Dangers and Health Hazards: Early Decades of Western Australian Gold Mining

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Much of the small historiography of gold mining in Western Australia focuses on the first two or three decades of the industry. Major contributors to the knowledge of this period, beginning with the years of the first major gold finds in Western Australia (1892 and 1893 in Coolgardie and Kalgoorlie respectively), described the discovery of gold, the early speculative period, the emergence of economic growth and industrial production, the influence of the goldfields on the evolution of Western Australian political and cultural institutions and the social life on the Goldfields, as well as the role of Kalgoorlie gold in the Imperial economy. [1]

In the 1990s, understanding of the extent and role of technological innovation in early Western Australian gold mining gained significantly from the work of Hartley[2] and, to a lesser degree, from that of Bertola.[3] Hartley investigated metallurgical innovations, including the dry crush and roast and the Diehl processes, filterpressing, the use of a copper converter for gold smelting and the tube mill. His conclusions, important for this article, were that there was a 'large number of rapidly implemented incremental improvements in gold processing made in Kalgoorlie in the 1900s'[4] and that, between 1901 and 1905, 'average Kalgoorlie unit treatment costs had been halved and were comparable with those on other major fields with similar ores, despite Kalgoorlie's environmental disadvantages', [5] prime among which were the shortage of water and the cost of transport.

Among the organisational and technological changes to the labour process before World War I which Bertola identified were:

i. new forms of machinery, for example tube and ball mills, the vacuum filter, air powered hoists, self-dumping skips, conveyor belts, electric powered motors and drill sharpening machines;
ii. improvements to existing machinery, for example to roasting furnaces and condensers;
iii. increased plant capacity, for example of winding engines, compression units, mechanical drills underground and surface plants [6] and,

iv. consequent on company amalgamations, attempts to centralise operations, for example treatment processes, to achieve, *inter alia,* reductions in the number of workers.

Bertola also emphasised the major impact of available, cheap, fresh water to the mines from 1903 onwards by means of the Goldfields Water Supply scheme, and the role of this water in the spread of complex treatment processes and in reducing both the costs of production to the mines and the cost of living to mine labour. [7] Bertola's conclusion, also critical here, was that the technological and organisational changes introduced by the mines allowed them, as of 1905, to gradually increase their output without increasing to any significant extent the size of their workforce. By 1907, the companies had ‘radically' improved productivity. By 1910, they had achieved both peak production and peak productivity of labour. [8]

The conclusions from Hartley's and Bertola's works are that the large Western Australian mines achieved major efficiency gains and cost reductions through technological and organisational change at least up to 1910. Segal’s work [9] additionally demonstrates that, between 1902 and 1914 the industry, through the Chamber of Mines of Western Australia, took advantage of compulsory arbitration to reclassify its workforce into some new occupational divisions, thereby further reducing costs. Industry representatives also prevailed with the Arbitration Court to reduce wages directly and, whenever this was not possible, to maintain the *status quo.* When arbitration failed or was not possible for some reason, they often used collective bargaining to the same end. Better yet, from the perspective of individual mine employers’ balance sheets, a pervasive shifting of workers from wage labour to piece-work (commonly referred to as ‘contracting’) allowed them to evade industrial regulation and to intensify work. Individual mine employers also made economic decisions in relation to occupational health and safety in their mines which reduced or minimised this area of expenditure.

The managerial decision-making outlined above affected the organisation of work, the effort, the discomfort and risks the labour process entailed and therefore, the work experience of early mine workers. It also impinged on workers’ sense of occupational status and the wage justice they felt they received. Garnsey has argued that analysis of the changes to the division of labour can be linked to analyses at the macro level and to ‘structural differentiation’, that is, class formation. [10] It is the purpose of this article to begin the kind of analysis that Garnsey advocates, and to do so by focusing on the under-researched[11] labour process in the early mines. Studying the logic the labour process reflects (the 'logic of industrialism'),[12] the risks it entailed and workers' experience of it, provides an appropriate base from which future studies of the social relations of production in the early mines can proceed.

This article therefore examines the labour process in the early mines, both when mining at depth and in processing and treating gold-containing ores on the surface. Also it describes mine workers' experience of this process: the effort, discomfort, risks taken and hazards faced. Furthermore, it explores some of the connections between the logic of efficient production and adverse health effects on miners.[13]

Because methods of working the mines varied greatly, the labour process is examined in this paper in only generic terms, but sufficient will be said to highlight the diversity of occupations and processes that were followed.

Shaft sinking

Shaft sinking or 'sinking' involved 'systematically opening up blocks of ground' by digging shafts for 'development' or exploitation purposes.[14] In the early years of Western Australian gold mining, gold mining companies considered that speed was especially critical at the sinking stage, in part due to of the economic advantages in quickly supplying the mine's mill with ore for processing.[15] Sinking included lowering and hoisting of men, tools and timber, the setting up and removing of rock drilling machines and boring out the bottom of the shaft (that is charging and firing it). Also under this heading was removal of the reduced rock either by filling buckets or kibbles for hoisting from the surface, or by winching it from an underground position to a location in the mine where it was either tipped into trucks for transfer to the surface in cages or skips, or used for stope filling.[16]

Sinking also involved timbering the shaft, and construction of head frames to assist with winding[17] and building penthouses to protect workers in the shaft. Associated activities included providing power, water, compressed air and communication to the underground areas.[18] Sinking could also involve excavating and timbering capacious chambers known as 'plats',[19] which were the 'loading areas near the shaft at each level of the mine'.[20] These were sited where the different 'levels'[21] were to be developed,[22] and were the point through which miners entered and left the cage, and to which full or empty trucks were transported. Timber, rails and tools and various other supplies were also stored in plats.[23]

The term 'development' as used by some company mine managers in the early days of the industry covered all the work of exploring the ore reserves of a mine to establish their extent, and the creation of various excavations through which the mine could be exploited.[24] Underground passages were known as: 'crosscuts' when extending across the ore body; 'drives' if at right angle to the crosscuts;[25] 'winzes' when burrowed 'from an upper to a lower level'; and 'rises' when excavated 'from a lower to an upper level'.[26] Excavating winzes and rises tested ore distribution and value, determined points from or towards which stoping would take place, and separated exploitable ore into blocks.[27] Winzes and rises were also intended to ventilate the workings.[28] The frequency and distance between such excavations could be critical to the quality of air in a level, especially in 'dead ends', as could the distance between levels. Ventilation was especially poor during the 'development' stage, when winzes were either not yet in place or were being put in a few at a time.[29]

Whereas winzes and rises were dug from the crosscuts, 'stoping', which was the removal of the valuable ore, took place in the drives or levels. 'Stopes' were the underground excavations of gold-containing rock, located 'between two levels' or 'between the first level and the surface', from which the ore was sent to the mill for treatment[30] (rock that did not contain gold was known as 'country rock' or 'country' for short). Stoping was mainly 'overhand', that is from the bottom of the rise in an upward direction, until the upper level was reached,[31] leaving the ore to be shoveled or dropped through chutes to trucks in the level below (overhand stoping was further divided into flat-back, rill, and shrinkage stoping, employed according to the specific conditions prevailing in the mine).[32] Regularly distributed ore chutes allowed ore to be transferred directly to trucks below them, and reduced the amount of shovelling required.[33]

Because there were different methods of sinking shafts, of timbering, of stoping and of constructing chutes, underground operations could differ from one mine to another[34] or even, over time, within the same mine.[35] However, underground operations were not generally as variable in this period as the treatment processes on the surface.[36]

During these years, miners sinking in the Western Australian mines operated large ($3\frac{5}{8}$, $3\frac{1}{2}$ and $3\frac{1}{4}$ inch)[37] diameter rock drills, each worked by two men. In soft rock, shafts could be sunk using hand mining or smaller rock drills operated by one man only. On small mines, miners also timbered stopes and shafts to secure the ground as required. By contrast, on large mines, specialist timbermen used a variety of styles to secure the ground. These specialists were often highly experienced miners with carpentry skills who timbered in pairs, sometimes with the aid of other workers. A large proportion of the underground workforce shovelled the broken ore into ore chutes or trucks. 'Truckers' removed the ore to a designated location in specially designed conveyances (small wagons, heavy in themselves, and once filled with ore, 12-18 cwt), sometimes at a run, often uphill or along twisted lines.[38] Workers called mullockers replaced the mined ore with cyanided tailings or waste rock. Workers also laid the tracks and lines as required throughout the mine.

