Uranium Deposits in the USSR

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CONTRARY TO POPULAR IMPRESSIONS, a fair amount of authentic information has been published on the uranium resources of the Soviet Union. Because of widespread interest in this subject, I believe it worth while to summarize the pertinent facts.

According to Vernadskii (*26*, especially pp. 56–70), Russian research on radioactive minerals began in 1900–1903 with the work of I. A. Antipov in the Fergana Valley (40° to 41° N, 70° to 73° E) of Russian Central Asia. Beginning in 1909 the Imperial Academy of Sciences initiated more ambitious investigations. All previously gathered information was sifted carefully, so that field work in 1911–1913 could be concentrated on the most promising localities: the Fergana Valley, Siberia, the Caucasus, Transcaucasus, and Urals. By 1914, indications from the Caucasus and Transcaucasus had become negative. In the Urals no indication of deposits of sufficient size for commercial exploitation could be found. Two areas appeared promising. One was Tyuya Muyun (40° 21′ N, 72° 0′ E) in the Fergana Valley, with deposits of *tyuyamunite*, $Ca(UO_2)_2 \cdot V_2O_8 \cdot 6\,H_2O$, closely comparable to the carnotite of the American southwest.[1] The other was the northwest slopes of the Khamar-Daban Range (51° to 52° N, 103° to 106° E), especially near Slyudyanka (51° 40′ N, 103° 35′ E) and along the Trans-Siberian railroad between Baikal and Kultuk immediately across Lake Baikal, characterized by sites rich in *mendelyeevite*, with the probable composition, $2\,CaO \cdot 2(Ti, U)O_2 \cdot (Nb, Ta)_2O_5$, strikingly similar to betafite and allied niobium-tantalum-uranium minerals of Madagascar.[2]

In 1914, a three-year program of research was authorized for the Academy of Sciences. The largest sums were to be devoted to expeditions in the Baikal area and the Fergana Valley, with lesser amounts going for investigations of the placer monazite deposits of the Transbaikal and for various minor projects (*26*, pp. 71–80; *10*, pp. 15–16). While World War I prevented full accomplishment of the program of the Academy of Sciences, enough was done to establish that only the Fergana Valley and the Baikal area had possibilities of commercial development (*10*, pp. 15–16). By 1918, the new Soviet government began pressing for the resumption of laboratory and field investigations of radioactive minerals; on January 1, 1922, scattered radiological facilities in the USSR were combined in the Governmental Radium Institute of the Academy of Sciences, headed by V. I. Vernadskii (*10*, pp. 19–35).

This new Institute concentrated its efforts on the site of Tyuya Muyun. An important reason for this decision was the fact that small-scale commercial operations had been begun there in 1908. Between 1908 and 1913 the Fergana Company had mined 2,088,000 pounds of ore, 1,512,000 pounds of which had been sent to its plant in Leningrad for refining. According to Company records, the ore contained, on the average, 2.36% V, 0.97% U_3O_8, and 3.73% Cu (*10*, p. 19). Scientific study of Tyuya Muyun and the surrounding area, which had been conducted sporadically since 1914, was pressed throughout the decade 1924–1934. Detailed investigations and construction of exploratory and operating shafts permitted analyses of the site by Fersman (*4*) in 1928, Kirikov (*12*) in 1929, Pavlenko (*19*) in 1933, and Butov and Zaitsev (*2*) in 1934.

The Tyuya Muyun deposit is a vein field in highly metamorphosed Paleozoic limestone, closely—but probably not genetically—associated with extensive karst channels and caves. The vein field consists of at least five (1933) barite ore veins bearing uranium, vanadium, and copper minerals and of over 30 pure barite veins. The productive veins are found near the center of the deposit, being located along a line conforming with the NE 70° strike. The barite veins extend up to 1,500 meters from the center; the maximum depth of the main vein may reach 500 meters (*12*, especially pp. 63–5, *19*).

