“Out of Sight is not Out of Mind”

a written intervention by the

Canadian Coalition for Nuclear Responsibility

submitted to the

Canadian Nuclear Safety Commission

on the subject of the

Wheeler River Project

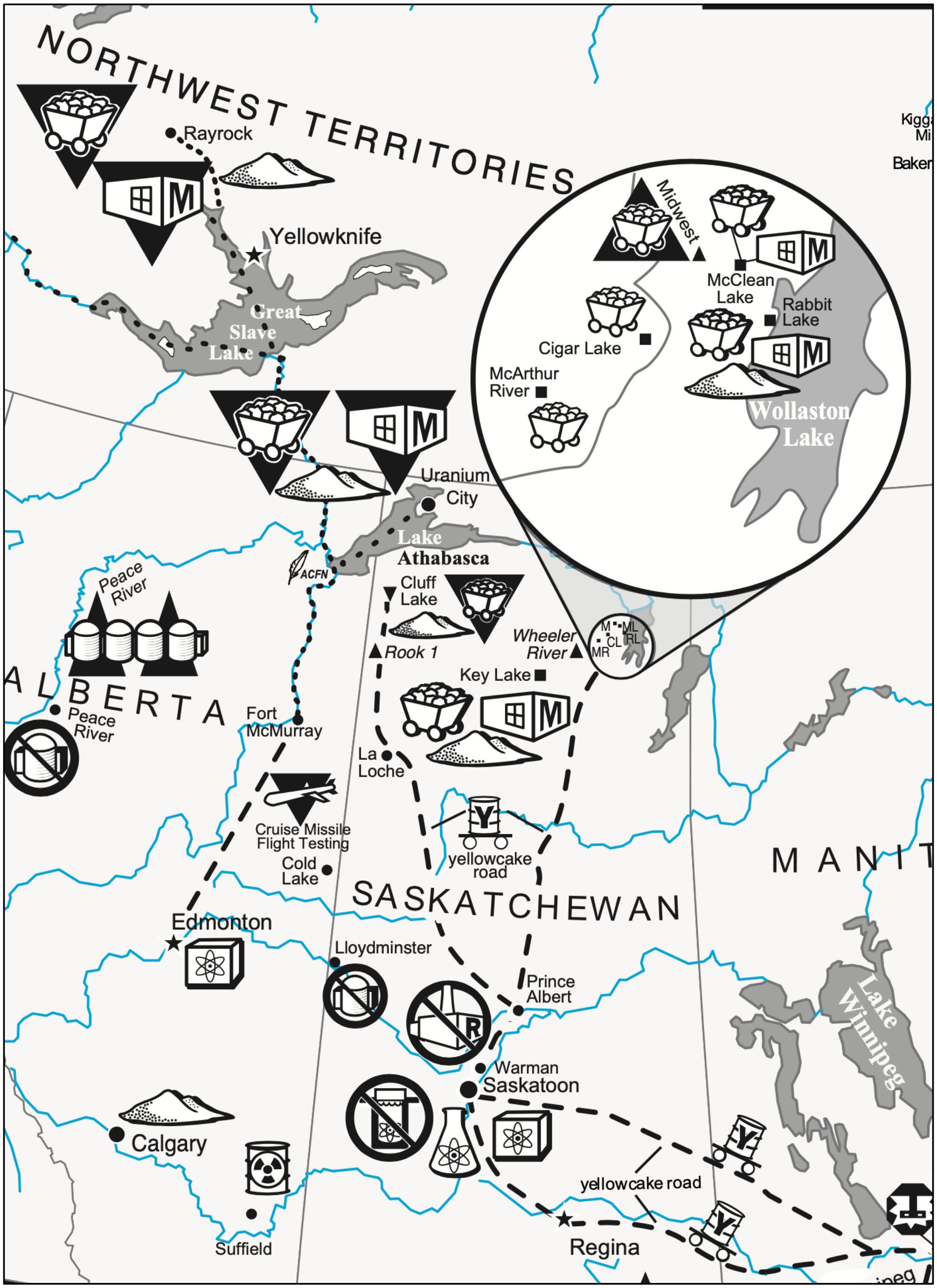
an in situ recovery uranium mining and milling operation

proposed by the

Denison Mines Corporation

October 24 2025

This image lifted from CCNR's Nuclear Map of Canada shows the locations of the proposed Wheeler River Project and the Cluff Lake mine and mill (closed), as well as the McArthur River, Cigar Lake and Midwest uranium projects – all of them sited in Northern Saskatchewan, south and east of Lake Athabasca. [Map by Gordon Edwards and Robert Del Tredici of CCNR]



The dotted lines represent the "yellowcake road" from the mines to the world's largest uranium refinery at Blind River, and then to the conversion plant at Port Hope. Most Canadian uranium (about 85%) is converted into hexafluoride for export to enrichment facilities in other countries while the rest is converted to uranium dioxide for fabrication into CANDU fuel for domestic use.

