

VLADIMIR I. VERNADSKY AND HIS ROLE IN RESOLUTION OF CHALLENGES OF NUCLEAR ENERGY UTILIZATION IN RUSSIA

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The article describes V.I. Vernadsky's activity in the area of study of natural source of radioactive decay, prospective of practical use of energy of nuclear decay. Activity of Fedorovsky All-Russian Institute of Mineral Resources in the development of mineral resources for nuclear industry in Russia is explained.

6 references.

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150th anniversary of academician V.I. Vernadsky, a prominent Russian scientist, mineralogist, historian of science, philosopher, founder of geochemistry and many of its branches such as radiogeochemistry, biogeochemistry, cosmochemistry, geochemistry of Earths' hydrosphere and other was celebrated on March 12, 2013. He was promoted to a member of Prague and Paris Academies of Science, was granted many international awards. Majority of geologists, mineralogists and other specialists in Earth sciences in Russia and other countries employ ideas of the grand intellectual acumen of V.I. Vernadsky as the outstanding naturalist of the 20th century. His bright dynamic ideas connected all natural processes and phenomena, anticipated and defined development of Russian and the World's science for decades. Vernadsky gave an impulse to Russian science in many areas to contribute to the treasury of the World's science.

One of the most interesting areas of Vernadsky's creativity and executive scientific management was connected to his works on radioactivity, search for its natural sources and practical application of nuclear decay energy. He was one of few scientists who recognized and foresaw the new great source of energy for the humanity, the least known by the turn of the last century with hardly realized consequences of its use in the future. He mentioned in one of his first speeches "The urgent issues of radium" on the open meeting of the Academy of Science on December 25, 1910: *"We watch a revelation of such a source of energy that will make negligible power of steam, electricity, power of explosive chemical processes..., in the phenomenon of radioactivity we anticipate a source of nuclear energy which is millions of times greater than all energy sources that the mankind was dreaming of."* His report included the following words: *"... with a thrill and expectations we direct our vision to the new*

power revealing for the human awareness. What will it bring us in its future development?". He stated later: *"...with hope and concern we look into our new ally and defender"* (Vernadsky, 1954).

Amazing farsightedness of the great scientist, who could vividly describe complete meaning of the recent discovery was astonishing. Contemporary history showed that his concerns were not baseless: tragic incidents such as atomic bombs explosions on Hiroshima and Nagasaki, serious accidents at nuclear power stations: Three Mile Island, tragedies at Chernobyl, in the South Urals and Fukushima. Those episodes worsen with the problem of safe nuclear waste disposal that awaits its solution as many other ecological problems caused by careless human activities not mentioning radioactive factor. The world community started to actively address these issues, so hope for the effectiveness of the collective mind gives a space for some cautious optimism. This is why Vernadsky stated: *"The way of history is changing before our own eyes... Humankind as a whole becomes a great geologic factor. Demand to accommodate the biosphere according to the interests of freely thinking humanity as a unity arises before its mind and effort. This new state of the biosphere which we are unaware approaching is noosphere"* (Vernadsky, 1944; Armand, 2001).

Vernadsky's belief in the power and rationalism of the collective mind of humanity and subsequently his forecast of evolutionary development of human civilization with transition to the era of noosphere has been inspiring natural scientists and philosophers of various schools to dynamic research for almost half a century. Specific attention has been paid to the issue of sustained development of the civilization in the last decade. This issue is in the mainstream of the noosphere concept. Prevailing optimistic approach to the future of the humanity in the world

spread out because of the great influence of V.I. Vernadsky. The scientist was convinced of the civilization stability and its regular and global development towards more sophisticated forms of structuring and collaboration in harmony with the whole biosphere. It brings natural response of optimism because he cherished this idea in the time of numerous natural, technological and social catastrophes that happened on the break of the 20th century.

