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NOTES ON WORLD RESOURCES OF URANIUM

by

C.J. Sullivan

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INTRODUCTION.

The following are brief descriptions and estimates of the size and grade of the more important known uranium deposits in various parts of the world. Geological literature contains only limited information concerning the vital factor of ore reserves in the various deposits and this is particularly so with regard to the important mines of the Belgian Congo. For this reason, the information given cannot be precise.

Table I on page 2 shows the estimated world uranium and radium production to the end of 1942. Since that year statistics have not been published.

TABLE I.

ESTIMATED WORLD RADIUM AND URANIUM PRODUCTION.

TO THE END OF 1942.

Country	Radium grams.	U_3O_8 tons *	Minerals Mined	Remarks
Belgian Congo	1,020	3,720	Uraninite, torbernite, other secondary minerals	Radium production 1923-1932 close to 400 gm. = 1360 tons U_3O_8. If uranium ore exported from Congo, 1933-42, contained 65% U_3O_8, this would give 2,360 tons U_3O_8. Radium estimated.
Canada	520	2,425	Mainly Uraninite	Production known, 1933-38. Estimates 1939-42 based on plant capacity, said to be working full time.
United States of America	223	1,025	Carnotite	Main production 1907-23. Believed relatively accurate estimate, mainly based on statistics of U.S. Bureau of Mines. Production since 1930, 1-3 gm. of radium per annum.
Portugal	80?	270	Mainly torbernite and autunite with a little pitchblende	Difficult to arrive at figure. Early exports were ore containing 1-3 per cent U_3O_8. Ore production 1200 tons per annum 1913-14, total 1913-15 was 2,678 tons. Estimated Ra content of ore produced to 1926, 15 gm. Output 1926-42 approximately 4 gm. Ra. per year. Imperial Institute records export of minerals 1920-37 containing approximately 250 tons U_3O_8 (estimated). No production 1926, 1929-31, 1943.
Czechoslovakia	60? To end of 1938.	350	Uraninite	Production 46.8 gm. radium to end of 1932. Since then 2-4 gm. per annum. Imperial Institute records production 191 tons U_3O_8 1926-37, 143 tons uranium minerals, 1920-25.
Madagascar	8	30	Betafite, euxenite, autunite, torbernite.	Estimated. Production intermittent. Output 1913-20, 42 tons of mineral; 1926-37 25.6 tons of mineral exported.
England	6	20	Mainly uraninite, minor autunite and torbernite	Production began about 1890. Uranium ore produced up to 1929, but quantities not always published. Records showed production 1913-25 of 1352 tons uranium minerals. Uranium content of minerals not given. Believed that above figures refer to ore containing approximately 2 per cent U_3O_8.

Country	Radium grams.	U_3O_8 tons	Minerals Mined	Remarks
Australia	1	3	Torbernite and autunite	Estimated.
U.S.S.R.	7	25	Tyuyamunite	Ferghana only. May be other deposits found during recent years.
TOTAL	1,925	7,868		

* Tonnages given in this report are long tons (2240 lb.) except where otherwise stated.

BELGIAN CONGO.

Introduction.

The uranium deposit at Shinkolobwe in the Belgian Congo was discovered in 1915 by an Englishman, Major Sharp. Very little information has been published regarding size and grade, the operating company adopting a policy of secrecy from the outset.

In 1932 J. Thoreau and R. du Trieu de Terdonck published a general account of the deposits which is summarised by Hess(1934).

The main deposit appears to be situated at Shinkolobwe approximately 100 miles northwest of Elizabethville and a few miles west of the Elizabethville - Bukama Railway line. It is 10 miles south of the Kambove copper mine. It is probable that Shinkolobwe is now connected by rail to Elizabethville.

Deposits occur in a number of localities including Kalongwe and Shinkolobwe, but only those at the latter place are described.

Geology.

At the surface the Shinkolobwe deposit presented the general appearance of a silicified copper outcrop but fragments of yellow mineral attracted attention. Systematic mining, begun in 1921, revealed extensive deposits of torbernite and other secondary uranium minerals and also veins of crystalline uraninite.

The occurrence of uranium minerals is so sporadic that an estimate of reserves can be made only by a network of shafts and tunnels. At the time of publication of the quoted report, workings had not yet gone below the oxidised zone. All work was under the observation of geologists: records were carefully kept and type specimens collected.

