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COBALT

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GOVERNMENT OF INDIA
MINISTRY OF MINES
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4 Cobalt

Cobalt is an important ferromagnetic strategic alloying metal having irreplaceable industrial applications. Cobalt is associated mostly with copper, nickel and arsenic ores. Cobalt is extracted as a by-product of copper, nickel, zinc or precious metals. Lateritic/limonitic nickel ore usually is found to contain 0.08-0.15% Co along with 1.5-4% Ni in many parts of the world.

RESERVES/RESOURCES

Occurrences of cobalt are reported from Singhbhum district, Jharkhand; Kendujhar and Jajpur districts, Odisha; Jhunjhunu district, Rajasthan; Tuensang district, Nagaland; and Jhabua & Hoshangabad districts, Madhya Pradesh. Cobalt occurring with nickeliferous limonite/laterite in Sukinda area, Jajpur district, Odisha and copper slags produced by HCL are two possible sources of cobalt. The sea-bed multimetal nodules which contain 0.3% Co (Av) along with other minerals are the other sources of cobalt.

As per NMI data based on UNFC system, reserves/resources of cobalt in terms of ore as on 1.4.2015 have been estimated at 44.91 million tonnes of which about 69%, i.e. 30.91 million tonnes are estimated in Odisha. The remaining 31% resources are in Jharkhand (9 million tonnes) and Nagaland (5 million tonnes). The Reserves/Resources of cobalt as per UNFC system are furnished below in Table-1.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are given in the review on "Exploration & Development" in "General Reviews".

USES

Major use of cobalt is in metallurgical applications, in special alloy/super alloy industry, in magnets and cutting tools industries. Cobalt is used as precursors (cobalt compounds) for cathodes in rechargeable batteries. Largest demand for cobalt has been from the Rechargeable Battery Industry. It was initially used in Ni Cd and NiMH cells since the invention of the Lithium ion battery, this technology accounted for all the growth in cobalt consumption from the Battery Sector (CRU). Cobalt-based super alloys normally contain 45% or more cobalt, while nickel and iron-based super alloys contain 8 to 20% cobalt. Cobalt oxide is used in chemical applications, such as, catalyst, dyes & pigments, paint driers/adhesives and glass & ceramics. Cobalt catalyst, mostly cobalt acetate, is used in the manufacture of terephthalic acid (TPA) and di-methyl- terephthalate (DMT).

Super alloys made of cobalt have improved strength and wear & corrosion-resistance characteristics at elevated temperatures. Another use of cobalt-based super alloys is in turbines for pipeline compressors and jet aircraft engines. Hard-facing or cutting tools with cobalt alloys provide greater resistance to wear, heat, impact and corrosion. Cobalt powder finds an important application as a binder in the production of cemented tungsten carbides for heavy-duty and high-speed cutting tools. It is also used on bonded tools for Diamond Industry. Cobalt application improves the coating/adhesive property of enamel in steel appliances and is used in manufacturing of steel-belted tyres. Cobalt-molybdenum-alumina compound is used as catalyst in hydrogenation and for petroleum desulphurisation. Elemental Cobalt-60 (radioactive isotope, a production of atomic pile) is used in industrial radiography and therapeutics. Cobalt can retain ferromagnetic property up to a temperature of 1,100 ^{o}C, highest for any metal. It is used in the manufacturing of Alnico magnets, magnetic recording media, soft magnetic material, alloys for spacecraft, etc. Cobalt is alloyed with aluminium and nickel to manufacture powerful magnets. Permanent magnets are used in wind turbines and electric motors for automobiles & aircraft. Other significant uses of cobalt are in battery electrodes, airbags in automobiles, etc. Further, as per Avicenne (CRU), 2015, different types of lithium ion batteries with composition of cobalt are available in the market i.e. LCO-Lithium-Cobalt Oxide which contains 60% of cobalt oxide is used in high capacity storage cell phone, iPad cameras and wearables; NMC-Lithium-Nickel-Manganese-Cobalt oxide that contains 10-20% of cobalt sulphate is used in the manufacture of low capacity but high specific power batteries which have longer cycle life have found applications in laptops and electronic vehicle (EVs); and NCA Lithium-Nickel-Cobalt Aluminium-oxide that contains 9% cobalt sulphate is used in EVs, electric grid storage (Tesla's EVs and Smart Grid/home storage and laptops).

