	16 598	6,5
1956	123 000	18 493	6,7
1957	142 900	20 047	7,1
1958	159 300	22 707	7,0
1959	165 400	21 808	7,6
1960	159 600	20 012	8,0
1961	176 700	21 219	8,3
1962	200 800	23 209	8,7
1963	186 600	20 886	8,9
1964	195 500	20 384	9,6
1965	218 500	21 500	10,2
1966	250 900	23 687	10,6
1967	243 600	21 228	11,5
1968	236 300	18 303	12,9
1969	258 200	18 836	13,7
1970	287 400	19 817	14,5
1971	319 300	20 631	15,5
1972	320 600	21 324	15,0
1973	332 700	20 033	16,6
1974	333 300	19 421	17,2
1975	354 500	20 115	17,6
1976	369 800	21 504	17,2
1977	380 164	21 665	17,6

TABLE 9: EMPLOYMENT ON THE ASBESTOS MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	170	4 093	..	..	..	4 263
1947	221	4 704	..	..	..	4 925
1948	321	6 464	..	..	..	6 785
1949	476	10 481	..	..	..	10 957
1950	639	13 463	..	..	..	14 102
1951	792	17 235	..	..	..	18 027
1952	997	22 042	..	..	..	23 039
1953	837	17 493	..	..	..	18 330
1954	878	18 288	..	..	..	19 166
1955	795	15 803	..	..	..	16 598
1956	925	17 568	..	..	..	18 493
1957	1 052	18 995	..	..	..	20 047
1958	1 157	21 550	..	..	..	22 707
1959	1 074	20 734	..	..	..	21 808
1960	1 000	19 012	..	..	..	20 012
1961	1 103	20 116	..	..	..	21 219
1962	1 216	21 993	..	..	..	23 209
1963	1 090	19 796	..	..	..	20 886
1964	1 049	19 335	..	..	..	20 384
1965	1 092	20 408	..	..	..	21 500
1966	1 150	22 537	1	409	22 127	23 687
1967	1 119	20 109	1	326	19 782	21 228
1968	952	17 351	1	259	17 091	18 303
1969	995	17 841	0	237	17 604	18 836
1970	990	18 827	0	255	18 572	19 817
1971	1 018	19 613	0	285	19 328	20 631
1972	1 008	20 316	0	294	20 022	21 324
1973	973	19 060	0	295	18 765	20 033
1974	935	18 486	0	294	18 192	19 421
1975	1 012	19 103	0	377	18 726	20 115
1976	1 110	20 394	0	492	19 902	21 504
1977						21 665



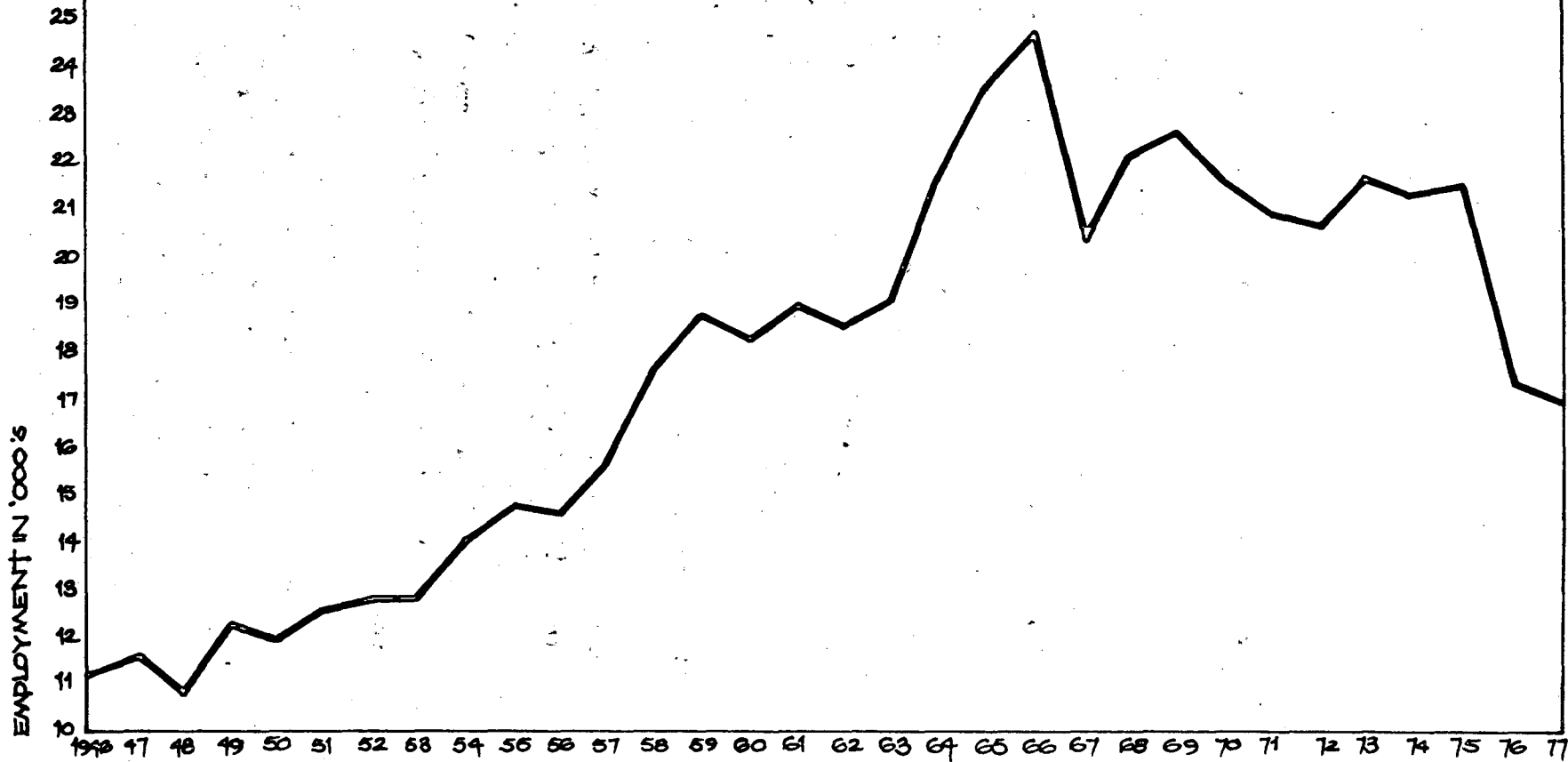
6. Employment in Quarries and Salt Mines

- 6.1 The minerals being quarried are: calcite, felspar, fuller's earth, granite, gypsum, limes, marble, phosphates, sandstone, silcrete, silica, slate, wonderstone, tiger's eye, and miscellaneous stone.
- 6.2 This category of mining employment comprised in 1976 2,6 per cent of the total. It was thus on a par with diamond mining employment - less important than asbestos (3,3 per cent) but ahead of copper mining (2,0 per cent). In this year 17 319 workers were employed on average - but this is well below the historical employment peak of 24 061 (achieved in 1966) when also the share of employment generated in quarries and salt-mines was higher at 3,8 per cent.
- 6.3 One way of looking at the employment figures in this category for 1946-1976 is to treat them as belonging to two phases (see Graph 6 p.32).
- 6.3.1 During the years 1946 to 1966 (inclusive) there was a strong growth surge in employment in quarrying etc. 1958, 1964 and 1965 showed above average increases in a fairly regular upward movement - which was averaging close to 4 per cent per annum.
- 6.3.2 In the subsequent period 1967-1976, the employment level does not grow but varies gently in the range established during the last 3-4 years of the previous growth phase viz. 20 000-22 000 workers. If the heavy decline in 1976 (to 17 319) is taken as being more than a cyclical phenomenon there is a case for suggesting that there is in fact a gently declining trend in this category of employment. However there are presumably strong cyclical influences because of the market connection with construction.
- 6.4 Because there are a range of minerals being quarried it is not possible to study the production statistics that exactly correspond to this employment category. However a rough survey of individual production /sales statistics suggests that enough of these minerals have been quarried in increasing volume for a weighted index of production volume to register gains during the last decade. If this is the case then we must have another mining industry in which changes in techniques and organisation are sufficiently labour-saving to stabilise employment, although output is growing.

TABLE 10: EMPLOYMENT ON QUARRIES AND SALT MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	686	10 583	..	..	..	11 269
1947	767	10 858	..	..	..	11 625
1948	751	10 119	..	..	..	10 870
1949	824	11 515	..	..	..	12 339
1950	908	11 158	..	..	..	12 066
1951	918	11 695	..	..	..	12 613
1952	920	11 949	..	..	..	12 869
1953	976	11 991	..	..	..	12 967
1954	1 125	12 924	..	..	..	14 049
1955	1 188	13 597	..	..	..	14 785
1956	1 278	13 316	..	..	..	14 594
1957	1 556	14 073	..	..	..	15 629
1958	1 548	16 077	..	..	..	17 625
1959	1 646	17 004	..	..	..	18 650
1960	1 749	16 449	..	..	..	18 198
1961	1 778	17 135	..	..	..	18 913
1962	1 781	16 755	..	..	..	18 536
1963	2 004	17 001	..	..	..	19 005
1964	1 919	19 665	..	..	..	21 584
1965	2 100	21 378	..	..	..	23 478
1966	2 237	21 824	288	1 109	20 427	24 061
1967	1 887	18 407	276	1 032	17 099	20 294
1968	1 967	20 058	289	1 213	18 556	22 025
1969	1 948	20 502	265	1 376	18 861	22 450
1970	1 798	19 740	325	1 270	18 145	21 538
1971	1 790	19 037	307	1 147	17 583	20 827
1972	1 814	18 732	286	1 434	17 012	20 546
1973	1 911	19 484	294	1 205	17 985	21 395
1974	1 921	19 181	245	1 154	17 782	21 102
1975	1 703	19 544	281	1 232	18 031	21 247
1976	1 618	15 701	260	1 209	14 232	17 319
1977						16 877

GRAPH 6: MINING EMPLOYMENT  
QUARRIES AND SALT



## 7. Employment in Copper Mining

7.1 During 1972-4 there were somewhat over 15 000 workers on average employed in the mining of copper. Since then the number has declined to 13 229 in 1976 - constituting 2 per cent of the total labour-force in mining.

7.2 Taking the whole period 1946 to 1976, employment grew at an average rate of 2,9 per cent per annum (from 5 658 to 8 914).

7.2.1 During the years 1946 to 1957 (inclusive) the growth of employment was uninterrupted - and averaged over 4 per cent per annum.

7.2.2 However it was 1965 before the 1957 employment level was regained, and in the interval years 1958-65 employment fluctuated gently between 8 and 9 thousand workers a year.

7.2.3 In 1966 employment jumped to over 10 000 and there are radical discontinuities in the output and output per worker series. In fact this year saw the coming into operation of the Palaborwa mine<sup>22</sup> - using advanced open-cast techniques and destined to become one of the largest copper mines in the world.

7.2.4 Employment then grew by something like 50 per cent to 1974 - presumably having to do with the expansion of Palaborwa and the development and coming into full production (1972-4) of the Prieska underground mine (using trackless equipment).<sup>23</sup> However in 1975 and 1976 employment fell quite sharply - even though by 1976 output was back on trend.

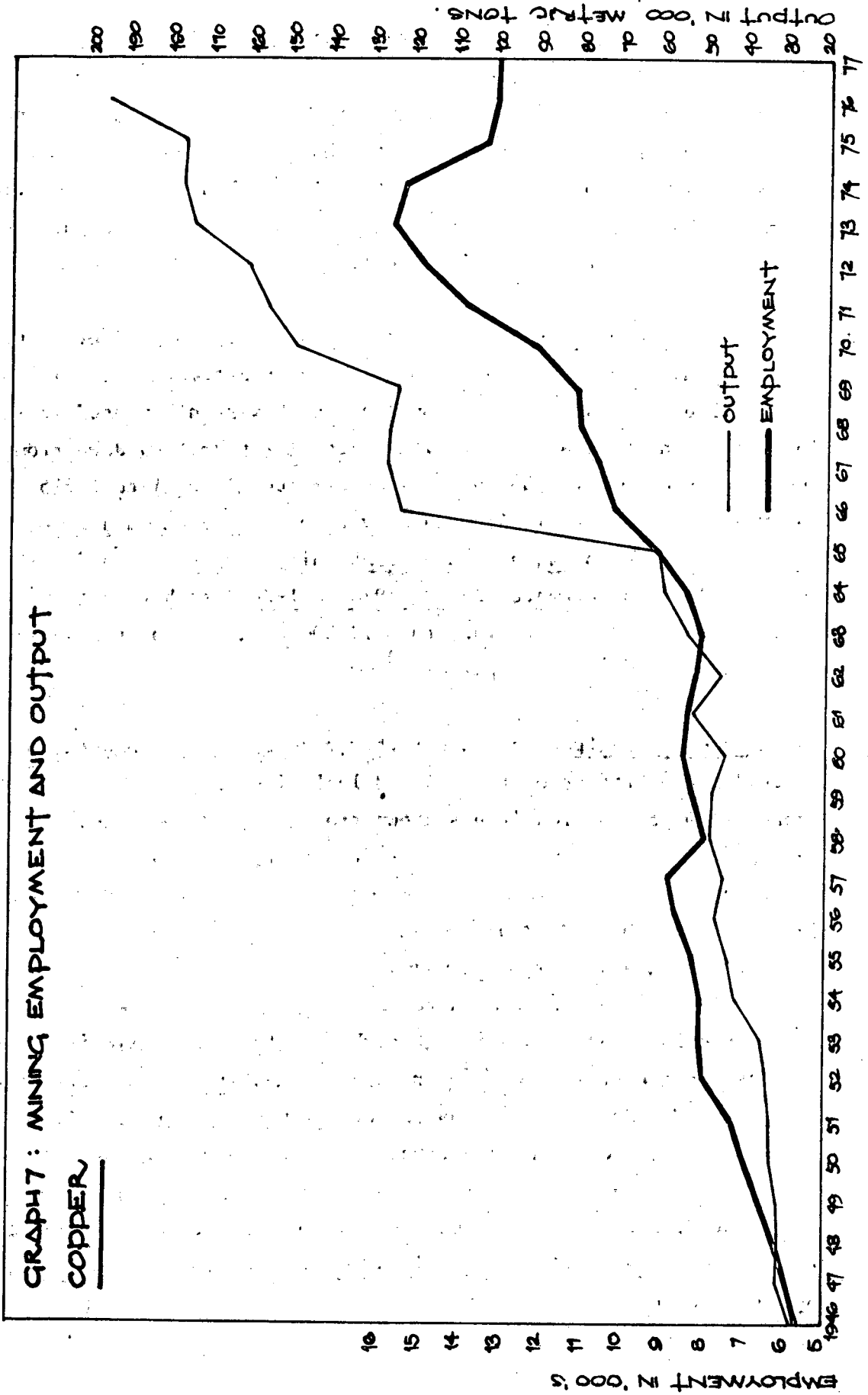
7.3 Without more detailed information about individual mines (there are only 4: Messina, O'kiep, Palaborwa, Prieska) it is not possible to explain the developments of the last few years. It looks as though the strong employment trend and the slight tendency for labour productivity to fall are the result of Prieska's entry: its full employment is in the region of 4 000<sup>24</sup> and presumably output per worker in underground trackless mining does not run at Palaborwa open-cast levels. The last two years may be connected with the strong expansion of the scale of Palaborwa's operations - and the possible contraction of some others because of the low copper price (e.g. O'kiep).<sup>25</sup>

TABLE 11: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE COPPER MINES:  
1946- 1977

Year	Output (1000 metric tons)	Employment	Output (tons) per worker
1946	28,3	5 658	5,0
1947	30,7	5 993	5,1
1948	30,7	6 240	4,9
1949	31,3	6 651	4,7
1950	34,0	7 029	4,8
1951	33,7	7 351	4,6
1952	35,1	8 001	4,4
1953	36,1	8 049	4,5
1954	42,3	8 072	5,2
1955	44,6	8 294	5,4
1956	46,5	8 725	5,3
1957	46,3	8 914	5,2
1958	49,5	8 025	6,2
1959	49,4	8 324	5,9
1960	46,1	8 526	5,4
1961	52,6	8 512	6,2
1962	46,4	8 181	5,7
1963	55,2	8 104	6,8
1964	59,5	8 371	7,1
1965	60,4	9 057	6,7
1966	124,6	10 314	12,1
1967	127,6	10 540	12,1
1968	128,3	11 068	11,6
1969	126,2	11 245	11,2
1970	149,2	12 205	12,2
1971	157,5	13 936	11,3
1972	161,9	15 019	10,8
1973	175,8	15 744	11,2
1974	179,1	15 521	11,5
1975	178,9	13 423	13,3
1976	196,9	13 229	14,9
1977	205,4	13 186	15,6

