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Title: Death in the New Town: Edinburgh's hidden story of stonemasons' silicosis.

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TB tuberculosis

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Abstract

The building of the Edinburgh New Town, from the mid-18th to the mid-19th centuries, was a major advance in harmonious and elegant town planning. However, there is anecdotal evidence that it led to the occurrence of an epidemic of silicosis/tuberculosis among the stonemasons. We have reviewed contemporary accounts of the episode and early records of the understanding of silicosis. We have also studied the lung of a contemporary stonemason, preserved in the museum of the Royal College of Surgeons of Edinburgh and confirmed the presence of silico-tuberculosis in it. The evidence shows that a major epidemic did in fact occur, caused by a combination of factors. The size of the undertaking attracted many stonemasons to Edinburgh over a period of almost 100 years, intensively cutting and dressing stone. The principal stone worked was a very high-quartz sandstone, derived from the local Craigleith quarry, having properties that made it desirable for prestige buildings. However, even before the construction of the New Town commenced, Craigleith sandstone was notorious for its dustiness during working. The Edinburgh stonemasons worked the stone in unventilated sheds. Stonemasons appeared to be aware of the risk of their trade, but little was known about preventive measures at this time. It appears that it was assumed that the risks to stonemasons disappeared after the Craigleith quarry closed, the employers emphasising (without evidence) the lack of health risks in other quarries, and the tragic episode appears to have been forgotten. However, the authors point to the continuing occurrence of silicosis among stonemasons to the present day; the importance of remembering such episodes is stressed if the lessons they provide are to be learned.

Edinburgh New Town

With a population of 57,195 in 1755, Edinburgh, with Leith, was the third most populous city in the UK in the 18th century (1). Geological constraints had restricted the expansion necessary to meet the population increase over time and the inhabitants had resorted to building houses up to 12 storeys high (2;3). The consequent overcrowding, absent sanitation and lack of running water made living conditions almost intolerable. With a view to remedying the situation a report was commissioned by the Town Council entitled '*Proposals for carrying on certain public works in the city of Edinburgh*' (4). This sanctioned a competition for the design of a New Town to the North of the existing old town. In 1766, James Craig, a young Edinburgh architect, won the competition with his ambitious plan for an elegant Edinburgh New Town. This was to be in a rectilinear design, built to the North of the Nor'

Loch which was to be drained and filled in to allow access (3). In 1767 work began on the impressive houses and public buildings on wide boulevards and squares.

Craigleith sandstone and the building of the New Town

The New Town was built in the neoclassical Georgian style, characterised by grandeur of scale with Greco-Roman detail indoors but, save for columns, more restraint outside. It was to be built in stone, in keeping with Scottish tradition, rather than the brick preferred in England. (5) The stone was hewn by quarriers and shaped and dressed by craftsmen stonemasons to produce high quality ashlar masonry for the frontages. Most of the stone originated from an outcrop of Lower Carboniferous sandstone at Craigleith Quarry, two miles north-West of the New Town. (Figure 1) (6). Other quarries also contributed some stone with, for example most of the paving stones, of lower quality sandstone, derived from the Hailes Quarry (2) (Figure 1 C). Craigleith sandstone is 98.3% quartz, 1.1% limestone, and 0.6% iron and alumina (7). As well as being beautiful in its finished ashlar form (Figure 1c), the extreme hardness of this stone meant that it was virtually weatherproof, retaining its sharp edges and carved detail over time. These key properties had already been recognised in its use in the building of Edinburgh Castle, in prestige buildings elsewhere in the UK such as Buckingham Palace, and even in export to Europe and the USA (8).

Stonemasons and lung disease

The first known account of lung disease in stone workers was by Georg Bauer, known as Agricola. In his work, *De re Metallica,* of 1556 he mentions the early deaths of metal miners "*carried off by a terrible consumption*". The Dutch anatomist Isbrand de Diemerbroeck in his *Anatomy of Human Bodies* of 1672 (9) wrote in his chapter on the lung:

"*In the year 1649 I dissected a stone cutter's boy that dy'd of an asthma, in whose lungs I found a great quantity of stone dust suck'd in with the air and stuffing almost all the vessels, insomuch that I seem'd to cut through a heap of sand; so that the vessels being filled with dust, could not admit the air, which was the occasion of the poor fellow's death. The next year, two like cases happen'd of stone cutters that dy'd after the same manner and were by me dissected in our hospital. At the same time, the master stone cutter reported to us that while the stones are cut, there flies into the air such a subtile powder from the stones, as was able to penetrate the pores of an oxe's bladder that hung up blown and dried in his shop, so that at the end of the year, he found a handful of dust at the bottom of the bladder; which powder was that which killed so many stone cutters, that were not very careful how they preserv'd themselves from that dust."*