Table – 1: Reserves/Resources of Cobalt Ore as on 1.4.2015
(By States)

(In million tonnes)

State	Reserves	Remaining Resources					Total
	Total (A)	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	Resources (A+B)
All India	**-**	**30.63**	**2**	**0.28**	**12**	**44.91**	**44.91**
Jharkhand	-	-	2	-	7	9	9
Nagaland	-	-	-	-	5	5	5
Odisha	-	30.63	-	0.28	-	30.91	30.91

INDUSTRY & PRODUCTION

Presently, there is no production of cobalt in the country from primary cobalt resources. The demand for cobalt is usually met through imports.

Refining capacity of cobalt in India is estimated at about 2,060 tonnes per year. Of these, NiComet Industries Ltd, Cuncolim, Goa and Rubamin Ltd, Vadodara, Gujarat were India's leading producers of cobalt cathodes and compounds. Installed capacity for cobalt metal and different cobalt salts at NiComet is 1,000 tpy.

Nicomet Industries Ltd manufactures cobalt cathodes of LME - approved specifications under NICO Brand along with nickel cathodes & sodium sulphate in Mumbai, Maharashtra. Vedanta Group is also exploring ways to produce cobalt for batteries as the Group has become the latest entrant among companies that seek to capitalise on the anticipated electric vehicle boom. Vedanta produces about 1,000 tonnes of cobalt-copper alloy per year and in addition aims to produce 3,000 to 4,000 tonnes of pure cobalt per year. The Group source heterogeneite-type cobalt ores from the Democratic Republic of Congo and other countries and manufactures high-purity cobalt metal and salts, viz, sulphate, acetate, oxide, chloride, carbonate and nitrate of cobalt. Cobalt metal powder is reportedly recovered from cemented carbide scrap by Sandvik Asia Ltd at its pilot plant in Pune, Maharashtra. In addition, spent cobalt catalyst from plants producing DMT, TPA and oxo alcohols are also understood to be reprocessed by several small cobalt chemical processors. However, information on reprocessing of cobalt from scrap is not available. It is expected that recycled cobalt would continue to be used for domestic supply.

SUBSTITUTES

Cobalt is used in specialised applications and is difficult to be substituted. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron or nickel-iron alloys in magnets; nickel, cermets or ceramics in cutting and wear-resistant materials; nickel-based alloys or ceramics in jet engines; nickel in petroleum catalysts; rhodium in hydroformylation catalysts; and cerium, lead, manganese, iron, or vanadium in paints. Presently, about one-third of cobalt is replaced by cobalt-manganese-nickel in lithium-ion batteries. In some applications, substitution for cobalt would result in a loss in product performance. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron, or nickel-iron alloys in magnets; cerium, iron, lead, manganese, or vanadium in paints; cobalt-iron-copper or iron-copper in diamond tools; copper-iron-manganese for curing unsaturated polyester resins; iron, iron-cobalt-nickel, nickel, cermets, or ceramics in cutting and wear-resistant materials; iron-phosphorous, manganese, nickel-cobalt-aluminum, or nickel-cobalt-manganese in lithium-ion batteries; nickel-based alloys or ceramics in jet engines; nickel in petroleum catalysts; and rhodium in hydroformylation catalysts.

RECYCLING

Recycling technologies for recovery of cobalt especially from waste Li-ion batteries have been an evolving process. The need for technologies which can recover valuable metals and the commercialisation of that technology by the industry is highly desirable. The technology related to "Recovery of cobalt from Li-ion batteries of mobile phones" developed by National Metallurgical Laboratory (NML), Jamshedpur reportedly claims up to 95% recovery of pure cobalt from Li-ion batteries. The present technology uses Hydrometallurgy process for the recovery of cobalt from waste Li-ion batteries. In this process metal is extracted using sulphuric acid as it is less hazardous to the environment as compared to other materials. Hydrometallurgical processes are considered better than other known processes because of high proportion and purity of recovered metals, low energy requirement and minimal emission. Recovery of cobalt by this process has following benefits.