There were also people who did not share the optimism of the followers of Vernadsky noosphere concept. Philosopher N.N. Moiseyev discussing the "gradual transition to the noosphere" was very cautious about this change of humanity "... *half a century ago thinkers (Vernadsky and Teilhard de Chardin – authors note) had more reasons to be optimistic than the people of today's fin de siècle. They did not know about nuclear weapons and did not realize that the humankind is up to pass a harsh and severe global economic crisis. This transition will not be gradual and painless "amalgamation of the races, nature and God" as Teilhard de Chardin thought, but will be more likely bifurcation with unpredictable outcome*" (Moiseyev, 1994).

Nevertheless, let us be optimistic together with V.I. Vernadsky and based on the main law of the dialectics – the law of development and let us believe in the human mind: "... *the human had realized for the first time that he was a dweller of the planet and has to think and act in the new approach that is not limited by minding each individual, family or tribe, states or their alliances but in the light of the globe as a whole*" (Vernadsky, 1991).

Study of radioactivity was one of the main interests of V.I. Vernadsky of during all his life. Among a large group of professors he resigned from his professor position at Moscow University in 1911 in the protest to the repressive actions taken by the Tsars' government against students. He moved to Petersburg and in a year had organized Radium Expedition of the Academy of Science that explored for radioactive ores. The first results of the expedition allowed pioneering makeshift recovery of uranium and radium from ores of small Tyuya-Muyun and Taboshar deposits. Small amount of the metals was recovered from the ores for research and applied purposes.

A special chemical-mineralogical laboratory was organized at Mineralogical Museum of Academy of Science in Petersburg, which Vernadsky was leading since 1906. Mineralogy of rare and radioactive elements was studied there. Mineralogical and geochemical studies in Ilmeny Mountains in the Urals conducted by

Vernadsky was a special direction of studies of that period. It was in the Urals in the Ilmens, where he started to study formation of thorium and uranium minerals yet in 1897. Radiogeochemistry was formed there as a new branch of geochemistry. Regions of Caucasus, Middle Asia, Siberia, Transbaykalia were other regions where Radium expedition worked till 1918. The researchers in the expedition gathered mineral collections to replenish funds of Saint-Petersburg Mineralogical Museum of the Academy of Science, Geological and Mineralogical museum of Peter the Great back then. The mineralogical laboratory of the museum formed upon Vernadsky's initiative in 1912, was transformed into Radium Institute of the Academy of Science in 1922.

Stepping away from the main topic of the article, I would like to present some interesting facts that linked V.I. Vernadsky and Nikolay Mikhailovich Fedorovsky. Fedorovsky later became his student and successor, then prominent mineralogist, corresponding fellow of the Academy of Science and the director of the Institute of Applied Mineralogy (All-Union from 1935 and then All-Russian Research Institute of Mineral Resources, VIMS). They met in the Ilmeny, where Fedorovsky, was sent to collect mineral collections by the owner of a store selling learning guides. Fedorovsky was previously dismissed from the university for his political activities and experienced big financial troubles. Vernadsky liked the smart and sharp-sighted young man. He involved Fedorovsky in work of his expedition, helped him to resume study at the university, which he graduated in 1914 and cultivated love of mineralogy in him. Fedorovsky had respect and gratefulness to the teacher for all his life and there friendship lasted for many years.

Fedorovsky was politically active person and became Bolshevik in 1904. He headed the Mining Council of the VSNKh (Supreme Council on National Economy) after October 1917 and executed some very important commands of the government. He got to know in the summer of 1921 that Vernadsky was arrested as an active member of Constitutional Democratic Party and an associate of a minister of the Temporary government. Fedorovsky promptly sent a telegram to narkom Lunacharsky assuring him that accusation of Vernadsky in anti-Soviet activity was baseless and demanding his immediate release. Vernadsky was freed the next day.

