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## SKETCHES ON HISTORY OF STUDYING RADIOACTIVITY AND FORMATION OF URANIUM GEOLOGY IN THE CENTRAL SIBERIA. Sketch one. Beginnings

V.A. Domarenko, L.P. Rikhvanov

Tomsk Polytechnic University  
E-mail: domarenkoVA@ignd.tpu.ru

*The history of studying radioactivity and the radioactive elements has already numbered more than one hundred years. In the beginning of XX century interest to uranium was defined, first of all, by cost of its radioactive product – radium, which, at the earliest stage, was applied in medicine and for research purposes. Short description of studying radioactivity and beginning uranium geology in the Central Siberia is given. Unknown pages of this history are shown.*

The history of studying radioactivity and the radioactive elements in the territory of the Central Siberia has already numbered more than one hundred years. Interest to uranium in the beginning of XX century was defined by the cost of its decay product – radium which was applied in medicine and for research purposes at the earliest stages.

Peter Orlov, professor, chair of chemistry, medical faculty of Tomsk State University, and Dmitry Alekseev, an employee of chair of chemistry of Institute of Technology (he read public lectures about properties of radium in 1904) organized goal oriented researches on studying the radioactivity phenomenon. They are to be considered pioneers in the field of studying radioactive elements not only in Siberia, but also in Russia. They began this work earlier, than the academician V.I. Vernadsky who is considered to be the founder of classical radiogeology. V.I. Vernadsky began studying radioactivity in the Russian Academy of Sciences [1].

First expeditions on researching radioelements worked in Siberia in 1904-1905, under the guidance of the laboratory assistant of Tomsk Institute of Technology, Veniamin Semyonovich Titov. Professor P.N. Lebedev's follower, the future professor of Moscow State University, studied radioactive waters near Belokurikha. In archives there is his application to the head of the Institute (March, 1908) where he wrote: «In summer 1907, I had a case to research the radioactivity of Belokurikha warm sources in Altai using Elstera and Geitel devices. These researches proved my guess about high level of radioactivity of the mentioned water» and further «... besides I found that radioactive gas bleeding from Belokurikha sources possessed extremely high level of the gas radioactivity and the level is higher than Narzan's» [1].

On the basis of this record, Council of the Tomsk Institute of Technology (TIT) sent V.S. Titov and student V.P. Markov for detailed studying radioactivity waters and gas to village Belokurikha, and appropriated 300 rubles for this purpose. In the beginning of 1909, for the first time, materials on studying radioactivity of radonic waters at Belokurikha, were discussed on XII congress of scientists (journal # 9, 1909–1910). In 1913, under the order of V.S. Titov, head of TIT, the book «Radioactive emanation in therm waters and gases of Belokurikha on Altai» [1] was published.

Professor P.P. Orlov, in 1907, organized studying of radioactive elements in the Yenisei Guberniya one year earlier the first academic expedition, on his own means. Students of Tomsk higher educational institutions P.P. Orlov, B.K. Shishkin, and others, took part in these works.

These expeditions showed that air-radioactivity on ore mine Julia, mineral water of lake Shira, Domozhakov, Shunet was high and the same phenomenon could be seen on Ushaika river (Zavarzinsky sources), Tom' river, especially in winter time (P.P. Orlov, L. Bertenson). L. Bertenson in 1914 published work «Radioactivity in medical waters and muds» with comprehensive information [2].

In October-November 1909, P.P. Orlov made a report «Radioactive substances in environment» on sessions of the Society of investigators and doctors at Tomsk State University (TSU). He noted the radioactive minerals on Altai which were found by P.P. Pilipenko, junior laboratory assistant of the mineralogy sample room of Tomsk Institute of Technology, V.I. Vernadsky's follower employed at TIT by V.A. Obruchev under the personal request of V.I. Vernadsky [1].

In 1912, P.P. Orlov, on the request of N.I. Kartashov (head of TIT), investigated a specimen of the mineral given by the East-Siberian department of Russian geographical society. The mineral appeared to be allanite with rather interesting properties what was reported in materials of the Geographical society in 1914 [2].