TABLE 12: EMPLOYMENT ON THE COPPER MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	665	4 993	..	..	..	5 658
1947	707	5 286	..	..	..	5 993
1948	803	5 437	..	..	..	6 240
1949	881	5 770	..	..	..	6 651
1950	944	6 085	..	..	..	7 029
1951	1 002	6 349	..	..	..	7 351
1952	1 054	6 947	..	..	..	8 001
1953	1 088	6 961	..	..	..	8 049
1954	1 127	6 945	..	..	..	8 072
1955	1 214	7 080	..	..	..	8 294
1956	1 370	7 355	..	..	..	8 725
1957	1 406	7 508	..	..	..	8 914
1958	1 303	6 722	..	..	..	8 025
1959	1 335	6 989	..	..	..	8 324
1960	1 384	7 142	..	..	..	8 526
1961	1 444	7 068	..	..	..	8 512
1962	1 406	6 775	..	..	..	8 181
1963	1 393	6 711	..	..	..	8 104
1964	1 446	6 925	..	..	..	8 371
1965	1 620	7 437	..	..	..	9 057
1966	1 947	8 367	0	1 596	6 771	10 314
1967	2 082	8 458	0	1 644	6 814	10 540
1968	2 204	8 864	0	1 647	7 217	11 068
1969	2 261	8 984	0	1 648	7 336	11 245
1970	2 388	9 817	0	1 875	7 942	12 205
1971	2 557	11 379	0	2 357	9 022	13 936
1972	2 671	12 348	0	2 464	9 884	15 019
1973	2 727	13 017	0	2 453	10 564	15 744
1974	2 739	12 782	0	2 538	10 244	15 521
1975	2 478	10 945	0	1 894	9 051	13 423
1976	2 357	10 872	0	1 889	8 983	13 229
1977						13 186



8. Employment in Chrome Mining

- 8.1 In 1976 9 000 workers were on average engaged in mining chrome (8 960 to be exact), a mere 1,4 per cent of the total manpower in mining and quarrying. Both the number employed and its share in total employment were very similar to those for iron ore and manganese ore mining. Although the number of employees had grown substantially above its 1946 level (2 391) the share had not changed enough to be impressive (0,5 per cent in 1946 to 1,4 per cent in 1976).
- 8.2 The growth in employment during the 30-year period under review has been uneven. Sharp increases in 1947 and 1953 took the total from 2 391 (1946) to 5 437 (1953) - but that peak was only passed again in 1971! In the years between, the total first drifted down from (what was presumably) the 1953 Korean War 'boom' level to 2 215 in 1959. From there it fluctuated very mildly to the mid-1960s, and at that stage began a steady climb which (after a mild dip in 1972 and 1973) accelerated during 1974 to 1976 (and has continued to do so into 1977 - with more than 13 000 workers employed during some months). (See Graph 8 p.40a).
- 8.3 The movement of output has been rather more steady (though there were short dips in production in 1954 and 1955, in 1958, 1963 and 1972). Over the 30-year period it has grown from 212 to 2 409 thousand metric tons - involving an average rate of growth of 8,4 per cent per annum; since employment grew on average at 4,5 per cent per annum for the same period it would appear that substantial gains in labour productivity must have been achieved.
- 8.4 Examination of the annual data for output per worker turns up a somewhat unusual pattern - though perhaps with some similarity to the case of copper mining. There was a somewhat erratic pattern of change to 1958 and then in 1959 output per worker-year went from 169 metric tons to 307 metric tons. This was a year of very low employment but the productivity gain was not all lost and a new level of labour productivity - between 250 and 300 metric tons per employee per year - was established at this stage and not later abandoned or advanced beyond.

- 8.5 The importance of this of course is that since output has been growing steadily in this period (recently connected with the domestic production of ferro-chrome) employment has been required to expand rapidly to increase output at relatively constant levels of per worker productivity. During the years 1960 to 1976 this employment growth has averaged 6,5 per cent per annum. This sets chrome apart from a number of the mining industries we have previously examined. Clearly the technical and/or geological and/or economic determinants of the situation need to be investigated and understood - but we are unable to do so here:
- 8.6 In 1977 chrome production increased by 37,8 per cent and (in line with experience since 1960) output per worker changed little. Employment consequently rose by 40,1 per cent for the year.

TABLE 13: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE CHROME MINES:  
1946-1977

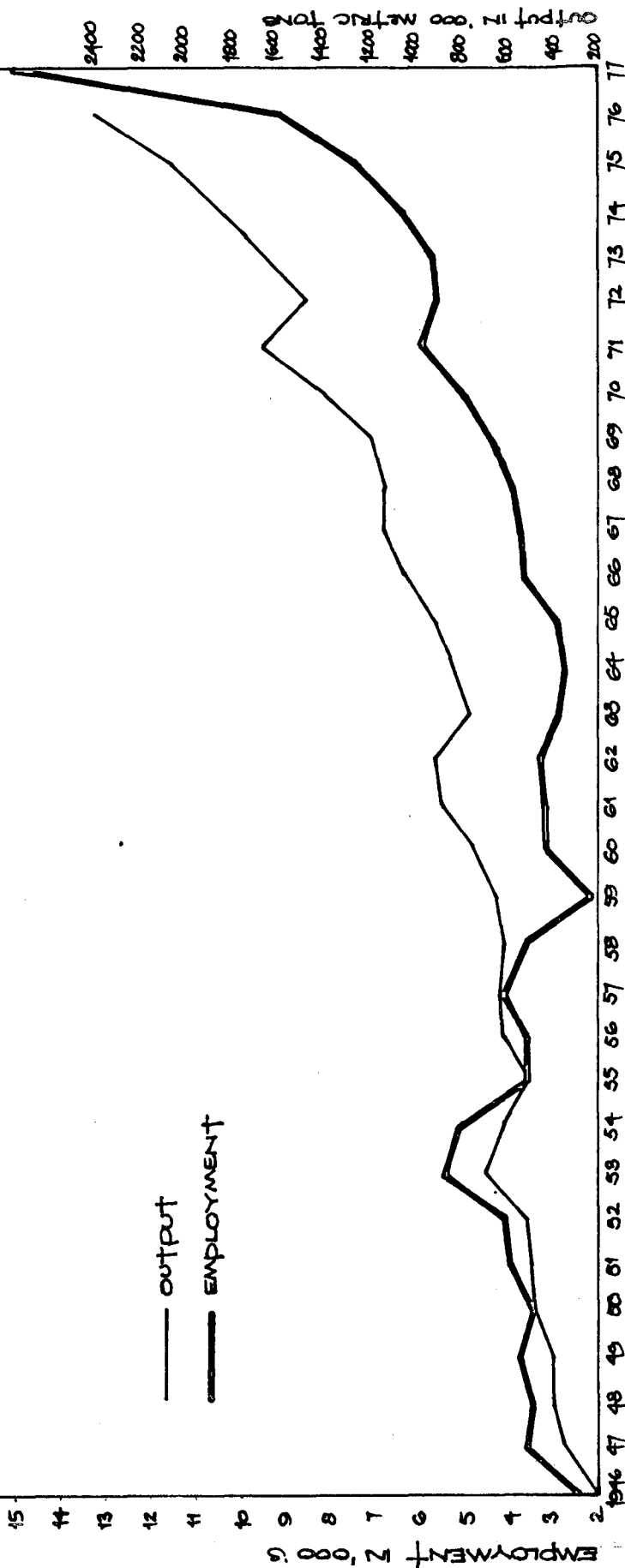
Year	Output (1000 metric tons)	Employment	Output (tons) per worker
1946	212	2 391	89
1947	373	3 680	101
1948	413	3 603	115
1949	404	3 954	102
1950	496	3 514	141
1951	545	4 017	136
1952	580	4 151	140
1953	725	5 437	133
1954	641	5 234	123
1955	542	3 735	145
1956	627	3 730	168
1957	666	4 153	160
1958	632	3 738	169
1959	680	2 215	307
1960	772	3 255	237
1961	898	3 189	282
1962	913	3 324	275
1963	792	2 917	272
1964	849	2 823	301
1965	942	2 956	319
1966	1 060	3 673	289
1967	1 149	3 926	293
1968	1 153	4 001	288
1969	1 197	4 461	268
1970	1 427	5 078	281
1971	1 644	5 907	278
1972	1 483	5 738	258
1973	1 650	5 874	281
1974	1 877	6 398	293
1975	2 075	7 443	279
1976	2 409	8 960	269
1977	3 319	12 556	264

TABLE 14: EMPLOYMENT ON THE CHROME MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	108	2 283	..	..	..	2 391
1947	174	3 506	..	..	..	3 680
1948	208	3 395	..	..	..	3 603
1949	223	3 731	..	..	..	3 954
1950	195	3 319	..	..	..	3 514
1951	224	3 793	..	..	..	4 017
1952	237	3 914	..	..	..	4 151
1953	286	5 151	..	..	..	5 437
1954	298	4 936	..	..	..	5 234
1955	195	3 540	..	..	..	3 735
1956	216	3 514	..	..	..	3 730
1957	244	3 909	..	..	..	4 153
1958	215	3 523	..	..	..	3 738
1959	180	2 035	..	..	..	2 215
1960	174	3 081	..	..	..	3 255
1961	171	3 018	..	..	..	3 189
1962	170	3 154	..	..	..	3 324
1963	160	2 757	..	..	..	2 917
1964	155	2 668	..	..	..	2 823
1965	160	2 796	..	..	..	2 956
1966	191	3 482	0	1	3 481	3 673
1967	198	3 728	0	1	3 727	3 926
1968	203	3 798	0	0	3 798	4 001
1969	215	4 246	0	0	4 246	4 461
1970	234	4 844	0	0	4 844	5 078
1971	282	5 625	0	0	5 625	5 907
1972	290	5 448	2	0	5 446	5 738
1973	287	5 587	2	0	5 585	5 874
1974	320	6 078	1	0	6 077	6 398
1975	386	7 057	0	0	7 057	7 443
1976	490	8 470	1	0	8 469	8 960
1977						12 556

GRAPH 8 : MINING EMPLOYMENT AND OUTPUT

CHROME



9. Employment in Iron Ore mining

9.1 In 1976 there were over 9 000 workers on average engaged in mining iron ore, some 1,4 per cent of the aggregate labour force in mining and quarrying. These magnitudes are very similar to those for chrome and manganese - and so are the changes during the 30-year period from 1946-1976: employment in iron ore mining grew from 2 597 (1946) to its current level of 9 334, and its share in total mining employment rose from 0,5 per cent to 1,4 per cent.

9.2 A study of employment statistics for iron ore mining (and of the graph on which they are represented) suggests the following rough subdivisions of our period (see Graph 9 p.44a).

9.2.1 During the first decade 1946 to 1956 (inclusive) employment was constant in trend terms - with fluctuations in a small range (roughly, 2 500 - 3 000 workers).

9.2.2 From 1957 to 1968 there was an unbroken expansion in employment to 1965 followed by a 3-year plateau at the level reached in 1965.

9.2.3 This growth phase was followed by a 4-year period, 1969 to 1972 (inclusive), in which the employment level fell - especially sharply in 1969 and 1972 - and remained well below the 1965-68 level. (Some part at least of this is cyclical).

9.2.4 Employment picked up in 1973 and 1974 and experienced a massive gain of slightly over 30 per cent in 1975. A slight drop in 1976 left the basic picture of expansion unaffected: employment had increased by over 80 per cent from 5 121 (1972) to 9 334 (1976) in 4 years.

9.3 Output of iron ore presents a remarkably regular progress for the 30-year period: in fact it has increased year on year, except for 1948, 1950, 1954 (all very slight declines) and 1973. Over this period the 5-year moving average of output has increased about 11-fold (from the quinquennium centred on 1948 to that centred on 1974). Since employment over this period has increased only between 3 - and 4-fold, it is clear that physical output of iron-ore per worker per

year must have increased considerably. This is indeed so: it ranged between 350 and 450 metric tons in the first 5 years after the war; and fluctuated more heavily, but at much higher level, between 2 200 and 1 300 metric tons in the last 5 years.

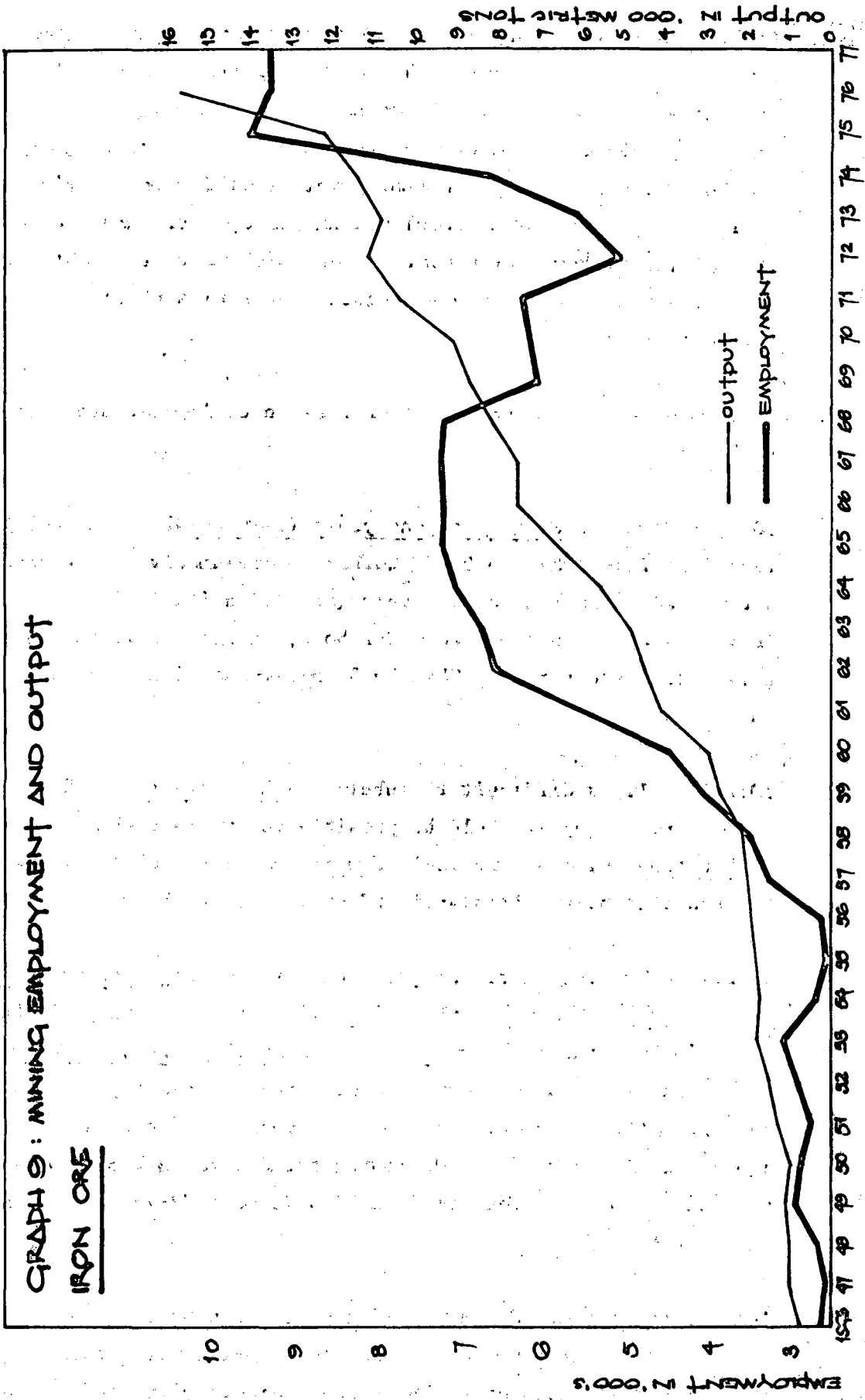
- 9.4 There seems a good deal that needs explaining in looking at the statistics (and graphs) of employment, output and output per worker. In particular, output per worker tended to grow quite markedly during the first employment period (1946-56) but then to decline during the period of fast employment growth to the mid-1960s. It then grew very fast - in fact more than doubled between 1965-66 and 1972 - as output continued to expand fast accompanied by an actual decline in employment. Since then, however, productivity has been tending to decline somewhat (though the series is very volatile) in the recent years of heavy employment growth. Statistics for 1977 suggest that we have very fast output growth with almost static employment. We know there has been the development of a major new open-cast pit at Sishen to supply Saldanha Bay and export markets.<sup>26</sup> It seems possible that part of the 1975 employment increase has to do with development work for this project.
- 9.5 Detailed explanations of the changes recorded in 9.4 will not be attempted - beyond noting i) that the period has seen the development and use of both more productive open-cast techniques and of various underground improvements and ii) that as with coal, manganese, and copper (and perhaps other minerals) there are different types of deposit (e.g. surface and underground) which require different techniques (with different associated labour productivities) for their exploitation. With the qualification that there are technical factors involved which are not well understood, it seems possible to say that there has been a trend increase in employment since the mid-1950s, of the order of 5-6 per cent per annum, which technical progress has not thus far eliminated.