Figure 1: *'Stoping', Sons of Gwalia Gold Mine 1909*

Source: Courtesy Battye Library, reference 003800D

Treatment and other work on the surface

Generally speaking, according to Hartley, the problem of how to treat the lower grade refractory ores of the Kalgoorlie area economically was resolved either by dry crushing and roasting, to allow 'fine grinding to slimes and filtration'[39], or by chemical methods, involving fine crushing by what were then innovative tube mills, and 'concentration' (the Diehl method).[40] On the Great Boulder Pty mine, where ore was dry-crushed, for example, the process involved mechanically separating, breaking and grinding the ore, then roasting, cyaniding and fine grinding. The ore was then chemically treated and agitated, the solution filterpressed[41] before precipitating the gold and finally disposing of the residues. At several stages of this process, some of the dust generated was also collected and treated.

By comparison, at the Lake View Consols Gold Mine, ore was 'wet-crushed'. After wet-milling the ore, the pulp was classified and 'concentrated',[42] in part further fine ground and the slimed ore bromocyanided. The concentrates saved earlier were roasted, then fine ground, cyanide-agitated and filterpressed[43] before precipitating the gold and disposing of the residues.[44]

Workers on the surface attended to the mine's rock breakers, conveyor belts, concentration tables, mills and pumps. They also saw to the settling, agitation, and precipitation vats and boxes, emptying and cleaning them. Filter pressers, numbering about a quarter of the workforce on the surface, operated the mines' filter presses. Considered to be among the worker elite, they 'had to be strong men with nimble fingers and quick brains'.[45] They were required to turn numerous taps on and off during a filter pressing cycle, and to attend to the physically demanding emptying of the heavy press frames. Trucking of residues on the surface was in some mines the work of horse-drivers, whereas on others it was mechanical. A small number of men supervised the treatment process as a whole or only parts of it.

Workers also distributed and prepared wood for firing the mines' furnaces and boilers, attended to the boilers and cleaned them or, if the ore was to be smelted off the mine, packed and loaded it for transport. Teams of riggers secured heavy equipment, and 'engineers' (fitters, turners and blacksmiths) repaired machinery, while drill sharpeners and their assistants honed drills manually (only some mines had mechanical sharpening machines). Engine-drivers pumped water and hauled ore, equipment and men. The mines also employed electricians, plumbers, bricklayers and carpenters, as required and, on the largest among them, sanitation workers who disposed of pans of human waste and other refuse.

Dangers and hazards

Knowledge and understanding of the ground was essential to all underground work but was especially important in 'sinking', given that the ground was unexplored, water was frequently present and the miner worked in exposed conditions (timbering and the protection of a penthouse followed only after the shaft had reached a certain depth and, even then, not in all cases, a sore point with mining unions).

The miner involved in 'sinking' was vulnerable not only to rock falls, but also to injury from objects being lowered into or raised from the shaft or otherwise falling down it accidentally. Reports of objects falling down shafts included trucks filled with ore, cages, buckets, stage poles, planks and a variety of tools.[46] Miners 'stripping' the shaft, that is preparing it for timbering, worked on stages, and were at risk of being knocked down the shaft by groundfalls or stage collapses. During early Arbitration hearings, the Arbitration Court, relying on miners' evidence, acknowledged that 'shaft sinking required the greatest possible mining skill'.[47] In later years, however, especially outside East Coolgardie, miners appeared divided on how to rate the danger and skill of 'sinking' versus 'rising'. Whatever the comparative risks, workers came to perceive exposure to the risks of rising as unnecessary, arguing that all rises could be replaced by winzes. Rises, however, were cheaper to excavate than winzes, 'since the broken rock falls to the level instead of, as in a winze, having to be hoisted in buckets'.[48] Whereas management in one mine accepted workers' concerns and avoided 'rising' entirely, the more common practice was to sink winzes 'a little more than half way' and then to connect rises to them.[49] According to an 'unwritten' Goldfields rule, which still prevailed in 1912, though how widely is not possible to say, workers working in rises were to do so for no more than a month at a time.[50]

In addition to the hazards already mentioned, there were many other dangers: unreliable winding ropes; inadequately built or dirty, slippery and wet ladders and staging; bursting underground ore bins; faulty doors to chutes causing injuries or deaths when ore rushed through them unexpectedly; [51] misfirings, noxious explosives and detonator fumes;[52] cyanide-associated emissions from the cyanided tailings used as stope filling; [53] incorrect signaling or misinterpretation of signals to engine-drivers; overwinding by engine-drivers; and falls into ore passes or winzes unperceived in the smoke generated by firing.

In some mines, workers underground were exposed to salt water, resulting in 'acute dermatitis' accompanied by carbuncles, which caused 'sloughing, [which] expos[ed] and even penetrat[ed] the muscles'.[54] Cuts exposed workers to the risk of septicemia. Many a worker who fell off a ladder or platform to the bottom of a shaft, if not immediately killed, drowned, as did others exposed to a sudden rush of water from disused workings, or a flash flood which inundated the mine.[55]

The heavy lifting required to work machine drills, to handle, load, lift or tip the cages, skips, kibbles, buckets or oversized trucks of the East Coolgardie mines, and the sustained physical effort of shoveling or trucking over extended periods resulted in back injuries and strains. As in other localities, [56] sustained effort may have led to increased rates of heart disease among workers. Flying rock and steel splinters, cuts from sharp rocks, falls of ground, crushes from moving loads, and blows from tools caused eye injuries, concussion, and fractured or crushed spines, jaws, skulls, limbs, fingers, feet, or toes. At best, they produced only cuts and bruises.[57]

On the mine surface, workers ran the risk of being mangled by moving machinery, such as conveyor belts or revolving shafting or pulleys. Other hazards were crushing of bodies and limbs by overturning machinery or trucks, smothering by falls of dry slimes and, more commonly, poisoning, both acute and chronic, by cyanide solids, solutions or fumes to which workers were exposed. Such exposure could arise, for example, from emptying cases of the chemical, dressing plates with it as amalgamators,[58] filterpressing, trucking slimes from underneath filterpresses,[59]clearing storage tanks or percolating vats, and moving treated tailings.[60] All workers dealing with chemical processes were at risk of exposure to poisons through skin contact, inhalation or both. Other risks were exposure to arsenic oxides, lead, zinc and mercury vapors during reduction processes.[61] Some surface workers were injured or killed by explosive charges accidentally introduced into machinery along with broken ore. Though they were countermanded by regulation, unfenced, unlit or poorly lit passes and poorly maintained or overstressed boilers also exacted casualties.

