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Presentation at the BAPE - Bureau des Audiences Publique sur l'Environnement
Hearings on Uranium Mining in Quebec, Canada

1. Uranium

a. Uranium

Uranium is a radioactive, toxic heavy metal, with the capacity to cause negative effects on the reproductive system; through the radiation emitted by uranium - and its decay products - it can also cause damage to the DNA (the genetic information in cells); this may lead to damages in the offsprings of persons who have been exposed to radiation.

b. Uranium progeny / decay products

Uranium-235 and U-238 decay in different series of decay products, some of which are more radioactive than uranium itself, some are more toxic than uranium itself.

2. Factual Problems of Uranium Exploitation

a. Factual Problems of Uranium Mining

Uranium exploitation poses a series of severe problems:

Once, uranium ore is dug up via open-pit or underground mines, the radiological situation is changed irreversibly. Uranium and its decay products are mobilized physically and chemically, and they can spread easily in the environment via groundwater, surface water, air etc.

Uranium and its decay products can finally effect plants, crops, animals, humans and in the end human health, reproduction as well as the DNA, and thus, negative impacts can be passed on to future generations.

Due to the low concentration of uranium in the ore, the extraction of uranium from the ore leaves behind big quantities of waste, referred to as tailings and tailings ponds (much of the residue is in liquid form or slurry).

These wastes contain approx. 85% of the original radioactivity of the uranium ore due to the decay products which remain in the tailings.

b. <u>Special Problem: Longevity of radionuclides</u>

All of the decay products (except the last one in a series) are radioactive; some have very long half-lifes.

Uranium-238 half life 4,5 billion years
Uranium-234 half life 234.000 years
Thorium-230 half life 77.000 years
Radium-226 half life 1.590 years

The long half-lives of certain - radioactive - decay products of uranium require that tailings are kept isolated from the biosphere for thousands of years since the radioactivity declines very slowly.

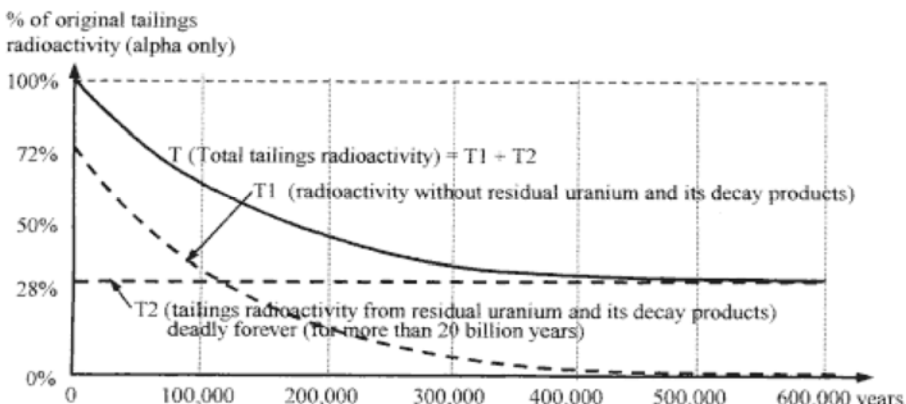


Fig.3: The Roxby tailings radioactivity (residual uranium in tailings: 23% of the ore's uranium)

The graph shows that after 100.000 years approx. 70% of the original radioactivity of the tailings remains.

Up to now, there is no method available to store any kind of material "safely" and isolated from the environment for hundreds, let alone for thousands of years.

c. <u>Quantity of Tailings</u>

Many uranium deposits which are considered worth mining today, have concentrations of uranium in the ore of 0.1% and less (down to 0.01%). This creates huge quantities of "waste" - which are also radioactive, and toxic.

In many cases, other substances such as arsenic, mercury etc. which are toxic, are released from the underground through the mining process.

<u>Quantity of tailings generated for 1 t Uranium, as a function of Uranium concentration in the ore</u>:

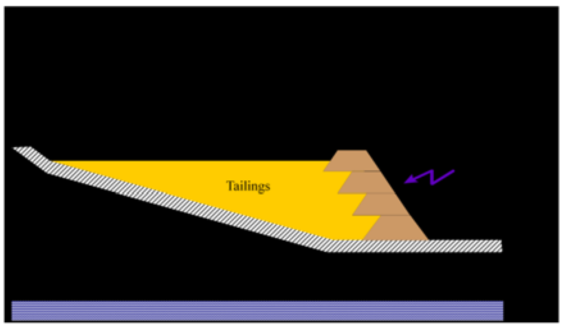
Concentration of uranium in the ore / soil		-->	Quantity of tailings
1 %	**1 t Uranium**	**→**	**99 t waste / 'tailings'**
0.1 %	**1 t Uranium**	**→**	**999 t waste / ‚tailings‘**
0.01 %	**1 t Uranium**	**→**	**9.999 t waste / ‚tailings‘**

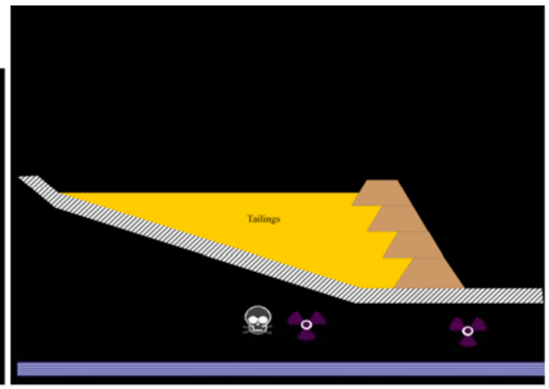
The huge quantity of tailings adds to the difficulty to store these quantities of radioactive and toxic tailings safely for hundreds or thousands of years.

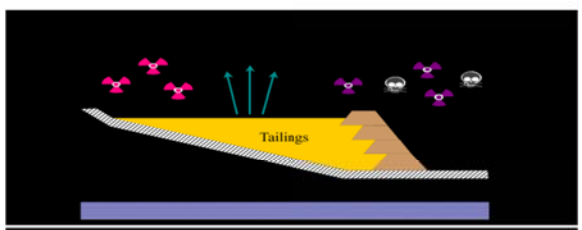
d. Tailings management

Tailings, much of which is in form of liquids or slurry, are usually stored in tailings ponds artificially created. The storage in / behind so-called "tailings dams" poses a number of dangers which are shown in brief in the following graph.

- Failure of tailings dam
- Seepage of radioactive and toxic liquid into the underground, contaminating groundwater aquifers
- Dust blown from tailings
- Exhalation / emission of the radioactive gas Radon-222
- Gamma radiation effecting people, animals passing by







Each of the risks portrayed here has already happened at least once, in most cases, repeatedly, with uranium mining and milling wastes.

Conclusion

Obviously, it is virtually impossible to store the quantities of waste / tailings generated by a commercial-size uranium mine safely for hundreds or thousands of years.

e. ISL - in-situ leaching

A newer method to mine uranium is in-situ leaching: Putting it simply, an acid fluid is pumped underground, pressed through the uraniferous rock, and recovered at other places (wells), then containing uranium - and its decay products as well as other possibly toxic substances. This liquid is then treated much the same way as in a conventional uranium mill, the uranium is extracted and yellowcake is produced

The uranium industry likes to advertise this method as "environmentally friendly".
This is not correct.

in-situ leaching avoids digging huge holes in the ground (open-pit mines) and it also avoids - visible - tailings and tailings ponds and the risks associated with storing tailings in ponds and behind dams. However, the process remains basically the same: The uraniferous rock is treated with acid (in most cases) and uranium and its decay products are (partially) removed from their natural environment. The radiological situation is changed irreversibly; the radioactive elements (and other substances) are mobilized physically.
They can move much easier with groundwater flows, and the possibility that they will contaminate groundwater aquifers, is enhanced.

The restoration of groundwater quality AFTER in-situ leaching has proven to be very difficult, often, the groundwater quality BEFORE mining cannot be restored., as shown in some examples.

Additional information:
www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6870/

NRC identifies irregularities with groundwater restoration at Mine Unit B of Cameco's Highland in situ leach uranium mine; Cameco pursues request for relaxed standards

"By letter dated June 26, 2009, Cameco submitted its Mine Unit B Ground Water Restoration Report for NRC approval. The report contained supporting data and related historical documentation leading to approval of the restoration by the Wyoming Department of Environmental Quality (WDEQ) between 2004 and 2008.
During the acceptance review, staff observed that one monitor well appeared to remain on excursion status at the completion of groundwater restoration. Additionally, the staff identified that there appeared to be pumping activities at several perimeter and overlying monitor wells during the stability monitoring period that were not fully described in the report. By letter dated September 29, 2009, the staff did not accept it for a detailed technical review. Since that time, Cameco has re-evaluated the groundwater restoration data for Mine Unit B and has decided to pursue a request for alternate concentration limits (ACLs) in this mine unit to accompany the revised report."

http://www.wise-uranium.org/udusail.html

Cogema seeks approval for groundwater restoration at Christensen Ranch in-situ leach site - with uranium levels still up to 27 times the target restoration value and up to 128 times the drinking water standard

By letter dated June 8, 2010, NRC notified current mine owner Uranium One Inc. that it has determined that corrective action is required regarding the excursion observed at monitoring well 5MW66.

On March 5, 2008, Cogema Mining Inc. submitted the Wellfield restoration report for Mine Units 2-6 of its Christensen Ranch uranium in-situ leach mine in Wyoming.
Constituents that exceeded Target Restoration Values (TRVs) and either WDEQ or EPA standards in at least one Mine Unit were iron (Fe), manganese (Mn), selenium (Se), total dissolved solids (TDS), uranium (U) and radium-226 (Ra-226). The uranium values are listed below.

According to Cogema, groundwater within the production zone has been restored to the pre-mining *class of use* and the groundwater restoration meets the requirements for unconditional restoration approval by WDEQ and NRC.

http://www.wise-uranium.org/udusail.html

USGS presents study of groundwater restoration at uranium in-situ leach mines in south Texas

In Texas, 27 mines were developed by construction of 77 well fields, termed Production Authorization Areas (PAAs). Only 22 PAAs from 13 mines have final sample values. These 22 PAAs form the basis of the USGS study of restoration at these well fields.

- **All PAAs in Texas have received amended restoration goals for at least one element** after operators have expended a reasonable degree of effort to restore groundwater, as determined by TCEQ regulators, following established guidelines.
- The USEPA-established maximum contaminant level (MCL) for uranium in drinking water is 0.03 milligram per liter. Ninety-five percent of Texas PAAs have a baseline value above MCL. Eighty-six percent of Texas PAAs show a final restoration above MCL. In **68 percent of PAAs, final value exceeded baseline for uranium**.
- The MCL for selenium is 0.05 milligram per liter in drinking water. In 18 percent of PAAs, baseline of groundwater was above MCL, and in 24 percent of PAAs, the final restoration value was above MCL. After mining and restoration, **55 percent of PAAs exceeded baseline for selenium**.
- It was observed that **no well field** for which final sample results were found in TCEQ records **returned *every* element to baseline**. However, two PAAs returned all elements for which USEPA has established MCLs to baseline.
- In Texas, after ISR mining ceased and restoration of the well fields was completed, PAAs were monitored for a minimum of 6 months.

Some well fields monitored for longer periods of time during the post-mining and post remediation stability period **show trends of increasing analyte concentration**, as noted by USGS geologists while examining records at pilot projects in Colorado (Grover), New Mexico (Crown Point), and throughout Wyoming.

http://www.wise-uranium.org/udusail.html

A study published by the U.S. Geological Survey in 2009 found that *"To date, no remediation of an ISR operation in the United States has successfully returned the aquifer to baseline conditions."* [Otton 2009]

http://www.wise-uranium.org/uisl.html#RECLAMPROJ

Thus, in-situ leaching is by no means more "environmentally friendly" - it moves the problems from a more visible area to the deep underground - which makes it even more difficult to survey any irregularities, accidents, leakages etc. since nobody can really see what is happening underground.

Conclusion

- **It is obviously virtually impossible to dispose of the huge amounts of radioactive and toxic wastes generated by uranium mining in a "safe" way, i.e. in a way acceptable for the environment and the health and well-being of humans now and of future generations.**

- **Thus, uranium mining cannot be recommended to any community, province, or state, since the legacy created is far beyond what can be managed.**

3. The Actual Performance of Uranium Mining Companies

Mining uranium and, more specifically, dealing with the wastes, is a serious issue.
Uranium mining companies, Governments prone to mine the mineral believed to be "valuable" try to argue that uranium mining can be done safely and the aftermath might be "manageable".

In many cases, reality is different.

Some examples may show the real situation, the list of examples could be continued nearly "ad infinitum".

a. History of Uranium Mining - a Brief Recall

After the first artificial nuclear fission had been performed (in 1938), it soon became obvious to scientists - and then to politicians and military - that massive explosions could be performed by an uncontrolled chain reaction of nuclear fission - and the material needed for this is Uranium (U-235).

Thus, uranium was first - and for many years exclusively - mined for military purposes. Often, a high degree of secrecy was applied to these operations. Protection of the environment and of health of workers (miners, millworkers) was neglected since uranium mining was considered a matter of "national security".

To date, the uranium industry is a rather secret industry. For ex., European consumers of partially nuclear generated electricity do not know where the uranium used in European nuclear power plants is coming from, and Governments and companies conceal the origins of uranium.

In addition, cleaning up mine sites after mine closure was not a matter of concern; in many cases, companies went bankrupt or dissolved after the deposit(s) they had exploited had been mined out - thus leaving behind a enormous number of abandoned mine sites.

These mine sites are, in very many cases, not rehabilitated or dealt with in any way; they continue to contaminate the environment; if clean-up measures have been started, they are normally initiated and paid for by Government agencies, i.e. by taxpayers' money.

b. Example: Canada

(1) Saskatchewan: Gunnar and Lorado Mine

Gunnar mine was shut down in 1964, with no or little decommissioning and no reclamation of tailings done.
In 2002 - 38 years later - a report (published by SERM) indicated severe problems of ongoing contamination from the abandoned 37 (!) uranium mine sites in Northern Saskatchewan (Uranium City area).

www.wise-uranium.org/udcdn.html

2002/3

New report shows abandoned uranium mines a concern in northern Saskatchewan

A 170-page report on abandoned mines in northern Saskatchewan, released by the province on Sep. 24, 2002, states that many of the sites pose "severe public safety hazards and possible long-term environmental concerns."

The report says "unconfined tailings deposits" from the abandoned Gunnar uranium mine, amounting to 4.4-million tonnes, have made their way into Lake Athabasca since the operation was shut down in 1964.

The report entitled 'An Assessment of Abandoned Mines in Northern Saskatchewan', also raises serious concerns about the Lorado Mill site, about eight kilometres south of Uranium City. The mill was used to treat uranium ore from the Lorado mine and smaller satellite mines in the region. It says tailings at the site, which cover an area of about 14 hectares, are leaching into two nearby lakes. A 1976 study showed that discharges of waste into Nero Lake had severely affected water quality. (Canadian Press, September 24, 2002)

Another 3 years later, in 2005, a dispute is reported between the Government of the Province of Saskatchewan and the Federal Government of Canada in regard to which level of Government shall pay for the considerable costs of reclamation.
Still, no reclamation work had been done.

In 2007, 43 years after closure, the first phase of cleanup is announced to start.

www.wise-uranium.org/udcdn.html

Government of Canada and Province of Saskatchewan launch first phase of cleanup of legacy uranium mines

On April 2, 2007, Canada's New Government and the Province of Saskatchewan announced the first phase of the cleanup of Saskatchewan's abandoned uranium mine sites. The total cost, which the Governments of Canada and Saskatchewan will share, will be $24.6 million. The clean-up project is the result of an agreement between the Governments of Canada and Saskatchewan to address the issue of "Cold War legacy mines," which were small, short-term mining operations conducted in the 1950s and 1960s primarily in the vicinity of Uranium City in northern Saskatchewan.

More information:
www.policyalternatives.ca/sites/default/files/uploads/publications/Saskatchewan%20Office/2013/07/SK notes_Govt_Legacy_Contamination_Watersheds.pdf

The CNSC - Canadian Nuclear Safety Commission - confirms that "Gvt's of Canada and Saskatchewan are "responsible" for the cost of the cleanup"

http://nuclearsafety.gc.ca/eng/waste/uranium-mines-and-millswaste/index.cfm#Northwest

Gunnar and Lorado

The Saskatchewan Research Council holds the decommissioning licence for the Gunnar and Lorado sites. Both sites have yet to be fully decommissioned.

Private-sector companies that no longer exist operated these facilities from the 1950s until the early 1960s.
The governments of Canada and Saskatchewan are responsible for the cost of the cleanup.

