

# Is the hypothesis “Arafat poisoned” moderately supported by the Swiss report, “strongly wrong”?

**Dr. R. Roth**  
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## History

Yasser Arafat, 1st President of the Palestinian National Authority, suddenly fell ill on the evening of October 12<sup>th</sup>, 2004 with severe nausea, vomiting and abdominal pain. Mr Arafat had been flown to France on a French government jet on October 29<sup>th</sup> and he was admitted to the Hôpital d'instruction des armées Percy in Clamart, a suburb of Paris. Arafat fell into a coma on November 3<sup>rd</sup>. He never regained consciousness. His condition deteriorated during the following days. He was pronounced dead on November 11<sup>th</sup>, 2004. His medical records never were disclosed to the public.

In 2012 tests revealed that Arafat's final personal belongings – his clothes, his toothbrush, even his iconic kaffiyeh – contained abnormal levels of polonium, a rare, highly radioactive element. Those personal effects, which were analyzed at the Institut de Radiophysique in Lausanne, Switzerland, were variously stained with Arafat's blood, sweat, saliva and urine.

The unexplained polonium-210 on Arafat's personal effects led to the opening of his tomb in November 2012. Russian, French and Swiss investigators took samples from his body, shroud and surrounding soil. The report from the University Centre of Legal Medicine in Switzerland was published by Al Jazeera in November 2013 and presented the day after by the CHUV to the public. The French and Russian teams have yet to disclose their findings.

## What did we do?

In order to have a better understanding of the conclusions mentioned in the report, several technical questions were drafted on behalf of the name of the Belgian monthly, Joods Actueel, published in Antwerp and having the Dutch speaking Jewish community as their main readership as well as other friends and politicians. The CHUV of Lausanne, Switzerland was also contacted as well as several medical and research specialists in several countries. Furthermore even more specialized literature about the case was consulted. The main sources as well as the individuals contacted are detailed at the end of the article.

## Short explanation of radioactivity

A material that spontaneously emits radiation, such as alpha particles, beta particles and gamma rays, is defined as radioactive material. The best known such materials are radium and uranium because of their discovery and their use to produce atomic energy. Another one is polonium which has 33 isotopes (variations) and in particular isotope Po-210. All radioactive material is unstable and subject to decay, which involves the loss of the above mentioned particles and results in a transformation into other materials. Thus Po-210 emits alpha particles, which makes it decay and form a stable isotope of lead Pb-210. Those alpha particles as such do not penetrate into the human skin and a paper sheet suffices to stop the radiation emitted by Po-210. But inside the human body they are very harmful above a certain level.

Po-210 is found naturally in the environment. The general population is contaminated internally with small but measurable amounts Po-210 on a regular basis through the consumption of organic food. It is mainly stored in human bones. Smoking too has a certain influence on Po-210 levels in the human body. The unit generally used to measure radioactivity is the Becquerel (Bq). According to the Journal Of Environmental Radioactivity the average concentration levels of supported Po-210 in various soils are in the range of 20-240 Bq/kg but in some regions in Norway, soil layers can have naturally up to 363 Bq/kg. High levels are also found due to pollution by phosphogypsum used in construction material.

## What is Decay of Po-210?

The decay process is quite stable for each radioactive material in the sense that it will lose its radioactivity and therefore mutate into another material in a defined period of time. Half-life is the period needed for the material to be reduced to 50%. A very simplified comparison for decay is the evaporation of a pool of water on the ground after some time into water vapor; the time half of the pool would evaporate would then correspond to the half-life of the pool.

It is important to understand the difference between supported and unsupported polonium. Supported Po-210 is formed when radioactive uranium decays in nature.

For Po-210 the half-life is 138.4 days and it decays into lead-206. On the other hand it is together with Pb-210 the longer surviving result of the decay process of uranium present in the crust of the earth. This naturally generated polonium is what is called supported polonium and is linked to the existence of Pb-210.

The isotope Pb-210 that accompanies natural polonium-210 has a half-life of 22 years. This means that roughly two years after death, those isotopes would normally reach equilibrium and emit the same amounts of radiation.

There is also synthetic polonium-210 made by irradiating bismuth-209 with neutrons, and it shouldn't contain any Pb-210 though the CHUV states it could contain some impurities of Pb-210.