In smelters, workers faced the additional hazard of lead poisoning as well as heat exhaustion, which was also a hazard leading faced by miners as the mine increased in depth. At the surface, workers also faced extreme heat and sandstorms in summer, and engine rooms that reached temperatures of 120^0F (48.8°C). All these problems, as late as 1915, led members of the Industrial Workers of the World (IWW) to refer to the Kalgoorlie mines as the 'hell holes of the Boulder belt' and to describe them as twice as bad as those at Broken Hill.[62]

The dangers of contracting

Mining unions maintained that what was known as 'contracting', but was really mostly team piece-work, contributed to poor safety standards in the mines. By shifting workers to ‘contracting’, companies could weed out individual workers who complained about unsafe conditions, or even the whole of a mine’s obstreperous work force. Unions also argued that ‘rushing’ by contractors was responsible for most mine accidents, and that contractors took greater risks with their own health, and inevitably also with that of waged workers working with them or alongside them. It was also pointed out that contractors were ‘induced to go into the [fracture] fumes a little quicker’[63] than day workers. Contracting also allowed mine managers to dispense with supervision, an especially significant cost in dispersed and difficult-to-monitor underground locations. The absence of supervision had safety implications, including in the sense that it could reduce managers’ legal liability for unsafe work practices by shifting such liability to workers.

Arbitration Court hearings revealed that contractors often endured poor or difficult working conditions for longer periods than waged workers. Contract workers either did not ‘change about’ at all, or did so less than waged workers, whom management in some mines would shift around regularly, for example from working in the ends to working in better ventilated areas, [64] or from mining in rises to mining that was less demanding physically.

Unions appreciated that payment by results was automatically regressive and attributed this to the competition employers fostered among workers. Competition was increased by casualisation and part-time work, as mine managers purchased ‘just the right quantities and qualities of labour power’.[65] Men might be laid off for parts of the week,[66] or even hired for only ‘fractions’ of shifts (a ‘fraction’ equalled two hours).[67] This practice left many underemployed. Contracting out as much of the work as possible could provide some employers with the additional vicarious benefit of weakening unions. It reduced the impact of unions’ fight to improve safety, as piece or contract workers tended to be less unionised, at least in some districts.[68]

Initially, on some mines, workers resistance to contract work was spontaneous and tenacious. ‘You cannot get men on the Boulder to take contracts, if they can get wages’, one union witness claimed in 1902.[69] Some workers did acknowledge that contract work provided them with ‘big wages’. Even these workers, however, opposed contracts that yielded less than the minimum wage,[70] and complained about being unable to verify the company’s measurement of the work delivered.[71] Moreover, they objected to being arbitrarily shifted from wage labour to contracting on employers’ terms. They also alleged that some mines transferred to contractors the cost of maintenance of the rock drilling machines under the guise of liability for breakages.

Figure 2: *Lake View Consols stoping, ca.1900 [suggesting hazardous practices]*

Source: Courtesy Battye Library, reference J.J. Dwyer photograph, 002883D

Despite substantial opposition, [72] contract or piece-work gained rather than lost ground in the first two decades of the gold mining industry's existence. Not only machine mining, but also filterpressing, emptying of cyanide vats, boiler cleaning,[73] wood trimming, wire splicing[74] and even trucking were done on a piece-work basis. The expansion of contracting, the tensions contracting gave rise to between unions and employers, contracting's role in the wage system generally, and Southern European contractors' role in the wage system specifically deserve further attention. So does the role of contracting in reducing the cost of labour in a declining industry. However, the limits on this paper are such that a fuller discussion of this method of worker engagement and its influence on the labour process has to be deferred to another forum.

Ventilation

Firing, using nitro-glycerine explosives (blasting gelignite, gelignite, dynamite and gelatine dynamite)[75] required, *inter alia,* knowledge of how to locate the bore holes to best advantage, correct handling of explosives susceptible to deterioration and premature explosion, as well as wariness of faulty fuses and of over- and under-charging (that is, using detonators that were too strong or too weak). Managers considered 'over-charging', commonly practised on the Western Australian Goldfields,[76] wasteful and responsible for avoidable levels of pollution of mine air with carbon monoxide and noxious fumes[77] (the detonators contained 'fulminate of mercury' as explosives).[78] Anglo-Celtic workers regularly blamed Southern Europeans for overcharging.[79] Some suggested that contractors, regardless of their cultural origins, used more explosives than waged workers,[80] thereby incurring greater risks. It was also commonly believed that 'undercharging' could lead to combustion rather than explosion, which then produced substantial quantities of noxious fumes. Not all agreed. The 1905 Royal Commission on the Ventilation and Sanitation of Mines discredited this explanation for failure to explode. Blame was directed instead at poor storage of the detonators, which left them damp or, more rarely, at faulty detonators or defective or damp explosives which were responsible for charge failures.[81] When unexploded or partly exploded 'plugs' of gelignite were left either in the borehole or in the broken rock and were accidentally drilled into, as happened with some regularity, they caused deaths and injuries. If they remained undetected when accidentally mixed with broken rock, they caused considerable damage to mine machinery on the surface.[82] To survive, miners needed to be able to identify misfirings as well as to avoid returning to the site before noxious fume levels had cleared.

The practice on the Kalgoorlie mines, according to Cleland, was to fire during crib time (the meal break), a period officially only twenty minutes long. Much evidence suggests, however, that firing took place when convenient,[83] especially when workers were on contract or piece rates (used here interchangeably) and that workers returned, or were required to return, to the site before fumes had cleared. Fatalities and adverse reactions due to exposure to firing fumes were common.[84] Whereas forced ventilation with compressed air was believed to remove fumes sooner and reduce risks to workers, some companies were reluctant to incur the high cost in clearing the air in this way or argued that it was ineffective. Mechanical ventilation consisted of compressed air from the rock drills, as well as use of small fans and blowers (Root's and Buffalo blowers, for example) worked manually, or by water or electricity, [85] but none of these devices, 'while useful in rises or dead ends',[86] supplied clean air.

Besides being dusty, rises were hot as 'ovens' and, after firing, fumes and smoke failed to disperse in them.[87] Unions advocated a limit on the height of rises and a system known as box rising (construction in three compartments, of which the central was blocked, while the other two created an updraft and a downdraft, respectively),[88] so as to improve both safety and ventilation. By 1905, only a few of the mines had adopted this system, the majority 'go[ing] up with stages on 'spreaders',[89] without any division of the rise'.[90] Only two (the Ivanhoe and the Sons of Gwalia) relied on regulating air currents throughout the mine using a system of air doors in shafts and workings to introduce and remove air from the mine.[91]

Sanitation

Even if not resulting in immediate bodily injury, environmental and sanitary conditions on the mines and in miners' camps on mining leases[92] could give rise to disease or ill health. Both water quality and sanitation were defective on many mining leases. In the mines, the drinking water dispensed to workers was often polluted, sometimes with oil. Change houses, where they existed,[93] were initially unheated and cramped, and sometimes lacked any or provided only inadequate washing facilities.[94] Of 36 mines examined on behalf of the Royal Commission on the Ventilation and Sanitation of Mines in 1905, 16 had no sanitary facilities underground whatsoever, while on the surface three had either no sanitary conveniences or only 'primitive constructions'. [95] Even among the mines that had sanitary pans or conveniences underground, none but a very few had 'a pan ... at every level on which men were working'.[96] Moreover, even where such pans were available underground, their number, design and maintenance (very few mines had 'proper double pan service') were described to the Royal Commission on Ventilation and Sanitation as 'abominations calculated to repel cleanly men', and 'nothing short of disgraceful'.[97] The attempts by the Chamber of Mines to impress the Royal Commission with a specially designed pan, hurriedly developed to anticipate the Commission's criticisms, only partially succeeded, as not all the major East Coolgardie mines had time to introduce the novelty.[98]

The Report of the Royal Commission linked the substantially higher incidence of typhoid among Kalgoorlie miners relative to the general population, some two years after scheme water reached the Goldfields, to poor sanitary conditions.[99] Individual medical practitioners and miners also referred to high rates of diarrhoea and dysentery among miners, and to epidemics of jaundice, by which they probably meant hepatitis.[100] They also attributed a high incidence of pubic lice among miners to the poor sanitary arrangements.[101] Lack of privies underground meant that workers inevitably used the workings to relieve themselves, the excreta often ending up in the mullock on the surface or, in some mines, in the water.