Results

- **It took over 40 years to start reclamation work on Gunnar (and Lorado) uranium mine sites**
- **Reclamation will be paid for by the Province of Saskatchewan and the Federal Government of Canada; in any cases, it is always taxpayers' money.**

- **Other mines in Northern Saskatchewan have experienced a similar fate; details may be different, but the common denominator is:**
  - NO reclamation done by the company
  - approx. 40 years no reclamation work has been done, i.e. tailings contaminated area for a prolonged period of time

- **The profits from uranium exploitation have been internalized by the owners and shareholders of the (former) uranium mining companies, whereas the costs of reclamation are externalized.**

(2) ONTARIO - ELLIOT LAKE

Another uranium mine site not reclaimed is located in Ontario, in / around Elliot Lake.

www.miningwatch.ca/elliot-lake-uranium-mines

Uranium Tailings in Elliot Lake

from: NUCLEAR AWARENESS NEWS WINTER 1993/1994

The majority of uranium tailings in Canada -- about 200 million tonnes -- are located in Elliot Lake. However, neither the federal or provincial governments can confirm exact locations and quantities. There are about 60 million tonnes of tailings at Rio Algom's Quirke and Panel mines, and about 70 million tonnes at Denison's Stanrock and Denison mines. In addition, Rio's Stanleigh mine is still operating in Elliot Lake until 1996 and has produced over 15 million tonnes of tailings. Former Rio Algom mines in the Elliot Lake area include Nordic, Lacnor, Spanish American and Pronto. There are also a number of areas where tailings have spilled accidentally over the years. The Agnew Lake site near Espanola, while not in the Elliot Lake basin, also has an impact on the regional environment.

c. Example: France

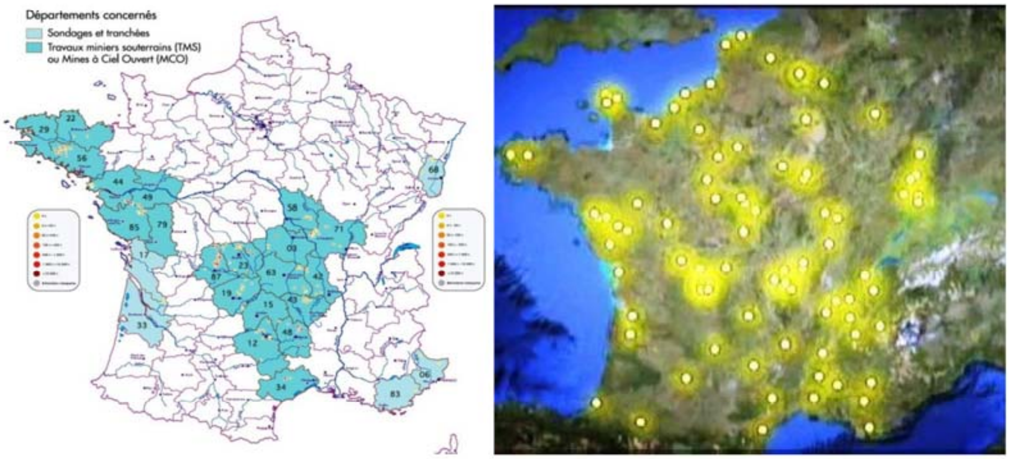
In France, state-owned company COGEMA (now called AREVA) mined uranium throughout the country, for 56 years, from 1945 - 2001.
210 uranium mines were spread in a variety of 'departments' in France (see map on the left, green areas indicate 'departments' with uranium mining); they left approximately 300 million tons of radioactive (and toxic) wastes.

The reclamation work - if done at all - has been performed in a very superficial way. Radioactive waste rock has been used to built parking lots, to pave roads and new housings have been located on the top of old tailings.

The negligent reclamation of AREVA's French uranium mines was documented by France3-series "Pieces a Conviction": "***Uranium - Le Scandale de la France contaminee***" (11. February 2009)

see:
www.sortirdunucleaire.org/Mines-d-uranium-le-scandale-de-la
or on youtube: www.youtube.com/watch?v=S9HbgGAv-84

The station later reported that the show had the highest number of e-mail, call-ins etc. ever.



Screenshots from the Documentary "Uranium - Le Scandale de la France contaminee"

CRIIRAD - Commission de Recherche et d'Information Indépendantes sur la Radioactivité, Valence, France, has taken the measurements of radioactivity for the documentary. CRIIRAD also published a report on this issue: "L'impact radiologique de 50 années d'extraction de l'uranium en France" (www.criirad.org/actualites/uraniumfrance/Synthese_PDF/francais.pdf)

Result

An industrialized and densely populated country like France has not been willing or not been able to take care of the wastes of uranium adequately.

d. Example: GABON (and Niger)

French state-owned uranium mining company COGEMA (now named AREVA) was mining uranium in France's former colony, Gabon.

The Gabon NGO BRAINFOREST published a documentation "Impacts de l'exploitation minière sur les populations locales et l'environnement dans le Haut-Ogooué, Landry LEBAS, Août 2010" (www.uranium-network.org/images/pdf-Gabon/Gabon1.pdf)

from: "Impacts de l'exploitation minière sur les populations locales et l'environnement dans le Haut-Ogooué, Landry LEBAS, Août 2010"

La réhabilitation

Suite à la fermeture de la mine, Areva a dû procéder à la réhabilitation des sites afin de réduire les impacts sur l'environnement et les populations.
Ce réaménagement a été mené à partir de 1997 à Mounana et a bénéficié de financements européens à travers le programme SYSMIN (plus de 10 millions d'euro, soit plus de 6,5 milliards de FCFA).
Pourquoi est-ce le SYSMIN, financé par l'Union Européenne, qui a dû payer l'étude à la place de la COMUF ? (le principe de Pollueur-Payeur apparait pourtant dans l'Acte unique européen)
Les travaux réalisés jusqu'en 2004 furent jugés satisfaisants par l'AIEA (Agence Internationale de l'Energie Atomique).

(...)

La COMUF a ainsi mis en place ces zones de restriction d'usage (pêche, trempage du manioc, cueillette, baignade) pour révenir la population.
Les zones de restriction se trouvent à proximité immédiate des zones d'activité des populations locales comme les plantations et la pêche. Les restrictions d'usage ne sont donc pas respectées.
Le documentaire de Dominique Hennequin « Uranium, l'héritage empoisonné » (2009) montrait ainsi que les femmes trempaient leur manioc dans la rivière Mitembe en aval de la Ngamaboungou **dont les eaux présentent un niveau radiologique élevé.**

www.uranium-network.org/images/pdf-Gabon/Gabon1.pdf

A study by the European Union says ("both countries" refers to Gabon AND Niger):

The assessment indicates that substantial problems and negligence exist in both countries with respect to the operation of the uranium mines, the safety of mines and local citizens.
It also criticises a lack of transparency regarding company's data on radioactive pollution and, in one case, claims that radioactive materials have been used for construction and that water sources and soil around the mining villages have been affected.

DIRECTORATE-GENERAL FOR EXTERNAL POLICIES OF THE UNION, DIRECTORATE B, POLICY DEPARTMENT, STUDY: POTENTIAL USE OF RADIOACTIVELY CONTAMINATED MINING MATERIALS
IN THE CONSTRUCTION OF RESIDENTIAL HOMES FROM OPEN PIT URANIUM MINES IN GABON AND NIGER
(EXPO/B/DEVE/FWC/2009-01/Lot05-07 November/ 2010, PE 433.662 EN)

Additional information:
www.youtube.com/watch?v=iw-igDQh8kY
www.youtube.com/watch?v=xUfe-yYJnow
www.youtube.com/watch?v=kaN5LlbwpK4

Results

- **Some remediation work has been done by COMUF, the local 100% subsidiary of COGEMA / AREVA in Gabon, but it is unsatisfying in the context of the local people, their habits and their needs.**
- **A major part of the reclamation work has been funded by the European Union - i.e. by taxpayers money, not by COMUF or COGEMA / AREVA.**

e. Example: NAMIBIA

Uranium has been mined in Namibia since 1976: Rössing Uranium Ltd, owned by Rio Tinto, and others (now including the the Governemt of Namibia)

When uranium mining started in 1976, Namibia was still a territory more or less occupied by South Africa. Uranium mining was done in violation of UN Resolution https://wikispooks.com/wiki/R%C3%B6ssing_Uranium_Mine

On some readings of international law, the Rössing operation was illegal right from the start since apartheid South Africa was continuing to occupy Namibia in defiance of UN Security Council Resolution 435.
The UN had formally ended South Africa's mandate to govern the territory in 1966 by transferring that mandate to the newly created UN Council for Namibia (UNCN) pending the country's independence, and demanded the immediate withdrawal of South African troops.
(...)

In 1974 the UNCN issued Decree № 1, which prohibited the extraction and distribution of any natural resource from Namibian territory without the UNCN's explicit permission, provided for the seizure of any illegally exported material, and warned that violators could be held liable for damages.

After independence of Namibia was achieved in 1990, Rössing continued to mine uranium.
Workers complained about diseases and treatment of miners who had fallen sick.

In 2008, LaRRI - Labour Resource and Research Institute, Windhoek, Namibia, investigated the situation of uranium miners and millworkers and published a report:
"***URANIUM MINING IN NAMIBIA - The mystery behind 'low level radiation***"
(www.uranium-network.org/images/pdfs_namibia/Uranium_mining_in_Namibia-LARRY.pdf)

In 2013, more research into the situation was done by two EJOLT-Studies:
"***Radiological Impact of Rössing Rio Tinto Uranium Mine, EJOLT Report April, 2014, Contributions by Bruno Chareyron***"
(www.criirad.org/mines-uranium/namibie/radiological-impactofriotintorossing-CRIIRAD-EJOLT.pdf)

"Study on low-level radiation of Rio Tinto's Rössing Uranium mine workers EJOLT Report April, 2014"
(www.criirad.org/mines-uranium/namibie/riotinto-rossing-workers-EARTHLIFE-LARRI-EJOLT.pdf)

Results

- **The health and general situation of some uranium miners and mill workers is precarious.**
- **Contamination has spread from the tailings into the surroundings, contaminating groundwater aquifers.**
- **Reclamation: There are no plans for reclamation of the mine site**
  (personal communication from Rössing during a visit in 2009 to the mine)

f. Example: NIGER

Uranium has been mined in Niger, in two mines, since the 1968, by two subsidiaries of COGEMA (now named AREVA), in the region of Arlit at the southern rim of the Sahara desert.

The mining activities - still going on - left to date approx. 35 million tons of radioactive waste under open sky, with no reclamation or security measures.

Groundwater aquifers / wells have been contaminated, soil - and thus crops from gardens - are contaminated through dust blown from uncovered tailings, the air carries radioactive dust which is easily blown from the (uncovered) tailings in the arid area of the Sahara desert.

Local workers and inhabitants of the mining towns of Arlit and Akokan sought help from CRIIRAD which did first measurements of radioactivity in 2003 and issued a report on the situation:

"Compte rendu de mission a ALRKIT /NIGER du 3 au 11 decembre 2003 - Mission exploratoire en vue de la realisation d'une expertise independante de l'impact radiologique des mines d'uranium SOMAIR et COMINAK. filiales de COGEMA"
(www.criirad.org/actualites/communiques/niger/notecriiradfinal.pdf)

The report showed that the concentration of uranium in some drinking water wells (only a few could be surveyed) was clearly above WHO standards. the soil was contaminated as well as the air.

Workers reported "strange diseases", workers died prematurely, but the company-owned hospitals have no doctors employed icensed to diagnose occupational diseases.

More scientific research was done by CRIIRAD on the radiologicla situation:
"Remarques sur la situation radiologique dans l'environnement des sites miniers uranifères exploités par SOMAÏR et COMINAK (filiale s d'AREVA) au Nord du NIGER Rapport CRIIRAD N°10-09)"
(www.criirad.org/actualites/dossiers2005/niger/greenpeace/niger_greenpeace_%20synthese.pdf)

More information available via CRIIRAD'S site:
www.criirad.org/actualites/dossiers2005/niger/somniger.html

A more general report - including the scientific findings of CRRIRAD was published by GRENPEACE:
" Left in the dust - AREVA's radioactive legacy in the desert towns of Niger" (4 May, 2010)

English version: www.greenpeace.org/international/en/publications/reports/Left-in-the-dust/
French version: "Abandonnés dans la poussière - L'héritage radioactif d'AREVA dans les villes du désert nigérien"
www.greenpeace.org/international/Global/international/publications/nuclear/2010/LeftinthedustF.pdf

Results

- **The reports published state serious problems of radioactive contamination,**
- **There are serious concerns about the health of workers.**

g. Example: UNITED STATES of AMERICA

Uranium mining in the US has left hundreds, if not thousands of uranium mine sites; most of them are unreclaimed and pose a serious radiation risk for the environment and people.

The US Government started programs to clean up some of the mine sites.
Addressing all of them is far beyond the space available here.

Some examples illustrate the magnitude of the problem; some reclamation work has been done, much more remains to be done. In many cases, the reclamation work is paid for by the Government, i.e. by taxpayers money.

Uranium-mine cleanup on Navajo Reservation could take 100 years
Decades after the uranium mines and mills served their purpose, hundreds remain as health threats, many with no clear path to cleanup.
Brandon Loomis, The Republic | azcentral.com

Likewise, the federal purse isn't up to the task. The entire budget for 2008-12 reservation cleanups was only $110 million, less than what it will eventually cost to clean up just these two mines.

"This whole thing is huge," Lane said. "It's homes. It's mines. It's our old dump site in Tuba City."

America's legacy of uranium extraction and toxic abandonment remains a bitter betrayal to Navajos here, on their reservation's eastern side, and across thousands of square miles through northern Arizona to Cameron on the west. Decades after the mines and mills served their purpose, hundreds remain as health threats, many with no clear path to cleanup.

Some mines left heaps of radioactive waste that sloughs or blows toward homes. Others were pits that have since been bulldozed over with a temporary soil covering. Still others were shafts that have been plugged but may still contaminate groundwater.
(...)
The U.S. Department of Justice this spring announced a $5.15 billion settlement for nationwide environmental cleanups — the largest in U.S. history. It included about $1 billion to clean up 49 mine sites on Navajo lands, with $87 million to remove the Quivira waste. The settlement from Anadarko Petroleum Co. covers hazards left by Kerr-McGee Corp., which Anadarko purchased in 2006.

Anadarko officials did not respond to requests for comment.

The Northeast Church Rock pile across the road, owned by General Electric since its acquisition of United Nuclear Corp., will cost $44 million to move up the road to an existing tailings dump on private land nearer the spired sandstone tower that gives Church Rock its name. Hundreds of thousands of cubic yards will roll out on trucks from each.

http://www.azcentral.com/longform/news/arizona/investigations/**2014/08/06**/uranium-mining-navajo-reservation-cleanup-radioactive-waste/13680399/

The clean up funded by now is only the "tip of the iceberg": Thousands of abandoned uranium mine sites, some sources speak of 10.000 sites, have been identified, and need to be cleaned up-

Uranium Mine Clean-up Movement Claims Victory, Vows to Go National

By Talli Nauman | 5 / June / 2014

More than 10,000 abandoned uranium mines have been identified across the United States, primarily in the West, and more than 10 million people live within a 50-mile radius of one, they said.

According to the draft report to the U.S. Congress, the six states that have the most abandoned uranium mines within their boundaries are Arizona (416), Colorado (1,347), New Mexico (249), South Dakota (155), Utah (1,376), and Wyoming (319).

www.cipamericas.org/archives/12256

Environmental activists and Native American (First Nations) people started a common campaign to push for a clean up of the abandoned sites.

More information: see attachment
http://www.cleanupthemines.org/facts/

Another example from the US is the clan-up of the Moab mine tailings. The original cost estimate (by the company) was 10 Million US $, today, the costs are estimated at 1 billion US $ (as work in progressing).

h. Example: GERMANY

Germany spent approx 7. Billion € on the reclamation of uranium mine tailings form former East Germany / Russian uranium mining company SDAG Wismut.

(More detailed info will be provided in English)

i. Example: KYRGYZSTAN

Uranium has been mined in Kyrgyzstan and adjacent countries for the USSR nuclear weapons program; the tailings have been left behind unreclaimed, unmarked and unsecured; they pose a serious health and environmental hazard.

Kyrgyzstan does not have the means to deal with these challenges. a UN High-Level Forum was held in 2009 (in Geneva, Switzerland).

The Forum resulted in a Joint Declaration of Central Asia countries to donor community, international organizations and private sector for financial support.

(www.un.org.kg/un-in-kyrgyzstan/what-we-do/article/233-what-un-does/en/news-center/news-releases/article/65-news-center/3556-the-high-level-international-forum-uranium-tailings-local-problems-regional-consequences-global-solution-took-place-in-geneva-on-29-june-2009)

Result

- **The companies and / or states responsible for uranium mining are not willing and / or not able to take responsibility for the reclamation of former uranium mine site.**
  In this case, 'the international community' is approached to fund the costs of reclamation.

- **So far, no reclamation work has been done in Kyrgysztan**
  (personal communication from a NGO representative at the "Uranium Mining and Hydrogeology"-conference in Freiberg, Germany, Sept. 2014)

Conclusion

- **The uranium industry has a track record of uranium mining and milling sites not being "cleaned up" at all or not reclaimed in an acceptable way.**

- **In many cases, IF reclamation is done, it is initiated by Governments - often after being pressurized by citizens' groups. Costs are paid for by Government agencies - i.e. by taxpayers' money. The "polluter pays"-principle is abandoned, reclamation costs, again, are externalized.**

- **In view of these facts, it cannot be recommended to any community, province or state to exploit uranium.**

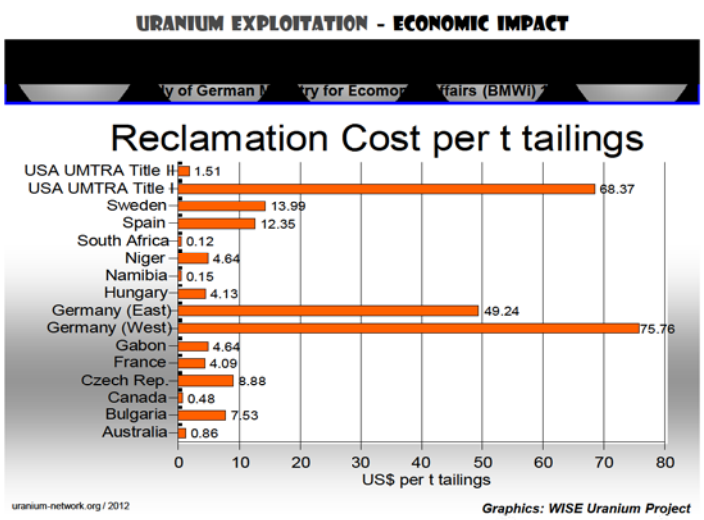
4. Economics of Uranium Mining and Reclamation of 'Tailings'

Uranium mining companies like to emphasize the economic benefits which would come from their activities, for the state / province via taxes and royalties etc., and for the people in the area via jobs and income generated.