The ore bodies within the productive veins vary in thickness from 1.5 meters to a few centimeters, and correspondingly in length. Run-of-the-mine ore averages 1.5% U_3O_8, with a range of 0.6 to 4.0%, the higher values being found in the lower horizons. However, the uranium oxide content of the amorphous, brown, cupro-uranium carbonate lenses associated with the karst stalagmitic core runs from 26.12 to 50.25%. Also noteworthy are the uranium-free radiobarites—$(Ba, Ra)SO_4$—and radiocarbonates—$RaCO_3$—established in relatively high concentrations at both lower and upper horizons of the deposit (*4*,

[1] Fersman (*4*, p. 47) and Kirikov (*12*, p. 42) give an alternative analysis, $V_2O_5 \cdot 2\,UO_2 \cdot CaO \cdot nH_2O$. The replacement of the Ca^{++} by 2 K^+ gives the formula of carnotite, cf. Betekhtin (*1*, p. 234).

[2] This affinity was recognized by V. I. Vernadskii in 1914, cf. *15*, p. 236; see also *6*, p. 279, and for betafites, *13*, I, 365–392.

12). The irregularity of the Tyuya Muyun deposit has made impossible the estimation of reserves; the mine produced 534 metric tons of hand-sorted ore in 1925–26 (*7*, pp. 571–573). By 1936, according to Nikitin (*18*), the quantity of radium extracted from the Tyuya Muyun ores and from radioactive waters near Ukhta (approximately 63° 35′ N, 53° 40′ E) was enough to meet the needs of the Soviet Union.

The origin of the Tyuya Muyun deposit is highly controversial. Careful examination of the literature has led the writer to believe that (1) the original source of the uranium has not been satisfactorily established; (2) that deep, relatively low-temperature, hydrothermal processes, possibly connected with the Variscean revolution of the Upper Paleozoic, appear to have been the primary agents of deposition; (3) that subsequent orogenic movements (Alpine?) faulted the deposit; (4) that the post-Eocene karst redistributed the deposit, partly destroying veins, partly reconcentrating ores. Interesting parallels may be found with the Ukhta radium-bearing wells, particularly in regard to the high concentrations of radium, mesothorium, and barium (*3, 5*).[3]

Explorations in other parts of the Fergana Valley have also been undertaken. In 1928, numerous indications of intense radioactivity were discovered in the western part of the Valley, but no uranium deposits (*22, 23*). In 1923, however, V. I. Popov published an account of the discovery of a uranium deposit at Uigar-sai or Atbash (41° 02′ N, 71° 12′ E) on the northern side of the Fergana Valley. Geologically, the site was said to be closely similar to carnotite deposits in Colorado and Utah. It is characterized by young, stream-deposited lenses of urano-vanadium ore, some of considerable size and richness. "In terms of its high percentage of content, dimensions of individual ore bodies, and probable reserves, the urano-vanadium deposit discovered at Uigar-sai does not yield to many carnotite sites in the U. S. A. The deposit is found under very favorable economic conditions, being situated at an automobile road; it is to undergo survey in 1939" (*21*).

Volfson's comprehensive survey of metallogenesis in the western Tian Shan range (*27*) also gives brief details of other newly discovered deposits at Taboshar (40° 37′ N, 69° 39′ E) and Maili su (41° 18′ N, 72° 27′ E). In the first of these, which has also been described by Mashkovtsev (*16*), uranium pitch (pitchblende?) is associated with bismuth glitter, wolframite, arsenopyrites, and sulfide polymetallic (lead, zinc) deposits. According to Mashkovtsev's preliminary report of 1928, the indicated uranium content of the ore is only of the order of 0.12–0.2%, which probably deprives it of economic significance. In the second site, infiltrations of urano-vanadium compounds are associated with tertiary limestones. Neither site was being commercially exploited in 1940 (*27*).

In evaluating the significance of the Central Asiatic sites, it should be noted that, according to the Soviet prospecting plan for 1940, search for uranium and radium was to be concentrated in that area (*8*).