Unsupported polonium is an amount above the expected natural level of polonium and might originate from synthetic polonium. Such polonium should not have Pb-210 associated with it. Detecting unsupported polonium could signify that an external source is involved. The potential detection of a relatively small level of radiation (or of polonium presence) above the natural background radiation after 8 years can be compared to background noise. *"It is like the noise when you're standing on a street. If someone is standing next to you, talking to you, you can probably hear him. Detecting low levels of radiation is like listening to a whisper on a busy street. Detecting Polonium 210 after 8 years is like trying to hear someone whispering on a busy street in New York... while you're standing in London."* (Israeli blogger Brian Thomas).

After 8 years or 2,922 days this implies 21 times halving the original quantity or dividing it by 2.342.180. The small quantity of polonium left above the naturally supported polonium would practically be impossible to detect. If we use our comparison with the evaporation which occurs in pool of water, it is like trying to establish whether the water comes from the soil, the rain, ice that fell off an ice-vendor or neighbors cleaning their cars many months/years later and trying to calculate how much of each could have contributed to the remaining water in the pool.

## **What happens in the body?**

The Centers for Disease Control and Prevention (CDC America's health protection agency) explains that *"Between 50% and 90% of ingested Po-210 passes thru the gastrointestinal (GI) tract and leaves the body in the feces. The retained amount enters the bloodstream where it concentrates in the soft tissues. Approximately 45% of ingested Po-210 is deposited in the spleen, kidneys, and liver; 10% is deposited in the bone marrow and the remainder is distributed throughout the body. Within the bloodstream, Po-210 combines with hemoglobin."*

In the body the total amount of remaining Po-210 is subject to physical decay but also to a biological half-time which is a measure of the time required for biological processes to eliminate one-half of the Po-210 retained by the body through feces or urine. The combination of both actions is that the effective half-life of Po-210 is approximately 40 days. So original intake through food etc, will leave only half the Po-210 after 40 days.

Seventy-five percent of the intake of lead-210 and polonium-210 is derived from bread, milk, cereals, beverages, other vegetables, sugars and preserves, and meat products. The average daily intake of these radionuclides are tentatively calculated to be 82 mBq for both Pb-210 and Po-210. Users of tobacco products are likely to have higher levels of this radioactive element in their bodies because of the higher intake by the smoke..

## **The critical views on the study**

Let's now take a closer look at the main issues in the report.

### **Error margins: not clear in the report.**

What is quite astonishing in a report which purports to be scientific is the lack of all-important error margins or confidence intervals. Some error margins are shown in X.1.4.16 on p. 94 but they are considered as typical and not as specifically applicable to the research done. Also error margins add up very fast in calculations or when comparisons are made.

In fact professor François Bochud, director of the Chuv Radiophysics Institute and leader of the research team in Lausanne, Switzerland, admitted in an email to Joods Actueel: *"Étant donné les grandes incertitudes liées aux modèles (très peu de cas ont pu les valider) et aux valeurs mesurées, il ne nous a pas paru raisonnable de reconstruire l'activité ingérée en faisant un calcul inverse."* or *"Considering the major uncertainties linked to the models (only validated by very few cases) and the measured values it did not seem reasonable to reconstruct the polonium ingestion by reverse calculation."*

Professor Atie Verschoor, Expertise Centre Environmental Medicine (ECEMed) in the Netherlands, comments on this declaration are very clear: *“Indeed Bochud confirms there are important uncertainties in the used model and for that reason and several others no conclusions at all can be taken. That had to be the conclusion of the report.”* Could this explain why professor Bochud did not address our question *“What would according to your experience be reliable error-margins for the obtained results and could these influence somehow your conclusions?”*

Verschoor further indicated to Joods Actueel that the *“error-margins are very high and caused by the fact that the material has not been kept in a controlled environment (8 years in a tomb), the decontamination operation and the calculation trying to eliminate the Po-210 quantity caused by radon in the soil. There are a lot of assumptions and that creates important inaccuracies. The researchers must have noticed it but did not document it.”*

Also Kai Vetter, head of applied nuclear physics at the Lawrence Berkeley National Laboratory in California, states to Nature *“After so many half-lives (implying a division by 2.342.180), you can’t reliably say how much polonium was there eight years ago, there’s too much background interference (from other radiation sources)”*

Professor Nicholas Priest, who formerly headed the biomedical research unit of the Atomic Energy Authority in Britain, still active in Radiological Protection Research and Instrumentation, and who is familiar with the Litvinenko case mentioned that one of his colleagues also noted that the comparisons in the report are always performed versus mean values used in scientific literature, though most of these follow a statistical normal distribution whereby confidence is expressed in percentage. Therefore there is no real confidence interval provided by the report.

