COMMENTS ON THE EMISSIONS FROM THE YALDHURST QUARRIES

Dear Brian Roche,

Recently you published an article rejecting the claims of harm from quarrying greywacke rock in close proximity to public access ways and houses in the quarries around Christchurch. I wish to correct the false assumptions and conclusions in this article.

For instance, you stated that according to your European quarry colleague that there have been no cases of respirable silica reaching to and over a quarry boundary in sufficient volumes to cause any neighbour any issues. Setting aside the fact that, unlike the Yaldhurst quarries, all the European quarries I have seen are set back well away from public spaces, even a cursory review of the literature would reveal that high doses of RCS result in classical silicosis in both workers and residents whereas low levels of exposure tend to result in heart or other non-respiratory organ failure.

So let's look at the whole picture to see where you went wrong.

What they are quarrying: greywacke rock

The extensive quarries adjacent to the Old West Coast Road on the outskirts of Christchurch quarry greywacke from the relatively thin deposits above the aquifers. The operators crush the rock, and screen it and transport it for the Christchurch rebuild. These operations cause dust. Greywacke contains between 30% and 40% silica dioxide, a fact that has been known for over one hundred years. Silica dioxide is a common component in many types of rocks and it is relatively harmless in nature (although not always so), but it can become very dangerous when crushed, sawn, worked, run over, transported on uncovered or dirty trucks, or otherwise disrupted by human activities, such as quarrying. When released by human activity from the greywacke rock, the much of the silica dioxide is in the form of minute, sharp-edged, refractive crystals which are so small they are invisible to the naked eye. Air currents can lift these minute crystals into the air and carry them for considerable distances (between 500 m to 1.5 km). I have attached a photomicrograph taken at very high magnification through a microscope that shows that these crystals are very small with sharp edges and points. They also refract light beautifully giving a range of colour just like diamonds. They are lovely, but deadly.

Silicosis

When dust is inhaled, the larger particles in the dust are trapped in the mucus lining of the larger airways and are cleared from the lung by the action of cilia – hair-like organelles that propel the dust-laden mucus stream up and out of the lung. However, the smaller (<10 μm) respirable crystalline silica (RCS) crystals can bypass the defences located in the larger airways, and pass down into the very smallest airways which do not have mucus/cilia defences. Here they may cut into the cells of the lung epithelium, causing an inflammatory response which then results in scarring and a non-functional lung cell. The damaged cell cannot transport oxygen to the blood, nor carbon dioxide out. Lung function becomes impaired with reduced gas exchange capacity, leading to shortness of breath, fatigue and worse conditions - much, much worse.

This lung disease is called silicosis and it has been known for centuries. In fact, it was the first lung disease to be recognised. It can kill if the sufferer loses lung function after prolonged exposure. It is incurable, but can be arrested if the source of the problem, the respirable crystalline silica, is stopped. Inhaling RCS can also cause heart disease, cancer kidney disease and a number of other diseases depending on the physiology of the patient. All of these conditions can be fatal. Note that RCS is classified as a carcinogen in most countries and as a presumptive carcinogen in New Zealand. These aren't bananas.

International regulations aimed at reducing silicosis

Most countries have a number of regulations aimed at preventing silicosis. Avoiding quarrying silica-rich rocks close to homes or public areas is a common requirement throughout the world, though not in New Zealand. Setbacks or buffer zones between the quarry and the quarry boundary of between 500 m and 1.5 km are common in other countries, such as Australia and India, but not in New Zealand where setbacks of a mere 25 m have been allowed. However, the NZ Environmental Protection Agency recommends a best practice guideline of a setback of 500 m.
The reasons why such large setbacks are demanded is because the invisible silica dust travels much further than visible dust (my modelling suggests up to eight times further).

Another problem in New Zealand is the requirement for bunds in quarrying consents aimed at reducing the incidence of dust. But bunds are now known to make the situation worse by forcing an airstream to deflect higher in the air thus causing the finest dust to travel further. In many countries dust fences tend to be favoured over bunds; though not in New Zealand, perhaps because they are much more obvious.

Other operating requirements are the sealing of every surface where trucks and diggers operate. Other surfaces may be required to be irrigated continuously in order to keep the dust down. High efficiency face masks must be worn by staff. And crushers and other dust-emitting equipment may have to be be enclosed. Semi-continuous monitoring may be required and staff examined at regular intervals for signs of silicosis. When an exceedance occurs the quarry may be closed down until the problem is fixed.

The WHO has set up a task force aimed at the elimination of silicosis by 2030 (Task Force 4, URL given below). The WHO seeks to find and promote best practice for quarrying.

