

have been overturned so that the oldest strata now overlies the younger formations. It is probable that the Paleozoic sediments are also overturned, and that limestone found in the district is probably of early Paleozoic age, and fossils found in limestone lenses indicate that they are not Devonian; Diller would suggest that they are Silurian rather than Carboniferous in age."

Pennsylvania.- Cobalt is reported as a constituent of the Cornwall iron ores. Tens of thousands of tons of cobalt element have been smelted in the iron blast furnaces, the cobalt content, of course, being partly lost in the slag and partly retained in the pig iron. The copper content of these ores has been recovered in recent years, but no information is available as to the possibility of saving the cobalt in a marketable form.

IMPORTS AND EXPORTS

Since the United States has produced very little cobalt, its fast growing consumption is reflected in the imports. The aggregate value of the cobalt imported annually in the form of ore, metal, and oxide has increased from a pre-war average of only \$36,080 (average of fiscal years, 1909-1913, inclusive) to \$2,680,200 in 1929. The imports of oxide have increased substantially, but the remarkable growth in imports under this general category is mainly attributable to the increased demand for cobalt metal. During the World War the demand for cobalt metal grew rapidly, but following the Armistice it dropped off abruptly with the result that imports of the metal in 1919 amounted to only 60,511 pounds. After increasing to 143,603 pounds in the boom year of 1920 they slumped again to 38,442 pounds in 1921. Since 1921, however, the imports have increased fairly steadily. The increase has been most marked in the last few years, the imports in 1929 being more than four times as great as those in 1925.

Even before the World War some cobalt metal was imported, but the quantities were combined in the statistics with the imports of ore. Both cobalt metal and cobalt ore have remained free of duty, whereas cobalt oxide has been dutiable for many years. Previous to the Tariff Act of 1913 the rate (25 cents per pound under the act of 1909) was sufficient to encourage the importation of cobalt metal free of duty for manufacture back into cobalt oxide. This situation was described by F. L. Merry of Swansea, England, in his testimony before the Ontario Nickel Commission: "The marketable stuff is cobalt oxide. * * * We used to reduce it to the metallic state and reburn it to the oxide. The black oxide, reduced to metal, will burn back black and the prepared oxide, reduced to metal, will burn back prepared."

Zaffre, the impure oxide of cobalt obtained by roasting cobalt or ore speiss, also has been admitted free of duty. Under the Tariff Act of 1922, cobalt and cobalt ore are provided for in Paragraph 1550 and zaffre in Paragraph 1710 of the free list. Under Paragraph 29 of the same act, cobalt oxide is dutiable at 20 cents per pound; the sulphate and linoleate at 10 cents per pound; and all other cobalt salts and compounds at 30 per cent ad valorem.

During and shortly after the World War the imports of cobalt in various forms were derived almost exclusively from Canada, but later Belgium became of even greater importance as a source of supply, and since 1927 Australia has been contributing a rapidly increasing quantity. Germany, in addition to furnishing a part of the imports of oxide, is a source of practically all of the linoleate, sulphate, and other salts.

Table 2. - Cobalt ore, cobalt metal, and oxide and zaffre imported for consumption in the United States, 1901-1929