He stated in The Independent that it is *“far too dangerous and scientifically unjustified”* to calculate how much polonium was in Arafat’s body on the basis of *“such tiny concentrations of polonium”*.

Professor Bochud candidly admitted to Joods Actueel *“We limited ourselves to determine that the measurements would be compatible with the values of potential intake. In this kind of comparison, obtaining the good order of magnitude can be considered as satisfactory”*.

But professor Priest sees it another way: *“The amount found was about one thousandth of a Bq [becquerel] per gram, and if you multiply it back up to what it might have been eight years earlier you get a figure of 192 million Bq administered.”* To Joods Actueel he added *“The inverse calculation indicates that the assumed intake amount of Po-210 is much lower (in MBq) versus the amount for Litvinenko (in GBq) that circulates among scientists.”*

According to CNN this is how Paddy Regan, a professor of radionuclide metrology in the physics department at the University of Surrey described the forensic examination: *“It’s like a blindfolded man holding the tail of an elephant and using that to estimate the weight of the elephant. You can do it, but there is a huge amount of extrapolation involved.”*

The Swiss scientists wrote regarding the only one bone test that had significant Pb-210 levels: *“In other words, if poisoning with polonium actually occurred, the high level of Pb<sup>210</sup> would probably not allow for the detection of its presence. Its detection would be masked”*. This argument is dismissed by professor Priest. Professor Priest *“is not confident that the Po-210 is unsupported because of the random ratios versus Pb-210 they found. The checking for Po-210 and Pb-210 is done by different methods, each with its error-margins and these uncertainties become much higher when one makes ratios, in particular because it are very low levels that are measured. So due to error margins it give very small confidence of the results”*.

Professor Verschoor is very clear about the report: *“The several data in the report have quite a lot of variation. Even ribs have surprisingly different quantities of Po-210. This is due to the fact that the body remained for a long time in the tomb. The researchers had insufficient material to be decontaminated and beside that it had to be corrected for Po-210 originated from Radon. The entirety has big inaccuracies that don’t allow to draft any conclusion.”*

## **Tampering?**

Nature writes: *“A piece of Arafat’s underwear stained with urine had a radioactivity of 181 mBq, almost 100 times higher than normal background levels”* (on p. 25 of the CHUV report). But as all materials were, according Arafat’s wife, kept together there is no valid scientific explanation as to why the samples kept with the underwear only had a typical background level. After 8 years the contamination should have been more evenly distributed.

So a hypothesis in support of H1 (poisoned) is *“Specimen adulteration is highly unlikely.”* is a very subjective argument of no serious scientific value, because it could read as well with sound Boolean logic *“Specimen adulteration is not entirely excluded”*.

But as if the Swiss scientists wanted to cover themselves: “*Finally, the “chain of custody” of the specimens contained in the bag cannot be documented between the death in November 2004 and their reception in Lausanne in February*” what makes Dan Kaszeta to state: “*Another huge deficit in the evidence is the chain of custody. This concern is actually voiced in the report itself. The evidence has been out of the control of those examining it for years. There’s no assurance that the personal effects or the human remains were not tampered with in some way between 2004 and 2012. I’m not saying that they were; it is just that it cannot be ruled out.*”

Maurice Ostroff voiced doubts: “*Among the intriguing mysteries involved is the fact that among the personal items examined by the lab eight years after his death was a urine stained pair of underpants. This is puzzling. Unless another explanation is offered one must assume that when Arafat arrived at the hospital the part of his clothing that was not submitted for forensic examination including underpants would have been sent to the laundry.*”

Dan Kaszeta argues that: “*Likewise, it could be possible that Mr. Arafat’s grave could have been tampered with at some point in the intervening years.*”

## **Hypotheses used to conclude poisoning “moderately supported”**

On pages 67 e.a. of the examination, the conclusions are drawn based on a number of observations and argumentation, classified under H0 (The death was not caused by polonium-210 poisoning) and H1 (The death was caused by polonium-210 poisoning). What it shows by taking a closer look is that several of the supporting arguments for H1 are very subjective or based on the absence of conclusive data:

- Acute digestive symptoms remain **unexplained**.
- **No diagnosis** had been obtained.
- Sudden onset of symptoms after a meal in an **apparent healthy individual**.
- Unsupported polonium-210 was found on the **stained personal effects**.
- **Death occurred** approximately one month after the onset of symptoms.
- Specimen adulteration is **highly unlikely**.

