

A Precarious Situation in the Uranium Mines of Siberia

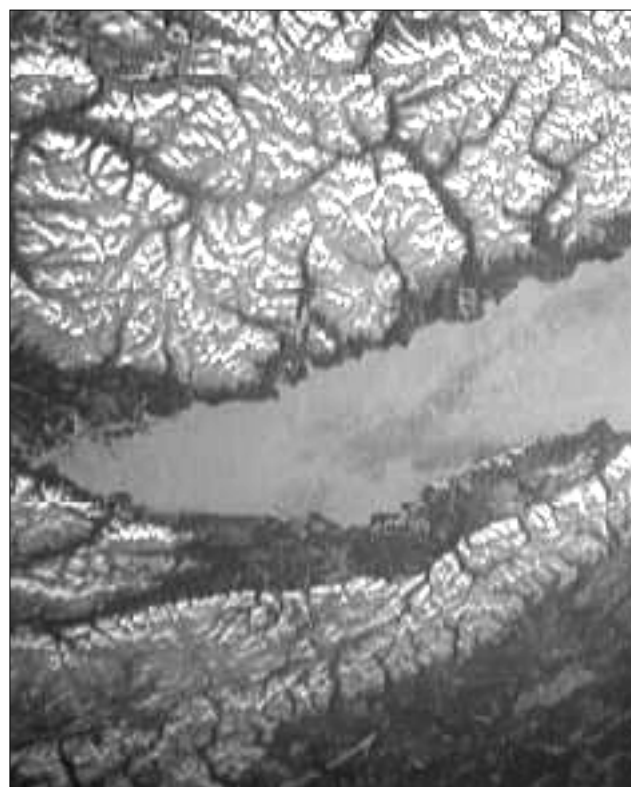
BY ALEXANDER NAZARYAN '02

Introduction

The mining of uranium in the former USSR, namely in geologically rich Siberia, has had serious repercussions that are only now coming to light. Not only are the safety standards of such mines highly questionable, these mines endanger people living in proximity to uranium-extraction areas. Dangerous aspects of uranium mining include seepage of radioactive tailings into groundwater, radon exposure that threatens communities near uranium mines and suspect storage conditions of spent nuclear fuel. Furthermore, precious natural areas like Lake Baikal, and the animal species endemic to this unique lake, are in danger as a result of improper mining practices. The secrecy of the Soviet Union prevented any knowledge of uranium mining from making its way into the scientific communities of the Western world. But in the post-Soviet era this information has become more accessible, and it is now possible to create a factual history of uranium mining and to demonstrate how various stages of this process present possible dangers that need serious and immediate consideration. Documentation by Baikal Watch, a non-profit environmental group fighting for preservation of Lake Baikal and Siberia, and socially-conscious nuclear researchers like Paul Robinson, President and Director of the Sandia National Laboratories, present these problems from a first-hand perspective that show the immediacy of the threat to both humans and the natural environment.

Geological History of Siberia

It is important to recognize that Siberia is a geological treasure trove, and a potential key to the economic revival of Russia. As the Soviet-era researcher Alexander Sutulov notes, the Soviet Union lies on two Precambrian plates – one granitic, the other gneissic. The “Russian Platform” is bounded by the Urals and the Caucasus, while the “Siberian Platform” stretches from the Pacific Ocean to the Urals, bordered on the south by the mountains of Central Asia (Sutulov 1973). Siberia’s rich oil reserves lie in sedimentary rocks where detritus was once deposited, having since turned into oil or methane gas. Sutulov continues by pointing out that geological transformations are still occurring around the former Soviet Union:



Courtesy NASA

Lake Baikal, Siberia seen from Space Shuttle Mission STS-60

“These rigid continental structures remained relatively stable and unchanged during the periods of mountain building...In many parts of the country the mountain building is still in progress as, for instance, in the Caucasus, Central Asia and Kamchatka, where strong seismic activity is still observed...The magmatic intrusions brought with them mineralization of the host rocks, and this is how many mineral deposits were formed on the Kola Peninsula, in the Urals, Kazakhstan, Siberia, and the Caucasus,” (Sutulov 1973). The unique combination of tectonic movements, contact metamorphism through continued magmatic intrusions and significant and prolonged decay of organic matter into fossil fuels has rendered Siberia a region rife with extractable ore deposits and natural resources.

Uranium Ore and its Extraction

Uranium, of course, is a particularly scarce and valuable element; Craig, et. al. report that its occurrence in the crust is 2 parts per million. Because uranium crystals are large, they do not precipitate out of igneous intrusions until the latest stages of cooling (Craig, et. al. 2001). “Hence, the uranium is commonly concentrated in the final (residual) melts and fluids, and in silica-rich rocks like granites that are rich in alkali elements such as sodium and potassium” (Craig, et. al. 2001). Pitchblende, UO_2 , appears to be the rock with the highest concentration of uranium, where it is present as the ion U^{4+} , the “uranous state” (Craig, et. al. 2001). Furthermore, Craig describes another process, through which U^{4+} is oxidized by oxygen to U^{6+} and is carried (within an ion of $(UO_2)^{2+}$) in groundwater into areas of organic deposits, where it is reduced back into its solid uranous state (Craig, et. al. 2001). “The leaching, transporting, and precipitation of uranium in this way can lead to the formation of large bodies of rock enriched in the

metal, and deposits produced by these processes are the most important sources of uranium” (Craig, et. al. 2001). Unfortunately, because of the Soviet Union’s secrecy concerning radioactive elements, information about uranium deposits and their locations in Siberia is only now starting to come to light (Craig, et. al. 2001).

The History of Uranium in Russia

Mining has been a historically profitable enterprise, and Baikal Watch describes Siberia as “an area where gold and uranium and other heavy metals had been extracted ever since the days of Joseph Stalin” (Baikal Watch 2001). The main use of this uranium was in the Soviet nuclear weapons project. Furthermore, mining in Siberia has actually increased since the collapse of the Soviet Union. The 1986 Chernobyl disaster - a core meltdown that led to wide dispersal of radioactive elements into the atmosphere - did not curb the use of nuclear energy. Craig et. al write that “Russia and the Ukraine have acknowledged grave safety concerns about their old plants but continue to use them because they have no other energy sources to produce power” (Craig, et. al. 2001).

Therefore, it is of little surprise that Siberia has experienced an increase in uranium mining in recent years. In the above-mentioned article, Earth Watch notes that since the fall of the Soviet regime, concerns for the economic well-being of Russia have created a push for increased mining of gold, uranium and thorium. Foreign investors have also been attracted to Siberia, bringing with them new mining technologies (Craig, et. al. 2001). As profits compete with environmental concerns in the public sphere, one can be sure that the dangers these mines pose may grow exponentially. The curtain has been lifted for environmental journalists to finally peek into Siberian mines, but has also allowed reckless investors to undermine the delicate ecology of the landscape.

There are various well-documented practices that threaten to further turn the tables against the environment in the name of greater financial gain. In 1998, the Bellona Foundation, an environmental watch group, reported that the Karelian Republic (a region in eastern Russia) would begin mining uranium and vanadium in the Srednya Padma deposit (Bellona Foundation 1998). Bellona notes that the Srednya Padma mine has five uranium and ten vanadium deposits. While Russia already produced 2,500 tons of uranium per year (plus 1,000 tons through enrichment) through the Priargunsky Mining and Chemical Combine in Chita, the hope was that the Srednya Padma would increase production to 4,000 tons. The potential profits dictated by this mining indicate that a lack of funding for this venture is highly unlikely (Bellona Foundation 2001).

The Khiagda and Krasnokamensk Mines

The physical process of extracting and enriching uranium presents two glaring problems: groundwater contamination from radioactive tailings and radon exposure from the uranium ore. The latter problem arises when radon gas is emitted by minerals containing uranium or thorium when the rocks decay radioactively (Craig, et. al. 2001). The gas is undetectable by the human senses and can greatly affect residential areas because of its covert movement from the soil into households (Craig, et. al. 2001). "If homes are built in such areas [above thorium or uranium deposits], some of the radon may enter through cracks in the basement, through drains and even in water pumped from wells in household use" (Craig, et. al. 2001). Many communities situated around uranium mines have been exposed to very high levels of radon, far above international regulations. Furthermore, water used in the process of separating uranium from its component minerals can seep into the ground, contaminating water used by near-

by communities. Craig, et. al. describes a process of in situ leaching, "in which a solvent (commonly acid) is drained downward through a previously broken ore zone" (Craig, et. al. 2001). Because of negligent practices, the acidic water is allowed to escape, thereby infiltrating water to be used by humans. Lastly, the beneficiation processes involved in extracting U235 (which is used in nuclear fission) from U238 involves complex chemical processes and the utmost knowledge of the various steps involved in order to avoid similar contamination (Craig, et. al. 2001).

Instrumental in exposing these and many other problems has been the work of Paul Robinson, an environmental journalist who descended into a uranium mine (Khiagda) near Lake Baikal, not far from Russia's southern borders. He was able to glean sufficiently disturbing evidence of negligence and potentially hazardous practices. He writes,

They did not maintain radio or telephone links to local communities, points of significant concern for residents of Romankova, the nearest villages which straddles the mine's sole access road to the site. The maintenance of the mine as a secret, government-controlled facility only heightened the discomfort of the nearby residents who had found the mine operators unresponsive to their concerns about potential radioactive releases from the mine. They were also concerned about the management of past and future spill of hazardous materials that had been coming to and leaving the mine. (Robinson 2001)

As a result of his time in the mine, Robinson was able to draw several conclusions concerning occupational and health hazards. The following, paraphrased from Robinson, are the most pressing issues: 1) Despite international regulations mandating otherwise, workers were not individually assigned counters (dosimeters) that recorded the level of exposure. 2) Groundwater near the mine was polluted because uranium was leached with large amounts of sulfuric acid (Robinson 2001). The pollution was so extensive that it was impractical to even consider restoration of groundwater. 3) Some of this sulfuric acid

seeped into the water at a large rate during an uncontained flow of leaching chemicals (Robinson 2001). 4) The Khaigda mine showed little desire or impetus to establish a communications framework with the nearby civilian community of Romanovka. 5) Khaigda showed equally little desire to take safety measures that would prevent the sulfuric acid from leaking during transportation to and from the mine, something Robinson claims could have easily been fixed. He grimly concludes his account: "The Khaigda mine is a small operation, but it is likely to establish a modern precedent for the quality of environmental performance and public transparency for Russian uranium operations" (Robinson 2001).

A more detailed report by Robinson describes his experiences in Krasnokamensk, Siberia's most extensive uranium mine, where he finds strong signs of negligence and disarray (Robinson 1999). "Residential areas are surrounded by the pits [the largest of these being, according to Robinson 500 meters deep and a kilometer in width], piles and headframes in the 30-40 square kilometer valley within which the mines and city are found...One of these settlements, Octobrysky, has homes with reported indoor radon level up to 28,000 Bq/m³, some 190 times applicable indoor radon standards" (Robinson 1999).

The Krasnokamensk mine was headed, at the time of Robinson's visit, by Priargunsky Chemical Mining Union, whose administration was open with Robinson, although no photographs were allowed. The mine was first prospected in 1952, with mineral extraction beginning in 1967. France, Sweden and Spain were the main recipients of uranium from the mine, for which they paid \$18/kg, a price that Robinson points out is less than half of the usual world-wide rate (Robinson 1999).

Like the Khaigda mine, Krasnokamensk presented serious concerns related to water contamination. Namely, Robinson identified two problems: 'mine water discharge' and 'acidic tailings

seepage' (Robinson 1999). Water used in the mine travels through a pipe and is discharged (still untreated) at Bambakai. Robinson points out that the radioactivity of the water was measured to be 150 microrentgen/hr, and Russian scientists could still detect radioactivity 10 km from the point where the water is discharged. "At the 150 cubic meters/hour mine water release rate for 17 years, the total amount of untreated waste water released was more than 22,300,000 cubic meters – more than 5,850,000,000 gallons or 17,955 acre-feet" (Robinson 1999).

The other problem concerned the acidic residue that seeped from a facility that treated tailings. These tailings are released after ore is processed in order to recover the uranium. The residue from this process is left in a pond. Robinson notes that the water that seeped from the tailings pond had been treated with sulfuric acid, thus significantly increasing its acidity. This water also contains contaminants related to decayed uranium, as well as heavy ores, nitrates and chlorides, and had a pH of 1-2 (Robinson 1999). There are clear similarities to the Khaigda mine, as the most pressing problem is again the contamination of groundwater by the sulfuric acid (and other residual chemicals) used to treat and purify the uranium ore. The residue from the mining process is carried by water, thus dissipating the radiation and contaminating a larger radius.