"The maps of the deposits show mineral deposits at sixteen places and a great number of discontinuous uranium-bearing veins in the workings". A plan indicates that continuous underground workings exist over a length of 1350 feet and mining appears to have taken place over a maximum width of about 175 feet.

The report by Thoreau and de Trieu de Terdonck does not mention the output or give any figures for ore reserves.

It is clear from the description that the individual veins are short and irregular in form. It is rare that a vein can be followed for more than a dozen metres (40 feet). A vein a few centimetres in width may swell to a metre and yield masses of compact mineral weighing several tons. In mining, the entire mass of rock is removed to reduce losses to a minimum. Veins form stockwerk-like masses; as they are followed downward they coalesce and pinch out and new veins are found.

Disseminated minerals are found -

(1) For a short distance outward from uraninite veins, all being now altered to secondary minerals.

(2) Distributed with no apparent relation to the veins mostly as individual plates of torbernite, or lining cavities in a cellular magnesian limestone at varying distances from the veins.

More than half of the uranium in the oxidised zone is in the form of such disseminated torbernite. There is no information as to whether the disseminated ore has been mined. Kasolite (ochre, yellow, $3PbO.3UO_3.3SiO_2.4H_2O$) and sklodowskite (pale yellow, $MgO.2UO_3.2SiO_2$) are also found as disseminated minerals, the latter lining cavities like torbernite. Small quantities of copper, cobalt and nickel sulphides are found in the uranium veins.

Gold can be panned from uranium veins and is occasionally seen in them. A little palladium and platinum are shown by assays.

It is clear that the deposits are of magmatic origin. Pyrite, linnaeite, chalcopyrite and molybdenite are associated with the uraninite. Monazite, tourmaline and apatite are found in the surrounding rocks. Copper sulphide deposits, mainly distinct from the uraninite deposits, occur in the district. Uranium in smaller quantities has been found at a large number of localities in the Katanga copper belt. Pitchblende, or minerals formed by its alteration, have been found in seven deposits from Ruashi in the southeast to the extreme northwest of the copper zone passing through Luishia and Kambove. i.e. over a distance of approximately 150 miles.

Production.

Before the discovery and exploitation of the Canadian deposits, radium from the Belgian Congo had a virtual monopoly of the world's market. The uranium ore was forwarded to the refinery at Oolen, Belgium, after initial concentration at the mine in Africa. Radium was sold at about $60 a milligram. By 1939 Canadian competition had forced the price down to about $25 a milligram.

In 1932, the Oolen refinery was stated (Ellsworth 1932) to have a capacity of 6 gms. of radium per month, equivalent to an output of approximately 245 long tons uranium trioxide per annum. Further information concerning output is as follows -

The mine was inoperative from 1937 to 1941 inclusive, apparently owing to the accumulation of ore-stocks. The Oolen refinery was captured by the Germans in 1940 and "uranium ore" from the Belgian Congo was shipped to the United States of America.

EXPORTS OF "URANIUM ORE" FROM THE BELGIAN CONGO
1930 - 1942.

	Year	Metric tons	
	1930	1295	
	1931	382	
	1932	130	
	1933	Nil	
	1934	212	
	1935	253	
	1936	Nil	
Mine Closed -	1937	1052	
Mine Closed -	1938	3	
Mine Closed -	1939	Unknown	- Probably small
Mine Closed -	1940	1070	- Exptd. to U.S.A. Oolen captured by Germans.
Mine Closed -	1941	24	
	1942	1021	
		5442	

The output of the mine has apparently been governed by refinery capacity and ultimately by the ability to sell radium at the price demanded.

Total production in 1942 is reported (Matthews,1943) as 1,021 metric tons of "uranium ore" containing 695.6 metric tons of U_3O_8 (68 per cent U308). It is evident that the "ore" is probably a rather high-grade concentrate, though Ellsworth (1932) reports that the "extensive deposits at Shinkolobwe run 50 per cent U_3O_8 or better." Other reports suggest that much ore averaging 30 to 40 per cent U_3O_8 has been won.

Summary.

Though few exact data about the Belgian Congo deposits are available, it seems likely that they are very important. The plan published by Thoreau and du Trieu de Terdonck in 1932, shows a continuous network of uraninite veins over a length of 660 feet and width of up to 170 feet. An open cut 225 feet long by approximately 150 feet wide has been excavated in the main shoot mentioned above. Underground workings extend over a length of 1350 feet (Hess, 1934).

The output of 696.5 metric tons of U_3O_8 in 1942 after a lapse of production since 1937, is equal to more than 1.5 times the normal Canadian production.