The “apparent healthy individual” hypothesis is also a contraindication to the information from Robert Fisk, Middle-East journalist for the Independent: “*Arafat did not look after himself. Diplomats who visited him there in the last days were appalled at the lack of hygiene, the blocked lavatories, Arafat’s own physical deterioration. One embassy official from Europe described to me how, during a conversation, Arafat was absent-mindedly tearing dead skin off his toes with his fingers.*” and “*In the end...his few visitors noted how old he looked, how sick. One Scandinavian diplomat who managed to visit him noted how he no longer wore socks, how he had a habit of picking loose skin from his feet during interviews, how the lavatories smelled.*”

Even the supported Po-210 present in the body remains used as an argument for H0 (no poisoning) is used here in support of the poison hypothesis H1. The stained personal effects for which the “custody-chain” is not guaranteed or are based on a curious logical approach such as:

- This is **coherent** with an intake that occurred at the time of the first symptoms.
- The high activity of lead-210 **could hide** the presence of unsupported polonium-210.
- The amount of lead-210 impurity found in a marketed polonium-210 source **was sufficient** to explain the large activity of lead-210 observed in the bones.

Professor Bochud commented to Joods Actueel “*Notre conclusion ne se fonde pas sur une évidence en particulier, mais sur la cohérence de l'ensemble de nos observations. C'est pourquoi nous disons que nos résultats supportent raisonnablement la proposition d'un empoisonnement au polonium.*” or “*Our conclusion is not based on any particular evidence but on the coherence of the totality of our observations. This is why we declare that our results moderately support the proposition of poisoning by polonium.*”

Professor Verschoor argued: “*to conclude that there was a Polonium-210 poisoning is not correct and lacks supported evidence*”

Professor Priest follows the same line. When asked whether the list of arguments in the report that support poisoning lack scientific credibility, his answer is “yes”. And whether one would give weight factors to the several arguments to reflect their real value in a decision process, would the conclusion be different: “*Yes I agree*”

Likewise Cyrille Vanlerberghe, **senior** Science and Health Editor for the major French daily Le Figaro, who wrote **an article** “*thesis of poisoning maintained by the Swiss*” accepted this observation and wrote to Joods Actueel “*no element of the tests performed on the corpse allows without ambiguity to conclude that poisoning occurred; but the number of the items under H1, their presentation and the full turning of the report let us think that the authors privileged the poisoning though their cautions and the use of the word “moderately*”

Priest finally adds to us *"I think the study is seriously done, but their conclusions were to my mind somewhat biased as to please the people who were paying for the report and probably Aljazeera was also quite happy with that."*

## **Contraindications to poisoning**

One of the main arguments in the report that leads to conclude the poisoning is:

*"The amount of Pb-210 impurity found in a marketed Po-210 source was sufficient to explain the large activity of Pb-210 observed in the bones."* This is seriously challenged by Kai Vetter in Nature who suggests that the team should survey other commercial polonium samples to back-up their lead-contamination hypothesis, and re-check the methods they used to extract the isotopes from tissue for systematic errors. Indeed, the hypothesis is not sufficiently justified by one sample of commercial Po-210 that is supposed to have no Pb-210 present, to entail such an important conclusion.

Dan Kaszeta adds: *"Often, these kinds of mBq levels are at the lower detection limit or within the error margin of instruments, although this is not made clear in the report. Even the highest figures noted in the report, in the range of 900 mBq, are actually very small by most standards. It should be noted that much coverage of the report fixates on the single 900 mBq figure, which is the highest, by far, of any of the figures in the report."*

However Professor Priest told The Independent that, while poisoning by polonium *"cannot be totally ruled out"*, the symptoms were very different from those of the Russian dissident Alexander Litvinenko, who died in London in 2006. *"Key indicators it was not polonium [that killed Arafat] were lack of hair loss in the face, and no damage to his bone marrow, both of which were found extensively in Litvinenko,"*

Professor Priest said. *"Photographs show Arafat stepping into a helicopter on the way to France sporting a white beard, while pictures of Litvinenko in hospital reveal an absence of any hair"*. One of the arguments used by the Swiss team in support of the potential poisoning: *"Myelosuppression and hair loss are associated with external radiation exposure, but not always with internal exposure...."* looks very light because the writers also state *"Furthermore, very little scientific literature exists on the acute exposure to Po-210"*