It was unfortunate, that Fedorovsky fell victim of defamatory accusation report as well in 1937 and was imprisoned for 15 years. Neither V.I. Vernadsky, nor V.A. Obruchev, who wrote appeals to I.V. Stalin to release Fedorovsky,

could help him. Presently the Institute of Mineral Resources and streets in Nizhny Novgorod and Talnakh bear name of N.M. Fedorovsky. Soviet geologists remember the talented student of V.I. Vernadsky. Fedorovsky All-Union (All-Russian now) Institute of Mineral Resources made the essential contribution to development of the mineral resource basis for the nuclear industry of the USSR.

In 1920–30s V.I. Vernadsky paid considerable attention to the matters of nuclear reactions connected with fission of uranium nucleus with high energetic effects. He meticulously kept track of publications on the topic. Simultaneously with other soviet scientists, especially physicists, he noticed almost complete withdrawal of materials on this matter from public accessibility in the end of 1930s. It was a certain sign of concealing work on the topic because of possible weapon applications of nuclear fission. We need to note that further materials were taken from book of V.S. Gubarev (2009).

Materials gathered by Russian intelligence informed on commencing of development of nuclear weapons in England and USA. These data was delivered to the Soviet administration but at first was regarded to be disinformation determined to deviate Soviet efforts to the false direction. It was even more, that the intelligence data did not reach the people who actually worked on the nuclear program. In particular, I.V. Kurchatov was surprised when he was given helpful materials on the weapon development in England and USA in 1943. It needs mentioning, that the study on the nuclear program was carried out in several institutes of the Academy of Science even before the Second World War in spite of blunt skepticism from some scientists. There were problems with production of necessary instrumentation and obtaining radioactive materials for experiments. Vernadsky was aware of the situation.

Vernadsky knew about discovery of the effective chain fission reaction of nuclei of uranium-235 with neutrons and actively called for attention to it from the Presidium of the Academy of Science of the USSR. There were always visionaries in our nation who could foresee the future. Academicians Vernadsky and Khlopin directed a "Note on arranging uranium production" to the Presidium of the Academy of Science of the USSR. This document stated the important fundamental scientific and applied meaning of the study of nuclear reactions with energy effects. In particular it said: "...We think, that even now, when the question of separation of U-235 isotope and utilization of nuclear fission energy meets some technical issues, which in our opinion

do not have fundamental problems, urgent measures of establishing uranium exploration, mining and extraction in the USSR have to be taken. They are necessary to provide enough precious energy source material by the time when the technical issues in interatomic energy utilization will be solved. So far, the situation with such resources in the USSR is exceptionally bad. There is absolutely no resource of uranium. This metal is very scarce. There is no established recovery of the metal. Large explored deposits of it on the (Soviet) Union territory are unknown. Detailed exploration of the known deposits and searching for new ones go at very low pace, are not enough and are not connected with one big idea..." The "Note" was discussed on the Department of the Academy of Science few days later and academicians were asked to develop a project with certain implementation plan in two-week time. Vernadsky wrote in his diary on July 17, 1940: *"There was a question on uranium on Presidium session. I presented a report that was not very successful, but the result was gained. The vast majority does not understand the historical meaning of the moment. I wonder if I'm mistaken? A note to the Government is needed..."*

The Commission on uranium issues was formed on the meeting of Presidium of the Academy of Science of the USSR on July 30. It was a group of 14 people. There were ten academicians: Khlopin (the chairman), Vernadsky, Joffe, Fersman, Vavilov, Lazarev, Frumkin, Mandelshtam, Krzhizhanovsky, Kapitsa, professor Vinogradov and senior researchers Kurchatov, Shcherbakov, Khariton. Academicians Vernadsky and A.F. Joffe were appointed to deputy chairmen of the commission. However, the commission worked much slower than expected. It became particularly clear with the start of the Second World War. All the energy was turned to the defense. Attention to the nuclear problem increased somewhat in 1942 after the first successes of the Red Army.