Thoreau and R. du Trieu de Terdonck state that the whole of the rock is mined in order to avoid wastage and this is also evident from the plan. (At this time, mining was confined to the oxidised zone.)

If it is assumed then, that the whole of the rock shown as developed by a network of workings and seamed by numerous uraninite veinlets, is payable ore, then the ore available (in the oxidised zone, which may be enriched) would be of the order of 500,000 tons per 100 feet vertically. Some of this ore is definitely very rich, but the average grade is not known. There are apparently several other deposits about which little has been published. There is too little evidence to form a definite opinion, but it seems very likely that the Belgian Congo deposits are more important than the Canadian deposits.

It was announced recently in the Australian press that American interests were equipping the Belgian Congo deposits.

CANADA.

Introduction.

In 1930 a prospector named Gilbert La Bine first noted pitchblende and silver minerals on the shores of Great Bear Lake, North Western Territories, Canada. Soon after discovery an air service to the deposit was established and development began. The deposits were taken over by Eldorado Gold Mines in 1937.

The mine is 800 miles by airline north of the nearest railhead. A concentrating plant capable of treating 50 tons daily was in operation in 1934 and was later enlarged to 100 tons capacity. Concentration is by cobbing, gravity and flotation. In 1937, 107 men were employed on the mine. Pitchblende concentrates are forwarded by air, rail and boat a distance of about 2500 miles to the radium and uranium refinery at Port Hope, Ontario, which commenced operations in 1933.

Geology.

According to D.F. Kidd (1942) three main sub-parallel zones filled with a stockwerk of quartz, occur on the Eldorado property. Their lengths are approximately 230 feet, 800 feet and 500 feet respectively. The widths of the fracture zones range up to a maximum of 30 feet.

Ore-shoots with a maximum length of 200 feet and a width of 4 feet occur mainly in the hangingwall of the brecciated zones. A plan published by Kidd, showed a total of seven shoots in the three main zones. At the surface some of the ore-lenses were only 40 feet in length and are separated by barren zones from 100 to 350 feet in length. The best ore has been found in the No.2 or central vein, and in 1937, exploration in this vein had reached a depth of 590 feet where high-grade uranium and silver ore were reported. Crosscuts from the 500-foot level to the two sub-parallel veins are also reported to have intersected ore.

Kidd and Haycock (1935) state that there are two main types of useful mineralisation -

(1) Colloform pitchblende and hematite in quartz veins with minor cobalt-nickel-bismuth mineralisation.

(2) Silver-bearing minerals with manganiferous carbonates and chalcedonic quartz with considerable copper-cobalt-nickel-bismuth minerals and minor amounts of lead and zinc. The No.1 group is the earlier of the two. Supergene alteration is quantitatively unimportant but torbernite etc. were present in the outcrop.

Production and Ore Reserves.

An indication of the nature and grade of the ore may be gained from the following production figures for 1937 (Tyler, 1939).

Tons of 2000 lbs.

Ore	Pitchblende-Silver conc.	Silver-Copper Flot.conc.	Cobalt conc.cobbed	Total conc.
25,486	475.3	193.3	5.9	674.5

The pitchblende-silver concentrate amounts to 1.86 per cent of the ore. Assuming this concentrate contains 85 per cent U_3O_8, the uranium content of the ore is equivalent to 1.58 per cent U_3O_8.

It is estimated from figures given by Tyler (1939) that the average value of ore raised during 1937 was approximately $55 per ton. At June 1938, ore reserves were valued at $7,000,000 which at $55 per ton is equivalent to approximately 127,000 tons. However Engineering and Mining Journal (1945), reports that ore reserves in 1938 were 60,000 tons containing 1 per cent U_3O_8.

Production has to some extent been governed by refinery capacity and the ability to sell radium. The mine was closed from June 1940 until August 1942. The refinery continued full-time operation throughout this period, working on accumulated ore-stocks.

The initial output of uranium salts was 15.4 tons in 1933.

It has been stated by the Company that 5.2 short tons of uranium salts are produced for each gram of radium. On this basis the output of uranium salts for the years 1936 to 1938 are -

OUTPUT OF PORT HOPE REFINERY 1936 to 1938.

Year	Ra. Gm.	Uranium salts Long tons
1936≠	15.54	84
1937≠	23.77	242
1938	70	320

(≠ The Mineral Industry, 1941)

In 1942, the plant was stated to have a monthly capacity of 8 to 9 grams of radium and 40 short tons or uranium salts. This is equivalent to an annual output of about 420 long tons of uranium salts.