Year	Ore		Cobalt		Oxide		Total			
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value		
1901	-	-	-	-	-	-	1/	71,969	1/	134,208
1902	-	-	-	-	-	-	1/	79,984	1/	151,115
1903	-	-	-	-	-	-	1/	73,350	1/	145,264
1904	-	-	-	-	-	-	1/	42,354	1/	86,925
1905	-	-	-	-	-	-	1/	70,048	1/	139,377
1906	-	-	-	-	-	-	2/	41,084	2/	83,167
1907	-	-	5,219	\$ 1,821	42,794	\$73,028	-	48,013	-	74,849
1908	-	-	217,548	13,982	1,550	3,095	-	219,098	-	17,077
1909	-	-	2,314	631	9,818	11,065	-	12,132	-	11,696
1910	-	-	8,811	1,546	6,124	4,806	-	14,935	-	6,352
1911	-	-	579,520	48,104	22,934	11,047	-	602,454	-	59,151
1912	-	-	759,394	67,948	31,848	15,132	-	791,242	-	83,080
1913	-	-	164,119	69,581	45,277	26,154	-	209,396	-	95,735
1914	-	-	106,670	53,945	227,886	220,593	-	334,556	-	274,538
1915	-	-	53,375	70,283	154,672	148,828	-	208,047	-	219,111
1916	-	-	136,770	175,236	206,639	192,009	-	343,409	-	367,245
1917	-	-	223,794	369,950	276,406	275,821	-	500,200	-	645,771
1918	3/	-	504,391	628,099	208,596	291,699	-	712,987	-	919,798
1919	17,045	\$2,832	60,511	141,450	131,424	184,751	-	208,980	-	329,033
1920	13,039	4,794	143,603	326,864	202,724	399,605	4/	359,586	4/	731,277
1921	7,657	3,325	38,442	105,539	164,003	342,426	-	210,102	-	451,200
1922	5,195	7,075	126,364	321,396	217,530	435,895	-	349,089	-	764,366
1923	58,719	56,326	225,639	552,434	258,574	511,903	-	542,932	1,	1,120,663
1924	28,786	37,273	118,952	264,935	226,703	440,898	-	374,441	-	743,109
1925	34,782	31,320	198,669	422,185	287,265	546,292	-	520,716	-	999,797
1926	154,468	55,820	387,076	820,873	333,132	632,478	4/	874,786	4/	1,509,211
1927	60,332	3,019	407,193	841,442	369,747	703,608	-	837,327	-	1,548,069
1928	107,498	25,922	535,817	1,147,574	364,154	692,753	-	1,007,469	-	1,866,249
1929	434,443	51,862	806,640	1,743,465	475,928	884,873	-	1,717,011	-	2,680,200

- 1 Cobalt oxide, ore, and zaffre imported for the years 1901 to 1905, inclusive.
 2 The imports for 1906, included 12,850 pounds of ore and zaffre.
 3 Ore included with cobalt not separately recorded until July 1, 1918. From July 1 to Dec. 31, 1918, imports are recorded as follows: Ore, 220,115 pounds, valued at \$55,188; metal, 250,920 pounds, \$498,316.
 4 Includes 220 pounds of zaffre, valued at \$14, in 1920, and 110 pounds, valued at \$40, in 1926. Imports of zaffre not separately recorded for 1918, and none imported in 1919, 1921, 1922, 1923, 1924, 1925, 1927, 1928, and 1929.

Table 3. - Cobalt compounds (other than cobalt oxide)
imported for consumption in the United
States, 1922-1929¹

Calendar Years	Linoleate		Sulphate		Other salts		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1922	- - -	- - -	- - -	- - -	- - -	- - -	2/ 11	2/ \$ 26
1923	3,617	\$1,140	39,691	\$24,597	2,336	\$1,619	45,644	27,356
1924	40	22	- - -	- - -	757	834	797	856
1925	3,258	1,196	9,780	5,951	218	747	13,256	7,894
1926	2,522	952	34,466	20,163	354	532	37,342	21,647
1927	- - -	- - -	55,045	28,617	82	64	55,127	28,681
1928	- - -	- - -	68,150	39,791	131	202	68,281	39,993
1929	- - -	- - -	60,596	34,893	4,186	2,655	64,782	37,548

¹ Figures on imports compiled by J. A. Dorsey, of the Bureau of Mines, from records of the Bureau of Foreign and Domestic Commerce.

² Cobalt compounds, other than linoleate and sulphate, imported Sept. 22 to Dec. 31, 1922. Not separately classified prior to change in tariff.

THE INDUSTRY IN FOREIGN COUNTRIES

The Deloro Smelting and Refining Co. (Ltd.), recovering cobalt metal, oxides, and salts from arsenical-silver-cobalt-nickel residues from the Ontario silver mines, and the Union Minière du Haut-Katanga, in Belgium, producing cobalt and its oxides as a by-product from its copper ores mined in the Belgian Congo, are the dominant factors in the world's supply of cobalt in its various forms. In England, Henry Wiggin and Co. are important factors in the industry, and considerable cobalt is produced in Germany from residues and other by-products material. Other countries, notably Australia, have come forward in recent years as sources of cobalt ores, and cobalt occurrences of varying degrees of importance have been reported in many parts of the world. Since the advent of the Belgian Congo into the race, Canada's leadership in the industry captured from New Caledonia more than two decades ago has not been successfully challenged. The Belgian company's output, though a close second to that of the Canadian company, has never yet exceeded the output of the smelter in Ontario.

