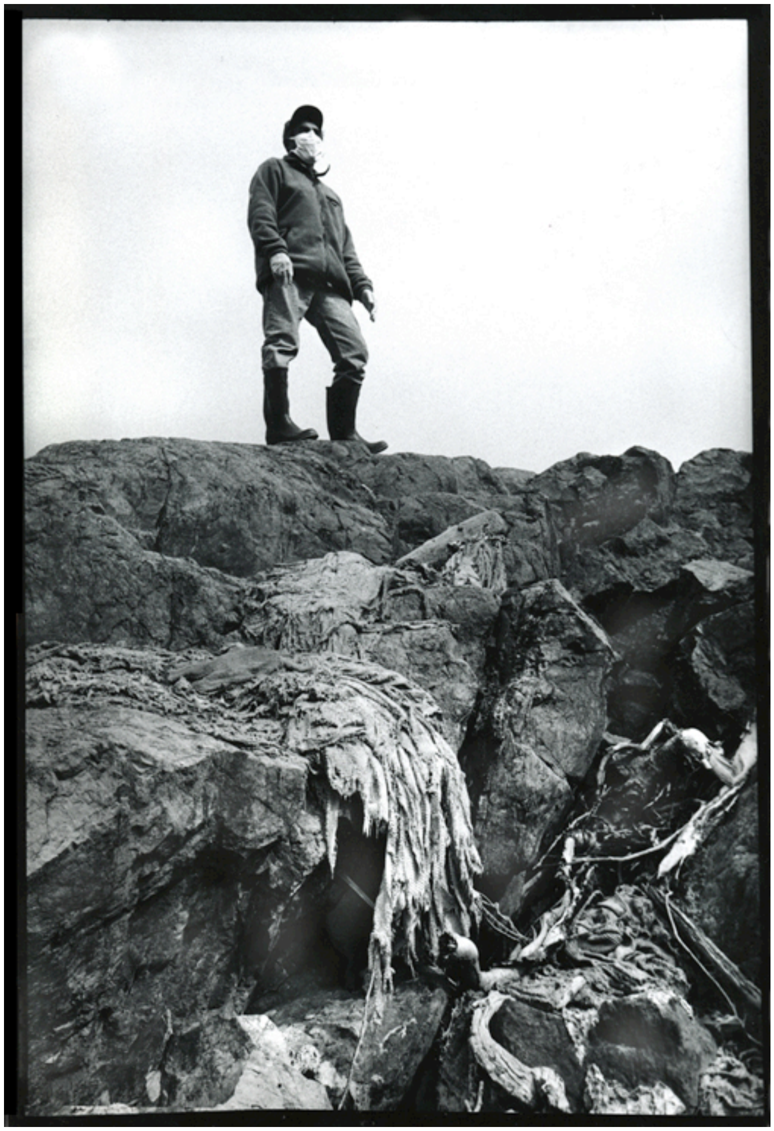
The Secret Life of the Atom



a photographic exhibit by **Robert Del Tredici**

with commentary by **Gordon Edwards Ph.D.**

winner of the 2006 Nuclear-Free Future Award in Education

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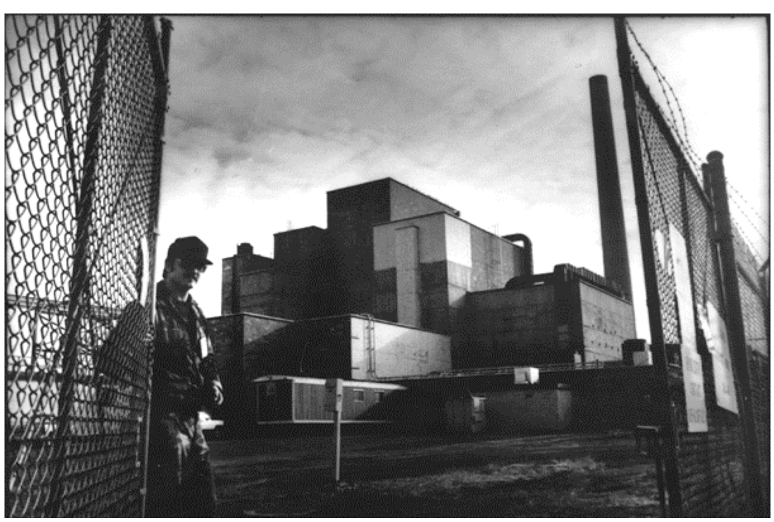
Column 1: History Lesson

Much of the uranium for the WW II atomic bomb project came from Canada. The decision to build Canada's first nuclear reactors was made in Washington DC in 1944, as part of the wartime effort to produce plutonium for the same atomic bomb program. After the war, Canada supplied plutonium (free) to Britain for its first atomic bomb, and sold plutonium to the Americans for their bomb program. And, by 1959, uranium had become Canada's fourth most important export after wheat, lumber, and pulp; up to that time it was all used in the American nuclear weapons program. In 1974, India exploded its first A-bomb using plutonium from a Canadian-donated research reactor. Since 1965, all Canadian nuclear materials were declared to be for peaceful purposes only. However Canada continued to send irradiated fuel from Chalk River to Savannah River where it was used for weapons purposes, and Canadian depleted uranium continued to be used in the fabrication of American warheads. The large amounts of plutonium produced in Canadian reactors has attracted the interest of militaristic regimes in a number of countries.