Unfortunately, reports on these expeditions were published much later. So, V.S. Titov's work became known to the Russian scientific community in 1913, and P.P. Orlov's work «On finding radioactive substances in primary concentrate of gold-bearing stream gravels of Siberia» where he noted high radioactivity of gold-bearing deposits of Ayakhtha river (Yenisei log), was published only in 1915 [2]. We should note, that V.I. Vernadsky's first big publication in works of Radium expedition of Imperial Academy of Sciences got out in 1914, and the Radium laboratory was established in 1911, whereas in Tomsk the analogous laboratory was established in 1908.

N.A. Gezhus (TSU rector), professors, private-senior lecturers and laboratory assistants of TSU and TIT A.I. Efimov, D.A. Alekseyev, geologists and miners P.P. Pilipenko, P.P. Gudkov, M.N. Sobolev, V.A. Obruchev, A.V. Lavrsky, B.L. Stepanov, L.L. Tove and many others were involved in studying questions on radioactivity and radioactive elements, first of all, radium sources. In the letter of July 01, 1913, P.P. Orlov wrote to V.I. Vernadsky: «... Using acquaintances at the Institute of Technology, I try to propagandise studying radioactive substances...». Close contact with different specialists, allowed P.P. Orlov to develop the fundamental scientific program on studying radioactivity and radioactive substances of Siberia which according to researchers of that time, was the most interesting.

In 1913, the radium problem was constantly on periodicals pages. Radium cost reached 300 thousand gold rubles per one gram. It is necessary to note, that radium extraction in the world was, in those days, about six grams for all previous period [1].

The meeting of the Russian scientists and a Moscow merchant Pavel Pavlovich Ryabushinsky was the historical moment in studying radioactivity and radioactive substances in Siberia. Interesting notes are stored in V.A. Obruchev's personal archive who was one of the founders of Tomsk Polytechnic University, a well-known scientist, writer, traveler and academician. These notes include recollections about his meeting with this known businessman and the patron of art. The meeting occurred on Thursday, November, 14th, 1913 at P.P. Ryabushinsky's apartment in Moscow. V.I. Vernadsky, V.A. Obruchev, V.D. Sokolov and other known scientists were invited to this meeting.

P.P. Ryabushinsky with interest listened to messages of Professor V.I. Vernadsky and other scientists about radium, its value for science and mankind and about the future which would expect it. P.P. Ryabushinsky as the businessman was rather interested in this problem, and he asked a lot of questions. In the end of the meeting he said, that he was ready to finance searches of radium and radioactive elements, but under certain conditions

by those who would carry out these searches for the account of its means. As the businessman, he thought, what practical benefits could be taken from working out this theme.

After this meeting measures on accelerating searching radioactive elements in Russia were taken. At the expense of manufactures there were organised two complex expeditions: to Central Asia (Fergana) and in Zabaikal. Interest to radium ore in Siberia, was not casual, that, apparently, was connected with high price of radium at that time, and an interdiction of the government of Austro-Hungary and Germany (the main suppliers of raw materials for radium reception) on export of the radioactive ore from the countries in 1913 [3].

P.P. Ryabushinsky equipped special (Moscow) expedition for researching radioactive elements in Zabaikal region and Fergana in summer and autumn of 1914. Zabaikal department of the expedition was headed by Michael Nikolaevich Sobolev, the economist by training. He was a great scientist and worked for a number of years at Tomsk State University and Tomsk Institute of Technology and was amicable with professor V.A. Obruchev, G.N. Potanin and many other scientists who were engaged in researches of Siberia. M.N. Sobolev was the skilled researcher, knew locality well and, for this reason, not being the specialist in the field of geology, he was charged to head Zabaikalian department of the Moscow expedition. All materials collected during researches belonged to P.P. Ryabushinsky according to the contract. In the end of 1914, professor M.N. Sobolev published the short message on summarising works of Zabaikalian expedition. Nowadays it is stored in A.A. Chernov's personal archive at the Institute of Geochemistry named after V.I. Vernadsky (IGC) [3].