Two other recent finds of uranium-vanadium ores in Central Asia may be mentioned. In 1937, Gotman (*9*) published an account of the deposit at Agalyk (39° 32′ N, 66° 52′ E); petrographic analysis of surface finds here established that tyuyamunite was the most frequently occurring ore. The geology of the site remained unclear; some evidence of primary deposition existed, but secondary hydrothermal deposition could not be excluded. Sampling at ground-water depths (50–60 m) would therefore be necessary to establish the potentialities of the site; no data are available as to whether such sampling has been undertaken. In 1940–41, the presence of uranium was established by Tyurin (*24*) in a vanadium site in the northwestern tip of the Karatau Range (44° 30′ N, 67° 30′ E). It represents a sedimentary deposit with subsequent metamorphism which has created a reiterated interbedding of thin bands of vanadium ores (with uranium-mineral accumulations) with flint bands. The total amount of uranium in the ore body (which extends for 25–30 km, with a thickness of 10–14 m) is great; but the improbability of finding large pockets of uranium and the difficulty of separating the disseminated uranium from vanadium on a large scale are serious obstacles. According to Tyurin, the preliminary surveys of 1942 should be followed by more extensive explorations of the area.

In the area of the Khamar-Daban Range, serious investigations have been undertaken only at Slyudyanka, which is significant as a phlogopite mica deposit. Luchitskii and his collaborators (*15*, pp. 74–95, 146–7, 236) verified the presence of mendelyeevite and established the existence of two phases, crystalline and amorphous, with differing compositions and physical properties. For instance, two analyses of the crystalline phase yielded 36.75% Ta_2O_5 and no Nb_2O_5; 14 analyses of the amorphous phase, 39.46% Nb_2O_5 and 3.82% Ta_2O_5. Total uranium-oxide content in all samples ranged from 19.70 to 28.90%.

From an economic standpoint the results at Slyudyanka seem to be negative for mendelyeevite was found only in the pegmatite veins of two parts of the deposit, in which it appears generally to play a subordinate role. The productive sector (Zayavka No. 5)

[3] This interpretation is supported by L. A. Osipov's (*Sovietskaya Geologiya*, 1941, No. 3, 36–48) association of the Fergana uranium deposits as a group with Paleozoic oil-bearing marine formations.

consists of a large mass of Pre-Cambrian crystalline limestones, penetrated by a 200-meter-thick band of biotite and biotite-granitic gneisses, which in turn are interlaced—in places, virtually engulfed—by the thick pattern of pegmatite veins in which mendelyeevite has been found. The bulk of the phlogopite veins of the sector are associated with the pegmatite-gneiss zone of contact.

Despite the seemingly negative picture at Slyudyanka, the widespread development of formations closely resembling the productive sector of this deposit from the Sayan Range (approx. 50° N, 100° E) northeastward to the Aldan gold fields (approx. 58° N, 125° E) cannot be ignored (*6*, pp. 382–3, 467–9, 552–560). A genetic association may exist between niobium-tantalum-uranium ores and phlogopite mica; their immediate proximity at Slyudyanka and their relative proximity in Central Madagascar (Volonandrongo and Ambatofotsy) raise unanswered questions.[4] Thus the discovery of three major phlogopite mica deposits in the Aldan gold field area—Emeldzhik (approx. 58° 22′ N, 126° 40′ E), Kuranakh (58° 46′ N, 125° 35′ E), and Chuga or Ust Nelyuka (58° 06′ N, 123° 0′ E)—heightens the probability of corresponding uranium finds to an unknown degree (*20*).

Finally, it should be mentioned that Fersman (*6*, pp. 480–484, 579) attached great importance to further study of the Ukrainian magnetito-ortite pegmatites, particularly in the areas of Novograd Volynskii (50° 30′ N, 27° 40′ E) and Berdyansk-Mariupol' (46° 40′ N, 36° 50′ E to 47° N, 37° 30′ E). He emphasized the likelihood of large, unexpected discoveries of Nb, Ta, U, Ti, and other minerals in these areas.

In brief, Soviet discoveries of uranium in Central Asia within the last decade, while in no sense approaching the great significance of the African and Canadian deposits, appear to provide a possible basis for the development of atomic power in that area. It must be stressed that all of the Central Asiatic deposits are found within a radius of 250 miles from the important hydroelectric plants of the Tashkent area, which produced 882,000,000 kilowatt-hours of energy in 1943 (*28*, p. 53). Labor, transportation, and climatic conditions are also favorable here.

[4] See *13*, I, pp. 365–392, 474–476; II, pp. 122–135, 145–147.

Possibilities for the discovery of significant uranium deposits associated with pegmatites in the region between Lake Baikal and the Aldan gold fields, and in the Ukraine, also exist.

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