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Review Article

Hormetic effects of depleted uranium to the biosphere and lithosphere-atmosphere-ionosphere coupling

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Abstract

Although in the composition of the earth's crust, uranium exerts its harmful health, as well as environment effects if used both for nuclear weapons systems, or released in nuclear disasters. The thesis on the local application of uranium is unsustainable considering its physicochemical characteristics. Natural uranium, as well as depleted uranium emits alpha particles. The high ionization potential is liable for alpha particles' bystander effect in the living tissues, what is the basis of early and delayed health effects of depleted uranium. In the nature, repeated releases of no natural, high amounts of alpha particles, as it has been since 1991, when depleted uranium was used first time for military purposes, may induce empirically unknown consequences and catastrophic phenomena, including atmosphere heating. Some molecular mechanisms that resist radiation harm were discussed as examples of hormesis related to the biosphere and lithosphere-atmosphere-ionosphere coupling.

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Unequivocal evidence of the early effects of depleted uranium (DU) on the health of children from exposed territories after bombing of Persian Gulf and Balkans with DU ammunition has been based on authentic medical data [1]. Depleted uranium is an emitter of alpha-particles with high ionization impact in living tissues as well as in nature. The most accurate information about the effects of DU can be obtained in studies that take into account the natural characteristics of this substance, and assumed a simultaneous monitoring of the occurrence of events that at first glance do not seem to be associated with the effects of DU. Quantitative results, as opposed to the qualitative results, enable a more comprehensive analysis of DU effects in the living world or nature.

The hypothesis is that the repeated use of significant amounts of DU over a longer period of time could significantly influence the balance of all natural

resources and undermine the human health inducing the early and delayed health effects. Present study shows at least one of many possible molecular mechanisms that was the basis for hypothesis on the biosphere and lithosphere-atmosphere-ionosphere coupling and outlines the global environmental and biological effects of DU.

Keller and coworkers 2001 [2] reported that an extensive increase in the uranium concentration will occur in the environment after Gulf military use only in limited "hot spots" areas. However, in real-time, data suggested the detection of uranium dust in remote regions (distance about 2,400 miles) [3]. Kerkes and coworkers reported slightly increased concentration of small uranium particles caused by dispersed DU dust emitted during the bombing of Serbia, namely Kosovo region [4]. After inhalation, alpha particles induce harmful, longstanding bystander effect with possible

early and delayed health consequences [1]. The concept of DU induced health effects is unexpectedly plain. The depleted uranium repeated military use, every four years (1991-2011 in Persian Gulf and in Balkans) has some peculiarities: the low doses (air pollution easy transferable to the remote distances from the place of explosion) [3], and the slow doses (DU ammunition remnants can be fully oxidized into corrosion products twenty-five to thirty-five years after impact) [5], has ensured further prolonged contribution to the maintenance of alpha particles radiation with the consequent disastrous Petkau effect in the biosphere.

With uncontrolled military use of high amounts (over 2300 tons) of DU [2], numerous unusual environmental physical manifestations have been recorded in the last 20 years. Simultaneous monitoring of natural phenomena on Earth and in the atmosphere, revealed an exceptional parallelism between the phenomena in the environment and in the living world. The increased number of earthquakes [6], increased humidity in the environment [7], increasing number of forest fires [8], increased extreme weather events during the last 20 years [9], directed focus of our thinking to the question if periodically, artificial discharge of large amounts of ionizing alpha particles emitted from the decay of uranium that was used in military purposes, can seriously misbalance the nature equilibrium conditions?

There is a remarkable parallelism between the use of DU ammunition and physical phenomena described by sources cited above [6-9]. Having in mind the natural properties of uranium, which ignites spontaneously in air [5], it is possible that forest fires may be caused by the friable remnants of exploded armaments with DU, or by unexploded items in that region. For example, from 1990 to 2005 there were more than 1,700 forest fires in the Republic of Serbia. The total burnt area of forests was about 40,000 ha. Prominent peaks were detected in the period 1995-1997 (after bombing of Bosnia and Herzegovina), whose territory is next the border with Serbia, and in 1999-2001, after bombing of Serbia in 1999 [10].

Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) Model, given by Sergey Pulnits proposed the model on strong influence of radon decay generated alpha particles and its ionization onto atmosphere heating, as well as their importance in earthquake clouds formation. There are evidences regarding the releases of large amounts of radon in the days before an earthquake [7]. The radon concentrations measured in Iraq on some battlefields may originate from natural uranium [2], but radon may come from radioactive decay of DU used in the Persian Gulf. Radon mostly appears with the decay chain of the radium and

uranium series and marginally with the thorium series. Radon-226 undergoes alpha decay to produce Polonium-218, that ticks to dust particles which may be inhaled and stay in the lungs [11].