While studying radioactive substances in Zabaikal region, Doctor I.A. Bagashev noted high disease of the population of the Cossack settlements. They used drinking water with high radioactivity (2,25...10,22 Mach units) from local wells and sources.

Irrespective of these expeditions, other geologists working in Siberia were engaged in radium searches too. V.A. Obruchev undertook independent steps on searching radium. He sent through his follower, Professor P.P. Gudkov who became his successor at TIT, a big paper «Search for radium» which was soon published in Tomsk newspaper «Siberian life» of December 01, 1913. In this paper V.A. Obruchev represented radium, what it served for people and motivated everybody to search deposits of radium and radioactive elements. Having gained the letter of his instructor, P.P. Gudkov called all geologists working under his supervision, and students of the mines branch, having practice in Siberia, read them lecture about radium and radioactive elements and offered, together with basic work on survey deposits, to search radium.

Results of these searches were not so good. There were not opened large deposits. There were objective reasons, namely, weak knowledge of the radioactivity origin, unknown uranium minerals; the technique of searching these ore was not developed, there was no hardware maintenance.

About details how Siberians searched for radium, the former student of the mines branch of TIT, well-known Siberian geologist, Professor Nikolay Nikolayevich Urvantsev who under P.P. Gudkov's recommendations investigated iron-ore deposits of Kuznetsk Ala Tau recollected: «... There were no devices for searching radioactive ore. Used P.P. Gudkov's recommendations». Uranium bearing of iron ore in Kuznetsk Ala Tau was proved only in the fifties of the past century [3].

Problems of radioactivity and possibility of revealing radium ore, were widely discussed in local geological publications. A lot of papers and notes on radioactivity problems were published in the journal «Mining and gold-mining news», in Tomsk. In 1914, there were about 30 papers. In a note behind the signature «G.M.» was written: «... From the moment of opening America there was no such convenient field for scientific researchers and the enterprise, selectors of happiness aimed to a profit, as the emerged question on searching the radioactive ore...» [3]. A mining geologist V.M. Boreysha wrote a detailed article «About necessity of a wide public initiative for researching radioactive ore in Russia». The article noted, that there were signs of the increased radioactivity in waters of Shira, Tagarsky, Uchum, and in waters around copper ore mine «Julia». Under V.M. Boreysha's order, the collection consisting of 15 typical radioactive minerals arrived to the Martyanovsky museum of Minusinsk. On this paper, there were many responses with the direction of places for searching the radioactive ore in Siberia [3].

In the same journal of 1914 (№ 12, P. 257), a note «Uranium ore on Baikal» was mentioned about the first expedition of Curie Institute: «... As informs G.M., the expedition consisting of three engineers led by the head of Curie institute Mr. Zhilber for surveying uranium ore...». This note, or, most likely, free interpretation, formed a beautiful legend about Maria Sklodovskaya-Curie's stay in Siberia. This note was used by V.A. Obruchev in the book «Bibliography of Buryat-Mongoliya (1890–1936)» to which referred Soviet historiographers while discussing the fact that Marie Curie, the twice Nobel prize winner, the outstanding researcher of radioactivity and radioactive elements stayed in Siberia [4, 5].

A.A. Hahalkin stated [4] that the activity of this expedition was as follows: «... The French expedition headed by outstanding scientist Maria Sklodovskaya-Curie, worked in May-June, attended Krasnoyarsk and Zabaikal region...». Further he noted, that in Krasnoyarsk Mrs. Curie met the head of labor mining searching crew, peasant I.G. Prokopyev who later corresponded with her and sent specimens of radioactive ore.

Who was I.G. Prokopyev? Researching primary sources [3, 6–9] tells that it was a person who played bright and, according to employees of the Museum of Geology of the Central Siberia, even a tragical role in prospecting business of Siberia – Ivan Grigoreviche Prokhorov (1887–1963). If to take into consideration the memoirs published by F.P. Zyryanov in the newspaper «Zavety Ilyicha» in 1977, the peasant of Kazansko-Bogorodsky village (nowadays Tagashet village),

Knyshinsky volost of Minusinsk district, was the first pioneer and the getter of uranium ore in Siberia [3].

