Environmental impacts of current uranium mine projects

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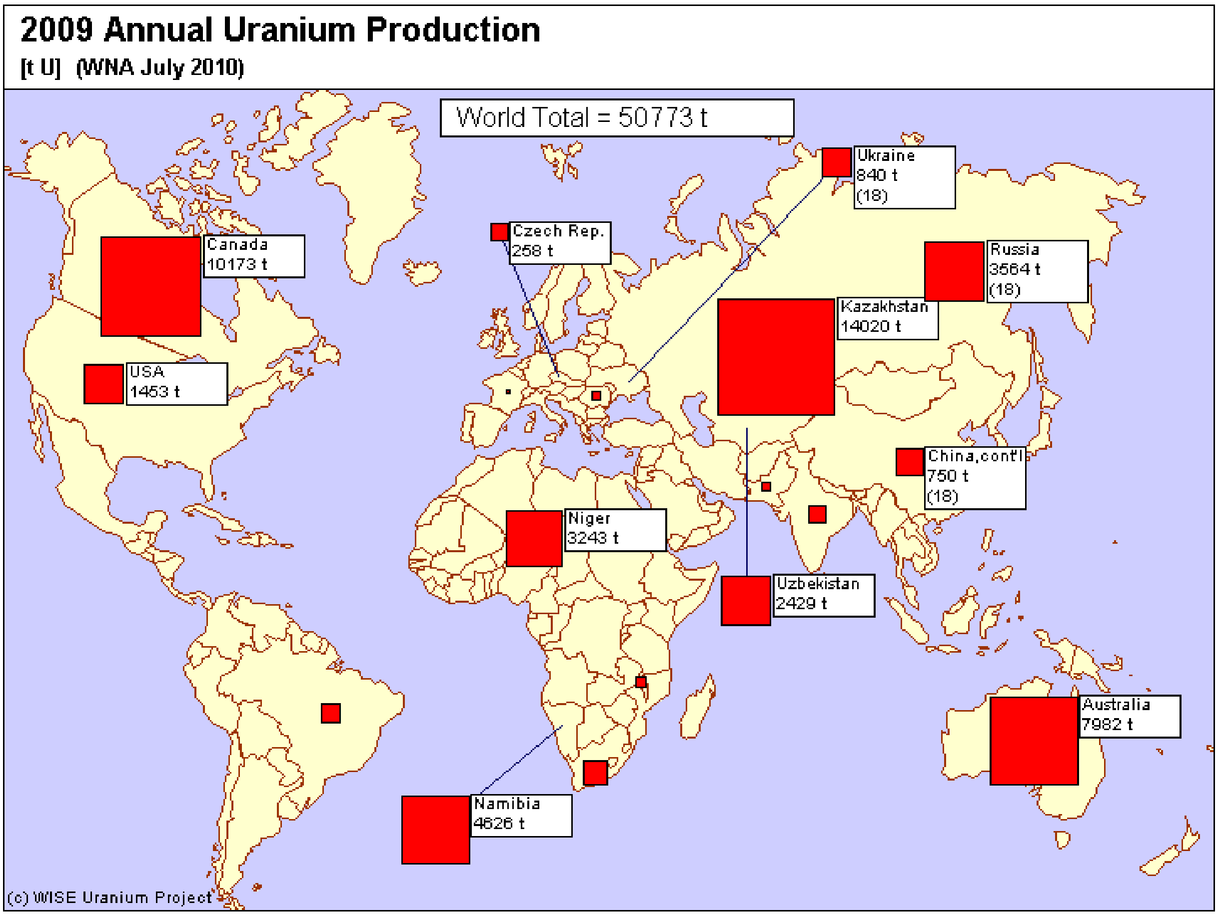
In spite of the uranium price rise in recent years, the mining of various uranium deposit types that used to be mined for decades still has not become feasible again. Many currently planned mining projects are only profitable because of their excessive environmental impact.

In 2009, total world uranium production amounted to 50,773 t U. In the same period, demand of nuclear power stations was 61,730 t U, so, mining covered only 82% of the demand. The remainder was supplied by several secondary sources and stock holdings. The single largest contributor is the downblending of surplus Russian nuclear weapons uranium for use in U.S. nuclear power reactors, the contracts for which expire in 2013, however.