The total value of Canadian refinery production of pitchblende products from the commencement of operations in 1933 up to 1941, after which statistics ceased to be published amounted to $5,805,423 which at $45 per ton (allowing $10 per ton for silver cobalt, nickel, etc.) is equivalent to approximately 130,000 short tons of ore, which, at the estimated grade of 1.58 per cent U_3O_8, is equivalent to approximately 1800 long tons of U_3O_8. This is approximately the figure obtained by calculating the tonnage of uranium salts which would have been obtained from the recorded production of radium.

The assets of the company were taken over by the Canadian Government in January 1944, but recent reports indicate that the property has been returned to private ownership (E. and M.J., 1945).

The scale of operations after the taking over of the mine and refinery by the Canadian Government is not known. The Government paid $1.35 a share for the 3,905,046 shares or approximately $5,250,000 for the whole of the company's assets. If it is assumed that the plant, including the refinery, mining and concentrating plant, aircraft etc, is valued at $1,000,000 and that $20 per ton profit can be made on the ore worth $55 per short ton, it would appear that the Canadian Government considers that ore reserves are of the order of 200,000 short tons. This figure is obviously a rough estimate but, in view of the increased value of uranium, the price paid does indicate that ore reserves were not considered to be very large.

Pitchblende deposits described as "small" have been discovered at points 12 miles north and 110 miles south respectively from the Eldorado mine. In 1943, geological and geophysical methods were being used in the search for new orebodies. From February 1943, all future discoveries of pitchblende were reserved to the Crown.

UNITED STATES OF AMERICA.

Geology and Production -

From 1907 to about 1923, the United States of America yielded most of the world's radium supply, but from about 1923 onwards the market was dominated by radium derived from Belgian Congo and Canadian ores. The United States production was obtained mainly from uranium-vanadium ores of sedimentary origin, occurring in carbonaceous beds of the Morrison (Upper Jurassic) sandstone of Western Colorado and Utah. The main uranium mineral is carnotite. (Hess, 1933B). Ore production reached nearly 42,000 tons in 1915.

The uranium-vanadium deposits occurred in relatively flat-lying sheets, one of which was mined fairly continuously over a length of 3,000 feet. From these workings 19,000 tons of ore were reported to average 1.46 per cent U_3O_8 and 4.32 per cent V_2O_5. A further 29,000 tons averaged 1.25 per cent U_3O_8 and 3.5 per cent V_2O_5.

A second deposit was exploited for 700 feet down the dip over a maximum width of 600 feet and an average thickness of 2 feet.

Total production from the Morrison formation of the Colorado Plateau to the end of 1932 when mining ceased, is estimated at 202 grams of radium, equivalent to approximately 900 tons U_3O_8. In addition, some 330 tons of vanadium were recovered mainly as a by-product, but some ore was treated for vanadium alone. The total vanadium content of the ore treated was estimated at 1300 tons.

The production of radium from domestic ores was only 2.6 grams in 1942, corresponding to about 13.5 tons of U_3O_8.

Ore Reserves. (Morrison Formation)

It was estimated in 1919 (4 years before uranium mining ceased) that 500 grams of radium could be produced from carnotite ore averaging not less than 1.25 per cent U308 and 3.5 per cent V_2O_5. The radium recovery was about 70 per cent and this corresponded to about 700 grams of radium in the ground. Hess (1933B) estimated that including lean ores, the deposits might still contain 800 grams of radium, 2700 tons of U_3O_8 and 5000 tons of vanadium.

At East Rifle Creek, Colorado, rosceolite-bearing sandstone containing 2.25 per cent V_2O_5 was mined up to 1932. The sandstone was up to 30 feet thick, 700 feet or more long and 600 feet wide. No attempt was made to recover uranium, but carnotite stains were present and the ore was said to contain 0.2 per cent U_3O_8. Some 400,000 tons of ore were mined and produced 4,256,000 lb., of vanadium. (Hess, 1933B).

Other Localities.

Temple Rock, Utah - At this locality asphaltic sandstones of Triassic Age contain shoots of uranium-vanadium ore which have maximum dimensions of 100 feet long by 15 to 20 feet broad by 7 feet thick. A considerable tonnage of the ore shipped during World War I, averaged about 1.75 per cent U_3O_8 and 4 per cent V_2O_5.