Vernadsky wrote in November of 1942: *"It is necessary to seriously and extensively establish development of nuclear energy of actin-uranium. In this order the Uranium commission has to be reorganized and transformed into a flexible organization that would have two main goals: First of all, the quick discovery of rich uranium ores in our country, which is possible. In the second place, few kilograms of actin-uranium for experimental work with practical applications have to be produced promptly. We need to quickly solve the dilemma if we are indeed in the wake of a new era of the humankind, as I and many other geochemists and physicists think, the new era of application of new forms of atomic energy or we*

are not. In the light of devastation that Nazis barbarians caused to the national economy, we need to find out if it is realistic and beneficial to utilize this form of energy".

The government made the decision creating "the Nuclear project of the USSR" on September 28, 1942. It was the direction No 2352cc of the State Committee of Defense "On arranging work on uranium", signed by I.V. Stalin. This document considered organization of a special laboratory (It was laboratory No 2 from 1943), separation of materials for experimental work and providing laboratory space for atomic nucleus laboratory in the city of Kazan. A.F. Joffe was appointed to a lead resuming the study on uranium. He, in turn, insisted on transferring the duties to I.V. Kurchatov. I.V. Kurchatov was appointed the scientific chief of the work on uranium by the order of State Committee of Defense on February 11, 1943.

V.I. Vernadsky was concerned with low activity of the Uranium Commission of the Academy of Science of the USSR and addressed to the President of the Academy of Science from Borovoy, where he was evacuated. He wrote: "I consider it is urgent to resume activities of the Uranium commission, having in mind possibility of military application of uranium as well as in quick reconstruction of the economy after devastation of the country from Hitlers barbarians. New sources of powerful energy are needed to reach these tasks." With these words Vernadsky actually pointed to possibility of electric energy generation and anticipated design of nuclear power plants.

He wrote to the President of the Academy of Science later in personal letter criticizing his colleague: "I'm certain that the future belongs to the atomic energy and we need to understand where uranium ores localize in our country. Our efforts in this question have been stalled for few years. Unfortunately, Ioffe does not understand or pretends that he does not understand, that to utilize atomic energy, in the first place uranium ores need to be found in significant amount. I think that it can be done during one summer campaign. Fersman and Khlopina share the same opinion as far as I know" (Gubarev, 2009).

The Manhattan project was actively deploying in the USA from January 1943, according to the intelligence sources. It resulted in creation of the atomic bomb that killed hundreds of thousands of people in Japan in September 1945. Active work on the Atomic project, which was numerous times endorsed by Vernadsky, commenced in the USSR in the same time. We know now that its mission was accomplished successfully.

Vernadsky took part in the meeting of the Committee on geological affairs at the Sovnarkom of the USSR on October 2nd, 1943. It was chaired by I.I. Malyshev and worked out a plan for uranium exploration program and organizing a permanent Consulting Bureau on the issues of uranium resources at the All-Union Research Institute of Mineral Resources. V.I. Vernadsky was a member of the bureau.

It can be noted with satisfaction that intensive work of all exploration and mining companies, research institutes of the country quickly provided the solution for uranium resource problem. Several large deposits of radioactive ores had been discovered and the work on nuclear defense program succeeded. In very restricted time limits USSR obtained enough uranium to extract isotope U-235, the main component of weapon metal as well as fuel elements of the world's first nuclear power plants developed in the Soviet Union.

The soviet scientists, designer engineers, researchers of the nuclear industry, numerous geological parties and the whole soviet nation accomplished a great historical achievement. Monumental efforts of the soviet nation created a reliable and safe nuclear shield in unreasonably short period. The opponents who wanted to destroy Soviet Union with atomic fire were stopped in their efforts being aware of inevitability of protective retaliation.

Importance of Vernadsky's contribution to the solution of the nuclear problem in our country is gigantic. We, the grateful descendants of the great scientist will remember this accomplishment!

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