Conveniently, the downside is not mentioned: the costs of rehabilitation / reclamation of uranium mining sites.

Two studies on the costs for reclamation, one by the German Ministry for Economic Affairs, 1995 ("Kosten der Stillegung und Sanierung von Urangewinnungsprojekten im internationalen Vergleich") and a joint study by the IAEA and OECD ("Environmental Remediation of Uranium Production Facilities" Joint Report by the OECD Nuclear Energy Agency and the IAEA).

The results of the German BMWi-Study are shown in the following graph:



The joint OECD-IAEA-study arrives at similar conclusions.

(see: "Uranium Mining - Impact on Health & Environment, published by Rosa-Luxembeurg-Foundation, Dar es Salaam, 2013, page 46)
www.rosalux.de/fileadmin/rls_uploads/pdfs/sonst_publikationen/Uranium_Mining_Impact.pdf

The author has calculated tailings management costs, on occasion, for uranium mine projects (planned in Tanzania) adapted to 2013 costs, as follows:

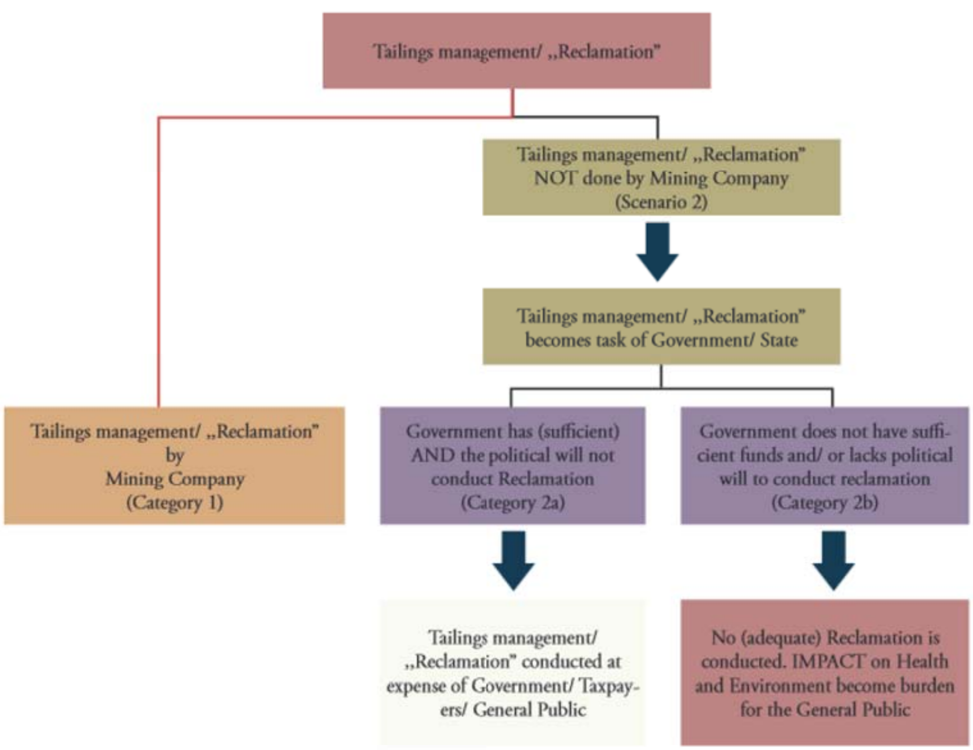
Tailings Management Costs				
		Per Ton Tailings		
From Uranium Exploitation "only"		1993 Costs		2013 Costs
Estimate B:	Average calculated by German BMWI- Study	4.00 US$	(+)	4.88 US$
Estimate C:	Average based on all cost data available	15.76 US$	(x)	19.23 US$
Estimate D:	Average of Minimum and Maximum	37.94 US$	(x)	46.29 US$
Estimate A is disregarded since it deals with mines where uranium had been mined as a by-product of copper or gold mining- which is not relevant for Tanzania.				
(+) Original German BMWI - Study of 1995 (x) Calculations made by the author, based on German BMWI - Study				

(Source: "Uranium Mining - Impact on Health & Environment", published by Rosa-Luxembeurg-Foundation, Dar es Salaam, 2013, page 46)

In face of the millions of tons of ore mined and nearly the same amount of tailings generated (due to the very low concentraotion of uranium in the ore / rock), the costs of reclamation of mine sites amounts to many millions, easily reaching amounts of several billions of $$$ or €€€.

The factual costs of, for example, the Moab clean-up, the reclamation of (former East-) German uranium mines etc. confirm these figures.

Secondly, in many cases, as shown on Chapter 2, companies often do not clean up the tailings, and governments are left to take on the huge and costly task of reclamation work (Graph: Case 2a).



Conclusion

- **From an economic point of view, the benefits of uranium mining in terms of taxes, royalties and income for jobs generated through mining, need to be weighed against the costs of reclamation of uranium mining sites. the costs of reclamation may outweigh the benefits.**

- **Laws and regulations may require a company to clean up - however, experience shows that often companies dissolve before fulfilling this task, and the state, province or community is left with the aftermath of mining. Yearly cash deposits for the estimated reclamation costs may lower that risk.**

5. Final Conclusion and Recommendation

Uranium mining poses serious and long-term risks to the environment, to the health and well-being of people, workers as well as people in the vicinity of the mines.

Due to the long half-lives of uranium and of some of the decay products of uranium, the wastes will be hazardous for many generations to come, in human terms, for ever.

These factual problems are exacerbated by the performance of uranium mining activities, especially by the uranium mining companies: the uranium industry is a prime example for internalizing profits and externalizing costs for reclamation, for compensation of health of workers etc. on the general public, i.e. on the taxpayer.

The costs of reclamation of mining sites are very high, and may easily outweigh the financial benefits (via taxes and royalties etc.) for state or provincial governments, leaving governments with high financial burdens - and / or communities to deal with the environmental and health damages caused by the mining activities.

In face of these facts and these experiences, uranium mining cannot be recommended to any community, province or state.

We therefore recommend to the Government of Quebec to implement a permanent moratorium on Uranium exploration.

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October 2014

www.cleanupthemines.org/facts/

ABANDONED URANIUM MINES FACTS

There are more than 10,000 abandoned uranium mines (AUMs) in 15 western states. (1)
The true number, location, existing hazard, and off-site migration potential for toxic and radioactive materials from these sites have not yet been adequately determined.

10 million people are estimated to live within 50 miles of a recorded AUM. (2),
That's about 1 in 7 people in the western US.

75% of AUMs are located on federal and tribal lands.
Most of those locations are found in Colorado, Utah, New Mexico, Arizona, and Wyoming. (1)
There are 3,272 abandoned uranium mines and prospects located in just five states; Montana, Wyoming, North Dakota, South Dakota, and Colorado. 169 AUMs are located 40 miles southwest of Mount Rushmore in the Black Hills. (3) More than 1,200 AUMs have been documented on Navajo Reservation. (4)

No existing federal laws require clean up of these hazardous sites.
The US Environmental Protection Agency states, "Unlike the uranium mill tailings cleanup program, there is no specific legislation to address abandoned uranium mines." (5) Most of these AUMs were established under the "General Mining Law of 1872," that does not require reclamation or remediation. (6)

Corporations walk away while the public pays.
Mining companies walked away from their clean up responsibilities after decades of mining, leaving the public to bear their toxic legacy. The costs for clean-up of these abandoned sites have been moved from the past uranium mining operators onto the general taxpayers, as have the public health and environmental costs of these toxic sites.

AUMs remain dangerously radioactive for hundreds of thousands of years.
99 percent or more of the rock extracted from a mine can wind up in the remaining pulverized rock debris, also known as tailings. That waste retains 85 percent of the radioactivity of the original underground deposit. (7) Quantities of radium and radon gas, which are potent human carcinogens(8), given off by AUMs will have diminished by only one-half in 80,000 years. (9) After about 1 million years, carcinogenic effects are limited to the continuous decay of thorium-230 in residual uranium which releases toxic alpha and gamma radiation. Both are dangerous and deadly to all living beings. (10)

AUMs pose greater public health threats the longer they are left abandoned.
Long-term public use of an area, such as recreation, ranching, & Indigenous religious practice, means greater exposure to radioactive waste. Some long-term issues include toxins and radioactivity leaking from tailings piles and containment areas and animals eating contaminated vegetation. AUM waste has also been used for house construction (11), creating significant radon and radiation hazards to humans.

AUMs pose an 'invisible threat.'
Uranium radioactivity poses a hazard that cannot be smelled or tasted because radioactive dust looks just like regular dust. Without proper scientific instruments it is nearly impossible

to identify a health threat. People who live near AUMs may drink from contaminated wells. Fields may also become contaminated, impacting livestock. (12) When uranium decays, it releases radon, an odorless gas that trails only tobacco as a cause of lung cancer in the United States. (13)

There is no dose of radiation that is considered to be harmless.

There is no minimum threshold for radiation damage (no dose which is harmless). (14) Radioactivity from AUMs can cause cancer and other organ damage, especially during fetal development and in young children. Higher incidence rates of childhood leukemia, respiratory disease and kidney disease have been recorded in areas near uranium mine sites. Uranium in drinking water has been associated with increases in kidney disease. (15) Chronic exposure to radium in humans by inhalation has resulted in the death of blood cells, tissues and organs. Chronic exposure to radon in humans and animals via inhalation has resulted in respiratory, while animal studies have also reported effects on the blood and a decrease in body weights. (16) (17)

Contaminated water that enters municipal water supplies can threaten the health of large numbers of people.

Due to uranium contamination in the Colorado River, the drinking water supply for half of the population of the Western U.S. may already be radioactive. (18) Mining near the Colorado River, which flows through the Grand Canyon, threatens the drinking water supplies of millions of people in cities like Phoenix, Los Angeles, and Las Vegas. (19) Samples from 15 springs and 5 wells in the Grand Canyon exhibited dissolved uranium concentrations greater than the Environmental Protection Agency maximum for drinking water. (20)

Toxic, radioactive substances from AUMs take the form of dust which travels with the wind for hundreds of miles.

Alpha and beta radiation—particles emitted from atomic nuclei—can cause severe damage to cells if they are released from within the body, which can happen after a person drinks contaminated water or inhales contaminated dust. If inhaled, that dust can increase the risk of lung cancer; it can also blow into streams or onto nearby ground, spreading radioactive contamination. (21)

Presentation at the BAPE Hearings: Uranium Mining and its Impacts

by Gunter Wippel, Germany

uranium-network.org

with information and graphs from:

wise – World Information Service on Energy – Uranium Project

In memoriam

Adele RATT

Cree from LaRonge, Saskatchewan, Canada

passed away 4th of August 2014

1. Uranium, Properties

1. Uranium - its Properties

Uranium and its decay products

Uranium NEVER occurs alone.

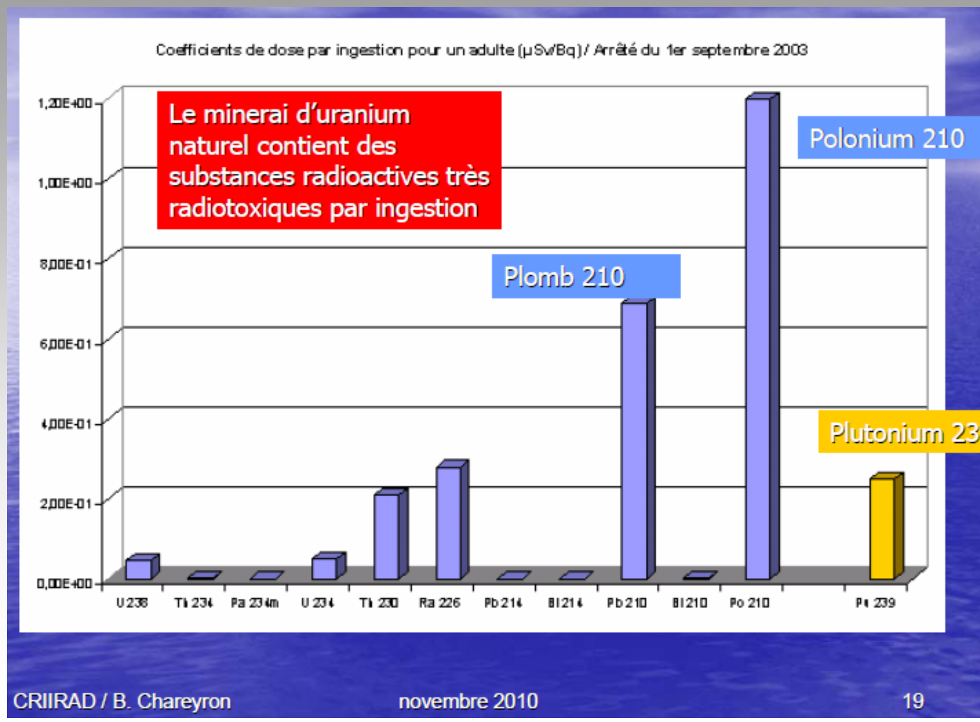
It is ALWAYS accompanied by its decay products.

ALL of the decay products are radioactive themselves.

Many are also toxic (poisonous).

Radionuclide		Mode of decay	Half-life
Uranium-238	^{238}U	α	**4.5 billion years**
Thorium-234	^{234}Th	β	24 days
Protactinium-234	^{234}Pa	β	6.7 hours
Uranium-234	^{234}U	α	**245.500 years**
Thorium-230	^{230}Th	α	**77.000 years**
Radium-226	^{226}Ra	α	**1.600 years**
Radon-222	^{222}Rn	α	3.85 days
Polonium-218	^{218}Po	α	3 minutes
Lead-214	^{214}Pb	β	27 minutes
Bismuth-214	^{214}Bi	β	20 minutes
Polonium-214	^{214}Po	α	164 micro-seconds
Lead-210	^{210}Pb	β	22 years
Bismuth-210	^{210}Bi	β	5 days
Polonium-210	^{210}Po	α	238 days
Lead-206	^{206}Pb		stable

Uranium ore IS harmful



2. Factual Problems with Uranium Exploitation

Conflicts about Land Use, Land Ownership

- Local communities and First Nations / indigenous people not informed
- Right to Free, Prior and Informed Consent (FPIC) in many cases violated
- Right to self-determination threatened / violated (UN Covenant on Economic, Social and Cultural Rights)

***for example*: Mali**

Falea, Southwest Mali

A Uranium mine in Falea would not only destroy the village, the agricultural land, the sacred places, the cultural heritage, a unique and rich wildlife and fauna (plants) , but it would also destroy this source of life, the groundwater aquifers.

www.falea21.org

Impacts of Extraction of Uranium

Natural situation

- Uranium is contained in rock, underground
- Low concentrations: 0,1% - 0,01%
- LOW risk for health and environment

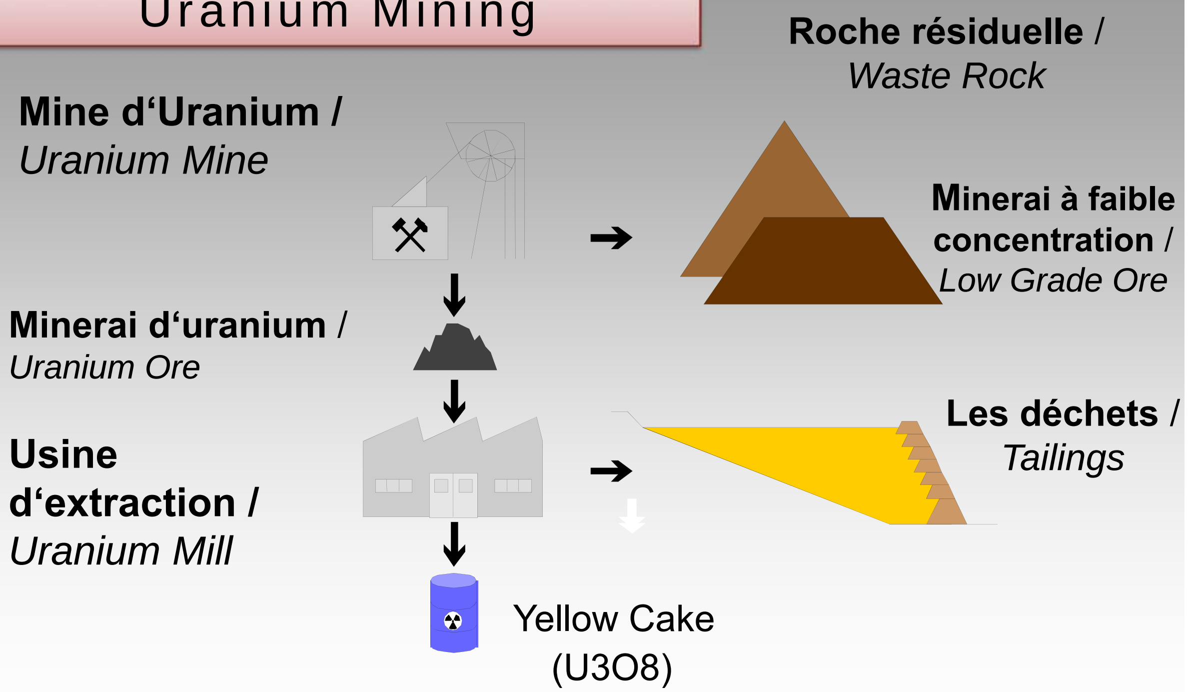
***Exploitation / Extraction of Uranium*:**

- **Ore is grounded to sand**
- **Uranium (U-235, U-238) is extracted chemically**
  - → **through sulphur acid and other chemicals**
  - → **extraction uses big quanitities of water**
  - → **extraction uses big quantities of energy (electricity)**

Radiologic situation is changed irreversibly

Uranium and decay products can disperse easily into the environment: Air, water, soil → Wildlife and livestock, plants and crops,→ Human beings → Impact on Health

Uranium Mining



The „Tailings“ – Specific Problems

- **Radioactivity**
  Tailings contain approx. 85% of the original radioactivity of the ore
  (due to the decay products of uranium)
- **Longevity**
  Some decay products have very long half lifes, tailings will stay radioactive „forever“ (hundreds of thousands of years)
- **Mass of Tailings**
  Tailings will be 100 to 10.000 times the amount of the uranium extracted
- **‚Cocktail‘ of approx. 25 decay products**
  All of them are radioactive, some of them are also toxic (poisonous)
- **Toxicity of other substances**
  Tailings also contain other poisonous substances (for ex. heavy metals

Longevity of decay products

Uranium-238 half life 4,5 billion years
Uranium-234 half life 234.000 years
Thorium-230 half life 77.000 years
Radium-226 half life 1.590 years
etc.