(i) Cobalt is recovered as precious metal in more pure form.

(ii) The recovery process is less hazardous.

(iii) It enables removal of Li-ion batteries from open environment and this is considered as an effective disposal mechanism by the industry.

Table – 2 : World Reserves of Cobalt (By Principal Countries)

(In '000 tonnes of metal content)

Country	Reserves
World: Total (rounded)	**7100**
Australia	1200
Canada	250
Congo (Kinshasa)	3500
Cuba	500
Madagascar	150
Papua New Guinea	51
Philippines	280
Russia	250
South Africa	29
USA	23
Zambia	270
Other countries	560

Source: *Mineral Commodity Summaries, 2018.*

TRADE POLICY

As per the Foreign Trade Policy 2015-2020, imports of cobalt ores & concentrates under Heading No. 2605 and cobalt alloys and its products under Heading No. 8105 are allowed freely, except cobalt waste & scrap (ITC-HS Code No. 8105 3000) which are restricted.

WORLD REVIEW

The world cobalt reserves are estimated at 7.1 million tonnes of cobalt metal content. Cobalt reserves are mainly in the Congo Dem. Rep. which contributes 49% to the total reserves followed by Australia (17%). Besides, major reserves are also located in Cuba (7%), Philippines, Canada, Zambia & Russia (4% each). The world reserves of cobalt are provided in Table-2.

The world mine production of cobalt in terms of metal content decreased to 128 thousand tonnes in 2016 from 145 thousand tonnes in the previous year. The Democratic Republic of Congo (DRC) was the principal producer contributing about 54%, followed by China (8%), Canada and Australia (5 % each) (Table-3).

Table – 3 : World Mine Production of Cobalt (By Principal Countries)

(In tonnes of metal Content)

Country	2014	2015	2016
World Total	**134000**	**145000**	**128000**
Australia	6252	6777	6012
Brazil	3838	3800[e]	3600[e]
Canada	6907	7489	6969
China	9619	10093	10500[e]
Congo, Dem. P.R.	75560	83529	68822
Cuba	3210	3734	3694
Finland	2104	2119	2308
Madagascar	3221	3920	3370
Morocco[a]	1391	1722	2081
New Caledonia	4681	5098	4350
Papua New Guinea	2134	2505	2191
Philippines	4094	4140	2554
Poland	1640	1730	1670
Russia[a]	2302	2040	2100
South Africa[a]	1332	1362	1101
Zambia[a]	4317	2997	4725
Other countries	1226	2058	1831

Source: *World Mineral Production, 2012-2016, BGS.*
a: Metal and/or refined

Australia

In 2015, Western Australian cobalt mine production, which is a by-product of the State's Nickel Industry, was estimated to be similar to that of 2014. Australian production of refined cobalt, which included production from imported lateritic ore, decreased by 5%.

The Palmer Nickel and Cobalt Refinery (owned by Australian businessman Clive Palmer, operated by Queensland Nickel Pty. Ltd) in Townsville, Queensland, produced 1,850 tonnes of refined cobalt as cobalt oxide hydroxide in 2015 which is 27% less than the 2,519 tonnes produced in 2014. Darton Commodities Ltd attributed the decrease to reduced feed supply and lower cobalt recoveries. In recent years, the refinery has processed lateritic ore from the Brolga Mine and the Dingo Dam mining lease of Metallica Minerals Ltd's Lucky Break project, both in Queensland; lateritic ore imported from New Caledonia and the Philippines; and an intermediate cobalt compound from Vale S.A.'s New Caledonia operation. In early 2016, Queensland Nickel entered voluntary administration as a result of financial problems owing to the low nickel price and the refinery temporarily ceased operations in March 2016 owing to a shortage of ore supply.