Before discussing the industry in the more important producing countries, brief mention may be made of a few of the minor occurrences. In South America cobalt is found in two countries, Chile and Argentina, but production is spasmodic and of no great importance.¹³ In the Chilean Province, Atacama, oxidized arsenical ore averaging 4 per cent cobalt has been worked. The chief mines are about 30 miles from the Port of Huasco, although veins of cobalt are found in the silver mines of this province as well as in Coquimbo and Santiago. The Argentine deposits are in Lar Rioja and Catamarca.

¹³ Min. Ind., 1921, vol. 30, p. 142.

Cobalt minerals have been reported from various Mexican localities, chiefly as accessory minerals present in minor amounts. No important production has been reported. Erythrite has been found in Chihuahua and Jalisco, and wad containing cobalt has been reported in several States. Occurrences of cobaltite have been mentioned in Chihuahua, Durango, Jalisco, and Sinaloa. The arsenide, amaltite, is a constituent of the ores of the Esmeralda mine in Jalisco, and the Pitmano mine in Hidalgo.

In the British Isles cobalt minerals have been noted in the tin and copper lodes of Cornwall and, associated with arsenic, cobalt occurs in small amounts in the Peak district of Derbyshire, England. A small shipment of cobalt ore is said to have been made from the Muckcross mine, Killarney, Ireland, linnaeite is reported in the coal measures of South Wales, and nickel cobalt ore has been found at Talnoy, Kirkcudbrightshire, Scotland.

In Czechoslovakia there are two areas, both in Bohemia. The metal-bearing veins of Pribram contain copper, lead, silver, arsenic, and antimony, and locally cobalt and nickel.¹⁴ Cobalt, with nickel, tungsten, and uranium, is found in the Kaiserwald, in northwest Bohemia.¹⁵

During the latter part of 1927, discovery of cobalt in France, at Plombières, on the Arpen Plateau, was announced. A sample from the Plombières deposit showed 20 per cent cobalt.¹⁶ Saxony was once an important producer of cobalt; now the small supply mined in that district is officially recorded as "cobalt-bismuth-nickel ores."¹⁷ Sulitjelma, Norway, has yielded arsenopyrite crystals that contained from 0.98 to 1.32 per cent cobalt. Many years ago cobalt ore was mined for smalt (arsenic being a by-product) at the old smalt works of Modum, southern Norway. The ore forms fahlbands and is too poor to be mined with profit. Soil analyses from Pantchevo, near Belgrade, gave 0.0028 gram of cobalt and 0.0136 gram of nickel in a kilogram of earth.¹⁸ H. Fehlmann, in the "Volkwirtschaftsdepartment Abteilung für industrielle Kriegswirtschaft Bergbaubureau, Bern, 1919," describes small deposits of cobalt at several places in Switzerland.

Belgium, in addition to producing cobalt from the Congo ores, contains a deposit of technical interest near Brussels where sand blackened in some places by manganese also contains cobalt in small amounts.¹⁹ In Spain the Aramo mine near Pola de Lena, at La Saterana, Asturias, and the Profunda mine, near Villamanin, Leon, have both produced cobalt. The former mine belonged at one time to the

14 Slavik, F., The minerals of Pribram, *Am. Mineralogist*, vol. 12, No. 9, Sept., 1927, pp. 345-350.

15 Frieser, Anton, *Erzvorkommen im Kaiserwaldgebirge: Glückauf*, Baud 64, Heft 2, Vienna, 1916, pp. 53-120.

16 *Eng. and Min. Jour.*, vol. 125, Jan. 7, 1928, p. 31.

17 Hess, Frank L., *Rare metals: Mineral Resources of the United States, 1927*, Pt. II, Bureau of Mines, 1929, p. 394.

18 Bertrand, Gabriel, and Mokragatz, , *Sur la présence du cobalt et du nickel dans la terre arable: Compt. rend.*, vol. 175, 1922, pp. 112-114.

