A303 - Stonehenge to Berwick Down Scheme

Response to Written Question AQ.1.20

by:

Winterbourne Stoke Parish Council

Registration ID 20019107

&

Dr A D Shuttleworth

Registration ID 20018263

Question

Construction Dust Assessment

Please explain what is known about inhalation risks posed by radiation from particulate alpha emitters (particularly isotopes of polonium, bismuth and lead) found in phosphatic chalk, and the nature and extent of local concern?

Our Response

1.0 We are not experts in geochemistry nor in the radiological hazards posed by geological sources of radiation. Consequently, we believe your question has been misdirected and would be better addressed to that part of Public Health England that was the National Radiological Protection Board and also to a competent geochemistry department, such as the Royal

School of Mines based at Imperial College London who, between them, do have the expertise to answer your questions and our concerns.

1.1 We were alerted to the claimed existence of radiation bearing phosphatic chalk by an article[1] published on the internet by geologist Professor Rory Mortimore, then of Brighton University, in 2014, which claimed that:

"The big surprise," said Mortimore, "was discovery that the geology on the tunnel route contains a large deposit of phosphatic chalks which contain weak and poorly banded sand and silt layers and a high register of radon radiation. Such a large deposit of phosphatic chalks were unknown in Wiltshire and, indeed, in Europe and their impact on the proposed tunnel project were profound."

1.2 Mortimore further claimed that in earlier iterations of tunnel planning for Stonehenge:

"Disposing of radon contaminated phosphatic chalk in a landfill presented major concerns and special handling of groundwater and construction wastewater added to the tunnelling and construction cost estimates,"

1.3 When Highways England decided they wanted to process chalk waste from the tunnel excavations within the Parish and also dump significant quantities around the village and particularly to the east of Parsonage Down, we and our fellow villagers were, unsurprisingly, concerned by the potential health risks this might create.

1.4 The source of the radon in radiochemical terms is fairly straightforward, and uncontentious. It is a radioactive, colourless, odourless, tasteless noble gas, formed during the radioactive decay of thorium and uranium to lead and other less stable isotopes (See Fig 1 on following page). As thorium and uranium are very common isotopes and have half lives in the order of several billion years, radon is constantly being produced and will be long into the future.

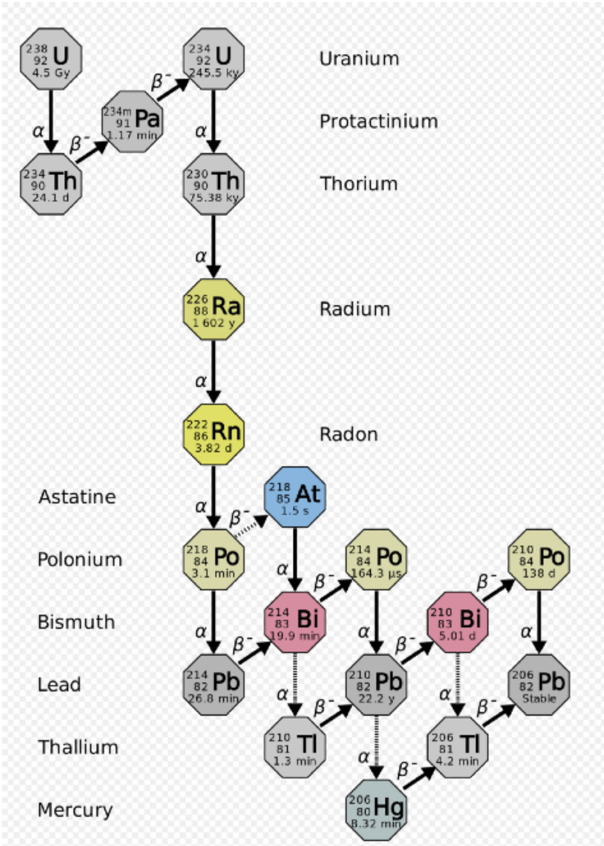
1.5 It follows that if radon is found in phosphatic chalk, it is being produced continuously by long lived isotopes in the thorium and uranium decay series. In this case, the immediate source is Radium-226 which has a half-life of 1600 years. Clearly, as the phosphatic chalk has been under

---

[1] https://www.tunneltalk.com/UK-21Nov2014-Stonehenge-TBM-bored-road-traffic-tunnel-revived.php

Stonehenge for millions of years, the Radium-226 is itself a decay product of a much longer-lived isotope of uranium or thorium.