Some of the other secondary sources are also expected to expire, so a supply gap may arise in the years to come, unless production from mines is boosted massively. As the lead times for new mines are ten or more years, uranium supply might become quite tight in the next few years to come, at least.
In response to the looming supply gap, the uranium price increased from a US$ 7.10 low in 2000 to a peak of US$ 136 per lb U_3O_8 in June 2007, but then decreased again to the current level of US$ 48 per lb U_3O_8.
Consequently, uranium prospection and exploration restarted after decades of depression - also in Europe, where uranium is being hunted for in a dozen countries now.

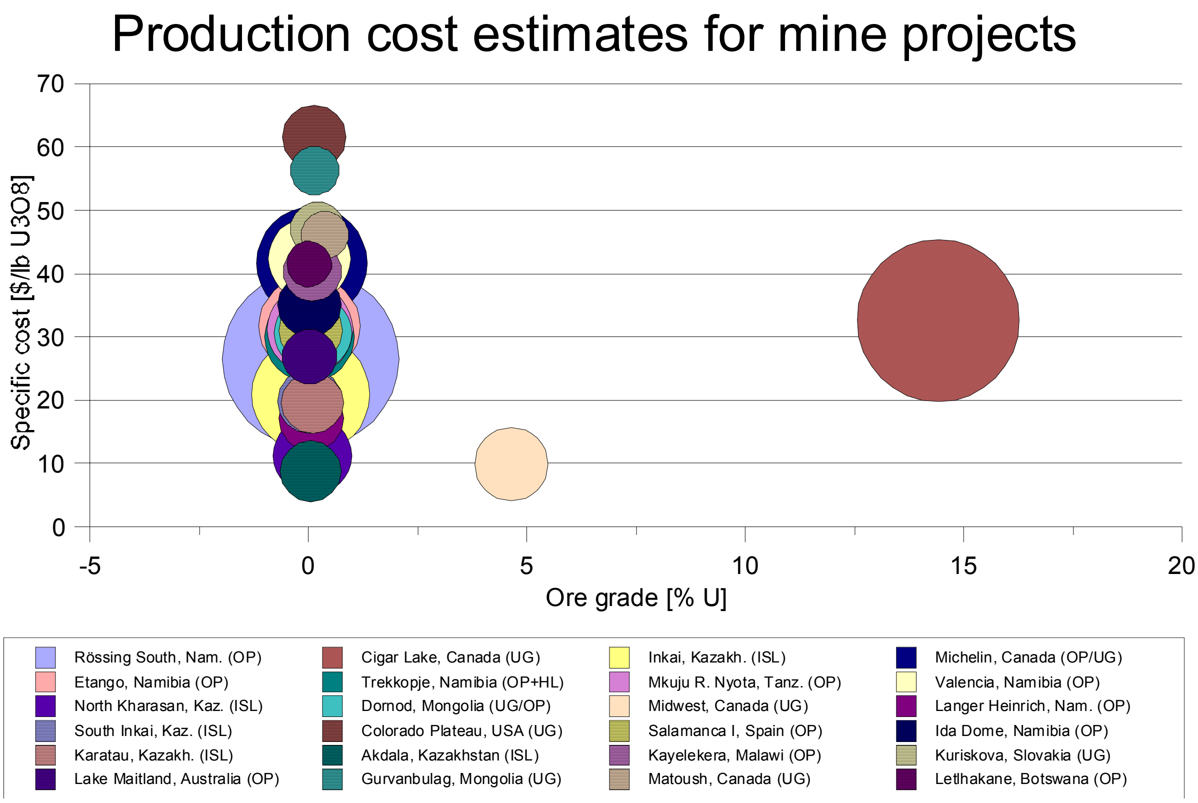
In the meantime, feasibility studies have been completed for a number of deposits. For the larger deposits, the results are shown in the following graph. The size of the circles represents the size of the deposit, while the horizontal axis indicates the ore grade and the vertical axis the estimated specific mining cost. The cost includes capital and operating costs, while other costs are mostly not included. The cost data is not directly comparable for a number of reasons, so it can only give a clue.