19 *Cobalt in the sands of Woluwe-Saint-Lambert: Jour. Chem. Soc.*, vol. 70, pt. 2, London, 1896, p. 434.

fabrica de Mieres and the Profunda mine to the heirs of D. Ruperto Sanchez, but in recent years there have been rumors to the effect that one or both of these mines would be reopened by an English company. Russia has produced small amounts of cobalt. The chief deposit is in the neighborhood of the Kedabek copper mines, at Dashkessan, in the Government of Elizabethopol. Arsenical ore is here found in irregular pockets with epidote, garnet, and hornblende in a porphyritic rock, accompanied by magnetic iron ore and occasionally galena and zinc blende. An analysis of the mineral gave 18 per cent cobalt.²⁰ "Nickel and cobalt ores are found in Transbaikal territory, almost exclusively in silver-lead mines. There are unverified reports. . . . of occurrences of cobalt in the silver-lead mines of Petropavlovski, Blagodatski, Chalbushinski, Mikhailovski, and Kultun."²¹ Cobalt is one of the elements included in the monopoly granted the rare elements cartel, Rjedky Elementy.

In the Far East, China has been producing cobalt for centuries for use locally in ceramic glazes. At present the output, amounting to 200 to 300 tons annually, is shipped largely to the potteries in Kiangsi Province. It is mined in Hunan in various localities, notably Pingi, Fuming, Sungming, Suntien, Chanyi, Anning, Lunan, Luchuan, Wanshaan, and Luishui. India, likewise, has cobalt deposits, and cobalt-nickel speiss is produced in Burma in small amounts. According to a British official report,²² cobalt ore, locally known as "sehta," carrying 28 per cent of cobalt, has long been known to occur in the copper mines of Babai and Bagor, in the neighborhood of Khetri, Rajputana; Cobaltiferous matte (11 to 14 per cent cobalt) was reported from the copper mines of Kachipatar Argah, in Nepal; cobalt has been detected in the sulphide ores that occur near Arumanallur, in Travancore; a cobaltiferous wad from Olatura, in the Kalahandi State, yielded 0.82 per cent of cobalt oxide; linnaeite has been found in the copper ore of Sikkim; and erythrite occurs as a pinkish encrustation on the zinc-lead sulphide ore of the Bawdwin mines, in Burma.

Australia

Before the discovery of the Canadian deposits, Australia was second only to New Caledonia in the supply of cobalt. At that time the production came from the deposits at Port Macquarie which are similar to those of New Caledonia. As a result of the development of the cobalt-silver mines in Ontario production from this area, virtually ceased, but in 1921 Australia again began to produce cobalt in significant quantities from Queensland. After 1924 the output from this State dropped off rapidly and in 1927 there was no production recorded in Queensland. Shortly thereafter, however, Australia again came forward as a minor factor in supply.

Small shipments of arsenical gold ore containing cobalt have been made from British Columbia to Australia, and undoubtedly ore and concentrates produced in New Caledonia are treated in Australian works from time to time.

²⁰ The Mineral Industry during 1919, vol. 28, p. 137.

²¹ Baievsky, Boris, Iron and Alloy Metals in Siberia: Bureau of Foreign and Domestic Commerce Trade Information Bull. 359, 1925, p. 27.

²² Imperial Mineral Resources Bureau, Cobalt (1913-1919): The Mining Industry, British Empire and Foreign Countries, War Period, 1921, p. 16.

New South Wales.- At Port Macquarie cobalt-bearing wad associated with loosely cemented grains of chromite and containing as much as 7.48 per cent of cobalt oxide, occurs in serpentine and in the iron-bearing claims resulting from a decomposition of the same rock which intrudes the sedimentary formations, chiefly carboniferous sandstones.

Other deposits in New South Wales are at Carcoar, where the ore is glaucodot, or cobalt-bearing mispickel, containing 28 per cent cobalt oxide; at Bungonia, where the ore is cobalt-bearing manganese oxide, found as concretionary nodules and as the cementing material of a grit, which contains 3.25 per cent of cobalt and 0.38 per cent of nickel; and at Cobalt (near Torrington), where the ore has been treated principally for bismuth and wolfram, and where the tailing dumps resulting from this treatment contain about 6.15 per cent of cobalt.²³

Queensland.- The principal mines are at Mount Cobalt in the Cloncurry district, 19 miles south of Selwyn, the nearest railroad station, which is 71 miles from Cloncurry. Cobalt there occurs in a vein, in places as much as 3 feet in thickness, along the contact of a diorite dike intruded into Silurian schists. The vein minerals are cobaltite, and various oxidation products include erythrite and also some asbolite (cobalt-bearing powdery manganese dioxide). Analyses of the ore (concentrates?) show from 10 to 19.5 per cent of cobalt with relatively small amounts of gold and silver, and what is worthy of special comment, no nickel or copper. The arsenic content ranges from 9 to 28.3 per cent.²⁴

At Sally's Creek, in the Cloncurry district, 50 miles north of Cloncurry and about 11 miles north of Koolamarra siding on the Cloncurry-Mount Cuthbert Railway, cobalt ore was discovered in 1924, and work was begun at the Queen Sally mine in 1925. Domestic water is obtained within half a mile of the mine, and abundant water is available in Cabbage-tree Creek, 2 miles north. Timber for shafts is within easy distance. The cobalt occurs²⁵ in lenses of black oxidized ore; assays as high as 28 per cent of cobalt have been obtained. The ore is associated with sulphides but is free from manganese and nickel.