Fig 1 - Uranium Decay Series



1.6 Radon is a recognised cause of cancer and in the US is believed to be the second greatest cause of lung cancer after smoking. In the UK, it is a particular problem in basements and sealed ground floor structures in Cornwall. It is also a potential problem for tunnelling under Stonehenge, as alluded to by Professor Mortimore.

1.7 Being a short-lived gas, Radon is not overly problematic in the open air - it will blow away and disperse on the wind. At any one time, there are estimated to be only a few tens of grams of radon on earth. It decays rapidly and more is produced.

1.8 Unfortunately, radon is not the subject of our concern, merely a symptom of an underlying and much longer-lived problem; the radon daughters/progeny. The Radon progeny are decay products of radon that are produced in the following series:

Radon 222, 3.82 days, alpha decaying to...

Polonium 218, 3.10 minutes, alpha decaying to...

Lead 214, 26.8 minutes, beta decaying to...

Bismuth 214, 19.9 minutes, beta decaying to...

Polonium 214, 0.1643 ms, alpha decaying to...

Lead 210, which has a much longer half-life of 22.3 years, beta decaying to...

Bismuth 210, 5.013 days, beta decaying to...

Polonium 210, 138.376 days, alpha decaying to...

Lead 206, stable

1.9 Some of these progeny, Lead 210 and Polonium 210 in particular are relatively long-lived and are alpha or beta emitters. They are particulate materials that bind readily to other particulates, like chalk dust, and can then be inhaled into the deep lung on particles of a respirable size where the decay products are brought into direct contact with the lung surface. Alternatively, the progeny bind directly to biological materials like grass and are ingested by animals, or man. The direct contact with the intestinal surface means that vulnerable tissue is readily damaged by the alpha and beta emitters.

1.10 Having raised this as a concern with Highways England, we were puzzled by their apparent fixation with radon and not the progeny and that whilst they had commissioned tests for gamma and beta radiation in the phosphatic chalk, they have not, to date, produced any data for alpha emitters - the real concern in this context.

1.11 We believe the science above to be correct, however, by itself, this does not address our concerns. The issue is whether the levels of radon progeny pose any credible risk to villagers, or their livestock. To establish this, Highways England need to undertake the appropriate analysis of the phosphatic chalk to determine the levels of radon progeny being released by samples under several conditions that mimic the real-world situations of concern:

- As extracted from the ground during core sampling;
- When processed using the methods that are going to be used;
- When put into a dry aerosol form, as would happen with wind-blown chalk dust

1.12 Alpha particles from the radon progeny have relatively low energy, they won't pass through a piece of paper, or into the body through the thick dead skin on your hands and feet. However, they can readily pass into highly vulnerable cells like those in the lung or intestinal tract when placed in close proximity to the alpha source; as they would be if inhaled or ingested. They certainly won't pass out of a lump of phosphatic chalk, as they will be blocked by the chalk itself.

1.13 Processed chalk and chalk dust are an entirely different matter. We are advised that the microfossils in phosphatic chalk have a mass median diameter of around 20um in size - at the top end of the respirable range for deep lung penetration. Processed chalk may give rise to even smaller chalk particles; increasing the risk of materials being taken into the deep lung.

1.14 Quite clearly in this context, inappropriate sampling and analysis could distort the hazard quite significantly, so Highways England must be challenged on their choice of samples and the way the detailed analyses have been undertaken by their contractors. A good starting point would be to establish if the contractor had been asked to establish radiation levels in the appropriate context, or had merely been asked to establish radiation levels *per se* with no reference to specific context having been made.

1.15 Ultimately, we believe that Highways England, if they have not already done so, will need to provide particle size distribution figures for the chalk as mined and then as processed, to allow radiological specialists at Public Health England to determine realistic risk levels for the methods they wish to use in processing the phosphatic chalk from the tunnel spoil and ultimately spread on the ground in the vicinity of Winterbourne Stoke.

1.16 At the end of the day, there may be no significant risk to human or animal life, but that needs to be determined empirically. Highways

England, or their contractors/consultants, need to advise us, the Inspectorate and the Secretary of State, of the likely increase in morbidity and mortality caused by the phosphatic chalk excavation, processing and re-location, couched in readily understandable terms; such as the number of additional cancer cases/deaths per 10,000 population.