Alpha particles from any source are easily stopped by smoke. The excess of positively charged ionizing alpha particles that are deliberated from uranium decay can be temporarily concentrated by the air pollution above big cities. Ionization of these alpha particles may induce there locally changed the electromagnetic properties in the atmosphere, and heating as well. We wonder if the seismic activity may be provoked there in regard of the Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) Model [7].

The atmosphere heating effects of military used DU could be better clarified by the fact that 1gram of uranium gives energy that is equal ~3 tons of coal [12]. If about 3000 tones of depleted uranium were used in military campaigns during the last 20 years (1991-2011), then, approximately 3×10^9 grams of uranium has the equivalent heating effect as if about 9×10^9 tones of coal have burnt at the Earths surface! This may be one of reasons why during the 20th century and the last 2 decades, the global mean sea level rose at rates of 1.7 mm/yr and 3.2 mm/yr respectively, as a result of both increase of ocean thermal expansion and land ice loss. For the period 1993–2010, glaciers and ice caps have accounted for ~30% of sea level rise [13].

The bystander effect in the living tissue, or heating in the atmosphere are main ionization effects of alpha particles that originated from DU decay. If an open system is influenced by the input signal (the living cell and its external environment), the system is resisting to the change by numerous mechanisms that are basically adaptive, with the goal to preserve the existing balance. One of early radioadaptive tissue responses to inhaled DU particles transferred by air pollution was discussed recently by Zunic [1]. Under excessive, repetitive or continuous effects of radiation, above-mentioned adaptive cell effects could become exceeded and they induce the pathogenic mechanism by themselves. We proposed heat shock proteins (HSP) as at least one of molecular mechanisms operating between the environment and the biosystem (Figure 1). HSP are anti-stressor molecules, highly conserved through evolution, that resist noxious effect of the heat, heavy metals, antibiotics, protein denaturation [14]. It is a question when protective effects of HSP get his pathogenic feature? Some types of dementia showed highly induced expression of small HSP in affected cortex [15]. These *in vivo* models could be understood as examples of radiation hormesis.

