Radiation With Benefits

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A conversation between artists Lucy Beech and Riar Rizaldi who are both members of the Working With Waste research group.

LB With every high there's a low, and this is especially true when talking about radiation.

RR In relation to this I was thinking about the idea that nuclear energy is considered a *high temperature energy* because it produces so much energy with very small amounts of material. Anything related to nuclear energy is often related to low and high measurements, especially when working with pressure.

LB Have you heard of the acronym ALARA—As Low As Reasonably Achievable—which are guidelines for avoiding exposure to radiation that does not have a direct benefit to you. It makes me think about the distinction between 'radiation with benefits' and 'undesirable radiation'.

RR This is actually the first time I've heard of the term ALARA. Now I know it, from you.

LB It's interesting that the acronym changed over time. In the 1950s a version, ALARA meant As Low As *Practically* Achievable, and then As Low As *Readily* Achievable in the 1960s. Whether practically, readily, or reasonably achievable, low-level radioactivity is an inevitable byproduct of many industries—including those not necessarily associated with nuclear reactors. Another interesting acronym is NORM for Naturally Occurring Radioactive Materials that have to be cared for in line with their radioactive residues. You and I have a shared interest in the ways in which NORM waste arises from activities such as burning coal, gas and oil production, wastewater treatment, making and using fertilisers, or in the case of your field research, mining metal or extracting thorium for use in nuclear reactors. Did you encounter these acronyms whilst undertaking your research into mining in Bangka?

RR I actually encountered NORM protocol for the first time during my field research with a state-owned company that oversees a lot of the extractive business in a small island located in the west Indonesian archipelago called Bangka. I was researching the ecological impact of tin mining in the region.

LB So, you encountered radioactive residues as a byproduct of the mining industry? If so, how was the issue of low-level radiation being handled?

RR I did. And to deal with the growing concern about NORM wastes in this context the state-owned tin mining corporation PT Timah in Indonesia organised a safety management workshop in 2018, which was led by the International Atomic Energy Agency (IAEA). They discovered in this workshop that the tin mining area contains elevated natural minerals which are radioactive. News spread, because prior to this workshop people's concern about the mining activity was focused very much on ecological destruction. The workshop revealed radioactivity as another threat to the miners, especially those illegal artisanal miners. Geologists and nuclear physicists started to realise there were heavy deposits of thorium in Bangka, which is actually generated from the presence of tin ore. This discovery led to companies like ThorCon International (a company specialised in molten salt reactors) to lobby for a prototype nuclear reactor in Bangka.

LB So, a safety workshop initiated as a result of the miners' fears around radioactive exposure led to investments in thorium mining!

RR Yeah, it's almost like the NORM regulations and the workshop itself was like a pharmakon; opening the floodgate to other kinds of extractions. NORM protocol for many industries is about nuclear safety, but what happened in Indonesia was different.

LB This idea of the pharmakon is very interesting in the context of NORM wastes. I've also been exploring naturally occurring radiation produced from tin ore in the metal smelting industry. I was introduced to the subject via my mother who is a writer and retired environmental activist. When she was pregnant with me, she lived in a heavy mining and metal smelting area of the north of England, where metal waste from all over the world was recycled. My mother had become really preoccupied with the term 'sacrifice zone' and speculation over potential levels of radiation she and her community were exposed to via the smelting chimney at the heart of the community. This was in 1985 and prior to the formalisation of what we now understand to be NORM protocols for disposing radioactive residues from industrial processes. Her story is part of the paradigm shift which occurred in the UK (and of course globally) around attitudes to radioactive waste. The use of rivers and tidal flows as natural tools for evacuating radioactive waste to the sea was being strongly contested on the basis of environmental deterioration, declines in biological diversity, and even biological extinction that were observed in areas such as Hull where I grew up as a small child. Environmentalists were working with scientists (along with health workers, midwives, and community volunteers) to provide evidence for the need to instate 'safe zones' which could protect humans and aquaculture in the vicinity of metal smelting and nuclear power plants.

RR It's interesting that the standardisation of NORM is also always subject to change and updates.

LB As is the role that everyday people, workers, and environmental activists play in implementing those changes. For example, in my mum's story, which she actually wrote up into a screenplay, she was involved in consciousness raising via her midwife, who was collecting evidence on the way in which the toxicities were effecting children in the area… In Bangka were there also self-organised investigations of the radiation? What was the kickback from the wider community?

RR Yeah, there is a very strong anti-nuclear position in Indonesia and because of the discovery of radioactive thorium on the islands, the community in Bangka is still very worried that the island will be used for a nuclear power plant. But there are very interesting modes of resistance emerging on the island, including a small group of reactionary scientists working in tin mining who are focused on phytomining which is a form of nonhuman mining implemented by plants. The plant is genetically modified to syphon desired minerals from the ground soils. The plant is then cut and burned, and the burnt plant residue is extracted and used to produce pure material in the shape of ingot. So, these scientists are now genetically engineering new plants which could act in place of machinery extractions. This research exemplifies how future mining could be a slow process of using the lands as an apparatus to extract minerals. Their proposal is really interesting because it's also very speculative, yet actually quite feasible in terms of creating hyperaccumulators, or plants that do this work. Kale and broccoli, for example, have proved to be very good at sucking iron from the soil.

LB The use of plants to leech naturally occurring radioactive minerals makes me think about mineral evolution and the ways in which we might think of the Earth as an open system;

accumulating various irons and receiving celestial debris on a daily basis from space, which include meteorites, etc.

RR Totally, I'm very interested in the idea of mineral evolution which was proposed by astrobiologist Robert Hansan. Hansan works from the question: "Were all of Earth's minerals created before Earth's formation, during, or after?" The basic chemical elements of life—including rocks, minerals, thorium, radium and so on—are derived from atoms that were made in the deep interior of the sun and other stars where carbon and oxygen atoms are produced, along with nitrogen and phosphorus. These elements are synthesised via a nuclear reaction that takes place deep in the star's interior and are then thrown out into space by a supernova. Earth's formation is part of this process. In addition to this idea of the planet as an open system, I think there is a discussion to be had on the concept of native and non-native minerals on Earth which somehow determines the economy of space mining—although perhaps space mining is subject for another discussion!

LB So, is this also a way of thinking about panspermia?

RR The general idea of panspermia is that life is actually coming from outside the Earth. In this context, I think nuclear energy is an entity of panspermia. Minerals that can generate endless heat are doing so via cosmic processes rather than geological ones. Meteorite mineralogy for example is a fascinating subject in which it's stated that every 30 or 40 years, new minerals are found. There are maybe 6,000 chemical compounds that are actually now known—some discovered in the last 20 years. To come back to Hansan—he was talking about the evolution of science as also the evolution of minerals. We see in this example how science needs to be continually upgraded as the minerals evolve.

LB In the context of measuring toxicity and radiation exposure and thinking about evolution, you mentioned in one of our earlier conversations that human evolution may adjust to radioactivity and this will affect standardizations of high or low exposure, or even make such standardisation irrelevant. I am interested in hearing more about what you mean by that.

RR I was drawn to ideas of Russian cosmism, a philosophical movement in turn of the 20th century Russia which tapped into the idea of immortality by hacking the trajectory of human evolution and biomimicry to explore the potentiality of an organism that thrives in extreme environments. At the same time, I was interested in this ongoing research on the effect of radioactivity in animals and plants of contaminated zones like Chernobyl and Fukushima. Some of these animals have mutated, some are dead, and some survived with damaged DNA which eventually affects their genes, producing a generation with contaminated DNA. These animals you could say are adjusted to the radioactivity level of Fukushima or Chernobyl. I was wondering then, could this perhaps also apply to humanity? The more radiation we are exposed to, the more possibilities of human species adjusting to radioactivity. All of these speculations on the effects of high and low exposure to radioactivity are central topics in terms of space travel and DNA mutation which emerged since geneticists like Chris Mason put forward the idea of DNA evolution in relation to radioactivity and the human body. Perhaps high and low standardisations will become obsolete in the future and humans will live side by side with radioactive materials? This kind of idea resonates with the notion of longtermism.

LB Thinking about deep time processes and the sense of time more generally in the context of nuclear/ atomic discourse, how does longtermism relate to the scope of atomic energy according to your research?

RR I think the cosmological scope of nuclear energy is interesting in terms of time and nonhuman connections to nuclear fission. The scientific discovery of nuclear fission is really important and fascinating. In fact, to this day, I cannot comprehend the idea that somehow humanity could split atomic energy. But I am also interested in the notion that nuclear fission occurs naturally over billions of years in the Earth's core. Perhaps you are familiar with the natural nuclear fission in Oklo, Gabon? Natural nuclear fission is a process that requires deep time. Long before the discovery of radioactivity and the possibility of splitting the atom, the long process of fission reaction in uranium deposits was activated through a deep time process of chemical reaction over the course of two billion years.

LB Did this natural nuclear fission provide evidence that long-term geologic storage of nuclear waste is feasible?

RR Yes, but also the deep time process of natural nuclear fission exemplifies the time it takes Earth to generate a radioactivity: a process which took approximately two billion years. As an artist and filmmaker the scope of time is always intriguing to me.

LB I agree, I'm fascinated by Marie Curie's discovery of radioactivity and how this opened up where scientists understood the Earth to be in history—I know you are too! I started researching polonium 210 (the radioactive isotope in which Curie observed radiation along with radium) because Polonium 210 were the radioactive isotopes found in the river system that my mother was documenting in the 1980s. I remember reading in Curie's diaries that her discovery of radiation forced her to recognise how limited her perception was of the world which surrounded her and that of future generations. Curie's diaries are still radioactive and have to be measured with a Geiger counter before and after use.

RR Curie's findings, especially in radium and polonium, opened up new ideas about time for many scientists during a period in which they were trying to grasp the complex inner structure and immense energy stored in atoms. Curie discovered large amounts of endless energy emitting from radium and recorded its capacity to generate endless heat.

LB So, how did this discovery revolutionise the way physicists were conceptualising time and energy?

RR Before the discovery of radioactivity many scientists believed that the Sun someday would dim. This was because they didn't know where the source of energy in the Sun was coming from. Scientists until that point had speculated mathematically based only on heat and temperature. When the discovery of radioactivity went public, scientists started to extend cosmical time scales.

LB So, geological practices for understanding time and the history of the Earth evolved into cosmic processes involving the Sun?

RR Yeah, and through the discovery of radioactivity, scientists were able to predict the cosmic scale of the future. Radioactivity also helped many scientists to measure carbon radioactivity through radiometric dating which eventually could generate a precise number of the absolute age of geological features, including the age of Earth, that eventually gave way to the idea of geological time scale.

LB It's also interesting that Curie named Polonium after Poland, her homeland, making Polonium the first element on the table with a politically charged name. Poland in 1898 remained partitioned among three empires: Russian, Austrian, and Prussian, and Curie used its naming as a means to shed light on the occupation.

RR For me, personally, the connection of radioactivity and time is also very political because after independence the political imagination of Indonesia was very entangled with nuclear discourse. The first president, Soekarno, was keen on the idea of implementing a nuclear power plan in the Indonesian archipelago. The archipelago is vast with thousands of islands so he thought nuclear power could cut the logistical nightmare of distributing energy whilst creating a long term vision for Indonesia as a state that could be run sustainably on nuclear energy. In the early '50s until mid-'60s his idea was really supported by both sides, American and Soviet. The International Atomic Energy Association also supported his proposal, and asked him to launch the country's own nuclear

Abandoned tin mining sites in Bangka Island. Image from Kasiterit, 2019.

agency Badan Tenaga Atom Nasional (founded in 1958). However, in the mid-'60s, the Southeast Asian region was a neo-colonial regime. Most of Indochina, especially Vietnam, was under American occupation and the British Empire also went back to Malaysia. He saw this as a threat, and he changed his idealistic longtermist nuclear power plant utopia into a site for manufacturing nuclear weapons. He built a close connection with China and this triggered America (and the West) in particular to stop him from developing nuclear weapons—which also ended in the coup. His career ended in the coup and the next regime was run by a military dictatorship that basically sold much of the land that contained radioactive minerals to the West, thus contributing to mineral extraction for the development of nuclear power.

LB What are the benefits of the archipelago as space for mining and producing nuclear energy?

RR It's safer to build a nuclear power plant in uninhabited islands detached from populated islands. But in the context of Soekarno, he was thinking a lot about logistics. Using coal as an energy resource would have cost more—as well as the need to transfer coal from one island to another. Building more coal-fired power plants was more logistically difficult than nuclear power plants for the whole archipelago distributing the electricity through a generator.

LB This example of Soekarno's attempted reinvention of the nuclear reactor as a site for manufacturing weapons represents one of the biggest fears of anti-nuclearism (along with of course the threat of climate change and the onset of natural disaster). Soekarno's inconsistency perfectly describes the need for the acknowledgement of uncertainty within contemporary nuclear narratives. It seems to me that much pronuclear rhetoric works from a quite aggressive veneer of certainty which seems to occlude these kinds of cases where political circumstances have the potential to change hands.

RR It makes me think of the history of the radiation symbol, the trefoil and the recent updates on this ionizing radiation warning symbol by International Atomic Energy Agency and International Standard Organisation. The symbol was first initiated in 1948 by Berkeley Radiation Laboratory, and in late 2000 apparently there was a survey that said many people in the world are not so familiar with the trefoil symbol. Thus, later in 2007, IAEA decided to revise the symbol using an additional skull to illustrate death. It fascinates me to think how the symbolism will evolve. I wonder whether the future human will be baffled with the variation of these symbols. Perhaps it feels similar to how we use cave paintings to understand a specific history.

LB The Dutch nuclear waste processing and storage company COVRA is also an interesting example, as they have become a beacon of hope for many pro-nuclear environmentalists due to the pride the organisation takes in their transparency. CORVA reflects the cultural appreciation of straight talking in the Netherlands. They explain on their website that it's valuable to communicate clearly what goes on inside the facility where waste is stored and cooled for 100 years before moving to a deep geological repository where it will remain radioactive for up to one million years. One way this has been put into practice is to make a climate controlled 'low level' nuclear waste storage bunker double up as storage space for the local art museums in the region. COVRA have created a loud statement that says nuclear waste is not something that must be forgotten or obscured, but transformed into heritage that needs to be taken care of (in the same way you would a tapestry or painting).

RR Have you ever found out what their intention in using art in this nuclear context?

LB Art seems to have been enlisted to aid in their process of clear communication…which, according to COVRA, makes the process more legible and thus ideally less contested. It seems to be a process of distillation where the presence of these artefacts function as a way of making the inexplicable timespan of the waste's radioactivity more contained or easily

defined. But I wonder how COVRA's neatly sewn narrative of transparency, as open as it may appear, can account for any unforeseeable political or natural change to the environment (as we see so clearly in your earlier Soekarno example).

RR Yes, and as we know, no one predicted Fukushima.

LB I do think COVRA is opening up some of the misconceptions about radioactive waste as glowing green ghostbusters goo from nuclear reactors (which is also a focus of many pronuclear ecomodernists). Until I took the time to research NORM waste, I never really understood that industries like recycling, gas, oil, fertiliser production, even wastewater treatment all produce radioactive wastes that have to be cooled and stored (like radioactive waste) before being also moved to a geological repository for a further million years! This includes unexpected materials like medical waste and animal carcasses which are first reduced to ash through incineration and cast in concrete to contain their toxicity before sitting side by side with nuclear waste in spaces like COVRA.

RR They're not the deep geological repository. They're above ground, right?

LB Yes, and for the Netherlands, the longer term storage consignment will be a cooperation with another small country such as Belgium. We are living through a particularly interesting time regarding debates around nuclear longtermism. This month here in Germany, the last three nuclear power stations went off grid. On one side of Brandenburg gate, anti-atomic activists celebrated a win in a battle that has lasted 60 years, on the other side, pro-nuclear environmentalists were vehement that Germany should "PHASE OUT COAL AND GAS NOT NUCLEAR."The deep geological repository for low and intermediate nuclear waste called the Konrad repository that Germany has worked tirelessly to build will close indefinitely before its planned opening in 2027 due to such ideological rifts. This year, Finland opened the first repository for high level radioactive waste in the world and it will soon become mandatory for other countries to have their own. I was talking with someone in Germany who works with a group of engineers who are applying to close the Morsleben GDR mine-turned-nuclear repository (which once operated as a subterraneous arms production facility, and later a chicken farm). The process of closing the repository is an engineering puzzle (headed up by female engineers) that depends on ensuring the chosen materials will be water tight for 1 million years. It seems unthinkable, the task of speculating on the Earth's composition in a million year's time.

RR Shall we go to COVRA together?

LB Yes! Let's do it. The crazy thing is, I read somewhere that the art on view at COVRA are actually reproductions!