CCNR urges CNSC not to grant a licence to Denison

The Canadian Coalition for Nuclear Responsibility (CCNR) has intervened on issues related to uranium mining in Saskatchewan and elsewhere for five decades. Our earliest involvement with uranium mining was in 1976-77, when CCNR played a major role in the hearings of the Bayda Commission, formally known as the Cluff Lake Board of Inquiry into Uranium Mining in Saskatchewan. In 1997, CCNR played an important role in the Joint Environmental Assessment hearings on proposed uranium mining projects in Northern Saskatchewan, in particular the McArthur River, Cigar Lake, and Midwest uranium mines.

CCNR is opposed to the licensing of the proposed in-situ acid leaching operation known as the Wheeler River project. The proponent, Denison Mines, proposes to extract uranium from underground ore bodies by injecting sulphuric acid into the rock formations to dissolve the uranium minerals, then pumping the pregnant solution to the surface where the uranium can be extracted for sale.

Although the proponent proposes to create an “ice wall” to prevent contamination of nearby ground water during operation, that ice wall will ultimately disappear after the surface operations have ceased – thereby providing pathways for the mobilized radiological and non-radiological contaminants, deep underground, to find their way not only into nearby ground water, but quite possibly into the vast network of ponds streams and wetlands that honeycomb vast regions of the northern Saskatchewan landscape in a highly interconnected hydrological maze of precious pockets of fresh water, essential to aquatic life, terrestrial biota, birds, and vegetation of all kinds. CCNR believes that this in-situ operation could ultimately succeed in poisoning the food chain long after commercial operations at the surface have ceased, as an underground lake of mobilized pollutants and solvents gradually migrates into nearby water bodies and beyond.

The technology of in-situ acid leaching of uranium deposits is still very young. Although it has been practiced in several other countries, and is clearly less costly for the exploiter, it is still much too early for scientists to appreciate the long-term environmental implications of this approach, which could be very serious and extremely long-lived.

Since CNSC has pledged itself never to compromise public safety due to financial or expediency considerations, and since there is no urgent need for more uranium production capacity in the national interest, **we urge CNSC not to licence this operation. CCNR contends that the proponent is incapable of truly demonstrating the long-term safety of this operation because of the inadequacy of relevant data**.

As we read in "CONTAMINATION RISKS ASSOCIATED WITH IN SITU-RECOVERY MINING FOR URANIUM" (APRIL 24, 2018)

> *"In October 2015, the EPA proposed that uranium mines be monitored for 30 years and include the observation of other constituents that mobilize during mining, including arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, nitrate (as nitrogen), molybdenum, and radium. After two years of negotiations with stakeholders and the appointment of Scott Pruitt to head the EPA, the original recommendation was retracted and shortened to 6 years, cutting the amount of constituents to be monitored by 50% (EPA, 2015). The EPA originally proposed a 30 year plan because according to geological monitoring of the conditions of the groundwater near ISR mines, it takes this long to determine if the conditions around the mining site are stable and then to regulate the problems if there are any. After 30 years of monitoring groundwater stability, the mine is considered to be permanently stable and monitoring no longer needs to occur (EPA, 2015). The EPA also argued that ISL is still a relatively new practice at less than 30 years old and because of this the contamination risks are understudied and research is underfunded (Fonseca, 2018)."*

Already there are alarming indications that the long-term problems may be very serious and extremely difficult to remediate. Althpough the "in-situ leaching" technique is cheaper and visually "cleaner" than open-pit mining, it leaves behind a long-lasting chemical footprint. According to Andrey Ozharovsky, a nuclear physicist and co-founder of the public program Radioactive Waste Safety, the environmental threat from in-situ leaching is significant.