Deborah Blum, an American journalist and a professor of journalism at the University of Wisconsin-Madison, who wrote about the case and was quoted in the CHUV report, publishes: *"Curious because Arafat didn't demonstrate the classic symptoms of acute radiation syndrome. He suffered no hair loss, for instance, and no signs of the usual bone marrow damage which routinely leads to a devastating drop in blood cells. In fact, counter to the typical pattern, his white blood cell counts were elevated, suggesting infection rather than radiation poisoning."*

And professor Roland Masse, a member of the prestigious Académie de Médecine who currently teaches radiopathology at Percy Military Training Hospital, where Arafat was hospitalized two weeks before his death, already told the Times of Israel and Le Figaro already a year ago that it would have been impossible to miss radioactive poisoning in the tests that were carried out at the hospital. The tests showed that there was absolutely no way Arafat was poisoned. Also several other French doctors such as professor Stanislas Pol and professor André Aurengo said that poisoning would have been detected. As far as the Po-210 found in the stains of Arafat, Roland Masse adds with some sarcastic view: *"there is Po-210 all around; when you look for it you will find it"*

## **Conclusions**

What can we conclude? The main evidence shows that should he have been poisoned, reactions such as hair loss and damage to his bone marrow were not observed. The Swiss study specifies *"We have limited experience working with such specimens and very little has been published in the scientific literature"*(P 66)

Professor Priest is very specific though *"I would have come up with a different conclusion because the main arguments for Po-210 are hair loss and damage to his bone marrow what wasn't observed"* and *"both of which were found extensively in Litvinenko"*. *(The clinical description is not consistent with typical acute radiation which includes bone marrow disruption).*

Professor Alfred Bernard, Industrial Toxicology from the University of Louvain, UCL, Belgium, added kindly after reading this article: *"The data obtained on residual Po and PB can be qualified as 'unconclusive'... The second element is the clinical picture of the victim. In this instance, the comparison with the Litvinenko case is interesting. The period between the onset of the first symptoms and death is quite comparable (3 to 4 weeks in both cases) which means that, in the event of Arafat having been poisoned by Po210, the gravity of the poisoning would be comparable and therefore the clinical picture the same. It must be acknowledged, on the basis of available evidence, that Arafat's clinical picture does not support the hypothesis of poisoning by Po210. A drop in blood cells in addition to hair loss did not occur. It is my belief that if that was Arafat's clinical picture, French doctors would have proceeded to investigate radionuclides. ... Investigations were performed too late and the clinical picture does not back up the tested hypothesis."*

Professor Bochud himself wrote *“One cannot exclude the possibility of chemical degradation or redistribution with the surrounding environment. The very short half-life (138 days) renders their detection eight years after subject to large uncertainties. The elapsed 8 years prevented directly measuring soft tissues more suited to confirm the presence or absence of artificial polonium, as was found in the clothing.”... “it was not possible to explain what we did measure. The polonium that we did measure is actually the supported kind of polonium, the same kind of polonium that you would find naturally.”*

Also according to Patrick Regan, a nuclear physicist at the University of Surrey, UK, in the Nature article: *“But his lengthy report on the investigations, released yesterday (PDF), is clear that the evidence offers no firm conclusions. “I don’t think it will settle the debate,”*

The Independent also quoted Priest *“He pointed out that polonium would be naturally produced in the bones of anyone buried as a by-product of the bones absorbing lead from the soil, a point, he said, that “the authors of the report understand but the journalists do not”. The Swiss researchers’ carefully worded report admits that even in the tiny samples of non-bone body remains it found in the grave “no significant amount of unsupported polonium-210 was measured”. They also admit that the pattern of Arafat’s illness was “not consistent with typical acute radiation syndrome”.*

Paddy Regan stated as reported by Nature that If Arafat had been poisoned, *“a significant enhancement of polonium-210 compared to Pb-210 would be a smoking gun.”* Dan Kaszeta also adds *“The report clearly states on page 58 that the polonium in the human remains was likely to be “supported.” In my mind this casts some serious doubt on the poisoning hypothesis.”*

Atie Verschoor goes even further *“The fact that Po-210 has been discovered is probably due to soil-pollution. There were no urine, blood nor tissue samples and only few remains after 8 years in a tomb... the scientists in the report also indicate a number of items that are a contraindication to the poisoning such a loss of hair loss had to be present due to an high dose of Po-210. Not the typical damage to bone marrow that is expected by radiation. Also the toxicological analysis of urine before his death did not show any radiation”*