BHP Billiton Plc's Nickel West operations in Western Australia comprised nickel sulphide mines; concentrators, which processed ores mined by BHP Billiton and other companies; the Kalgoorlie smelter, where nickel matte was produced; and the Kwinana nickel refinery, which produced cobalt in intermediate nickel-cobalt sulphide.

Following the sale of the Cosmos Mine to Western Areas Ltd in mid-2015, Glencore plc had one remaining nickel asset in Western Australia—Minara Resources Ltd's Murrin Murrin nickel-cobalt laterite mining and pressure-acid-leaching operation. In 2015, Murrin Murrin produced 3,300 tonnes of cobalt metal (2,900 tonnes in 2014), approximately 500 tonnes of this 2015 production was from third-party feed (200 tonnes in 2014).

First Quantum Minerals Ltd (Vancouver, British Columbia, Canada) produced intermediate nickel-cobalt hydroxide from its Ravensthorpe nickel-cobalt laterite mine and hydrometallurgical processing plant in Western Australia. In 2015, the plant produced 26,668 tonnes of nickel and, based on the hydroxide containing 40% nickel and 1.4% cobalt, an estimated 920 tonnes of cobalt were produced as against 36,445 tonnes of nickel and an estimated 1,260 tonnes of cobalt produced in 2014. The decrease in production was attributed to a structural failure in an atmospheric leaching tank, which disrupted production in December 2014. The leach circuit was recommissioned in July, but the plant operated at reduced capacity for the remainder of the year while refurbishment efforts took place. Most of Ravensthorpe's hydroxide reportedly was sent to China, with lesser amounts sold to Brazil and India.

Panoramic Resources Ltd produced concentrates containing 465 tonnes of cobalt (436 tonnes in 2014) from its Savannah underground nickel-copper sulphide mine operation in Western Australia. The concentrates were shipped to Jinchuan Group Co. Ltd's operations in China under a long-term offtake agreement. In early 2016, Panoramic announced that it would place the mine on care-and-maintenance status to preserve the resource until nickel prices improved.

Mincor Resources NL mined nickel-copper sulphide ores from its South Kambalda operations in Western Australia. All of the ore was toll processed by BHP Billiton at its Nickel West Kambalda concentrator and the resulting concentrate was sold to BHP Billiton under long-term agreements. In 2015, Mincor produced nickel concentrate from its Mariners and Miitel Mines and sold concentrate containing 96 tonnes of cobalt (191 tonnes in 2014). The Company planned to cease mining at the end of January 2016 and implement a care-and-maintenance programme in response to the continuous decline in the price of nickel.

Brazil

Votorantim Metais S.A. produced cobalt cathode at its Sao Miguel Paulista, Sao Paulo State, refinery mainly from lateritic nickel-cobalt ore mined from Niquelandia, Goias State. In January 2016, Votorantim announced that because of market conditions it would temporarily suspend its nickel operations. The Company reportedly planned to shut down mining operations at Niquelandia in February and cease processing at Niquelandia and refining at Sao Miguel Paulista in May.

During the first half of 2015, Mirabela Nickel Ltd produced 149 tonnes of cobalt in nickel sulphide concentrate from its Santa Rita open-pit mine and concentrator in Bahia State. In September, the Company was placed under voluntary administration and production results were not released for the second half of the year 2015. Production was cut back during late October 2015 to reduce operating costs in response to the low nickel price, and the Company planned to place the mine on care-and-maintenance status in early 2016.