I.G. Prokhorov's role in opening the radioactive ore of Tagashetsky deposit (the Bes-Detlovsky mining region) is represented in the geological report of Tagashetsky prospecting party of 1936. The report underlined, that, in 1914, I.G. Prokhorov brought to Krasnoyarsk for Maria Sklodovskaya-Curie ore specimens of high radioactivity. There are data, that Norwegian engineer Hans under the order of prospector I.G. Prokhorov studied graphic granite radioactivity in Bes-Detlovsky. Being in German imprisonment in 1916, I.G. Prokhorov informed M. Curie about this deposit. The camp military authorities, having learnt on it, published in the special German journal a paper about finding radium ore in East Sayan [7]. Unfortunately it was not possible to find this paper.

I.G. Prokhorov [4] told about Marie Curie's staying in Krasnoyarsk in the memoirs in 1956. He wrote: «... My companions and I found a lot of signs of radium ore and established the first Siberian labor mining searching crew in spring, in 1914 in Krasnoyarsk. In one of my arrival to Krasnoyarsk I met a very kind and easy-care woman. She was very attentive to common people. The engineers respected her. They said me that she was a very famous scientist and found radium. She wanted to see the specimens and to give them estimation. Her estimation was the most important for all scientists. Engineers of the company «Razvedchik» wanted me to go away from the hall where M. Curie was working with the specimens from Minusinsk province. She was observing and measuring the specimens using the electroscope. I was in work wear, water boots, my clothes and boots smelled unpleasantly and I understood that I was disturbing such a great scientist. M. Curie knew Russian and understood that I was asked to go away; she remonstrated against it and invited me to stay and listen to her lecture about the specimens found by our crew and about radium and radioactive materials. This lecture, as I understood later, she agreed to read only for engineers and other people of Krasnoyarsk invited them by Company «Razvedchik».

Marie Curie, having observed all specimens collected from territory of this district by Company «Razvedchik», named them «a brain of highly radioactive bodies», deposited under an ancient crown of Asia as this territory of Siberia, before the revolution, was named by all geologists... She visited the territory of Eastern Siberia in the Krugobaykalsk railway region because of her great scientific interest which appeared after getting uranium minerals specimens. These specimens were sent by different regional ethnographers, natural scientists, local teachers, political exiled students. I listened to her lecture and got her works, published in Russian, her Paris mail address in the memory of our meeting and a warm wish not to be afraid of difficulties and to seize a science which should bring happiness and longevity to mankind. I, as a sign of a great gratitude, sent to the great scientist to Paris the best specimens which were found only by our crew in Sayansk mountains... (Newspaper «Zavety Ilyicha», 1977) [8].

About Marie Curie's possible stay in Eastern Siberia there are memories of G.A. Nandelshtedt who personally knew her [3, 4, 7].

Truly the world is close, and the planet Earth is such small, that has allowed to meet the Siberian researcher-self-educated person and the great scientist, but historical memory at the same time is short because even after hundred years we can not exactly establish the fact of this event.

The fact is difficult to establish univocal. There are in I.G. Prokhorov's memoirs many real facts (about Kazansko-Bogorodsky crew and its charter, about mountain-industrial company «Razvedchik» and many other things), but there is no documentary evidences on the meeting with Marie Curie. There is an impression that it is a beautiful legend, half-true-story – semiimagination. Studying archives of the Curies' family stored in National library of France was made by professor L.P. Rikhvanov during his stay in Paris in 2001 proves this guessing. There is no documentary acknowledging, including Marie Curie's personal diaries, about her stay in Russia in 1914, there is no correspondence with I.G. Prokhorov and engineer Hans. To separate the husk from the grain in this beautiful fairy tale is a problem of historians and specialists in the field of geology and geochemistry of the radioactive raw materials could help them.