"Miners dissolve uranium, turning it from a stable solid into a chemically active, mobile liquid," he explained. "That uranium will never return to its original state, no matter what operators claim." Ozharovsky added that while an accident involving solid uranium concentrate can be cleaned up, contaminated aquifers are almost impossible to restore. "Once acid is injected underground, humans lose control," Ozharovsky warned. "It's chemistry unfolding unseen, beneath the surface — forming real lakes of radioactive waste." (Fayzleva, K. 2025)

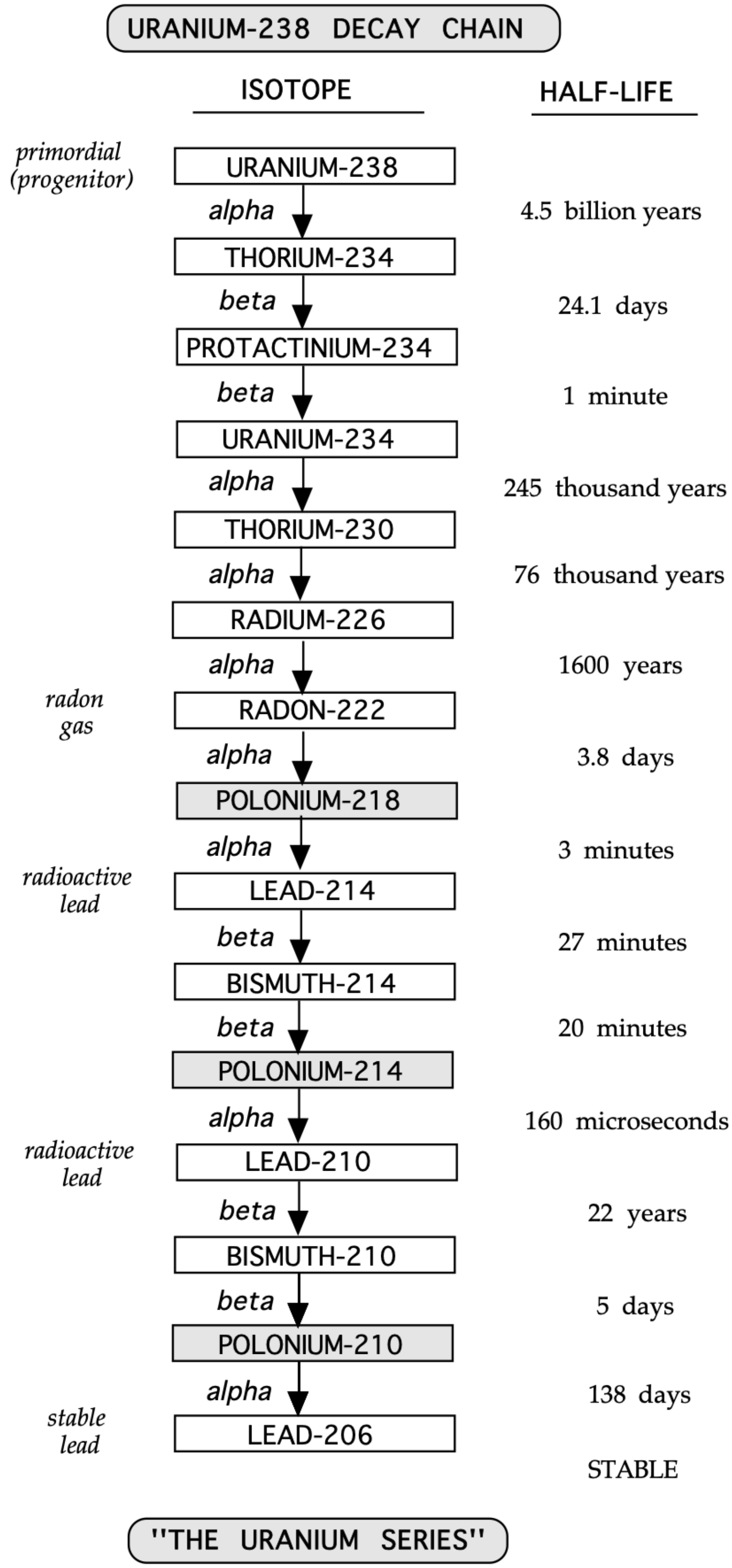
The Nature of the Radiological Beast

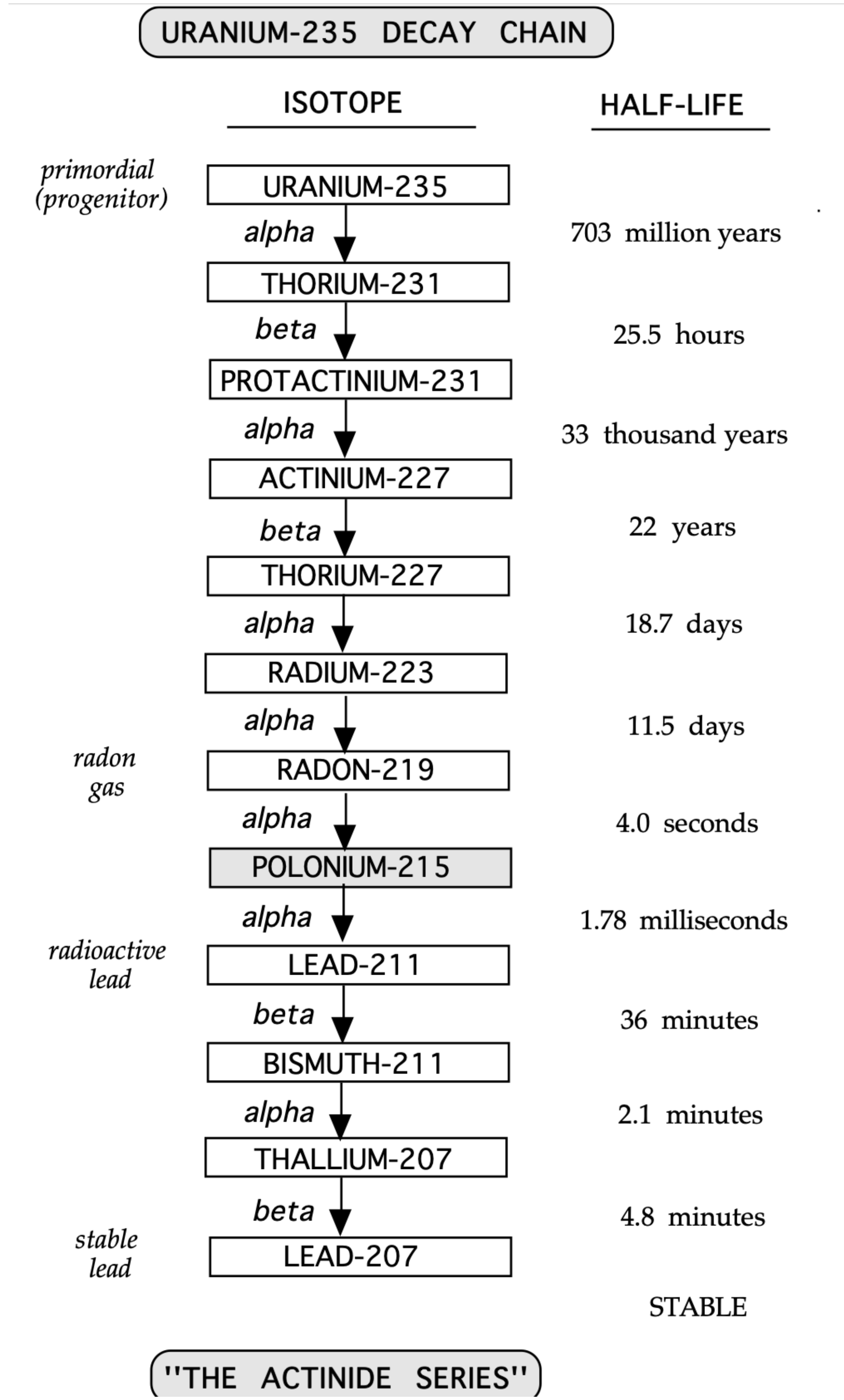
Radiologically, the fundamental problem with uranium mining, is that in an ore body, uranium is always accompanied by about three dozen other radionuclides. They are the "decay products" of uranium-238, uranium-235 and thorium-232. There are in fact three distinct families of radionuclides in the ore body corresponding to the three decay chains associated with the three primordial radionuclides identified in the previous sentence.

