

*The Profits of Death: A
Comparative Study of
Miners' Phthisis in Cornwall
and the Transvaal, 1876-1918*

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' . . . this imprisoned Air taken in at the Mouth for the use of Respiration, is loaded with Particles very injurious to the Lungs, Brain and Spirits, which joyning in with the Mass of Blood and Spirits, produce all the evils the Workmen complain of."

A close connection between metalliferous mining and lung disease has been observed, if not understood, for a very long time. As early as 1556, for example, Agricola drew attention to the high death rate from lung diseases amongst metal miners in the Carpathian mountains.² Ramazzini's seminal study of occupational medicine at the beginning of the eighteenth century likewise drew attention to the specific illnesses associated with metal diggings.³ By the beginning of the nineteenth century medical research was specifying the particular dangers of dust and the possible correlation between dusty trades and tuberculous infections. Thus Thomas Beddoes noted that stone-cutters, millers and miners were particularly liable to tuberculosis.⁴ More significantly, Charles Thackrah's studies indicated that

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¹B. Ramazzini, *A Treatise of the Diseases of Tradesmen, etc.*, London 1705, 10.

²E. Agricola, *De Re Metallica*, Saxony 1556, Trans by H. C. Hoover and L. H. Hoover, London 1912, 6, 214-5.

³Ramazzini, *op. cit.* 1, 13.

⁴T. Beddoes, *Essay on the Causes, Early signs and Prevention of Pulmonary Consumption for the use of Parents and Preceptors*, Bristol 1799.

pulmonary conditions in miners were possibly associated with particular types of dust produced in the pits and mines.⁵ Nevertheless, despite the fact that by the third decade of the nineteenth century medical knowledge was moving towards a recognisably modern pathology of dust diseases, the advances in medical science were only haltingly, and sometimes even erroneously, applied to the control of working conditions in the mining industry in Cornwall and the Transvaal more than forty years later. The reasons for this lethal neglect of working conditions in these two areas in the light of this medical history, forms the subject matter of this investigation.

II

In the last quarter of the nineteenth century and the first decade of the twentieth century, the links between Cornwall and the Transvaal were particularly close. Cornish miners, or miners of Cornish descent, formed the overwhelming proportion of the skilled labour force on the Witwatersrand gold fields in the first twenty years of mineral exploitation. In 1902-3, the Miners' Phthisis Commission of the Transvaal estimated that over 90 per cent of all white miners on the Rand were of foreign origin and the greatest proportion of these men were Cornish.⁶ Not that the Rand was unique in this respect. At an earlier period, miners of Cornish origin had been instrumental in exploiting gold, silver and copper in Butte City, Montana, for example, and had, along with their fellow countrymen in South Africa, suffered fearsomely from the depredations of miners' phthisis or 'miners con'.⁷

The reasons behind this international migration of Cornish miners, and the migration of the diseases particularly associated with hard rock mining which accompanied this movement, are complex and too little studied. They are bound up with the falling price of copper and tin on the world market and its catastrophic effect on the Cornish industry, the workings of the English Poor Law, and the particular nature of the Cornish Tut and Tribute system of mine organisation which emasculated labour militancy and made emigration the logical alternative in times of hardship.⁸ If the reasons are little discussed the effects of these forces are well known. In the decade 1870-80 one third of the whole population left Cornwall permanently.⁹ Between 1873 and 1898 the total numbers employed in the Cornish mining

⁵ C. T. Thackrah, *The Effects of Arts, Trades and Professions, and Civic States and Habits of Living, on Health and Longevity etc.*, London 1832.

⁶ Miners Phthisis Commission, *Report*, 1902-3, para. 10, Pretoria 1903, (Hereinafter MPCR 1902-3).

⁷ J. Rowe, *The Hard Rock Men: Cornish Immigrants and the North American Mining Frontier*, Liverpool 1974, 238-44.

⁸ A. K. Hamilton Jenking, *The Cornish Miner*, London 1927; D. B. Barton, *A History of Tin Mining and Smelting in Cornwall* Truro 1967; A. C. Todd *The Cornish Miner in America*, Truro 1967.

⁹ Census of England and Wales, *General Report* 1881, vol IV, 48.

industry declined from 26,814 to 5,193, with a slight recovery thereafter.¹⁰ The Less Eligibility clauses of the Poor Law Amendment Act of 1834 and assisted passages given by the major steamship companies ensured that Cornwall's loss would be the world's gain. Australia, India, the United States, Mexico, Canada, the Cape Colony and the South African Republic all recorded large influxes of Cornish miners uprooted from their homes in the wake of the copper and tin crashes. South Africa, and particularly the Witwatersrand, became a particularly popular destination as the following contemporary account reveals:

So through the villages and all over the downs the news spread like fire among the bracken. The budding manhood full of sap and hope, panted to get to South Africa. The old people should live at home in clover if every bal (i.e. mine) in the country were shut down they said. The old people caught the fever of unrest, and sighed that they could not go also, for they remembered 'rushes' in the old times when men went to Australia and California, and came back 'rich beyond the dreams of avarice'. Grand old days! And now a new generation was going to exploit a new land, wherein the mountains were of gold, and the rivers washed it like sand in tin streams. A new light suffused homes of misery, a new song reached the lips; the old praised God that He had heard their prayers, the young married in joyous abandonment, and started for the Land of Gold."

By the first decade of the twentieth century, the mortality of miners on the Rand, the moral corruption of this 'Land of Gold', the labour policies of the Rand mining industry and the slight up-turn in the fortunes of the Cornish tin industry, meant that Johannesburg had lost much of its appeal for Cornishmen and other European migrants.¹² In 1911, only 65 per cent of miners examined by the Miners' Phthisis Medical Commission were of foreign origin, and only 19 per cent had worked in any other country on mining work.¹³ Thereafter, the number of South African born white miners increased consistently, so that by 1930 no less than 73 per cent of white miners were South African born, and 91 per cent of the whole body of white miners had their experience of mining solely in South Africa¹⁴ In this early

^D Royal Commission on Metalliferous Mines and Quarries, *First Report*, Appendix A, Cd 6390, 1912-13, (Hereinafter RCMMQ); see also R. Samuel *Mineral Workers*, 3-4 in R. Samuel (ed) *Miners Quarrymen and Saltworkers*, London 1977.

J. H. Harris, *The Luck of the Wheel Vor, and other stories of the Mine, Moor and Sea*, Truro and London 1901, 64-5; in March 1903 the *Mining Journal* stated '... since 1884 the average Cornish Miner has regarded the goldfields of South Africa as a sort of Eldorado or Tom Tiddlers ground, to which when tired of cold pasty, an eight hour shift, and 18/- a week, he might retire for a few years.'

An interesting example of this is to be found in A. Pratt, *The Real South Africa*, London 1913, 164-6. (We are indebted to Charles Van Onselen for this reference.)

¹ Miners' Phthisis (Medical) Commission, *Report 1912*, Pretoria 1912. (Hereinafter MP(M)CR 1911-12).

* L. G. Irvine, A. Mavrogordato, H. Pirow, *A Review of the History of Silicosis on the Witwatersrand Goldfields*, Paper given to the International Silicosis Conference, Johannesburg, August 1930, organized by the International Labour Office Geneva, Geneva 1930. (Hereinafter ILO Int Conf, 1930).

period of Rand mining however, the British connection remained strong and gives historians a rich ground for a comparative study of the responses of government and mining capitalism to the problems of industrial disease.