Ramazzini in his classic work *De Morbis Artificium*, published in 1713 and widely known in Britain thereafter, described stonecutters as suffering from chronic lung disease, which he ascribed to the inhalation of "splinters" (10). In 1796, James Johnstone, a physician from Worcester gave an address to the Medical Society of London which was intended to inform his colleagues of a scandal and by which he hoped to initiate reforms (11). Speaking of the needle making industry in what became known as the Black Country, he said: "*Persons employed in pointing the needles by dry grinding them are constantly very soon affected with pulmonary complaints, such as cough, purulent or bloody expectoration; and being so affected, they gradually waste in flesh and strength, and hardly ever attain the age of 40 years. As the business is known to be constantly attended by such fatal effects, the manufacturers find it not very easy to engage persons to work at it; and they who are engaged are so well paid as to get money enough to misspend in drink; being for the most part, in this respect, persons of very irregular manners." (11).*

He went on to suggest some protective measures including: "*Nor would it be difficult to contrive a crape hood or gauze helmet, to receive the head and rest on the shoulders, which would prevent a great deal of the metalline and stony particles of dust, which fly off in the operation of dry grinding the needles, from entering the ramifications of the arteria trachea cells of the lungs in the action of inspiration. The cause of the pulmonary phthisis peculiar to the people who follow this business is undoubtedly the continual irritation of the lungs by the dust of small particles of iron and stone and their gradual congestion into small concretions on the air cells of the lung." (11),*

In 1832 Thackrah noted lung disease and early mortality in knife grinders, miners and masons, but reflected current difficulty in deciding whether to agree with earlier reports of sand in the lungs as causative or to attribute all to intemperance (12). He suggested the sand might in fact be concretions secondary to the disease. Nevertheless, in 1857 Hall recorded that the incidence of lung disease in Sheffield knife grinders was greatly reduced when the grinding was done wet, with its resultant suppressive effect on dust generation showing that by then, in some trades, preventive measures were being implemented (13).

Up to the mid-19th century any chronic lung disease with loss of weight was named phthisis, consumption or tabes, all implying wasting. The dominant cause by far in the general public was tuberculosis, which had been defined pathologically. Since infective organisms were not known, there was a tendency among doctors to attribute these diseases to intemperance, the cause of TB not being identified until 1882 when Koch stained and identified the tubercle bacillus. Employment in trades involving knife grinding, mining or cutting stone was known to involve a risk of lung disease and early mortality, which in stonemasons had acquired the name "stonemason's rot". However,

lacking any means of diagnosis other than autopsy, physicians of the period could not differentiate silicosis and tuberculosis. Indeed, it is likely that many masons suffered from both, as tuberculosis was endemic in Edinburgh at the time.

Both quarriers and stonemasons are at risk from inhaling stone dust while they work, the latter more so from the amount of dust they produce with tools such as grinders and chisels (14). These activities generate airborne clouds of fine particles, a proportion being small enough to be inhaled and deposited in the lungs. The particles are highly pathogenic if they contain a significant proportion of quartz, owing to its cytotoxic and pro-inflammatory actions (15), causing the fibrosing lung disease silicosis and increasing the risk of lung cancer (16). Silicosis may occur in different forms, acute, accelerated and chronic, depending on the exposure intensity and the rate of its progression (17).

Silico-tuberculosis

The problem of silico-tuberculosis was recognised by Sankey, writing in Edinburgh in 1840 (18). He described how "*stonemasons' tabes*" could be confused with *phthisis pulmonalis* and that receiving treatment for *phthisis pulmonalis*, such as it was, lulled the patient into a lethal false sense of security. Believing that he might benefit from the therapy for *phthisis pulmonalis*, the stonemason would not consider quitting his occupation, the only step that posed any hope of limiting disease progression. Writing in a paper to the Edinburgh Medico-chirurgical Society in 1909, Gulland (19) noted that the average onset of TB (as evidenced by tubercle bacilli in the sputum) was about 10 years later in stonemasons than in the general public but that their mortality was doubled. He concluded that the irritating effects of stone dust on the lung enhanced the likelihood of TB infection taking hold, but also possibly delayed its progression; he also suggested correctly that the finer the dust the more irritant it was to the lungs. Later experimental studies, however, revealing that the tubercle bacillus lives in macrophages, showed the silicotic lung to be susceptible to infection because of enhanced intracellular bacillary growth in macrophages containing silica (20) and systemic immuno-suppression (21).

Contemporary accounts of silicosis during the building of Edinburgh New Town

The building of the New Town required large numbers of stonemasons over almost 100 years and the Edinburgh stonemasons became, by the end of the project, "*perhaps the most skilled of their profession in the world"* (22) . However, the particular conditions they met in Edinburgh imposed a considerable cost in terms of morbidity and mortality from silicosis/tuberculosis during the intense building programme. Alison, writing on scrofulous diseases (tuberculosis) (23) in 1842 at the height

of the later phase of building the New Town, stated that Scottish stonemasons generally showed signs of phthisis at the age of 40 and that virtually all masons had it by the time they reached 50. In 1837 at the 7th meeting of the British Association for the Advancement of Science, Macintosh commented on the particular harmfulness of Craigleith stone (24): "*In the neighbourhood of Edinburgh were many stone-quarries, and the workers in which not unfrequently died from consumption"*. He provided a brief report of a mason who worked in Craigleith Quarry who was well, caught cold twice within a short period, and was dead within 2 years from phthisis. At autopsy his lung was described as cutting "*like cartilage*" i.e. was fibrosed. The bronchial glands, where dust particles from the lung accumulate following clearance, contained a "cretaceous matter" which on analysis had the same composition as the Craigleith sandstone.

In his 1892 textbook, Arlidge (25) described "..*the terrible fatality attending work on Edinburgh stone especially that got from Craigleith quarry*" and recorded that, in Edinburgh, "*stonemason's lungs is a well -understood phenomenon..*' Arlidge also quoted Dr (later Sir William) Philip, who had founded the Edinburgh Chest Dispensary in 1887, as stating: "*A large number of cases of stonemason's phthisis seek relief at that institution. The average age at which they come under observation has been about thirty-five*." In 1881 Steele (26) remarked on the remarkably large number of stonemasons treated for phthisis in Edinburgh compared to Glasgow , a contention supported by figures for the incidence of TB in stonemasons in Glasgow and Edinburgh (Table 2). He suggested this could be explained by the difference in the hardness of the stone in Edinburgh compared to Glasgow. In fact hardness can be equated with both dustiness and fineness of dust, both of which would have contributed to a greater risk among Edinburgh masons.

Knowledge of these dangers was not confined to the medical profession. In October 1852 a newspaper, The Edinburgh News, contained a long article on masons and their conditions, as part of a series on the working classes (27). Written near the end of the building of the New Town, it described the problem masons encountered from breathing stone dust and repeated Alison's statement that few masons reached the age of 50 without symptoms of phthisis. The anonymous author(s), however note that they "*can go lower than that*' and state that "*from pretty extensive observation .. there are none but suffer from it at forty. We do not, in truth know ten hewers (working) in Edinburgh above fifty and only two above sixty".* The authors directly implicated Craigleith stone, observing that someone who worked in Craigleith quarry, *"An old Craigleith man"*, was "*done at thirty and died at thirty five*".

The article also points to specific New Town building projects and provides the death rates from phthisis amongst the masons in each project (see Table 1). Amongst these, the building of the Scott

monument in Princes Street appears to have been especially associated with deaths amongst its stonemasons. Its ornate design required the intensive stone-carving that is likely to explain the high mortality. The article reported 23 men to have died whilst Tomlinson (28) cited *"a reliable source"* informing him that 18 out of 70 stonemasons working on the monument died from phthisis during its construction. A news article in the Surgical Times and Gazette of 1853 (29) made brief reference to this, stating that "*one half of the whole number of masons employed"* on building the monument died of phthisis. Wilson (30), an Edinburgh geologist, in referring to "*beautiful Craigleith stone, which kills so many masons"* declared that "*Sir Walter Scott's monument is a monument to 18 workers as well as to himself*". Whilst an exposure duration of 12 to 26 years is consistent with chronic silicosis, deaths over four years in the case on the Scott Monument imply acute or accelerated silicosis, as was the case of the masons working on Elgin Cathedral described in 1991 (17).

Tomlinson (28) also wrote: "*Craigleith sandstone has always had an evil notoriety as most prejudicial to the hewers of Edinburgh"* and "*the sandstone of which the Scottish capital is built has long been evil in repute for producing diseases in the lungs of the masons who work it*"". He also reported: "*The hardness of the stone requires much chiselling and causes it to yield a fine irritating powder*". Referring to Edinburgh stonemasons who suffer from "*mason's trouble"*, he stated that that it was rare to see a stone hewer aged above 50 and common for men who begin to hew at 16 to be dead by age of 24, whilst many died about 35 years of age. Fothergill in an 1882 textbook (31) also commented on the hazard associated with Craigleith sandstone as a consequence of its propensity to produce very fine dust which is highly inflammogenic to the lungs. He recorded an occasion when work was done to repair a sandstone church, whose location is not stated: "*Every man, without exception, who worked on that building has died … in his early days, of mason's asthma"*. He highlighted its hardness in increasing dust exposure and, like Tomlinson, equated hardness directly to "*dustiness during chiselling*". In fact he went so far as to recommend the use of softer stone such as limestone for building if the health of the stoneworkers were to be preserved.

The Edinburgh News article (27) also differentiated between "*carving' or hewing*" masons and "*building"* masons in terms of susceptibility to disease. The former dress and shape the stone whilst the latter position it in the buildings. The article points out that phthisis is virtually unknown in the building masons, since they do not generate dust to anything like the same extent as the carving masons and do not work in sheds. Gulland (19) noted the same trend in stonemasons who were out-patients at the Edinburgh Dispensary where, of 87 total phthisical stonemasons, only 11 were building masons while 76 were hewing masons.

Figures for mortality from tuberculosis in the 50 or so years following the completion of the New Town, in Scottish stonemasons and the general Scottish male population over 20, shows stonemasons to be more than three times more likely to die from TB than Scottish males in general (33) (Table 2). The frequency of death from TB in stonemasons in Edinburgh considerably exceeds that of Scotland as an average and exceeds the incidence of TB in stonemasons in Glasgow by about 5 percent. Most, if not all of the TB in these stonemasons, can be inferred to be silico-tuberculosis.

The end of the Craigleith story

By 1911 Craigleith quarry was essentially exhausted, but it was used as an exemplar during parliamentary hearings of the Committee of Metalliferous Mines and Quarries (33) During questioning, representatives of the industry admitted that essentially all stonemasons who had worked Craigleith stone contracted phthisis, by which they specifically meant silico-tuberculosis. During the hearings, industry representative of quarries in Scotland stated, disingenuously, that Craigleith quarry was the only one they had ever heard of where the workers developed phthisis. The Industry representatives went on to state that Craigleith stone was *"the worst stone that has ever been known"* in terms of causing lung disease in stonemasons. As Craigleith Quarry was more-or-less closed, they resorted to claiming that stonemasons and quarriers other than Craigleith men were "*an exceptionally healthy class of men"*! In fact whilst Craigleith stone was indeed highly pathogenic compared to some stones due to its high quartz content, all quarriers were at risk and would have had an increased incidence of lung disease. Such obvious mendacity in the interests of the employers is no surprise to any student of the history of occupational disease, where denial of risk to workers until the weight of evidence rendered it absolutely undeniable, was often standard practice to avoid compensation claims. In the authors' experience, silicosis continues to take its toll in Edinburgh to this day.

Reasons for the severity of the New Town episode

Sankey (18) commented on the great prevalence of "stonemasons tabes" in Scotland, which he blamed on the greater use of stone in Scotland versus brick in England. This preference for stone as the primary building material in Scotland peaked in the 19th century and rapidly declined in the 20th century as brick and concrete replaced it (5).

Working practices of Edinburgh stone-masons increased their risk as pointed out by Traill in 1841 (33) who described how the Scots dressed and carved the stone in sheds whilst the English worked

in the open air. Accumulation of high airborne levels of respirable quartz dust is obviously greater in still and confined air than in the open air where natural dilution would occur. Support for this contention was reported in the early 20th century when the levels of dust generated by working masons were measured in a closed yard in dead calm and in an open yard in gusty wind (34). The study did not involve sheds – we know of no data measuring the dust levels in sheds where stone was worked versus outdoor working. The study does however report the diluting effect that breezy conditions could have in dissipating the exposure resulting from working stone and thereby decreasing the received lung dose, compared to the still conditions that would pertain in a shed. We suggest that still conditions are an admittedly imperfect surrogate for a closed Scottish shed and the breezy conditions mimic outside working when there is a breeze. The study found about 5 times greater airborne stone dust during working in the still conditions (34). Tomlinson (29) commented on the high levels of dust attained in the stonemason's sheds where the men worked in rows: "S*o great a cloud of sandstone-powder was raised that you could not, standing at one end of the row, see men at the other end"*. Gulland (20) commented further on the practice of Scottish masons working in sheds: "*The freestone [1] used in building made a fine dust which remained suspended in the air for long and so was inhaled by the hewers*". He also pointed out that "*No steps were taken to remove this dust from the sheds and thus it was stirred up in walking"*. This re-entrainment of dust into the air would have added to the level being produced from working the stone.

Details of the working conditions of the Edinburgh stonemasons are also provided by the article in Edinburgh News of 1835 (28) which discussed "*the evil of close(d) sheds*". It describes the sheds as long and narrow, '*boarded up*' and '*very air-tight*'. Echoing Tomlinson, it also describes how, standing at one end of a forty foot mason's shed, the men at the far end "*were all but invisible"*. Hugh Miller, the geologist and writer of the post-enlightenment, had personal experience of working in the stonemason's sheds in Edinburgh and contrasted the "*dusty work-shed*" where he spent his working days with the countryside he enjoyed in evening walks. In fact he contracted stonemason's lung disease in 1824 aged 22, but stopped working as a stonemason in time to avoid a precipitous decline in his health, dying aged 54. He considered himself lucky to be able to give up the work, commenting that *"From the stage of the malady at which I had already arrived, poor workmen, unable to do what I did, throw themselves loose from their employment, and sink in six or eight months into the grave"* (22).

Tomlinson (28) recommended a respirator, which was designed by the Reverend Mr Nisbet of Canongate, Edinburgh to protect masons. This looks remarkably like a modern respirator with ties to

[1] Scottish term for sandstone

secure it around the mouth and nose and incorporating a cloth filter to trap fine dust and prevent it from being inhaled. There is however no indication that any form of respiratory protection was generally adopted at that time. In fact it had traditionally been suggested that stonemasons grow a beard and moustache, which might filter out the harmful stone dust! The anonymous Edinburgh News article (27) contains the unlikely statement: "I*n the South of Germany .. where freestone is extensively worked ..the masons are fine looking muscular fellows with large beards.. such a disease as phthisis is never heard of".* It was also suggested that masons should keep their mouths closed during working: *"It is always recommended for the stonemasons to work with closed lips, as it is observed that such as keep open their mouths much during work fall victims more surely and speedily to the disease*" (27). In fact a beard or moustache would be useless against the very small size of the respirable fraction of airborne quartz which would easily pass between the hairs. Nose-breathing would somewhat decrease the dose of fine dust to the lungs compared to mouth-breathing, as the nasal route is a more efficient filter of particles than the oral route (35). However, given the high exposures assumed from the foregoing descriptions, nasal breathing alone would not have prevented the silicosis.

The stonemasons themselves seem to have been generally accepting of the fact that their working lives might be shortened by ill-health and early death, or as Sankey (18) puts it, they react "*coolly*" when they *"contemplate their fate*". In a similar vein Gulland (19) reflected on the "*extraordinary apathy*" of masons in relation to the issue of the wearing of respirators. When Sankey suggested that some form of respiratory protection from the stone-dust would be advisable, he found the masons "*averse to anything of the kind"*. Wilson (30) likewise found them "*unwilling*" when he raised with them specific steps to decrease their exposure using increased ventilation. The reason they worked in closed sheds appeared to be to avoid the Edinburgh weather according to the Edinburgh News article (27) . However, the article points out that they would be better to endure the weather and retain their health than work in the sheds which they describe as "*nothing better than a place of human sacrifice*". Finally, the use of water to supress dust was understood by the 19th century (13;27), but this does not seem to have been appreciated or accepted by stonemasons during the building of the New Town.

Stonemason's lungs in the collection of the Museums of the Royal College of Surgeons of Edinburgh

In spite of the large number of deaths of Edinburgh New Town stonemasons, there does not appear to have been a previous pathological report. The museum of the Royal College of Surgeons of

Edinburgh [2] was collecting specimens in large numbers in the mid-19th century for teaching purposes. The collection contains 2 lungs from Edinburgh stonemasons diagnosed with silico-tuberculosis (GC.2061 and GC.14428); in addition, there is one specimen comprising several enlarged pulmonary lymph nodes from a stonemason (GC.461).

Number GC.2061 in the General Catalogue of the Museum of the Royal College of Surgeons of Edinburgh This lung is selected for pathological description but it also represents the other stonemason's lung (GC.14428) which is similar in appearance and description. GC.2061 was preserved in 1840, towards the end of the building of the New Town. Its entry in the General Catalogue of the Museum of the Royal College of Surgeons of Edinburgh in 1840 is as follows:

"*Portion of the lung of a stonemason, tubercular with purulent cavities. The individual from whom this was taken had been a stone-hewer for about 20 years. For three or four years previous to his death, he had been subject to cough and dyspnoea and died phthisical at the age of 43. Presented by Dr P. Newbigging 22nd Jan 1840..'*

In the 1960s the specimen was re-catalogued and the entry was expanded to the following description of classical silico tuberculosis:

'Portion of left lung, showing pneumokoniosis, a disease associated with tuberculosis which results from inhaling dust. From a man aged 43, who died of phthisis, also known as pulmonary tuberculosis. For 20 years his occupation had been that of a stone-hewer, and the last 3-4 of these he was troubled by a cough and difficulty breathing. At the apex of the lung there is an old cavity covered by thickened adherent pleura with which a bronchus communicates. The rest of the upper lobe is condensed and fibrous and contains several recent small cavities. The density is due to an interstitial fibrosis induced by the irritation from inhaled particles of stone. The fibrous tissue occurs in rounded nodules paler at the centre than at the periphery where there is a deposit of carbon. Scattered tuberculous foci occur throughout the lung but are more obvious in the lower lobe where the surface shows numerous firm elevations the larger of which are undergoing central caseation. The pleura is less thick towards the basal part of the lung..'

Pathological description of GC2061

[2] https://museum.rcsed.ac.uk/

The lung was removed from its jar and macroscopic pathological evaluation was undertaken and conscious of the historical value of the specimen, a single small block was taken from the periphery of the upper lobe for histological sectioning (see below).

Macroscopic appearance (Figure 2 A and B) The lung felt very firm to palpation with nodules of various sizes detectable within its substance. White patches of thickening or inflammation were visible across the cut surface, indicating silicotic nodules or tubercles, it was difficult to tell which. The deep cavity at the apex (Fig 1B c) was approximately 5cm in its main dimensions and the walls were striated with bands of fibrous tissue (Fig 1B s). The pleura was rough, thickened and fibrosed across most of its surface with evidence of adhesions; where cut, the pleural thickening was obvious (Fig 1B p).

Microscopic appearance (Figures 2B and C) Section of the block of tissue obtained from the specimen, stained with haematoxylin and eosin, reveals variably-sized nodules of fibrous tissue (Fig 1C n) some of which are hyalinised (Fig 1C h). In places these nodules coalesce to form larger fibrous masses. Admixed with this, in the background, are scattered dust macules arranged principally around vessels. Both the macules and the nodules show focally the presence of some black anthracotic material (Fig 1C a) with, in addition, evidence of a small quantity of birefringent crystalline material (Fig 1D arrows) the appearances of which are in keeping with silica. These histological appearances are typical of nodular silicosis. No histological features to suggest co-existing TB (silico-tuberculosis) are identified in the section taken and a Ziehl-Nielsen stain revealed no tubercle bacilli. Given the valuable historical nature of the specimen only a small piece of tissue was taken for histology and it is possible that there was evidence of TB infection elsewhere in the lung.

Conclusion

In summary, we report evidence that there was an epidemic of silico-tuberculosis in stonemasons during the building of the Edinburgh New Town. The reasons for it can be summarised as:

- Accumulation in Edinburgh, during the construction period from 1767-1859, of a greatly expanded population of stonemasons.
- The use of Craigleith stone with its very high quartz content and hardness
- The work of the stonemasons in unventilated sheds rather than the open air.
- The masons' poor understanding of preventive measures and probably necessary acceptance of their fate.

In addition, the lung of a stonemason diagnosed with silico-tuberculosis and preserved in Edinburgh in 1840 was identified in the collection of the Surgeons Hall Museums. The lung of this stonemason, who is likely to have worked on the New Town, was subjected to histological examination, which confirmed the presence of advanced silicosis and showed birefringent particles consistent with quartz together with evidence of tuberculosis.

The actual numbers of silicotic deaths remain obscure in the absence of mortality data for the period, but the anecdotal accounts reviewed suggest they must have been considerable. Moreover, since not all silicosis is fatal, the numbers adversely affected by the disease must have outnumbered those recorded as dying from it. The weight of evidence described here from contemporary sources argues persuasively for the occurrence of a forgotten occupational health disaster amongst stonemasons during the building of the Edinburgh New Town.

Unfortunately silicosis still occurs among stonemasons in Scotland and of course elsewhere. Scotland has the highest age-standardized rate of silicosis in the UK, being twice that of England and Wales and five times greater than Northern Ireland (36). Edinburgh still sees the occurrence of early stage silicosis in stonemasons. A recent report of 6 cases of silicosis in individuals referred to specialist respiratory clinics with minimal respiratory symptoms were all found to be stonemasons (37) . According to the International Labour Organisation, silicosis afflicts tens of millions of workers in hazardous occupations and kills thousands of people every year, everywhere in the world (38). The World Health Organization (WHO) recommends all workers exposed to crystalline silica should undergo lifelong health surveillance with baseline chest X-ray at commencement of employment, and a repeat chest X-ray after 2‑3 years. A screening chest X-ray should take place every 2‑5 years thereafter. Spirometry and symptom questionnaires should be obtained annually from the start of employment and any abnormality should be met with referral to specialist respiratory services

Table 1 Table showing mortality from phthisis amongst stonemasons working on specific building projects in the New Town; compiled from (25-27).

Building project	**Death toll**	**Reference**	**Notes**
Erection of Cramond Bridge (1825)	'Out of 27 apprentices ..fine, young, healthy men ..2 survive 26 years later'	(28)	Deaths occurred over the following 26 years
Construction of Edinburgh High School (1827)	'Out of 120 hewers..only 10 survivors'	(28)	Deaths occurred over the following 24 years
Construction of the Edinburgh and Glasgow Bank (1831)	'of thirty stout hewers.. only the one half lived to see it finished'	(28)	Deaths occurred over the following 12 years
Erection of the Scott monument (1840-1844)	' killed twenty three of the finest hewers in Edinburgh'	(28)	Deaths occurred over 4 years of building
	'70 men … 18 men died of mason's trouble'	(29)	
	'One half of the whole number of masons employed …dead of phthisis'	(30)	

Table 2 Percentage mortality from TB in the general male population over 20 years for the years 1901- 1908 and stonemasons for the years 1872-1911; the implication is that the TB in the stonemasons is silico-tuberculosis. Data for Scotland as a whole, for Edinburgh and Glasgow . Data taken from Table 12 in (33).

	Percentage dying from TB		
	Scotland	Edinburgh	Glasgow
All males over 20 years	12.7	13.4	14.4
Stonemasons	37.6	46.1	41.2

Figure 1. A) Craigleith quarry by John Bell, likely painted in the early 19th century and reproduced courtesy of Museums and Galleries Edinburgh, City Art Centre. B) Craigleith Quarry photographed by Thomas Vernon Begbie in the late 1850s; reproduced courtesy of The Cavaye Collection of Thomas Begbie images, Edinburgh Galleries and Museums. C) An image of Craigleith sandstone. This specimen is of the best quality ashlar 'Liver rock' used for the fronts of the best houses and public buildings because it could be given a very smooth surface. The stone has a cut surface of a very pale buff colour with variable dark wispy markings. Specimen from the building stone collection of the Edinburgh World Heritage Trust no. EWHT 19. D) Image of Hailes quarry, Edinburgh, c1926 where most of the paving stones of the new town originated. The picks and wedges used to release blocks of stone from the stratum can be clearly seen. Image reproduced courtesy of the British Geological Survey (BGS Photograph P216874. C3114).

