Health Dangers of Uranium Mining

by Dr. Gordon Edwards (Ph.D.)
on behalf of Physicians for Global Survival (PGS)

Narsaq, Greenland
June 11 2016

Canadian Coalition for Nuclear Responsibility
www.ccnr.org
All uranium goes to Port Hope on Lake Ontario for conversion to uranium hexafluoride or uranium dioxide.
HEALTH DANGERS OF URANIUM MINING AND JURISDICTIONAL QUESTIONS

The British Columbia Medical Association

A SUMMARY OF MATERIAL BEFORE THE BRITISH COLUMBIA ROYAL COMMISSION OF INQUIRY

HEALTH AND ENVIRONMENTAL PROTECTION ~ URANIUM MINING ~

PRESENTED: AUGUST 1980

BY

E.R. YOUNG, B.Sc., M.D.
R.F. WOOLLARD, M.D.
Uranium is Special
Uranium mining brings heavy metals and radioactive materials to the surface
POLLUTION INFILTRATES THE FOOD CHAIN

RADIOACTIVE AND CHEMICAL PARTICLES AND GASES CONTAMINATE THE LAND, WATER, PLANTS, ANIMALS AND PEOPLE OF NORTHERN CANADA

Graphic: Dave Geary
A radioactive atom has an unstable nucleus. It will **suddenly disintegrate**, giving off a highly energetic particle and/or a photon of energy. These emissions are **damaging to living cells**.
A scientist with a radiation monitor found the rocks in this garden are dangerously radioactive.

Dose rate measured:

*1 mS per hour on contact = 5000 times above background level
*18.3 μS per hour at a distance of 1 m

Comparison with EURATOM limits:

* Staying one hour at 1 meter: cancer risk is ‘non negligible’
* Staying 10 minutes per day, each day of the year: cancer risk is ‘unacceptable’.

CRIIRAD asked the mining company to remove the mineral.

Bruno Chareyron is with the organization CRIIRAD.
A woman in France kept these pretty rocks from the mine site in her garden (June 2002)
Invisible radioactive emissions leave visible tracks in a “cloud chamber”
A Model of the Uranium Atom

Photo: Robert Del Tredici
Chemical energy is powerful.

Nuclear energy comes directly from the nucleus – it is millions of times more powerful than chemical energy.
Radioactivity:
a form of Nuclear Energy . . .

... that cannot be shut off
Chronic radioactive exposures at low doses increases the incidence of cancer, leukemia, genetic damage, strokes, heart attacks, other blood diseases and low intelligence in young children.
Chronic radioactive exposures at low doses increases the incidence of cancer, leukemia, genetic damage, strokes, heart attacks, other blood diseases and low intelligence in young children.

...but there is a “latency period”; the onset of disease will occur years or decades after exposure.
Dr. Alice Stewart (MD) showed embryos are very vulnerable to radiation damage.
Dr. Karl Morgan (Ph.D.) found **there is no safe level** of radioactive exposure.
Uranium
is
Never Alone
URANIUM-238 DECAY CHAIN

Uranium-238
becomes
Thorium-234.

URANIUM-238

alpha

THORIUM-234

"THE URANIUM SERIES"
Thorium-234 becomes Protactinium-234

"THE URANIUM SERIES"
Protactinium-234 becomes Uranium-234
URANIUM-238 DECAY CHAIN

"THE URANIUM SERIES"

Uranium-234 becomes Thorium-230

URANIUM-238
  \[ \text{primordial (progenitor)} \]
  \[ \text{alpha} \]
THORIUM-234
  \[ \text{beta} \]
PROTACTINIUM-234
  \[ \text{beta} \]
URANIUM-234
  \[ \text{alpha} \]
THORIUM-230
Here is the full decay chain of uranium-238 (It is the most common type of uranium found in nature).

It's like a family of radioactive elements – the great-great-great grandfather is uranium.

<table>
<thead>
<tr>
<th>ISOTOPE</th>
<th>Decay Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>URANIUM-238</td>
<td>alpha</td>
</tr>
<tr>
<td>THORIUM-234</td>
<td>beta</td>
</tr>
<tr>
<td>PROTACTININIUM-234</td>
<td>beta</td>
</tr>
<tr>
<td>URANIUM-234</td>
<td>alpha</td>
</tr>
<tr>
<td>THORIUM-230</td>
<td>alpha</td>
</tr>
<tr>
<td>RADIUM-226</td>
<td>alpha</td>
</tr>
<tr>
<td>RADON-222</td>
<td>alpha</td>
</tr>
<tr>
<td>POLONIUM-218</td>
<td>alpha</td>
</tr>
<tr>
<td>LEAD-214</td>
<td>beta</td>
</tr>
<tr>
<td>BISMUTH-214</td>
<td>beta</td>
</tr>
<tr>
<td>POLONIUM-214</td>
<td>alpha</td>
</tr>
<tr>
<td>LEAD-210</td>
<td>beta</td>
</tr>
<tr>
<td>BISMUTH-210</td>
<td>beta</td>
</tr>
<tr>
<td>POLONIUM-210</td>
<td>alpha</td>
</tr>
<tr>
<td>LEAD-206</td>
<td></td>
</tr>
</tbody>
</table>

"THE URANIUM SERIES"
The decay products are much more radioactive and much more dangerous than uranium itself.