Dust and disease

More important than sanitation, though in part linked to it, was the high incidence of lung diseases among miners.[102] Underground, silica-containing dust was sometimes so thick that 'it [was] impossible to see a light a yard away from the eyes'. [103] Miners' exposure to silica-containing dust was extensive as such dust was generated by machine drilling, blasting, shoveling, and the crushing and processing of the ore.

It is now well known that chronic exposure to silica-particles can induce a number of pulmonary diseases including silicosis (a form of pneumoconiosis, causing scarring of lung tissue),[104] chronic bronchitis and emphysema. Silicotic lungs are more susceptible to infection, including by pneumococcus and tuberculosis bacteria.[105] That respiratory disease was rife in the early Western Australian gold mines is indisputable. Fitzgerald, for example, cites 804 applications for relief for respiratory diseases to the Mine Workers' Relief Fund between 1915 and 1922.[106] In 1908, the number of Western Australian miners' deaths from pneumonia alone equaled the number of fatal mine accidents. [107]

Over time, unions and government authorities blamed the incidence of respiratory disease in miners primarily on the practices of rising and contracting, the use of unsuitable rock drills, poor ventilation and blasting practices, and the absence of dust-abating measures. A profound terminological confusion associated with the concept of 'miners' phthisis'[108] and the lack of clear diagnostic tools, such as X-rays, hindered management of the epidemic. Until the mid 1920s, the classification of the disease also remained politically fraught, as the mining industry worried about having to shoulder the entire compensation burden for respiratory diseases in miners, when these could not be clearly differentiated, especially as to etiology. Unions lobbied for a single definition that subsumed all forms of major respiratory diseases in miners and classed them as 'industrial' (or even an 'accident').[109]

In the many years in which the issue failed to be resolved, the transmission of tuberculosis through close contact among workers in the mines continued unabated, aided by poor sanitary conditions. Nor did most mines implement measures to reduce the dust problem.

In 1914 the industry's peak body, the Chamber of Mines of Western Australia, finally conceded (though not publicly) that 'the time has now been reached when some provision must be made for the incapacitated miners' and that 'the mine-owners can no longer hide the fact that bronchial diseases are brought about by the dust in the mines'.[110] Instrumental in that concession were arrangements to provide incapacitated miners with some relief on a tripartite basis without, however, requiring an admission of liability from the mines.[111]

Figure 3: *Mining and Ore Treatment, Boulder/Kalgoorlie -1930s [illustrating pollution]*

Source: Courtesy Battye Library, reference 041200PD, Gore Stuart Collection, BA575/1575

A proper insurance scheme covering industrial respiratory disease and measures attempting to keep the mines free of silicotic, tubercular and tubercular-silicotic workers[112] finally eventuated in the 1920s. The insurance scheme gained industry co-operation only after the State Government provided inducements to tubercular and silicotic men to leave the mines, shouldered the financial burden of the early years of insurance itself (these were the most risky years for insurers)[113] and promised to compensate the mining companies for the increased subsequent premiums by providing the industry with reductions in State government charges.[114]

Hartley argued that the susceptibility of both workers and Golden Mile residents to respiratory diseases would have been enhanced by poor general air quality in Kalgoorlie–Boulder (Figure 3), resulting from the sulphur gas emissions of the mines' roasting process, the fine particulate pollution from the fine dust of dry slime residues, and the particulates from the mines' wood-firing.[115] While apparently unaware of any long term consequences from such exposures, J. Hudson, Inspector of Mines for the East Coolgardie Goldfield in 1909, expressed concern at the fumes from furnaces and cyanide clean ups, which women and children, living in proximity to the large mines, breathed daily. He further observed that the clouds of dust stirred up from residue heaps with every gust of wind pursued the miner living near the mine into his home 'at meals and while sleeping'.[116]

Responsibility for and incidence of accidents

Whereas mine inspectors attributed some accidents to lack of care by workers, to worker inexperience or to dereliction of duty by managers, they relegated a 'great majority' of accidents to the category of 'accidental mishaps, not preventable by exercise of ordinary skill and care' and in 'a class inseparable from the miner's occupation'.[117] Such an 'accidental mishap' occurred to Alexander Horrocks,[118] who, while stoping at the Burbanks Gift Mine in Coolgardie, was struck 'full on the face by a falling stone', which gouged out his left eye and crushed his upper jaw and skull',[119] landing him in hospital in a serious condition.

The fatalism of inspectors and many workers, along with the doctrine of 'common employment',[120] and a number of legislative changes introduced in response to industry pressure,[121] substantially reduced employer liability and with it, probably, also some of the incentive to work the mines more cautiously. Unions blamed the accident rate, which, at times, was considerably higher than in comparable mines in New South Wales, Queensland and Victoria,[122] on inadequate or biased mine inspection, and on sweating or 'speeding up' under the piece-work system. Yet a Parliamentary inquiry, headed by Labor's M.F. Troy and set up to investigate sweating in 1906, was unable to obtain proof that sweating was prevalent 'to the alarming extent that was commonly believed'.[123] Publicly, it identified only subletting by tributers as generating 'unfair conditions' in the mining industry.[124] This verdict, however, must be considered highly questionable, as apparently witnesses were reluctant to provide information to the Committee.

The majority of fatal accidents occurred underground, as did most serious injuries. For example, in 1908, 29 out of 40 deaths of mine workers were underground, while in 1909, out of 34 fatalities, 29 were below the surface. In 1909, out of 461 serious injuries, 338 occurred underground. Whereas surface labourers numbered consistently fewer than underground workers, with the ratio only marginally varying from year to year, this difference does not account for the wide margin between surface and underground casualties.

Table 1: *Number of surface and underground workers in Western Australian gold mines.*

Year	Number of under-ground workers	Number of surface workers	Total number of workers	Ratio of surface to under-ground workers
1903	9,349	7,980	17,329	1.17
1907	8,945	7,113	16,058	1.25
1908	8,403	6,727	15,130	1.24
1909	9,034	6,973	16,007	1.29
1912	7,364	5,840	13,204	1.26
1914	6,588	5,134	11,722	1.28

Compiled from Annual Reports, West Australian Department of Mines.