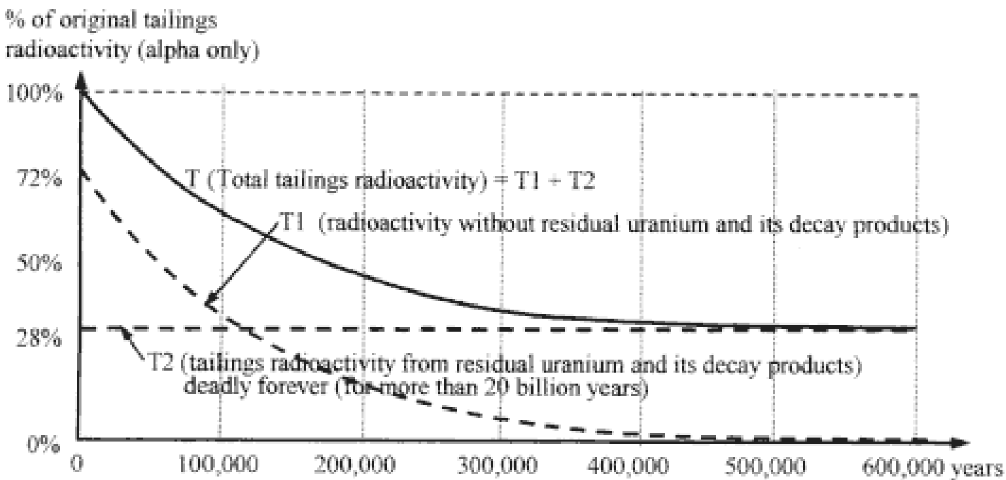


Fig.3: The Roxby tailings radioactivity (residual uranium in tailings: 23% of the ore's uranium)

2. Factual Problems with Uranium Exploitation

Longevity of decay products

- **Tailings will stay radioactive for VERY long periods of time / in human perspective: „forever"**
- **Tailings need to be stored SAFELY – isolated from the environment**

→No *PROVEN METHOD* available to store material safely for thousands of years

The cheap way out:

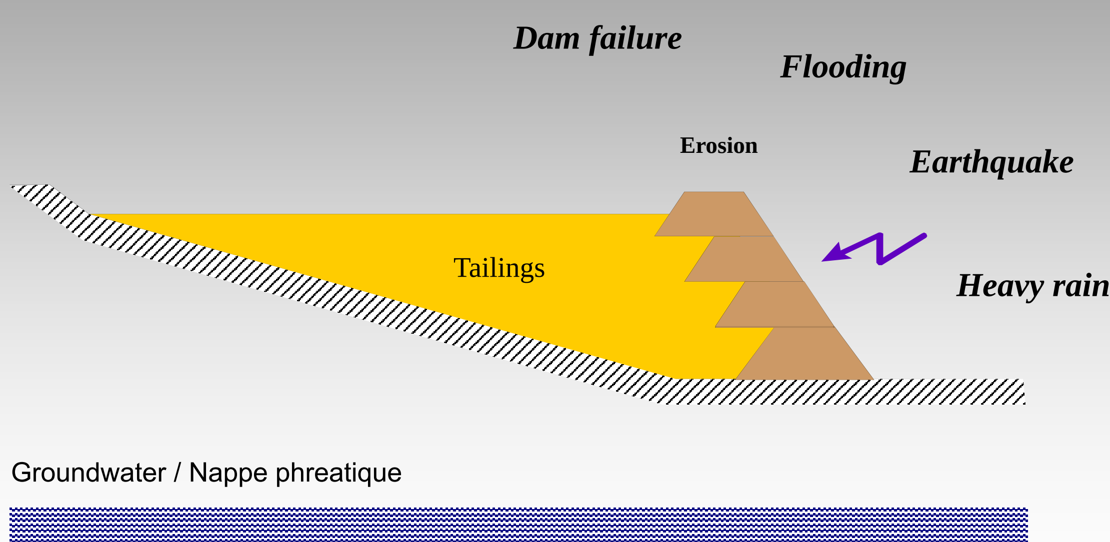
Laws and regulations often require only 100 or 200 years tailings stabililty …

Quantity / Mass of Tailings

- **Concentration of uranium in the ore / soil**
  at 1 %: 1 t Uranium → 99 t waste / tailings
  at 0.1 %: 1 t Uranium → 999 t waste / ‚tailings'
  at 0.01 %: 1 t Uranium → 9.999 t waste / ‚tailings'
- **Tailings**
  - **partially solid →**
  - **partially liquid / slurry → to be stored in „ponds" / behind dams etc.**

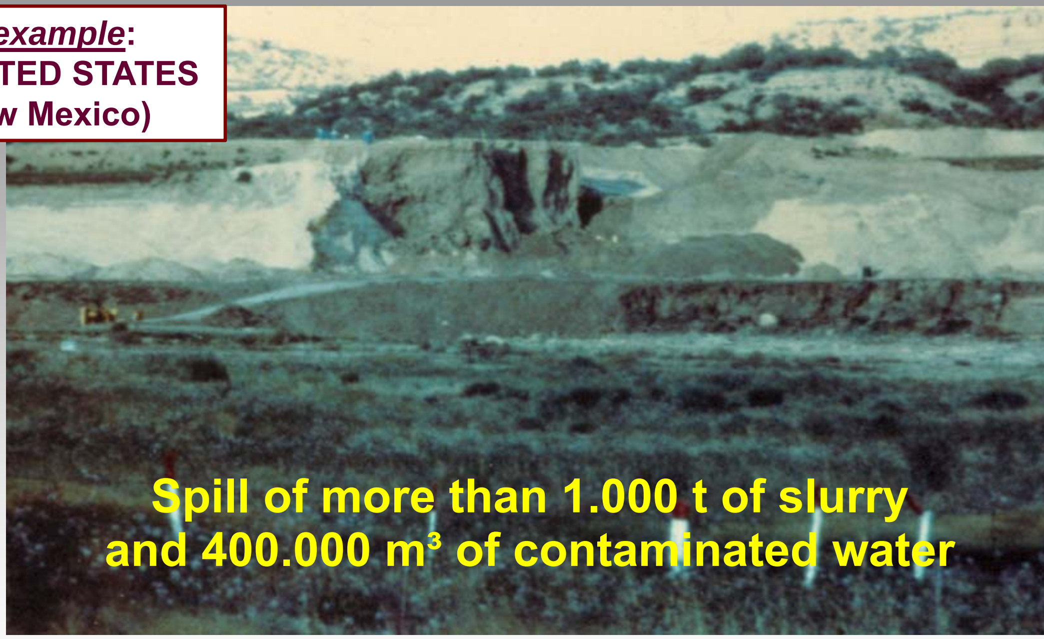
2. Factual Problems with Uranium Exploitation

Failure / breaking of Tailings dam



Graphics: WISE Uranium Project

for example:
UNITED STATES
(New Mexico)



Church Rock tailings dam failure,
New Mexico, USA, July 16, 1979

for example:
FRANCE
Malvesi, March 2004

How Often Do They Fail?

An extensive 2001 study [PDF] by the International Commission of Large Dams and the **United Nations Environmental Programme** found that, on average, **one major tailings dam incident occurs each year**, although that figure doubled between 1995 to 2001.

Most of the failures were a result of issues with water balance, construction and a general lack of understanding about how the dams work, according to the study. There were also failures caused by "unpredictable" climate and geological events, such as floods and earthquakes, though the report makes clear that "it can be argued that with today's knowledge, allowance should have been made for these events."

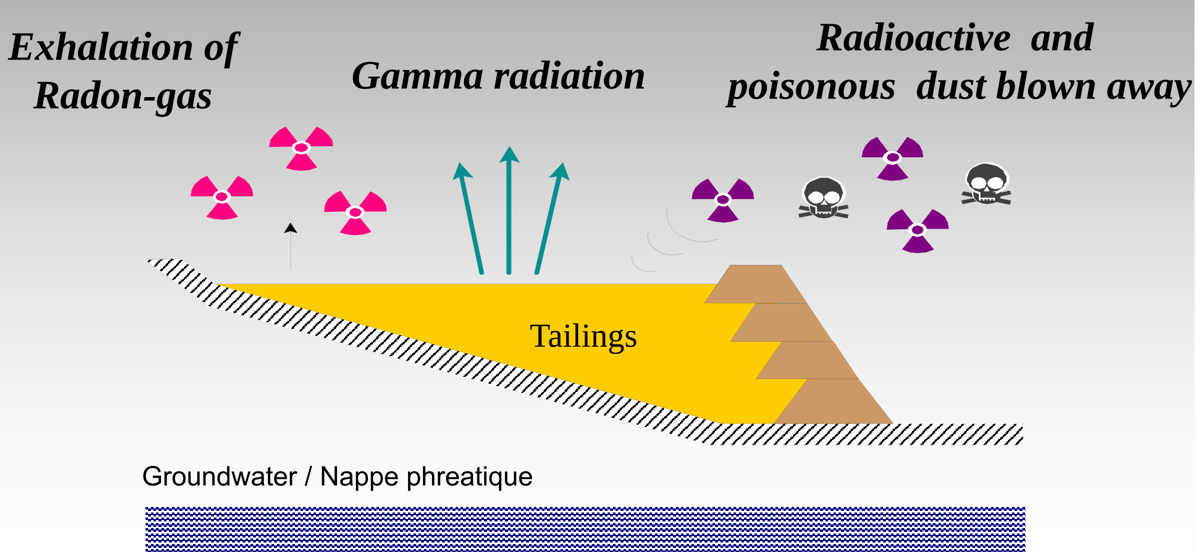
Heavy rain can also pose problems. "The most common failure mechanism is related to hydrologic events — that is large storms that basically overwhelm the storm retaining capacities that the dam was designed for," Chambers told FRONTLINE.

A 2002 paper [PDF] by Michael P. Davies found an increase in failures in the early 2000s matched only by statistics from the early to mid-1930s. "**There's quite a long list of recent tailings dam failures of dams that were built with modern technology,**" said Ron Cohen, a professor at the Colorado School of Mines.

from: http://www.pbs.org/wgbh/pages/frontline/environment/alaska-gold/tailings-dams-where-mining-waste-is-stored-forever/

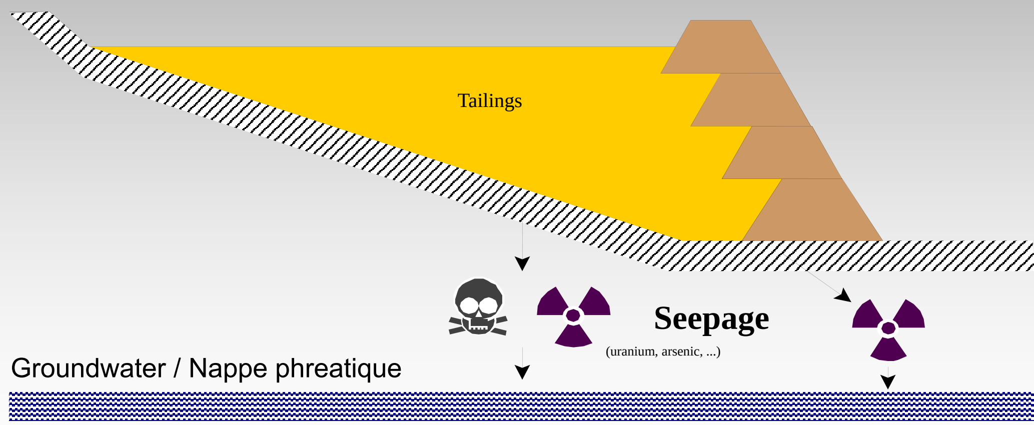
Emission of Radon gas (Radon-222)

Radioactive and toxic dust blown away by wind



Graphics: WISE Uranium Project

Radioactive and toxic substances seep into the water, contaminate aquifer



Graphics: WISE Uranium Project

In-situ leaching (ISL)

- Called „environmentally friendly“ by companies
- Not correct:
- **Similar problems, the „tailings“ remain underground unseen, but radionuclides and heavy metals are mobilized the same way**
- **it is much harder to survey the situation underground**

A study published by the U.S. Geological Survey in 2009 found that

"To date, no remediation of an ISR operation in the United States has successfully returned the aquifer to baseline conditions."
[Otton 2009]

http://www.wise-uranium.org/uisl.html#RECLAMPROJ

Health Impacts of Uranium / U mining (1)

Acknowledged Impacts

- Lung cancer (mainly from inhalation of radon gas)
- Diseases of the kidney (mainly from ingestion)
- Respiratory Diseases (mainly from inhalation)

Possible / Probable Impacts

- U and decay products can cause „all solid cancers"
- Diseases of the blood / Leukemia
- Cancer of Kidneys
- Mental disorders
- Spontanous Abortions, Malformations with children
- Lymphoma
- Myeloma etc.

Health Impacts of Uranium / U mining (2)

Not well researched

- ❖ Changes in the DNA, will be passed on from generation to generation and may lead to malformations etc.
- ❖ Synergetic effects of the impact of several decay products on humans, synergetic effect or toxicity and radioactivity

People living in the vicinity of mines / tailings have multiple exposures to radiation via air, food, drinking water, probably ɣ-radiation

Impacts on Health of Workers / Miners

for example: NIGER

Asked whether she knew of similar disease cases among Nigerien workers at the mines, she (Peggy Venel) said:

„Hundreds of Nigerien people have died of all types of cancer, but their cases are extremely difficult to document."

***Venel said that whenever consulted by the ill uranium mine workers,* Areva doctors would always diagnose AIDS related causes or other diseases but never cancer.**

"Until today, Areva doctors deny any causal link between the working conditions in the mines, the radioactivity, and the numerous cases of cancer among the workers."

from: Lack of Data on Causes of Death Buffers French Company, IPS, 122. April 2010
by Julio Godoy (http://ipsnews.net/news.asp?idnews=51149)

3. Actual Performance of Uranium Mining Companies (selected examples)

***for example*: CANADA, Northern Saskatchewan**

2002 / 2003 Report: 37 abandoned Uranium mines in Sask.

for example: →Gunnar Mine
→operated from 1955 – 1963, closed 1964
→NO reclamation

Reclamation

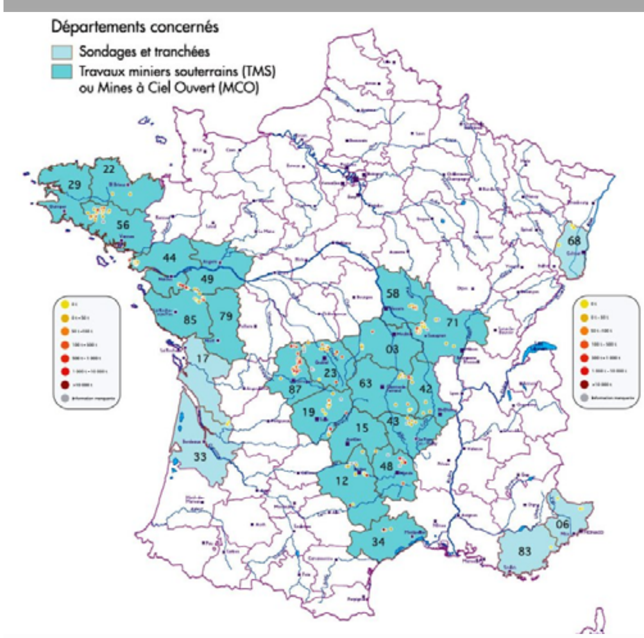
- 2007: 43 years later first steps of reclamation are announced
- „Clean-up“ of Northern Saskatchwan abandoned uranium mine sites is paid for by Gvt. of Canada and Saskatchewan
- Costs for Gunnar Mine clean-up est‘d. 24.7 Million Can$

from: http://www.nrcan.gc.ca/evaluation/reports/2012/790

3. Actual Performance of U mining companies

***for example*: FRANCE**

Uranium Mining 1945 – 2001



210 Uranium Mines

300 million tons of radioactive tailings

Reclamation … ?

uranium-network.org / 2014

for example: FRANCE / 2

Uranium Mining 1945 – 2001

- **Reclamation of tailings is grosly insufficient**
- **Exposed in a France3-documentary:**
  ***„Uranium - Le Scandale de la France contaminee"* (11. Febr. 2009)**
- **Measurements of radioactivity by CRIIRAD, documented in:**