E. C. Saint-Smith, Government Geologist of Queensland says:²⁶

"The ore-bearing formation consists of a narrow belt of quartz schist, quartzite, and limestone (Cloncurry series) lying within an extensive mass of intrusive (?) highly schistose diorite apparently striking northwest-southeast, parallel with the ore body.

"Occasional occurrence of an earthy blue mineral simulating azurite through the ore is of interest; from tests of Geological Survey, there can be little doubt but that it is an unusual form of the ordinary pink hydrous arseniate (erythrine). Greenish-yellow iron silicate is present in small quantity."

- 23 Dept. of Mines (New South Wales) Geol. Surv. Bull. 13, 1925, p. 11.
 24 Reid, J. H., Cobalt in the Cloncurry District: Queensland Govt. Min. Jour., vol. 22, Jan. 15, 1921, pp. 12-14.
 25 Min. Ind., 1925, vol. 34, p. 177.
 26 Saint-Smith, E. C., Queen Sally Cobalt Mine, Koolamarra, Cloncurry Mineral Field: Queensland Govt. Min. Jour., vol. 26, July 15, 1925, p. 281.

A promising prospect at Dugald River, 50 miles north of Cloncurry, was announced by the Queensland Government Mining Journal, vol. 54, p. 2, 1928, which reported also a lode carrying 40 per cent of copper and 17 to 18 per cent of cobalt at Loongana, 20 miles south of Cloncurry. According to the same journal (April 15, 1924), cobalt was discovered in an old copper dump at Redcap, Chillagoe field.

South Australia.- Cobalt ore, containing smaltite and other minerals, is found at Bimbowrie, near Clary, on the Broken Hill line. According to L. C. E. Gee,²⁷ who quotes Government geologists, "rich cobalt ores in considerable variety were found; a lot of shallow shaft and costeaning work has been done. . . . This Simba Hill locality is, indeed, a curious and interesting one in the way of metals and minerals. Copper, cobalt, nickel, and silver-lead occur. . . . These deposits carrying cobalt are worthy of special attention from prospectors, for the reason that cobalt is a common associate of rich silver ores." H. Y. L. Brown²⁸ says: "Cobalt ores occur in crystalline limestone near granite dikes and schists, along the bedding planes in seams and pockets: erythrite, smaltite, cobaltite, and earthy cobalt (oxide-MnO₂ and Fe oxides). Assays run to 22 per cent cobalt."

Western Australia.- Cobaltiferous epsomite was discovered²⁹ during 1918-19 at Parkerville, in an efflorescence in the form of a soft, loose white powder (3 to 25 mm. thick), on the western wall of the municipal quarry. An analysis indicates that the efflorescence is essentially epsomite mixed with a small percentage of gypsum. The presence of appreciable amounts of cobalt, nickel, and copper sulphates co-crystallized with the magnesium sulphate is unique, the only other occurrence known to literature being that of Neusohl (Hungary).³⁰

Parkerville is situated in the midst of the immense granite massif of the Darling Ranges; the granite is transversed by a network of large epidiorite dikes and by pegmatite and quartz veins, with occasional narrow greenstone dikes of later date. The quarry has exposed large faces of epidiorite and granite, both kaolinized near the surface.

Belgian Congo

The largest known deposits of cobalt, at least outside of Canada, are at Katanga near Elisabethville, Belgian Congo. The operating company, the Union Minière du Haut-Katanga, which was formed in 1906 to exploit a 60,000-square-mile area, is a joint corporation representing the Comité Speciale du Katanga and the Tanganyika Concessions (Ltd.), a British company. The Comité Speciale is a combination of big banking houses and the Belgian Government; it is said to control 40

²⁷ Reports by the Chief Registrar of Mines; a review of mining operations in the State of South Australia during the half year ended Dec. 31, 1914, No. 21, 1915, pp. 27-29.