Canada

Vale's global cobalt production was 4,533 tonnes in 2015, 21% more than the 3,743 tonnes produced in 2014. Vale produced 1,448 tonnes (1,362 tonnes in 2014) of refined cobalt metal at its Port Colborne, Ontario, refinery; 2,926 tonnes (1,124 tonnes in 2014) of cobalt in a cobalt intermediate product at its nickel operations in Canada and New Caledonia; and 159 tonnes (1,257 tonnes in 2014) of cobalt contained in other intermediate products such as nickel concentrates. Vale's cobalt originated from company-owned nickel sulphide mines at Sudbury, Ontario, Thompson, Manitoba, and Voisey's Bay in northeastern Labrador; from a company owned nickel laterite mine in New Caledonia; and from purchased feedstock materials. Vale reported that 751 tonnes (833 tonnes in 2014) of cobalt came from Ontario, 365 tonnes (489 tonnes in 2014) came from Manitoba, 849 tonnes (952 tonnes in 2014) came from Voisey's Bay, 2,391 tonnes (1,384 tonnes in 2014) came from New Caledonia, and 177 tonnes (84 tonnes in 2014) came from external sources.

The decrease in Vale's cobalt production from Voisey's Bay was attributed to a shift in the processing location of that mine's nickel concentrate.

Vale was considering phasing out smelting and refining at Thompson, owing to Canadian sulphur dioxide emission standards that came into effect in 2015. The Company was allowed to continue smelting and refining through 2018, subject to negotiation of emission limits with Environment Canada.

Glencore reported that 800 tonnes of the cobalt produced at its Nikkelverk refinery in Norway originated from concentrates produced from its mines at Sudbury, Ontario, and Raglan, Quebec. This was the same as its Canadian production in 2014.

The Fort Saskatchewan refinery, a joint venture of Sherritt and General Nickel Co. S.A., produced 3,733 tonnes of cobalt as metal powder and briquettes in 2015, 16% more than the 3,210 tonnes produced in 2014. Approximately 88% of the cobalt originated from Cuba; the remainder was from purchased materials. As a result of a United States embargo on imports of products originating from Cuba, cobalt and nickel produced by Sherritt could not be sold to customers in the United States.

China

China was the world's leading producer and consumer of refined cobalt. In 2015, China's imports of raw materials, production, consumption, and recovery from scrap increased from those of 2014. China's total production, including an estimate for Umicore's Ganzhou Yi Hao plant, was estimated to constitute more than one-half of world refined cobalt production. Nearly 80% of China's cobalt consumption was used to make cathode materials for rechargeable batteries, primarily lithium-ion batteries with cobalt or nickel-cobalt-manganese cathodes.

Numerous companies refined and (or) processed cobalt in China. As a result of consolidation in recent years, in 2015, more than 90% of China's refined cobalt was produced by 10 companies and nearly 60% was produced by three companies—Jinchuan, Shenzhen GEM High-Tech Co. Ltd (including subsidiary Jiangsu Cobalt Nickel Metal Co. Ltd), and Zhejiang Huayou Cobalt Co. Ltd. In 2015, Huayou began production at its newly constructed cobalt refinery in Quzhou, Zhejiang Province, reportedly bringing the Company's total refining capacity to 15,000 t/yr of contained cobalt. As a result, Huayou increased its direct involvement in acquiring raw materials from Congo (Kinshasa) and planned to triple its capacity to produce battery precursor materials. The trend of extending their businesses upstream towards raw materials supply and downstream towards cobalt products was being adopted by most of China's cobalt refiners.

Only a small portion of China's cobalt production originated from domestic mines. Most of the production was from imported cobalt concentrate and intermediate chemical compounds, the majority of which was sourced from Congo (Kinshasa). China also imported cobalt raw materials from nickel operations in Australia and elsewhere and has been recovering increasing

amounts of cobalt from scrap in recent years. A comparison of China's cobalt supply (mine production, imports of raw materials and refined metal, and cobalt recovered from scrap) with its domestic cobalt consumption and exports indicated a stock buildup of 4,000 to 7,800 tonnes in 2015. At year end 2015, China reportedly held about 17,000 tonnes of cobalt in stocks

China's State Reserve Bureau (SRB) continued to add cobalt to its national stockpile in 2015. The SRB purchased 400 tonnes of cobalt in September and 1,800 tonnes in November. The cobalt reportedly was sourced mainly from domestic producers Jinchuan and Jiangsu Cobalt Nickel Metal.