« L'impact radiologique de 50 années d'extraction de l'uranium en France »

www.criirad.org/actualites/uraniumfrance/Synthese_PDF/francais.pdf

for example: GABON and NIGER

Gabon: 1971 – 1975

COMUF dumped 2 Mio t radioactive tailings into a local creek

***for example*:**
GABON and NIGER

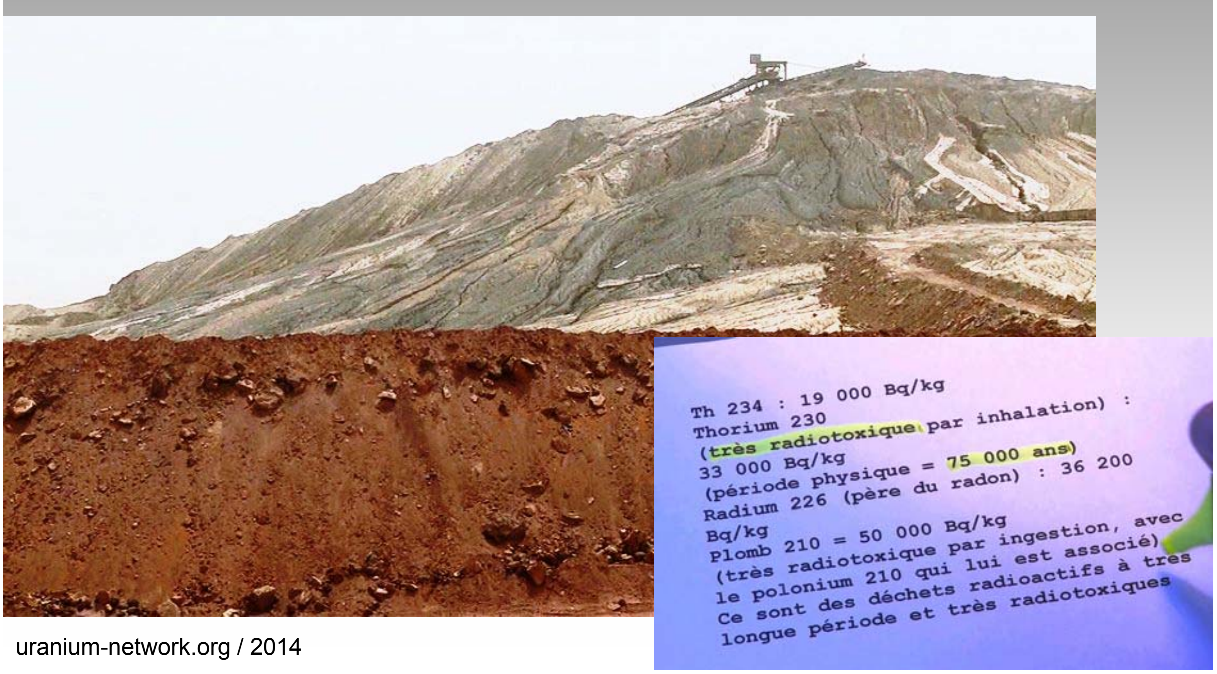
Study by the European Union, 2010

„The assessment indicates that **substantial problems and negligence exist in both countries with respect to the operation of the uranium mines, the safety of mines and local citizens.**
It also criticises a **lack of transparency regarding company's data on radioactive pollution and**, in one case, **claims that radioactive materials have been used for construction and that water sources and soil around the mining villages have been affected.**"

from:
DIRECTORATE-GENERAL FOR EXTERNAL POLICIES OF THE UNION
DIRECTORATE B, POLICY DEPARTMENT, STUDY:
POTENTIAL USE OF RADIOACTIVELY CONTAMINATED MINING MATERIALS IN THE CONSTRUCTION OF RESIDENTIAL HOMES FROM OPEN PIT URANIUM MINES IN GABON AND NIGER
EXPO/B/DEVE/FWC/2009-01/Lot05-07 November/ 2010, PE 433.662 EN

***for example*:**
NIGER

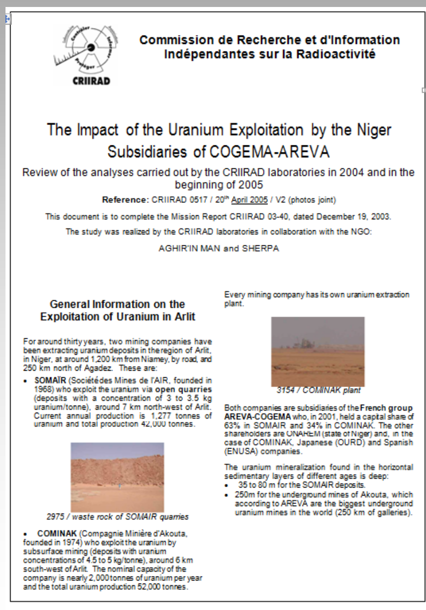
Uranium Mining since 1968: 35 million tons of radioactive tailings unreclaimed, unsecured …


Th 234 : 19 000 Bq/kg
Thorium 230
(très radiotoxique par inhalation) :
33 000 Bq/kg
(période physique = 75 000 ans)
Radium 226 (père du radon) : 36 200
Bq/kg
Plomb 210 = 50 000 Bq/kg
(très radiotoxique par ingestion, avec le polonium 210 qui lui est associé)
Ce sont des déchets radioactifs à très longue période et très radiotoxiques

3. Actual Performance of U mining companies

for example: **NIGER / 2**

CRIIRAD 2004 / 2005


Commission de Recherche et d'Information Indépendantes sur la Radioactivité

CRIIRAD

The Impact of the Uranium Exploitation by the Niger Subsidiaries of COGEMA-AREVA

Review of the analyses carried out by the CRIIRAD laboratories in 2004 and in the beginning of 2005

Reference: CRIIRAD 0517 / 20th April 2005 / V2 (photos joint)

This document is to complete the Mission Report CRIIRAD 03-40, dated December 19, 2003.

The study was realized by the CRIIRAD laboratories in collaboration with the NGO:

AGHIR'IN MAN and SHERPA

General Information on the Exploitation of Uranium in Arlit

For around thirty years, two mining companies have been extracting uranium deposits in the region of Arlit, in Niger, at around 1,200 km from Niamey, by road, and 250 km north of Agadez. These are:

- **SOMAÏR** (Sociétédes Mines de l'AIR, founded in 1968) who exploit the uranium via **open quarries** (deposits with a concentration of 3 to 3.5 kg uranium/tonne), around 7 km north-west of Arlit. Current annual production is 1,277 tonnes of uranium and total production 42,000 tonnes.

2975 / waste rock of SOMAIR quarries

- **COMINAK** (Compagnie Minière d'Akouta, founded in 1974) who exploit the uranium by subsurface mining (deposits with uranium concentrations of 4.5 to 5 kg/tonne), around 6 km south-west of Arlit. The nominal capacity of the company is nearly 2,000 tonnes of uranium per year and the total uranium production 52,000 tonnes.

Every mining company has its own uranium extraction plant.

3154 / COMINAK plant

Both companies are subsidiaries of the **French group AREVA-COGEMA** who, in 2001, held a capital share of 63% in SOMAIR and 34% in COMINAK. The other shareholders are ONAREM (state of Niger) and, in the case of COMINAK, Japanese (OURD) and Spanish (ENUSA) companies.

The uranium mineralization found in the horizontal sedimentary layers of different ages is deep:

- 35 to 80 m for the SOMAIR deposits.
- 250m for the underground mines of Akouta, which according to AREVA are the biggest underground uranium mines in the world (250 km of galleries).

Note CRIIRAD 0517 ARLIT V1

GREENPEACE, 2010

3. Actual Performance of U mining companies

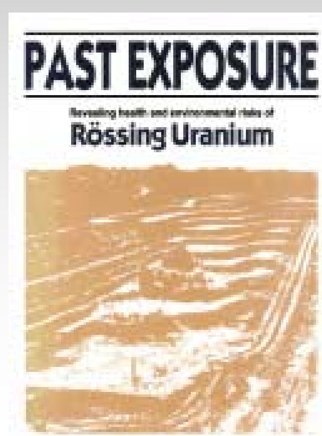
for example: **NIGER / 2**

for example: **NAMIBIA / 2**

from 1976 on: Uranium Mining by Rössing U Company, looked upon as illegal, under UN Security Council Resolution 435 and UNCN Decree No. 1

1992: Serious concerns re: health and social situation of workers, Study „Past Exposure …“ by Greg Dropkin and David Clark

late 1990ies: A court case is launched against Rio Tinto, majority owner of Rössing, unsuccessful



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3. Actual Performance of U mining companies

for example: **NAMIBIA / 3**

2009: Labour Research & Resource Institute (LaRRI) Study:

"URANIUM MINING IN NAMIBIA - The mystery behind 'low level radiation":

Serious concerns about health and social situation of workers are voiced

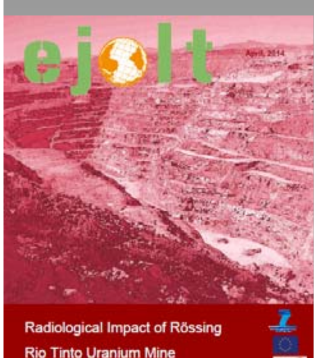
April 2014: EJOLT – Environmental Justice Organisations, Liabilities and Trade, publishes two reports:

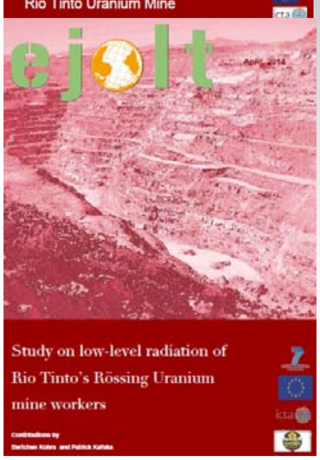
„Radiological Impact of Rössing Rio Tinto Uranium Mine"

and

„Study on low-level radiation of Rio Tinto's Rössing Uranium mine workers"

3. Actual Performance of U mining companies





for example: **NAMIBIA / 4**

Results (some extracts):

"The highest impact concerns the uranium concentration that increased by a factor of 2155, from 0.2 µg/l upstream to 431 µg/l downstream. WHO recommendation for uranium concentration limit in drinkable water is now 30 µg/l."

„The older workers all said they know miners dying of cancer and other diseases, mainly after retirement. These are workers started working in the mine in the 70s and early 80s when safety conditions were non-existing or very poor. (…) … many of these workers are by now retired and many have already died of cancer or unknown diseases:

"People get sick. We are seeing it in people that have worked for Rössing for a long time. They just go back and die after working for Rössing."

for example: UNITED STATES

"More than 10,000 abandoned uranium mines have been identified across the United States, primarily in the West, and more than 10 million people live within a 50-mile radius of one, they said.

According to the draft report to the U.S. Congress, the six states that have the most abandoned uranium mines within their boundaries are Arizona (416), Colorado (1,347), New Mexico (249), South Dakota (155), Utah (1,376), and Wyoming (319)."

from: http://www.cipamericas.org/archives/12256

http://www.cleanupthemines.org/resources/

for example: GERMANY …

Uranium Mining in East Germany (former GDR) 1945 - 1990

At reunification in 1990, West Germany (FRG) ‚inherited' mines and tailings of Soviet-East-German U mining company „SDAG Wismut"

- **Approx. 7.100 miners dead from lung cancer**
- **<u>Reclamation costs: approx. 7 billion €</u>**
- **Reclamation takes 20 years +**
  … not finished in 2014
- **Continuation of water treatment for time unknown**
- **Today, 20 yrs. after end of mining, 200 <u>new</u> cases of lung cancer/year**

(Study by BfS – Bundesamt für Strahlenschutz, German Federal Agency for Radiation Protection)

for example: GERMANY …

…current problems

2008 / 2009

Mice undermining stability of uranium mine waste rock pile in Saxony

After heavy rain, a section of the soil cover on Wismut's waste rock pile No. 366 in Aue (Saxony) slipped down. The 1 metre soil cover had been installed in 2001 and was meant to last for decades. It is assumed that burrowing mice have contributed to the problem. (Freie Presse Jan. 22, 2008)
The investigation concluded that the cover failure had been caused by heavy rain, in combination with tunnels burrowed by mice.
Meanwhile, another section of the cover began sliding down.
(Freie Presse Apr. 15, 2008)

2011

Wismut began the construction of a second deposit for the residues from its Ronneburg water treatment plant. The deposit with a capacity of 540,000 cubic metres will cover an area of 7.6 hectares. (Wismut GmbH Aug. 29, 2011)

for example: GERMANY …

…current problems

2013

Rising radon emissions from Wismut's reclaimed waste rock piles leading to public doses above 1 mSv/a target value. (…) the doses actually reach **3 - 5 mSv/a** in certain local areas.

July 2014

The decommissioning work is expected to be completed by 2020, while longterm maintenance and surveillance will have to continue for an indefinite period of time.
So far, 5.8 billion of the 6.6 billion Euros allocated by the government have been spent. It is expected that the total cost until 2040 will rise to EUR 7.1 billion. (Ostthüringer Zeitung July 15, 2014)

3.b. The „bad old times“ and the „good new times“ (selected example)

for example: „UraniumOne“ in South Africa

2006: Plans for Dominion Reef Uranium Mine, South Africa
Promise to build school, water pipeline for village etc.
Most positive future outlooks advertised: jobs, prosperity …an

2007: Capital costs expected to be 25% higher than planned, 70% cost overrun

2008: Production of U3O8 ist 32% less than planned

10. Oct: Company shuts down operation due to an „illegal strike“
ALL workers – approx. 1,400 persons – are fired

The national Congress of South African Trade Unions (COSATU) has reported at least 18 workers have died of work related causes over the past four years, and four women employees reported miscarriages in the past year. These concerns were further verified in 2007 when **government inspectors called on UraniumOne "to halt all mining operations" until minimum legal health and safety precautions could be met.**
(from: http://intercontinentalcry.org/uranium-company-accused-of-killing-communites-in-south-africa/)

22. Oct: UraniumOne closes Dominion Reef Uranium Mine

2010: Uranium One sells Dominion Reef Uranium Mine to „Shiva Uranium“
and leaves witgout any reclamation work done

for example: „Uranium One“ in South Africa

"Discussing the community's sense of dispossession, Tahlita, a community organizer from the local group 'Justice and Peace,' stated,

"We don't have electricity or water services, our houses are very cracked, and there are no jobs here. We want work, but we want our health also.

- **In the past, we had land for our children.
  Now we don't have anything.
  The mine has taken our land and contaminated our water.“**

"The trickle of water from the one functioning tap in the community has a distinct yellow tinge and sickening odour," Davis adds.

"Meanwhile, the suffocating effects of radioactive tailings dust blowing across the 14,000 hectare area leased by Uranium One are exacerbated during the frequent exploratory mine blasting being conducted by Uranium One's subcontractors.

Eye irritations and severe cases of asthma are common amongst children and adults and many have festering rashes discolouring their entire bodies."

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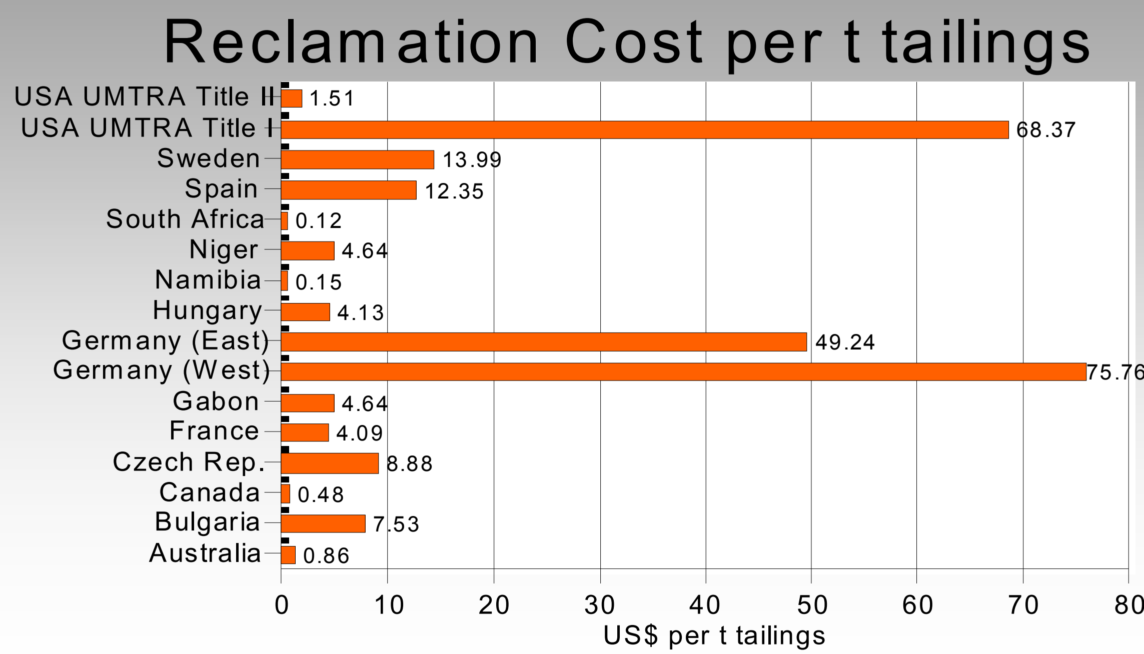
4. Economics of Uranium Mining and Reclamation of 'Tailings'

Reclamation costs of Uranium tailings by ton

Study by German Ministry for Ecomomic Affairs (BMWi) 1995



Graphics: WISE Uranium Project

Reclamation costs of Uranium tailings by ton

Study by German Ministry for Economic Affairs (BMWi), 1995

Reclamation Costs of Uranium Mine Tailings (per ton tailings)			
(adapted to inflation of 1 % / year)		1995	2013
			(at 1% Inflation / year)
Scenario 1	Uranium mining with Gold or Copper	2,20 USD	3,86 USD
Scenario 2	Uranium Mining	4,00 USD	4,88 USD
Scenario 3 a	Arithmetic Average of all Values	15,76 USD	19,23 USD
Scenario 3 b	Mean Value between Minimum and Maximum	37,97 USD	46,29 USD

Study by OECD and IAEA, 2002

/OCE-02/ quotes unit costs (without water treatment) for the decommissioning and remediation of uranium mines in a range from US$0.76 to US$16.9 per tonne of mined uranium ore or of **US$ 0.55 to US$ 13.62 per kg of uranium produced**, respectively.

Costs of decommissioning and remediation of mill plants (again without water treatment) are in the range from **US$ 3.1 to US$ 32.9 per kg of uranium**.