²⁸ Brown, H. Y. L., Record of the Mines of South Australia: 4th ed., Adelaide, 1908, pp. 53, 353, and 354.

²⁹ Simpson, Dr. Edward S., Cobaltiferous Epsomite at Parkerville, Jour. and Proc. of the Royal Soc. of Western Australia, vol. 6, Pt. II, Perth, 1919-20, pp. 88-89.

³⁰ Dana, E. D., 1889 ed., p. 644.

per cent of the stock of the Union Minière. The copper smelting works of the company are situated about 2 miles from Elisabethville on the Lufria River. At this plant there is a cobalt furnace in which the cobalt is "slagged off." The slag is then treated in electric furnaces at Panda, 80 miles away, producing a copper-cobalt-iron alloy which is sent to Colen, near Antwerp, for refining. The production of cobalt by the Union Minière in 1928 rose to 400 tons, an increase of 50 tons as compared with the previous year. The company proposed to double its output in 1929.³¹ The Union Minière began to sell cobalt, at least on an extensive scale, only since the completion of its refinery in 1925. Previous to that, however, considerable cobalt was recovered in the electrolytic refining of its blister copper. Formerly this crude copper contained from 2 to 4 per cent cobalt and previous to 1914 much of it was refined at Hamburg. After the outbreak of the War in Europe, it went to the United States (first to the American Smelting and Refining Co. and later to the Nichols Copper Co.) but in recent years the cobalt content of this blister copper has declined to 0.10 or 0.12 per cent.

Little information has been furnished as to the nature or extent of the cobalt deposits. It is known, however, that deposits are extensive and that the cobalt occurs principally as linnaeite, together with heterogenite and possibly cobaltite. The cobalt is always associated with copper; at the Luisha mine the ore contains 9 per cent of copper and 9 per cent of cobalt. Ore containing less than 6 per cent of cobalt is mechanically concentrated previous to smelting.

Canada

Most of the cobalt produced in Canada is obtained by treating the complex arsenical ores from the Cobalt, South Lorrain, and Gowganda silver-mining districts. In addition to by-product cobalt, however, a certain amount of low-silver, high-cobalt ore is mined primarily for its cobalt content. The nickel-copper ores of the Sudbury district contain small amounts of cobalt, and the nickel produced therefrom in Canada is said to carry on the average 0.5 per cent cobalt. Since this cobalt is not deleterious for most purposes it is not necessary to remove it. Nickel produced in Wales by the Mond process is practically cobalt-free, but no figures are available showing the recovery of cobalt from the residues of this process. Cobalt has also been identified in the Michipicoten district in Ontario, The Pas Mineral belt, Manitoba, where cobalt minerals (chiefly smaltite and erythrite) occur with gold, lead, silver, and antimony; the property of the New Hazelton Cobalt Mines (Ltd.) on the west side of the Rocher de Boule Mountain, and more recently (1928) on Boulder Creek, in the Cowichan district, British Columbia.

Cobalt ore was first discovered in Canada in 1903 on the line of the Temiskaming and Northern Ontario Railway, about 100 miles north of North Bay. The name "Cobalt" was given to the district which has subsequently furnished by far the greater part of the world's supply of cobalt in addition to being the greatest silver producing area of the world for some 20 years. Geology of the Cobalt district has often been described, and for information as to the general character and origin of the vein formations the reader is referred to a report by Willet G. Miller.³²

³¹ Union Minière Outputs: South African Min. and Eng. Jour., vol. 40, No. 1954, pt. 1, Mar. 9, 1929, p. 45.

³² Miller, W. G., The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming: Rept. of Canadian Bureau of Mines, vol. 19, Pt. II, 1913, p. 5.

Production figures for Canada include the cobalt content of the various cobalt products sold by the south Ontario smelters added to the cobalt content of the ores and residues exported for treatment in foreign smelters; the value given is the net amount received by the shippers. In the earlier years cobalt-bearing ores low in silver were left in the mine or thrown on the dump, as the cobalt contents were of little or no value. In recent years, on the other hand, as the price of silver has declined and the demand for cobalt increased, the situation is beginning to change. Early in 1930, in fact, it was proposed to resume work at the old La Rose mine, a worked-out silver mine which is said to contain quantities of cobalt ore. Although at present the smelter at Doloro, Ontario, is the only plant in North America producing cobalt, cobalt oxides, and other compounds, cobalt has also been recovered by the Coniagas Reduction Co. of Thorold; by the Canadian Refining and Smelting Co. at Orillia; by the Canadian Copper Co. (International Nickel) at Copper Cliff; and the Metals Chemical Co. at Welland. The last of these smaller plants (Thorold) ceased operations in 1926.