Congo (Kinshasa)

Congo (Kinshasa) was the world's leading producer of mined cobalt and was estimated to represent one-half of global production. Some of the country's cobalt mine production was from copper-cobalt ores mined by industrial or mechanised methods, and some was gathered by tens of thousands of artisanal miners by handpicking cobalt-rich ores. Spencer identified a correlation between cobalt prices and the amount of cobalt mine production by artisanal methods and estimated that artisanal mines in Congo (Kinshasa) produced approximately 10,500 tonnes of cobalt in 2015. Some of Congo (Kinshasa)'s ores and concentrates were exported, some were processed in Congo (Kinshasa) to intermediate materials (crude cobalt carbonate, crude cobalt hydroxide, or cobalt bearing alloys, such as alliage blanc), and some were refined in Congo (Kinshasa) to cobalt metal. China was the leading destination for Congo (Kinshasa)'s cobalt exports. In December, the Government of Congo (Kinshasa) extended a moratorium on its 2013 ban on exports of copper and cobalt concentrates until December 31, 2016. The justification for the moratorium was the inadequate power supply to process the concentrates in the country.

In 2015, the Government of Congo (Kinshasa) began the process of dividing its existing 11 Provinces into 26. Following the division, the copper-cobalt deposits of the African Copper belt in the former Katanga Province were located in two Provinces. One was Lualaba Province, with Kolwezi as its capital, in the southwestern part of the former Katanga Province and the other was Haut-Katanga Province, with Lubumbashi as its capital, in the southeastern part of the former Katanga Province.

State-owned La Generale des Carrieres et des Mines SARL (Gecamines) held a minority interest in most of the coppercobalt operations in Congo (Kinshasa). In 2015, Gecamines produced an estimated 400 tonnes of refined cobalt at its Shituru refinery in Likasi, down from an estimated 500 tonnes in 2014. In July, Gecamines sold the mining permit for Compagnie Miniere du Sud Katanga's Luiswishi and Lukuni copper-cobalt deposits to Congo Dongfang International Mining SPRL (CDM). CDM, a subsidiary of Zhejiang Huayou Cobalt Co., Ltd, was responsible for procuring cobalt concentrates for Huayou's refineries in China and also producing crude cobalt hydroxide at its hydrometallurgical plant in Lubumbashi.

Kamoto Copper Company SARL (KCC) (Katanga Mining Ltd, Gecamines, and La Societe Immobiliere du Congo) produced 2,901 tonnes of cobalt cathode in 2015, 4% more than the 2,784 tonnes produced in 2014.

Boss Mining Sprl [70% Eurasian Resources Group B.V. (ERG) and 30% Gecamines] mined copper-cobalt ore from open pits at Mukondo Mountain and Kabolela and produced oxide and sulphide concentrates at the Kakanda concentrator. Darton Commodities Ltd estimated a decrease in Boss Mining's cobalt production from 8,500 tonnes in 2014 to 3,500 tonnes in 2015. The decreases in cobalt contained in oxide and sulphide concentrates were attributed to changes in ore mineralogy.

In 2015, Tenke Fungurume Mining S.A.R.L. [Freeport- McMoRan Inc. (FCX), Lundin, and Gecamines] extracted copper-cobalt ore from an open-pit mine, which it processed onsite to produce 16,014 tonnes of cobalt in hydroxide, 20% more than the 13,334 tonnes produced in 2014.

Mutanda Mining SPRL (Glencore and Fleurette Mumi Holding Ltd) mined copper-cobalt oxide ore from open pits near Kolwezi and produced 16,500 tonnes of cobalt in concentrate and hydroxide, 15% more than the 14,400 tonnes produced in 2014.

Chemaf SPRL mined copper-cobalt ore from the Etoile open-pit mine and produced concentrate using heavy media separation technology, which it processed at its solvent extraction–electrowinning (SX–EW) plant at Usoke in Lubumbashi.