During this period of premilitary and prerevolutionary hard years, scientific community did not practically noticed V.I. Vernadsky's business trip in Tomsk in 1914 (the travelling certificate remained) and Irkutsk provinces in July, 1914. He worked in Zabaikal region. In the memoirs, V.I. Vernadsky wrote: «... We have executed all plot of work, but I admit, from time to time it was difficult enough to conduct work among mobilisation and alarm...» [9].

First world, then the civil war, began shortly after searching radioactive elements in Siberia and considerably complicated the work in this direction. Many geologists and students were called in army. There stepped chaos, laboratories solidified, and researches were interrupted for a long time.

The destiny of many researchers was difficult. So P.P. Gudkov, heading works in Siberia on radium searches for a short period of time, in 1919, immigrated to the USA where he worked before the death in 1955. He was the largest geologist of the world, the academician, was considered as the well-known American scientist, but he always remained truly Russian person, letters from the USA convincingly testify it which have remained up to now.

The chaos of the civil war swept and annihilated many archival materials of those years and what remained partially or completely had been withdrawn from open using and placed in special storage archives (including P.P. Orlova's materials), or annihilated. Today these materials are gathered from various isolated unsystematized sources, including mass media. In this connection we have fairly not the full list of names of the Siberian researchers of the radioactivity phenomenon.

In the works appeared after 1917 and devoted to studying radioactive substances in Siberia, the description of both separate deposits, various genetic types of deve-

loping processes, and whole regions of the Central Siberia [10, 11] is given.

P.P. Orlov and M.P. Orlov's works on radioactivity of mineral radonic waters, and also air on gold placer mines referred to this period; G.S. Labazina, S.M. Kurbatov, Yu.A. Bilibina, K.S. Filatova, studied separate deposits or regions of radioactivity development in some geological formations.

In by G.S. Labazin work [11] there are microradiographies illustrated distribution of radioactive substances in rocks of present Republic Khakassia. He specifies, that in most cases the nature of radioactivity of the studied rocks, including coal, thorium magnitude of relation thorium-uranium variables from 4,4 (cuprous sandstones) to 43,9 (Kluchevaya town).

The description of known developing processes of radioactive ore in Krasnoyarsk region is resulted in the two-volume K.S. Filatov's book «Minerals of Krasnoyarsk region» [3] in the mid-thirties of the last century.

In 1926-1929, the expedition of Radium Institute produced more than 1,5 t of allanite from graphic granite around the station Slyudyanka in East Sayan.

In 1934, the problem of uranium-radium-thorium of ore in Siberia was discussed by Felix Nikolaevich Shakhov, future corresponding member of the Academy of Sciences of the USSR, the founder of the first chair beyond Urals Mountains (1954), conducting training specialists on studying rare ore and radioactive elements [12].

V.K. Monich, in 1938, published the monography in which he underlined the possibility of revealing uranium ore in Siberia, close to a five-element formation of Erzgebirge [13].

The Siberian geologists in details investigated a question about helium, one of the end-products of decay of radioactive substances and paid attention to the Tomsk deposit of helium. Using this element, they tried to define absolute age of dikes of diabasic structure on the Saralinsky gold field [14].

Despite considerable interest to problems of the radioactive raw materials, up to 1939, the year of finding the induced fission of uranium-235, what started using nuclear energy, in territory of the Central Siberia there were known only insignificant on sizes complex thorium uranium rare ore, including: Tarasky monazite stream gravels on Yeniseisk mountain range, Tagashetsky graphic granite deposit and Potehinsky deposits of uranium (village Big Etba) in Khakassia. There was the extremely insignificant information on radioactivity of gold-bearing stream gravels, nepheline syenite (Tardanov Ulus, region of Lake Bulankol'), cuprous sandstones and coals of Khakassia, and also a number of radioactive water sources (ore mine «Julia» regions, Belokurikha). In the USSR by then it was known only five small uranium deposits: Tyuya-Muyun (1901), Tabasharsky (1926), the Mayli-sou (1932), Uigur (1938) and Adrasmanovskiy (1940) [15–17].

Who could think, that so quickly the result of the greatest discovery being capable to bring people light and heat, will manifest malicious force in the form of an atomic bomb [12, 15–19].

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