Two deposits attract attention for their extraordinary uranium grades: Midwest and Cigar Lake, both located in the north of the Canadian province of Saskatchewan. One might think that mining such deposits must be pure fun, the opposite is true, however: these deposits are located in instable rock formations at depths of 500 m below ground and are extremely difficult to mine; during development of the Cigar Lake mine, massive water inflow halted the project twice, delaying it for years and causing a strong cost increase.

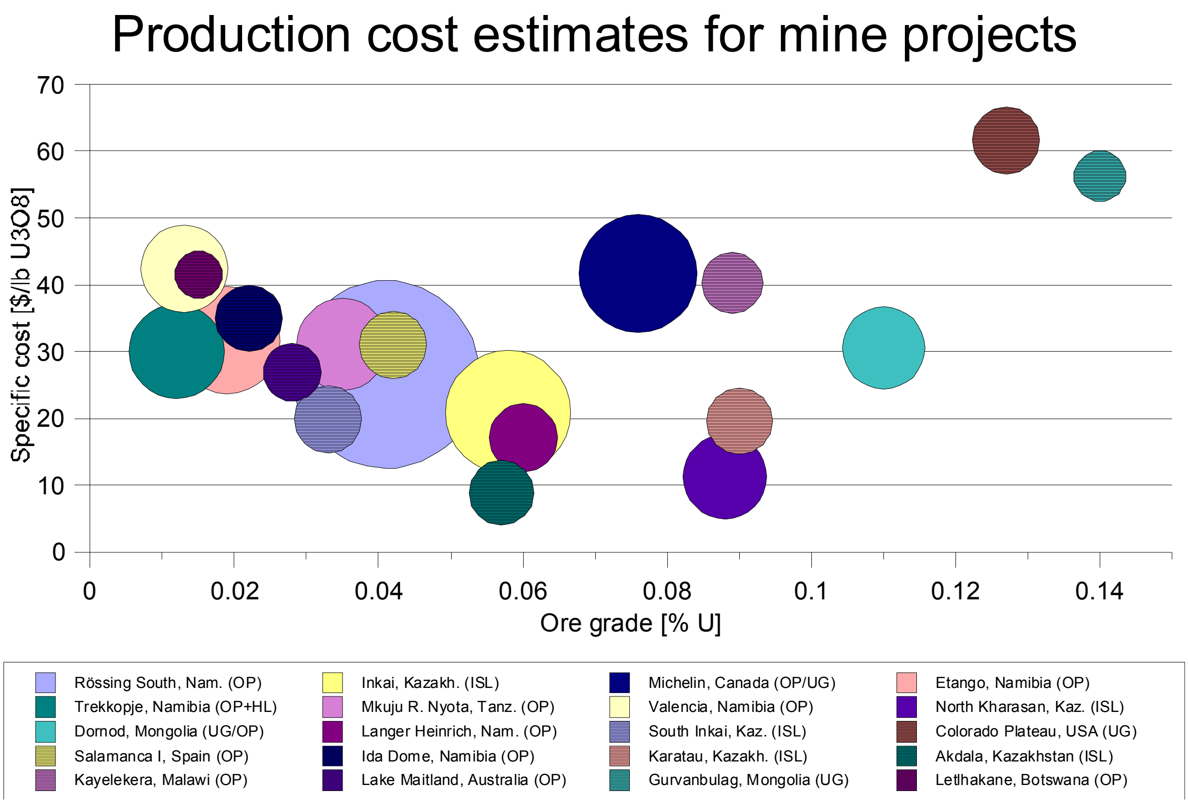
The range for an ore grade up to 0.15% U is shown in more detail in the subsequent graph. The highest specific mining cost is found with the deposit type that used to be the backbone of uranium mining in the U.S. for decades (Colorado Plateau, generic), with uranium grades in the range of 0.1 – 0.2% U. The specific cost not only exceeds the current spot market price of US$ 48 per lb U_3O_8, but also the current long-term contract price of US$ 60 per lb U_3O_8. This familiar kind of uranium mining thus still is not feasible at current prices.

Most of the projects with specific costs below current market prices are noticeable for their ore grades below 0.1% U; therefore there must exist some very special circumstances to make the mining of these deposits at all feasible:

- Rössing South open pit mine in Namibia
Here, feasibility is mainly based on the sheer size of the project: a huge deep open pit mine is to be excavated, similar to the one of the existing Rössing mine. The ore with a grade of 0.04% U is to be milled and processed in a conventional hydro-metallurgical process to extract the uranium. The slurry-like residue (called tailings) left from the processing is to be pumped to a tailings pond that also serves as a final repository. The tailings comprise 99.96% of the mass of the ore originally mined, and they still contain 85% of the radioactivity initially present in the ore.



Production cost estimates for mine projects
Specific cost [$/lb U3O8]
Ore grade [% U]
70
60
50
40
30
20
10
0
-5
0
5
10
15
20
Rössing South, Nam. (OP)
Etango, Namibia (OP)
North Kharasan, Kaz. (ISL)
South Inkai, Kaz. (ISL)
Karatau, Kazakh. (ISL)
Lake Maitland, Australia (OP)
Cigar Lake, Canada (UG)
Trekkopje, Namibia (OP+HL)
Dornod, Mongolia (UG/OP)
Colorado Plateau, USA (UG)
Akdala, Kazakhstan (ISL)
Gurvanbulag, Mongolia (UG)
Inkai, Kazakh. (ISL)
Mkuju R. Nyota, Tanz. (OP)
Midwest, Canada (UG)
Salamanca I, Spain (OP)
Kayelekera, Malawi (OP)
Matoush, Canada (UG)
Michelin, Canada (OP/UG)
Valencia, Namibia (OP)
Langer Heinrich, Nam. (OP)
Ida Dome, Namibia (OP)
Kuriskova, Slovakia (UG)
Letlhakane, Botswana (OP)



Production cost estimates for mine projects
Specific cost [$/lb U3O8]
Ore grade [% U]
70
60
50
40
30
20
10
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
Rössing South, Nam. (OP)
Trekkopje, Namibia (OP+HL)
Dornod, Mongolia (UG/OP)
Salamanca I, Spain (OP)
Kayelekera, Malawi (OP)
Inkai, Kazakh. (ISL)
Mkuju R. Nyota, Tanz. (OP)
Langer Heinrich, Nam. (OP)
Ida Dome, Namibia (OP)
Lake Maitland, Australia (OP)
Michelin, Canada (OP/UG)
Valencia, Namibia (OP)
South Inkai, Kaz. (ISL)
Karatau, Kazakh. (ISL)
Gurvanbulag, Mongolia (UG)
Etango, Namibia (OP)
North Kharasan, Kaz. (ISL)
Colorado Plateau, USA (UG)
Akdala, Kazakhstan (ISL)
Letlhakane, Botswana (OP)

> Such tailings deposits generally represent the most important long-term hazard left from uranium mining:
> Once the surface of the deposit has dried, the fine material can be blown by the wind, such as in the case of the Koshkar-Ata deposit in Kazakhstan, covering an area of 10 square kilometres and containing 120 million tonnes of tailings; here, the dust is blown into the town of Aktau on a regular basis. Although this deposit is a legacy of the Soviet era, a large part of its surface still hasn't been covered yet.
> Seepage from tailings deposits can contaminate groundwater. The seepage plume from the Rössing tailings deposit in Namibia (covering 7.3 square kilometres), for example, has already extended over an area twice this size.
> But, even an expert securing and covering of such deposits does not necessarily assure the prevention of any contaminant release, as can be seen at the former Rum Jungle mine in Australia, for example, where seepage escaped already a few years after completion of the cover, leading to widely visible crystallization of metal salts in large areas around the deposit.

- Langer Heinrich open pit mine, Namibia
Here, the crucial factor is the easy amenability of the deposit to mining: the deposit is located near the surface and is mostly comprised of unconsolidated rock that can easily be excavated. The deposit, located in the Namib-Naukluft National Park, is to be mined over a length of 15 km and a width of up to 1 km. Mining has already started, but the processing capacity is still being increased.
The National Park hosts a highly specialized fauna and flora that are adapted to the extremely arid climate. The licensing and development of the mine was completed within a record-breaking two years, telling also a lot about the political situation in Namibia. The water required for the processing of the ore is brought in through an 80 km pipeline sourced from the scarce groundwater resources found in Namibia. While the current water abstraction already affects the landscape, the mining company now plans to pump even more water for the planned processing capacity increase.

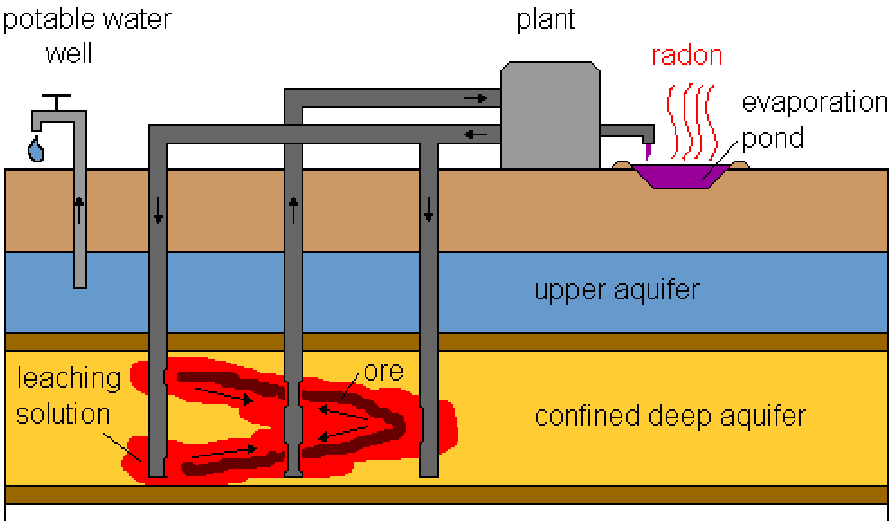
- further extremely low-grade open pit mine projects in Namibia
In Namibia, four more open pit mine projects are planned on deposits with ore grades far below the minimum of 0.03% U so far mined worldwide; much more material has to be mined therefore, to obtain the same amount of uranium.
The lowest ore grades of 0.013% U are found in the Trekkopje deposit, currently being developed by French company Areva. As a conventional uranium mill is not feasible here, the ore is to be processed by a heap leaching scheme: the crushed ore is to be stacked on a 2.2 square kilometre leach pad forming a pile containing 30 million tonnes; then, the pile is to be leached with an alkaline solution, partly dissolving the uranium that is then recovered from the solution. The soaking wet spent ore is then to be transported back to the open pit mines, and new ore is to be stacked on the leach pad. A 3.2 million tonne pilot-scale leach pad has been taken into operation in July 2010. The water required for the processing is supplied by a purpose-built seawater desalination plant.

- In situ leach projects in Kazakhstan
The projects featuring the lowest specific costs are almost exclusively projects in Kazakhstan, employing the solution mining process, also called in situ leaching (ISL), or in situ recovery (ISR).

With this process, the ore is not removed from the deposit, but a solution (sulphuric acid in this case) is injected into the deposit, dissolving the uranium. The pregnant solution is pumped back to the surface, where the uranium is recovered.
In 2009, Kazakhstan has for the first time become the largest uranium producer in the world, mainly based on this process. The capacities are still being massively expanded.

> An important advantage of the in situ leach scheme is the lack of all conventional mining hazards to the workers; however, problems exist as well, in particular for groundwater. A typical problem are spills from the kilometres of plastic pipe work bringing the solutions to the injection wells and removing them from the production wells: seepage from any spills endangers aquifers that are meant to remain clean. Additional hazards for such aquifers result from well failures or any pathways from the leaching zone through leaks in natural confining layers.
> An extreme example of a surface spill occurred in June 2007 at the Highland in situ leach mine in Wyoming, USA, operated by Canadian company Cameco. Due to an improperly connected pipe, a total of 751 cubic metres of solution containing 8 mg/L of uranium spilled to the ground - unnoticed for four weeks.
> Alarmed by this event, the Wyoming Department of Environmental Quality conducted an investigation, identifying – other than expected for this largest operation of its kind in the U.S. – more deficiencies: the near total disturbance of the native vegetation and soils with typical wellfield installation procedures, an inordinate number of spills, leaks and other releases, massive delays with the groundwater restoration at depleted sections of the deposit, deposit of a financial surety for cleanup that covers only a fraction of the real cost – so the tax payer will have to cover most of the cost, if the company cannot meet its obligations, and so on.
> But the problems with in situ leaching really begin only when the groundwater of a leached deposit is to be restored. While the mining companies are obliged to restore the groundwater quality to pre-mining levels, experience shows that this is not generally possible. A study performed by the U.S. Geological Survey in 2009 showed that "to date, no remediation of an ISR operation in the United States has successfully returned the aquifer to baseline conditions".