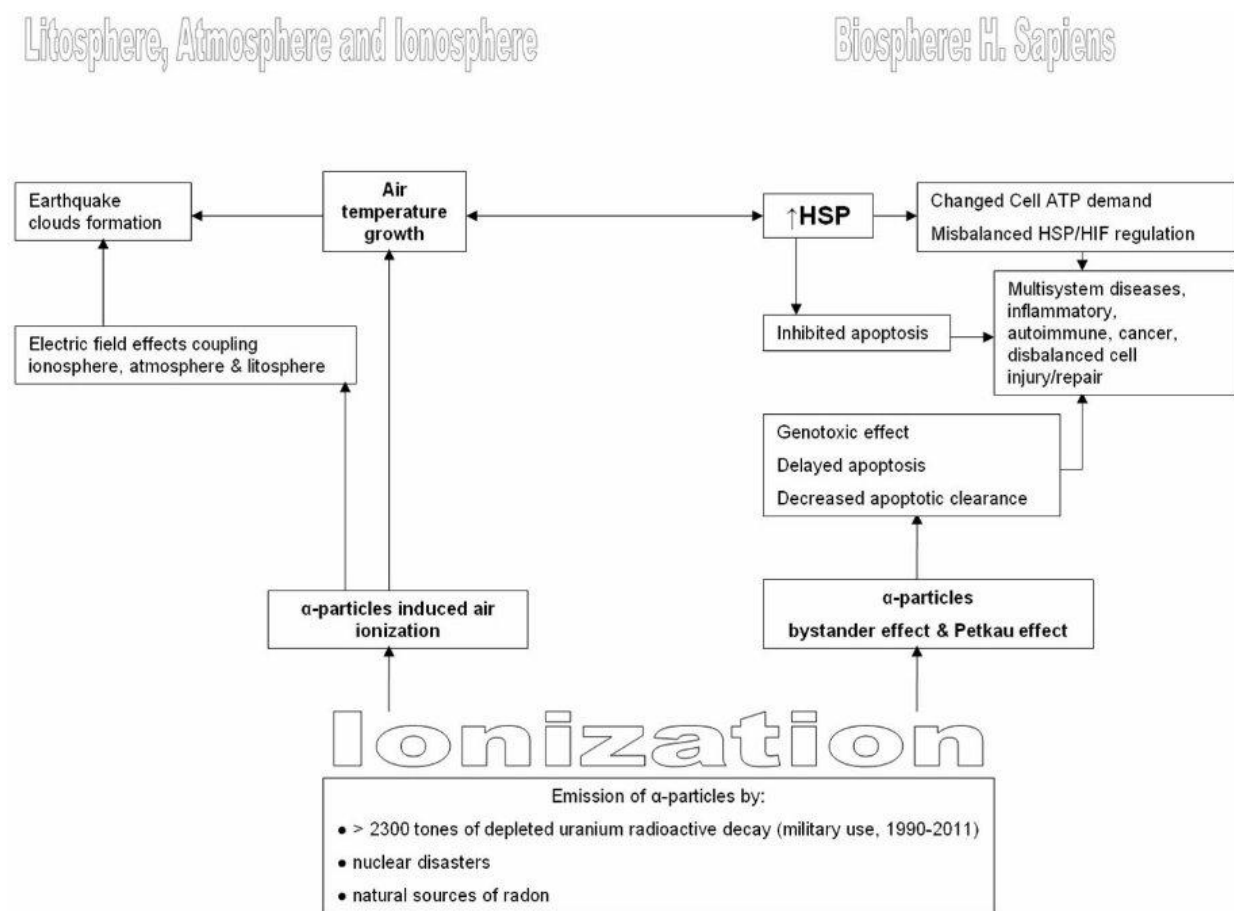


Fig. 1. The impact of alpha-particles ionization on the Lithosphere-Atmosphere-Ionosphere and Biosphere coupling.

Alpha (α)-particles from natural sources, nuclear disasters in peace-time and after military use of several tones of depleted uranium are emitted from the uranium decay. In the environment, as well as in living tissues, α -particles induce ionization. Rapidly increasing of positively charged α -particles in atmosphere, may induce changes in the electromagnetic field and changed coupling mechanism between the Lithosphere-Atmosphere-Ionosphere. Heat shock proteins (HSP) are presented as at least one of anti-stressor molecules which expression may be induced by influence of increased environmental temperature, which contributes to the causal connection between the atmosphere and biosphere. On the other hand, there is a wide range of molecules in the body that regulate metabolic turnover together with HSP. Adenosine triphosphate (ATP), hypoxia inducible factor (HIF), regulation of apoptosis may be changed because of α -particles bystander effect and the Petkau effect in living tissues.

In contrast to the example of radiation hormesis in the biosystem, in the environment, radiation hormesis is feasible, sometimes with concomitant catastrophic natural phenomena. Our hypothesis on the linking between environmental changes and living tissues induced by alpha particles (both, natural as well as of artificial origin) is schematically presented in Figure 1. Figure 1 shows equally the causes and outputs of alpha particles ionization of air as well as in living tissues. In regard of proposed model of lithosphere-atmosphere-ionosphere coupling [7], the Figure 1 pointed out the HSP as one of the anti-stress molecules that are universal in the living systems and that are included in complex regulatory networks to influence metabolic properties and tissue remodeling [16, 17].

The existence of hysteresis of alpha particles' output radiation power can be supposed in the biosystem. This mechanism includes alpha radiation induced bystander effect and relates to increasing the Petkau effect in the almost sustainable alpha particles release from corroded armaments, or by repeated explosions of DU missiles. Hysteresis that can be understood as the dependence of a system not only on its current environment but also on its past environment, in the case of Earth, means that every change that is high enough to modify ionic, magnetic, temperature equilibriums depends on natural default Earth's properties and tends to reach this equilibrium again. We propose that thousand tons of DU that have been used since the first military use in Persian Gulf, 1991, until present, changed sufficiently

the Earth's natural equilibrium in terms of default activity of natural uranium in the earth's crust and have triggered the visible outputs. The output retains its value until the input changes sufficiently to trigger a change. Every new use of DU in military campaigns, or discharge of radioactivity in peacetime nuclear disasters, may intensify the output. Repeated use of depleted uranium can produce ionizing radiation that, above a certain (unexplored) threshold, may trigger the disproportionately high response to the level where it becomes unpredictable and gives empirically unknown consequences. When the input is below a hypothetical preset threshold (natural properties of Earth), the output is absent to low, and records can be confusing, or misinterpreted. The big cities-big earthquakes relation has been outlined in one of the latest Science releases [18]. Santiago and Tokyo were in areas of increased seismic activity, but...data given by Mr. Oyama in his website in May 2012 reported alpha ray on Japan sea side too high even compared to the contamination situation in Fukushima and he suspected that it might be from past nuclear tests [19].

Considering the above-mentioned data, as well as the simultaneous occurrence of physical phenomena and health effects that could be measured during artificial use of depleted uranium for military purposes in the Persian Gulf and the Balkans, we believe that is 1) impossible to distinguish the origin of alpha particles from natural sources and from depleted uranium bearing in mind the nature of isotopes and their decay; 2) repeated abrupt release of the amount of ionizing particles in the atmosphere (military or peacetime disasters) may induce increased air ionization with consequent big increase in the atmosphere heating; 3) the present study was based on observations of other authors, that indirectly support the lithosphere-atmosphere-ionosphere-biosphere coupling and that implied the use of depleted uranium, or release of toxic and ionizing substances during peacetime nuclear disasters as the examples of environmental or biological hormesis.

ONE SENTENCE SUMMARY

The harmful effects of depleted uranium on the human health and the environment are discussed in relation to the effects of alpha particles ionizing impact in relation to the biosphere and lithosphere-atmosphere-ionosphere coupling

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