The 3 types of polonium are most dangerous of all.
Henri Becquerel 1896
accidentally discovered that uranium ore is radioactive
Marie Curie 1898

discovered \textit{radium} and \textit{polonium} in uranium residues
Health Effects of
Radioactive Exposure
Radium Dial Painters 1920

Girls hired to use radioactive paint to make numerals on watch dials glow in the dark ... ... ingested minute amounts of radium when they licked the tips of their brushes to get a very fine point.

deaths from
Fatal anemia
Bone cancer
Head cancer
Deaths of Radium Dial Painters
from ingesting minute amounts of radium

- Fatal anemias
- Bone cancers
- Head cancers

radium (like calcium) – goes to bones and teeth
dial painters developed severe dental damage called “radium jaw”
radium also damaged blood-forming organs in their bone marrow
many died of anemia (as did Marie Curie and her daughter Irene) and others of bone cancer
radon gas (produced by radium) was carried by blood to the head and caused cancers there

radium is a bone-seeker
Radium, like calcium, goes to bones & teeth.

Dial painters suffered from

Phase 1: Fatal anemia (blood disease)
Phase 2: Bone cancers (skeletal damage)
Phase 3: Head cancers (sinuses and mastoid)

Phase 3: radon gas is produced in the bones by radium disintegration -- then carried by the blood to the head where the radioactive gas builds up.

In 1920s, radium sold for $100 000 per gram. Now it is discarded as a waste byproduct.

BCMA: “Radium is a superb carcinogen”
In the Sahtu-Dene Village of Deline, Great Bear Lake, NWT

Photo:
Robert Del Tredici
Dene man standing over discarded uranium ore sacks at Port Radium, NWT
Recent investigations in the field of radium poisoning have led to the conclusion that precautions are necessary even in the handling of substances of low radioactivity. The ingestion of small amounts of radioactive dust or emanation over a long period of time may have serious consequences: lung cancer, bone necrosis and rapid anemia are possible diseases due to deposition of radioactive substances in the cell tissue or bone structure of the body.
Alexander Litvinenko 2006

polonium is chemically similar to potassium – it attaches itself to the red blood corpuscles ...
polonium travels throughout the body damaging soft organs ...
polonium is 250 billion times more toxic than hydrogen cyanide ...
polonium is the only material that can deliver a dose of whole-body alpha radiation ...
polonium is produced by the disintegration of radon atoms ...

murdered by polonium poisoning in London England (a tiny amount of polonium added to a cup of tea)
Polonium-210

Weight by weight

polonium-210 is about 250 billion times as toxic as hydrogen cyanide.
polonium-210 is probably the cause of up to 90 percent of the deaths attributed to tobacco (lung cancers, heart attacks, strokes)

polonium is a blood-seeker

radon gas from soil and uranium-rich fertilizer builds up under a canopy of tobacco leaves ...

radon disintegrates to form radioactive lead-210 that sticks to the resinous hairs on tobacco leaves ...

harvested tobacco has very minute amounts of radioactive lead-210 ...

lead-210 disintegrates to form polonium-210 that is inhaled by smoker ...

polonium-210 damages the lung to cause cancer and enters the blood to cause strokes and heart attacks...
radioactive radon gas is produced when radium atoms disintegrate.

Radon is the leading cause of lung cancer among non-smokers.

Radon causes lung cancers and other lung diseases in uranium miners.

Radon gas deposits solid radioactive materials in lung tissue.

Radon is eight times heavier than air and travels great distances ...
Although radon is a gas . . .

Radon progeny (chart)

Radon is a lung-seeker

RADON-222
(3.8 days)

short-lived radon progeny
(principal hazard to miners)

long-lived radon progeny
(principal threat from fallout)
Although radon is a gas . . .
its decay products are solids and lodge in the lungs . . .
Although radon is a gas . . .

its decay products are solids
and lodge in the lungs . . .

. . . in fact 85% of the lung dose
is from alpha-emitting polonium
Non-Penetrating

Alpha Radiation
Every radionuclide emits either an alpha or a beta particle. Such particles are electrically charged and move very fast. In some cases a powerful gamma ray is also given off. All three forms of atomic radiation damage living cells.
A gamma ray is like an x-ray, but more powerful. 
*highly penetrating ~ most easily detected*

A beta particle is like a sub-atomic bullet. 
*moderately penetrating ~ harder to detect*

An alpha particle is like a subatomic cannon ball. 
*least penetrating, but most damaging ~ often undetected*

*Alpha and Beta particles are INTERNAL hazards.*
*Gamma rays are both internal & external hazards.*
Alpha particles can be stopped by a sheet of paper. Alpha emitters are harmless outside the body, but exceedingly dangerous when ingested or inhaled.

Beta particles penetrate only part-way. They can damage eyes or skin externally. But the main danger is internal exposure.

Gamma rays are highly penetrating. They give “whole body” radiation. Heavy shielding is often needed.
All of these deadly radionuclides
~ radium, radon, and polonium ~
are “alpha emitters”

Alpha radiation is harmless outside the body, but deadly inside

uranium, thorium and plutonium
are also alpha emitters
“Alpha Radiation” from a tiny radioactive particle in lung tissue
Radioactive Tailings
Behind this 10 meter wall is 70 million tonnes of Uranium tailings.
Mill Tailings Hazards

Gamma radiation
Mill Tailings Hazards

Gamma radiation

Dust blowing (radium, arsenic, ...)

Tailings

Groundwater
Mill Tailings Hazards

- Radon exhalation
- Gamma radiation
- Dust blowing (radium, arsenic, ...)

Groundwater
Mill Tailings Hazard

- Radon exhalation
- Gamma radiation
- Dust blowing (radium, arsenic, ...)

Tailings

Groundwater

Seepage (uranium, arsenic, ...)

Résidus miniers rayonnement gamma

Graduate work
URANIUM-238 DECAY CHAIN

<table>
<thead>
<tr>
<th>ISOTOPE</th>
<th>HALF-LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>URANIUM-238</td>
<td>4.5 billion yrs</td>
</tr>
<tr>
<td>THORIUM-234</td>
<td>24.1 days</td>
</tr>
<tr>
<td>PROTACTINIUM-234</td>
<td>1 min</td>
</tr>
<tr>
<td>URANIUM-234</td>
<td>245 thousand yrs</td>
</tr>
<tr>
<td>THORIUM-230</td>
<td>76 thousand yrs</td>
</tr>
<tr>
<td>RADIUM-226</td>
<td>1600 yrs</td>
</tr>
<tr>
<td>RADON-222</td>
<td>3.8 days</td>
</tr>
<tr>
<td>POLONIUM-218</td>
<td>3 min</td>
</tr>
<tr>
<td>LEAD-214</td>
<td>27 min</td>
</tr>
<tr>
<td>BISMUTH-214</td>
<td>20 min</td>
</tr>
<tr>
<td>POLONIUM-214</td>
<td>160 microseconds</td>
</tr>
<tr>
<td>LEAD-210</td>
<td>22 years</td>
</tr>
<tr>
<td>BISMUTH-210</td>
<td>5 days</td>
</tr>
<tr>
<td>POLONIUM-210</td>
<td>138 days</td>
</tr>
<tr>
<td>LEAD-206</td>
<td>STABLE</td>
</tr>
</tbody>
</table>

“THE URANIUM SERIES”
In the uranium decay chain each element has its own half-life indicated by the black bars.

The half-life of Uranium-238 is about equal to the age of the Earth.
Uranium Decay Chain

half life = 76,000 years

In the uranium residues (tailings) thorium-230 replenishes the inventory of radium, radon and polonium, for hundreds of thousands of years.

After uranium is taken away, 85 percent of all radioactive material is left behind as waste.

The half-life of these wastes is 76,000 years.
LE RADON À OKA

Rapport d’intervention de santé publique

1998
Direction régionale de la santé publique
Cameco uranium conversion plant on Port Hope harbor.

Photo: Robert Del Tredici
Uranium Boom
The first use of uranium is to build nuclear weapons.
The second use of uranium is to fuel nuclear reactors.
When the uranium nucleus is “split” enormous energy is released. Highly radioactive broken pieces of uranium atoms are left behind.

*Photo: Robert Del Tredici*
Quebec Accord: tripartite cooperation in the making of the first atomic bombs
Destruction of the City of Hiroshima caused by A-Bomb, August 6, 1945
Until 1945, all Canadian uranium was sold to the US military for Bombs. Although military sales ended in 1965, deliveries continued for a few more years.

Over 85% of Canada’s uranium is sold to other countries.
Creation of plutonium in a nuclear reactor occurs…

…when an atom of uranium-238 absorbs a neutron
... it is transformed into an atom of plutonium-239
Doctors
on Call
A model of all the nuclear weapons in the American nuclear arsenal
A Race Against Time

Royal Commission on Electric Power Planning

Nuclear Reactor Waste
Radionuclides are chemical substances which are also radioactive.
Final Word
World Uranium Symposium (Quebec 2015) calls for global halt to uranium mining
U-BAN = International Campaign to Ban Uranium Mining Worldwide
The End

This backgrounder prepared by Dr. Gordon Edwards on behalf of PGS, the Canadian chapter of IPPNW.

Narsaq June 11 2016

Canadian Coalition for Nuclear Responsibility

www.ccnr.org