In this context it is important to emphasize that the connection between Cornwall and the Rand, was closer even than that suggested by a study of labour migration. For example, Cornish engineering firms, such as Harveys of Hayle, had large and lucrative contracts with South African mining firms. The economies of scale facilitated by the limited liability and group organization of the South African mines, was, for example, urged upon the Cornish industry by returning mine managers with experience in Kimberley and Johannesburg at the end of the nineteenth century.¹⁶ Geologically also, there were important similarities between the two countries which facilitated the flow of mining knowledge and expertise. The nature of the tin lode presented strikingly similar problems of deep-level mining as those encountered on the Witwatersrand in the 1890s and 1900s. Indeed, it is arguable that it was the skill of the Cornish miners on the Rand which made possible the successful exploitation of the deep-levels after 1895. The terminology of Rand mining clearly reflects this Cornish debt.¹⁷ Most important of all for the subject matter of this paper was the chemical similarities of the geological deposits in which the tin and gold were discovered. Both Cornish tin and Witwatersrand gold lay in country rock which contained a high degree of quartz. Furthermore, both the lode and the ore themselves contained very large concentrations of silica, which, it is now known, was highly conducive to the formation of phthisis, when absorbed in microscopic form into the lungs.¹⁸ Thus the migration pattern of the Cornishmen between South Africa and England set up a particularly macabre sub-migration of phthisis, and its attendant disease of tuberculosis. This can be clearly seen in the *Health of Cornish Miners Report*, which was published in 1904. During the course of this investigation,—which was occasioned by the discovery that miners at the large Dolcoath mine in Cornwall had contracted the worm infestation known as

⁵ For an interesting example of this in connection with the Barberton (?) fields see Matheson & Co to Harvey's Hayle, 16 February 1883; 7 August 1884, in Cornwall County Record Office, Truro (Hereinafter CRO Truro).

* H. Thomas, *Cornish Mining Interviews*, Camborne 1896, 148-63. Also *Report of Inspector of Metalliferous Mines 1897*, Cd 8819, 1898.

¹⁶ The technique and terminology of Rand mining in the 1890s and 1900s is best examined in F. M. Hatch and J. A. Chalmers, *The Gold Mines of the Rand*, London 1895, S. J. Truscott, *The Witwatersrand Goldfields: Banket and Mining Practice*, London 1902. For some definitions see *Reference 54* below.

* On the silicious content of Cornish Mines see for example: H. G. Dines, *The Metalliferous Mining Region of South West England*, 2 Vols, London 1956, D. C. Davies *A Treatise on Metalliferous Minerals and Mining*, London 1886; on the Transvaal, see Union of South Africa, *The Prevention of Silicosis in the Mines of the Witwatersrand Johannesburg 1937* 31-2; A. F. McEwen and J. Buist, *The Nature and Source of Dust in Mine Air, Together with a Brief Reference to those Operations -which produce Dust*, ILO Int Conf 1930.

g Ankylostomiasis, — it was revealed that those, who had worked in the gold
, mines of the Transvaal were suffering from the highest death rate from
, phthisis of all miners' investigated, including phthisical deaths recorded
5 amongst miners who had only worked in Cornwall. For the period
, 1900-02, 342 miners' deaths were investigated in the Redruth, Camborne,
p Illogan, Gwennap and Phillack sub-registration districts. Of these 342, it
e was found that 185 had worked in South Africa and another foreign
p country. A further 95 had been abroad but not to South Africa. Generally
e speaking, the average age at death of Cornishmen who had worked on rock
e drills in the Transvaal was only 36.4 years, with an average period of rock
s drill employment of only 4.7 years. Men who worked in Cornwall only were
8.4 years respectively."

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The disease of phthisis to which these figures refer is a disease particularly associated with the practice of metalliferous mining. More especially it is to be found where mining for gold, tin, copper, and mica is carried out. Phthisis is also found amongst coal miners working in mines where deposits of sandstone are found in the country rock. All these types of mining are associated with geological formations containing high degrees of free silica in a crystalline or micro-crystalline state, which, upon extraction of the ore, is released in dangerous quantities in the form of fine or needle-like dust. Phthisis, or miners' phthisis, is in fact a form of silicosis, particularly associated with such mineral bearing rocks as quartz, quartzite, cristobalite, flint and chert. As a silicosis, phthisis is part of the disease group covered under the generic description of pneumoconiosis. However, it differs from other forms of pneumoconiosis in one particularly important respect: it predisposes significantly to the development of pulmonary tuberculosis. °

For practical purposes there is a distinction to be made between silicosis and phthisis. The former illness is characterized by its non-infective nature and by its tendency to predispose towards the development of tuberculosis. The latter, although initially a form of pure silicosis, is in fact a composite disease upon which an infective process has been superimposed. Silicosis, which is a condition of fibroid change in the lung, arises from the presence in the lung of very fine silicious particles deriving from a dust-laden atmosphere. Phthisis, which develops from this fibroid change is a disease

* Secretary of State for the Home Department, *Report on the Health of Cornish Miners*, Cd 2091, 1904, (Hereinafter HCM Report 1904).

W. R. Parkes, *Occupational Lung Diseases*, London 1974, 166-216.

with an infective tuberculous element added. Generally speaking, the liability of miners to contract phthisis increases in proportion to the degree of silicosis present in the substance of the lung.²¹ This crucial interrelationship may be gathered from the following definition given to the 1938 International Conference on Silicosis at Geneva:

- (1) That an uncomplicated silicosis in the sense of a simple pathological reaction to the effective occupation of the lungs by silicious dust is a distinct pathological entity consisting of the development of a more or less generalized miliary fibroid nodulation of the lung, with associated fibrotic changes. There is always an accompanying bronchitis, and in established cases varying degrees of emphysema. In many cases this is, throughout, the sole condition present.
- (2) That the effective occupation of the lungs by silicious dust not only leads to fibrosis but facilitates the development of tuberculosis, either at sites of pre-existing dormant foci of tuberculosis, or at sites where silicotic lesions are developing or have developed at which tubercle bacilli may arrive and become arrested.
- (3) That the conjunction of a limited tuberculous infection with developing or developed silicotic lesions does not, however, in general lead to the development of an active spreading tuberculosis (although this may and does happen in particularly susceptible individuals), but to a mutual modification of the infective and silicotic process, resulting in the production of chronic indurated lesions of mixed silicotic and tuberculous origin, marked by an excessive fibroid reaction, with the result that the extension of the infective process is retarded and not infrequently becomes virtually arrested for lengthy or indefinite periods. Commonly, ultimately to break down and to initiate a terminal active tuberculosis. Ultimately, either from this source or by dissemination of the infection from some less conspicuous focus within the respiratory organs or by reinfection from a source outside the lungs an active tuberculosis is present at death in perhaps the majority of cases of silicosis who die from their disease."

In its terminal condition silicosis gives rise to these distinctive mixed lesions which distinguish it from pure tuberculosis, and which have given rise to the term phthisis to distinguish it from non-terminal silicosis.²³ It is in this sense of a composite terminal disease, that the term phthisis is used in this paper.

The composite nature of phthisis is a fact of the first importance not only in discussing the pathology of the disease, but also in discussing its particular incidence in the two mining areas of Cornwall and the Transvaal, and the migration of the disease between the two areas. It is also of significance in considering the nature of controls that were or were not imposed upon the mining operations of the respective countries. However, it is apparent that these factors were influenced by the current state of medical research on dust induced diseases, and, more importantly, the extent to which this research was applied in commercial mining operations, hi this context, it is to be noted, that in the last thirty years of the nineteenth

²¹ Union of South Africa, *General Report of the Miners' Phthisis Prevention Committee*, Johannesburg 1916, 10. (Hereinafter GRMPPC 1916).

²³ L. G. Irvine *Notes on Silicosis* Appendix 6 to the Proceedings of the International Silicosis Conference, Geneva August-September 1938 (ILO Int Conf 1938), 151.

" Union of South Africa, *The Prevention of Silicosis etc.*, 151.

century the pace of medical enquiry into pigmented and dust-laden lungs declined markedly in Britain and on the European continent. This was possibly the result of an apparent improvement in the conditions in the all-important coal mining industry during this period, largely as a result of improved ventilation. Concern for the non-bacteriological causes of miners' diseases was also reduced as a result of Koch's discovery of the tuberculous bacillus in 1882. Attention thereafter became increasingly centred upon bacteriological causes of the disease to the detriment of non-medical prophylactic measures.²⁴

The consequences of this trend for the conditions in metalliferous mines were particularly unfortunate. The state of medical research reinforced a growing official reluctance to investigate the health conditions in Cornish mines. Thus, not until 1904 did the *Health of Cornish Miners Report* apply the results of experiments conducted by E. H. Greenhow in the 1860s. Greenhow's findings had irrefutably confirmed the fact of impregnation of the pulmonary organs with dust as a result of inhalation of vitiated air.²⁵ The proceeding *Kinnaird Commission* of 1864, had, in direct contradiction to much of the evidence submitted to it by the miners themselves, attributed the prevalent poor health amongst Cornish copper and tin miners to poor ventilation.²⁶ Similarly in South Africa, it was not until the *Transvaal Mining Regulations Commission of 1907-1910*, that a serious effort was made to apply Koch's important discovery to the underground conditions in the effects of this arrested state of medical research and official neglect upon mining conditions were evident for a considerable time after conscientious medical officers had begun to reexamine the prevailing concepts of silicosis formation in the first two decades of the twentieth century. Positive changes in the understanding of the etiology of phthisis were necessarily dependent upon extended clinical observation of the disease. Thus, the process of medical research tended to compound the effects of neglect in this field in the first instance. This can be seen in four major areas

²⁴ G. Rosen, *A History of Miners' Disease*, New York 1943, 380-2.