It was stated (E. and M.J., 1945) that the United States Vanadium Corporation, which controls deposits similar to the above, had built two plants of 50 and 100 tons daily capacity respectively to recover uranium. Three other plants of 200 tons, 250 tons and 85 tons daily capacity respectively were treating vanadium ore containing some uranium. Some of these plants have been built in the last two or three years. The anticipated output of uranium is not stated.

Geophysical methods are being used to prospect for uranium ores in the Western United States. It seems likely that if the demand is sufficient a very appreciable production of uranium is possible from the Colorado-Utah-Arizona-New Mexico region.

CZECHOSLOVAKIA.

The first radium produced by Mme. Curie was derived from pitchblende produced at Jachymov (Joachimstahl), Bohemia, Czechoslovakia. The Czechoslovak Government operated the mine for a considerable number of years, sometimes at a loss. Annual production was normally 2 to 4 grams of radium, but during 1913-15 for example, only 10 to 20 tons of ore were mined annually and up to 1932, Czechoslovakia was estimated to have produced 46.8 grams of radium. In 1926 it was reported to be the third largest producer in the world.

The pitchblende occurs in quartz or carbonate veins, associated with cobalt, nickel, arsenic, silver and bismuth. Mining was being conducted in this area as early as 1237, but it was only in the late 19th century, when uranium began to be used for colouring glass, that an attempt was made to save pitchblende. From 1926 to 1937, the deposits are reported (Imper. Inst. 1926-1937) to have produced 190.6 tons of U_3O_8, an average of approximately 16 tons per year. It was stated (E. and M.J. 1945) that the annual production of ore was 180-190 tons, when Germany invaded Czechoslovakia in 1938.

It is estimated that these mines may have produced approximately 60 grams of radium and 350 tons of U_3O_8 up to 1938.

PORTUGAL.

Small deposits situated in the Guarado region of Northern Portugal, are now owned by British-controlled Urgeirica Radium Consolidated though for many years most of the ore was shipped to France. In the oxidised zone autunite and torbernite were found. These minerals are stated to have been derived by weathering from primary uranium minerals occurring in small quartz veins and pegmatite dykes. The secondary minerals usually impregnate the granite surrounding the upper parts of the veins and dykes. The autunite and torbernite were confined to a zone 15 to 20 metres deep. Below this was a leached, barren zone. Below the barren zone some patches of ore carrying a black uranium-bearing mineral, presumably pitchblende, were encountered. The average grade was stated to be 0.5 to 1.5 per cent U_3O_8. One mine had reached a depth of 100 metres in the early 1920's.

Production has come from a considerable number of small veins and ore reserves are believed to be small.

Output in 1941 was -

Ore, Metric Tons.	Grade	U_3O_8 content
330	1 to 1.8 per cent U_3O_8	33 to 59.5 tons U_3O_8

The recovery from the above ore was 5.8 grams of radium equivalent to approximately 20 tons of uranium trioxide.

In 1942, the output was 4.5 grams radium equivalent to approximately 15 long tons uranium salts.

Matthews (1945), stated that there was no production during 1943. Maximum production was 1,000 to 2,000 tons of ore per annum.

The total production of radium from Portuguese ores to the end of 1926 was estimated (Hess 1929) at 15 grams.

production appears to have been at the rate of about 4 grams per year since that time, making a total of approximately 80 grams to the end of 1942. This is probably a maximum figure and is equivalent to approximately 270 tons of U_3O_8.

ENGLAND.

In the tin and copper mines of Cornwall, minor veins containing pitchblende cut the tin-bearing reefs. Production has been recorded from seven mines. In the oxidised zones, autunite and torbernite result from the weathering of the pitchblende and small quantities of the secondary minerals have been mined (Ellsworth, 1932).

The total production of radium up to 1926 from Cornwall pitchblende was estimated at 5 grams equivalent to about 17 tons of U_3O_8 but may have been considerably greater. (Hess, 1929). For some years two companies, one French and the other British, each operated Cornish mines for the production of radium ores. Considerable quantities of pitchblende are reported to have been discarded in tin and copper mining operations during the 19th century, when the presence of uranium in concentrates was penalised.