Inclusion of water treatment will push up costs between 10 and 50 %.

from: Environmental Remediation of Uranium Production Facilities, OECD, International Atomic Energy Agency (IAEA). Published by: OECD 2002

Reclamation costs of Uranium tailings

At low ore grades (0.1 – 0.01%) big quantities of tailings are generated, amounting to millions of tons of tailings

Costs for reclamation of these tailings are extremely high.

for example:

Germany

6 – 7 billion € for reclamation of uranium mine tailings

US

Moab U mine reclamation: costs of 1 billion US$

U.S. Department of Justice, spring 2014:
$5.15 billion settlement for nationwide environmental cleanups (…)
about $1 billion to clean up 49 mine sites on Navajo lands

→ The costs for clean-up of tailings may outweigh the 'profits' made via taxes, royalties etc.

for example: UNITED STATES (Moab U mine reclamation)

Budget of Company for Reclamation: US $ 10 Mio.

Estimated costs for reclamation on site: US $ 19 Mio.

Estimated costs for reclamation „off-site“: US $ 155 Mio.

Up-to-date Cost Estimation: US $ 1.000 Mio. (1billion)

Conclusions and Recommendation

1. The factual problems of U exploitation, especially the longevity and the huge quantities, make it virtually impossible to store the tailings „safely“.
→ Risks for many generations to come.

2. The track record of the uranium industry shows that many times it is not taking care of its aftermath;
→ the costs for tailings management are in many cases externalized, i.e. imposed on the general public.

3. Short-term economic benefits are in contrast to

a. the high expenses incurred by reclamation
b. the long-term risks imposed on future generations
c. the social costs of premature deaths of miners and people in the vicinty of the mines are not yet taken into account.

In regard of the environmental, health and economic issues,
we recommend a PERMANENT MORATORIUM on uranium exploration and exploitation.

...thank your for your attention!

uranium-network.org

http://www.wise-uranium.org/udcos.html

Costs of Uranium Mill Tailings Management

(last updated 22 Apr 2012)

Contents:

> see also: Unit Converter

Comparison on an International Basis

BMWi 1995

Kosten der Stillegung und Sanierung von Urangewinnungsprojekten im internationalen Vergleich - Einflußgrößen und Abhängigkeiten - Auszug aus dem Abschlußbericht zum Forschungsauftrag Nr.37/93, im Auftrag des Bundesministeriums für Wirtschaft durchgeführt von Uranerzbergbau GmbH, BMWi Studienreihe Nr.90, Bundesministerium für Wirtschaft, Bonn 1995 *[Comparison of Decommissioning and Cleanup Costs of Uranium Producing Projects on an International Basis; with summaries in English, French, Spanish, and Russian]*
"The 14 uranium producing countries investigated with regard to rehabilitation costs represent a cumulative uranium production until and including 1992 of approximately 1.14 million tonnes of uranium or nearly 3 billion pounds of uranium oxide (U_3O_8). This corresponds to approx. 63% of the entire cumulative world production of uranium. This production is accompanied by about 1,681 million tonnes of processing residues. 780 million tonnes thereof are related to plants which produced or still produce uranium as a by-product. The accumulated and estimated costs for the decommissioning and rehabilitation of the uranium-producing plants referred to in this study amount to about US$ 3.7 billion (cost basis: 1993). The resulting specific rehabilitation costs are US$ 1.25 per lb of U_3O_8 and US$ 2.20 per tonne of tailings. Omitting plants which produce/produced uranium as by-product of gold and copper production, the specific cost per tonne of milling doubles to nearly US$ 4.00.

These cost values are, however, indicative only because the specific costs for different projects and countries vary widely: They range from a minimum of US$ 0.12 per lb of U_3O_8 (Canada) and US$ 0.12 per tonne of tailings (South Africa), to a maximum of approximately

US$ 40 per lb of U_3O_8 (Sweden) and US$ 68 per tonne of tailings (UMTRA Title I Program, USA).

This large range indicates that costs depend on numerous factors having different effects." [...]

Decommissioning and Cleanup Costs of Uranium Producing Projects					
Country	**Production t U (incl.1992)**	**Tailings million t**	**Total Cost million US$ (1993)**	**Specific Cost**	
				US$/t tailings	**US$/lb U3O8**
Australia, total	54,225	98.7	85.10	0.86	0.60
(f)	49,625	18.7	63.30	3.39	0.49
Bulgaria	(d) 21,871	23.0	173.10	7.53	3.04
Canada	257,702	160.6	77.10	0.48	0.12
Czech Republic	(d) 101,901	48.8	433.33	8.88	1.64
France	70,038	31.4	128.45	4.09	0.71
Gabon	21,446	6.5	30.13	4.64	0.54
Germany, total	218,463				
West	650	0.2	15.15	75.76	8.97
East	217,813	160.0	7,878.79	49.24	13.91
Hungary	19,970	19.0	78.40	4.13	1.51
Namibia	53,074	350.0	53.20	0.15	0.39
Niger	56,845	17.2	79.87	4.64	0.54
South Africa	143,305	700.0	81.97	0.12	0.22
Spain	1,145	1.2	14.82	12.35	4.98
Sweden	200	1.5	20.98	13.99	40.35
USA, total	(e) 310,000	222.9	2,428.96	10.90	3.01
UMTRA Title I	56,000	31.3	2,140.00	68.37	14.70
UMTRA Title II	254,000	191.6	288.96	1.51	0.44
SUBTOTAL (a)		901.0	3,596.79	3.99	
SUBTOTAL (b)		780.0	103.74	0.13	
TOTAL	1,141,276	1,681.0	3,700.53	2.20	(c) 1.25

Notes:
(a) from plants where uranium is the only product
(b) from plants where uranium is a by-product of gold and copper production
(c) weighted average
(d) including production from in-situ leaching
(e) excluding non-conventional production (ISL etc.)
(f) without Olympic Dam

NEA/IAEA 2002

Environmental Remediation of Uranium Production Facilities, ISBN 92-64-19509-2,
OECD NEA / IAEA, Paris, Feb 2002, 328 p.
> View full book online (Google books)

> See: Chapter 9. Costs and Funding (p. 103 - 120)

USA: Decommissioning Costs for Title II Sites

Location and Status of Uranium Mills at the End of 1996 (map - US DOE IDB97)

Status of Conventional Uranium Mill Sites at the End of 1996 (table - US DOE IDB97)

Estimated Decommissioning Costs for Conventional Uranium Production Facilities (a) as of January 1, 1994 (Thousand Dollars)

Name	Mill Dismantling Costs	Tailings Reclamation Costs	Groundwater Restoration Costs	Indirect Costs	Total Decommiss. Costs
Ambrosia Lake, NM	1,432	12,485	1,183	4,293	19,393
Bear Creek, WY	628	6,635	2,559	2,974	12,796
Cañon City, CO	944	8,123	3,238	530	12,835
Church Rock, NM	709	3,574	2,180	2,134	8,597
Ford, WA	1,000	5,500	5,750	2,500	14,750
Gas Hills (ANC), WY (b)	400	4,800	200	2,000	7,400
Gas Hills (UMETCO), WY	996	8,500	3,735	3,826	17,057
Grants, NM	1,654	6,593	9,972	5,073	23,292
Highland, WY	2,500	5,600	600	900	9,600
L-Bar, NM	709	10,456	729	3,492	15,386
Lisbon, UT	600	5,400	1,600	1,500	9,100
Lucky Mc, WY	565	3,983	2,390	2,253	9,191
Panna Maria, TX	609	5,221	1,700	2,401	9,931

Ray Point, TX	500	1,800	500	1,300	4,100
Shirley Basin, WY	1,094	3,017	603	1,697	6,411
Split Rock, WY	800	10,000	3,614	11,500	25,914
Sweetwater, WY	581	2,776	275	1,426	5,058
Uravan, CO	944	26,751	3,142	7,442	38,279
White Mesa, UT	654	14,656	(c) 0	4,345	19,655
Total	17,319	145,870	43,970	61,586	268,745
Average	912	7,677	2,314	3,241	14,144

Notes:
(a) The following sites did not have complete data and are excluded from this table: Bluewater, Edgemont, Falls City, Moab, Petrotomics, Sherwood, and Shootering.
(b) American Nuclear Corporation.
(c) White Mesa reported "0" for groundwater restoration costs. These costs may have been included under another category. All facilities have at least some groundwater restoration costs.
Source:
Decommissioning of U.S. Uranium Production Facilities. U.S. DOE Energy Information Administration, Report No. DOE/EIA-0592, February 1995.
Available by FTP- Download (681k, PDF format).

Mill Tailings Reclamation Summary as of January 1, 1994								
Mill (a)	**Tailings Area (Acre)**	**Tailings Tonnages (Thousand Tons)**	**Tailings Reclamation Costs (b) (Thousand Dollars)**	**Total Decommiss. Costs (b) (Thousand Dollars)**	**Tailings Cost (b) per Ton (Dollars)**	**Total Decommiss. Costs (b) per Ton (Dollars)**	**Tailings Cost (b) per Acre (Dollars)**	**Tailings Tons per Acre**
Ambrosia Lake, NM	328	33,180	12,485	19,393	0.38	0.58	38,064	101,159
Bear Creek, WY	150	4,740	6,635	12,796	1.40	2.70	44,233	31,600
Cañon City, CO	165	2,315	8,123	(b) 12,835	3.51	5.54	49,230	14,030
Church Rock, NM	100	3,527	3,574	8,597	1.01	2.44	35,740	35,270
Ford, WA	133	3,086	5,500	14,750	1.78	4.78	41,353	23,203
Gas Hills (ANC), WY (c)	117	5,842	4,800	7,400	0.82	1.27	41,026	49,932
Gas Hills	146	8,047	8,500	17,057	1.06	2.12	58,219	55,116

(UMETCO), WY								
Grants, NM	215	22,377	6,593	23,292	0.29	1.04	30,665	104,079
Highland, WY	290	11,354	5,600	9,600	0.49	0.85	19,310	39,152
L-Bar, NM	115	2,094	10,456	15,386	4.99	7.35	90,922	18,209
Lisbon, UT	35	3,858	5,400	9,100	1.40	2.36	154,286	110,229
Lucky Mc, WY	248	11,685	3,983	9,191	0.34	0.79	16,060	47,117
Panna Maria, TX	250	6,504	5,221	9,931	0.80	1.55	20,884	26,016
Ray Point, TX	45	441	1,800	4,100	4.08	9.30	40,000	9,800
Shirley Basin, WY	263	8,157	3,017	6,411	0.37	0.80	11,471	31,015
Split Rock, WY	167	7,716	10,000	25,914	1.30	3.36	59,880	46,204
Sweetwater, WY	300	2,315	2,776	5,058	1.20	2.18	9,253	7,717
Uravan, CO	85	10,472	26,751	38,279	2.55	2.66	314,718	123,200
White Mesa, UT	333	3,527	14,656	19,655	4.16	5.57	44,012	10,592
Total	3,485	151,237	145,870	268,745				
Average	183	7,960	7,677	14,144	0.97	1.78	41,857	43,397

Notes:
(a) The following sites did not have complete data and are excluded from this table: Bluewater, Edgemont, Falls City, Moab, Petrotomics, Sherwood, and Shootering.
(b) All costs are estimated.
(c) American Nuclear Corporation.
Note: Totals may not equal sum of components because of independent rounding.
1 acre = 4046.8 m^2
1 (short) ton = 907.185 kg

Source:
Decommissioning of U.S. Uranium Production Facilities. U.S. DOE Energy Information Administration, Report No. DOE/EIA-0592, February 1995.
Available by FTP- Download (681k, PDF format).

Title X of the Energy Policy Act of 1992: Uranium/Thorium Reimbursement Program
Federal Reimbursement for Costs of Remedial Action at Active Uranium and Thorium Processing Sites

Status of Payments through Fiscal Year 2001 and Estimated Future Payments - Uranium (dollars in thousands) - excerpt -				
Licensee	**Site**	**Federal reimbur-sement ratio** [e]	**Total Payments FY 1994 - FY 2001**	**Estimated Payments: FY 2001 through End of Program.** [b]
- American Nuclear Corporation	Gas Hills, WY	0.365	807	20
- State of Wyoming			1,218	626
Atlantic Richfield Company	Bluewater, NM	0.370	32,306	0
Atlas Corporation/Moab Mill Reclamation Trust. [d]	Moab, UT	0.561	8,903	789
Cotter Corporation	Cañon City, CO	0.143	2,391	736
Dawn Mining Company	Ford, WA	0.378	3,124	4,740
Homestake Mining Company	Grants, NM	0.512	35,540	17,410
Pathfinder Mines Corporation	Lucky Mc, WY	0.243	7,532	1,167
Petrotomics Company	Shirley Basin, WY	0.115	2,392	516
Quivira Mining Company	Ambrosia Lake, NM	0.302	14,249	6,844
Tennessee Valley Authority	Edgemont, SD	0.813	12,334	3,795
Umetco Minerals Corporation	Uravan, CO	0.543	43,270	13,313
	East Gas Hills, WY	0.263	13,568	7,305
Western Nuclear, Incorporated	Split Rock, WY	0.435	27,521	4,177
Sub-total, Uranium		0.552	205,155	61,438

[b] These amounts are estimates of future claims provided by the licensees in early 2001.
[d] Effective December 30, 1999, the Nuclear Regulatory Commission transferred the license from the Atlas Corporation to a newly created trust approved by a bankruptcy court. In FY 2000 and FY 2001, Title X payments were made to the trust. The license was terminated and DOE assumed title to the site in October 2001. The current trust is expected to be dissolved in early CY 2002, and a new trust will be formed and will be eligible for reimbursement of the remaining claim amount that is scheduled for approval in April 2002. That will be the final Title X liability for the Moab site.
[e] the portion of costs of remedial action attributable to byproduct material generated as an incident of sales to the United States

Sources:
FY 2003 Congressional Budget, Environmental Management/Uranium Facilities Maintenance and Remediation Appropriation Language (132k PDF)

Federal Register: May 23, 1994: 10 CFR Part 765, Reimbursement for Costs of Remedial Action at Active Uranium and Thorium Processing Sites; Final Rule and Notice

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USA: Costs for UMTRA Project (Title I Sites)

U.S. Uranium Production Facilities: Operating History and Remediation Cost Under Uranium Mill Tailings Remedial Action Project as of 2000, U.S. DOE Energy Information Administration, August 2001

- Summary Table: Uranium Ore Processed, Disposal Cell Material, and Cost for Remediation as of December 31, 1999

Locations and Status of UMTRAP sites (map - US DOE IDB97)

Estimated cost and cancer deaths prevented by the UMTRA project based on FY98 federal UMTRA budget					
Site	**Tailings [million t] [a]**	**Cleanup cost [US$ million]**	**Specific cost [US$/t tailings]**	**Deaths prevented in 100 years**	**Cost per death prevented in 100 years [US$ million]**
Grand Junction, CO	4.2	256.3	61	588	0.44
Salt Lake City, UT	3.3	75.0	23	313	0.24
Rifle, CO	3.8	94.9	25	40	2.4
Durango, CO	3.1	63.1	20	22	2.8
Canonsburg, PA	0.32	35.8	112	15.0	2.4
Gunnison, CO	1.0	63.2	63	6.5	9.7
Riverton, WY	2.2	45.6	21	5.6	8.1
Falls City, TX	6.7	56.7	8.5	2.3	25
Shiprock, NM	3.4	22.9	6.7	2.0	11
Tuba City, AZ	2.0	34.9	17	1.9	18
Mexican Hat, UT	3.1	53.2	17	1.3	41

Naturita, CO	0.7	59.8	85	0.91	66
Lakeview, OR	1.2	32.6	27	0.27	120
Ambrosia Lake, NM	3.3	39.0	12	0.086	450
Monument Valley, AZ	1.3	23.3	18	0.016	1,500
Lowman, ID	0.15	14.9	99	0.013	1,100
Green River, UT	0.46	21.5	47	0.007	3,100
Slick Rock, CO	0.8	53.1	66	0.003	18,000
Maybell, CO	3.9	39.1	10	0.003	13,000
Spook, WY	0.38	10.3	27	0.002	5,200
Site totals	45.31	1,105.2	24	999	1.1
Vicinity properties		345.2		290	1.2
Grand totals		1,450.4		1,289	1.1

[(a)] calculated from volume using density of 1.6
t = metric tonne
Sources:
Mark L. Miller, Robert E. Cornish, and C. Beth Pomatto: Calculation of the Number of Cancer Deaths Prevented by the Uranium Mill Tailings Remedial Action Project, in: *Health Physics*, Vol. 76, No. 5, (May 1999), p. 544-546. Decommissioning Data - USA

> See also: Risk Reduction and Cost-Effectiveness in the UMTRA Project, by Robert E. Cornish, Mark L. Miller, C. Beth Pomatto; Waste Management Symposium, Tucson, Arizona, 1997

US DOE Cost Reduction and Productivity Improvement:

National Performance Review 1994
The Uranium Mill Tailings Remedial Action (UMTRA) Project Office at DOE's Albuquerque Operations Office has saved or avoided costs of $59 million since instituting its Cost Reduction/Productivity Improvement Program (CR/PIP) in 1988.

US GAO Review of UMTRA Project

Uranium Mill Tailings: Cleanup Continues, But Future Costs Are Uncertain, U.S. General Accounting Office, Chapter Report, December 15, 1995, GAO/RCED-96-37.
> download full text
Pursuant to a legislative requirement, GAO reviewed the Department of Energy's (DOE) program for cleaning up uranium mill tailings, focusing on: (1) the status and cost of DOE

surface and groundwater cleanups; and (2) factors that could affect the federal government's costs and liabilities in the future.

