COAL IS TOXIC

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Mother Nature knew what she was doing when she buried organic coal sediments deep underground within sedimentary layers of rock. She did not want coal's toxic components near the fertile and life-giving topsoil, competing for absorption with life-giving elements and thereby entering and adversely affecting the food chain, plant and animal health. Neither did she want them contaminating the aquifers by allowing water to filter through the strata and mobilise toxic compounds. Nor did she want coal's radioactive particle load disseminated in the local airflows or intercontinental jet streams.

WHAT IS COAL?

Coal is an organic, combustible sedimentary rock that also contains minerals and inorganic material, within the organic matter. The compressed organic matter laid down in typically saline inland sea basins or swamps millions of years ago, is interspersed with finely weathered rock material, known as shale. The heaviest metals accumulate in the coal and shale strata because their densities and electronic charge mean they tend to concentrate in depositional environments. Coal and coal shales therefore concentrate and accumulate the heaviest of metals, amongst other elements, most of which are bio-toxic and some of which are also radioactive.

WHY IS IT TOXIC?

Coal is toxic because:-

- Elements such as arsenic, mercury, lead, cadmium, selenium, nickel, vanadium and copper are accumulated and concentrated within coal and associated strata.
    - For example, coal seams can have 6 x as much arsenic, 5 x as much uranium, 4 x as much mercury, 3 x as much lead compared to a typical basalt (hard igneous rock).
    - These elements are referred to as toxic metals or toxic, heavy, metals because of their negative physiological effects, both chronic and acute on plants, animals and aquatic life and, for the latter, their physical density and atomic weight.
- Radioactive elements such as uranium, thorium and radium (the latter which decays to radon gas) are also accumulated and concentrated within coal strata. These are toxic in their own right *and* toxic via the radioactivity they emit.
- Coal seams, even those considered 'low sulphur' contain significant amounts of sulphur and sulphides whose bio-toxicity increases when exposed to air or water.
- The fine particulate nature of coal dust, and the toxic constituents therein are readily inhaled and lodge in the lungs as well as being ingested.
- Coal strata also contain hydrocarbons and benzene-ring derivatives within their organic layers that are considered carcinogenic.
- Coal seams outgas methane when their layers are disrupted.

- Any water that is found within coal strata will be saline in nature, contaminated with organic derivatives and toxic and heavy metals.

WHAT DOES THIS TOXICITY DO TO OUR ENVIRONMENT?

- The disruption of strata below ground by mining causes heavy metals to be oxidised and mobilised into water within or near the coal strata. Since multiple strata are impacted by the immediate act of mining or through tension-generated slumps or earth faulting in the aftermath, this contaminated water, now unconfined, can seep into quality water veins and aquifers. The result is town, irrigation and horticultural water supplies that are contaminated with heavy metals and other non-beneficial organic components from the coal strata.
    - For example, concentrations of arsenic are of particular concern and there are well-documented cases of the poisoning of ground water by arsenic near coal-mining sites. The US Environmental Protection Agency places arsenic in Group 1A of its toxins listing: *known human carcinogen*.
- Salinity levels will also be increased generally due to the contact of these waters with salt-heavy coal strata and surrounding shales.
- Above ground, whether wind-blown from dried-up tailing ponds, coal heaps or coal transportation these toxic metals will concentrate in the sediments of streams and surface water supplies. The cycle of accumulation and concentration starts again causing stream and river sediments to be less conducive to aquatic life, decreasing biodiversity and health of the waterways.
- Given its particulate nature, and its toxicity, it is all the more surprising that coal loads are not covered during transportation, although grain loads have to be. This anomaly seems to have more to do with economic pressure - cost of coverage and process efficiency than any environmental concern.
- On exposure to air or during combustion at the power station, the sulphurous compounds within coal strata form highly toxic sulphur dioxide and trioxides. On exposure to the moisture in the air, or the water in rivers and streams, these gases form sulphuric acid and acid rain.
- Acid conditions mobilise (release) heavy metals from coal heaps, overburden piles or tailing ponds more rapidly, increasing their dissemination and widening the area of contamination. Acidity also increases the absorption rate of these metals by plant and animal life. (Many of Australia's arable soils are already acidic due to the long-term effects of fertilisers, hence take up of heavy metals is increased).
- Overburden piles also contain more silicious matter which is finely divided and readily wind-blown spreading contaminants and fibers that can cause the full spectrum of respiratory conditions from irritation to lung cancer. High levels of silicious matter has been shown to overwhelm immune function in this regard.
- Radioactive elements within coal strata are concentrated when coal is burned in power stations. Some is emitted to the atmosphere as 'fly ash', despite electrostatic scrubbers, some transferred to cooling ponds, most is removed from the power station as 'deposited ash'. Since Australia produces >7 Mt of ash per annum, the production of radioactive waste and heavy-metal

contaminated waste from coal-fired power stations and its safe containment/disposal is not an inconsiderable issue.

- Radioactive particle emission has been shown to be higher from coal-fired power stations than nuclear ones.
- Methane gas escaping from mines has been shown to destroy soil and plant life on the surface through which it seeps.
- As a comparison, quarrying or mining of harder rock strata containing heavy metals is not so environmentally damaging because metal concentrations are less and the compounds are not as easily mobilised from within the harder rock's structure as they are within the finer particulate, sheet-like and loosely bound coal strata.

In conclusion, the liberation of heavy metals and radiactivity into our environment has been shown to be persistent ie. non-biodegradable, concentrated in water sources and sediments and cumulative in plant and animal tissue resulting in both acute and long-term bio-toxicity.

WHAT DOES THIS TOXICITY DO TO HUMAN HEALTH?

- Coal can contain bio-toxic levels of cadmium, lead, chromium, selenium, nickel, vanadium, copper, sulphur and fluorine as well as radioactive elements such as uranium, thorium and radium, amongst others.
    - For example, teeth and bone fluorosis has been documented in cattle (UK) and humans (China) exposed to the combustion of fluorine-rich coals in power stations. Fluorine is highly phytotoxic, as was demonstrated by its adverse effect on vines downwind of a power station in NSW, Australia.
    - Radioactive particles have been shown to increase rates of lung cancer and coal dust is of a particle size that is readily inhaled and absorbed into the lungs.
- These elements are capable of being taken up by plants and farming animals in toxic levels and thereby enter the food chain of humans.
- Many of these elements have been implicated in causing cancers, cardiovascular, gastrointestinal and respiratory diseases. Certain heavy metals have been shown to impair immunity, cause both hepatic and renal disorders, be neurotoxic, especially to children, and are implicated in numerous other neurological and neurobehavioural problems, diabetes, bone disorders, blood disorders and general oxidative damage.
- Most of the toxic metals exert their effect by being absorbed 'accidentally' or taken up preferentially if the required nutritional minerals (eg. calcium, magnesium, zinc) are in deficit. Similar electrochemical charges and sizes can 'fool' the body's normal mechanisms for metal ion uptake. Once within the body, toxic metals interfere irreversibly with enzyme processes, like ramming a key into a lock that does not fit or block a process outright. The resultant dysfunction or cessation of biochemical processes is thought to account for the disorders that follow.
- Alternatively, the body may try to excrete these toxic metals. Arsenic is particularly toxic in this regard because the body's own methylation processes, which it uses to release nutritional metals, actually make the mineral *more* toxic to human tissue.

- Excretion of heavy metals, once inhaled, ingested or absorbed by dermal contact is therefore problematic in animal tissue as there are very limited pathways for this to occur, since the body has not adapted over time to deal with such toxins.
    - For example, the excretion of cadmium has been linked to hypertension and kidney damage.
- Thus the tendency is for heavy metals to be stored in the bones, fatty tissue such as the breast or the prostate or in organs such as the liver and spleen.
    - For example, cadmium has been implicated in prostate cancer as it is known to impair immunity and compete with zinc, required for prostate and immune health amongst its many bio-functions.

Scientists and health professionals are only just beginning to research the effects of low to medium toxic metal exposure on human health from the effects of extracting coal and coal-related sedimentary strata. Safe exposure levels for such metals in the air and drinking water are continually being revised downwards in the US as more light is shed on their deleterious action within the human body. Active and disused mines are proving much of the toxicity data.

Children, with their increased needs for minerals are particularly at risk from heavy metal toxicity. Some of these metals, like lead, have half lives in the body of 20 years, which means that their effects will only be truly known over several decades.

CONCLUSION

Coal does not just contain one harmful material but many. The effect of low dose accumulation of multiple toxic metals in plants, animals and humans is almost certain to exert a compounding of individual harmful effects and cause ultimately a catastrophic breakdown in health to those affected.

There is no doubt that coal will be seen as a toxic substance in years to come when studies into the effect of toxic metals on the human body are complete. In the short term, no amount of 'green, clean' solutions for burning coal will ameliorate the toxic contamination that coal causes *the moment* its secure, storage compartments underground, those that Mother Nature designed specifically to avoid just such contamination of water, land and air and consequent harm to biological life, are breached.

We are already in a hole with coal, time to stop digging.

[Pauline Roberts is a researcher and alternative medicine practitioner who observes, on a regular basis, the low-dose, accumulative effects of toxic metals on human health. She is concerned at the continuing pollution of the land, radioactive contamination of the air and mining of water supplies caused by the short-term, expedient energy policies of the Australian government and its industry masters.]