The two main producers were the Trenwith mine near St. Ives, with an output of 500 tons of uranium-bearing ore between 1889 and 1907 and the St. Austell Consols mine which produced 576 tons of uranium-bearing ore from intermittent production between 1854 and 1906. The mines continued production after these dates and there was some output from Cornwall as late as 1929 but precise figures are difficult to obtain. The Imperial Institute reports that from 1921 to 1925, 607 tons of "uranium minerals" were produced. It seems more likely that this would be uranium-bearing ore containing perhaps 2 per cent U_3O_8.

It is likely that if the need were urgent, Cornwall might still produce appreciable quantities of uranium.

BULGARIA.

In recent years, a deposit of autunite, torbernite and meta-torbernite, has been opened up at Goten, about 20 kilometres northeast of Sofia, Bulgaria. The secondary minerals have resulted from the weathering of primary minerals in a crushed pegmatite dyke. The geology is stated to be similar to that at Guarado, Northern Portugal.

The ore occurs in a crush zone 50 to 70 metres long and 4 to 15 metres wide. A ton of hand-picked ore was stated to have contained 2 per cent uranium. It was stated (Kostov 1943) that exploration had revealed the presence of 25,000 tons of ore. The uranium minerals are associated with limonite. There is probably a similarity of origin between the Bulgarian and Portuguese deposits and those occurring at Mount Painter, South Australia.

MADAGASCAR.

Autunite and uranocircite (secondary hydrous, barium, uranium phosphate) occur in peaty muds in old lake beds in Madagascar. It has been utilised as ore. It was reported by A. Lacroix, 1920, that autunite is scattered through the peaty bed over a thickness of 1 metre. The quantity present "hardly exceeds 1.5 per cent". Between 1909 and 1923, 36.9 metric tons of these minerals were exported.

Secondary uranium and vanadium ores have also been found associated with hydrocarbons in sediments. They appear to be of syngenetic origin.

Small quantities of betafite and euxenite have been mined from pegmatites.

Production.

Eight grams of radium corresponding to approximately 27 tons of U_3O_8 were reported to have been produced from Madagascan ores up to 1926.

During the period 1926 to 1937 25.6 tons of betafite and euxenite were exported to France, where two companies were engaged in the extraction of radium from the ores.

General.

The uranium-bearing minerals of the pegmatite dykes are normally unsatisfactory sources of uranium on account of their sparse distribution and complex character. The Madagascan deposits are however, interesting, as they show how secondary deposits may be formed by the weathering of uranium-bearing minerals occurring in small quantity in pegmatitic and granitic areas. In some instances uranium has been transported considerable distances in solution in meteoric water. This fact helps to explain the formation of the Colorado-Utah carnotite ores and also throws light on the origin of such materials as the uranium-bearing koln of Sweden.

U.S.S.R.

It was estimated in 1936 that up to that time the uranium-vanadium deposit in the Tyuya Muyun mountains, Ferghana, Russian Turkestan, had yielded a total of 6 grams of radium corresponding to about 20 tons of U_3O_8. The minerals exploited are of secondary origin, the most important being tyuyamunite, a calcium carnotite. In 1926, this was the only deposit being exploited in the U.S.S.R. In 1941, experiments were carried out on the solubility of the secondary uranium minerals in this deposit in order to throw light on the origin. It was found that the minerals were very insoluble - less soluble than $BaSO_4$.

A radium extraction plant was in operation in the U.S.S.R. in 1932.

In 1943 it was announced that the work of the Radium Institute of the Academy of Science of the U.S.S.R. "led to the discovery of new deposits of radioactive substances in the Soviet Union and laid the foundation for an extensive radium industry in that country". The above academy built the first cyclotron in Europe in 1937. (Matthews, 1945)

INDO-CHINA.

Small quantities of autunite-bearing ore were exported to France but no systematic exploitation of the deposits is reported.

SWEDEN.

The state-owned shale-oil plant at Kvarntorp, Province of Narke, Sweden, yields an ash containing uranium and other metals, which may be extracted in the future (Matthews, 1945). A black carbonaceous rock, known as koln contains up to 0.5 per cent uranium which is apparently of syngenetic origin. The koln resembles cannel coal and contains a high proportion of hydrocarbons. The deposits may be similar in origin to the Colorado carnotite uranium-vanadium ores, where these metals have been precipitated by carbonaceous material and by hydrocarbons. It was announced in Sweden that the deposits of the southern and eastern parts of the province had a very high uranium content and would become ore of the world's principal sources of uranium and vanadium.

Uraninite occurs in pegmatite dykes in Sweden, but has not been utilised as an ore.

(C.J. Sullivan)
Geologist.

CANBERRA.
28/2/46.

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