TABLE 15: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE IRON ORE MINES  
1946-1977

Year	Output (1000 metric tons)	Employment	Output (tons) per worker
1946	917	2 597	353
1947	1 124	2 543	442
1948	1 120	2 655	422
1949	1 181	2 975	397
1950	1 119	2 916	384
1951	1 358	2 770	490
1952	1 717	2 931	586
1953	1 971	3 108	634
1954	1 893	2 714	698
1955	1 999	2 515	795
1956	2 064	2 625	786
1957	2 080	3 334	624
1958	2 212	3 529	627
1959	2 889	4 075	709
1960	3 071	4 491	684
1961	4 174	5 638	740
1962	4 612	6 600	699
1963	4 990	6 757	738
1964	5 689	7 048	807
1965	6 723	7 244	928
1966	7 671	7 201	1 065
1967	7 737	7 220	1 072
1968	8 233	7 240	1 137
1969	8 788	6 052	1 452
1970	9 192	6 153	1 494
1971	10 496	6 261	1 676
1972	11 223	5 121	2 192
1973	10 955	5 549	1 974
1974	11 553	7 217	1 601
1975	12 298	9 515	1 292
1976	15 663	9 334	1 678
1977	26 481	9 371	2 826

TABLE 16: EMPLOYMENT ON THE IRON ORE MINES 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	315	2 282	..	..	..	2 597
1947	340	2 203	..	..	..	2 543
1948	350	2 305	..	..	..	2 655
1949	413	2 562	..	..	..	2 975
1950	422	2 494	..	..	..	2 916
1951	431	2 339	..	..	..	2 770
1952	462	2 469	..	..	..	2 931
1953	471	2 637	..	..	..	3 108
1954	446	2 268	..	..	..	2 714
1955	432	2 083	..	..	..	2 515
1956	441	2 184	..	..	..	2 625
1957	503	2 831	..	..	..	3 334
1958	567	2 962	..	..	..	3 529
1959	608	3 467	..	..	..	4 075
1960	654	3 837	..	..	..	4 491
1961	710	4 928	..	..	..	5 638
1962	788	5 812	..	..	..	6 600
1963	861	5 896	..	..	..	6 757
1964	943	6 105	..	..	..	7 048
1965	964	6 280	..	..	..	7 244
1966	1 013	6 188	..	..	..	7 201
1967	976	6 244	0	13	6 231	7 220
1968	1 032	6 208	0	13	6 195	7 240
1969	1 065	4 987	0	9	4 978	6 052
1970	1 012	5 141	0	20	5 121	6 153
1971	976	5 285	0	30	5 255	6 261
1972	982	4 139	0	41	4 098	5 121
1973	1 067	4 482	0	101	4 381	5 549
1974	1 268	5 949	1	215	5 733	7 217
1975	1 731	7 784	1	406	7 377	9 515
1976	2 168	7 166	1	294	6 871	9 334
1977						9 371



## 10. Employment in Manganese Ore mining

10.1 In 1976 there were just over 9 000 workers on average engaged in mining manganese ore, some 1,4 per cent of the aggregate labour force in mining and quarrying. As we have seen these magnitudes are very similar to those for chrome and iron ore, and so are the 30-year beginning-to-end changes in employment level (3 026 in 1946 to 9 176 in 1976) and in share of total mining employment. However the pattern of employment growth over time is very different from that in the iron ore case; and while there are similarities with chrome there are also differences.

10.2 It is possible to describe the changes in employment over time as follows:

10.2.1 In the early post-war years (1946-1953) employment grew very fast from 3 026 to 9 605 workers - presumably as the result of a combination of increased supply (mine capacity) and upswing in demand (peaking in the Korean War boom; manganese is sold to the world steel industry). This 1953 employment figure was only surpassed in 1975.

10.2.2 It is difficult to subdivide the years after 1953. In a rough sort of way it would be possible to consider them as exhibiting a flat trend with a good deal of mild cyclical variation (apart from the sharp downturn of 1954-55 and upswing of 1956-60)

10.2.3 However there is also a case for seeing a slightly falling trend in the 1960s and early 1970s (after the regaining of the 1953 level in 1960 and 1962) and a reversal of that trend since 1972. This view is compatible with the behaviour of the 5-year moving averages of employment. The 5-year averages in the series from 1959-63 to 1968-72 show a declining trend (from 8 793 to 7 887); whereas the 5-year averages from 1969-73 to 1972-74 are rising from 8 111 to 8 940).

10.3 Across the 30 years output has increased by more than 20-fold (from, roughly, a 1/4 million metric tons to 5 1/2 million). There was the initial rapid expansion, a 1950s level of capacity, and then a shift to a higher level in the first half of the 1960s (Hotazel open-cast

mine was commissioned in 1959).<sup>27</sup> From that stage growth is strong and uninterrupted (except for 1972 and 1976 - presumably market-related) and probably shows in 1973-75 the influence of the new Wessels underground mine using trackless equipment etc.<sup>28</sup>

- 10.4 With output growing on average at about 11 per cent per annum since the mid-1960s labour productivity must have been increasing fast for employment to have been drifting down to 1972 before a reversal of trend. This is in fact so. Since the opening of the Hotazel open-cast mine in 1959, output per worker per year has gone from 115 metric tons to 600 (in 1976); this represents an average compound rate of growth of over 10 per cent per annum. It has taken the growth of output at an average of 13 per cent per annum for the last 4 years with (possibly) the introduction of a new underground (as distinct from open-cast) mine to produce some clear employment growth.

TABLE 17: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE MANGANESE MINES:  
1946-1977

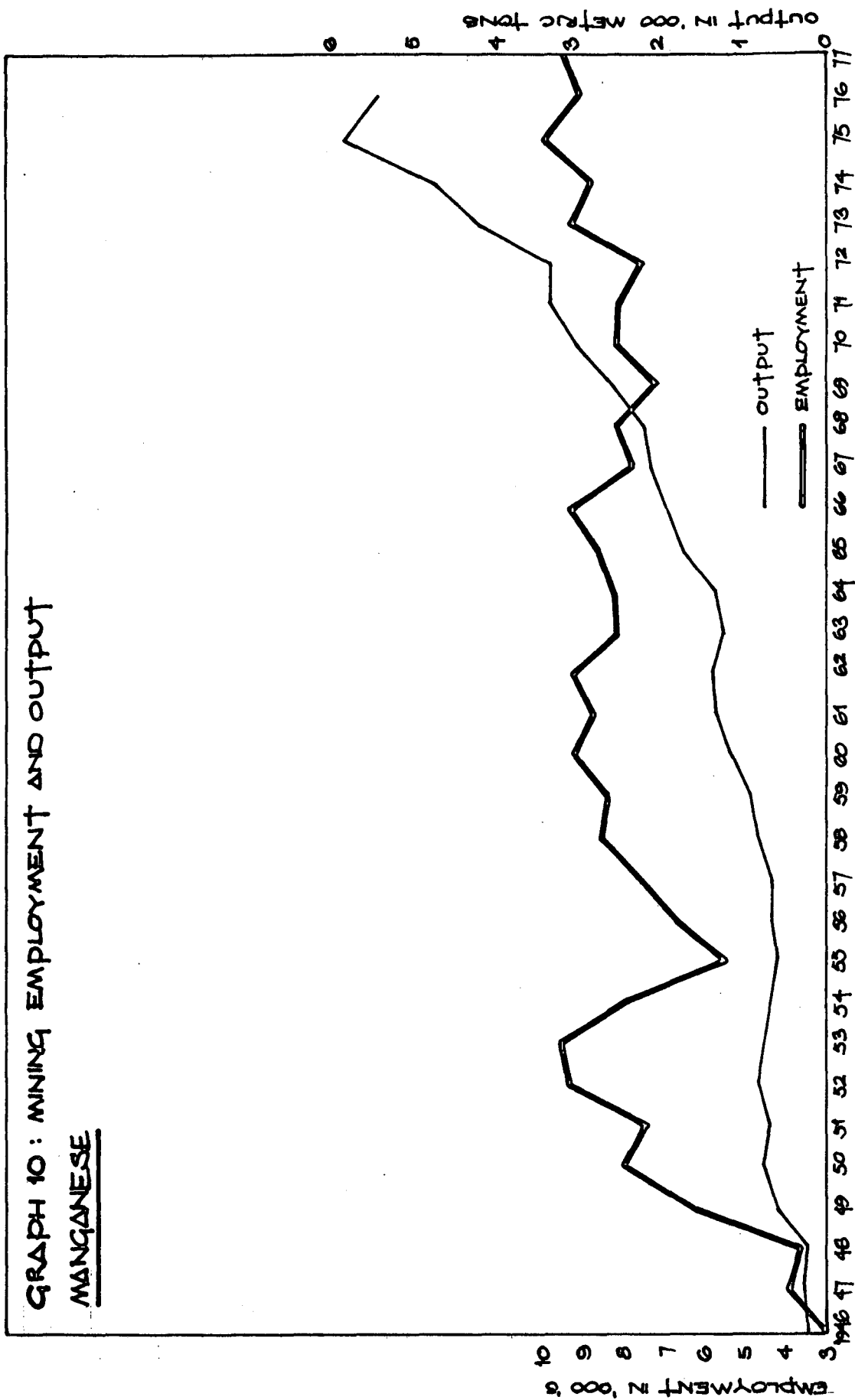
Year	Output (1000 metric tons)	Employment	Output (tons) per worker
1946	238	3 026	79
1947	288	4 016	72
1948	276	3 734	74
1949	655	6 366	103
1950	791	8 042	98
1951	759	7 509	101
1952	875	9 357	93
1953	828	9 605	86
1954	701	7 956	88
1955	589	5 596	105
1956	697	6 709	104
1957	715	7 659	93
1958	847	8 577	99
1959	969	8 431	115
1960	1 194	9 318	128
1961	1 418	8 816	161
1962	1 465	9 280	158
1963	1 358	8 120	167
1964	1 468	8 229	178
1965	1 775	8 703	204
1966	1 982	9 280	214
1967	2 121	7 769	273
1968	2 428	8 091	300
1969	2 644	7 310	362
1970	3 053	8 244	370
1971	3 418	8 149	419
1972	3 373	7 643	441
1973	4 242	9 211	461
1974	4 835	8 765	552
1975	5 881	9 905	594
1976	5 503	9 176	600
1977	5 290	9 595	551

TABLE 18: EMPLOYMENT ON THE MANGANESE MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	149	2 877	..	..	..	3 026
1947	202	3 814	..	..	..	4 016
1948	219	3 515	..	..	..	3 734
1949	290	6 076	..	..	..	6 366
1950	365	7 677	..	..	..	8 042
1951	399	7 110	..	..	..	7 509
1952	410	8 947	..	..	..	9 357
1953	423	9 182	..	..	..	9 605
1954	391	7 565	..	..	..	7 956
1955	309	5 287	..	..	..	5 596
1956	350	6 359	..	..	..	6 709
1957	388	7 271	..	..	..	7 659
1958	411	8 166	..	..	..	8 577
1959	412	8 019	..	..	..	8 431
1960	460	8 858	..	..	..	9 318
1961	453	8 363	..	..	..	8 816
1962	502	8 778	..	..	..	9 280
1963	503	7 617	..	..	..	8 120
1964	509	7 720	..	..	..	8 229
1965	507	8 196	..	..	..	8 703
1966	502	8 778	..	..	..	9 280
1967	507	7 262	0	17	7 245	7 769
1968	533	7 558	0	15	7 543	8 091
1969	523	6 787	0	14	6 773	7 310
1970	536	7 708	0	13	7 695	8 244
1971	521	7 628	0	44	7 584	8 149
1972	560	7 083	0	78	7 005	7 643
1973	876	8 335	0	138	8 197	9 211
1974	577	8 188	0	175	8 013	8 765
1975	636	9 269	0	221	9 048	9 905
1976	533	8 643	0	211	8 432	9 176
1977						9 595

GRAPH 10 : MINING EMPLOYMENT AND OUTPUT

MANGANESE



11. Employment in Tin Mining

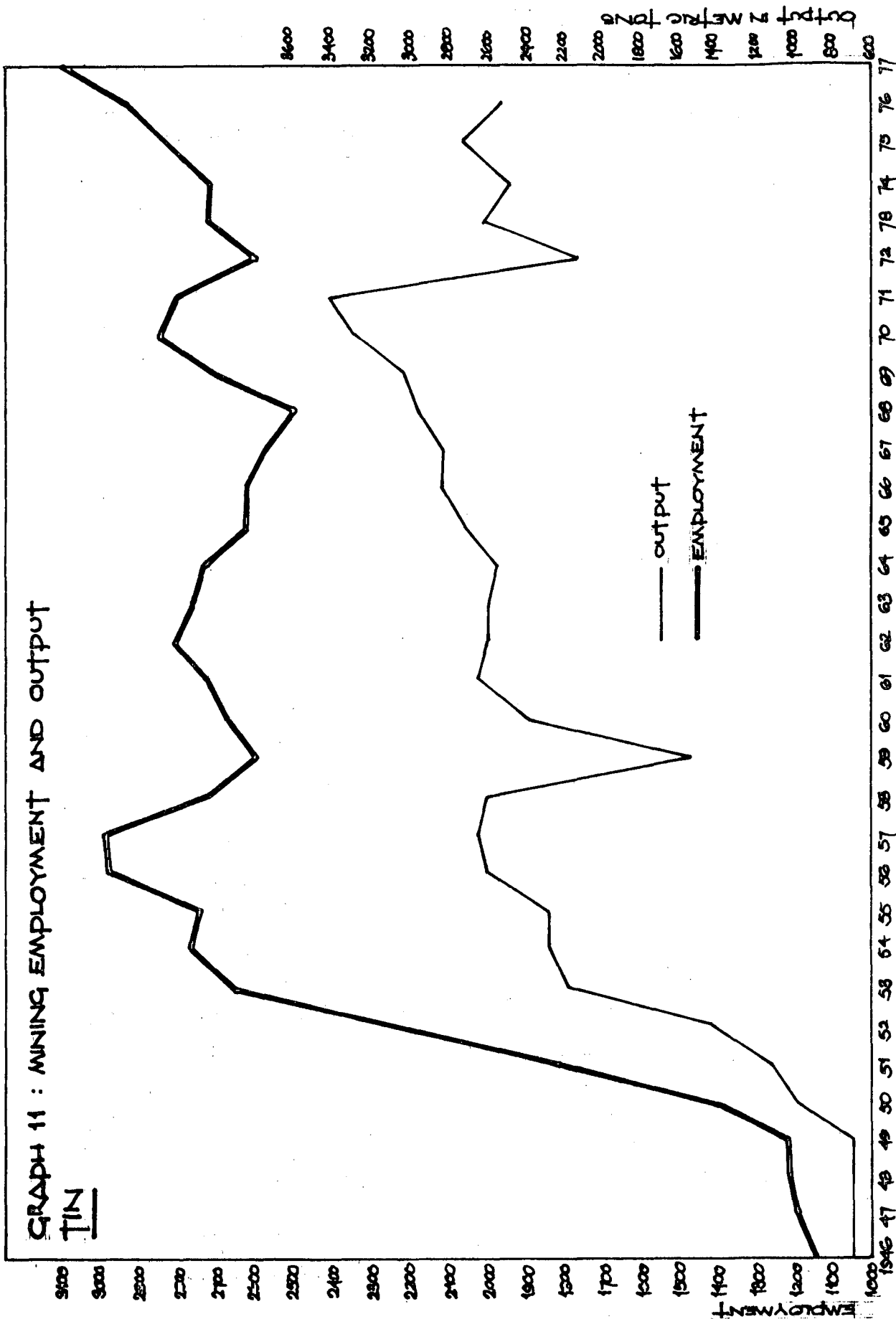
Statistics and graphs of employment on tin mines are provided but will not be discussed because of the relatively small numbers of workers involved and the long-run static level of tin employment.

TABLE 19: OUTPUT, EMPLOYMENT AND PRODUCTIVITY ON THE TIN MINES  
1946-1977

Year	Output (metric tons)	Employment	Output (tons per worker)
1946	733	1 150	0,64
1947	723	1 210	0,60
1948	698	1 227	0,57
1949	711	1 232	0,58
1950	1 018	1 438	0,71
1951	1 153	1 825	0,63
1952	1 443	2 259	0,64
1953	2 177	2 659	0,82
1954	2 315	2 779	0,83
1955	2 311	2 749	0,84
1956	2 619	2 925	0,90
1957	2 644	3 001	0,88
1958	2 624	2 730	0,96
1959	1 560	2 601	0,60
1960	2 439	2 685	0,91
1961	2 660	2 733	0,97
1962	2 600	2 816	0,92
1963	2 606	2 764	0,94
1964	2 570	2 730	0,94
1965	2 726	2 631	1,04
1966	2 872	2 632	1,09
1967	2 874	2 580	1,11
1968	2 944	2 498	1,18
1969	3 026	2 711	1,12
1970	3 299	2 857	1,15
1971	3 418	2 824	1,21
1972	2 126	2 601	0,82
1973	2 628	2 730	0,96
1974	2 497	2 725	0,92
1975	2 771	2 827	0,98
1976	2 548	2 945	0,87
1977	?	3 190	?

TABLE 20: EMPLOYMENT ON THE TIN MINES: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	76	1 074	..	..	..	1 150
1947	80	1 130	..	..	..	1 210
1948	80	1 147	..	..	..	1 227
1949	83	1 149	..	..	..	1 232
1950	88	1 350	..	..	..	1 438
1951	132	1 693	..	..	..	1 825
1952	161	2 098	..	..	..	2 259
1953	174	2 485	..	..	..	2 659
1954	193	2 586	..	..	..	2 779
1955	192	2 557	..	..	..	2 749
1956	200	2 725	..	..	..	2 925
1957	205	2 796	..	..	..	3 001
1958	182	2 548	..	..	..	2 730
1959	171	2 430	..	..	..	2 601
1960	175	2 510	..	..	..	2 685
1961	178	2 555	..	..	..	2 733
1962	172	2 644	..	..	..	2 816
1963	187	2 577	..	..	..	2 764
1964	191	2 539	..	..	..	2 730
1965	195	2 436	..	..	..	2 631
1966	203	2 429	0	2	2 427	2 632
1967	199	2 381	0	2	2 379	2 580
1968	197	2 301	0	4	2 297	2 498
1969	215	2 496	0	3	2 493	2 711
1970	224	2 633	0	0	2 633	2 857
1971	224	2 600	0	0	2 600	2 824
1972	213	2 388	0	0	2 388	2 601
1973	217	2 513	0	0	2 513	2 730
1974	201	2 524	0	0	2 524	2 725
1975	205	2 622	0	0	2 622	2 827
1976	223	2 722	0	0	2 722	2 945
1977						3 190



12. Total employment in all mines

12.1 Total employment seems to fall easily into 2 major phases - which is not so surprising given that gold mining employment does so too, and that over our period it has constituted between 60 and 80 per cent of the total.

12.1.1. Between 1946 and 1961 there is a long expansion of mining sector employment (with dips in 1947-48 and 1953). About 140 000 jobs were added to the (roughly) 500 000 in existence in mining. This represents 15 years of employment expansion at an average compound rate of 2 per cent per annum.