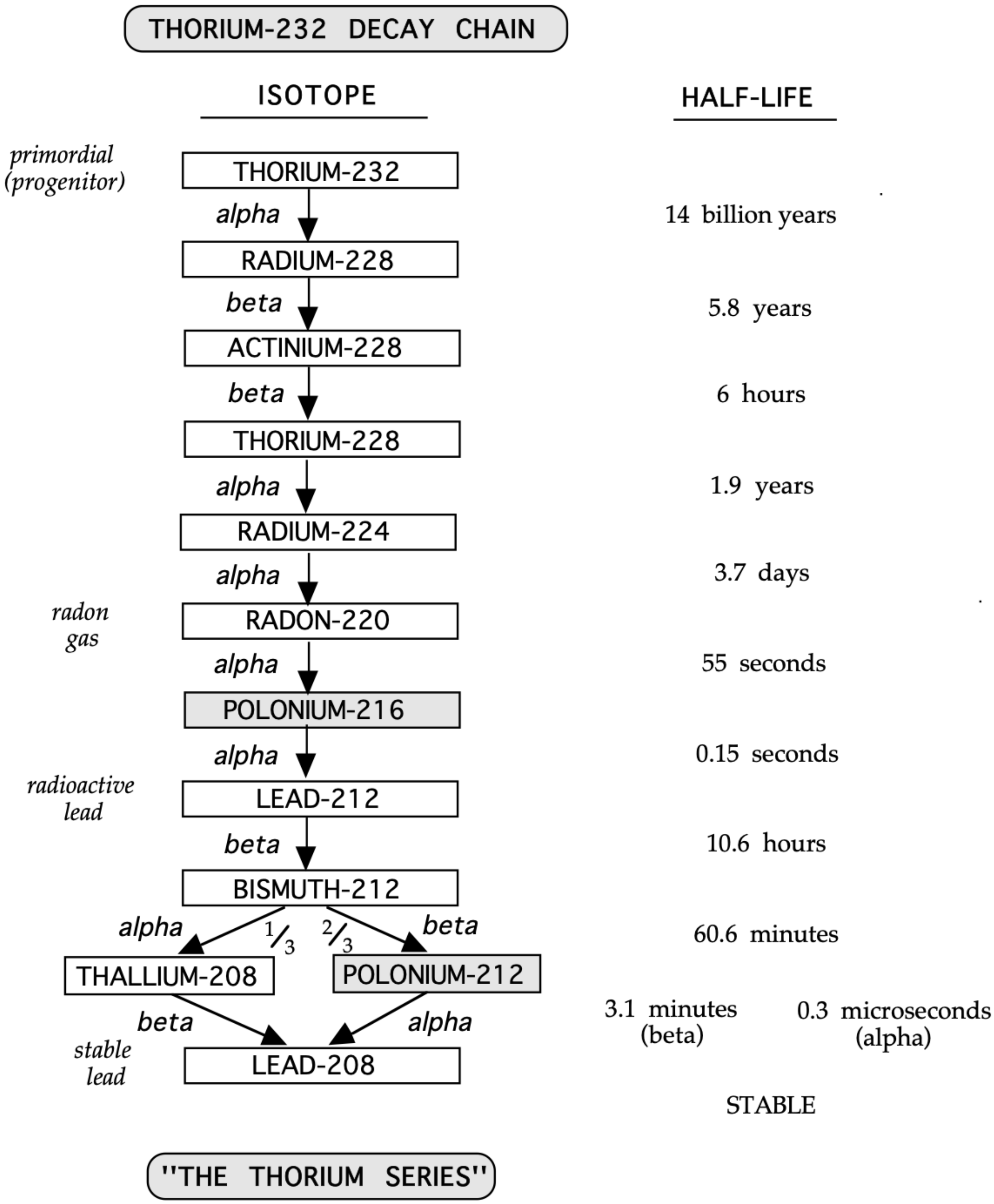
The three families of radionuclides found in the ore body include radioactive isotopes of actinium, protactinium, thorium, radium, radon, bismuth, lead, thallium and polonium. These radionuclides are all very much more radiotoxic than the primordial radionuclides that gave rise to them. In particular, radium and radon and polonium are known to have killed large numbers of people in the twentieth century.

The three decay chains are described as the "Uranium Series" (radioactive decay products of uranium-238), the "Actinide Series" (radioactive decay products of uranium-235), and the "Thorium Series" (radioactive decay products of thorium-232).

These decay chains are illustrated on the three following pages. In each case, the final lead isotope is stable; in other words, the final lead isotopes in all three chains are non-radioactive varieties of lead.


URANIUM-238 DECAY CHAIN
ISOTOPE
HALF-LIFE
primordial (progenitor)
URANIUM-238
alpha
4.5 billion years
THORIUM-234
beta
24.1 days
PROTACTINIUM-234
beta
1 minute
URANIUM-234
alpha
245 thousand years
THORIUM-230
alpha
76 thousand years
RADIUM-226
alpha
1600 years
radon gas
RADON-222
alpha
3.8 days
POLONIUM-218
alpha
3 minutes
radioactive lead
LEAD-214
beta
27 minutes
BISMUTH-214
beta
20 minutes
POLONIUM-214
alpha
160 microseconds
radioactive lead
LEAD-210
beta
22 years
BISMUTH-210
beta
5 days
POLONIUM-210
alpha
138 days
stable lead
LEAD-206
STABLE
"THE URANIUM SERIES"