In view of Kazakhstan's inability to reclaim even the tailings pile left from the Soviet era, the question arises, how the country ever intends to restore the groundwater in the huge areas now being used for the in situ leach process. The answer was given by the national uranium mining company Kazatomprom in 2008: "…the natural hydrochemical environment of uranium deposits of South Kazakhstan has a unique capability of self-restoration…" – this means that there is no intention at all to perform any groundwater restoration efforts after completion of the mining.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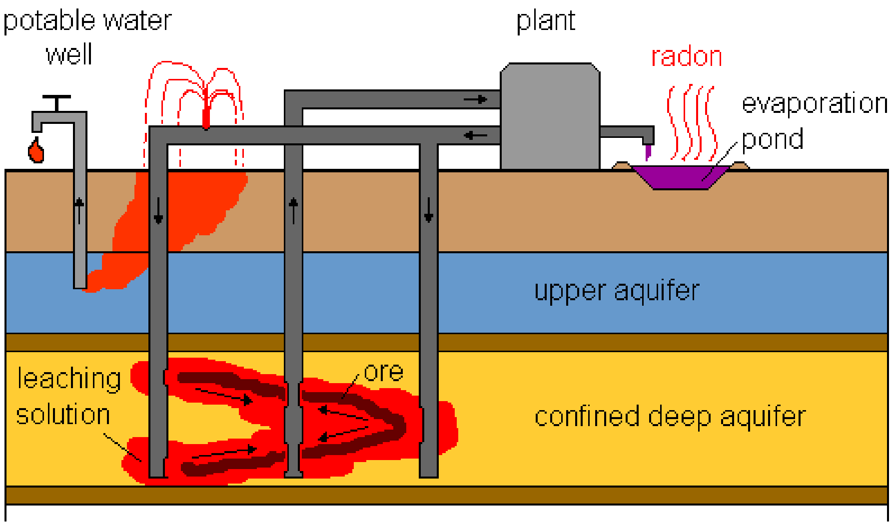
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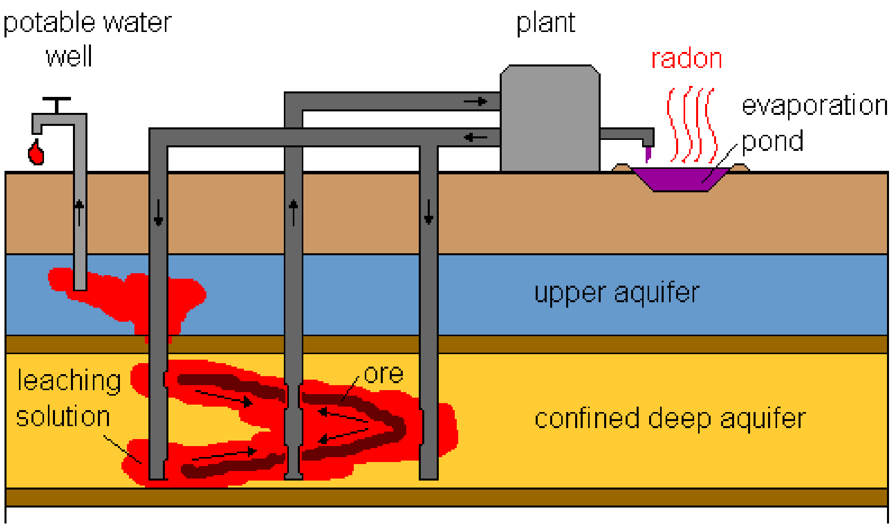
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