The majority of the accidents occurred in the East Coolgardie field,[125] where between one-third to more than half the mine workforce was employed.[126] Thus, in 1912, 23 out of 34 deaths occurred in East Coolgardie mines, five in Murchison mines, and two in the Mt Margaret district. Of the 384 serious injuries in 1908, 272 occurred in the East Coolgardie Goldfield, 34 in the Murchison and East Murchison goldfields, and 29 at Mt Margaret. East Coolgardie miners and managers also figured prominently among those prosecuted for a variety of safety breaches under the Mines Regulations Act. Among East Coolgardie mines, the Great Boulder Proprietary management was prosecuted more frequently than any other for breaching safety rules. The conclusion at the end of a Coroner's inquest in 1904 was that the Great Boulder Pty management was guilty of 'great carelessness' in permitting an engine to be overloaded without a test, causing, thereby, the loss of five men's lives in one of the most horrific accidents on the mines.[127] In 1911, the miners' union claimed that the accident list on this mine was 'much heavier than [on] any other mine on the belt' and pointed to many fatalities caused by falls of ground in the preceding two years.[128] Privately, Alexander Montgomery, Chief Mining Engineer, identified the callousness of managers as the reason for the 'unusual number of accidents' on the Great Boulder rather than any particular mining practice. He relied for his opinion on mines inspectors' observations that

> a little less solicitude about getting out ore and a good deal more concern about safety of working might often be exhibited with advantage by the staff in charge underground' at the Great Boulder Pty. [129]

Montgomery's conclusion, which provides insights into the attitudes of managers and the organisational culture on the East Coolgardie mines, also reveals the dilemma of regulators in dealing with both these factors. In Montgomery's own words:

> [b]ut though a reckless or callous temperament may often be a serious factor in causing accidents indirectly, it is rarely possible to connect it with them in such a way as to allow direct blame to be laid upon any person, and the matter is one little controllable by laws or regulations or by any sort of influence.[130]

When the Mines Department attempted to prosecute managers, the companies fought back fiercely. Among the most telling of such battles was that of the 1905 laying of a manslaughter charge against Joseph Chaffers, the underground manager of the Boulder Deep Levels mine, for causing the death of Albert Sergeant. Sergeant had died when a rope that had continued to be used after having been apparently condemned by an Inspector of Mines, broke). Ultimately, Joseph Chaffers was acquitted on the technical point of *'autrefois convict'*, since the Department had also proceeded against him under the Mines Regulations Act. The Chamber of Mines funded Chaffers' defence and assisted with the case, hiring not one, but two legal counsels on his behalf. Since the case was dismissed on a legal technicality, it left unresolved the issue of greatest interest to the Chamber, that is whether managers enjoyed immunity from criminal negligence once they employed competent men, in this case to 'examine the rope and keep it in proper order'.[131] In the end, the company incurred, over the death of Albert Sergeant, besides costs, two fines (£25 against the manager of the company and £10 against Joseph Chaffers), both under the Mines Regulation Act, for negligence in not keeping 'a rope in good order'.[132] The outcome attracted considerable worker outrage and cynicism.[133]

The dangers of machine mining

According to Hartley's extensive work, until 1915, Kalgoorlie mining was characterised by frequent and rapid technological changes to mining and metallurgical processes. Metallurgical innovations, in particular, gained the area international fame and some of the innovators an international reputation. For workers, such innovations could spell skill obsolescence, deskilling or reskilling. Their destiny depended on the nature of the change, on workers' role in the work process, on adaptability and, finally, on their standing with mine managers, since it was managers who determined who among the hand miners should be reskilled and promoted to work with the new technology.

From the perspective of workers, the introduction of the machine drill that replaced large numbers of hand miners, was among the most significant technological changes to the process of mining. Big rock drills 'would do three times the amount of work' of a hand miner, whereas 'baby' rock drills doubled the amount, claimed the shift boss on the Sons of Gwalia in 1903.[134] Advertisements for rock drills made even more impressive claims.[135]

Almost invariably, machine mining was undertaken on a piece-work basis.[136] In 1900 and somewhat later, such work involved 'taking dirt out by the foot…, by the ton', or by the fathom,[137] over a fixed period, usually two months. 'Sinking', including plat cutting, driving and stoping, when done on 'contract', could also be paid for in a lump sum agreed upon prior to the work being begun. It was more common, however, to undertake such work on a piece-work basis, [138] and be paid a rate per fathom or cubic foot or tonnage excavated.[139] The pay went to the 'contracting party', which divided the money among the partners. Stoping could also be paid for by the 'hole footage system', in which holes drilled were 'measured up before each firing', and payment was by 'the aggregate depth of holes bored in the face of a stope'.[140]

Payment by quantity excavated was generally confined to rock in which the valuable lode was easy to distinguish from waste rock, where managers did not fear that workers would be able to 'increase their footage by breaking into country'.[141] Apart from the piece rate or lump sum agreed upon, the arrangement between the mines and the contractors commonly required the mines to provide to workers rock drills and power, and to ensure their drills were sharpened. On the other hand, contractors provided their own truckers, light, and explosives.

Where shoots were erratic and the walls weak, contract rates were deemed too high and the mines employed wage labour.[142] They also did so when the ore presented as part of a large body of low grade ore, requiring frequent sampling to establish its payability, reasoning that with waged labour, 'progress can be suspended at any moment and labour diverted elsewhere, pending sampling and examination' [143] ('diverted elsewhere' could mean being laid off). Hand mining also continued to be used in mines where the rock was soft , as for example in the East Murchison United mines, or for specific purposes, such as the mining of small lodes, or on smaller mines in some districts, where the workforce continued to be less specialised.

While more productive, machine mining generated considerably more dust than hand mining, a feature which eventually made the arrangements according to which such work was remunerated largely irrelevant. By 1908, some workers refused to undertake rock drilling for fear of contracting silicosis. By the mid 1920s, a mining union representative blamed the refusal of young men to undertake such work on the mines' reputation as unhealthy and dangerous places.[144] According to this observer, average life expectancy of Western Australian mine workers was then 51 years, compared to the average male Australian's 58 years.[145] Whatever the accuracy or precise meaning of these figures, by then workers knew unequivocally that the dust generated by machine mining was a major cause of miners' lung diseases and recognized the immense cost in health and lost years of life exacted from those working in the early Western Australian gold mines.

Other disadvantages

Minework itself was often repetitious, dangerous and stressful. In mines which worked shifts (not all did), night shift workers complained about inability to sleep during the hot summer months. In remote districts, the absence of medical facilities delayed treatment of mine accident victims and disadvantaged miners' families. Confinement could precipitate a family into debt that would take years to discharge.

Work was largely insecure. Mines were liable to restructure and close down temporarily or permanently, or undergo major management or technological overhauls, which were often unsettling to workers. Loss of employment in remote locations spelt hefty expenses in transport costs to other mining centres or, alternatively, days of tramping out of the district. As mines shut down or 'downsized', the financial value of workers' residences, often their only major asset, depreciated or were entirely lost. It is not surprising that under these conditions many eventually abandoned mining for less hazardous and more secure work.

Conclusion

This paper has examined the labour process and associated workers' experiences in the early Western Australian gold mining industry. It identified worker grievances related to changes in the labour process and to managerial decision-making that shaped the process. Importantly, this presents a challenge to assumptions that class consensus existed in the Western Australian mines and that relations between capital and labour were 'smooth', and 'almost honey'.[146] Instead, the picture of working conditions that it paints suggests that the work experience and reaction by workers was far from conducive to harmonious relations between capital and labour. That there was worker resistance both overt and covert, and efforts by employers to contain, divert and defeat worker protests, should not surprise. Investigation by the author has shown this to be the case. The details of these struggles, not revealed here, will be the subject of a future paper.

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Endnotes

[1] Examples are M.K. Quartermaine and E. McGowan, ' A historical account of the development of mining in Western Australia', IN R. T. Prider (ed.) *Mining in Western Australia,* University of Western Australia Press, Nedlands, WA, 1979, pp. 1-23; J.W. McCarty, 'British investment in W.A. gold mining', *University Studies in History*, vol. 4, no. 1, 1961-62, pp. 7-23; A.L. Lougheed, *Ownership of British-Westralian mining companies, 1895-1914*, The University of Queensland. St. Lucia, Qld, 1992; R.T. Appleyard and M. Davies, 'Financiers of Western Australia's Goldfields' in R.T. Appleyard and C.B. Schedvin, *Australian Financiers: Biographical Essays*, Macmillan, South Melbourne, 1988, pp. 160-187; E. E. McGowan, 'Gold and growth: Western Australia in the 1890s', DA thesis, Carnegie-Mellon University, USA, 1979; D. Mossenson, 'Gold and politics: influence of the Eastern Goldfields on the political development of Western Australia, 1890-1914', MA thesis, University of Western Australia, 1952; C.T. Stannage, 'The composition of the Western Australian Parliament, 1890-1911', *University Studies in History,* vol. IV, no. 4, pp. 1-40; B.K. de Garis, 'Self-Government and the Evolution of Party Politics 1871-1911', in C.T. Stannage (ed.), *A New History of Western Australia*, UWA Press, Nedlands, WA, 1981, pp. 326-351; L. B. McIntyre, 'The development of trade unionism in Western Australia and the operation of industrial conciliation and arbitration, 1900-1914', MA thesis, University of Western Australia, 1972; H.J. Gibbney, 'The goldfields and the labour movement in Western Australia', in *Labour and the Goldfields',* Australian Society for the Study of Labour History, Canberra, 1968; Patrick Bertola, 'Kalgoorlie, gold and the World economy, 1893-1972', PhD thesis, Curtin University of Technology, 1993. Examples of regional histories are G. Blainey, *The Golden Mile*, Allen and Unwin, St Leonards, NSW, 1993 and M. and A. Webb, *Golden Destiny: the Centenary History of Kalgoorlie-Boulder and the Eastern Goldfields of Western Australia*, City of Kalgoorlie-Boulder, WA, 1993.
[2] R.G. Hartley, 'A history of technological change in Kalgoorlie gold metallurgy 1895-1915', PhD thesis, Murdoch University, 1998; also his 'Filter presses and vacuum filters in Kalgoorlie metallurgy 1895-1910', paper delivered to Australian Mining History Conference, Hobart, 1999; 'Western Australian gold smelters in the 1900s': a paper delivered to the Australian Mining History Conference, Kalgoorlie 2001; 'Kalgoorlie as the global centre for gold metallurgical innovation 1902-1907', in *Prometheus,* vol. 19, no. 2 , 2001, pp. 151-152.
[3] Bertola, 'Kalgoorlie, gold'.
[4] Hartley, 'A history of technological change', vol. 2, p. 376.
[5] *Ibid.,* p. 372.
[6] Bertola, 'Kalgoorlie, gold', vol. 1, pp. 53-58.
[7] *Ibid.*, p. 63.
[8] *Ibid.,* p. 56, relying on his vol. 2, tables 2.7, 2.8.
[9] N. Segal, 'Capital, Gold Mining and Labour: Collective Action in the Western Australian Gold Mining Industry, 1896-1914', Ph D thesis, UWA, 2006 (under examination).

[10] E. Garnsey, 'The rediscovery of the Division of Labor', *Theory and Society,* vol. 10, no. 3, 1981, p. 350.
[11] Hartley, 'A history of technological change', for example, examines treatment processes only. C.M.J Stronach, 'The fall and rise of the Golden Mile: the depression and recovery of gold mining on the Eastern Goldfields of W.A., 1925-1934', MA thesis, University of Western Australia, 2000, describes work in the mines so generally that his work lacks explanatory power.
[12] Garnsey, 'The rediscovery', p. 350.
[13] Apart from a brief examination here of working on contract, the operation of the wage system in the late 1890s and the early twentieth century in Western Australian company gold mines will be the subject of another paper.
[14] C.B. Jeppe, *Gold Mining on the Witwatersrand,* The Transvaal Chamber of Mines, Johannesburg, 1946, p. 328. The exceptions are mines which operated open cuts.
[15] This does not mean that the remainder of the process was not urgent, only that the need to show early returns in a speculative environment in which companies competed on the capital market, made speedy sinking a matter of critical importance in these early years.
[16] Filling the excavated area with waste ore, including in Western Australia at that time, with cyanided tailings.
[17] M. Pearson and B. McGowan, *Mining Heritage Places Assessment Manual,* Australian Council of National Trusts and the Australian Heritage Commission, Fyshwick, ACT, 2000, p. 171.
[18] E.D. Cleland, *West Australian Mining Practice: A Description of the Mining Methods followed by the Principal Gold Mines of Western Australia*, Chamber of Mines [hereafter COM], Kalgoorlie, 1911, p. 26.
[19] According to Cleland, *West Australian Mining Practice,* p. 26, the mine's accounting for 'sinking' excluded plats,
[20] G. MacGill, *Mining Heritage Manual, Western Australia,* Ministry for Planning, Perth, WA, 1999, p. 58.
[21] A 'level' here means 'an underground horizontal in a mine, driven to give access to ore bodies and to provide for truckways and tramways.' It is 'also used generally to indicate the different workings at varying depths within a mine', see McGill, *Mining Heritage Manual,* p. 56.
[22] Cleland, *West Australian Mining Practice*, p. 94, but see contradictory claim, p. 26.
[23] *Ibid.,* pp. 93, 96-97.
[24] Development can be construed as including shaft sinking, but was not so according to Cleland, *West Australian Mining Practice,* chapters 2 and 3. For an alternative understanding to that proposed here see also E.A. Loring in *West Australian Mining, Building and Engineering Journal* [hereafter *WAMBEJ*], 24 February 1912, p. 4. The inclusion of various operations under development was strategic as it affected the calculation of the efficiency of the mine, with more inclusive understandings reducing the costs per ton.
[25] Cleland, *West Australian Mining Practice,* p. 99.
[26] *Ibid*., p. 109.
[27] Stronach, 'The fall and rise of the Golden Mile', p. 95.
[28] Cleland, *West Australian Mining Practice*, p. 109.
[29] See, for example, the evidence of a mining inspector to the Royal Commission on the Ventilation and Sanitation of Mines [hereafter RoCVSM] that on one of the Kalgoorlie mines they had 'a lot of development work without winzes and too many winzes going on at one time, the only means of ventilation being the compressed air from the drills which he could not say were used for the winzes,' RoCVSM, *Western Australia. Votes and Proceedings* [hereafter *WAVP*], 1905, vol. 1, Parliamentary Paper [hereafter PP], no. 6, p. 244.
[30] Cleland, *West Australian Mining Practice,* p. 138.
[31] *Ibid.*
[32] Ibid., p. 139; Stronach, 'The fall and rise of the Golden Mile', p. 96, relying largely on Cleland's *West Australian Mining Practice*, describes rill stoping as the removal of ore in stages from the ore block, working upwards in a hill effect, while flat-back stoping sliced 'vertical slices off the block'. Filling replaced the removed rock in both methods. In shrinkage stoping, the ore was not removed until it was all broken out, and no filling replaced the emptied stope.
[33] R.J. Rowe, *Gold in Western Australia,* Rowe Scientific, 1989, p. 46.
[34] The differences could be due to the training, experience, and preference of managers, and/or the conditions in the mine, including the hardness of its rock.
[35] See, for example, the reference by the manager of the Associated Mine (Irwin) to the constant changes made in the mine and on the surface in 'Encouragement to miners to bring their wives to the colony,