12.1.2 In the years 1962 to 1976 (and 1977) employment creation continues but at a slower rate and subject to apparently increasing fluctuations. If one simply takes the employment statistics at their face value and fits a constant growth rate to the change between 1961 and 1976 the rate at which jobs are created in the second half of this 30-year period turns out to be one-tenth of what it was between 1946 and 1961 viz. 0,2 per cent per annum. If (as we have argued above in the case of gold) one allows for some supply-side constraints in 1974 to 1976 - and if one takes the first 10 months' employment figures for 1977 as establishing the probability of an annual average of about 700 000 workers in employment this year,<sup>29</sup> then the growth rate rises to about 0,6 per cent per annum - still quite distinctly below that for 1946-61.

12.2 The underlying reasons for the different employment growth records in the two periods are fairly clear.

12.2.1 In the period to 1961 employment in gold mining was expanding - adding about 95 000 jobs to the total. This impulse was imparted to the overall total. Similar expansion of output and employment in coal, asbestos, quarries and salt and manganese ore (to take the obvious candidates) reinforced the growth tendency. It appears that technical progress was not yet of the sort (or at the rate) to damp down employment growth markedly - in the face of rapid output growth.

12.2.2 In the second period gold employment was declining for most of the 1960s and then tended to stabilise - except that supply constraints of a social/political nature intervened. It is this tendency which underlies the overall slow growth of total employment in the period. Such growth as there is, is provided by very marked expansion in platinum and coal, and (on a smaller scale) copper, chrome and iron-ore. However, both in the case of these minerals and in others there is evidence of labour-saving technical change which has damped the rate of growth of employment well behind that of output. The fluctuations are a product of labour supply factors - but also of changes in market demand for the commodities. All mined commodities are sensitive (in both directions) to changes in international demand. We are not certain about how gold will be affected by fluctuations in its price under the new flexible-price regime - but the share of non-gold employment in the total has risen from 22,0 per cent in 1946 to 38,9 per cent in 1976. One unambiguous consequence of this is that (whatever its trend rate of growth) total employment in the South African mining sector will be less stable from year-to-year than was formerly the case.

TABLE 21: EMPLOYMENT ON ALL MINES (EXCLUDING POWER AND WORKS) 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	51 347	424 298	..	..	..	475 645
1947	50 425	418 625	..	..	..	469 050
1948	50 479	398 989	..	..	..	449 468
1949	51 720	428 249	..	..	..	479 969
1950	56 020	448 661	..	..	..	504 681
1951	57 996	448 794	..	..	..	506 790
1952	59 307	460 637	..	..	..	519 944
1953	60 332	447 064	..	..	..	507 396
1954	62 900	470 034	..	..	..	532 934
1955	65 428	476 276	..	..	..	541 704
1956	66 375	489 555	..	..	..	555 930
1957	66 010	498 290	..	..	..	564 300
1958	64 694	501 409	..	..	..	566 103
1959	67 031	544 352	..	..	..	611 383
1960	67 821	554 392	..	..	..	622 213
1961	67 852	570 306	..	..	..	638 158
1962	67 561	566 698	..	..	..	634 259
1963	66 800	551 053	..	..	..	617 853
1964	66 294	558 450	..	..	..	624 744
1965	65 907	565 207	..	..	..	631 114
1966	65 901	569 329	708	5 624	562 997	635 230
1967	64 327	554 492	681	5 716	548 095	618 819
1968	63 480	569 530	678	5 867	562 985	633 010
1969	63 228	577 172	612	6 188	570 372	640 400
1970	63 740	597 707	628	6 695	590 384	661 447
1971	61 732	595 449	604	6 881	587 964	657 181
1972	60 485	569 615	572	7 321	561 722	630 100
1973	61 921	615 747	570	7 805	607 372	677 668
1974	62 977	603 716	533	7 628	595 555	666 693
1975	63 223	565 092	600	7 545	556 947	628 315
1976	63 982	593 610	616	7 445	585 549	657 592
1977						701 434

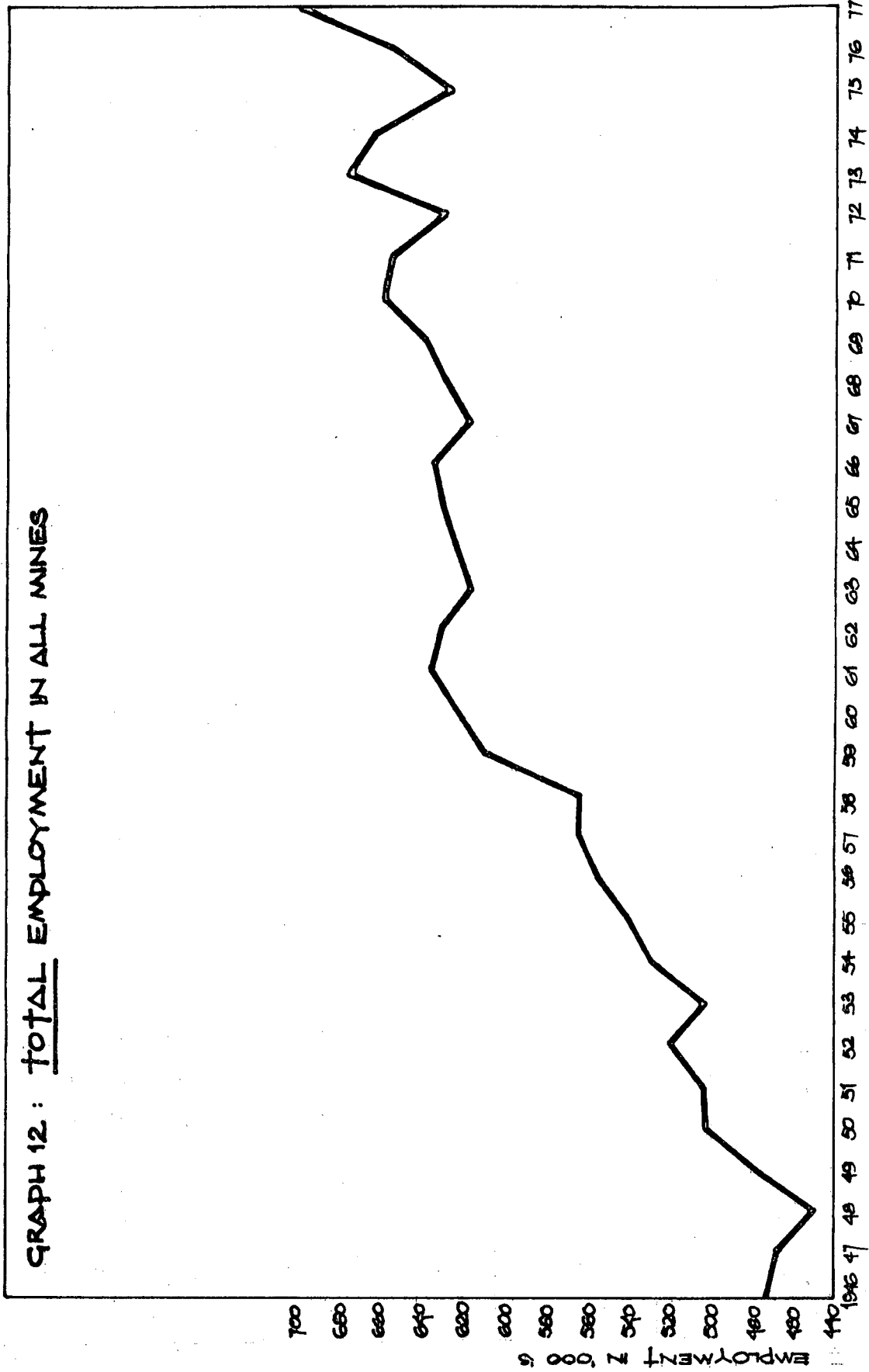


TABLE 22: EMPLOYMENT IN POWER AND WORKS: 1946-1977

Year	White	Black	Asian	Coloured	African	Total
1946	1 551	2 994	..	..	..	4 545
1947	1 614	3 172	..	..	..	4 786
1948	1 689	3 470	..	..	..	5 159
1949	1 754	3 654	..	..	..	5 408
1950	1 894	4 085	..	..	..	5 979
1951	2 033	4 581	..	..	..	6 614
1952	2 111	4 825	..	..	..	6 936
1953	2 221	4 927	..	..	..	7 148
1954	11 038	15 994	..	..	..	27 032
1955	11 602	16 734	..	..	..	28 336
1956	14 516	22 739	..	..	..	37 255
1957	15 286	22 828	..	..	..	38 114
1958	15 990	23 279	..	..	..	39 269
1959	17 127	24 421	..	..	..	41 548
1960	18 204	26 880	..	..	..	45 084
1961	18 873	26 566	..	..	..	45 439
1962	19 849	27 824	..	..	..	47 673
1963	20 718	29 385	..	..	..	50 103
1964	21 982	32 033	..	..	..	54 015
1965	16 585	20 568	..	..	..	37 153
1966	17 997	22 568	115	129	22 324	40 565
1967	17 997	22 568	115	129	22 324	40 565
1968	20 010	23 016	146	168	22 702	43 026
1969	20 008	21 652	141	157	21 354	41 660
1970	19 994	22 018	1	261	21 756	42 012
1971	23 813	42 947	321	826	41 800	66 760
1972	23 214	32 115	158	593	31 364	55 329
1973	23 356	34 468	171	649	33 648	57 824
1974	26 128	44 122	236	663	43 223	70 250
1975	28 409	35 315	355	177	34 783	63 724
1976	31 752	41 855	486	111	41 258	73 607
1977						75 023

## CHAPTER TWO :

### EMPLOYMENT PROJECTIONS

#### 1. Introduction

There is at least one reasonably detailed employment projection for the mining industry that has been published. This was contained in Professor R.P. Plewman's presidential address in 1974 to the South African Institute of Mining and Metallurgy.<sup>30</sup> We propose to approach the making of our own projections by an exposition and evaluation of Professor Plewman's earlier and pioneering effort. We do not have Professor Plewman's technical expertise nor his access to detailed technical and production information about individual mines - and so it seems sensible to use his work as a foundation, adding adjustments that may be required by information thrown up during the 3 to 4 years that have elapsed since he completed his research.

#### 2. The Plewman Projections

Professor Plewman first derives some estimates of the future rates of production of the main minerals mined or quarried in South Africa. The future dates examined are 1980 and 2000. He then considers the 'balance of different mining technologies' likely to be used for each mineral in the future and deduces the implications of these technological assumptions for the levels of output per worker likely to hold in the various branches of mining. He then presents the levels of employment in these various branches of mining that are entailed by his output and output per worker projections.

##### 2.1 Output projections (Table 23, p.60)

2.1.1 The minerals that Plewman separates out as worth individual attention (because of the relative size of the employment associated with their mining) are:

gold, diamonds, platinum;

copper, iron ore, chromium, manganese ore, coal and asbestos.

The remainder (including quarries and salt, and tin) he treats together as 'others'. Uranium is taken together with gold; zinc and lead with copper; nickel with platinum. In 1970, the base-year in Plewman's calculations, employment in these various branches was as follows (in order of size): gold - 413 272, coal - 72 555, platinum - 61 167,

diamonds - 21 005, asbestos - 19 817, copper - 11 541, manganese - 3 045, iron ore - 6 002, chromium - 4 895; and 'others' - 22 534.<sup>31</sup>

2.1.2 Plewman handles the three precious minerals differently from the others. His output projections are based on industry information and confidential reports: in the case of gold, on a 1972 Chamber of Mines study; in the case of platinum (about which information is in general scarce) he makes the assumption that output will grow on average at 5 per cent per annum over the 30-year period from 1970 - 2000; and in the case of diamonds a 45 per cent increase in output for the 1970-80 decade is followed by a plateau - with 2000 at much the same production level as 1980. (We do not know the source of these diamond projections, nor of the projected platinum growth rate of output.)

2.1.3 For the 6 base-metals and base-non-metals that he distinguishes Plewman disaggregates the projections into exports and domestic requirements. For all six he derives export figures from the report of the Commission of Enquiry into the Export Trade of the RSA (Reynders Commission) tabled in 1972.<sup>32</sup> Export figures were given in the report which Plewman interprets as export targets ("the Commissioners have included an estimate in money terms of the future rate of exports of minerals that is required if the Republic is to reach its targets for foreign exchange earnings"). These targets are taken as projections and "converted ... to physical units at 1970 prices".<sup>33</sup> To these export figures are added estimates of domestic requirements. In the case of coal two projections are made: the first assumes the domestic demand for coal will grow at 5 per cent per annum, the second at 8 per cent. In the cases of the other five minerals, the two alternative projections of the growth of domestic demand are based on 3 per cent per annum and 5 per cent.

2.1.4 In 1970, 85 per cent of total employment in base-minerals was covered by the listed six minerals. For the remaining minerals (tin, salt and quarrying in the main), Plewman assumes that output will grow at the same rate as the average rate for all minerals including gold, platinum, and diamonds.

TABLE 23: GROWTH OF THE MINERALS INDUSTRY  
(production in sales units - 1000s - base minerals)

	1 9 7 0			1 9 8 0					2 0 0 0				
	Export	Domestic	Total	Exp.	Dom. 1	Dom. 2	Total <sub>1</sub>	Total <sub>2</sub>	Exp.	Dom. 1	Dom. 2	Total <sub>1</sub>	Total <sub>2</sub>
	Copper	90	31,3	121,7	400	42	51	442	451	1 212	76	135	1 288
Iron	2 100	5 810	7 910	10 000	7 800	9 500	17 800	19 500	30 300	14 200	25 100	44 500	55 400
Chromium	954	290	1 244	2 060	390	473	2 390	2 472	6 060	706	1 250	6 766	7 310
Manganese	2 000	760	2 760	5 200	1 020	1 240	6 220	6 440	15 750	1 850	3 280	17 600	19 030
Coal	1 100	50 350	51 450	14 000	82 070	108 760	96 070	122 760	42 420	217 510	506 800	259 930	549 220
Asbestos	241	27	268	500	36	44	536	544	1 500	65	117	1 565	1 617

Note: Gold, diamonds, platinum are covered in Section 2.1.2  
and 'others' in Section 2.1.4.

## 2.2 Mining technologies and technical change

2.2.1 Plewman makes highly specific assumptions about technical change in the various branches of mining. There is no general way of summarising the detail - except to say that he assumes that all increases in the production of minerals will be at productivity (metric tons of ore produced per employee over a given period of time) rates at least equal to those of the most efficient present producers.

2.2.2 In the case of coal the assumption is that 50 per cent of the increase in production will come from strip-mining operations in which labour - productivity is taken to be 7 500 tons/employee/year - and is apparently assumed to remain constant at that level. The other half of increases in production is assumed to be forthcoming at 1 500 tons/employee/year, well above the current (1973) average of 700 tons/employee/year.

2.2.3 All increases in iron-ore production are assumed to be at current rates for open-cast operations viz. 2 250 tons/employee/year.

2.2.4 Copper, (lead and zinc) are assumed to continue at the current proportion of 55 per cent from open-pit operations, and the remaining 45 per cent of any increase in production is assumed to be mined by trackless mining methods (with given productivity rates). Since the balance of technologies does not change and since productivity rates in both are assumed constant, Plewman is assuming that technical change will not reduce employment (for a given level of output).

2.2.5 In the case of chromium Plewman takes the current average productivity rate as 400 units/employee/year - whereas the most productive operations achieve 850 units/employee/year. In line with his general principle Plewman assumes that all increases in chrome output will be at 850 units/employee/year.

2.2.6 Similarly, in manganese ore mining the maximum 'current' efficiency is 3 000 units/employee/year - more than five times the average labour productivity of 560. Plewman assumes all increases in output will be at the current maximum level.

2.2.7 As with copper, Plewman assumes that labour productivity in the mining of asbestos will not be affected by technical change ('No change is anticipated') - though there is no defence of this assumption.

2.2.8 For diamond-mining, Plewman says that he has assumed an increase in open-pit tonnages to 1980 but a reversion to block-caving methods for the next 20 years. The labour productivity implications of these technical assumptions are not clear: in fact diamonds are treated in the statistical tables in the same way as copper and asbestos (see above) and gold and platinum (see below) i.e. employment projections are not affected by considerations connected with changes in technology.

2.2.9 Plewman assumes constant productivity in gold and platinum mining over the next two-and-a-half decades. In this deep-level, narrow-tabular mining he is in effect 'offsetting the steady general improvement in productivity in the industry against the decline in grade of deposit exploited'.<sup>34</sup> (Given the importance of gold-mining as an employer and the projected increase in platinum output over time, this turns out to be an important assumption.)

2.2.10 Some increase in labour productivity as a result of technological change is assumed in the mining of 'other' minerals - but there is not in Plewman's paper a formal exposition of what the assumption is. The effects of the increase show up in the tables of employment projections.

### 2.3. Employment projections

Having established estimates of future output levels and of future changes in labour productivity (resulting from changes in techniques), Plewman is able to work out the employment implications of these projections. These are usefully presented in two stages: first, 'labour requirements of the minerals industry assuming no change in technology or average grade' and, secondly, these 'labour requirements ... adjusted to take account of changes in technology'. (Tables 24, 25, p.63).

TABLE 24: LABOUR REQUIREMENTS OF THE MINERALS INDUSTRY

(Assuming no change in technology or average grade)

Mineral	1970	1980		2000	
		Tot <sub>1</sub>	Tot <sub>2</sub>	Tot <sub>1</sub>	Tot <sub>2</sub>
Copper	11 541	41 900	42 800	122 100	128 000
Iron	6 002	13 500	14 800	33 800	42 000
Chromium	4 895	9 400	9 700	26 600	28 800
Manganese	8 045	18 100	18 800	51 300	55 500
Coal	72 555	135 500	173 100	366 600	774 500
Asbestos	19 817	39 600	40 200	115 700	119 600
Sub-total	122 855	258 000	299 400	716 000	1 148 000
Others	22 534	29 200	30 700	40 500	41 800
Gold	413 272	413 000	413 000	100 000	100 000
Diamonds	21 005	30 500	30 500	31 000	31 000
Platinum	61 167	99 700	99 700	264 000	264 000
Total	640 833	830 400	873 300	1 151 500	1 584 800
Growth rate		2,6%	3,1%	1,9%	1,9%

TABLE 25: LABOUR REQUIREMENTS OF THE MINERALS INDUSTRY

(Adjusted to take account of changes in technology).  
(headings as for Table 24)

Copper	11 541	41 900	42 800	122 000	128 000
Iron	6 002	10 400	11 200	20 000	27 000
Chromium	4 895	6 200	6 400	11 500	12 000
Manganese	8 045	9 200	9 300	13 000	13 500
Coal	72 555	84 000	95 500	156 000	271 500
Asbestos	19 817	39 600	40 200	115 700	119 600
Others	22 534	191 300	205 400	438 200	571 600
Gold	413 272	26 500	27 300	30 500	33 000
Diamonds	21 005		413 000		100 000
Platinum	61 167		30 500		31 000
Platinum	61 167		99 700		264 000
Total	640 833	761 000	775 900	863 800	999 600
Growth rate		1,73%	1,93%	(0,89%)	1,49%

The projections in the second of these tables are of course what really concern us.

2.3.1 According to these projections the aggregate labour force employed in the mining sector will continue to expand until the end of the century - by about 20 per cent in the first decade (to 1980) and by between 35 and 56 per cent for the full 3 decades to the end of the century (1970-2000). The following table summarises some of the measurements implicit in these figures.

TABLE 26:

	Labour force	Increase since 1970 ( % )	Increase since 1980 ( % )	Annual rate of increase since 1970 (% p.a.)	Annual rate of increase since 1980 ( % p.a.)
1970	640 833				
1980 Tot <sub>1</sub>	761 000	18,8		1,73	
1980 Tot <sub>2</sub>	775 900	21,0		1,93	
2000 Tot <sub>1</sub>	863 800	34,8	13,5	1,00	0,64
2000 Tot <sub>2</sub>	999 600	56,0	28,8	1,49	1,27

In relation to historical experience in recent decades, these figures represent a return in the 1970-80 decade (though not a full return) to the relatively rapid growth of mining employment in the 1950s - after the much slower employment growth of the 1960s. They envisage an average annual growth of employment in 1970-80 of between 1,7 and 1,9 per cent per annum; the 1950s achieved 2,1 and the 1960s only experienced 0,6 per cent per annum. In the post-1980 decades the projections return to (on the lower estimate) a 1960s-type growth-rate of employment of 0,6 per cent per annum; the higher estimate implies 1,3 per cent per annum - somewhere between the 1950s rate and the 1960s, and quite close to the average annual rate for the combined 1950s and 1960s period (viz. 1,4 per cent per annum).

2.3.2 In the precious minerals group there are two developments of interest. i) Gold-mining, after maintaining its 1970 level through to 1980, drops away strongly in the two decades after 1980 and by the year 2000 its labour-force has declined to slightly less than one-quarter of its 1970 - 1980 level. (This projection rests on the low probability that there will be further substantial discoveries of payable gold-bearing ore.

The full argument lying behind the industry - forecast is not available to us at present, nor do we know what assumptions were made about the market for uranium in arriving at the forecast.) ii) Platinum, interestingly enough, takes up a good part of the employment 'slack' (as it were) created by the decline of gold mining after 1980. On these projections the number of miners employed in platinum mines will rise from 61 167 in 1970 to 99 700 in 1980 and 264 000 in 2000. On the lower assumption about the domestic growth-rate of base-minerals demand, platinum becomes the largest single employer by the year 2000, but it narrowly loses that position to coal in terms of the higher assumption about domestic growth-rates (264 000 in platinum to 271 500 in coal). Given its important contribution to employment generation it is necessary to stress that this projection about platinum rests on (at least) two crucial assumptions viz. a) that output of platinum will grow on average at 5 per cent per annum throughout the period, and b) that there is no increase in average output of platinum per worker (as output is increased by mining more deeply and lower grades of ore).

2.3.3 In sustaining and expanding total mining employment (while the present major employer declines) base-minerals are projected to play an increased role. The labour force employed in mining these minerals will expand absolutely and will also increase its share of the total. The following table demonstrates this - by adding employment in 'other' minerals to that in the 6 base -mineral branches that Plewman distinguishes and finding what share this sum contributes of total mining employment.

TABLE 27: EMPLOYMENT IN BASE-MINERAL MINING (PLEWMAN)

	1970	1980 Tot <sup>1</sup>	1980 Tot <sup>2</sup>	2000 Tot <sup>1</sup>	2000 Tot <sup>2</sup>
1) Employment in listed base-minerals	122 855	191 300	205 400	438 200	571 600
2) Employment in 'other' minerals	<u>22 534</u>	<u>26 500</u>	<u>27 300</u>	<u>30 500</u>	<u>33 000</u>
3) Total (= (1) + (2) )	145 389	217 800	232 700	468 700	604 600
4) Total mining employment	<u>640 833</u>	<u>761 000</u>	<u>775 900</u>	<u>863 800</u>	<u>999 600</u>
3/4 X 100 Base-minerals' share(%)	22,7%	28,6%	30,0%	54,3%	60,5%

On the lower estimates, the base-minerals' share rises from 22,7 per cent (1970) to 28,6 per cent (1980) and nearly doubles to 54,3 per cent by 2000. On the higher estimates their share is slightly higher at 30,0 per cent (1980) and 60,5 per cent in 2000. In the base-minerals sub-group the really massive increases are in copper and asbestos. Copper mining is forecast to increase its labour-force more than 10-fold in the 30 years after 1970, rising from 11 541 to 41 900 during the 1970s and to 122 000 by the year 2000. Asbestos mining is forecast to increase its employment almost 6-fold in the period 1970-2000, rising from an initial 19 817 to 39 600 (1980) and 115 700 (2000). Coal, while not increasing its labour-force at the same rate as either copper or asbestos in these projections, remains a larger employer than either of them in 2000 (in terms of the lower estimates), and indeed, as we have already noticed, becomes the largest single employer of all (in terms of the higher estimates).

2.3.4 It is clear from a comparison of the two sets of projections (with and without technical change) that there is a very substantial impact on base-minerals' labour requirements arising from technical change that increases average labour productivity. Omitting 'others' the following comparisons can be made.

TABLE 28: TECHNICAL CHANGE AND BASE-METALS' LABOUR REQUIREMENTS (PLEWMAN)

	Without technical change	With technical change	Reduction due to technical change
1980 Total <sub>1</sub>	258 000	191 300	- 66 700
Total <sub>2</sub>	299 400	205 400	- 94 000
2000 Total <sub>1</sub>	716 000	438 200	- 277 800
Total <sub>2</sub>	1 148 000	571 600	- 576 400

### 3. Assessment of the Plewman projections

We shall attempt an evaluation of Plewman's work in the light of the output and employment experience of the mining sector during the period 1970-76 (and in some cases to mid-1977). At various points we shall also refer to other projections in attempting to assess Plewman's. In particular we shall use projections of output made, or reported, by von Wielligh<sup>35</sup> and Etheredge<sup>36</sup>, and of employment by the compilers of the Economic Development Programme (1976-81).

#### 3.1 Output projections, 1970-1980

Data for at least another 3 years have become available since Plewman made his projections and, indeed, by mid-1977 we are well on our way to 1980. It seems useful to make a very preliminary testing of the projections against the facts-to-date(3.1.1); also to take note of other forecasts of output from the mid-1970s to the early 1980s (3.1.2 and 3.1.3).

##### 3.1.1 A comparison of output projections, 1970-80, with actual output data, 1970-76.

We present the material in the two following tables: one presents levels of output (projected and actual) and the second average rates of growth of output per annum. (Tables 29 and 30, pp.68 and 69)

TABLE 29: ACTUAL (1970-1976) AND PROJECTED (1970-80) MINERALS PRODUCTION<sup>1/</sup>

	Plewman projections, 1970-80			Actual production, 1970-76		
	1970 <sup>2/</sup>	1980: Projection 1	1980: Projection 2	1970 <sup>3/</sup>	1976	Max. 1971-76 if not 1976
Copper	121,7	442	451	134	197	
Iron Ore	7 910	17 800	19 500	8 125	15 663	
Chrome	1 244	2 390	2 472	1 259	2 409	
Manganese	2 760	6 220	6 440	2 708	5 503	5 881(1975)
Coal	51 450	96 070	122 760	53 006	77 059	
Asbestos	268	536	544	261	370	
Others	n.a.	n.a.	n.a.	n.a.	n.a.	
Gold <sup>4/</sup>	980	980	980	980	713	Monotonic de- cline 1970-76
Diamonds <sup>4/</sup>	7 803	11 314	11 314	7 803	7 023	7 565 <sup>5/</sup> (1973)
Platinum <sup>4/</sup> (index)	100	170	170	n.a.	n.a.	

Notes to table :

- 1/ Units are thousand (metric) tons - except for gold (tons), diamonds (thousand metric carats) and platinum (index).
- 2/ Plewman's 1970 figures are not projections but refer to the 1968 - 1970 averages of the physical volume of sales (exports and domestic consumption); for gold, diamonds and platinum, see note 4/.
- 3/ Our 1970 figures are 1968-70 averages of physical production.
- 4/ Plewman does not give output levels for gold, diamonds and platinum; but it is possible to deduce what he is assuming given his technical assumptions and his employment projections. The 1970 figures for gold and diamonds are 1968-70 averages of physical production (since a sales figure is not available for gold; and in the case of diamonds there is a significant difference between sales and production), and for platinum we have used an index.
- 5/ The decline between 1970 and 1976 of diamonds production is not monotonic. The figure for 1973 is higher than those for the other years 1971-76.

TABLE 30: ACTUAL (1970-76) AND PROJECTED (1970-80) MINERALS PRODUCTION:  
PER ANNUM RATES OF GROWTH (% per annum)<sup>1/</sup>

	Plewman projections, 1970-80		Actual production, 1970-76
	Projection 1	Projection 2	
Copper	12,4	12,7	5,7
Iron ore	7,7	8,6	9,8
Chrome	6,1	6,4	9,7
Manganese	7,7	8,0	10,7 <sup>2/</sup>
Coal	5,8	8,2	5,5
Asbestos	6,5	6,7	5,1
Others	n.a.	n.a.	n.a.
Gold	0	0	- 4,4 <sup>3/</sup>
Diamonds	3,4	3,4	- 1,5
Platinum	5,0	5,0	14,7 <sup>4/</sup>

Notes to Table :

- 1/ Since 1970 base-year figures are 1968-70 averages (see notes 2/ and 3/ to previous table) we have computed average growth rates per annum over 11 years (Plewman) and 7 years (actual production).
- 2/ The average growth rate of manganese production 1970-75 was higher at 14,0 per cent per annum.
- 3/ The rate of decline of gold production accelerated to 1974 and then slowed in 1975 and 1976.
- 4/ The growth rate for platinum is for the years 1970-75 and is reported by von Wielligh; it is not extracted from published sources.
- 5/ See footnote 39 for growth rates 1970-77.

These tables speak for themselves but it may be useful to comment briefly on the comparative rates of growth in the second table.

1. The relatively small employers (iron ore, chrome, manganese) have experienced a growth of production to 1976 at a faster rate than Plewman projected. Iron ore production has grown at an average per annum rate of 9,8 per cent (against a projected range of 7,7 per cent - 8,6 per cent), chrome at 9,7 per cent (projected range 6,1 per cent - 6,4 per cent) and manganese at 10,7 per cent (projected range 7,7 per cent - 8 per cent).

2. Of the next rank of employers - copper, asbestos and diamonds - all have experienced output-growth at a slower rate than the average projected for the decade. The divergence is most marked in the cases of copper and diamonds, and in the latter of these production actually appears to be declining on trend rather than increasing. The relevant rates of change are: copper output grew at 5,7 per cent per annum on average 1970-76 (against a projected range of 12,4 per cent - 12,7 per cent), asbestos at 5,1 per cent (projected range 6,5 per cent - 6,7 per cent), and the production of diamonds declined for the 6-year period at an average rate of 1,5 per cent per annum (projected growth rate: 3,4 per cent).<sup>37</sup>
  
3. Coal and platinum are in the next rank of employers. The rate of growth of coal production is accelerating and by 1976 the compound per annum rate of growth had reached 5,5 per cent almost at the bottom end of the projected range of 5,8 per cent - 8,2 per cent. Unfortunately we do not have published figures for platinum production but one industry report gives 14,7 per cent per annum for 1970-75<sup>38</sup> - considerably above Plewman's assumption of 5 per cent per annum. (As we shall note later the market for platinum appears to be highly volatile - and this has serious implications both for the 'real world' and for this study: in particular we need year-to-year data to avoid the biases that come from having to use end-point information without knowledge of its cyclical context).
  
4. The largest employer of all, dominating all the rest statistically, is gold. Whereas Plewman assumed a 1980-output level equal to that in 1970, in fact the physical output of gold has fallen during the period 1970-76 at the fast rate of 4,4 per cent per annum - though, of course, with the changes in the price of gold the value of gold produced has risen dramatically.

3.1.2 In so far as 1977 (first-half) data is available it suggests that 1977 rates of growth of output will pull up the average 1970-76 compound rates of growth for iron ore (dramatically), chrome, coal and asbestos. Copper may not be much affected, but since 1977 output of manganese and platinum will be below the 1976 levels their rates of growth will be slowed. In the case of gold, production may have fallen further but the rate of decline may be slowing.

It is not possible to put much weight on these guesses. They are obtained by assuming that the average rate of production during the first half of the year will be repeated during the second; and this may not be generally true if faltering growth abroad brings the 1976-7 surge in minerals exports to a halt in late 1977. Still, the record of January to June 1977 suggests that iron ore exports are growing very rapidly (presumably with the opening of Saldanha Bay) and that the 1970-77 growth rate may be up to about 15 per cent per annum; coal exports and production are also growing strongly (presumably affected by the Richard's Bay developments) and the growth-rate looks as though it may now be up to about 6,5 per cent per annum (and hence within the Plewman range); asbestos may be up to the region of 5,9 per cent per annum (and so still below the projected range); and in the first quarter of 1977 chrome production was 30 per cent above 1976-first quarter levels (though this has probably not been sustained for the rest of the year). Manganese, in contrast to these minerals, will experience a further drop in its average rate of growth down towards the projected range, (it was up to 14 per cent per annum in the peak-year of 1975).<sup>39</sup>

Some sense of the role of gold as a depressant and of its importance, also of cyclical movements in non-gold minerals production and of the recent surge in their production can be gained from the following indexes of physical production.

TABLE 31:

Indexes of Physical Volume of Mining Production (1970 = 100)<sup>40</sup>

Total including gold		Total excluding gold
	(Gold weight = 58,3)	
1970	100,0	100,0
1971	97,4	97,1
1972	92,5	94,8
1973	95,9	110,5
1974	94,5	120,4
1975	93,3	124,0
1976	96,1	130,9
1977	101,4 <sup>41</sup>	145,4 <sup>41</sup>

3.1.3 Von Wielligh output projections, 1975-1980/85

In his presidential address last year to the South African Institute of Mining and Metallurgy Mr. von Wielligh, also Senior Vice-President of the Chamber of Mines, included some production projections for a series of minerals from 1975 to 1980/85 (to be discussed here) and to 2000 (to be discussed later).<sup>42</sup> His projections are given in terms of rates of growth per annum. We shall list them here and compare them with those of Plewman (made 3 years earlier).

TABLE 32:

PLEWMAN (1970-1980) AND VON WIELLIGH (1975-19780/85) PROJECTED RATES OF GROWTH OF MINERALS PRODUCTION (PER CENT PER ANNUM)

	P l e w m a n		von Wielligh
	Projection 1	Projection 2	
Copper	12,4	12,7	7,9
Iron ore	7,7	8,6	8,5
Chrome	6,1	6,4	9,4
Manganese	7,7	8,0	5,1
Coal	5,8	8,2	3,2
Asbestos	6,5	6,7	n.a.
Others	n.a.	n.a.	n.a.
Gold	0	0	n.a.
Diamonds	3,4	3,4	n.a.
Platinum	5,0	5,0	2,8

Of the four cases in which von Wielligh expects a lower rate of growth for the second half of the 1970s and early 1980s than Plewman does for the seventies decade, three viz. copper, coal and platinum, are important for employment generation. In the case of copper he is more in line with the actual growth rate so far this decade - though still above it. His projected growth-rate for coal is surprisingly low, and below the average to mid-1977. Given his own reported historical growth rate of + 16,96 per cent per annum for the platinum-group metals over the whole period 1941-75 his projection of 2,8 per cent per annum for the immediate future is also very surprising. Unfortunately we do not have published data to use in trying to evaluate this point.

3.1.4. Etheredge projections, 1976-81-85

In a recent article in Optima,<sup>43</sup> Mr. D. Etheredge executive director of the Anglo American Corporation, included some forecasts of production of various minerals during the next 5 (and in some cases, 10) years. Although it is not always easy to reduce his discussion to numerical estimates, it seems worthwhile to reproduce the Etheredge material - at least for the partial check it will provide of the Plewman and Von Wielligh projections.

- 1) Copper: (Plewman 12,4-12,7 per cent per annum; Von Wielligh 7,9 per cent per annum). Etheredge does not provide a numerical forecast. He mentions the north-western Cape as the area where new developments will occur in the next 5 years. At Aggenys silver, copper and lead are to be mined. Production, planned to commence in 1980, aims at 22 000 tons of copper concentrates a year. At Gamsberg zinc and lead will be mined, if feasibility studies go through. "Apart from developing the potential in the north-western Cape, current producers have plans only to increase existing plant and mining capacity over the next five years". The original Plewman projection for 1980 of 442 to 451 thousand tons will clearly not be reached. The Von Wielligh figure of 262 thousand tons (5 years of growth at 7,9 per cent per annum from (1975)) seems rather more plausible.
- 2) Iron ore: (Plewman 7,7 - 8,6 per cent per annum; Von Wielligh 8,5 per cent per annum). Contracts are already signed to export 17 million tons a year from Sishen via Saldanha Bay. Given domestic consumption which was already close to 8 million tons a year in 1968/70, it is clear that iron ore will considerably exceed the higher Plewman "target" of close to 20 million tons a year in 1980.
- 3) Chrome: (Plewman 6,1 - 6,4 per cent per annum; Von Wielligh 9,4 per cent per annum). Production is expected to more than double from 2,4 million tons to 5,5 million during the next 5 years. Much of this will be used to produce ferro-chrome in South Africa - at Tobatse and CMI in the Lydenburg district. If these plans are realized - and the market for chrome and ferro-chrome depends on the state of the world steel industry - their output will be increasing at about 18 per cent per annum into the early 1980's with Plewman's upper level projected production for 1980 (2 472 thousand metric tons) probably being surpassed in 1977. (Note: production = 3 319 t.m.tons).
- 4) Manganese : (Plewman 7,7 - 8,0 per cent per annum; Von Wielligh

5,1 per cent per annum). A third major producer of manganese ore will come into operation in mid - 1979 when the Anglo American Corporation's Middelplaats mine (Northern Cape) is opened. Etheredge mentions a "likely" total production of 8,5 million tons by 1981 - which implies a per annum growth rate of 9,1 per cent. This involves some slowing down of the 1970-76 rate of growth (10,7 per cent per annum) but not by as much as Von Williegh seems to expect - and presumably involves the assumption that world demand will recover after the 1976 and 1977 decline.

- 5) Coal: (Plewman 5,8 - 8,2 per cent per annum; Von Williegh 3,2 per cent per annum). Etheredge does not project total coal production, though he does discuss what may happen to certain of the components of demand - less in the short-run (that we are interested in here) than in the 1980-2000 period.
- 6) Asbestos: Etheredge does not discuss.
- 7) Gold: (Plewman projected 1980 production at the 1970 level: 980 - 1 000kgs). Etheredge expects gold production to rise somewhat from its 1975 and 1976 level - "During the next ten years production should increase gradually, possibly exceeding 500 tons in some of those years .....". It seems fairly clear that the Plewman projection will not be realized. Etheredge also draws some attention to uranium of which he says - "Its importance has increased so considerably over the last few years that it is now regarded as a co-product rather than a by-product (of gold). For some mines uranium, rather than gold, could be the key to future prosperity".<sup>44</sup> Production of uranium oxides was 3 111 tons in 1976, might reach 7 700 tons early in the 1980's and peak at just over 8 000 tons by 1986. If this is the case employment in "gold-mining" will be higher than historical data would lead one to expect given the level of gold output.
- 8) Diamonds: (Plewman apparently projects an output of about 11,3 million carats by 1980 - a 45 per cent increase on 1970). The picture Etheredge suggests is a far more static one : "In the case of diamonds there is in the short term no great potential for expanding production of South Africa's mines and none of the well known producers has plans for increasing output at present".<sup>45</sup> The one new mine (Koingnaas on the west coast of Namaqualand) will add a  $\frac{1}{2}$  million carats in 1978 to the current 7 million carats.

9) Platinum: (Plewman 5,0 per cent per annum; Von Wielligh 2,8 per cent per annum). "..... during the period under review (in the next 5 years) production capacity will remain as it is".<sup>46</sup> Of course production is at present at levels below full-capacity. If the Von Wielligh growth-rate figure of 14,72 per cent per annum for 1970-75<sup>47</sup> is correct then a simple return to 1974 output levels by the end of the decade will produce a growth rate for the decade in excess of Plewman's projection (over 7 per cent per annum).

3.2 Assumptions about (or projections of) technical change in mining, 1970-1980

Plewman's assumptions about changes in the technologies employed in mining are set out in section 2.2 above. It is in particular the impact of such changes on labour productivity (output per worker per period) that we are concerned with.

Rates of growth of labour productivity in mining (per cent per annum):

TABLE 33: projected (1970-80) and actual (1970-76)

	Projected rate of growth of output per worker		Actual rate of growth of output per worker
	Projection 1	Projection 2	
Copper	0	0	3,4
Iron Ore	2,7	2,8	2,0
Chrome	4,3	4,3	-0,7
Managanese	7,0	7,3	8,4
Coal	4,9	6,1	3,7
Asbestos	0	0	2,9
Gold	0	0	-4,5
Diamonds	0	0	1,1
Platinum	0	0	n.a. (probably
Others	n.a.	n.a.	n.a. postive)

Projected rates of change of output per worker are obtained by calculating projected levels of output per worker for 1970 and 1980 and finding the compound annual rate of growth between them. Actual rates of change are calculated directly from the series of output per worker available for each mineral (however, they suffer from overdependence on the endpoints and from ignoring the intermediate years between 1970 and 1976).

Technical change, or a change in the mix of technologies employed, was expected to raise labour productivity in the cases of 4 minerals viz. iron ore, chrome, manganese and coal - and hence to slow the rise of employment behind that of output. Of these only coal is a substantial employer - and there labour productivity has grown somewhat more slowly than projected (3,7 per cent per annum against a range of 4,9 per cent to 6,1 per cent per annum), although the deceleration is concentrated in 1975 and 1976. For the rest iron-ore is doing much as predicted, manganese is experiencing productivity gains somewhat greater than predicted, and chrome markedly less than expected. (In the case of chrome, if Etheredge's output projections are correct and output more than doubles by 1981, and if the current productivity performance - roughly constant or falling - continues, than chrome could well be employing somewhat over 20 000 workers by that date).

In five other cases - all important employers - little or no productivity-raising change in techniques was expected. In the case of platinum we do not know what has happened. In the four others it appears that this assumption has to-date not fitted the facts: copper, asbestos and diamonds have registered productivity gains and gold has shown a quite sharp reduction in (gold) output per worker.

However both copper and diamonds seemed well-fitted by the constant-output-per-worker description for some years before registering sharp productivity increases recently (in 1976, for diamonds and in 1975-76, for copper). By contrast the growth of labour productivity in the mining of asbestos seems to have been significant for some considerable period (at least since 1955) - though there has been a deceleration during the 1970's (1970-73: 4,6 per cent per annum; 1970-74: 4,3 per cent per annum; 1970-75: 4,0 per cent per annum; 1970-76: 2,9 per cent per annum). In all three cases we are not at present able to explain the recent changes, and hence not able to say whether copper and diamonds are likely to return to a constant - labour - productivity path and asbestos to decelerate to the same state. In all three cases, while they continue to experience rising levels of productivity, there will be technical influences reinforcing rate-or-growth-of-output reasons for employment to grow more slowly than projected.

In the case of gold mining these influences offset each other. Output (as we have noticed) has been falling, but so has gold output per worker - presumably in line with the declining ore-grades being worked with

a higher gold price. In consequence while output has fallen by close on 30 per cent since 1970 employment has not declined by more than 5,6 per cent (and there are grounds for believing that even that decline is not primarily a decline in the demand for labour).

3.3 Employment projections, 1970-1980

As with Plewman's output projections we shall try to confront his short-run employment projections with the facts about what has happened in the field of mining employment during the last 6 or 7 years. We shall also notice briefly the aggregate mining employment "projection" made for the 1976-81 Economic Development Programme.

3.3.1 A comparison of employment projections, 1970-80, with actual employment data, 1970-76.

We present the material in the two following tables (34, 35): the first presents levels of employment (projected and actual) and the second average rates of growth per annum.

TABLE 34: ACTUAL (1970-76) AND PROJECTED (1970-80) MINING EMPLOYMENT

	Plewman projections, 1970-80			Actual employment, 1970-76		
	1970 <u>1/</u>	1980:Projection <u>1/</u>	1980:Projection <u>2/</u>	1970 <u>2/</u>	1976	Max. 1971-76 if not 1976
Copper	11 541	41 900	42 800	12 205	13 229	15 744 (1973)
Iron Ore	6 002	10 400	11 200	6 153	9 334	9 515 (1975)
Chrome	4 895	6 200	6 400	5 078	8 960	
Manganese	8 045	9 200	9 300	8 244	9 176	9 211 (1973)
Coal	72 555	84 000	95 500	75 742	83 814	
Asbestos	19 817	39 600	40 200	19 817	21 504	
SUB-TOTAL	122 855	191 300	205 400	127 239	146 017	
Others	22 534 <sup>3/</sup>	26 500	27 300	21 538 <sup>4/</sup>	17 319 <sup>4/</sup>	21 395 <sup>4/</sup> (1973)
Gold	413 272	413 000	413 000	425 871	401 907	430 463 (1973)
Diamonds	21 005	30 500	30 500	21 488	17 415	20 934 (1974)
Platinum	61 167 <sup>3/</sup>	99 700	99 700	62 454 <sup>5/</sup>	71 999 <sup>5/</sup>	86 892 <sup>5/</sup> (1974)
TOTAL	640 833	761 000	775 900	661 442 <sup>6/</sup>	657 592 <sup>6/</sup>	677 668 <sup>6/</sup> (1973)

Notes:

- 1/ The Plewman 1970 figures are of actual employment. They measure the average number of persons at work, and exclude workers in 'works and power supplies'.
- 2/ Our 1970 employment figures measure the average number of persons in service, and also exclude workers in 'works and power supplies'.
- 3/ In Mining Statistics,<sup>48</sup> in place of Plewman's 'Others = 22 534' and 'Platinum = 61 167', we are given 'Tin mines = 2 720', 'Others = 59 443' and 'Quarries and Salt = 21 538'. These three add to 83 701, which is also the total for Plewman's two categories. He appears to have put about 1 000 workers with 'Other' and identified it as Platinum; and the remainder of Tin has gone in with 'Quarries and Salt' to a new 'Others' category.
- 4/ In looking at employment experience in the Plewman 'Others' category we have concentrated only on the Mining Statistics 'Quarries and Salt' category.
- 5/ In looking at employment experience in 'Platinum' we have taken it as identical with the Mining Statistics 'Other' category.
- 6/ The totals are greater by 2 700 than the sum of the listed components because tin mines employment is omitted - and not reallocated to other mining industries.

**TABLE 35: ACTUAL (1970-76) AND PROJECTED (1970-80) MINING EMPLOYMENT: per annum RATES OF GROWTH (PER CENT PER ANNUM)<sup>1</sup>**

	Plewman projections, 1970-80		Actual employment, 1970-76	
	Projection 1	Projection 2	1970-76	Max. growth rate 1970-, if not 1970-76
Copper	13,8	14,0	1,4	8,9 (1970-73)
Iron	5,7	6,4	7,2	9,1 (1970-75)
Chrome	2,4	2,7	9,9	
Manganese	1,4	1,5	1,8	3,7 (1970-75)
Coal	1,5	2,8	1,7	
Asbestos	7,1	7,3	1,4	
SUB TOTAL	4,5	5,3	2,3	
Others	1,6	1,9	-3,6	
Gold	0	0	-1,0	0,4 (1970-73)
Diamonds	3,8	3,8	-3,4	-0,7 (1970-74)
Platinum	5,0	5,0	2,4	8,6 (1970-74)
TOTAL	1,7	1,9	-0,1	0,8 (1970-73)

Notes to table:

- 1) This table is based on the previous table, and so all notes to that table carry over mutatis mutandis.
- 2) In footnote 51 growth rates of employment are recalculated for the period 1970-77.

The evidence to date is that in aggregate the employment projections are considerable over-estimates. Total mining sector employment has actually fallen between 1970 and 1976 (by roughly 4 000 workers, or at an average compound rate of 0,1 per cent per annum) instead of growing at a projected rate of between 1,7 per cent and 1,9 per cent per annum. While there is a danger in over-concentrating on the two years 1970 and 1976, we shall present a calculation of the overprojections for 1976. We have interpolated the 1980 projections for 1976 and compared them with actual employment in 1976.

TABLE 36: Mining employment over-projections (Plewman): 1970-76.

	Actual employment, 1976  (1)	Interpolated employment projections 1976		Employment overprojections 1976	
		Projection 1 (2)	Projection 2 (3)	Projection 1 (4)=(2)-(1)	Projection 2 (5)=(3)-(1)
Copper	13 229	26 453	26 790	13 224	13 561
Iron ore	9 334	8 557	8 948	- 777	- 386
Chrome	8 960	5 851	5 965	- 3 109	- 2 995
Manganese	9 176	8 935	8 993	- 241	- 183
Coal	83 814	82 722	89 339	- 1 092	5 525
Asbestos	21 504	30 025	30 295	8 521	8 791
SUB-TOTAL	146 017	162 543 <sup>1</sup>	170 330 <sup>1</sup>	16 526	24 313
Others	17 319	23 732	24 170	6 413	6 851
Gold	401 907	425 871	425 871	23 964	23 964
Diamonds	17 415	26 877	26 877	9 462	9 462
Platinum	71 999	83 742	83 742	11 743	11 743
TOTAL	654 657 <sup>2/</sup>	722 765 <sup>3/</sup>	730 990 <sup>3/</sup>	68 108	76 333

Notes to table: In general this table is based on the two previous tables and so, unless otherwise stated, the notes carry over mutatis mutandis. In particular 'platinum' and 'others' are handled as before. Note that in columns (4) and (5) overprojections are represented by positive numbers and underprojections are prefixed by a minus (-) sign. Interpolations are exponential. 1970 base figures are our in service employment figures, not Plewman's at work data.

- 1/ Subtotals for the base minerals in columns (2) and (3) are obtained by summing the individual projections for the six base minerals - and not by making an independent projection for the sub-total.
- 2/ The actual employment total for 1976 (for purposes of this table) is the sum of employment in the listed branches of mining, and since tin mining is not listed the total given here (654 657) is less than the total given previously (657 592).
- 3/ Note (1) applies to the totals in columns (2) and (3) mutatis mutandis.

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In aggregate the overprojections lie in the range between (roughly) 68 000 and 76 000. We shall return to the breakdown of these aggregate overprojections a little later in the discussion; at present we must try to assess the aggregate experience. While total mining employment in 1976 was below the corresponding level for 1970 we think it would almost certainly be a mistake to say that there is a declining trend in total employment. For one thing 1970 was the peak year of an 'upswing' in mining employment that began in 1968, and it was followed by two years of lower employment (1971 and 1972) before the next short, sharp 'upswing' in 1973. ('Upswing' is put in inverted commas because we suspect that there may be more than ordinary cyclical factors involved). If an average of 1968-70 is taken as the base then the 7-year compound per annum growth rate to 1976 is positive though low (0,4 per cent per annum). The peak-to-peak growth-rate (1970-73) is positive and higher at 0,8 per cent per annum. Of course both of these are lower than the projected average growth rates of 1,7 per cent to 1,9 per cent per annum for the decade.

There is one further complicating factor which is almost certainly accounting for some of the very slow growth (or actual decline) in mining employment in the period viz. the fact that at times the gold-mines (and other mines e.g. coal?) have been operating at below desired levels of capacity because of socio-political influences (of several sorts) on their supplies of black labour. We cannot at this stage make an adequate statement about the statistical dimensions of this crucial effect but we hope that further

investigation will enable us to do so.<sup>49</sup> (See also Section 3.3.2 below and the section on gold-mining in Chapter One.)

It remains to make some comment on the performances of individual minerals. We have given a breakdown of the aggregate employment overprojection to 1976 by mineral<sup>\*</sup>, which together with the earlier tables will summarise the facts we wish to discuss. \* (Table 36, p.80).

Iron ore, chrome and manganese are above their projected rates of growth (chrome dramatically so - since output has grown faster than projected and output per worker has not risen as projected), but these three are of course not large employers. Coal, which is large, is within its projected range - though closer to the lower than the upper end. It will be important to see whether the accelerating output growth rate in 1977 is also transmitted to the rate of growth of employment: evidence for the first 5 months suggests that it is (January - May 1977 employment is 11,7 per cent up on that for the same 5 months of 1976).<sup>50</sup>

The other three base-minerals (all larger employers than iron, chrome and manganese but smaller than coal) viz. copper, asbestos, and 'others' (i.e. quarries and salt) are all very much below their projected rates of growth of employment; and in 1976 they were employing respectively 13 200 - 13 600, 8 500 - 8 800 and 6 400 - 6 900 less workers than had been projected by Plewman (using rounded figures). As we have seen in earlier discussions production of copper and asbestos has grown less fast than projected (markedly so in the case of copper), and in addition they have both experienced some unprojected increase in labour productivity which has reinforced the tendency for their labour complements to lag behind projections. Information about 'quarries and salt' output and productivity is not readily available.

For the rest, all the precious metals performed disappointingly as employers in the period under review and they dominate the overprojections. The labour force in gold-mining declined an average of about 1 per cent per annum instead of remaining constant (though the problem of supply constraints needs to be sorted out here). Because of the relative size of gold-mining as an employer this small divergence between actual and projected paths creates an overprojection of about

24 000 workers - larger than that for any other single mineral. In diamond-mining the labour force declined at 3,4 per cent per annum whereas Plewman projected growth at 3,8 per cent per annum. Employment in platinum-mining (assuming the Mining Statistics category of 'other mines' is dominated by platinum as far as employment is concerned) grew at only 2,4 per cent per annum whereas Plewman projected 5 per cent per annum. Behind these employment statistics lie output and productivity factors - which it may be worth repeating here briefly. For gold, output has fallen strongly below projection but this has been largely offset as output of gold per worker has also fallen. For diamonds, output has been well below projection and the effect on employment has been somewhat reinforced by a small unpredicted rise in labour productivity. In the case of platinum we are largely in the dark: but there is some evidence for thinking that productivity may have increased very rapidly (whereas Plewman predicted that as in the case of gold it would stay constant over time).

Before leaving the precious metals it might be worth putting on record that there is strong evidence of short-term instability in employment in these branches of mining (at least during the 1970s). Part of this instability is presumably cyclical and results from South Africa's dependence on foreign markets subject to an international trade cycle. Gold, of course, is now itself subject to short-term instability but we do not know whether this transmits itself to production and employment (as distinct from prices and revenue). For evidence of fluctuations note that for the period 1970-73 there was an increase in the labour-force in gold-mining of roughly 4 600 workers (or growth at 0,36 per cent per annum); in the period 1970-74 the decline in the number of workers mining diamonds was at a much slower rate of 0,65 per cent per annum; and that for the same period employment in platinum-mining (or, more exactly, in 'other mines') grew at 8,61 per cent per annum which is well above Plewman's projection. The degree of instability in 'other mines' employment is so marked as to be worth recording. The series is as follows: 1968- 42 162, 1969 -60 355, 1970- 62 454, 1971- 56 633, 1972- 43 799, 1973- 72 810, 1974- 86 892, 1975- 68 202, 1976- 71 999, 1977- 75 632.

3.3.2 Employment figures for mining are now available for the first five months of 1977. Since the source is the Bulletin of Statistics (rather than Mining Statistics) there is some small lack of fit with the series we have been using, but this does not create serious problems.

TABLE 37: COMPARISON OF AVERAGE EMPLOYMENT, JANUARY-MAY 1976 AND 1977<sup>51</sup>

	Average employment Jan - May 1976	Average employment Jan - May 1977	Percentage change in average employment 1976/1977
Iron Ore	9 472	9 508	0,4
Chrome	8 396	11 011	31,1
Manganese	9 314	9 596	3,0
Coal	80 924	90 371	11,7
Asbestos	19 370	22 237	14,8
Tin	2 836	3 047	7,4
Gold	399 359	417 275	4,5
Diamonds	17 785	17 431	- 2,0
Other minerals <sup>1/</sup>	83 273	93 089	11,8
Quarries <sup>2/</sup>	17 007	16 013	- 5,8
T O T A L	647 735	689 578	6,5

Notes:

1/ Copper appears to have been included with the usual category of 'others' (which we have taken to be largely platinum, in line with Plewman) to constitute 'other minerals'.

2/ 'Quarries' here seems very close to 'Quarries and Salt' which we have previously labelled 'Other' (in line with Plewman).

There is a good deal of interest in these figures.

1) Indications are that employment in gold-mining may well be closer to the 1970 level of 425 000-odd than it has been since 1973. Employment for the first five months was 369 810, 425 952, 429 168, 424 251 and 437 192 - averaging 417 275. We have been told by people in gold-mining that (as a result, they think, of unemployment in other sectors)

there were no difficulties in recruiting black labour in 1977 and that moreover the employment total (which usually takes some months to build up during the year) quickly approached target level. It is on these grounds that we think the annual average figure for 1977 may be in the region of 425 000; and also that employment figures for 1974-76 are below the desired levels of average employment for these years.

2) If this view about gold-mining employment is correct and if employment in other mining industries at least holds up for the remainder of 1977, the average total employment for the year would probably lie between 690 000 and 700 000. In that case total employment would have increased since 1970 (instead of declining) by between 30 and 40 thousand jobs - and the evidence would have been considerably strengthened for believing that the trend in aggregate mining employment is upward, though less marked (to date) than in the Plewman projections.

3) The short-run instability of the markets for the products of mining needs to be stressed however. Employment does not vary immediately with sales but the connection works through in due course. In the second half of 1977 ferro-chrome producers were finding resistance from Japanese contracted buyers, and Rustenburg Platinum announced they would not rehire 5 000 contract workers (late 1977). It remains to be seen what precisely has happened to total mining employment over the full year.<sup>52</sup>

### 3.3.3 Economic Development Programme employment 'projections', 1976-1981

In the published summary of the latest EDP<sup>53</sup> (the full version is not to be published) a figure is suggested for 1981 employment in the mining sector. Details of the employment break-down by mineral are not given but the total figure is of interest.

Put briefly, the EDP compilers "expect" rapid increases in mining employment linked to increases in mining output - partly in consequence of an "assumed" average GDP growth rate of 5 per cent per annum but mainly (so it appears) because of expansion in export markets.

Their figures are as follows:

TABLE 38: EMPLOYMENT IN MINING: EDP "PROJECTIONS"  
(thousands)

	1975	1981	Annual growth rate
Whites	61	71	2,6
Coloureds	8	10	4,2
Asians	1	1	4,9
Blacks	552	701	4,0
TOTAL	622	783	3,9

Note: The impression of rapid growth is compounded of course by having 1975 as base year - 1975 experienced the lowest level of employment in the mining sector since 1967.

The comparison with Plewman's 1981 figures is as follows: his figures for 1980 are 761 000 (3 per cent rate of growth of domestic demand) and 775 000 (5 per cent rate of growth of domestic demand) which became 774 165 and 790 875, respectively, when projected for another year at the 1970's projected employment growth rates. The EDP figure (based on 5 per cent domestic GDP growth) of 783 000 falls into the middle of the range between Plewman's figures (however this is a little fictitious because the EDP is using in service and Plewman uses at work figures. The relevant projected range using in service figures would be 799 000 and 816 000 above the EDP figure).

Of course the EDP scenario for 1976-81 involves rates of growth far higher than those assumed by Plewman - who is interested in decade averages and assumes smoother progress. It is important to understand the grounds for the EDP's 'optimism' for the late 1970's. They report that the share of mining in real GDP dropped from an average of 11,3 per cent in 1961-65 to an average of 8,8 per cent in the 5 years 1971-75. They maintain that these are "strong indications, however, that it will rise over the programming period, at a rate of 5,8 per cent per annum. This growth should be concentrated mainly on entry into the export markets, particularly for iron ore and coal. The expected strengthening of the share of mining in the South African economy is mainly related to the development of the export projects at Saldanha Bay and Richard's Bay". (p.21, Economic Development Programme 1976-81, summary). In addition mention is made of energy problems which have created a renewed interest in South African coal

and in her uranium.

In the absence of a detailed analysis it is difficult to react to these figures. In the last year or two output figures for coal and iron ore have certainly risen strongly. In 1977 production of coal had risen from an index of 137,2 for 1976 to 176,0 by June, and iron ore, even more dramatically, had risen from an index of 170,6 for 1976 to 359,1 by June. However as we have seen the increase in employment has been negligible for this period in iron ore mining - though substantial in coal-mining. Given also that there is no obvious reason why employment in copper, asbestos, quarries and diamonds should pick up in line with the original Plewman projections (though cyclical influences may be more potent than we are allowing for), the EDP 1981 total (783 000) looks somewhat ambitious to us; 720 - 750 000 would appear to be a safer guesstimate.

### 3.4 Projections 1980--2000 A.D.

In this section we shall try to discuss some longer-run projections of output, productivity and employment in mining for the 1980s and 1990s. As before, the Plewman work will act as starting-point.

#### 3.4.1 Output projections, 1980--2000

It is of course not possible to assess projections for 1980 - 2000 by comparing them (in some sense) with what has happened in the 1970s. There may be some value in comparing a number of projections - if they are provided. Unfortunately in our case there is not much to go on. There is only one other set of projections available covering a similar (though not identical) period. And neither its author (von Weilligh) nor Plewman spells out the empirical grounds for some quite basic assumptions. We shall have to do the best we can.

We present for a start output projections (in terms of rates of growth per annum) by Plewman, (I) and (II), for 1980 - 2000, and by von Weilligh, for 1980/85 - 2000.

TABLE 39: OUTPUT PROJECTIONS TO 2000 A.D.: RATES OF GROWTH PER ANNUM

	Plewman I (1980-2000)	Plewman II (1980-2000)	von Wielligh (1980/5-2000)	Actual output (1941-75)
Copper	5,5	5,6	6,0	8,3
Iron Ore	4,7	5,4	7,4-8,3	9,4
Chrome	5,3	5,6	5,0	9,4
Manganese	5,3	5,6	5,1	11,9
Coal	5,1	7,8	4,0	4,0
Asbestos	5,5	5,6	n.a.	9,2
Other	n.a.	n.a.	n.a.	n.a.
Gold	- 6,9	- 6,9	n.a.	1,7
Diamonds	0	0	n.a.	16,9
Platinum	5,0	5,0	2,8	17,0

Note: Source of column 4 is von Wielligh.<sup>54</sup> Much of the growth in diamonds production was concentrated in the period 1941-45: for those 5 years von Wielligh records average compound growth of 74,25 per cent per annum.

Copper, Chrome, Manganese

There is agreement between the projections that in the long-term output growth will be in the 5-6 per cent per annum range - in all three cases substantially slower than they are reported by von Wielligh to have grown in the 1940-75 period. All three are dependent - and will continue to be dependent - on world markets and in particular (for chrome, manganese) on the world steel industry. Long-term growth at 5-6 per cent per annum by selling to that market is not implausible but would seem to require some increase in share of world markets -if one is to take the view that global rates of growth of world mineral production are not likely to improve on the 1961-75 performance.

TABLE 40: RATES OF GROWTH OF WORLD PRODUCTION, 1961-75 (VON WIELLIGH)

(per cent per annum)	
Chrome	+ 3,73
Copper	+ 3,42
Manganese	+ 4,00
(Iron	+ 4,27)

Increasing its share should not in principle be difficult for copper which (according to von Wielligh) in 1975 only represented 2,6 per cent of world production. In the cases of chrome and manganese 1975 shares were much higher at 28,24 per cent per annum and 18,10 per cent respectively (von Wielligh) -- and current short-run prospects for the world steel industry are poor. However, unless the technical basis of our material culture is to change entirely the long-run growth of steel must be assured and with it the demand for chrome and manganese. Of course there is the possibility that demand will grow but that local resources will not any longer be available to meet demand - at least not at prevailing prices. An extremely crude answer to this is to compute the expected lives of mining industries given known reserves and current production levels. Using 1975 information von Wielligh estimated the lives of these 3 industries as:

Chrome	1 124 years
Copper	75 years
Manganese	512 years

The only value of these figures is to suggest strongly that in the 1980-2000 period we are considering there are unlikely to be natural resource supply constraints on the growth of these branches of mining. In summary: we have not turned up good reasons for rejecting the 5-6 per cent growth projections.

#### Asbestos

Since von Wielligh does not make projections for asbestos we have to rely on Plewman alone. He puts its growth in the 5-6 per cent per annum range, with the three that we have just considered - and for the same reason viz. that they are all heavily dependent on export markets (in 1970 241 thousand metric tons of asbestos were exported, 27 consumed domestically)<sup>55</sup> and that the underlying Plewman/Reynders assumption about minerals exports is that they will treble in the 1980-2000 period i.e. grow at about 5,7 per cent per annum. It is only iron ore and coal - which have substantial domestic demands - which have projected growth rates out of the 5-6 per cent per annum range. We shall allow the 5,5-5,6 per cent projections to stand.

#### Iron ore

Here there is some divergence between Plewman and von Wielligh. The latter proposes a 7,4-8,3 per cent per annum growth range - the whole of which lies well outside the Plewman range of 4,7-5,4 per cent per annum.

This higher estimate probably reflects the experience of the last two years in which iron ore output has reached levels two and three times what they were in 1970 - and this has been connected with the development of a special transport infrastructure to make access to export markets on this scale possible. Presumably expansion will not continue at recent enormous rates but it seems sensible to revise the Plewman range up somewhat.

### Coal

In this important case von Wielligh's projection is lower than Plewman's. von Wielligh projects at the historic (1941-75) rate of growth of coal output at 4 per cent per annum - whereas Plewman, allowing domestic demand to grow at either 5 per cent or 8 per cent per annum, and exports at 5,7 per cent per annum, produces an overall 5,1-7,8 per cent per annum range (5-8 per cent, effectively).

It would be possible to launch into a very detailed discussion about these coal output projections. There is not space for it - and we have not researched the whole problem. On the basis of what is available we incline to the Plewman view - but towards the lower end of his range. This growth range implies a 2000 A.D. output figure of between 260 and 550 million tons a year. It is not difficult to show that a figure of at least 300 million tons is quite plausible: Escom estimates for electricity generation are 110-120 million; the pyrolysis of coal and the use of 'char' in power stations could push this up another 70 million tons (see D. Horsfall, "A prognosis for coal in an integrated fuel technology", Optima, vol.26, no.2); Sasol needs have been put at 20 million already by 1985; exports may run at up to 40 million tons during the next decades if the infrastructure is available (Etheredge);<sup>56</sup> and we have not yet mentioned industrial, transport and domestic uses - which were 20 per cent of the total in 1974. In summary: growth at 6 per cent per annum is compatible with these rough figures for output in 2000.

### Platinum

Again von Wielligh is well below Plewman viz. 2,8 per cent against 5 per cent per annum - which is surprising because of the very high rate of growth for 1941-75 that he reports (17,0 per cent per annum). However, this historic rate is presumably heavily influenced by the fact that production in this period was growing from very low levels.

It may be that the Plewman figure reflected the optimism about platinum (and the associated group of metals) of a few years ago - when anti-pollution legislation in the U.S.A. (and hopefully elsewhere) promised to create a great demand for platinum for use as a catalyst in anti-pollution devices to be fitted in motor cars. There have been delays in implementation and perhaps the future is now less certain. von Wielligh in discussion was prepared to raise his 2,8 per cent somewhat but thought 5 per cent too high. It would seem sensible, given the potential importance of platinum as employer, to revise the Plewman 5 per cent per annum figure down conservatively into the 3-4 per cent range. (On the ore reserves side there are no constraints expected within the period we are discussing.)

### Diamonds

Plewman does not make explicit projections for gold and diamonds production - but they are implicit in his employment projections. (However, the gold case is treated more clearly than that of diamonds and there are some uncertainties about what follows.) The projection seems to be that production (in carats) will maintain its 1980 level to 2000 - and that as we saw earlier, the 1980-level will be about 45 per cent up on that of 1970.

As we read the production figures however, 1970 looks like a production peak which is unlikely to be regained (let alone surpassed by 45 per cent). (Even this is somewhat uncertain because of apparently conflicting figures in Statistical News Release P.10.1 on Mining Production - the problem may have to do with the inclusion (or otherwise) of South-West African production. But these figures - more 'optimistic' than those in Mining Statistics - still only put the production index (1970 = 100) at 103,8 for 1975 and 102,4 for 1976.<sup>57</sup>)

In the longer run (1980-2000) it is still more difficult at this stage to defend the 11 million carats per year (1970+45 per cent) production projection. It is true that plans have just been announced (1977) to increase the capacity of the Finsch mine by 1 million carats annually (from 2 to 3 million) but the emphasis on expansion in Southern Africa is outside of the Republic - in Botswana in particular (5 million carats a year by 1978/79), Lesotho and S.W.A./Namibia. von Wielligh put the future life of the diamond industry in South Africa at 13 years (from 1975). While this is almost certainly too drastic it belongs to the same family as Etheredge's view:

'The exploration programme is substantial but current indications for new orebodies in South Africa itself are poor. The two largest orebodies in the De Beers South African group, Finsch in the northern Cape and Premier in the Transvaal, have low carat values and the Kimberley mines, like the older gold mines, are coming toward the end of their productive lives. However, they will still be in existence well into the next decade.'<sup>58</sup>

In summary: it seems necessary to project a decline in diamonds production by 2000. At this stage we do not know on what scale to expect the decline to take place.

### Gold

Plewman's projection for gold production in 1980 was that the 1970 level would be maintained (1 000 metric tons, or 980 tons if one takes a 1968-70 average). Thereafter (on the basis of a 1972 study of the industry's future) he projected a steady decline over time to the end of the century. Projected output at that stage was  $\frac{100}{413}$  of its 1980 level - about 240 tons.

The more recent view is that gold output (which has fallen well below the 1970 level) may rise somewhat from 713 tons (the current level) to around 800 tons by 1985, and will decline thereafter to about half its current level by the end of the century (Etheredge).<sup>59</sup> This gives a 2000 projection of about 355 tons - about 115 tons higher than the initial Plewman projection (with considerable employment implications). The current fairly optimistic views about the future of the demand for uranium (as by-product of, or co-product with, gold) reinforce this estimate.

In summary: we shall revise up the Plewman gold production projection for 2000 by about 50 per cent.

#### 3.4.2 Labour productivity projections, 1980-2000

All long-run projections must be highly tentative, but one has the feeling this is especially true for forecasts of technical progress.

Plewman made assumptions (in Section 2.2 of this chapter) about the change of techniques and labour productivity over time. In general he assumed something about what we might call marginal labour productivity in the various branches of mining viz. that all increases in the production of minerals will be at productivity rates at least

equal to those of the most efficient present producers. We need to examine the implications of this assumption (and its detailed applications) for average labour productivity and the rate at which it will increase over time during 1980-2000.