" HCM Report 1904, 12; the results of Greenhow's experiments will be found in 'Specimen of a Coal Miner's Black Lung', *Transactions of the Pathological Society of London* xvii, 1865, 36-9; E. H. Greenhow 'Specimen of Colliers Lungs' *Trans Path Soc London*, xviii, 1866, 34-6; E. H. Greenhow 'Blacklungs from a case of Colliers' Phthisis; Specimen of Miners' and Flaxdressers Lungs', *Trans Path Soc London*, xx, 1886-9, 41-59.

" *Report of the Commissioners Appointed to Enquire into the Condition of all Mines in Great Britain to which the Provisions of the Act 23 & 24 Viet. Cap 15 do not apply, -with reference to the Health and Safety of Persons Employed in such Mines*, 1864, Cd 3389 (1864) (The Kinnaird Commission). Greenhow was a medical consultant to the Commission as was T. B. Peacock who claimed before the Pathological Society in 1865 that the lungs of a Cornish miner, examined by him, contained no silicious particles: T. B. Peacock 'Cornish Miners' Lungs' *Trans Path Soc London* xvi, 1865, 57-8.

" *Final Report of the Transvaal Mining Regulations Commission*, 1910, (hereinafter MRC, 1907-10) 44-6.

in the mining fields of Cornwall and the Transvaal at this period. In the first place it was not until after 1916 that the physical concept of silicosis formation was abandoned in favour of the solubility theory. Even the influential *General Report of the Miners' Phthisis Prevention Committee* (1916), of South Africa held that fibroid changes in the lung were caused by the hardness or sharpness of the crystalline silica.²⁸ Subsequently it was generally accepted that it was the soluble nature of silica, and the subsequent toxic formations produced in the substance of the lung which were the dominant factors in silicosis formation.²⁹ Secondly, continuing investigation, especially in South Africa, revealed that the precise relationship between the mass of silica inhaled and the development of silicosis was by no means fixed, and no definitive ratio or causal relationship between the mass of dust inhaled and the development of phthisis could be established. As late as the 1930s the estimate of the critical percentage of free silica in mine dusts was as high as 50 per cent of the dust by weight; in the mid 1940s this estimate had been progressively lowered to 5-1 per cent.³⁰ Thirdly, it became appreciated over time that the size of the silica particles, and their freshness, had a direct bearing on silicosis formation, and upon the chemical, physical and electrical properties of silica:

In all mine dusts, over 95 per cent by number of the particles are below $\frac{1}{2}$ μ in diameter. It is the very finest particles only which enter the lungs.

Dr Macrae has shown that the great majority of the mineral particles found in the ash of the silicotic lung have an average diameter of less than 1^{μ} . In a very extensive survey of several microscopic preparations only a negligible small number of particles was seen whose diameter exceeded 8.5μ and the very longest observed was 10.5μ ... It would appear therefore, that the silicious particles which are most important in producing silicosis are those of this minute size.¹

Lastly, it became increasingly obvious that the presence of mixed dusts in the mine atmosphere had a material affect upon the cause and development of phthisis, and the prognosis which could be reasonably entertained on the basis of mine air samples. In 1902-03 the *Transvaal Miners' Phthisis Commission* had suggested the collecting of evidence on the extent to which such deleterious gases as nitrous oxide, and carbon monoxide originating in

²⁸ GRMPPC, 1916, 11-12.

²⁹ For an example of the solubility theory see A. Mavrogordato, *Aetiology of Silicosis*, ILO Int Conf, 1930; recently this theory also has been superseded by the theory of the destruction of the lung macrophages, Parkes, *op. cit.*, 87 et seq.

³⁰ C. Biccard Jeppe, *Gold Mining on the Witwatersrand*, 2 Vols, Johannesburg 1946, ii, 1514-20.

¹ A. H. Watt; L. G. Irvine, J. Pratt Johnson, W. Stewart, *Silicosis (Miners' Phthisis) on the Witwatersrand: Causation, Incidence, Pathology, Symptoms and Radiographic Appearances*, GRMPPC, 1916, App.6.83; *ap* represents a measurement of minute dust particles usually known as microns. For further details see D. Hunter 'The Prevention of Silicosis' in 'A Symposium on Industrial Pulmonary Diseases' E. J. King and C. M. Fletcher (Eds), London, 1958.255 et seq.

the blasting operations of the mines and the consequent decomposition of nitro-glycerine explosives, predisposed towards the development of phthisis. The commission also drew attention to the dangers from noxious gases in the use of oils with a low flash point in the lubricating of the air cylinders of the compressor engine." However, not until 1916 was the Commission's erroneous assumption that carbon monoxide posed the greater danger in this respect, finally refuted.

The greater danger deriving from nitrous fumes in blasting was convincingly demonstrated by the 1916 Prevention Committee. In a report which laid the greatest possible stress upon the dust and gas producing effects of blasting, the Committee stated unequivocally:

... so far as the development of miner's phthisis is concerned, exposure to nitrous fumes produced by blasting operations is a greater danger than that of possible chronic poisoning by carbon monoxide. These fumes are intensely irritating to the air passages and lungs, and the repeated inhalation of very small quantities would produce and maintain a catarrhal condition which would aggravate and accelerate the irritative changes due to dust. There is no doubt that, under a system of 'cut' and 'round' blasting, where no water blast is employed, a practice which was formerly common, exposure to considerable quantities of nitrous fumes and of carbon monoxide must be a frequent occurrence."

From this type of evidence it must be apparant that it is insufficient to see miners' phthisis as simply the inevitable and lamentably unavoidable result of metalliferous mining in hard rock quartzite reefs of the type found in Cornwall and the Rand. Fof the incidence of the disease, dependent as it was upon a number of variable factors which produced such a complicated and composite disease, must have clearly altered with the type of mining undertaken. In this respect, the particular virulence of miners' phthisis in the two areas under review is significant. The similar geological deposits, similar production processes, and a migrant and common workforce, which produced considerable mortality in both areas from the disease had to be related to more particular factors than the simple existence of quartz bearing reef or lode, hi brief, there is very strong evidence to show that in both areas the prevalence of the disease is intimately and inextricably related to changes in the production process. These changes are in their turn related to the constraints imposed upon mining for profit under differing conditions of capitalist production.

IV
IV

By the turn of the twentieth century both the Transvaal and Cornish mining, despite their radically different fortunes, were characterized by a considerable degree of technological intensity in mineral extraction which

"MPCR, 1902-3, paras. 33-55; see also HCM Report, 1904,11.
"GRMPPC, 1916,40.

was known to have a direct bearing on the amount of dust produced, and thereby the incidence of phthisis. This pattern of mining contrasted with earlier patterns of gold mining in Southern Africa,³⁴ and even contrasted with the older deep level operations of the Cornish copper and tin industries.³⁵ Three major technological changes which were common to both areas can be identified, which contributed markedly to the increase in the proportions of dust in mine air. It must be stressed that in Cornwall these changes were introduced over a long period of time, and often piece-meal. Yet in Cornwall and the Rand it was the combination of these changes introduced on a commercial scale between the 1870s and the 1890s which transformed the character of mining in these areas and so changed the disease patterns.