1. **Great Bear Lake**. The Sahtu-Dene (*"people of the water"*) have lived along the shores of Great Bear Lake for thousands of years. The entire population of 700 now inhabit the village of Deline, 200 miles across open water from Port Radium, the world's first uranium mine. Indigenous Dene men were hired as "coolies" to carry sacks of refined uranium ore out of the mine. Some of this uranium was used in the Hiroshima bomb. *Deline Village, Northwest Territories, Canada. 27 October 1997.*

2. **Hiroshima Buddha** This bronze Buddha was melted by heat from the Hiroshima bomb on August 6, 1945. Dene ore-carriers were never told that the uranium they carried was used for bombs. On August 6, 1998 a delegation of Dene from Deline visited Hiroshima to make contact with A-bomb survivors. *Hiroshima Peace Museum, Hiroshima, Japan. 13 November 1984.*

3. **The Hanford "B" Reactor.** This is the first reactor designed to mass-produce weapons-grade plutonium from uranium. Built in 1944, it made the plutonium in the "Trinity" Alamogordo bomb and in the Nagasaki bomb. It continued to produce plutonium for bombs until 1968. *Hanford Site, Washington State. November 16, 1984.*



Column 2: Demystifying the Bomb

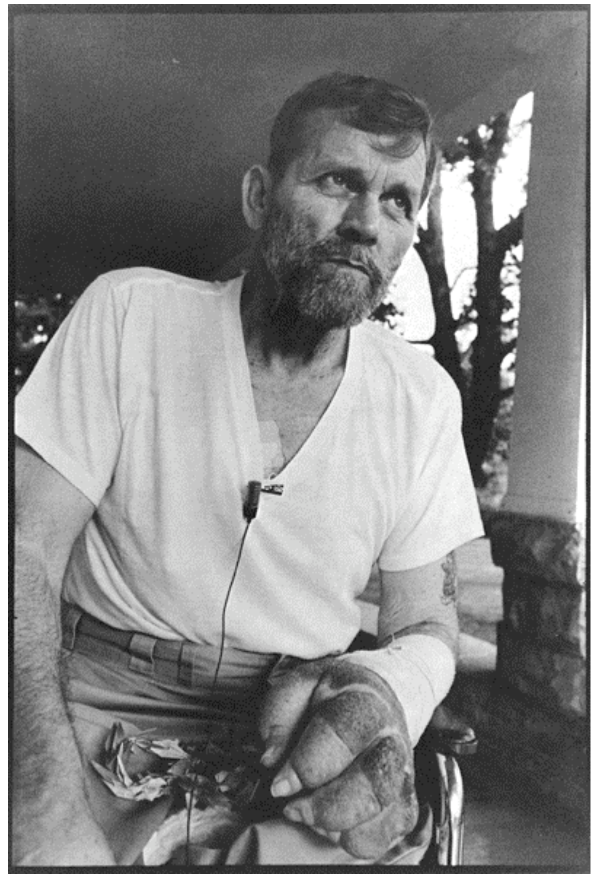
Most people know that energy is released when uranium atoms are split. But what many do not know is that hundreds of fiercely radioactive substances are created at the same time. These are the fragments of broken uranium atoms – the fission products – and they are millions of times more radioactive than the uranium from which they come. They make up the radioactive fallout that poisons the earth after a nuclear explosion. They are the radioactive waste materials that make irradiated fuel dangerous for millions of years. They are the residual heat generators that can melt the core of an uncooled nuclear reactor and send clouds of radioactivity over vast regions. Knowing how these materials are created and how they behave helps us comprehend the nature of the problem, and empowers us to act against the root cause. Nuclear fission is by no means a clean technology.

4. Model of the Uranium Atom. Uranium is the basic element from which nuclear explosives and reactor fuel are made. The nucleus of the uranium atom can be split to release energy in a self-sustaining reaction. Uranium for Bombs can be highly enriched (the Hiroshima bomb) or transformed into plutonium (the Nagasaki bomb). Most power reactors require some enrichment for their fuel. Uranium can also be used in its natural, unenriched state to fuel reactors like the Canadian CANDU reactor. *American Museum of Science & Energy, Oak Ridge, Tennessee. 11 June 1982.*

5. John Smitherman, atomic veteran. *Mulberry, Tennessee, July 31, 1983.* John Smitherman participated in "Operation Crossroads," the first nuclear explosions after Hiroshima and Nagasaki. He was one of 42,000 servicemen exposed in the Pacific to radioactive fallout from the two nuclear explosions code-named "Able" and "Baker". He died of multiple cancers in September, 1983, two months after this portrait was taken. The US government insists it is not responsible for his fatal cancers.