From 1907 until April, 1917, the Metal Refining Bounty Act was in operation. Under this act, bounties were paid to refineries on cobalt metal, cobalt oxide, and salts of cobalt, and also on nickel oxide and salts of nickel. The bounty was at the rate of 6 cents per pound on the metallic content.

Table 4. - Total shipments from Ontario silver mines, smelters, and refineries, 1904 to 1929^{1/2}

Year	Short tons	Value	Year	Short tons	Value
1904	16	\$ 19,960	1918	380	\$1,640,310
1905	118	100,000	1919	298	1,019,479
1906	321	80,904	1920	283	1,605,365
1907	739	104,426	1921	126	616,235
1908	1,224	111,118	1922	3/776	1,333,676
1909	1,533	94,965	1923	380	1,803,872
1910	1,093	54,699	1924	476	1,662,526
1911	852	170,890	1925	558	2,328,517
1912	934	314,381	1926	332	1,136,014
1913	821	420,386	1927	440	1,764,534
1914	351	590,406	1928	477	1,671,900
1915	206	383,261	1929	465	1,801,915
1916	400	805,014	Total ^{1/2}	13,941	\$22,772,743
1917	337	1,138,190			

Annual Reports of the Ontario Dept. of Mines. Toronto.

Cobalt metal and metallic contents of all cobalt compounds and cobalt in ores and speiss residues exported.

Includes 460 tons of speiss residues worth \$153,116.

Preliminary.

Table 5. - Cobalt products marketed by Ontario refineries, 1923-1925¹

	1923 ^{2/}	1924	1925
Cobalt oxide-pounds	454,772	450,038	575,580
Cobalt in residues	88,090	(3)	(3)
Cobalt salts	71,093	61,908	100,483
Cobalt-nickel oxides, unseparated ..	226,328	271,179	164,901
Cobalt, metallic	227,993	174,349	625,298
Total value	\$1,928,563	^{4/} \$1,421,826	^{5/} \$2,328,517

- 1 Annual Reports of the Ontario Dept. of Mines, Toronto. (After 1925 the various products are not segregated).
- 2 In 1923 the values of the various products are given separately. The average value per pound for the respective items were as follows: Oxide, \$1.94; residues (cobalt contents) \$2.50, salts, \$0.88; unseparated oxides, \$0.84; and metal, \$2.52.
- 3 Not listed separately.
- 4 Exclusive of value of cobalt in 60,044 pounds of base bullion, speiss, and blast furnace cleanings valued at \$37,263.
- 5 Exclusive of value of cobalt in 1,239,476 pounds of base bullion and speiss residues valued at \$347,834.

New Caledonia

There is no accurate account of the history of cobalt mining in the island of New Caledonia, but the first claim was taken up in 1876, and the first official export figures are for the year 1888. Thenceforth the island was the chief producer of cobalt until the discovery of the Canadian mines, after which the industry languished. Production in recent years has been small and very irregular. Since 1909 no mine of importance has been worked, only small deposits under special conditions.

Cobalt in the form of asbolite occurs in bluish-black nodules in ferruginous clay derived from the weathering of serpentine formations which overlie a large part of the island. The cobalt deposits though numerous are never large, and they are distributed very irregularly. The cobalt oxide content averages between 4 and 6 per cent, but production costs are apparently too high to permit production to be maintained in competition with Canada and the Belgian Congo. Former centers of exploitation, most of which might again produce cobalt if prices rose sufficiently, are the following: Ounia, Boandy, Nemeni, Bogota, Canala, Moneo, Mou, Wagap, Geyeto, Voh, Gatope, Thie baghi, Vande, Pam, and Belep.

South Africa

Cobalt mines have been worked from time to time in various parts of British Africa. Work has recently been resumed at the Kruis River mine, which was operated about 1875 by a German, Carl Maunch, who is said to have sold £25,010 worth of hand-picked ore. As a result of the Secocoeni it was not reopened. Developments in 1929 were described as follows: