Toxic Rocks, a history from A to Z

Tim Carter

The first HOGG lunchtime talk of 2022 was given by Dr Tim Carter, who told the fascinating story of rocks that have posed risks to health from the Palaeolithic to the present day and explored some of the ways in which risks have been mitigated over the years.

Humans have been using stones and been exposed to their dusts ever since the first flint was knapped. It was not until the renaissance that knowledge about their harmful effects started to be systematised. Agricola's treatise *De re Metallica* was published in 1556. As a scholar he studied all aspects of metal mining and processing, turning secretive trades into accessible and quaintly illustrated summaries. As a doctor he described three main toxic effects: damage to the lungs from dusts; gasses and vapours that induced unconsciousness (often thought of as 'mine devils' at the time), and early mortality.

Cherub powered mine ventilation: Agricola De Re Metallica *Public Domain*

This was followed by the first text specifically on miners' diseases, Paracelsus' *On the Mountain Consumption*… Here he made the key postulate 'it is the dose that makes the poison'. Both these authors gained their experience of mining in the mountains of central Europe.

All risks do not fit into Agricola's three categories. Lead dust enters the lungs but its effects manifest as lead poisoning affecting other organs. Mercury vapour is absorbed through the lungs as a vapour but has delayed toxic effects. These mattered more in Idrija, Slovenia where miners were free men than at Almaden in Spain where the mines were an alternative to a sentence as a galley slave. In 1822 arsenic was reported to be a cause of skin and scrotal cancer, not by inhalation but from skin contact with smelter dust, by Dr Ayrton Paris who was practising where it was extracted from copper ores in Devon and Cornwall.

It is dust diseases of the lungs that have been the major risk from mineral exposure. These presented first not in mining but in manufacturing. The short lives of those who dry ground on sandstone wheels were among the first risks to be identified, although there was initial uncertainty about whether it was the stone or the metal particles that were harmful. In 1796 Dr James Johnstone reported this in the needle pointers of Redditch who hunched close to fast sandstone wheels. They had a short life, but a wild one, with a risk premium in their wages to fund it. Soon after similar problems were reported from Sheffield. Years earlier flint had been introduced as a component of ceramics and those who ground it soon succumbed. A brilliant example of early prevention can be found in Benson's patent of 1728, for grinding flint under water.

Needle pointing, Redditch *Public Domain*

Mining silicious rocks with hand tools did not seem to pose the same level of risk, but when pneumatic rock drills were introduced, in the late nineteenth century, they were soon

called 'widow-makers'! Lung disease was seen on a big scale in the fast-developing gold mines of the Witwatersrand in South Africa, and there the development of water injection through drill bits led to a rapid reduction in exposure and in harm. Sadly, these techniques were not always adopted, and tunnelling workers recruited during the great depression in USA went unprotected, with some 500 out of 3,000 who worked on the Hawkes Nest hydro tunnel later dying from silicosis.

Meanwhile Britain was the dominant world producer of coal. Here gasses arising from the coal – the well-known 'mine damps' were an ever-present risk: fire from methane, poisoning from carbon mono- and dioxides and from hydrogen sulphide as well as collapse from lack of oxygen. J.S. Haldane's experimental work showed the relationships between exposures and harm, leading to better precautions. However, the health risks of coal dust proved controversial. Silicosis was a risk in some miners, but there seemed to be a different pattern of disease in those only exposed to coal itself. Studies on those who trimmed coal cargoes in Cardiff dock showed that there were specific X ray findings; how well they correlate with disability remains unclear.

Residual problems on a huge scale remain from the biggest exposure disaster of the last century – asbestos: a generic term for several fibrous amphiboles and serpentines that were found to cause lung fibrosis in the 1900s, lung cancer in the 1950s and mesothelioma in the 1960s; the latter still accounting for over 2,000 deaths a year in UK alone. Harm was seen first in the use of the fibres in fabrics and insulation. It took the finding that mesothelioma was almost specific to exposure by Chris Wagner in 1960 for the risks to be taken seriously. It was first recognised in the crocidolite mines of South Africa. Crocidolite was imported by the Cape Asbestos Company in Barking. Cases were found in workers there, and shortly afterwards in workers' relatives and in those living near the plant. Regulation and then a ban on import and use came into force.

Hand cobbing blue asbestos (Crocidolite) South Africa c.1960

Harm may come to the public not just from asbestos. The recognition that radiation from radon gas caused lung cancer was first made in miners in central Europe. This helped to explain many other puzzling cancer risks in miners of tin, haematite and uranium as well as public health risks in areas with high levels emanating from sub-surface rocks. It may even explain the miners' wives who had seven husbands mentioned by Agricola, as these mines have high radon levels. Volcanic dusts also raise questions about widespread public health risks, and old vulcanicity can leave a toxic legacy. Erionite, a fibrous volcanic zeolite in the walls of dwellings in Cappadocia is an even more potent cause of mesothelioma than crocidolite.

We have travelled through toxic rocks from A for asbestos to Z for zeolite. The postulates of Agricola and Paracelsus have largely stood the test of time ever since the sixteenth century.

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Tim has worked in occupational health, concerned with dust and chemical toxicity. He oversaw the work of the Quarries inspectorate for several years and has also helped with health care planning in the shadow of a volcanic eruption. Retirement has enabled him to develop his interests in the history of both geology and occupational disease prevention.

A further 'Toxic' Encounter…

In 1816 George Greenough and William Buckland visited the cave at Gailenreuth, near Muggendorf, about 50km north-east of Nuremberg. The cavern was famed for the ancient bear bones that littered its floor. Greenough's notes reveal some of the 'toxic' dangers of these early explorations…

The chasm continuing to an unknown depth – you descend by fixing your hands & feet on the rough projections of ye chasm striding alternately from side to side – while I was doing this a piece of flaming pitch fell from Buckland's torch on my cap & I did not dare extinguish it till I had reached the bottom. […] I lay on my back at full length there & when Buckland had descended took a flambeau from him in order to exhibit the bones with which this spot is filled […] in a short time the smoke became so oppressive that Buckland returned, the delay of a minute also almost rendered the light of the flambeau invisible & stopped respiration – it was with great difficulty that the woman who was our guide & myself could command sufficient strength to return up the chasm to a freer atmosphere.

Inside the Gailenreuth Cave , detail from W. Buckland's Reliquiae Diluvianae, *Plate 17*
Photo. P Lincoln

(Greenough's notes extracted from H.S. Torrens, 'Geology in peace time', *Algorismus*, 23, 1998)