> *"We watched the Baker shot from a ship about 19 miles away from the explosion, and mist from the mushroom fell on the deck of our ship and sand fell on our deck, little pieces of metal and rocks. We tried to wash off as much of it as we could. The mushroom cloud stayed in the air for almost two days – we could see that."*

6. John Hopkins, nuclear weapons designer. Hopkins displays multiple a-bomb blast photos that he refers to as *"just some pretty pictures from the early days"* illustrating how fission products are disseminated as fallout. *Los Alamos, New Mexico.*



Column 3: Radon Gas

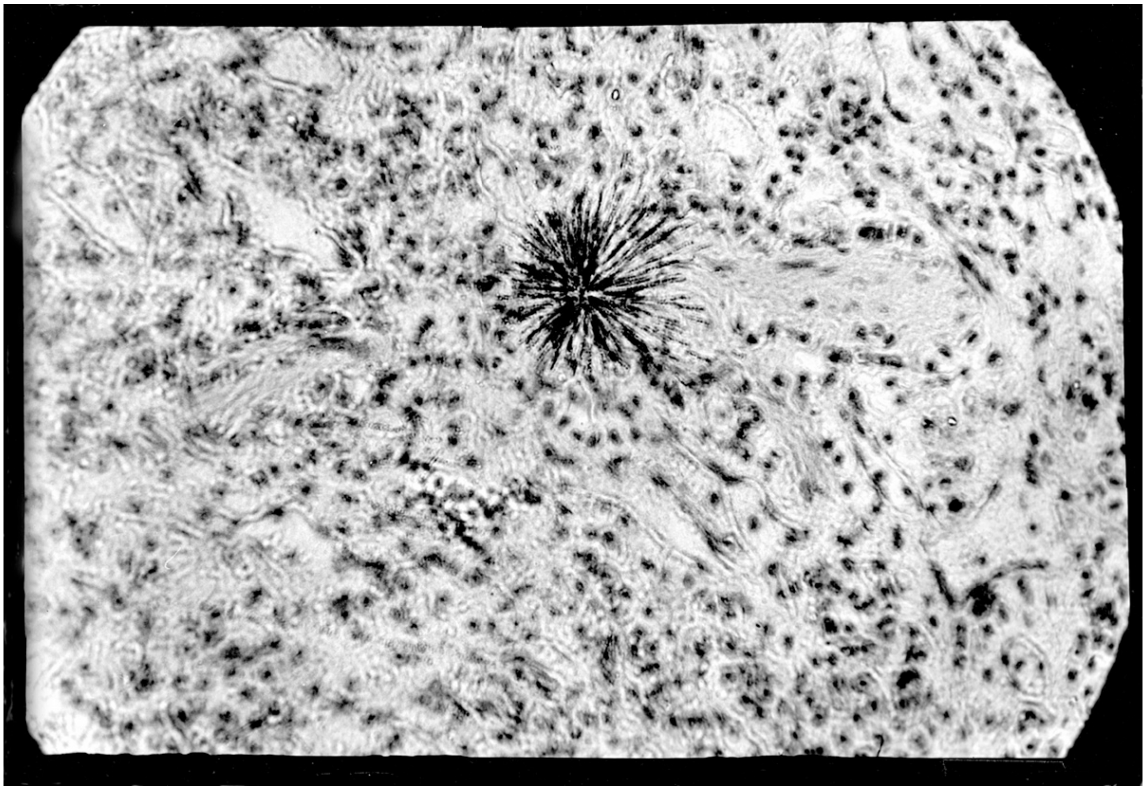
Radon gas has killed countless underground miners from radiation-induced lung cancers, fibrosis of the lungs, and other diseases for centuries. The deadly nature of this radioactive byproduct of uranium was already well-documented by the 1930s. Nevertheless Canadian authorities set allowable levels of radon in mines that would quadruple the lung cancer incidence among miners, and allowable domestic radon levels that would increase lung cancer rates by forty percent or more. Still, Canada's permissible limits on radon exposure in homes remain the most permissive in the western world. The soundness of Dr. Edwards' 1978 analysis of radon risks entitled "Estimating Lung Cancers, or, It's Perfectly Safe But Don't Breathe Too Deeply" was later confirmed by analyses from the British Columbia Medical Association, the US National Academy of Sciences' BEIR-III Report, and an independent study commissioned by Canada's Atomic Energy Control Board.

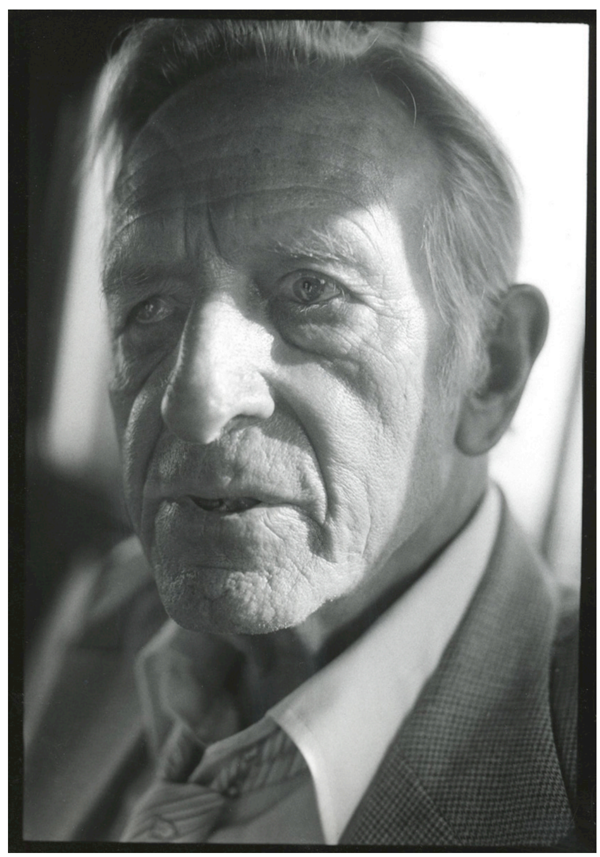
7. Particle of Plutonium in Lung Tissue. The black star in the middle of the picture shows tracks made by alpha rays emitted from a particle of plutonium in the lung tissue of an ape. Alpha rays do not travel far, but inside the body they can penetrate the more than 10 000 cells within their range. These tracks were made over a 48-hour period. Plutonium has a half-life of 24 400 years.
Lawrence Radiation Laboratory, Berkeley, California. 20 Sept. 1982.

8. Jeannette and Bernard Bennally. *Red Rock Navajo Reservation, Arizona. August 18, 1982.* Bernard Benally worked as a uranium miner for 6 years. He suffers from lung cancer, which developed after he retired.

> *"I used to go in and haul the rocks out, and I guess that's where I got hurt, because there was a lot of dust after they did the blasting and we went in right away."*

9. Dr. Karl Z. Morgan, Father of Health Physics. For 29 years Dr. Morgan was head of Health Physics at the Oak Ridge nuclear weapons lab in America. He concluded from his many studies on the health effects of radiation that "there is no safe level of radiation." *Atlanta, Georgia. 8 August 1983.*





Column 4: Depleted Uranium

When uranium is dug out of the ground, it is a blend of uranium-235 (less than 1 percent) and uranium-238 (more than 99 percent). U-235 is the kind of uranium that fissions and releases energy, so to make bombs or reactor fuel, the concentration of U-235 has to be increased or "enriched". This is done by removing much of the U-238. The left-over U-238 is called "depleted uranium" (DU). It has no significant civilian uses, but it does have several military uses.

(1) In recent years DU has been used to make armor-piercing shells and bullets. When used, these weapons spread radioactive waste (DU) over the battlefield; it can damage people's health long after hostilities have ceased.

(2) Depleted uranium is the source material for producing plutonium, the primary explosive in nuclear warheads. Each atom of plutonium-239 begins as an atom of U-238.

(3) Depleted uranium is also used as a metallic component in warheads, more than doubling the explosive power of the explosion. The broken fragments of depleted uranium atoms are the main components of the radioactive fallout from an H-bomb.

10. Uranium Enrichment. At the Portsmouth Gaseous Diffusion Plant, seen here, uranium in the form of a gas is pumped through miles of pipes that filter out the lighter uranium-235 atoms from the U-238 atoms. U-235 sustains the nuclear chain reaction in reactors and in bombs. Most power reactors use enriched uranium. If the enrichment is very high, weapons-grade material results. *Piketon, Ohio. July 27, 1983.*

11. Depleted Uranium Metal. The most important military use of depleted uranium occurs when the metal is processed into hollow "targets" to be irradiated in a special military reactor, which transforms the uranium into plutonium. *Fernald Feed Materials Production Center, Fernald, Ohio. December 17, 1985.*

12. The K-reactor head. Inside this reactor, DU metal targets are bombarded with neutrons, and some of the uranium-238 atoms are transformed into weapons-grade plutonium-239. *Savannah River Plant, South Carolina. January 7, 1994.*

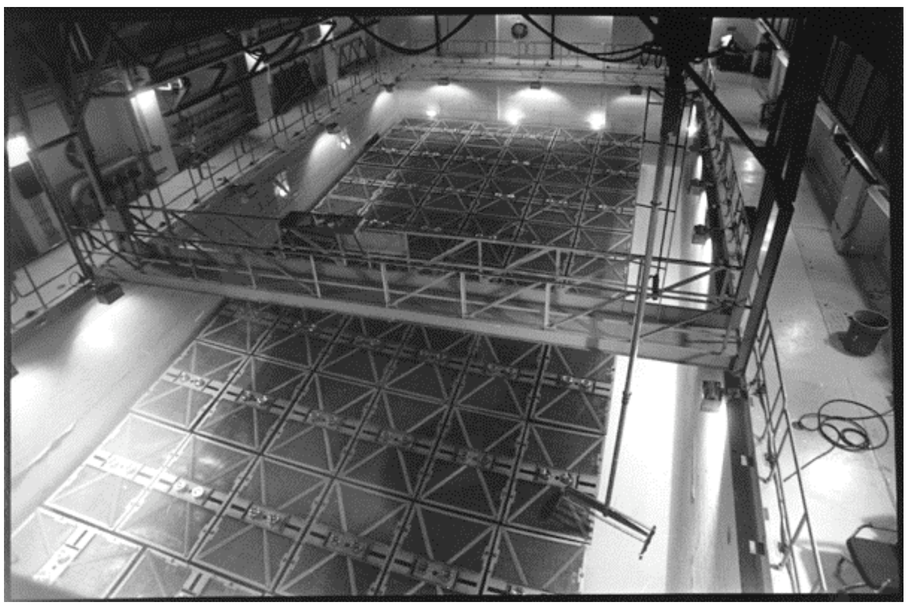
Column 5: The "Nuclear Renaissance"

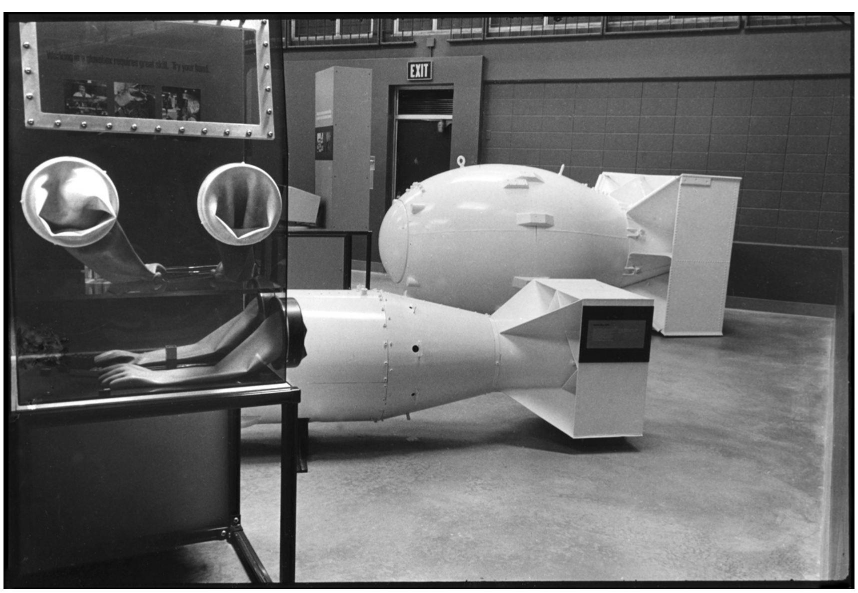
The "nuclear renaissance" is in fact a nuclear relapse. Proliferation of nuclear power will be accompanied by a multiplication of nuclear-weapons states. Nuclear proponents have long known that uranium supplies will not outlast oil supplies if tens of thousands of reactors are built. Thus nuclear power cannot replace a significant fraction of oil unless plutonium is used as the nuclear fuel of the future. It is no accident that the countries most committed to nuclear power – France, Japan, India, Russia, England – have all made large investments in plutonium recycling technology. Using plutonium as a commercially-traded fuel guarantees that this nuclear explosive material will fall into the hands of criminal organizations and terrorist groups. The advent of a plutonium economy makes a nuclear-weapons free world impossible.

13. The Amount of Plutonium in the Nagasaki Bomb.
This glass paperweight, 3.2 inches across, is the exact size of the plutonium sphere that formed the core of the Bomb that exploded over Nagasaki with a force of 22,000 tons of TNT. *Kansas City, Missouri. September 22, 1983.*

14. Full Spent Fuel Pool. Irradiated nuclear fuel generates heat long after it has been taken out of the reactor. This "radioactive decay heat" has to be removed by being submerged in water for 7 years, or the fuel will overheat and radioactive gases will be released. All irradiated nuclear fuel contains plutonium. Stockpiles of spent fuel are, in effect, "plutonium mines". *Gentilly 2 Nuclear Power Station, Bécancour, Québec. March 19, 1995.*

15. Nuclear Arms. In the background, a duplicate of the Nagasaki plutonium bomb. In front of it, a duplicate of the Hiroshima enriched uranium Since future reactors will use plutonium as fuel, the proliferation of nuclear power will inevitably grant terrorists access to the prime explosive ingredient of the Bomb. bomb. In the foreground, a glove-box for handling plutonium. *Bradbury Science Museum, Los Alamos, New Mexico.*

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Column 6: Uranium mining

When uranium ore is mined and the uranium is extracted, 85 percent of the radioactivity remains behind in the form of sands and slimes that will stay hazardous for hundreds of millennia. These wastes include some of the most toxic radioactive substances known to science: radium-226, which killed so many people in the first half of the twentieth century that it is now discarded; polonium-210, which has killed hundreds of thousands of cigarette smokers and was recently used to assassinate a Russian spy; and radon-222, which has been identified as the second leading cause of lung cancer by the US Surgeon General, killing at least 30,000 Americans each year. Twenty years ago, the Wall Street Journal characterized uranium tailings as "an ecological and economic time bomb".

16. Uranium Shovel. This steel claw sits in the Key Lake open-pit uranium mine. Canada is the world's biggest producer and exporter of uranium. For its first 20 years, Canada's uranium industry sent uranium into the US nuclear weapons program.

***17.* The Gaertner Pit** is located on the rim of the Athabasca Basin in a region sometimes referred to as "the Saudi Arabia of uranium." This mine, and others like it, have made Saskatchwan the undisputed uranium capital of the world.

18. The Stanrock Tailings Wall The wall of white sand behind the trees is made up of radioactive waste from the Stanrock mill near Elliot Lake. These radioactive tailings have contaminated the Serpent River system and the Great Lakes. Uranium mill tailings remain hazardous for hundreds of thousands of years. *Elliot Lake, Ontario.*

Column 7: High-level waste

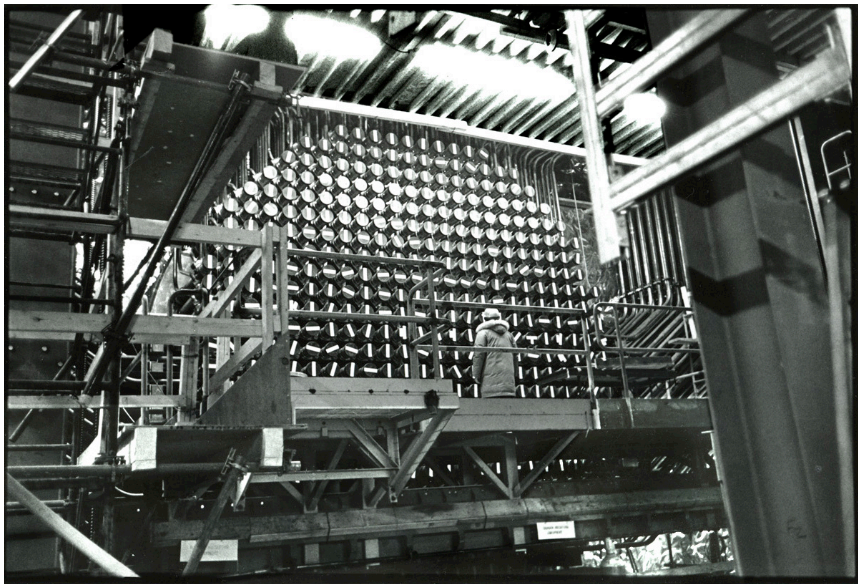
Irradiated nuclear fuel is millions of times more radioactive than the uranium that was used to produce it. After the fuel has been removed from the reactor, it has to be cooled for 7 to 10 years in pools of circulating water; otherwise it will spontaneously overheat and release radioactivity into the environment. Eventually the fuel may be moved to dry storage for an additional period of 10 to 30 years, before the wastes are cool enough to be buried underground. If the irradiated fuel is buried, the temperature of the rock around it increases for thousands of years; the rocks do not return to their original temperature for over 50 thousand years. During this time, and for millions of years afterwards, these wastes remain extremely toxic. Although nuclear proponents talk about "disposal" of these high-level radioactive wastes, scientists have never successfully disposed of any toxic materials in the entire course of human history. Nature has always found a way to disperse buried material into the environment.

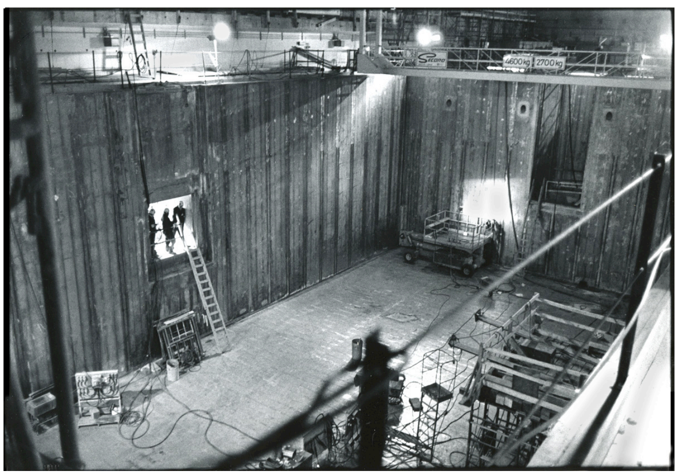
19. The Face of the CANDU Reactor. The Canadian CANDU reactor produces twice as much plutonium as other reactors. It uses individual tubes to hold its fuel bundles. This enables the reactor to be refueled without being shut down, which makes it difficult to determine if the plutonium in the spent fuel has been removed clandestinely. *Darlington Nuclear Complex, Ontario. January 21, 1987*

20. Empty Spent Fuel Pool. This spent fuel pool under construction is designed to contain the most radioactive objects on earth: irradiated nuclear fuel. Once the pool is filled with water, irradiated nuclear fuel bundles will be submerged under 14 feet of water for seven years, to cool the fuel and act as a shield against the intense radiation that the fuel gives off. *Darlington Nuclear Complex, Ontario. January 21, 1987.*

21. Dry Storage of Spent Fuel. After irradiated nuclear fuel has spent 7 years in a spent fuel pool, it has cooled off enough to be moved into dry storage where it can remain, under supervision, indefinitely – or be put into deep geologic storage – or be reprocessed to recover the plutonium in the fuel. *Gentilly Nuclear Power Station, Bécancour, Québec. March 19, 1995.*

22. Irretrievable High-Level Waste Disposal Test Shaft. This chamber lies 500 meters beneath the surface of the Great Canadian Shield. Its purpose is to determine if such a shaft can function as a permanent underground storage site for high-level radioactive waste in the form of spent nuclear fuel. *Lac du Bonnet, Manitoba, Canada. September 15, 1986.*



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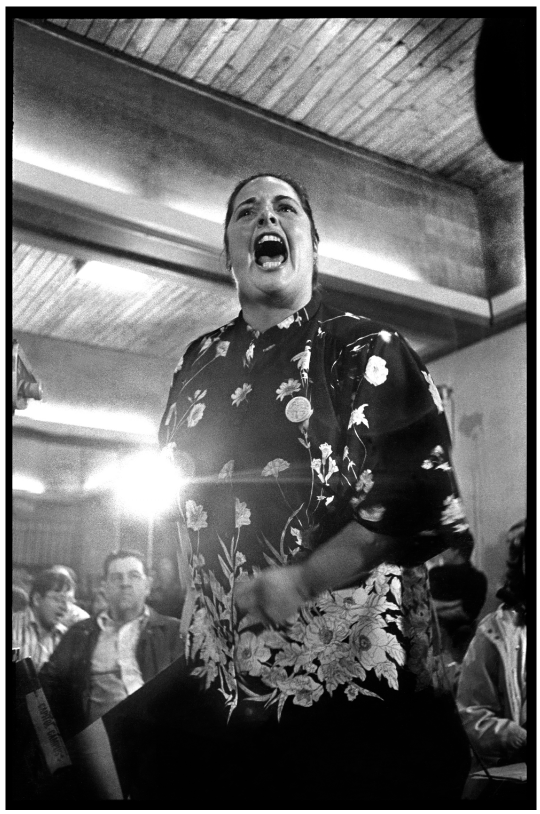
Column 8: Nuclear accidents

Even after the fission reaction is completely shut down in a nuclear reactor, the fuel is so radioactive that it will spontaneously melt unless it is actively cooled. When the core of the reactor melts, a cloud of poisonous gases and metallic vapours is released into the atmosphere, spreading radioactive contamination for thousands of miles. Today, more than 20 years after the Chernobyl meltdown in Russia, sheep farmers thousands of miles away in Northern England cannot sell their meat because it is too radioactive for human consumption. In 1976, a Royal Commission Report from Britain pointed out that if nuclear power had been developed before World War II, and nuclear reactors had been built near cities, large parts of Europe would be uninhabitable today due to massive radioactive contamination caused by the conventional bombing and/or sabotage of nuclear power plants.]Nuclear reactors are incompatible with the future of civilization as long as war is used to address human conflicts.

23. Chernobyl: the Becquerel Reindeer. Meat from reindeer feeding on lichen contaminated with radioactive fallout from the Chernobyl cloud rendered these reindeer unfit for human consumption. Slaughterhouse workers nick-named the carcasses "the becquerel reindeer." *Harads Same-produktor, Harads, Lappland, Sweden. December 3, 1986.*

24. Three Mile Island: Joyce Corradi. This housewife from Three Mile Island voices her opposition to the government's plan to release radioactive Krypton-85 gas into the air around the plant as a way of "cleaning up" the facility damaged in the 1978 nuclear meltdown. In spite of intense public opposition to this mode of cleanup, the gas was released. One year later the release was declared illegal.
Liberty Fire Station Number 1, Middletown, Pennsylvania. March 19, 1980.

25. Chelyabinsk: Maids of Muslyumovo. The Chelyabinsk plutonium production reactor produced the plutonium in the first Soviet atomic bomb. The plant is 35 km. upstream from the village of Muslyumovo. For four years, Soviets dumped high-level liquid nuclear waste directly into the Techa River that borders the town. Forty years later, women from Muslyumovo watch Western scientists measure radiation in the silt and water of the river that flows past their town.
Muslyumovo village, Chelyabinsk, Russia. March 17, 1991.



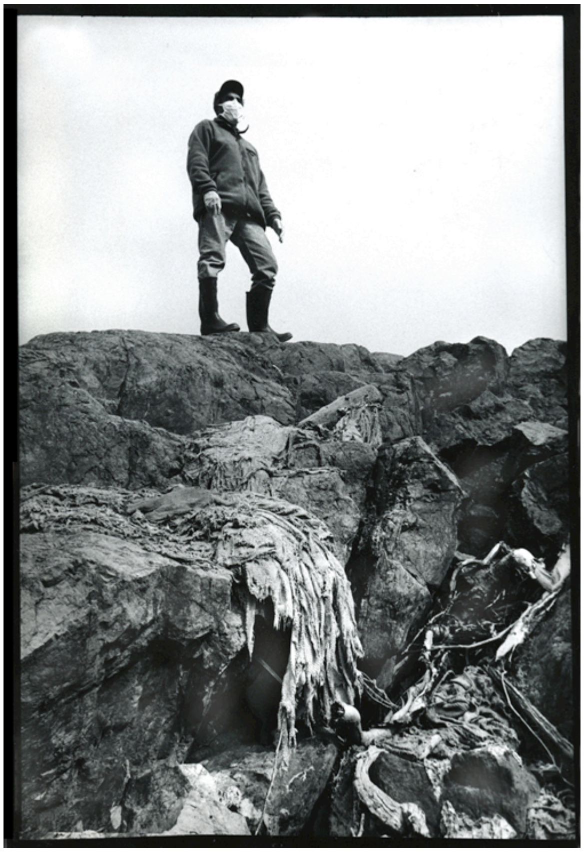
Column 9: The Sahtu Dene people

In the 1920s there was no market for uranium, but the radioactive element radium – a natural byproduct of uranium – sold for $100,000 per gram. It was the most valuable substance on earth. In 1930 a rich deposit was discovered at Port Radium, on the eastern shore of Great Bear Lake in Northern Canada. This Lake is the ancestral home of the Sahtu Dene people. Dene men were hired as "coolies" to carry burlap sacks of radium concentrates on their backs. By 1931, the Government of Canada had published warnings aimed at scientists in Ottawa who had to handle small quantities of this material for assay purposes. Ingestion of even minute amounts of radioactive dust, said the government documents, could cause death by cancer, rapid anemia, bone necrosis, or other fatal illnesses. These warnings were never passed on to the Dene who carried the sacks and slept on them for hours at a time. By 1940, when the deadly dangers of radium became known, the market for the substance dried up – to be replaced by a new market for uranium during World War II to make the world's first atomic bombs. Port Radium was re-opened as a uranium mine, and the radioactive exposures of the Dene people continued unabated. Today the Dene Village of Deline on Great Bear Lake is called the "Village of Widows" since so many men have died of radiation-induced cancers.

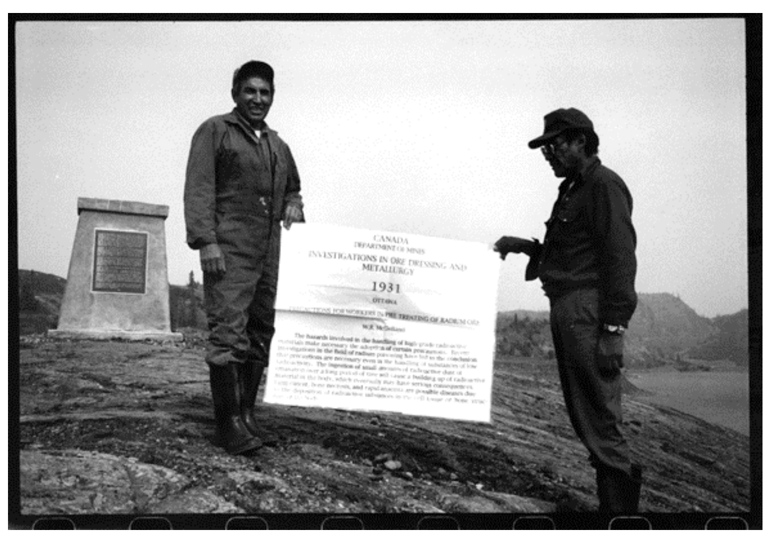
33. Abandoned Uranium Ore Sacks. These sacks, once filled with radioactive ore and carried by Dene men, now lie rotting in the sun at Port Radium. Dene native Joe Blondin Jr. surveys the scene. He was born in Port Radium when the mine was supplying uranium for bombs. Many Dene ore-carriers eventually sickened and died of cancer. *Port Radium, Great Bear Lake, NWT. 18 July 1998.*

34. Home of the Sahtu-Dene. The Sahtu-Dene people have lived on the shores of Great Bear Lake for thousands of years. Sahtu-Dene men used to work as ore-carriers at the Port Radium mine.

36. Government Warning, 1931. This advisory, issued by the Canadian Department of Mines in 1931, was based on deaths in the 1920s caused by contact with minute quantities of radium. Radium is always present in uranium ore. This advisory was intended to protect government workers; neither miners nor ore-carriers were told of the hazards. *Port Radium, Great Bear Lake, NWT. 18 July, 1998.*




Great Bear Lake
Deline


CANADA
DEPARTMENT OF MINES
INVESTIGATIONS IN ORE DRESSING AND METALLURGY
1931
OTTAWA

Gordon Edwards has a gold medal in Mathematics and Physics from the University of Toronto (1961), Masters' degrees in Mathematics and Literature from the University of Chicago (1962-64), and a Doctorate in Mathematics from Queen's University (1972).

In graduate school, Edwards co-founded the *Survival* movement with Alexandre Grothendieck. *Survival* held that scientists and non-scientists must work together to counteract threats to human survival posed by nuclear weapons and environmental catastrophe. Edwards edited the English language edition of the *Survival* newsletter from 1970 to 1974.

In 1975 Edwards co-founded and became president of the Canadian Coalition for Nuclear Responsibility, created to help citizens share information on nuclear technology and lobby for a national inquiry into its hazards. Edwards has intervened in many public fora, becoming one of the foremost critics of Canada's nuclear policies.

Edwards has worked with indigenous groups throughout Canada, including the Assembly of First Nations, the Inuit Tapiriit Kanatami, the Congress of Aboriginal Peoples, the Chippewas of Nawash, and the Mohawks of Kanesatake.

www.ccnr.org ccnr@web.ca

Robert Del Tredici has been photographing the nuclear age since 1979. In 1987 he founded the Atomic Photographers' Guild.

bdeltredici@hotmail.com