The Death of Alexander Litvinenko

By Audrey Keown

November 1, 2006. Three or possibly four men meet in the bar of London's Millennium Hotel. One is Alexander Litvinenko, a fiercely outspoken critic of the Russian government and an ex-KGB agent. The others are Russian businessmen Dmitri Kovtun, Andrei Lugovoi, and possibly Vyacheslav Sokolenko, all of whom have either current or past ties to the Russian intelligence community. A second meeting with an Italian security consultant at a Piccadilly sushi bar, Itsu, took place later that evening. Other meetings take place in and around London that day. The number of meetings and their locations are shrouded in mystery; the substance of their discussions, unknown. What is known is that hours later, Litvinenko became seriously ill, allegedly the result of an intentional poisoning. Twenty-two days later, Litvinenko died of a previously unheard of method of execution; poisoning with a rare radioactive isotope—polonium-210.

An ex-spy

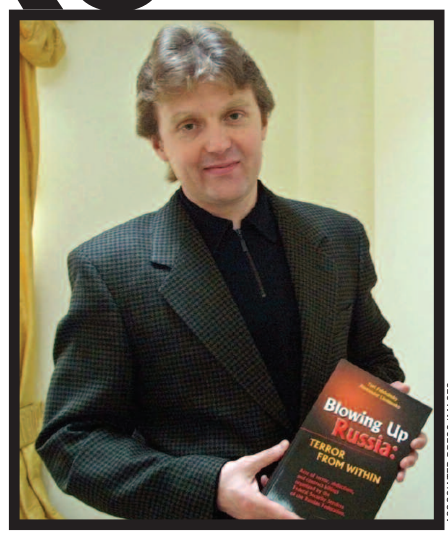
Alexander Valterovich Litvinenko was born in 1962 in the Russian city of Voronezh. At one time, Litvinenko transferred from the military into the FSB (the Russian Federal Security Service, which succeeded the KGB, an organization similar to the CIA), rising to the rank of lieutenant-colonel. His area of specialty was fighting organized crime, which no doubt made him some enemies. His disenchantment with the FSB and his falling out with Vladimir Putin (the current president of Russia), stems from the 1990s when Putin was the head of the FSB. Since that time, Litvinenko became an outspoken writer and a vehement critic of the Russian government, and Mr. Putin, in particular. In 1998, Litvinenko participated in a televised news conference in Moscow with other FSB officers. They claimed that their superiors had ordered them to assassinate people.

In the days following the November 1 meetings, Litvinenko's hair fell out, his throat became swollen, his bone marrow was attacked, and his immune and nervous systems became fatally damaged. After a valiant effort by doctors at London's University College Hospital, Litvinenko died of heart failure 22 agonizing days after his exposure to polonium-210 (^{210}Po).

Early on, British security sources revealed that MI5, the British counter-intelligence and security agency, had identified the FSB as the most likely culprit. From his deathbed, Litvinenko stated his belief that his death was ordered by Russian president Vladimir Putin himself.

Polonium-210

Polonium-210 is a rare, naturally occurring radioactive element found in minute amounts in the earth's crust. It was once used as a trigger in nuclear weapons. In this capacity, ^{210}Po is alloyed with beryllium (Be). The ^{210}Po fires off an alpha particle, which is absorbed by the Be, which subsequently spits out a neutron, initiating the uncontrolled chain reaction characteristic of nuclear fission. The ^{210}Po decays into stable ^{206}Pb after releasing the α-particle. Alpha decay causes the element to lose four mass units, and the atomic number is reduced by two.



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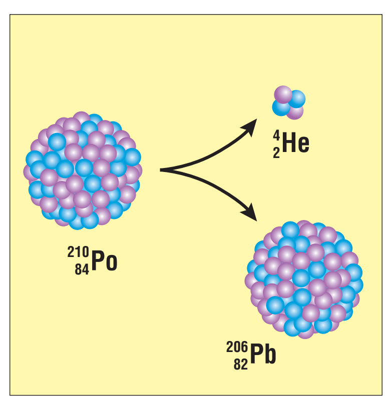
A. Litvinenko in 2002 holding a copy of his book, in which he alleged that agents from the FSB coordinated the 1999 apartment block bombings in Russia that killed more than 300 people.

$$^{210}_{84}Po \longrightarrow ^{206}_{82}Pb + ^{4}_{2}He$$

$$^{10}_{4}Be + ^{4}_{2}He \longrightarrow ^{13}_{6}C + ^{1}_{0}n$$

Using a $^{210}Po/^{10}Be$ alloy to trigger a nuclear weapon.



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Polonium-210 decays by alpha emission.

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German police seal the door of a Hamburg apartment building after finding traces of radiation in an apartment apparently used by Dmitri Kovtun.