URANIUM-235 DECAY CHAIN
ISOTOPE
HALF-LIFE
primordial (progenitor)
URANIUM-235
alpha
703 million years
THORIUM-231
beta
25.5 hours
PROTACTINIUM-231
alpha
33 thousand years
ACTINIUM-227
beta
22 years
THORIUM-227
alpha
18.7 days
RADIUM-223
alpha
11.5 days
radon gas
RADON-219
alpha
4.0 seconds
POLONIUM-215
alpha
1.78 milliseconds
radioactive lead
LEAD-211
beta
36 minutes
BISMUTH-211
alpha
2.1 minutes
THALLIUM-207
beta
4.8 minutes
stable lead
LEAD-207
STABLE
"THE ACTINIDE SERIES"



Note: 33 % of the stable lead-208 is produced from thallium-208 by "beta decay", and 67 % is produced from polonium-212 by "alpha decay".

Whenever uranium is mined, by whatever method, the bulk of the radioactivity in the original ore is left behind as radioactive waste. In traditional mining, this waste is generally left at the surface, as voluminous sand-like radioactive mill tailings along with large quantities of waste rocks that are significantly radioactive. Canada currently has about 220 million tonnes of such radioactive uranium tailings, and about 170 million tonnes of waste rock. The Wall street Journal has described such uranium tailings as posing "an ecological and economic disaster" waiting to happen, as these wastes are gradually disseminated into the environment by natural forces and/or human activity.

Because radioactivity cannot be detected by any of our five senses, ignorant and opportunistic entrepreneurs have used huge quantities of these radioactive wastes from uranium mining and processing in the construction of thousands of homes, schools, and other buildings in various communities. Here in Canada, the most well-known example is the town of Port Hope, where over two billion dollars have been spent since 1975 in the most expensive environmental cleanup project in Canadian history. Similar construction activities using radioactive wastes have occurred in Elliot Lake, Oka, Varennes, St. John's, and no doubt many other towns. Such homes invariably have elevated levels of radon gas due to the persistent disintegration of radium atoms in the contaminated building materials. Radon is the principal cause of lung cancer among non-smokers.

Initially, 85% of the radioactivity in the ore ends up as radioactive waste. That amount rapidly declines to about 70% and then stays at that level of radioactivity for many thousands of years. The radioactivity of the wastes will not be reduced by half for at least 76,000 years – that happens to be the half-life of thorium-230. During that enormously long time, the disintegration of thorium-230 atoms continually replenishes the inventory of radium-226, radon-222, lead-210, and the three most prevalent polonium isotopes (polonium-214, polonium-218, polonium-210). The radioactivity of each of these decay product remains equal to the radioactivity of the discarded thorium-230, which in turn is equal to the radioactivity of the uranium-238 that has been extracted from the ore body.

These decay products are much more toxic than uranium itself. For example, polonium is the most toxic element found in nature. In particular, Los Alamos Nuclear Laboratory has calculated that polonium-210 is about 250 billion times more toxic than hydrogen cyanide, a well-known and very deadly fast-acting chemical poison. The Russian KGB defector, Alexander Litvinenko, was murdered by two Russian agents who put a tiny amount of polonium-210 in his tea in London England in 2009. Litvinenko died an agonizing death and his body was buried as radioactive waste, in a lead-lined coffin. Polonium-214 and polonium-218 are even more toxic than polonium-210. All three are present in the radioactive waste from uranium mining and all are decay products of radon gas. In fact that is why radon gas is such an effective killer. The US EPA estimates that about 20 to 30 thousand Americans are killed every year just by breathing radon gas in their homes. More than 80% of the radiation dose to the lungs is from polonium. The American Health Physics Society has estimated that up to 90% of the deaths attributed to smoking cigarettes is likely due to the miniscule amounts of polonium-210 in the harvested tobacco plants.

In the case of in-situ leaching, it is not entirely clear where all of the radioactive waste ends up, and in what physical and chemical condition. It must go somewhere, it cannot simply disappear. No doubt much of it remains underground. In any event, it must be determined where, and in what condition, all of those dozens of radioactive materials end up.

Some of the radon, being a gas, no doubt finds its way to the surface – using the same pathways that bring the pregnant solution of dissolved uranium minerals to the surface. Once above ground, radon (being a gas that is seven times heavier than air) will stay close to the ground and deposit radioactive fallout (including the polonium isotopes) on the vegetation and the soil below. Radon has a 3.8 day half-life, and it is constantly producing solid radioactive byproducts – seven of them – as its atoms disintegrate. During one half-life, radon can travel 1300 kilometres in a 15 kilometre per hour breeze, spreading its decay products far and wide.

A Cautionary Tale.

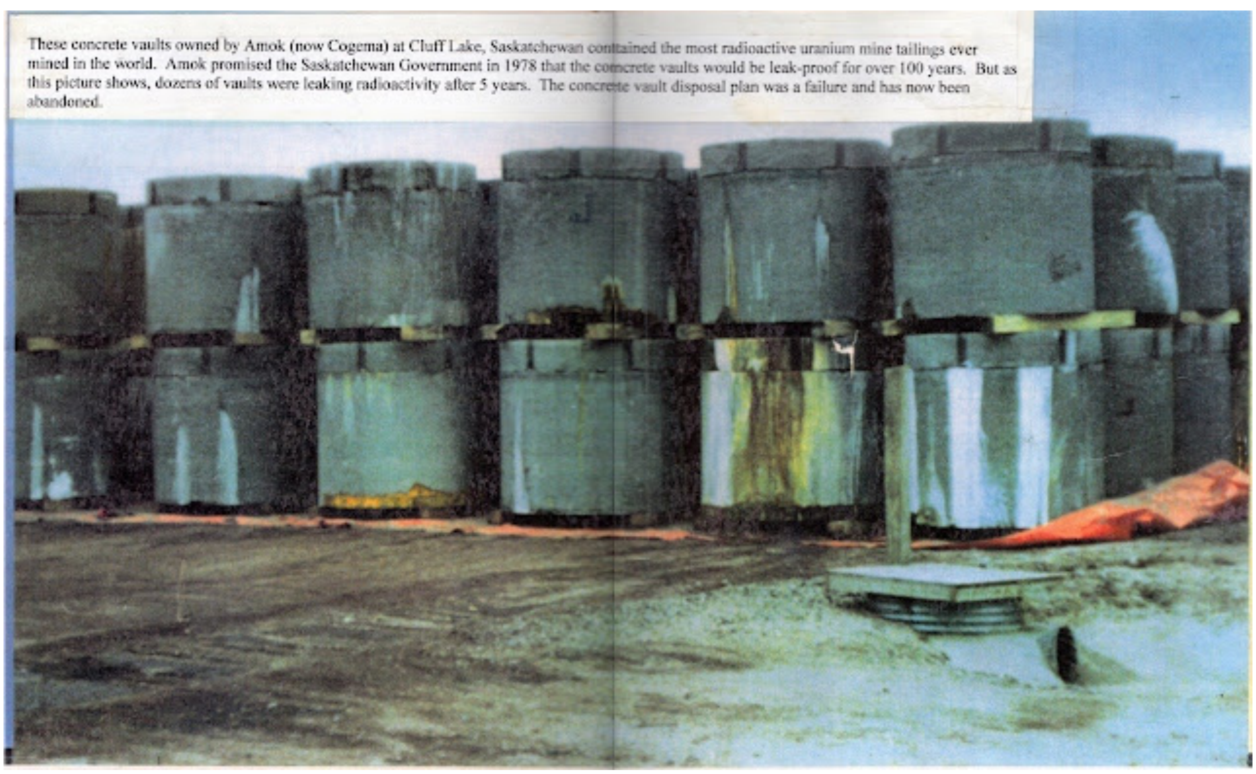
The Cluff Lake mine operated for 22 years, from 1980 to 2002. It was the first completely non-military uranium mine in Canada, and the first of a new batch of high-grade uranium mines developed around the rim of the Athabasca Basin, in a remote part of Northern Saskatchewan, far removed from population centres.

A few decades earlier, over five dozen lower-grade uranium mines had operated in an unregulated fashion near the northernmost border of the province, at a place called Uranium City. Starting out as a tent city, it later developed into a thriving mining town – but it is now largely deserted. The population crashed when the mines shut down in 1982. Extensive radioactive contamination occurred at Uranium City because huge volumes of uranium wastes were dumped into surface waters and were scattered far and wide by wind and rain. Hundreds of millions of dollars are currently being spent in an attempt to remediate some 67 abandoned uranium mining and milling sites, most in the vicinity of Uranium City.

In 1977 the Government of Saskatchewan established the Cluff Lake Board of Inquiry into Uranium Mining (also known as the Bayda Inquiry) to determine under what conditions, if any, the newly discovered rich deposits of uranium at Cluff Lake and elsewhere in the Athabasca Basin could be mined in an environmentally acceptable manner.

The mining company assured the Board that the most radioactive wastes from the Cluff Lake ore would be safely isolated using an advanced engineering concept. The richest uranium tailings would not be dumped into the environment or flushed into “tailings lagoons” behind earthen dams, as they were at Elliot Lake in Ontario. Instead, these wastes would be placed in thick-walled concrete vaults designed to last for 100 years or more. The walls of these vaults would be lined inside and out with an impermeable membrane to prevent radon gas from escaping into the atmosphere and to minimize leakage of radionuclides into surface water and/or groundwater.

The vaults would be positioned above the water table and below the frost line, to minimize the ravages of extreme weather. Each vault would be surrounded by one or two metres of sand and gravel for extra protection, and to further attenuate radioactive releases. Equipment would be installed to monitor the drainage runoff from the vaults on a regular basis with treatment to remove radioactive contaminants as needed.
On the basis of this testimony, the Cluff Lake Board of Inquiry's Final Report in 1978 recommended that the Cluff Lake mine be allowed to proceed. And indeed, the mining company did build hundreds of concrete vaults to contain the most radioactive tailings. (1) Originally the vaults were stored in a large warehouse but the gamma radiation levels became so high and were so dangerous for the workers that they had to move the vaults outside onto an elevated concrete pad. They were simply stacked on top of each other, as shown in the photo below.



These concrete vaults owned by Amok (now Cogema) at Cluff Lake, Saskatchewan contained the most radioactive uranium mine tailings ever mined in the world. Amok promised the Saskatchewan Government in 1978 that the concrete vaults would be leak-proof for over 100 years. But as this picture shows, dozens of vaults were leaking radioactivity after 5 years. The concrete vault disposal plan was a failure and has now been abandoned.

Before long, dozens of these vaults were cracked and leaking – as seen in the photo. Due to faulty preparation, winter freezing and thawing, and heaving of the ground, many of the vaults tipped over; the tailings inside spilled onto the ground and flowed downhill from the elevated knoll where the concrete pad was situated.

The advanced engineering concept put forward by the proponent and endorsed by the Cluff Lake Board of Inquiry had become an abysmal failure – a fiasco. Neither the mining company, nor the Saskatchewan Department of the Environment, nor the Canadian Nuclear Safety Commission, would release any public information on how the problem of the leaking vaults was being dealt with. It took a private citizen, Maisie Shiell, who persisted and finally got information from Washington, DC, using the USA Freedom of Information Act. She discovered that the "leaking vault" problem was "solved" by the company by simply recycling all the radioactive tailings stored in the vaults through the mill once again with the excuse of extracting any residual gold that might remain in the tailings. Then the residues were simply dumped into the tailings lagoon – thereby doing what the company had assured the Board of Inquiry they would never do. To the best of my knowledge, the vaults were also dumped into the lagoon; presumably, they are still there and are likely still leaking. These structures, designed to last for one or two centuries, did not survive for a decade. Dozens were leaking within five years. Meanwhile, the radioactive tailings are known to remain hazardous for millennia.

The Cluff Lake experience is troubling. It illustrates just how wrong the mining companies and regulatory authorities can be when confronted with such a daunting task – keeping radioactive sand out of the environment for hundreds of thousands of years.

It also shows how easily a public body like the Cluff Lake Board of Inquiry can be misled by empty promises. And how unwilling authorities sometime are to acknowledge or document their own mistakes (errors in judgment).

It is revealing that the 2003 Comprehensive Study Report on the Cluff Lake Decommissioning Project by **the Canadian Nuclear Safety Commission, makes no mention whatsoever of these specially engineered but ill-fated vaults** promised by the proponent in 1977. The story is not even found in section 2.4 of the CNSC Report, entitled *"Site History".*

Conclusion

The cautionary tale of the Cluff Lake waste management miscalculations has an important lesson for the proposed in-situ leaching operation proposed by Denison. If things can go so wrong above ground, where highly toxic radioactive waste materials can be seen and monitored and retrieved and re-purposed, why should we think they might not go equally wrong underground, long after the surface operation has been closed down? The mobilized radionuclides sitting in a chemical soup will never return to their initial condition, locked up as they once were in a hard rock formation. They are out of sight, and perhaps out of mind, but certainly not out of existence or "out of the running". They are mobilized and able to cause an enormous amount of damage over an unthinkably long time period – far longer than the span of recorded human history.

CCNR urges CNSC not to licence this operation because safety for the very long term cannot be demonstrated, and there is no plan in place to remediate contaminated groundwater and surface waters if these wastes find their way back into the environment of living things.

This written intervention was prepared by Dr. Gordon Edwards, PhD, CCNR President.

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