offering, 1 December 1898', Acc 1496, item 1772, 1 December 1898, State Records Office of Western Australia [hereafter SROWA].
[36] See, for example, the treatment charts of the Ivanhoe, The Oroya-Brownhill and the Associated Mines in Chamber of Mines of Western Australia, Inc., *West Australian Metallurgical Practice*, Kalgoorlie, 1906, pp. 17, 21, 36.
[37] Cleland, *West Australian Mining Practice,* pp. 87-88.
[38] *Westralian Worker* [hereafter *WW*] 14 July 1911. The size of the trucks on the Golden Mile was an occupational health issue, with unions demanding regulation.
[39] Hartley, 'Kalgoorlie as the global centre', p. 152.
[40] *Ibid*., p. 150.
[41] After 1906, the mine replaced filterpressing with vacuum filters, see Hartley, 'Kalgoorlie as the global centre', pp. 153-154.
[42] A process by which the non-valuable lighter portions of crushed ore are eliminated and valuable heavy components are collected, see Pearson and McGowan, *Mining Heritage Places,* p. 88.
[43] Filterpresses were devices designed to hold ore slimes in numerous separate compartments, 'while cyanide solution and wash water were separately pumped through them' to dissolve the gold. For a detailed description of these devices, see Hartley, 'A history of technological change in Kalgoorlie', vol. 1, pp. 87-88.
[44] For the intricacies of the various processing options and strategies see *ibid*.
[45] *Ibid*., vol. 1, p. 91.
[46] Western Australian Mines Department *Annual Reports*, 1896-1914.
[47]Troy's opening of case, 'The Baddera Miners Union of Workers AWA *v* The Fremantle Trading Coy Ltd. Industrial Dispute', Acc 1095, item 714, SROWA.
[48] Cleland, *West Australian Mining Practice,* p. 115. See also *RoCVSM*, pp. 227, 278, where the cost of excavating rises was estimated to be two-thirds that of digging winzes, while elsewhere the difference was represented as only slight.
[49] Cleland, *West Australian Mining Practice*, p. 109.
[50] *Western Australian Parliamentary Debates* [hereafter *WAPD*], XLIV, 30 October 1912, p. 2809.
[51] *WW,* 14 July 1911.
[52] In 1905, a report to the Royal Commission on the Ventilation and Sanitation of Mines referred to nine cases 'due to the fumes of explosives', see *RoCVSM*, p. 71, although evidence to the Commission suggested a far higher number of such cases with witnesses having personal experience of them or knowing the parties affected, see, for example, p. 242. By 1905, contemporary newspapers also reported many more cases than the Royal Commission acknowledged.
[53] The fumes from such tailings caused much illness and a number of fatalities, see, for example, the deaths at the Jacoletti Mine, the Golden Ridge, and the Paddington Consols, in *WW,* 23 May 1902, 16 February 1906; COM, Executive Committee [hereafter EC], 25 November 1899, Acc 6137A/409, Battye Library [hereafter BL]. Also Report of the *RoCVSM*, pp. 40, 235, 288. Reports of tipping of cyanided tailings directly from vats into the stopes existed for the Golden Horseshoe and the Paddington Consols and many other mines, *RoCVSM*, pp. 234, 237, 288, *et passim.*
[54] Dr Ernest Black, reporting to the Royal Commission on the Ventilation and Sanitation of Mines, p. 65.
[55] Western Australian Department of Mines, *Report for the year 1896,* p. 43, *WAVP*, 1897, vol. I, PP 8.
[56] See, for example, R. Burt and S. Kippen, 'Rational choice and a lifetime in metal mining: employment decisions by nineteenth-century Cornish miners', *International Review of Social History,* vol. 46, issue 1, 2001, p. 49.
[57] For one analysis of the injuries sustained both underground and on the surface see Department of Mines, *Annual Report 1909, WAVP*, 1910, vol. I, PP 1, pp. 65-66.
[58] *RoCVSM*, p. 248.
[59] *Ibid.,* p. 41.
[60] See *Ibid*. Also *ibid.,* p. 232, the statement of one miner who reported that 'nearly all the truckers were suffering from rash' due to cyanide exposure,
[61] Report of the *RoCVSM*, p. 42.
[62] Attorney-General, Correspondence Files 'W' series 1914-1927. Rex v Sawtell, Miller, Auwart, Horrocks, Johnstone, Lunn, Goller, Hanscombe and Parkinson. Seditious Conspiracy. Australian Archives: A456 item W26/148/57 Attachment B, Exhibit 64, Christensen to Lunn, 17 December 1915, Australian Archives, ACT.
[63] COM, *Monthly Report,* 1902, p. 254.
[64] See, for example, *ibid*., 1905, p. 361.

[65] B. Maddison, 'Labour commodification and skilled selves in late nineteenth century Australia', *International Review of Social History,* vol. 43, issue 2, 1998, p. 269.
[66] This practice was especially common on the Murchison.
[67] COM, *Monthly Report,* 1903, p. 91.
[68] For example, Thomas Cheston testified that the majority of contract men were outside the Murchison union, and estimated that only about two percent of his members worked on contract, item 36,45,46, Acc 1095, SROWA.
[69] COM, *Monthly Report* 1902, Hill's evidence, p. 219.
[70] See, for example, *ibid.,* Morris' evidence, p. 256. This issue was resolved in the 1912 overhaul of the arbitration legislation.
[71] COM, *Monthly Report* 1902, Joseph Verran's evidence, p. 227.
[72] Contracting continued to be a major concern of unions, though divisions among their members hampered collective action. Opposition to contracting was, however, the cause of a major dispute at the Youanmi mine in 1914.
[73] COM, *Monthly Journal,* 1905, p. 398.
[74] Elkington's evidence, item 163, Acc 1095, SROWA.
[75] Cleland, *West Australian Mining Practice*, p. 208.
[76] See, for example, Western Australian Department of Mines, *Report for the year 1903, WAVP*, 1904, vol. II, PP 17, p. 42.
[77] Cleland, *West Australian Mining Practice,* p. 221.
[78] *Ibid.,* p. 215.
[79] See, for example, *RoCVSM*, pp. 233, 238, 250.
[80] *Ibid*., p. 283.
[81] *Ibid.,* p. 38.
[82] As, for example, at the Great Fingall breaker, where frequent explosions took place, one injuring one man seriously, Western Australian Mines Department, *Annual Report 1903, WAVP*, 1904, vol. II, PP 17, p. 47, see also *RoCVSM*, p. 244.
[83] The time lapse for returning to the face ranged from 10 minutes to 20 hours, but most commonly appeared to be 20 minutes, with many mine managers deliberately allowing workers to assume responsibility for the decision, more than likely so as to avoid compensation liabilities, *RoCVSM*, p. 291, *et passim*. See, on the time lapse before returning to the face after firing, Stronach, 'The fall and rise of the Golden Mile', p. 96.
[84] See, for example, *WW,* 28 March 1902, 13 May, 30 September 1904, 25 November 1905, Mines Department *Annual Report 1909*, p. 41, *WAVP*, 1910, vol. I, PP 1, p. 41, also *RoCVSM*, pp. 111-115, *et passim*.
[85] *RoCVSM*, pp. 24, 237.
[86] *Ibid.,* p. 238.
[87] *Ibid.,* p. 247.
[88] *Ibid.,* p. 48.
[89] A piece of timber supported by two others.
[90] *RoCVSM,* p. 43.
[91] *Ibid.,* p. 22.
[92] *Ibid.,* p. 70.
[93] They did not, apparently, exist in 1909, either on the Lancefield Mine, on the Augusta Gold Mine, nor in many outback centres where the mines were 'dry or comparatively so', see Cullingworth report, Complaints in Legislative Assembly re inspection of mines, Acc 964, item 278, 1909, SROWA. Though instructed by the Mining Inspector in mid 1909 to provide a change house, the Lancefield had still not done so by mid 1910, *ibid*., Colbran's report.
[94] See, for example, *RoCVSM*, p. 227.
[95] *Ibid.,* p. 66.
[96] *Ibid.*
[97] *Ibid.,* pp. 66-67.
[98] See table, *Ibid.,* pp. 67-68, see also p. 289, A.T. Wilson, mining engineer and manager of the Fraser South Extended in the Yilgarn District, who freely but foolishly admitted to the Royal Commission that he had prepared for the Commission's visit by cleaning up the mine and providing conveniences where there were none before. It may be safe to assume that the overall conditions in the Western Australian mines were far worse before the setting up of the Commission than the poor conditions the Commission ultimately described.