Discovered by Marie Sklodowska-Curie and her husband Pierre Curie in 1898, it was tentatively called Radium F. Polonium was later renamed in honor of Marie's native land of Poland (Latin: *Polonia*).

There are 25 known isotopes of polonium, and all of them have short half-lives. A half-life is the time it takes for $^1/_2$ of a radioactive sample to decay to half of its initial value. The products of nuclear decay are called daughter nuclei. The range of atomic masses of these isotopes is 194 – 218 amu, with ^{210}Po being the most abundant.

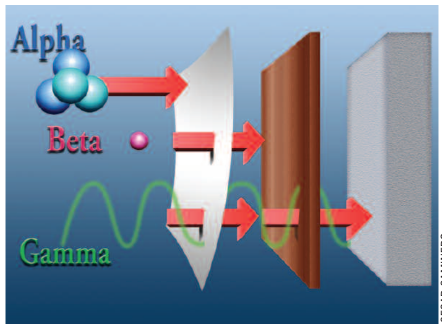
Polonium-210 is made by bombarding bismuth-209 with neutrons (that came from U-235) in nuclear reactors. The Bi-209 absorbs a neutron to become Bi-210, which spontaneously decays into Po-210 by beta emission. Beta particles are high-energy electrons. In the process of beta emission, a neutron in the nucleus is converted into a proton and an electron. The electron is ejected from the nucleus as the energetic beta particle. Thus, beta decay causes the element to gain one proton, but the mass number remains the same.

$$^{209}_{83}Bi + ^{1}_{0}n \longrightarrow ^{210}_{83}Bi \longrightarrow ^{210}_{84}Po + \beta$$

^{210}Po can be made from ^{209}Bi. The beta particle (β) has a charge of 1^-.

Biological hazards

The half-life of ^{210}Po is only 138 days. It decays by alpha emission, that is, it emits alpha particles, which are essentially high-energy helium nuclei. The alpha particles are high energy, but they have little penetrating ability—a single sheet of paper will stop them dead in their tracks. The particles are fired out of the polonium nucleus with 5.3 MeV of energy, which is more than 1 million times more energy needed to rupture a chemical bond. Because of their low penetrating ability, the particles are not harmful as long as the polonium is located outside the body. But if ^{210}Po is ingested, it becomes extremely dangerous. If only 1 μg of ^{210}Po is ingested, that corresponds roughly to 3 quadrillion (3×10^{15}) atoms of the radioactive isotope. This is enough for potentially hundreds of ^{210}Po isotopes to interact with each and every cell in a person's body. As the polonium atoms fire out the high-energy alpha particles, extreme damage occurs via ionization and radical formation. Proteins are destroyed and DNA is cleaved, making a mess of the internal functioning of the body.



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Comparing the penetrating ability of different types of radiation. Alpha particles can be stopped by a sheet of paper or skin. Beta radiation can be stopped by glass, plastic, metal, or wood. Dense materials such as lead, steel, or concrete are required to shield against gamma radiation.

It is theorized that alpha particles destroyed the fragile stem cells in Litvinenko's bone marrow. Stem cells are required for the maintenance of red blood cells and the immune system. A detailed autopsy was not possible at the time of this writing; the body was considered too dangerous to be safely handled.

Where did the ^{210}Po come from?

It has already been mentioned that ^{210}Po is very rare. Furthermore, the production and distribution of ^{210}Po is tightly controlled. There are no producers in Britain or the United States. Nearly all of the known ^{210}Po production worldwide takes place in Russian nuclear reactors, and almost all of it (less than 1 gram per year) is imported to the United States. In the United States the ^{210}Po is safely embedded in ceramic, so it may be used in static elimination equipment.

The United States keeps tabs on the imported ^{210}Po. Although it can be used to trigger a nuclear bomb, the likelihood of a terrorist group attaining a significant amount of fissionable fuel such as U-235 is small. They could, however, use the ^{210}Po along with conventional explosives to make a "dirty bomb" that would spread radioactive particles, creating a radioactive contamination hazard.

The investigation continues ...

If pure ^{210}Po was smuggled into Britain, authorities there have reason for concern. How did it get across the border, and how was it diverted? Interpol, the international police organization, has been called in to help coordinate the investigation, which now spans across three countries—Britain, Russia, and Germany. It will be some time before all of the evidence is in concerning Litvinenko's death.

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Investigators arrive in front of a Hamburg home to check for traces of polonium. The case now involves police and intelligence officials from three different countries, as well as Interpol, the international police force.

The evidence concerning his alleged poisoning will no doubt take even longer to conclude. Stay tuned to *ChemMatters*; we will be watching as the story continues to develop. When all of the facts are uncovered, expect to see a future issue with the conclusion to this extraordinary story.

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