GAO noted that:

1. DOE intends to complete the cleanup of surface and groundwater contamination sites by 2014, at a cost of more than $2.4 billion;
2. out of 24 sites, surface cleanup is complete at 15, under way at 7, and idle at 2;
3. surface cleanup costs total around $2 billion to date and may be completed in 1998 at an additional cost of $300 million;
4. DOE postponed its groundwater cleanup until 1991 because of its focus on surface cleanup and a delay in the Environmental Protection Agency's final groundwater standards;
5. DOE has not reached an agreement with any of the affected states or tribes to develop cleanup strategies or financial support;
6. DOE will need another $147 million to clean up the affected groundwater sites;
7. the costs and completion dates of the cleanups depend on whether DOE keeps a disposal site open to dispose of future unearthed tailings and whether states contribute 10 percent of the groundwater cleanup expenses; and
8. the Nuclear Regulatory Commission has not updated the minimum charge for owners of Title II sites to reflect the cost of basic surveillance and maintenance.

Uranium Mill Tailings: Status and Future Costs of Cleanup, Testimony, February 28, 1996, GAO/T-RCED-96- 85. (Statement of Bernice Steinhardt, Associate Director, Energy, Resources, and Science Issues, Resources, Community, and Economic Development Division, before the Subcommittee on Energy and Power, Committee on Commerce, House of Representatives)
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GAO reviewed the status and cost of the Department of Energy's (DOE) uranium mill tailings cleanup program and the factors that could affect future costs. GAO found that:

1. if DOE completes its surface cleanup program in 1998, it will have cost $2.3 billion, taken 8 years longer than expected, and be $621 million over budget;
2. DOE cleanup costs increased because there were more contaminated sites than originally anticipated, some sites had more contamination than others, changes were needed to respond to state and local concerns;
3. the future costs of the uranium mill tailings cleanup will largely depend on the remediation methods used and the willingness of states to share in the final cleanup costs; and
4. the Nuclear Regulatory Commission needs to ensure that enough funds are collected from private site owners to protect U.S. taxpayers from future cleanup costs.

DOE Cleanup: Status and Future Costs of Uranium Mill Tailings Program, by Bernice Steinhardt, Associate Director for Energy, Resources, and Science Issues, before the Subcommittee on Energy and Environment, House Committee on Science. GAO/T-RCED-96-167, May 1, 1996
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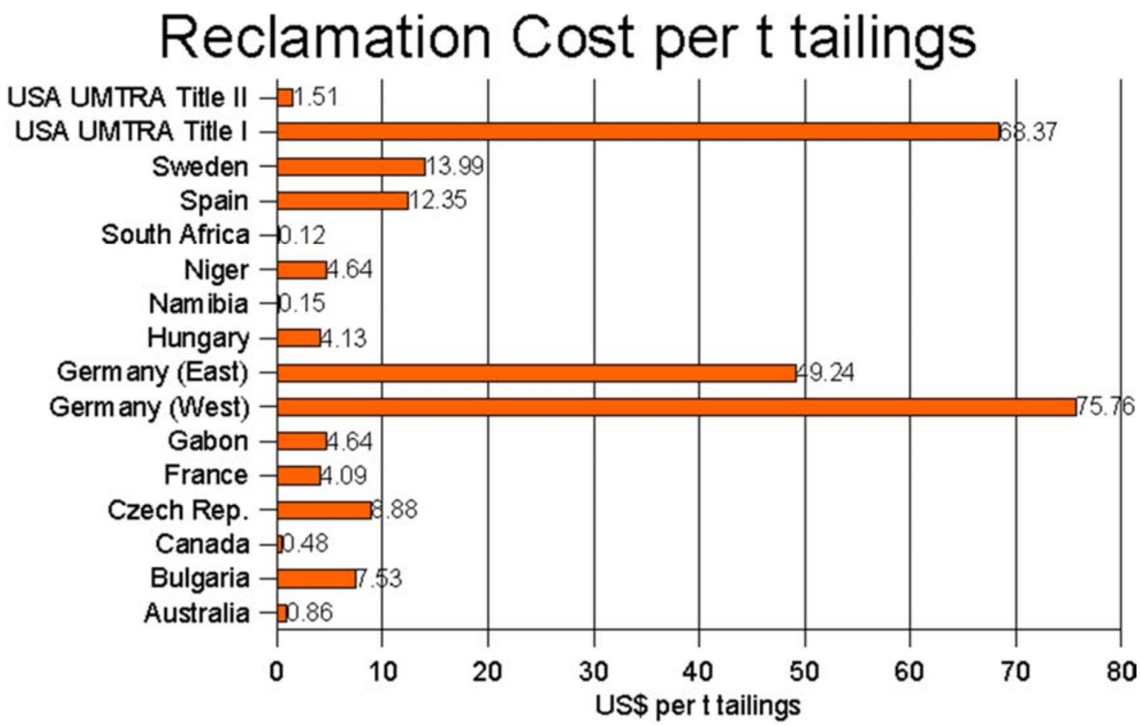
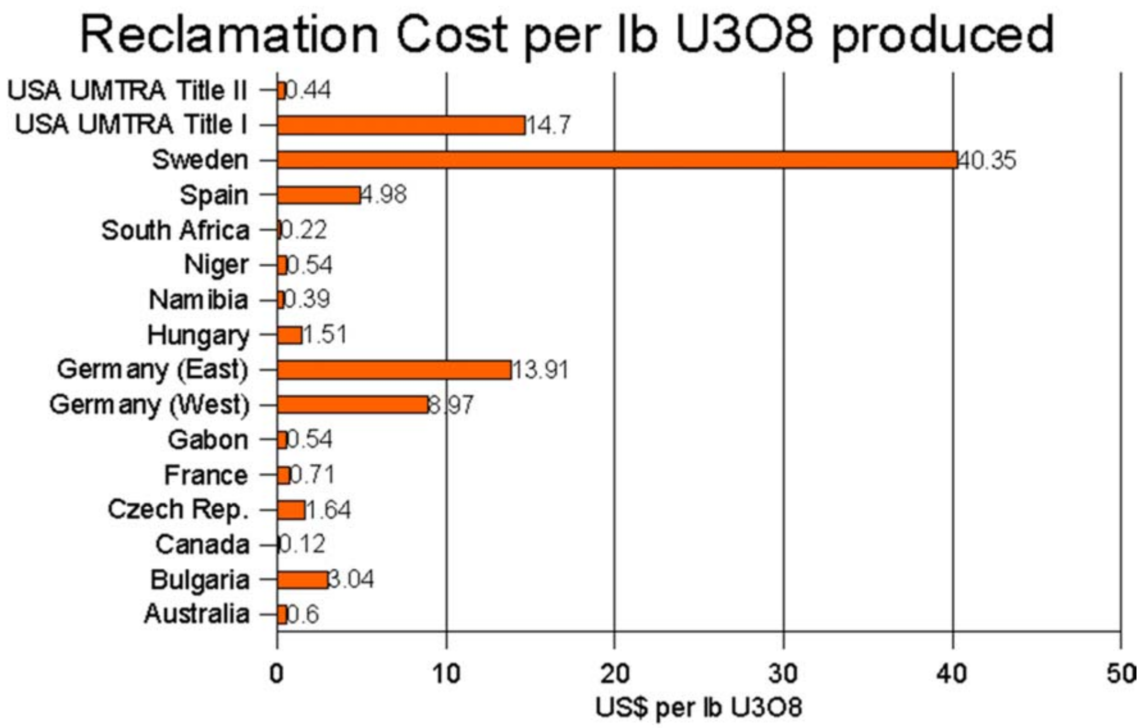
from: http://www.wise-uranium.org/stk.html?src=stkd01e
WISE Uranium Project / Slide Talks (PPPs)
Click:

- ✓ Uranium mill tailings hazards and reclamation

See slide 82 and 83





Reclamation Cost per lb U3O8 produced
USA UMTRA Title II
0.44
USA UMTRA Title I
14.7
Sweden
40.35
Spain
4.98
South Africa
0.22
Niger
0.54
Namibia
0.39
Hungary
1.51
Germany (East)
13.91
Germany (West)
8.97
Gabon
0.54
France
0.71
Czech Rep.
1.64
Canada
0.12
Bulgaria
3.04
Australia
0.6
0
10
20
30
40
50
US$ per lb U3O8

http://ije.oxfordjournals.org/content/39/4/980.full

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Cohort Profile: The German uranium miners cohort study (WISMUT cohort), 1946–2003

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How did the study come about?

Silver mining has been in existence since the 12th century in the Ore Mountains (Erzgebirge) located in the South of Eastern Germany in the Federal State of Saxony close to the border of the Czech Republic. In 1946, after World War II, the old silver mines were re-opened and the Soviet-Stock Corporation was founded with the code name WISMUT (i.e. the German name for bismuth).[1] The aim of this corporation was to produce as much uranium as possible for the Soviet nuclear weapon program. In the early years, from 1946 to about 1955, a large number of workers had been employed (about 100 000) under extremely bad working conditions. No worker-protection or radiation safety measures existed; consequently, exposures to radiation and dust were very high due to a lack of forced ventilation and the use of dry drilling. In 1954, the corporation was converted into the Soviet–German Stock Corporation. At that time mining was extended to the Federal State of Thuringia. In 1955, the first radon measurements were performed and from then onwards several worker-protection measures such as forced ventilation and wet drilling were introduced. Thus, from 1955 to 1970, the working conditions steadily improved and the number of employees was reduced to between 30 000 and 40 000. After 1970, international radiation protection standards were introduced, with provisions for individual radiation protection. The number of miners was stable at 20 000 and the working conditions had a high safety level. With the German reunification in 1990, mining was abandoned.

The Wismut company produced a total of 220 000 tons of uranium during its operation period from 1946 to 1990 and was the third-largest uranium producer worldwide. It is estimated that more than 400 000 persons worked at the company, most of whom were underground or in uranium-ore processing facilities.[2] Up to the end of 1990, more than 5000 of these workers were compensated for radiation induced cancers in the former German Democratic Republic (GDR). This number increased to 7695 by the end of 1999.[3] In 2004, the annual number of newly compensated cases was almost 200, though with a decreasing time trend.[4]

After German reunification, the German Federal Ministry of Environment (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit/BMU) decided to preserve the health data that were stored at the Wismut Health Data Archives (Gesundheitsdatenarchiv Wismut/GDAW), which are now held by the Federal Office for Occupational Protection and Medicine (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin/BAuA). These archives include paper files and histological material. The German Statutory Accident Insurance maintains records of all data relevant to the procedures for the compensation of occupational diseases. Payrolls are kept by the successor of the former Wismut company, the Wismut GmbH. Based on parts of the information held by these bodies, a cohort of former Wismut employees could be established,[5] with financial support from the BMU and the European Commission.

What does the study cover?

The Wismut cohort represents one of the largest occupationally radiation exposed collectives. The cohort forms the basis for investigations on the detrimental effects associated with: inhalation of radon and its progeny, inhalation of uranium dust, fine dust, silica dust and arsenic dust, and exposure to external gamma radiation and other risk factors. It is well known that occupational exposure to radon and its progeny increases the risk of lung cancer.[6–12] Uncertainty, however, still remains with regard to the exposure–response relationship at low levels of radon exposure, other risk or effect modifying factors (time since exposure, exposure rate, attained age, age at exposure, etc.) and the combined effects of radiation and dust, arsenic, smoking, etc. Another uncertainty concerns the radon-related risk for extra-pulmonary cancers[6,13–19] or cardiovascular diseases.[20–22]

Who is in the sample ?

Overall it is estimated that more than 400 000 workers may have been employed at the Wismut company during its operation period. Basic information on personal data and job history was available for about 130 000 workers from three files that allowed the establishment of a cohort study. Due to financial reasons it was decided to limit the size of the cohort to about 64 000 workers taken from the files of about 130 000 workers as a stratified random sample. In order to represent the different mining conditions at the Wismut company, the sample was stratified by the date of first employment (1946–54, 1955–70 and 1971–89), place of work (underground, milling/processing and surface) and area of mining (Saxony, Thuringia). Since it was assumed that, during the first years of production, women had also worked for at least some time underground, the sample was additionally stratified by gender. Moreover, all employees from one of the most important parts of the company (the so-called mining facility 'Object 09') who started working between 1955 and 1970 were included as well as any worker employed after 1970. Thus, the cohort is not representative of the entire Wismut workforce, but weighted towards those periods when exposures were medium to low in the selection of cohort members.

The following inclusion criteria were defined: (i) year of first employment between 1946 and 1989; (ii) minimum duration of employment 180 days; (iii) year of birth after 1899; and (iv) men only. Females were excluded because it turned out that only a very small number of females had in fact worked underground. A total of 58 987 male former Wismut employees remained in the final cohort after exclusion of all persons who did not fulfil the inclusion criteria (n = 5101), were included twice in the data set (n = 45), had implausible data (n = 22), had an unknown radon exposure (n = 97) or with unclear identity (n = 59).

What has been measured?

The cohort includes individual information on year of birth, vital status, mortality, job history and occupational exposure to several factors (Table 1). Data on the job histories had been extracted from the payrolls, including information on the type of job, type of mining facility, area of work place, number of shifts and periods of absence on a daily basis. In a feasibility study, a lot of effort had been spent to retrieve complete information from the payrolls. For about 200 cohort members data had been extracted from Wismut files a second time. Some discrepancies led to an improved standardized data collection procedure for the main cohort study. During the whole data collection period detailed double plausibility checks had been performed at the German Statutory Accident Insurance (DGUV) and the Federal Office for Radiation Protection. Implausible, incomplete or unclear data were returned to DGUV, where the data were re-examined and corrected. Thus a high validity of these data can be assured.

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Table 1

Available information for WISMUT cohort members

A mortality follow-up for the complete cohort is performed every 5 years. The first and second mortality follow-up periods finished on December 31, 1998 and December 31, 2003, respectively. The main sources of information on the vital status are the local registration offices. Other sources are the Pathology Archive of the Wismut company and additional records on the health data and occupational compensation procedures of the Wismut company. The main sources of information on the causes of death are the Public Health Administrations and their corresponding archives, where copies of the death certificates are stored. Other sources were the Pathology Archive of the Wismut Company, where the autopsy files of former Wismut employees and their family members were kept, and the Wismut Health Data Archives located in Chemnitz. Currently, the possibility of an additional follow-up for incidence, at least for the years 1960–89, is under investigation.

Table 2 shows some main characteristics of the first and second mortality follow-up, which ended on December 31, 1998 and December 31, 2003, respectively. The completeness of the follow-up could be greatly improved during the time between the two follow-ups. The observed percentage of cohort members lost to follow-up of 5.3% was reduced to 4.7% and the percentage of missing causes of deaths could be reduced from 11.8 to 6.4%. The second follow-up has a total of 60% of the cohort members still alive, 35.5% deceased and 4.7% were lost-to follow-up. The cause of death is available for 93.6% of the deceased cohort members. Missing causes of deaths predominate for miners who died pre-1970, because death certificates were rarely stored for more than 30 years. In the second mortality follow-up, the most frequent cause of death was cardiovascular diseases (37.8%), followed by malignant cancers (32.5%) and respiratory diseases (10.2%). Overall, a total of 6373 malignant cancer deaths occurred. The most frequent type of cancer is lung (*n* = 3016) followed by stomach (*n* = 595), colon (*n* = 291), prostate (*n* = 264), pancreas (*n* = 229), rectum (*n* = 222), bladder (*n* = 174), liver (*n* = 159) and kidney (*n* = 152).

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Table 2

Characteristics of the mortality follow-ups of the WISMUT cohort

For all cohort members complete information on the job history is available on a daily basis. A large proportion of the cohort members (40.5%) started to work at the Wismut company before 1955, when radon exposures were high (Table 3), whereas nearly two-thirds of all cohort members were employed until 1990, when mining was abandoned. On average, the miners were 24 years old when they started to work at the Wismut company. The average duration of employment was 12 years. Total employment years apportion to 53.5% spent underground, 38.4% at the surface, 6.9% in processing/milling and 1.1% in open-pit mining.

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Table 3

Job characteristics by year of start of employment, WISMUT cohort, 1946–2003

Radiation exposure was estimated by using a detailed job-exposure matrix (JEM), which includes information on exposure to radon and its progeny in WLM, external γ radiation in mSv and long-lived radionuclides (^{235}U, ^{238}U) in kBqh/m^3. [23,24] The JEM provides exposure values for each calendar year of employment between 1946 and 1989, each place of work and each type of job. More than 900 different jobs and 500 different working places were evaluated for this purpose. Radon (^{222}Rn) measurements in the Wismut mines were carried out from 1955 onwards. Thus, for the period from 1946 to 1954, radon concentrations were estimated retrospectively by an expert group based on measurements from 1955, taking into account ventilation rate, vein space, uranium content, etc. In addition to exposure evaluation, work is currently in progress on the calculation of the individual doses to the various organs from radon, gamma radiation and long-lived radionuclides either separately or combined.[25] This work is part of the European collaborative research project ALPHA-RISK.[26] Information on arsenic, dust and silica is also based on a job-exposure matrix similar to that for radiation.[24,27,28] Values are given in dust-years, where 1 dust-year is defined as an exposure to 1 mg/m^3 fine dust or silica dust and 1 µg/m^3 for arsenic over a time period of 220 shifts of 8 h. Differences in the number of shifts and daily working hours in the different calendar years were accounted for by multiplying with a correction factor. Arsenic exposures were present only in the mines of Saxony.

Figure 1 shows the number of radon-exposed cohort members by calendar year and the average cumulative radon exposure per year among exposed cohort members (n = 50 773). With the introduction of ventilation measures from 1955 onwards, the radon concentration dropped sharply, reaching levels of international radiation protection standards in the 1970s. In contrast to this, external gamma radiation and long-lived radionuclides (LRN) show a different pattern (Figure 2a), because their concentration was not affected by the improved ventilation. Exposure to fine dust and silica dust (Figure 2b) had its peak between 1952 and 1955, after which time it steadily decreased with the implementation of wet drilling after 1955. A similar pattern is also observed for arsenic exposure (data not shown).