New Zealand quarries are behind the rest of the world in these preventative measures for reasons unknown to me. The information about the extremely harmful effects of silica dust has been known for centuries, and modern information is readily available, especially since the growing realisation of the dangers has prompted many governments to conduct more and more research into the causes and prevention of silicosis. So the question arises why aren't the standard remediation measures to protect neighbours better known by New Zealand quarry companies?

Why isn't silicosis better known in New Zealand

One reason why silicosis slips under the radar may be that it is not generally known that greywacke, a type of sandstone, has between 30% and 40% quartz content. Another may be that it is very hard to diagnose silicosis in its early stages especially if the patient and the diagnostician are not aware

that the patient has been subject to sources of RCS. And if death does occur then the cause may be ascribed to one of the secondary conditions caused by the silica, such as cancer or heart disease, without anyone realising that the primary cause was inhaled crystalline silica dust.

The effect of silica dust on quarry neighbours

Traditionally, the focus of regulations was on the health and safety of workers. But of late much more attention is being paid to the effects on non-occupational neighbours of quarries. In 2012 L J Bhagia published a comprehensive review of studies that showed that respirable crystalline silica can seriously affect residents living near to dust emitting quarries.

Bhagia reported three major findings:

1. Non-occupational residents can be very seriously affected by silica dust discharges from nearby quarries;
2. Risk is cumulative, not non-cumulative as assumed by regulations; and
3. Permissible exposure limits (PEL) should be a mere 5 µg of respirable crystalline silica per m^3 of air. Below that level people living near quarries are safe. Above that some, or many, will develop silicosis. The PEL is much lower than for quarry workers since residents ma y be affected continuously (24/7/52), whereas workers are exposed only during working hours (8/5/48).

Regulations

After 40 years of prompting by experts and by NIOSH, OSHA, the US regulatory authority, has recently lowered the permissible exposure (PEL) limit to 50 µg/ m^3 on a time weighted average basis. It has been suggested that resident's exposure should be half or less of this, that is <25µg/ m^3. But if modern research is correct then the permissible exposure limit should be 5 µg/m^3. California has adopted a PEL for neighbours of silica rock quarries of 3 µg/ m^3, 16 times lower than NZ's work safety regulations.

As for setbacks, the State of Victoria requires a setback of 500 m (not 250 m as claimed by one local expert). Other countries may require even greater setbacks. The setbacks of the Yaldhurst quarries has been as small as 12 m, and the average is about 100 m or so, which is far too little to provide adequate protection to neighbouring residents and the public.

ECAN's study – further analysis

In a study conducted by ECAN in 2016 involving the placement of a number of monitor devices outside the quarries' boundaries and near the resident's homes, an exposure limit of 150 µg/m^3 was taken as the PEL. This is fine for dust free of respirable crystalline silica, but is totally inappropriate for dust that does contain respirable crystalline silica. However even using their incorrect PEL, a dangerously frequent number of exceedances above 150 µg/m^3 was recorded (see graph). In most

countries one such exceedance per annum is enough to trigger cessation of operations until adequate mitigation is instituted.

Although I have not been provided with the original data from this study to allow me to conduct further analyses, I did manage to show the number of exceedances at the NZ legal PEL of 50 µg/m^3 in the graph reproduced below·. This indicated frequent exceedances. At the Californian PEL of 3 µg/m^3 there would be near continuous exceedances.

Medical conditions shown by residents

The neighbours to this large zone of very active quarrying are showing disturbing medical conditions. They are experiencing wheezing and coughing, bleeding from the nose, eye irritation, shortness of breath, tiredness, dizziness, lung inflammation, dental problems, problematic blood chemistry, high and variable blood pressures, and general weakness, all of which are listed in the literature as being possible signs of early stage silicosis. The residents have been protesting for many years the development of quarries so close to their homes, but little has been done since dust experts, who didn't know that greywacke is made up of large amounts of silica, assured the Environment Court and Commissioners that the dust nuisance is "less than minor." Well, it isn't. And the amazing belief common in New Zealand regulatory authorities that only visible dust matters is risible. Now that is bananas.

We all agree we need quarries, that is a given, but like many human activities, quarrying must be carried out in ways that do not endanger the health and well-being of workers and others. Other countries manage this; why can't we?

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References:

Bhagia, LJ, 2012. Non-occupationl exposure to silica dust. Indian J Occup Environ Med. 16(3): 95-100.

http://www.who.int/occupational_health/publications/airdust/en/

Air Quality Investigation: Yaldhurst Quarries. Report Number R16/30