[99] The report on the health of miners, *RoCVSM,* p. 70, suggested an incidence of typhoid among East Coolgardie miners two-and-a-half times that in the general population. For a particular case in which poor sanitation affected the drinking water of a mining camp causing a typhoid epidemic see *ibid.,* p. 245.
[100] *Ibid.,* p. 230.
[101] *Ibid.,* p. 71.
[102] See for example Acc 964, 1390/11, vol. 1, SROWA.
[103] *RoCVSM,* p. 34. For reference to tuberculosis and contagion etc., see S. Kippen and Y. Collins, 'Radical Reformers: The role of medical men in improving working conditions in the Bendigo goldmines, 1890-1910', *Journal of Australian Mining History,* vol. 2, 2004, pp. 75-89, and C. Fitzgerald, 'Making tuberculosis everyone's business: the public health campaigns to prevent and control tuberculosis in Western Australia 1900 – 1960', PhD thesis, University of Western Australia, 2002.
[104] Kippen and Collins, 'Radical reformers', p. 76.
[105] Such damaged lungs are also more likely to be affected by smoking, leading to lung cancer, and while many miners smoked in Western Australia, the role of smoking in exacerbating respiratory disease among gold miners in the early mines is so far unresearched.
[106] Fitzgerald, 'Making tuberculosis', p. 166.
[107] Fitzgerald suggests, however, that the diagnosis of pneumonia as a cause of death in miners 'included deaths due to tuberculosis, see *ibid.* p. 148.
[108] See *ibid*., Chapter 4, for an examination of these terminological and diagnostic difficulties.
[109] *Evening Star* 13th June 1913.
[110] Bolton to Bramall, 23 March 1914, Acc 6137A/290, BL.
[111] Fitzgerald, 'Making tuberculosis', p. 158.
[112] They included pre- engagement medical examinations and thereafter regular medical examinations of workers.
[113] *Minutes of conference,* Acc 6137A/424.
[114] See *ibid.,* Chapter 4, and P. Bertola 'Depression and surviving: Gold mining at Kalgoorlie from World War I to 1931', *Journal of Australasian Mining History,* vol. 1, 2003, pp. 18-19.
[115] Hartley, 'Kalgoorlie as the global centre', pp. 151-152. This description of the air quality in 1904 cited from the *Westralian Worker* is probably only slightly exaggerated:

> thousands of men women and children live on the mining leases along the golden belt where the fumes from the roasters are so strong that the galvanised iron on the houses is eaten through in less than three years and to drink the rain water caught from the housetops would mean almost sudden death. At certain times the sulphur can be tasted in the atmosphere anywhere within a radius of three miles of the mines, *WW,* 12 February 1904.

[116] Complaints in Legislative Assembly re inspection of Mines, Acc 964, item 278, 1909 (Hudson's report), SROWA. For air quality see *RoCVSM,* pp. 116-122.
[117] Department of Mines, *Annual Report 1909, WAVP*, 1910, vol. I, PP 1, p. 65. .
[118] Later one of the Industrial Workers' of the World [IWW] prosecuted in Western Australia during World War I.
[119] *WW,* 18 January 1907.
[120] A legal concept that deprived an injured worker of compensation if co-workers were implicated in the accident.
[121] A key to such legislative change was the elimination of Clause 20 from the Goldfields Act of 1895, which construed accidents in a mine as *prima facie* proof of negligence by the employer. Another was the ceiling imposed on claims under the Workers' Compensation Act, see, for example, COM, EC, adjourned meeting 25 September 1900, Acc 6137A/409; COM, Parliamentary Committee, 13 August, 14 September 1901 6137A/414, BL.
[122] See, for example, the admission in the Annual Report of the WA Mines Department of 1901, p. 25, that Western Australian mines had 'a high death rate compared with other Australian states'.
[123] Standing Committee of the Legislative Assembly to inquire into the alleged existence of sweating in West Australian industries, *Report, WAVP* 1906, vol. II, PP A12.
[124] *Ibid.,* p. 5.
[125] See for example, the Western Australian Mines Department's Annual Reports for 1903, p. 22, also 1908, p. 38; also the Miners' Union's Kalgoorlie and Boulder branch's complaint in 1907, that the branch's accident pay was beginning to be 'perilously near its income', *WW* 25 June 1907.
[126] Bertola, 'Kalgoorlie, gold' vol. 2, Table 1.2.
[127] Inspector of Mines, Kalgoorlie Fatal accident to five men at the Great Boulder G.M. 25 May 1904 Reporting, Acc 964, item 1586, 1904, SROWA.

[128] Goldfields Federated Miners' Union, inquiry into underground conditions of Great Boulder Gold Mine, urging, Acc 964, item 2751, 1911, SROWA.
[129] Goldfields Federated Miners' Union, inquiry into underground conditions of Great Boulder Gold Mine, urging, Acc 964, item 2751, 1911, SROWA*,* Montgomery to Gregory*,* 15 August 1911.
[130] *Ibid*.
[131] COM, EC 3 July 1905, Acc 6137A/416, BL.
[132] Return of prosecutions under Mines Regulations Act, vol. 1, Acc 964, item 3960, 1904, SROWA.
[133] See, for example, *WW,* 21 October 1904, 17 March 1905.
[134] Griff Jones' evidence, item 59, Acc 1095, SROWA.
[135] In relation to baby hoists, for example, the Australian Metal Company claimed that 'their first cost is saved in one month', see Cleland, *Western Australian Mining Practice,* Advertisements, p. xxx.
[136] P. Bertola, 'Tributers and gold mining in Boulder, 1918-1934', *Labour History,* vol. 65, 1993, p. 54, described tributers as a replacement for both contract and wage labour. Tributers were workers who subleased part of a mine from which they or waged workers they employed could 'extract ore for sale to and treatment by a company, paying the company or leaseholder a royalty on the gold won and an agreed sum based on a scale of charges for services and stores the company provided'. Tributers have not been included in this paper, partly because they were not significant in the industry's first two decades..
[137] Smith's evidence, item 357, Acc 1095, SROWA.
[138] Employers usually paid for 'development' work per foot advanced, and calculated pay for stoping, plat and bin cutting by fathom excavated, see *WAMBEJ,* 24 February 1912.
[139] Cleland, *West Australian Mining Practice,* p. 94.
[140] *WAMBEJ,* 24 February 1912.
[141] Cleland, *West Australian Mining Practice,* p. 148.
[142] *Ibid.,* pp. 151-152.
[143] *Ibid.,* pp. 152-153.
[144] George McKennay, General Secretary, A.W.U., Royal Commission on the Mining Industry, Report, *WAVP,* 1925, vol. I, PP 3, p. 102.
[145] See *ibid*., p. 104 for the source of these figures is the Mine Workers' Relief Fund.
[146] G. Blainey, *The Golden Mile,* Allen and Unwin, St Leonards, NSW, 1993, pp. 118, 119.