That confirms Professor Priest’s idea and several other scientists opinion that: there is no real substance in the study to support poisoning by Polonium 210

The only “scientific” support and which was prominently shown by Al Jazeera comes from a certain Dave Barclay, an ex forensic scientist from 1972-1990 with the Forensic Science Service (FSS) at the Birmingham laboratory and a retired detective who dreamed of becoming Sherlock Holmes in his younger life. He told Al Jazeera that with these results he was wholly convinced that Arafat was murdered. *“Yasser Arafat died of polonium poisoning,”* he said. *“We found the smoking gun that caused his death. What we don’t know is who’s holding the gun at the time. “The level of polonium in Yasser Arafat’s rib ... is about 900 millibecquerels,”* Barclay said. *“That is either 18 or 36 times the average, depending on the literature.”*

After having heard above the real up to-date scientists mentioned here-above, we can only suggest that our Dave “Sherlock Holmes” Barclay asks the famous Agatha Christie detective, Hercule Poirot, to join him in his search for the “gun holder”.

## **Who was contacted and what information is used?**

- Prof François Bochud, director of the CHUV Radiophysics Institute and the team leader of the research team in Lausanne, Switzerland; email exchange with Joods Actueel,
- Professor Atie Verschoor, Expertise Centre Environmental Medicine (ECEMed) in the Netherlands; email exchange with Joods Actueel,
- M. Cyrille Vanlerberghe, Science and Health editor, Le Figaro, France; email exchange with Joods Actueel,
- Professor Nicholas Priest, who formerly headed the biomedical research unit of the Atomic Energy Authority in Britain, still active in Radiological Protection Research and Instrumentation and who is familiar with the Litvinenko case from nearby, telephonic interview Joods Actueel on Nov 13.
- Professor Alfred Bernard, Industrial Toxicology from the University of Louvain, UCL, Belgium, email exchange with Joods Actueel and kindly provided comments on this article.

Public sources

- Professor Nicholas Priest in Paul Martin, The Independent, British expert says it's 'highly unlikely' Arafat was poisoned. <http://www.independent.co.uk/news/world/middle-east/british-expert-says-its-highly-unlikely-arafat-was-poisoned-8929762.html>
- Professor Roland Masse, member of the prestigious Académie de Médecine who currently teaches radiopathology at Percy Military Training Hospital in the Paris, where Arafat was hospitalised two weeks before his death in <http://www.lefigaro.fr/international/2012/07/31/01003-20120731ARTFIG00553-arafat-des-medecins-doutent-de-la-these-du-polonium.php>
- Patrick Regan nuclear physicist at the University of Surrey, UK. Kai Vetter, head of applied nuclear physics at the Lawrence Berkeley National Laboratory in California in Nature, No firm proof Arafat was poisoned. <http://www.nature.com/news/no-firm-proof-arafat-was-poisoned-1.14130>
- Brian Thomas, Arafat polonium — junk science <http://blogs.timesofisrael.com/arafat-polonium-junk-science/>
- Dan Kaszeta, former US Army and US Secret Service specialist on chemical, biological, and radiological defence, now working as an independent consultant based in London, Was Arafat really poisoned? <https://now.mmedia.me/lb/en/commentaryanalysis/520151-was-arafat-really-poisoned>
- Deborah Blum, The Maybe-Murder of Yasser Arafat <http://www.wired.com/wiredscience/elemental/>
- Maurice Ostroff; The Arafat “Who Dunit” – Chapter 1 <http://blogs.timesofisrael.com/the-arafat-who-dunnit/>
- The Centers for Disease Control and Prevention (America’s health protection agency) [http://www.cdc.gov/nceh/radiation/fallon/polonium\\_faqs.pdf](http://www.cdc.gov/nceh/radiation/fallon/polonium_faqs.pdf)
- Dave Barclay (<http://www2.hull.ac.uk/pws4/ug/casestudies/casestudieschemistry.aspx>) in <http://www.aljazeera.com/indepth/opinion/2013/11/can-be-certain-yasser-arafat-was-poisoned-20131110101810225911.html>
- Robert Fisk in <http://www.independent.co.uk/voices/comment/did-israel-murder-yasser-arafat-with-polonium210-some-questions-about-his-death-wont-go-away-8360376.html>