TABLE 41: PROJECTED OUTPUT PER WORKER, 1980 and 2000, AND PROJECTED RATE OF CHANGE OF OUTPUT PER WORKER (PER CENT PER ANNUM)

	Plewman Projection I			Plewman Projection II		
	Output/worker 1980	Output/worker 2000	Rate of change % p.a.	Output/worker 1980	Output/worker 2000	Rate of change % p.a.
Copper	10,6	10,6	0	10,5	10,5	0
Iron	1 711,5	2 225,0	1,3	1 741,1	2 051,9 *	0,8*
Chrome	385,5	588,3	2,1	386,3	609,2	2,3
Manganese	676,1	1 353,8	3,5	692,5	1 409,6	3,6
Coal	1 143,7	1 666,2	1,9	1 285,4	2 022,9	2,3
Asbestos	13,5	13,5	0	13,5	13,5	0
Gold			0			0
Diamonds			0			0
Platinum			0			0

\* There appears to be some computational error in Plewman's underlying projections of employment.

It may be worth noting that these projected rates of productivity growth (where they are positive) are slower than those projected for the 1970-80 decade.

TABLE 42: PROJECTED RATES OF CHANGE OF OUTPUT PER WORKER, 1970-80 AND 1980-2000 (PER CENT PER ANNUM)

	Plewman Projection I		Plewman Projection II	
	1970 - 80	1980 - 2000	1970 - 80	1980 - 2000
Iron Ore	2,0	1,3	2,2	0,8*
Chrome	3,7	2,1	3,7	2,3
Manganese	6,3	3,5	6,5	3,6
Coal	4,3	1,9	5,4	2,3

\* See note to Table 41.

The basic reason for this slowing-down of the rate of productivity growth is that Plewman seems to assume a static 'best-practice' (or 'best-deposit') technology but also assumes the spread of that 'best-practice' among less efficient producers, or alternatively the increasing dominance of the 'best-practice' or 'best-deposit' producers in total production. Both of these processes are asymptotic - and the rate of change of the (average) output per worker slows down as the average approaches the level attained (already in the 1970s) by the 'best-practice' producers. Clearly Plewman's assumption is very stylised - both the static 'best-practice' techniques and the stipulation that all increases in production are forthcoming at the labour productivity level belonging to the 'best-practice' producers. But that does not mean that the stylised assumption will not predict well.

Detailed discussion of probable productivity changes in individual cases is beyond us. There are simply a few points that can be jotted down rather randomly. The constant-productivity assumption for copper is worrying because of recent increases; however, we know that the Phalaborwa Mine will have to switch from open-cast to underground by the mid-1980s and so recent gains may be lost.<sup>60</sup> The same assumption is even more worrying in the case of asbestos which seems to have experienced productivity growth for some time. The evidence from the 1970s (and back well into the 1960s) is that there has been no regular productivity advance in chrome mining. There do not seem strong reasons for objecting to the Plewman projections for iron ore, manganese and coal.

We shall accept the constant output per head assumption for gold mining. In the case of platinum the evidence is less clear and we would prefer to leave the door open for some (perhaps slow) growth of platinum output per head. And the same holds for diamonds.

### 3.4.3 Employment projections, 1980-2000

It may be more helpful to approach these employment projections by presenting numbers of workers who are to be employed in 2000 - rather than rates of growth of employment over time.

TABLE 43: EMPLOYMENT PROJECTIONS, 2000 (PLEWMAN)

	Projection 1	Projection 2
Copper	122 000	128 000
Iron ore	20 000	27 000
Chrome	11 500	12 000
Manganese	13 000	13 500
Coal	156 000	271 500
Asbestos	115 700	119 600
SUB-TOTAL	438 200	571 600
Others	30 500	33 000
Gold	100 000	100 000
Diamonds	31 000	31 000
Platinum	264 000	264 000
TOTAL	863 900	999 600

These two projections are in fact very similar - apart from the projections of coal employment (of the 135 900 difference between them coal is responsible for 115 500). The reason for the two divergent coal employment projections is the alternative assumptions allowed for about the rate of growth of domestic demand for coal - either 5 per cent or 8 per cent. The slight difference in projected rates of productivity growth is not relevant - since it actually offsets to some extent the employment effects of the alternative growth rates of demand and output. We have suggested earlier that it is relatively easy to make out a case for the lower end of Plewman's coal output projection range - but we have not made out a case against the upper end of the range. We shall retain it as a possibility therefore.

We shall concentrate on Projection 1 (for the reason just given). In terms of Plewman's statistics it represents an increase of around 220 000 jobs on 640 000 in 30 years (since 1970) - or employment growth at about 1 per cent per annum for the 30 years. From 1977 it represents the creation of approximately 193 000 jobs. (I am assuming that 1977 will see an average 700 000 workers in service, which converts to something like 671 200 at work - and the Plewman projections are of people at work).

One way into some discussion of the Projection is to note that there are 5 minerals which are making heavy impacts on the overall employment projection viz. copper, coal, asbestos and platinum (positive) and gold (negative). Their contributions to increases (+) or decreases (-) in employment since 1970 are projected to be as follows: + 110 458 (copper), + 83 445 (coal), + 95 883 (asbestos), + 202 833 (platinum), - 313 272 (gold). Out of total gross increases of 536 138, these four viz. copper, coal, asbestos and platinum, contribute 492 619.

Of these copper and asbestos are somewhat worrisome. We have already seen how seriously they have fallen behind schedule in the 1970s - both growing more slowly than projected and experiencing unprojected labour productivity increases. These employment backlogs will be carried forward - and even if the less ambitious output projections of the 1980s and 1990s are met and productivity stabilises there will still be a considerable shortfall.

Platinum is highly uncertain - both as to future output levels and as to productivity changes (which we have no direct evidence about). Coal by comparison seems a fairly dependable projection. Gold we have decided represents an overestimate of decline - and on present view may deliver up to 50 per cent more output than Plewman projected for 2000, and hence require about 50 000 more workers than projected.

For the rest we expect employment in diamond mining to decline not increase, and in chrome to be higher than projected because of apparently very slow productivity change.

Is it possible to put numbers to these views? It might be worth a try.

TABLE 44: PLEWMAN EMPLOYMENT PROJECTION I (2000 AD)

	Original Plewman	Revision
Copper	122 000	48 000 <sup>1/</sup>
Iron	20 000	20 000
Chrome	11 500	30 000 <sup>2/</sup>
Manganese	13 000	13 000
Coal	156 000	180 000 <sup>3/</sup>
Asbestos	115 700	78 000 <sup>4/</sup>
SUB-TOTAL	438 200	369 000
Others	30 500	30 500
Gold	100 000	148 000 <sup>5/</sup>
Diamonds	31 000	10 000 <sup>6/</sup>
Platinum	264 000	180 100 <sup>7/</sup>
TOTAL	863 900	737 600

Notes: to Table

- 1/ 5,5 per cent per annum growth of output for 24 years from actual 1976 assuming constant productivity: 1970s backlog not made up.
- 2/ Arbitrary. Accept c. 20 000 in early 1980s given current rate of output growth and constant productivity. Assume productivity grows much faster in next 2 decades: no attempt at calculation.
- 3/ Based on output figure of 300 million tons in 2000.
- 4/ As with copper. Projected 5,5 per cent per annum rate of growth of output for 24 years from actual 1976 assuming constant productivity. (In fact there is evidence of productivity growth; this figure of 78 000 should probably be reduced further).
- 5/ Assuming gold output 355 tons in 2000 and constant gold output per worker.
- 6/ Arbitrary: already down to 17 000 in 1976 and due to decline secularly.
- 7/ Assume platinum reaches Plewman 1980 employment projection of 99 700. Then assume either 4 per cent per annum output growth and 1 per cent per annum productivity gains or 3 per cent output growth and constant productivity.

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If these figures have any value at all they highlight the crucial role in Plewman's projections of copper, coal, asbestos, platinum. Except for coal (which has been raised) the others have all been lowered and the product is a level of total employment of 737 600 - which is the sort of level which we may well have in 1981 (see Section on EDP 'Projections').

In other words once gold mining employment begins to fall the labour-absorptiveness of the mining sector will depend on the big potential new employers - coal, platinum, asbestos, copper. If they perform as Plewman predicted total employment may still grow to 850 000 and beyond. If not, as in this revised version, there will be relatively little growth between now and the end of the century.

## FOOTNOTES

- 1 See Table 1 on page 8 for the 1977 figure for average employment (424 992). This is approximately the level of 1966, 1970 and 1971 and slightly below the local peak year of 1973.
- 2 (Transvaal) Chamber of Mines: Annual Report 1951: p.68.
- 3 (Transvaal and Orange Free State) Chamber of Mines: Annual Reports 1958 (p.51), 1960 (p.57) and 1961 (p.13)
- 4 Chamber of Mines (of South Africa): Annual Reports 1974 (p.5: "the twin problems of Black labour shortages and unprecedented inflation"), 1975 (p.5: "a shortfall of Black labour") and 1976 (p.12: "... the industry experienced a marked decline in labour strength in the last quarter of 1976").
- 4(a) In 1974 and 1975 riots and disturbances on the mines resulted in loss of working days and the repatriation of some contract workers. In 1974 new recruitment of labour from Malawi (the largest single supplier) was banned and the employment of workers from this source dropped drastically over the next two years. In 1976 employment of Mozambicans began to decline well below its previous levels - though the precise reasons for this are not clear. Moreover, increased recruitment of South African workers involved a heavier year-end seasonal fluctuation, and the repeal of the Masters and Servants Act in 1974 facilitated 'walkoffs' (i.e. failure to complete contracts) by inexperienced South African miners.
- 5 Beginning at 369 810 in January 1979 the level of total employment in goldmining climbed very rapidly to 425 952 in February and fluctuated between 428 443 and 437 192 during the next 8 months: Bulletin of Statistics, March 1978. (The monthly average for 1977 was 424 992: information supplied by the Minerals Bureau).
- 6 Chamber of Mines: Annual Report 1962: p.9.
- 7 Derived from information about the last year in which mines declared gold in Chamber of Mines: Annual Report 1976: pp. 56-57.
- 8 Chamber of Mines: Annual Reports for the relevant years.
- 9 Chamber of Mines: Annual Report 1962: p.9.
- 10 Ibid. and Tables A, B on p.20.
- 11 Calculated from industry data on tonnages treated and gold output (includes small mines, not members of Chamber of Mines). See Chamber of Mines Annual Report 1976, p.58.
- 12 As for note 11, with employment statistics from Mining Statistics. During this period an increasing share of output was coming from newer better-designed mines.

- 13 Chamber of Mines: Annual Report 1976: p.59.
- 14 Republic of South Africa, Department of Mines: Mining Statistics 1976, p.47.
- 15 Chamber of Mines: Annual Report 1976: p.65. (Data in fact refers to sales, not output).
- 16 Chamber of Mines: Annual Report 1974: p.7. and Annual Report 1976: pp. 6-7.
- 17 In 1976 the average domestic price of bituminous coal was R5,84 f.o.r., whereas the average export price was R16,59 f.o.b. Average prices are calculated from sales data in Mining Statistics for 1971 and 1976.
- 18 The number of coalmines rose temporarily to 63 in 1975 and fell to 55 in 1976: Mining Statistics for 1966 and 1976.
- 19 Chamber of Mines: Annual Report 1976: p.7.
- 20 Chamber of Mines: Annual Reports 1975 (p.66), 1976 (p.66). Data refers to sales. Natal Mines are Natal Coal Owners' Society members.
- 21 Mining Statistics 1976, p.49.
- 22 Ibid.
- 23 Ibid.
- 24 Interview at Anglovaal, September 1977.
- 25 Between 1974 and 1976 employment by Cape copper producers contracted from 9144 to 7662, while Transvaal employment was reduced from 6377 to 5607.
- 26 S.A. Mining and Engineering Journal, August 1977: p.29. The development of the North pit at Sishen was commenced in 1974. The South pit has been in operation since the early 1950s.
- 27 Mining Survey No.86 (No.3 of 1977), p.18.
- 28 Mining Statistics 1976, p.49.
- 29 In fact the 700 000 mark was reached for the year: 701 434 men were on average in service on all mines (excluding power and works) in 1977. (Information provided by the Minerals Bureau of the Department of Mines prior to publication of Mining Statistics 1977).
- 30 "Minerals and Manpower", Journal of the South African Institute of Mining and Metallurgy, Vol.75 No.3 (October 1974), pp. 49-62.
- 31 These employment figures are average numbers of persons at work. The main employment series used in this paper are of persons in service. Both sets of figures are available (Tables 1,2) in the annual Mining Statistics publication (see note 14).

- 32 2 volumes: RP 69/1972.
- 33 Plewman, p.49.
- 34 Plewman, p.51.
- 35 P.A. von Wielligh, "Minerals and the Survival of Mankind", Journal of the South African Institute of Mining and Metallurgy, Vol. 78 No.4. (November 1977); pp. 99-108.
- 36 Dennis Etheredge: "South Africa's Mineral Resources: the Next 5 Years", Optima, Vol. 26, No.3. (1977 One): pp. 170-180.
- 37 There is a problem about these diamond production figures. They are derived from Mining Statistics. The production index for diamonds from Statistical News Release P.10.1: Mining Production does not show a similar decline. (See p.91 of this paper and footnote 57 for the probable explanation of the divergence).
- 38 von Wielligh, op. cit., Table 1.
- 39 Production figures for the full year 1977 have subsequently been made available by the Minerals Bureau (and will be published in Mining Statistics 1977).

	Production 1977	Growth rate p.a. 1970-1977
Copper	205	5,5
Iron ore	26 481	15,9
Chrome	3 319	12,9
Manganese	5 290	8,7
Coal	85 411	6,1
Asbestos	380	4,8
Gold	700	-4,1
Diamonds	7 643	-0,3

Units and procedures are as for Tables 29 and 30. The guesses in the text for 1977 (based on figures for the first 6 months) are reasonably good. The growth rate for Asbestos however slowed to 4,8% p.a. rather than rising to "the region of 5,9% p.a.". And the surge in diamond production was not noticed.

- 40 Statistical News Release P.10.1 (28/9/77): Mining Production: June 1977, Two production series are provided for 1963-1976.
- 41 Statistical News Release P.10.1 (10/5/78): Mining Production: February 1978.
- 42 Loc. cit.
- 43 Loc. cit.
- 44 Ibid., p.171.
- 45 Ibid., p.172.
- 46 Ibid., p.174.
- 47 See footnote 38.

- 48 Mining Statistics 1970, Table 2. (The 1970 figures are reprinted in recent issues of the annual).
- 49 No precise measure of the labour shortage has yet been found, though the figures for employment in 1977 suggest a shortfall for 1974 and 1976 of the order of 20-25 thousand workers and (probably) a larger number in 1975.
- 50 Employment figures from Bulletin of Statistics, September 1977. Output figures from Statistical News Release P.10.1, Mining Production: June 1977. (See also Table 37 on p.84). For the whole year 1977 employment was 96 919 - 15,6% up on the 1976 level. A slight fall in output per man-year is consistent with the hypothesis that development work on several new large coal-mines may be contributing to the size of this current surge in coal-mining employment.
- 51 Bulletin of Statistics, September 1977. Average employment figures for the full year 1977 (provided by the Minerals Bureau of the Department of Mines prior to publication in Mining Statistics 1977) are as follows:

	1976	1977	Change 1976-7	Average growth rate 1970-77 (% p.a.)
Copper	13 229	13 186	- 43	+ 1,1
Iron Ore	9 334	9 371	+ 37	+ 6,2
Chrome	8 960	12 556	+ 3 596	+ 13,8
Manganese	9 176	9 595	+ 419	+ 2,2
Coal	83 814	96 919	+ 13 105	+ 3,6
Asbestos	21 504	21 665	+ 161	+ 1,3
Others	17 319	16 877	- 442	- 3,4
Gold	401 907	424 992	+ 23 085	0
Diamonds	17 415	17 451	+ 36	- 2,9
Platinum	71 999	75 632	+ 3 633	+ 2,8
<b>Total</b>	<b>657 592</b>	<b>701 434</b>	<b>+ 43 842</b>	<b>+ 0,8</b>

Note:

The relation between the list of minerals and the Mining Statistics list is as for Table 34 on page 78.

- 52 As shown in the previous footnote the guesses in (1) and (2) of the text turned out to be accurate for the full year. Average employment in gold-mining was close to 425 000 (424 992) and total employment in mining did reach 700 000 (701 434).
- 53 Republic of South Africa, Office of the Economic Adviser to the Prime Minister: Economic Development Programme for the Republic of South Africa - Summary and Policy Implications, 1976-1981.

- 54 See footnotes 35, 38.
- 55 Plewman, op. cit., p.50.
- 56 Etheredge, op. cit., p.172. Etheredge's summary of future coal consumption is on p.174 of his paper.
- 57 The probable explanation of the discrepancy between the two sets of figures turns out to have nothing to do with South-West Africa. It seems that the Mining Statistics figures are the simple aggregate of diamond production (in carats) from all sources, whereas the Statistical News Release figure is a weighted sum of (i) alluvial diamond production and (ii) diamond production from mines - with weights reflecting relative values per carat realized in the base year (1970). Given the greater per carat value of alluvial diamonds a decline of 5X carats in mining production will be more than offset by an increase of X carats in alluvial production.
- 58 Etheredge, op. cit., p.172.
- 59 Ibid., p.171.
- 60 S.A. Mining and Engineering Journal, August 1977 P.25.

# SQUATTER SETTLEMENTS & CAPE PENINSULA GEOGRAPHY