The first of these changes, for which Cornwall received world wide recognition, was the introduction of the steam driven pumping engine to control water in the mine levels. This process, which had begun with the Newcomen engine, had reached a sophisticated stage by the 1840s. Firms such as Sandys, Carne and Vivian, and Harvey's at Hayle, and Holman's at Camborne, built up an international reputation for the production of these pumping engines which rivalled the fame of the Boulton and Watt company.³⁶ The introduction of these machines greatly facilitated deep level mining, or the mining of hitherto inaccessible ore-bodies. The consequent increases in development work, blasting, shovelling and hoisting, greatly increased the amount of dust in the mines, both through increased quantities of dust-producing operations and through the resultant drying out of the mine levels. This process applied to the Transvaal as well in the 1890s once the deep levels had been proved and were exploited on a commercial basis. However, although water was a problem in some mines, the Rand was never considered a wet field in the same way as Cornwall. Here, indeed, the Cornish engine was seen more as a steam driven winding engine than as a pump.³⁷ Both areas depended upon access to large sources of coal for the commercial application of this development.

The second change came with the expiry of Nobel's patent in 1875, when large scale application of cheap dynamite to blasting operations became a real possibility. In Cornwall, there was an uneven pattern of introduction of this revolutionary explosive device. The larger and more efficient companies adopted it extensively after 1876, whilst the smaller and more

³⁴ For an interesting description of early techniques of gold mining in southern Africa, see I. R. Phimister, 'Alluvial Gold Mining and Trade in Nineteenth Century South-Central Africa', *Journal of African History*, xv, 3(1974), 445-56.

³⁵ For the labour intensity of early and mid-nineteenth Cornish tin and copper mining, see R. Samuel, *op. cit.*, 34-5.

* J. Rowe, *Cornwall in the Age of the Industrial Revolution*, Liverpool, 1953, is the best modern description of this development " Hatch and Chalmers, *op. cit.*, 136.

inefficient mines continued to use the old black powder.³⁸ The fact that dynamite was cheaper, easier to use, generally safer to handle, and six times more effective, clearly had an important influence upon the capacity of Cornish mining companies to survive the devastations of the late 1870s. By the 1890s investment in explosive manufacture was a well established part of the diversified pattern of Cornish mining capitalists' investment portfolio.³⁹ In the Transvaal, the impact of dynamite upon working operations of the deep level companies is well known. In the 1890s, when most of the deep-level mines were still developing operations this was particularly important:

Whereas the producing outcrop mines had an oxidized zone in which the rock was soft and required only small charges of gelignite, the deep level mines had no soft ground.

Moreover, most deep level companies were still developing their mines for production, and as they didn't operate a mill or cyanide plant, their sole working costs were in the mine; accordingly the costs of explosives was a much higher proportion of their total working costs.⁴⁰

At this period the State Mining Engineer of the Transvaal estimated that the mines spent £600,000 per annum or 8.6 per cent of total working costs on dynamite.⁴¹ The continued exploitation of second and third row deep-level companies after the War meant that even with the abolition of the dynamite monopoly by Milner the question of dynamite costs remained important. The net effect of this important change in mining technique in Cornwall and the Rand was to ensure that more rock was broken and hoisted at less cost, and that considerably finer dusts were created in the working places as a consequence. The implications for the development of a high death rate from phthisis in a situation of virtually unregulated blasting and shift work are readily apparent.

Thirdly, after 1876 in Cornwall and in the 1890s in South Africa, there was a widespread introduction of machine drilling. In Cornwall this was clearly a response to a situation of acute crisis. The falling price of tin on the world market and the antedeluvian, labour intensive, methods of ore extraction generally employed in the Cornish mines spelt disaster for many of the undercapitalized or impoverished companies. Survival for the more fortunate was largely secured by the introduction of machine drills to raise output per man and thereby lower working costs. Thus during the decade 1870-80, although the number of mines in Cornwall fell from 377 to 138,

* HCM Report, 1904,10.

" See for example the list of Directors of the Perranworth Explosives Co, for 1890-2, cited by B. Earle, *TrevithicKSoc. Newsletter*, Aug 1976.

* G. Blainey, 'Lost Causes of the Jameson Raid', *Economic History Review*, 2nd ser., 18, (1965), 356-78.

⁴ E. P. Rathbone, 'Some Economic Features in Connection with Mining on Witwatersrand Goldfields' *Trans. Inst. Mining and Metallurgy*, v, 1896-7, 50.

and the labour force contracted from 26,528 to 12,211, the value of ore per person per annum employed rose from £55.04 to £56.42, and the overall production figures fell by only 10 per cent over the decade.⁴² This revolution in productive technique was permanent. By the 1890s it was claimed that there was:

. . . not a mine of any importance which does not avail itself of this more expeditious ... method of making excavations in hard ground.⁴³

On the Rand, where the introduction of machine drills on a large scale coincided with the consolidation of the productive revolution in Cornwall, the reasons are to be sought in expansion rather than contraction. As the deep-levels were opened up, and the true extent of the possible productive operations became appreciated, the number of machine drills employed largely on development work increased rapidly. Already by 1896, there were no less than 1,015 of these machines in operation. By 1904, there were 1,736, and in 1909, 2,986.⁴⁴ At this stage, the size of the drill machines, and the cheapness of labour intensive methods of hand drilling discouraged the application of the machine drilling in sloping, except in times of labour shortage.⁴⁵

The machines generally employed in Cornwall and the Transvaal at this time were based on the reciprocating piston principle, which not only bored dry but on its return stroke tended to throw out dust and chips of rock from the hole.⁴⁶ Not until after 1900 did machine drills employing the hammer principle become a commercial proposition, and the Transvaal Chamber of Mines actually refused to recommend the introduction of the axial-feed "Water-Leyner" drill in 1904 on the grounds of its maintenance costs.⁴⁷ Only after 1910 did the axial-feed water drill of the hammer type begin to replace the dry reciprocating type of machine on the Rand.⁴⁸ In Cornwall too, dry mining continued to be the norm in the first decade of the twentieth century, despite the revelations of the 1904 Health of Miners Report, as the following statement indicates:

⁴² Figures calculated from B. R. Mitchell and P. Deane, *Abstracts of British Historical Statistics*, Cambridge 1971, 155; *The Mining Journal* 1870-80; O. B. Barton, *op. cit. Reports of the Inspectors of Metalliferous Mines, 1870-80*.

⁴³ Sir C. Le Neve Foster, 'The Progress of the Art of Mining', Introductory Lecture to Royal College of Science and Royal School of Mines, 1891, Archives of Imperial College London.

⁴⁴ Exhibit 14 of Statement of the Transvaal Chamber of Mines (TCM) to Transvaal Labour Commission, 29 August 1903, printed in *Annual Report* of TCM 1903, (ARTCM); ARTCM 1909,387.

* See for example of this see the *Half-Yearly Report* of the Transvaal Government Mining Engineer, December 1902.

T. Holman, 'Historical Relationship of Mining, Silicosis and Rock Removal', *British Journal of Industrial Medicine*, IV, 1 (1947), 1-29.

* ARTCM, 1904,121.

* Irvine, Mavrogordato and Pirow, *op. cit.*, 187,194.

* T. H. Prisk, 'Phthisis & Accidents in Cornish Mines', *Records of the London & West Country Chamber of Mines*, 1910,183-6.

In the majority of cases the form of spray is not used by the miner except for the purposes of hoodwinking mine officials and inspectors ... It will therefore be seen that although several attempts have been made to reduce the ravages among our miners by phthisis, practically little good has been done.⁴⁹

In the production processes which were associated with these technological and commercial changes, certain central and clearly defined activities were known to be responsible for the release of large amounts of dust containing a critical percentage of free silica, and variable temperature conditions which were conducive to pleural infections. Between 1902 and 1916 no less than six major investigations into the health conditions of miners on the Rand and in Cornwall were conducted, all of which drew attention to these activities.⁵⁰ In brief, these reports identified five dust producing operations. Firstly, blasting was increasingly seen as a major factor in the production of dust. This was identified in development work particularly, where 'cut' and 'round' blasting was usually undertaken on the same shift. Not until 1913 was some form of control imposed upon this lethal method of development in South Africa, and not until 1919 was it actually made illegal to blast the 'cut' and 'round' in the same shift in the same development end or drive.⁵¹ Furthermore, the high percentage of toxic fumes given off in the event of mis-fires in what amounted to unventilated areas increased the risk of catarrhal irritation resulting from nitrous fumes. This danger was aggravated by the deterioration of detonators and fuses in the damp atmosphere, and by the management policy of skimping costs by using inadequate blasting gelatine." Blasting in productive work was largely undertaken in the slopes, and although often ventilated and wider than many working areas in raises and drives, slopes were nevertheless prone to dust through the difficulty of applying watersprays to such large areas.⁵³

The second operation, universally recognized as dust producing, was drilling. This was the case even with hand drilling, which was prevalent on sloping work in the Rand and Cornwall at this time. The initial stages of such work known as 'collaring' produced very considerable amounts of fine dust. The downward direction of most of these holes facilitated the application of water after a depth of about 4-5 inches. However the beneficial effects of wetting in hand-drilled slopes was off-set by the wide shovelling areas and the occasional necessity of drilling on 'uppers' or overhead slopes.⁵⁴ Machine drilling, whether on sloping or development work always

⁸⁰ These investigations were, (i) in Cornwall: HCM Report 1904 and RCMMQ, 1914; (ii) in South Africa: MPCR, 1902-3; MRC 1907-10; MP(M)CR, 1911-12; GRMPPC, 1916.

⁵¹ Mining Regulation 106, s.33, was amended in 1913 to systematize all blasting at the end of each shift: Regulation 60, s.1 and 2, was amended in 1919 to confine blasting to once in 24 hours and legalize 'cut' and 'round' blasting in the same shift in the same end; there is no evidence of this practice being introduced in Cornwall at this time.

" MPCR, 1902-3, paras. 50-4 drew special attention to these areas.

⁵⁴ See for example HCM Report 1904, 29.

⁵⁴ *Ibid.*, 9. A 'Stops' was/is the working place in the lode; 'sloping'—winning of ore;

caused large amounts of dust, especially in the period under review, because of the nature of the machines and the prevalence of dry drilling. It was possible to off-set the more obvious effects of this in shafts, winzes and wide slopes because the majority of holes were 'downers' and so could be treated with water to allay the dust after the initial period of drilling. However, in raising and boxholing, the holes were all 'uppers'. When considered in conjunction with the deleterious effects of blasting in development ends under the 'cut' and 'round' system it is no exaggeration to describe such working conditions in Cornwall and the Transvaal as lethal. The following description of drilling on 'uppers' by the Miners' Phthisis Prevention Committee of South Africa applied equally to Cornish conditions in this period:

. . . large quantities of dust are produced throughout the whole period of operations. This, if unchecked, pours out in a cloud, and the finest portion being taken up in suspension, the air is carried away through the drive to other working places traversed by the air current, being inhaled not only by the workmen engaged in the actual operation of 'raising' but by others who happen to be in the vicinity. Those persons engaged in 'raising' have unquestionably in the past been the class most liable to develop miners phthisis and the fact that many samplers and shift bosses engaged in the superintendence of development work in the early history of these fields became affected with the disease is considered to have been largely due to 'raising' operations being carried out without water.⁵⁵

However, the question of dust removal in raises and overhand slopes was slow to be solved because of the particularly unpleasant conditions produced by the slime resulting from wet drilling in these conditions, and by the inefficiency of most respirators.⁵⁶

Thirdly, the whole question of ore removal greatly aggravated the problem of dust in mine air in Cornwall and the Transvaal. Shovelling, tramping and tipping were all operations which raised large amounts of dust, especially when undertaken with dry ore. These operations also had the effect that they could spread more rapidly the dangerous fresh fine particles around a larger area of the mine than would be the case with the simple passage of air currents. This was a particular problem in single shaft mines, or where ore bins were placed close to the area of the downcast shaft. The vitiation in these areas, and of the waiting places by the downcast shaft, often facilitated the spread of dangerous dust, by its injection into the main

'levels'—horizontal tunnels driven into the lode to expose the ore in depth; *'Overhand'* sloping—working upwards into the lode from the *root ('back')* of a level, produces *'uppers'* holes, whilst *'underhand'* sloping—where the lode is worked from a higher to a lower level, produced blasting holes termed *'downers'*; *'winzes'*—intermediate shafts, sunk from a higher to a lower level; *'raises'*—intermediate shafts made from a lower to a higher level; *'boxholes'*—connections into the main level, incurred in development, to allow access for compressed air and water pipes. HCM Report, 1904, 9, and B. Earle, *'Cornish Mining'* Truro, 1968, 49, 54, 64.

⁵⁵ GRMPPC, 1916,27.

⁵⁶ See for example MRC, 1907-10,40.

air currents of the mine, or hitherto uncontaminated areas. The obvious answer of avoiding these problems by dampening the ore was not as readily available as might be supposed. *The Health of Cornish Miners Report* summarized the problem as follows:

The dust produced in shovelling ore, and at ore-shoots etc., can be avoided by keeping the ore damp. If, however, the air of the mine is dry, it is very difficult to keep the ore and stone constantly damp . . . If the ventilation of a deep metalliferous mine is very ample, the air usually carries off moisture from the slopes very rapidly, with the result that everything is dry, and dust is produced. This is a natural result of the fact that the temperature is higher in the workings below ground than on the surface, or in a downcast shaft, so that air, even though it is saturated with moisture on the surface or in the downcast shaft, will take up a great deal of moisture in passing through the workings . . . Thus the good effect produced by the air may be more than neutralised by the bad effect due to drying, and a greater tendency to dust formation."

The real importance of this statement can best be appreciated when taken in conjunction with the problem of temperature and humidity in working places. This problem was the fourth of the risks identified by the six reports. One implication of the Cornish report was that a degree of restriction on the free passage of air would have substantially increased the possibilities of keeping the ore and working places damp. It would also have increased the temperature and humidity in these working places at the same time. This was at best uneconomic:

A man cannot, and in any case will not, do a full day's work in air which is both very warm and very moist; and where possible temperatures above 75° and >° 80° Fahrenheit should not be exceeded.⁵⁸

Such a state of affairs could also be dangerous, for it increased a man's susceptibility to heat stroke. Other dangers also waited upon a policy of dust control which relied too heavily upon constant wetting to offset the drying effects of ventilation. In general, too much water in the mine workings raised the possibility of infection induced by dampness and humidity underground. Such risks could easily turn cases of 'simple' silicosis into infective cases of miners' phthisis.⁵⁹ In short, Cornish and Rand miners were caught in a vicious circle which ensured that they would have to run the gauntlet either of dry and dust laden workings, or face the dangers of infective disease in excessive heat and wet workings. These problems were much aggravated by the dangers of drastic temperature

" HCM Report, 1904,29.

"*Ibid.*, 30.

" Irvine, Mavrogordato and Pirow *op. cit.* 183, 207, confirm this important point and state that a change in the type of silicosis present in South Africa can be observed between 1900 and 1930; viz an increasingly early tuberculous infection became observed as the volume of water underground increased. This also increased the risk from Bilharziosis and Ankylostomiasis.

change upon emergence from the mine at the end of the shift. Inadequate changing houses, and inferior quality housing and compounding, increased the risks of infection still further.⁶⁰

Lastly, these reports indicated that the dangers of phthisis by no means ended once the tin or gold ore had been lifted to the surface. Surface workers who dealt directly with the initial process of metal recovery were also exposed to the dangers of dust through evaporation of water applied to the ore underground, through the release of dust upon pulverization of the ore by the stamping batteries, and inadequate ventilation in the crusher houses. As late as 1916 the *Miners' Phthisis Prevention Committee of South Africa* found that air in the crusher houses could contain between 25 to 100 mg of dust per cubic metre.⁶¹ This was no less than five times as great as the incidence of dust in underground air passages recorded by the Government Dust Inspectors in the same year. This latter figure was itself considered unsatisfactory in view of the particular danger of microscopic particles in the air."

Such widespread areas of danger which these reports revealed made even concerted efforts of control difficult. Such prophylactic measures as were undertaken, especially in the earlier period, were, in addition, undermined by other factors as well. For example, the extent of dangers from dust produced in blasting was only slowly appreciated. This led, in the Transvaal particularly, to a concentration upon the dangers of drill work, and a neglect of the dangers of 'promiscuous blasting'.⁶³ Further, the system of piece-work payments, or tut and tribute working, which put premiums on speed, often mitigated against the adoption of such safety precautions as were available because they slowed the miners' progress. It was commonplace for mine managers and government inspectors to note that:

... for the welfare of the health (sic) of the rock drillers every precaution had been taken ... but he regretted to say that the men from time to time were reluctant and in some cases refused to make use of appliances provided for the prevention of the formation of dust and consequently for the preservation of their health.⁶⁴

On mines where this did not apply, the situation was often aggravated by the unwillingness or inability of mine management to provide adequate

* See for example MPCR, 1902-3, paras. 59-62, also *Transvaal Report of the Coloured Labour Compound Commission*, Pretoria 1905, *passim*; in Cornwall in 1904 there was no hospital where cases of miners phthisis could be treated and the affected men remained in then-homes, HCM Report 1904; the West Cornwall Miners Hospital only took cases that had a good prognosis, CRO Truro DDX436, 5-26 Miners Hospital Records.

* GRMPPC, 1916,37.

" Union of South Africa *The Prevention of Silicosis etc.*, 41-2.

⁸ This phrase was coined by A. E. Payne, H. Pirow, and F. G. A. Roberts in 'Historical Review of Mining Conditions on the Witwatersrand and the changes which have taken place since the early days of the fields', ELO, Int Conf, 1930,125.

⁸ The Workers Union and the Mine Managers' CRO Truro Mining Papers 20th C. October 1917, DDX 85/12.

safety measures for fear of their effect on overhead charges. Not until 1908, for example, were ventilation fans installed below ground on the Witwatersrand. As late as 1919 very little that could be called effective had been achieved by way of enforced circulation of air along the working faces.⁶⁵ Also paucity of Government funds and information, and even resolution to tackle the problem, contributed further to this general disregard of industrial hygiene. The 1912-14 Royal Commission on Metalliferous Mines gave the following summary of Cornish conditions, which could equally have applied to the Witwatersrand situation at the time:

We are of the opinion ... from personal observation, that the rules have not in all cases been strictly enforced or observed. It is natural perhaps, that the miner should be careless about the matter, because the danger is not so obvious or immediate as to impress him vividly. Each man is apt to think that the danger is so remote that he may hope to escape from it. The observance of the rules gives trouble to the workmen; and on the other hand, the owner or manager is perhaps reluctant to enforce with sufficient severity rules which are unpopular with the men employed, especially as the danger is one that only concerns individual miners."

As can be imagined, the net result of these conditions was one of appalling mortality, both on the Rand and in Cornwall. This state of affairs was much aggravated by the migration patterns of the Cornish miners who sought work in large numbers on the Rand in the 1890s and 1900s. Thus between 1894 and 1904, deaths from phthisis in Cornwall never accounted for less than 7.5 per cent of all deaths recorded. The Cornish death toll for phthisis fluctuated between 358 and 497 deaths per annum in these years.⁶⁷ In 1898, deaths from phthisis were equal to an annual average decimation of a declining working population in the mines of 7.6 per cent. Between 1904 and 1912, the Camborne district of Cornwall alone recorded 336 deaths from phthisis, of which 281 were men and 55 were women.⁶⁹ The latter figure is indicative of the continuing dangers from the crusher houses in Cornwall, as the majority of surface work on Cornish mines at the time was performed by the 'Bal Maidens'.

The figures for the Transvaal are even more striking, hi 1909 deaths from phthisis, including miners' phthisis, accounted for 9.6 of all deaths recorded in that year. This figure, which was the second largest category of deaths recorded for the year, represented a gross total of 1,228 deaths.⁷⁰

" Union of South Africa, *Prevention of Silicosis etc.* 41-2. "

Second Report of RCMMQ, 1914, 148, Cd7476, 1914.

⁸ Cornwall County Council Sanitary Committee Returns, 1894-1904, Rashleigh Scrap-books Royal Institute of Cornwall Library.

* *Ibid.*; *ist Report of RCMMQ*, 1912-13.

" *Second Report of RCMMQ*, 1914, App. O.

⁷⁰ 1909 Census of the Transvaal; causes of Death for the Year ending 30 June 1909, Union of SA Printed Annexures to Votes and Proceedings, 1910-11, Vol 6, 14-22.

Taken together, lung diseases accounted for 35.8 per cent of all deaths registered in the Transvaal in 1909, a striking and unusually high proportion of deaths for one single category. It is worth noting that the largest category of sufferers from phthisis in 1909 were so-called 'coloured males'—1,027 of whom died of the disease.⁷¹ This figure underestimates the total number of phthisis deaths amongst 'coloured males' because many sufferers would have been repatriated to areas outside the colony. This also holds true for the figures for white male deaths from phthisis. Thus, in 1913, no less than 289 phthisical white miners were repatriated by the Union Government under the terms of the Miners Phthisis Act 1912." The third largest category of repatriates were 49 men returned to Cornwall. These figures should not however be seen as random examples.⁷³ In 1902, the Transvaal Government Mining Engineer had estimated that:

Of the 1,177 rock drill miners employed, in the Witwatersrand mines prior to the War, 225, or 16.75 per cent had died during the two and a half years immediately following the outbreak of hostilities.⁷⁴

In 1910, the *Transvaal Mining Regulations Commission* indicated that between 1905-07 phthisis, including miners' phthisis, accounted for 43.1 per cent of all deaths of white mining males over 20 years of age. Other respiratory diseases accounted for a further 17.9 per cent, making a total of 61 per cent of all deaths from all lung diseases amongst this group of white miners. The comparative figures in these years for white non-mining males of the same age groups being 10.2 per cent (ordinary phthisis) 15.8 per cent, and 26 per cent respectively.⁷⁵ In 1911-12, the *Miners Phthisis (Medical) Commission* reported that out of a total of 3,136 white underground miners actually at work, no less than 26.1 per cent had definite signs of silicosis, and a further 5.5 per cent could be considered possible cases, but were then doubtful.⁷⁶

The seriousness of the situation revealed by the figures might lead one to suppose that they were sufficient reason for reform and change. The Chamber of Mines in the Transvaal certainly indicated that this was the case. At their Annual General Meeting for 1902 the Chairman claimed:

Reports of mortality from Europe among miners who had worked in the Rand pre-War caused the Executive Committee considerable alarm and immediate steps are to be taken to improve conditions and minimize the risks."

¹ *Ibid.* Age distribution of Major Causes of Death in the Transvaal, 1908-9; the deaths of adults start from age 15.

⁵ *Report of the Working of the Miners Phthisis Board up to 30 November 1912 and first six months ending 31 January 1913*, UG. 13-'13: Destination of Beneficiaries Repatriated.

* *Ibid.*

* *Report of the Transvaal Government Mining Engineer for the year ending 30 June 1902.*
⁵ MRC, 1907-10,37; the incidence of ordinary phthisis is indicative of the extent to which the air of Johannesburg was vitiated by its surrounding mines. "MP(M)CR, 1911-12,5." ARTCM, 1902,xxii-xxiiiL

As the above figures indicate however, things had hardly improved on the Rand between 1886 and 1912. In the immediate aftermath of the Chambers statement, indeed, things actually got worse. Cornish rock drill miners from the Redruth district of Cornwall working on the Rand, actually suffered a deterioration in their life expectancy if they worked in the Transvaal only. Between 1902 and 1910, the average length of rock-drill work for these men prior to death, declined from 4.7 years to 4.1 years. Only after 1912 is there any perceptible improvement." The situation in Cornwall showed an even more dramatic decline. In 1902, the average length of employment on rock-drills for men who died of phthisis who had worked in Cornwall only was 8.4 years. In 1911, the average length of employment for this type of work prior to death had declined to 5.8 years. Again, only after 1912 is there any perceptible change.⁷⁹ Nor was there any significant change in the average age of rock-drill men at the time of their death. On the Rand the average age at death rose from 36.3 years in 1902 to 36.8 years in 1912 for Cornish rock-drill men who had only worked in the Transvaal. In Cornwall, the average age at death for the non-migrant rock-drill miner rose from 37.5 years in 1902 to 39.4 years in 1912. As could be expected in this situation, the fate of those who worked in both areas was even worse. Their average length of employment on rock-drills prior to death between 1902 and 1912 declined from 11.6 years in 1902 to 4 years in 1912. Their average age at death did, however, show a more marked tendency to rise in the same period— being 36.4 years in 1902 and 44 years in 1912.⁸¹ This particular upward trend appears to be the result of a rising average age of men starting work, rather than the effect of any noticeable improvement in conditions.

In brief, Cornwall and the Rand claimed more lives of rock-drill men more quickly, than any other areas of the world to which these Cornishmen migrated, in the decade after the Chamber of Mines had expressed 'considerable alarm'. It was with justice that a contemporary exhorted his fellow miners to refrain from making that fateful trip to the Rand:

Miners of England and Australia, however poor may be your lot, however dark your present prospects, let no man tempt you to South Africa with tales of the wages that are paid upon the Rand! The wages are high indeed, but the price the workers pay for them is paid in suffering and blood. Better a thousand times, to perish as paupers in your own country, if such a chance should hap, than to race to an early tomb in a hot, deep African cavern. "

In the period after 1912, the similarities between the situation in Cornwall and the Rand begin to decline. After 1916 it is the differences rather than the similarities which are the striking feature. There were virtually no new

" 2nd Report RCMMQ, 1914,148: Table 2.

" *Ibid.*

" *Ibid.*

"Pratt *op. at.*, 166.

initiatives by the Cornish tin mining industry in prophylactic measures to control the incidence of dust in mine air.⁸³ Despite the addition of a Special Rule in 1905, issued under *the Metalliferous Mines Regulation Act of 1872*, following the publication of the *Health of Cornish Miners Report*, the state in Britain remained reluctant to intervene.⁸⁴ When the 1906 Workman's Compensation Act was passed, phthisis was omitted from the list of scheduled diseases on the grounds of the difficulty of apportioning liability and the risk of employers discharging potential sufferers.⁸⁵ When, finally, some form of compensation for phthisis was introduced under the terms of the Workmen's Compensation (Silicosis) Act, in 1918, the act was honoured mainly in the breach.

As in Cornwall, the first major initiatives in the control of phthisis in South Africa came from the State. Thus, in a series of Acts between 1912 and 1918 known as the Prior Law, the State laid down the basis for a comprehensive system of compensation for victims of miners' phthisis.⁸⁷ Between 1911 and 1919, fundamental changes in the Mining Regulations were introduced to control working hours and conditions.⁸⁸ After 1916 the basis was laid for a thorough medical check upon the working conditions of the mines through a series of periodical and initial examinations on white and black miners, and through the establishment of a Government Dust Inspectorate.⁸⁹ Partially in response to these initiatives, the industry also introduced important prophylactic measures. In 1911 for example, it established, with state aid, a sanatorium for white miners suffering from phthisis at Springkell, Modderfontein.⁹⁰ In 1914, a Standing Committee on Dust Sampling was established by the Chamber of Mines, and in 1915 the Chamber instituted a system of paid annual leave for the white miners for the first time.⁹¹

The consequences were as different as the responses in the two areas.

⁸³ Not until 1916 was a new type of drilling machine which could not be successfully worked without the use of water, introduced. This 'anti-phthisis' machine was however, only introduced on *some* mines. *Report of Inspector of Metalliferous Mines 1916*, Cd8732, 1917-18.

* "The Workers Union and the Mine Managers" *op. cit.*, the Metalliferous Mines Regulation Act was passed in 1872, 35 and 36 Viet c 77.

" *Report of the Departmental Committee Appointed to Enquire into the System of Compensation for Injuries to Workmen*, 1920, Cd 816, (1920), 25.

⁸⁶ For a full analysis of the 1918 Act see ILO, *Studies and Reports Series FNo 16: Workmen's Compensation for Silicosis, in the Union of South Africa, Great Britain and Germany*, Geneva 1937; in 1919 the *Mining Magazine* stated that 'little notice seems to have been taken (of the Act) in Cornwall', volxx, 1919.

" A. B. Du Toit, G. E. Barry and N. P. Dale 'Review of the Development of Silicosis Legislation in South Africa, with Particular Reference to Workmen's Compensation' ILO, Int Conf, 1930, 648-74; the following Acts comprised the Prior Law: No. 19 of 1912; No. 29 of 1914; No. 44 of 1916; No. 44 of 1917; No. 24 of 1918. The Prior Law was briefly preceded by a temporary Miners' Phthisis Allowance Act, No. 34 of 1911.

⁹¹ Union of SA *The Prevention of Silicosis etc.*, 11.

⁸⁸ Irvine, Mavrogordato & Priow, *op. cit.*, 187-94.

" ARTCM, 1910-i, p<m/m.

" Payne, Pirow and Roberts, *op. cit.* 120-1.

During the period of initial reform in South Africa it was still true in Cornwall that:

The miner who came up to grass at the end of a shift without being as white as a miller and covered from head — eyes nose and mouth — to foot in dust, was regarded as not having done a proper shift's work by the Bal Captains."

Migrants and non-migrants alike who still suffered from the disease remained a prominent feature of mining towns in the area:

For some-years, men dying in the smaller houses in the back streets of Camborne and Redruth were brought into the open air on mattresses and laid on the side walks."

whilst the only sound to break the quiet of the mid-morning shift above ground was the incessant coughing of men dying of the 'Africa' complaint.⁹⁴ In South Africa on the other hand, after 1912 there began a steady decline in the number of cases of miners' phthisis. In 1912-13 for example, the Miners' Phthisis Board made no less than 2,330 original awards under the 1912 Act. By 1915-16, the Board was only making 783 new awards.⁹⁵ In

^ the Miners' Phthisis Prevention Committee was able to state with justification that:

conditions underground have greatly improved since the inception of the Committee in 1912, when the general use of water for dust laying was inaugurated."

The picture in Cornwall between 1876 and 1919 is one of almost uninterrupted unwillingness to control the disease of phthisis. In South Africa, after a period of approximately twenty-five years, a very considerable measure of reform was introduced after 1911, which, if it did not eliminate, certainly controlled the ravages of the disease. How is this difference to be accounted for in mining areas whose initial neglect had been so similar? The answer must be sought in the changing viability of the two different industries in this period. In Cornwall, the period was one of almost uninterrupted decline. In 1880 there were 138 mines operating.⁹⁷ By 1907 there were only 88.⁹⁸ In 1919 the number had declined again to 60 and by 1923 it had fallen to two.⁹⁹ Similarly the number of workers continued to decline.

^K Holman, *op. dt.*, 8.

⁹ R R Blewett, 'The Village of St Day in the Parish of Gwennap', Paper given at a Board of Education Short Course on 'The Citizen in the Modern World', Cambridge 1935, Redruth, Library c/942.37.

⁹¹ Private Communication to the Authors by the Landlord of the Miners Arms, St Just, Cornwall, August 1976.

⁹⁵ D. Spence Fraser and L. G. Irvine 'Statistical Account of the Incidence and Progression of Silicosis Amongst Gold Miners of the Witwatersrand', ILO, Int Conf 1930,621.

" GMPPC, 1916,46.

⁹⁷ See note 42 above.

⁹¹ *Annual Report and Statistics of Mines and Minerals (ARSMM)* 1907,Cd4343, 1908.

"ARSMM, 1919, Cd 1007, 1920; *Annual Report of the Secretary for Mines* 1923, London 1923.

In 1900 there were 3,551 underground miners in Cornwall; by 1920 there were only 2,105.¹⁰⁰ The virtual elimination of Cornwall as a major tin and copper centre which these figures reveal, indicates the major reason for the continued neglect of working conditions: what profitability remained in the tin trade had to be bought at the expense of working men's health. This was made quite clear by the Inspector of Metalliferous Mines, who, when explaining away his failure to insist on what safety rules there were, stated:

I have not felt it expedient to press the matter as strongly as might be, for fear of arriving at the last straw which would bring about a total collapse of what little mining vitality remained.¹⁰¹

On the Rand, the situation was completely different. The period 1886-1910 saw a virtually uninterrupted ascent by the Transvaal fields to the undisputed position of the world's largest single producer of gold.¹⁰² As early as 1903, the Rand goldfields had a nominal capital value of £106,000,000.¹⁰³ Similarly, the labour force and the scale of working had increased in line with this trend, in 1889 there were about 12,000 white and 100,000 black miners on the fields working at an average sloping depth of 800 feet. By 1916 there were 11,000 white and 155,000 black miners at work, with an average sloping depth of 1,600 feet in addition, the number of machine drills at work had risen from 5,500 in 1910 to 9,500 in 1916.¹⁰⁴

It must be apparent that the viability of an industry of this size meant that the payment of compensation and the introduction of prophylactic measures, once the period of initial capital accumulation and consolidation had passed, was of small consequence. Indeed, the economic health of the industry allowed it to absorb the reduction in blasting time, and support a considerable burden of compensation without apparent difficulty. Between 1912 and March 1921, the industry had contributed substantially to an aggregate amount of compensation totalling £5,462,504.¹⁰⁵

Nevertheless, such general considerations, although they explain the fundamental reason why reform of working conditions was possible for the mining industry in the Transvaal, do not explain the actual timing of its introduction. For an explanation of this one must look to a series of influences which converged in the period 1907-16. Firstly, the policy of the state towards the mining industry underwent a change after 1907. The victory of Botha's *Het Volk* government in alliance with the Labour Party

¹⁰⁰ ARSMM 1900, Cd 766, 1901; *Reports from Commissioners: Mines and Quarries*, 1921 xli, 115.

¹⁰¹ *Report of the Inspector of Metalliferous Mines 1898*, Cd9264, 1899.

^c *Annual Report of the Transvaal Government Mining Engineer*, 1910.

^B *Report of the Sub-Committee on Mining*, 29 August 1903, Exhibit 9, evid of TCM to TLC in ARTCM, 1903, Iv.

^M Irvine, Mavrogordato and Pirow, *op. cit.*, 181, 194.

⁰⁸ TCM, *The Gold of the Rand; A Great National Industry, 1887-1923*, Johannesburg 1924, 62-64.

meant that some form of action upon working conditions was necessary if this alliance was to hold good. It is no accident, therefore, that the *Mining Industry Commission of 1907-08* and the *Mining Regulations Commission of 1907-10* made detailed investigations into the working conditions which were conducive to the development of phthisis.¹⁰⁶

Such Commissions, and more particularly their recommendations on phthisis control, owed a great deal to the increasing militancy of white mine workers in this period. In 1907 and again in 1913 there were serious strikes amongst white miners, both of which elicited concessions from the government and the industry over the control of conditions. Thus in November 1908 the Mining Regulations Commission urged the Government to take immediate steps to amend Regulation 146, to place responsibility for the provision of water in working places upon mine managers, rather than leaving it up to the white miner to provide it.¹⁰⁷ In 1914, the Chamber of Mines responded to the 1913 strike, in part at least, by agreeing to monitor permanently the extent of harmful dust in the mine atmosphere.¹⁰⁸ Also the changing labour policies of the Rand mining industry enabled it to contemplate a changed policy on dust control with equanimity. Thus the

changing proportion of migrant European labour in the white workforce, and the declining numbers of European miners, both relative to black miners and absolutely, meant that the costs of compensation measures, for example, could be effectively controlled. Probably even more important in this respect was the increasing control of the African labour market by the industry after 1907, which facilitated the passing off of the major burden of phthisis onto the black work force, as the figures for the 1909 census quoted above seem to indicate. This process was intimately related to the process of de-skilling of the white working class, which simultaneously reduced the number of white rock drill workers at the same time as it raised the number of Africans employed on the same job. This trend is reflected in the rock drill figures quoted above. In line with this trend, by 1910 tuberculous phthisis was the second largest killer of African labour, representing no less than 18 per cent of all African mortality.¹⁰⁹

More immediately, the hand of the industry was forced by the revelations that phthisis was on the increase. This trend was noted above. Given the changing labour policies of the industry at this time, this threatened to turn the labour force, literally, into a rapidly wasting asset. By 1910 at the latest, the industry was aware that there was a real contradiction between the

underground conditions which had made such a rapid growth possible, and the possibility of maintaining that rate of growth under such conditions in

^v This is discussed in E. Katz 'White Workers Grievances and the Industrial Colour Bar 1902-13' *South African Journal of Economics*, 42, 2, 1974, 135-8. ^w MRC, 1907-10, 40-1. ^{'''} Payne, Pirow and Robert, *op. cit.* 120. ^{'''} MRC, 1907-10, 50.

the future. An indication of this may be seen in the Chamber of Mines' publication of a highly critical letter from Dr J. L. Aymard in their Annual Report for 1910, which stated:

I regret to say that, in my opinion, the water spray issuing from the body of the drill, as in general use, is not only worse than useless, but a danger in itself, and for the following reasons:- The fine globules of spray floating in the air act as the most perfect conveyors of the deadly minute particles of dust (which are the most fatal) to the air passages. Either the spray is not in general use, as supposed, or it is useless. Under present conditions, I am inclined very strongly to believe it to be worse than useless, and miners' phthisis is on the increase.¹⁰

Dr Aymard had in fact struck upon the critical problem in the Chamber's strategy. De-skilling of whites required the continual increase in the number of black rock-drill workers. However, the reciprocating piston rock-drill, by requiring this fine spray which increased the risk of phthisis, threatened to kill those upon whom the policy depended. Furthermore, the water-feed axial drills which began to be introduced at this time also suffered from the same defect. The inability of mining engineers to separate the air from the water in the drill steel constantly raised the danger of air locks and the creation of the same fine mist.¹¹ To resolve this contradiction between present working conditions and future growth, the Chamber embarked upon the policy of co-operation outlined above. This had the additional advantage of buying off white working class militancy. Furthermore, to tease out whatever reluctance remained on the part of the mining industry, the State drafted compensation legislation along lines which effectively delineated the industry's costs, and through the law's provisions debarring claimants from underground work in the future, ensured a stronger and healthy work force.¹² The possibilities for intensified and more prolonged exploitation of this improved workforce of *New Rand Miners* admitted for work after the introduction of the 1916 periodical examination, can be seen in the constantly extending periods of underground work provided by these men.¹³ This examination had the effect of excluding overseas miners who had contracted phthisis elsewhere. There is some evidence to suggest that the existence of a lump sum compensation payment was attracting silicotic men from Cornwall anxious to receive some payment for their damaged

* Dr J. L. Aymard to the Chairman, TCM, 30 June 1910, ARTCM, 1910, 389.

¹ Holman, *op. cit.*, 16.

¹ The debarring certificates were a source of major irritation to the miners who were effectively debarred from obtaining any other type of work—see for example the evidence of J. Hindinan to *Select Committee on the Working of the Miners' Act 1912*, 6 March 1914, paras. 555-62;

The desire to control the total amount of compensation distributed was one of the major reasons given by this Select Committee for recommending an Amending Act to the 1912 Law—see *Report*, S.21(d).

¹³ Spence, Frazer and Irvine, *op. cit.*, Tables 3 and 4: 624-5.

health. The 1916 measure effectively terminated this practice.¹¹⁴

This comparative investigation into the prevalence of phthisis amongst mine workers in Cornwall and the Transvaal between 1876 and 1918, suggests two important general conclusions. Firstly, the existence of high mortality due to industrial disease was itself no guarantee whatever that significant reforms inevitably took place. Substantial reform of the working conditions of the Witwatersrand gold 'mines, themselves revolutionized by the application of technology which was largely instrumental in causing such a high disease rate, did not occur for the first twenty-five years of the commercial exploitation of the fields. In the Cornish tin mining industry, similarly revolutionized in its productive technique, there were no reforms of any major consequence in the working conditions of the miners. Secondly, it appears that such reform as did take place, only did so in the industry with a sufficiently strong and stable market position to bear the price/cost implications of the changes in working conditions which inevitably occurred. This meant reform was confined to the South African industry. In Cornwall with the industry in a weak market position, and in a Suite of long-term structural decline, reforms did not take place on any significant scale. Furthermore, failure to introduce reforms was not only a precondition of the continuance of any profitable operations in Cornwall, but might even have been the method most likely to ensure it. For by creating conditions which hastened the wastage of the work force in this state of decline, lethal working conditions facilitated the creation of economic conditions which permitted the economical substitution of labour intensive techniques by technologically intensive ones. By extension this facilitated the maintenance of output on the remaining mines which went some way towards maintaining the mass of profit. In short there is reason to echo this hyperbolic estimate of the Cornish/South African connection in this period:

The name 'South Africa' is cut deep in the heart of mining in Cornwall, not so much engraved with an instrument of steel, as jagged and ghastly with the malignant quartz that hid the gold and filled the lungs of the Cornish pioneers. "*

* Authors' interview with Mr Arthur Andrew of Liskeard, at the County Hall, Truro, 14 November 1977.

* H. Pascoe in *The Cornishman*, 9 January 1924, (we are indebted to Mr Alfred Jenkin of St Austell for this reference).