Shortcomings of Uranium Storage Facilities

Another problem highlighted by the Bellona Foundation has been the reprocessing of nuclear fuel. Although put to use in other countries, Russia has had particular problems with the "closed fuel cycle" in which nuclear fuel is reprocessed (Bellona Foundation). This is problematic because as Craig, et al. note, "The solid and liquid wastes generated in nuclear power plants are among the most danger-

ous materials on Earth” (2001). The reprocessing plants are in Siberia, and the Murmansk Shipping Company has had problems with the transportation of nuclear fuel to the region, which can be difficult to access. Therefore, nuclear fuel is simply piling up. “The reprocessing of spent nuclear fuel leads to an increase in the volume of radioactive waste, and much of this waste is in liquid form. There are large amounts of waste stored at the three facilities in Siberia, and the process has led to the contamination of large areas” (Bellona Foundation). Aqueous solutions with high radioactivity seep into Lake Karachay, which is in proximity to the Maya Chemical Combine in Ozersk. At the Siberian Chemical Combine in Seversk, a tank of nuclear fuel exploded, thoroughly contaminating the air. At Zheleznogorsk, near the Mining and Chemical Combine, “Fourteen million cubic meters of liquid waste with an activity of 26 million TBq [Tera-Becquerels] (700 million Ci [Curies]) have been pumped down into the ground.” Furthermore, “According to the Yablokov report, it has been estimated that in the period from 1961 to 1989, the rivers Ob and Yenisey have transported at least 1,100 Tbq (30,000 Ci) into the Kara Sea” (Bellona Foundation). Like other reports from Siberia, it underscores the inability of Russian mining operations to contain nuclear wastes and residues and prevent them from contaminating the water and air in proximity to the mines. Unfortunately, the increased interest shown by Western investors may very well exacerbate the problem, and the environmentally unsound mining projects of Siberia will continue to be strained by their own egregious inadequacies.

The Russian Nuclear Fleet also faces an increasing stockpile of nuclear waste, as the military was in such a frenzy during the Cold War that it is now faced with an over-abundance of nuclear fuel and waste. Storage facilities are brimming, and authorities appear to be helpless. “Solid waste is stored at 11 different places along the coast of the

Kola Peninsula and in Severodvinsk. All of the facilities are full, and at a number of them, solid radioactive waste is stored outside the storage facility in the open without any kind of protection” (Bellona Foundation). This disturbing piece of information is only made more so by the recent allegations that Al Qaeda terrorists had been snooping about Russian nuclear facilities, hoping to steal radioactive material which could have gone into a “dirty bomb,” which disperses, through explosion, highly radioactive material without creating a fusion reaction as is the case in nuclear weapons. The report continues: “Most of the storage tanks for liquid radioactive waste are full, and a number of them are in very poor condition. The storage crisis is precipitated by the lack of treatment plants” (Bellona Foundation). Once again, it can be expected that the negligent treatment of mining byproducts will cause the contamination of air and water surrounding waste facilities, as has been the case with the Khaigda and Krasnokamensk mines.

Possible Solutions

The dangers of continued uranium mining and careless use of this element are manifold. In his report on Krasnokamensk, Robinson shows just how precarious the situation is. “The Soviet technique of building mine towns in and around the mine sites, at both Baley and Krasnokamensk appears to have been a very effective way to establish a community in a high radiation area. Subjecting people to these hazards, and [supplementing] this relatively high background with construction materials made of tailings, are conditions [where] health risks are significantly increased and can therefore be said to be an ecological catastrophe in the making” (Bellona Foundation).

Nevertheless, Robinson offers solutions to the problems caused by mining, suggesting that tailing seepage can be reduced by decreasing the amount of liquid being pumped into tailings wells. Increased water volume directly raises the pressure, resulting in

the seepage of some of the waters. Investigations also showed that the wells were poorly built, resulting in increased seepage. "An array of well-engineered and well-constructed tailings ponds with multi-layer line and leachate collection systems also appear to be needed to address water management needs associated with current and future tailings management" (Bellona Foundation). Similarly, the problem of a contaminated high water table is far from unsolvable. Robinson suggests direct treatment of the water and other measures that would serve to provide a more balanced water level. "A more [detailed] understanding of shallow ground water flow system would provide a strong bases for selection of future drainage, treatment and discharge options" (Bellona Foundation).

The combination of a rich geological history and a newfound sense of Russian capitalism makes it highly unlikely that the exploitation of Siberia will cease until many of its reserves are exhausted. However, the manner in which mineral extraction is conducted will be crucial in determining the effect of mining on the environment of Eastern Russia. Uranium mining currently represents a nexus of problems, yet hopefully, better mining practices will alleviate its environmental impact.

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