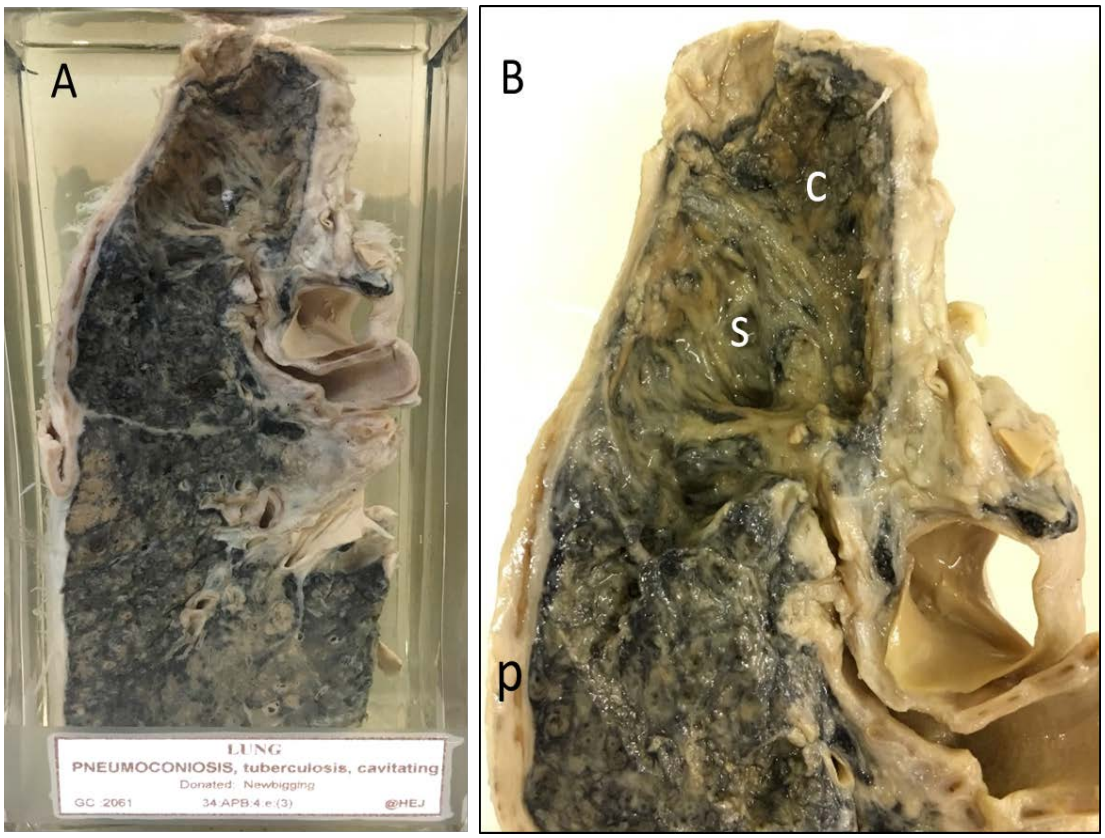

Figure 2. A) GC2061 in its original preservation jar. B) GC2061 removed from its jar and photographed to show the macroscopic appearance of the apical cavity (C) with its striated wall (S) and thickened pleura (P).

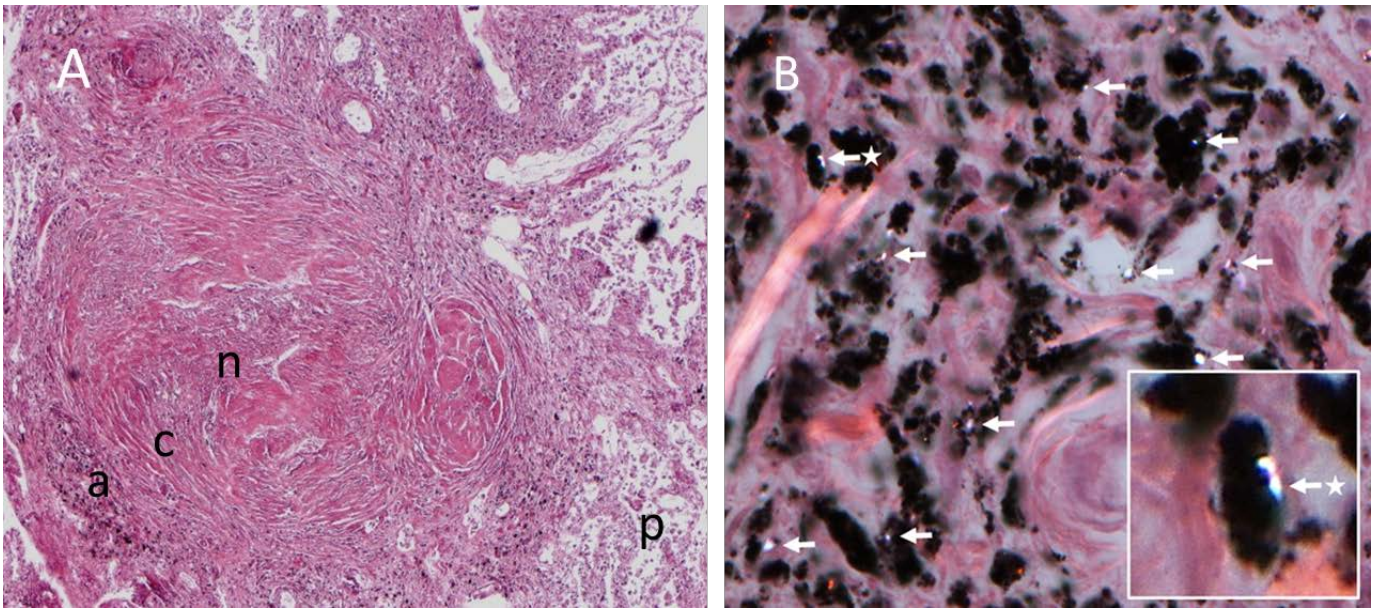

Figure 3 Haematoxylin and eosin-stained paraffin section from a block taken sub-pleurally from the peripheral apex of CG2060, away from the cavity. A) Most of the field is taken up by a silicotic nodule (n) with whorled, hyalinised, layers of collagen (c) and a cuff of cells laden with anthracotic material (a); some distended parenchymal airspaces are seen at the right containing inflammatory cells and debris (p). B) Higher power view under crossed polarised light of an area of cells laden with anthracotic material, presumed to be macrophages. This reveals birefringent quartz crystals (arrows) amongst anthracotic material in the dust-laden macrophages, partially birefringent collagen and inflammatory cells. The cell marked by the starred arrow is shown at higher power in the inset.

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