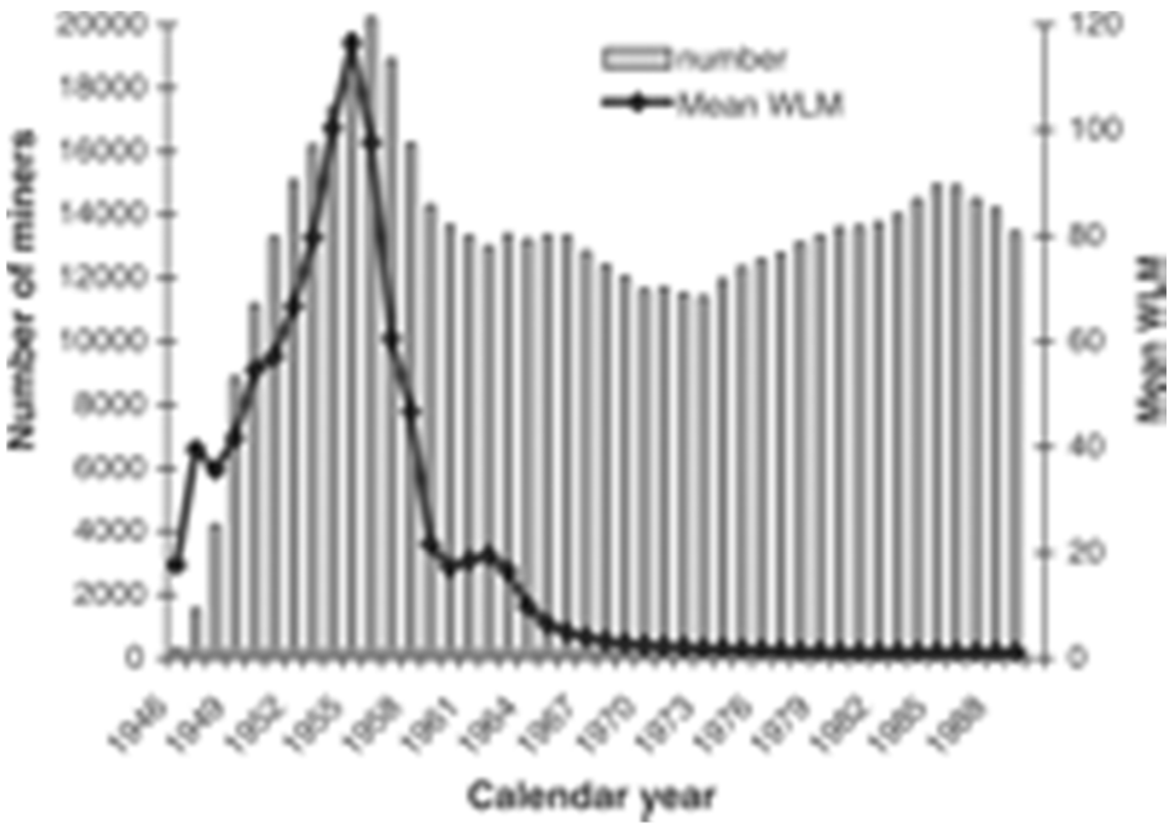

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Figure 1

Number of radon-exposed cohort members and mean cumulative radon exposure per calendar-year (n = 50 773)

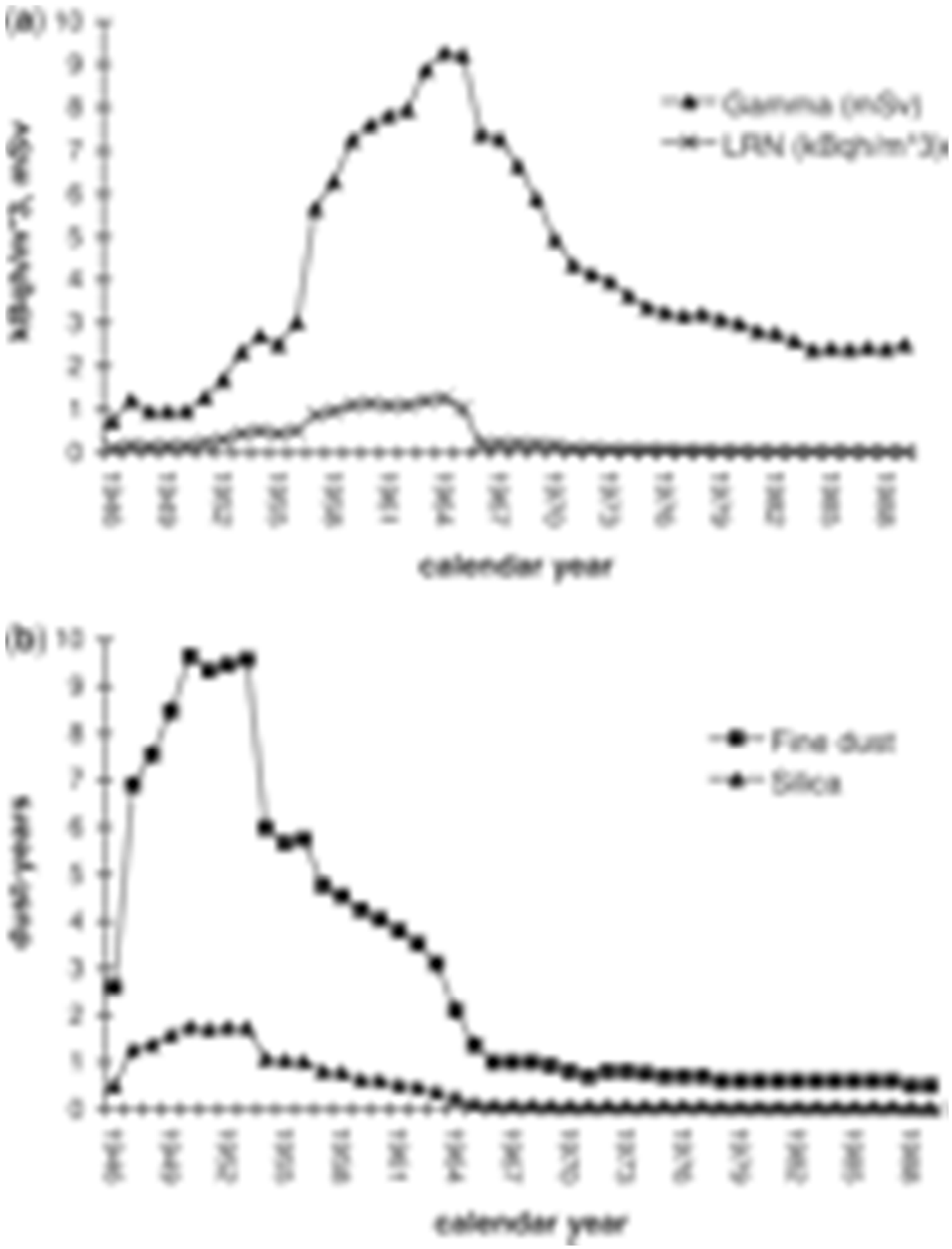

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Figure 2

(**a**) Mean annual exposure to external gamma radiation in mSv and LRN in kBqh/m^3 for exposed cohort members (*n* = 50 761). (**b**) Mean annual exposure to fine dust (*n* = 58 695) and silica dust (*n* = 58 658) in dust-years for exposed cohort members

A summary description of the distribution of cumulative exposure to radon and its progeny, external gamma radiation, LRN, fine dust, silica and arsenic is given in Table 4. There is a wide range of radon exposure levels, e.g. 8214 cohort members were unexposed; 27 739 members received <50 WLM, which represents the typical range for indoor radon levels; and 4698 subjects were exposed to >1000 WLM. The average duration of exposure was 11 years. Only 18 234 cohort members from the Saxony mines were occupationally exposed to arsenic.

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Table 4

Distribution parameters for exposure to radiation, dust and arsenic for the WISMUT cohort members, 1946–2003

No biological material is collected from the cohort members themselves, because the follow-up is passive without personal contact to the cohort members. However, other procedures are currently being tested in order to establish a biobank containing samples from high- and low-radon-exposed former Wismut employees, including the same exposure information as in the cohort. Several thousands of former Wismut employees are regularly undergoing medical examinations that are offered by the Wismut company. During these visits additional blood will be collected for a sub-sample of former Wismut miners. Next to that, it is planned to isolate DNA from autopsy material of former Wismut employees who died from lung cancer.

What has already been found?

The WISMUT cohort data have already been primarily used to estimate the radon-related risk of death from lung cancer, extra-pulmonary cancers and cardiovascular diseases.[9,19,21] A linear relationship between radon and lung cancer was observed in the follow-up period 1946–98, with an Excess Relative Risk (ERR) per WLM of 0.21% [95% Confidence Interval (CI): 0.18;0.24].[9] The ERR/WLM was modified by time since exposure, attained age and exposure rate. Whereas a strong inverse exposure-rate effect was detected for high exposures, no such effect was detected at exposures <100 WLM. The ERR/WLM was not found to be modified by duration of exposure. Currently, these risk estimates are being updated by using more-refined models and extending the follow-up period to 2003.

The risk of extra-pulmonary cancers due to cumulative exposure to radon was evaluated for the follow-up period 1960–2003.[19] Based on internal regression, a statistically significant relation with cumulative radon exposure was observed for all extra-pulmonary cancers combined (ERR/WLM = 0.014%; 95% CI: 0.006%; 0.023%). The majority of individual sites investigated revealed a positive exposure–response relationship. However, these relations were either not statistically significant or became insignificant after adjustment for potential confounders such as dust, arsenic, etc. Overall, the findings of the WISMUT cohort study provide some evidence for a relation between radon and extra-pulmonary cancers; however, chance and confounding cannot be ruled out.

The risk of cardiovascular diseases in relation to radiation was analysed based on the data of the first follow-up.[21] Overall, there was little evidence for a relationship with either cumulative exposure to radon, or external gamma radiation or LRN. This is also true for the sub-group cardial and cerebrovascular diseases. Low doses to the relevant organs and uncontrolled confounding, however, hamper interpretation.

Analyses based on part of the data of the WISMUT cohort together with data from the French and Czech uranium miner cohorts are currently being conducted within the European ALPHA-RISK project.[26] The main objective of this international collaboration is to evaluate the risk of mortality from lung cancer and other diseases by radon, with a focus on the low-exposure ranges. For this purpose the German cohort data were restricted to the follow-up period 1955–98. The feasibility of a pooled analysis of the three nested case–control studies on lung cancer from Germany, France and the Czech Republic is also under investigation.

A full list of papers arising on the WISMUT study, with links to the abstracts, can be found at the study website (http://www.bfs.de/de/bfs/forschung/Wismut).

What are the main strengths and weaknesses?

The WISMUT cohort is the largest single cohort study on uranium miners world wide. As well as to its size, the main strengths of the study are the long follow-up period (35 years and almost 2 million person-years); the small percentage of loss-to follow-up; the large number of deaths from cancer, cardiovascular and respiratory diseases and the wide range of exposure to radon and its progeny as well as the availability of detailed information on other occupational risk factors such as external gamma radiation, LRN, fine dust, quartz fine dust and arsenic.

Potential weaknesses of this study concern the accuracy of radiation exposure, particularly in the very early years of the WISMUT operation. Possible non-differential misclassification of radiation exposure and its effects on risk estimates are currently being investigated. Other potential limitations are the accuracy of causes of deaths, the proportion of missing causes of deaths as well as missing information on potential confounders such as smoking, asbestos exposure, exposure to diesel fumes, etc.

Several validity checks were completed for vital status ascertainment. First, the data on vital status from the pathology archive (all deceased) were compared with the data received from the local registries ($n = 2382$). About 1% of the deceased cohort members of the pathology archive had falsely been specified as ‘alive’ by the local registries. A second strategy compared the data on vital status from all deceased persons according to the health records of the Wismut company (excluding those with additional information from the pathology archive) with the data received from the local registries ($n = 1905$). Only 2% had been wrongly classified by either the Wismut company or by the local registries. In all cases this was due to erroneous spelling or falsely identified persons (e.g. same name but different year of birth). Based on these data from the first follow-up, it was estimated that the vital status may be wrong for ∼1% of the cohort. During the second follow-up this percentage had been further reduced.

Accuracy of the cause of death was checked by comparing persons for whom the cause of death was available both from autopsy files of the pathology archive and from certificates of death based on the clinical diagnosis without autopsy (n = 1836). With respect to lung cancer, 5.1% of the lung cancer cases had been wrongly classified as non-lung cancers by the clinical diagnoses and 1.7% of the non-lung cancers as lung cancer. Overall, a high validity for lung cancer as underlying cause of death is expected, because 49.8% of the lung cancer deaths are based on autopsy. This proportion is lower when all malignant cancers (35.8%) are considered.

With respect to potential confounders, some information is available on exposure to specific occupational risk factors (i.e. asbestos, weld smoke, solvents, noise, etc.) obtained from medical records. However, this information is selective and cannot be used for analyses. For 38% of the cohort members at least some very rough information is available with respect to smoking since 1971, when standardized and well-recorded medical check-ups were introduced. In order to obtain more information on smoking, a nested case–control study of lung cancer has been conducted. Additional information on smoking was collected from the miners themselves, their next of kin or the health archives for use within the case–control study. It was found that most of the miners were smokers. The correlation between smoking and cumulative radon exposure was rather low, rendering smoking to be an unlikely confounder in the cancer risk attributable to radon exposure.

How can I get hold of the data? Were can I find out more?

External collaborations are welcomed by the study management committee, which comprises BfS (Federal Office for Radiation Protection) staff members and an international advisory board. Mechanisms exist for the submission of research proposals to BfS. Successful applicants will be instructed on how to use the data. The study website (http://www.bfs.de/de/bfs/forschung/Wismut) has been set up to describe these procedures for applicants; it provides full contact details, a list of relevant publications and access to the technical report that provides a detailed description of the cohort.

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16.11.2014, 18:16 Uhr

Strahlende Vergangenheit - Lungenkrebs bei 3700 Wismut-Beschäftigten

Tino Moritz, dpa


Foto: dpaDresden.

Die Zahl der durch Uranerzbergbau an Lungenkrebs erkrankten ehemaligen Wismut-Mitarbeiter ist höher als erwartet. Nach Angaben der Deutschen Gesetzlichen Unfallversicherung (DGUV), die am Freitag in Dresden eine Bilanz vorlegte, wurden seit 1991 insgesamt 3700 Lungenkrebs-Fälle als Berufskrankheit bestätigt. Hinzu kämen 120 Menschen mit Kehlkopfkrebs sowie 2750 Menschen mit Silikose, einer durch Staub hervorgerufenen und für Bergleute typischen Lungenkrankheit.

Mit einer so hohen Zahl an Lungenkrebs-Fällen sei nicht gerechnet worden, sagte DGUV-Hauptgeschäftsführer Joachim Breuer. Bis 1990 waren bereits 5500 Fälle der zumeist tödlich verlaufenden Krankheit festgestellt worden - so dass die Zahl der durch den Uranerzbergbau in Sachsen und Thüringen verursachten Lungenkrebs-Fälle nicht mehr weit von der 10 000er Marke entfernt ist. Besonders die von Fachleuten als „wilde Zeit“ bezeichnete Anfangsphase der 1940er und 1950er Jahre galt für die Kumpel als extrem gefährlich, weil es damals keinerlei Schutzmaßnahmen gab.

Die DGUV hatte vor 20 Jahren eigens eine Betreuungsstelle eingerichtet. Mehr als 165 000 noch lebende Ex-Wismut-Beschäftigte waren nach der Wende ausgemacht worden. Allen habe man das medizinische Untersuchungsprogramm angeboten, aber nur rund 55 500 hätten schließlich daran teilgenommen. Um nachweisen zu können, dass die Erkrankungen auch wirklich durch die frühere Tätigkeit im Uranerzbergbau verursacht wurden, wurden laut Breuer 940 Tätigkeiten und 250 Arbeitsorte nachgestellt und analysiert. Die Daten reichten aus, um die Belastungen zu rekonstruieren, hieß es weiter. Insgesamt habe es 20 200 Verdachtsfälle gegeben, von denen 7800 als Berufskrankheiten bestätigt wurden - darunter sind auch Betroffene mit Meniskusschäden.

Bei den anderen 12 400 habe sich entweder der anfängliche Verdacht auf Erkrankung nicht bestätigt oder aber es habe sich herausgestellt, dass sie nicht durch den einstigen Wismut-Job verursacht wurden. „Wir sind in einem abklingenden Prozess“, sagte Breuer und verwies auf die altersbedingte Abnahme der Fälle. Von den einst 55 000 Wismut-Beschäftigten, die nach der Wende die Vorsorge-Untersuchungen in Anspruch nahmen, seien inzwischen nur noch 12 000 übrig geblieben.

Für das Programm wurde laut Breuer bisher insgesamt eine Milliarde Euro aufgewendet, der überwiegende Teil davon gehe als Rentenleistung an die Betroffenen. Das Geld stammt hauptsächlich aus Beiträgen der Unternehmer - lediglich 200 Millionen Euro davon stammten vom Bund. Laut Breuer handelt es sich dabei um eine Pauschalzahlung dafür, dass die Unfallversicherung auch für diejenigen aufkam, die etwa als Kriegsgefangene dem Strahlungs- und Staubrisiko bei der Wismut ausgesetzt waren.

Die sogenannte Berufskrankenrente sei im Durchschnitt etwa 1400 Euro hoch und werde den Betroffenen bis ans Lebensende gezahlt, fügte Breuer hinzu. Für bemerkenswert hielt er den Umstand, dass 73 Prozent der Entschädigten in Sachsen, 22 Prozent in Thüringen und nur 5 Prozent im Rest der Republik lebten. Dies sehe er als Beleg für eine Besonderheit: „Die Leute, die bei der Wismut gearbeitet haben, haben eine außergewöhnlich intensive Bodenständigkeit.“