Ruashi Mining SPRL (75% Jinchuan subsidiary Metorex (Proprietary) Ltd and 25% Gecamines) produced 4,344 tonnes of cobalt in cobalt hydroxide (3,885 tonnes in 2014) from its Ruashi operation east of Lubumbashi. The 12% increase in production was attributed to an increase in the grade of ore mined and treated. Ruashi comprised a copper-cobalt oxide open pit mine, a mill, and an SX–EW refinery. The cobalt hydroxide was sold to Jinchuan (Jinchuan Group International Resources Co. Ltd).

Societe Miniere du Katanga SPRL (Somika) mined and beneficiated copper-cobalt ore and refined the concentrate at its hydrometallurgical copper refinery in Lubumbashi. In 2015, the refinery produced 4,554 tonnes of cobalt hydroxide.

The La Sino-Congolaise des Mines S.A. (Sicomines) joint venture (China Railway Group Ltd, Gecamines, Sinohydro Corp., and Zhejiang Huayou Cobalt Co., Ltd) completed construction of its copper-cobalt mine and beneficiation plant and began production of copper and copper-cobalt concentrates. China Railway had two additional operating copper-cobalt mines in Congo (Kinshasa)—Luishia and Miniere de Kalumbwe Myunga.

New Caledonia

Vale continued to ramp up production at its Vale New Caledonia project in the southern tip of New Caledonia's main island. The project comprised a nickel cobalt laterite mine, a high-pressure acid-leaching processing plant, and a refinery. In 2015, Vale produced 2,391 tonnes of cobalt from New Caledonia (1,384 tonnes in 2014). Statistics from the Government of New Caledonia indicated that Vale produced 1,568 tonnes of cobalt in carbonate (435 tonnes in 2014). Following rampup, Vale New Caledonia was expected to have a nominal production capacity of 57,000 t/yr of nickel contained in nickel oxide and 4,500 t/yr of cobalt contained in an intermediate cobalt carbonate.

Lateritic nickel-cobalt ore was exported to the Palmer Nickel and Cobalt Refinery in Queensland, Australia, for processing. Nickel matte from Société Le Nickel's Doniambo smelter was sent to Eramet's refinery in Sandouville, France, where nickel products and cobalt chloride were produced. In late 2015, Eramet announced that it planned to cease production of matte at Doniambo and increase its output of ferro-nickel instead.

FOREIGN TRADE

Exports

The exports of cobalt ores & concentrates were negligible during 2015-16 & 2016-17.

Exports of cobalt and alloys including waste and scrap decreased to 37 tonnes in 2016-17 from 80 tonnes in the previous year. Exports were mainly to Finland (24%), USA (11%), Iran and Germany (6% each). Out of the total exports in 2016-17, exports of cobalt and alloys were 25 tonnes and those of cobalt waste & scrap were only 12 tonnes (Tables- 4 to 10).

Imports

During 2016-17, there was no import of cobalt ores and concentrates as against 25 tonnes in the previous year.

Imports of cobalt and alloys including waste and scrap increased to 902 tonnes in 2016-17 from 813 tonnes in the previous year. Imports in 2016-17 were mainly from Congo, Dem. Rep. (15%), USA (14%), Canada (13%), Belgium (12%) and Norway (9%). Besides, imports of cobalt in the form of cobalt powder, other articles and unwrought cobalt also took place at 248 tonnes, 241 tonnes and 413 tonnes, respectively (Tables - 11 to 17).

Table –4 : Exports of Cobalt Ores & Conc. (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**++**	**44**	**++**	**20**
Netherlands	++	7	++	16
Zambia	-	4	++	2
UK	-	-	++	2
Sri Lanka	++	33	-	-

Table – 5: Exports of Cobalt & Alloys (Including Waste and Scrap) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**80**	**63278**	**37**	**56720**
Finland	13	10129	9	16473
USA	26	29667	4	13858
Iran	++	1056	2	13264
Germany	2	1161	2	3569
Sri Lanka	++	739	1	2345
Canada	-	-	8	2047
Hungary	++	267	++	1342
Slovenia	-	-	3	1046
UK	11	10011	2	921
Bangladesh	2	108	6	625
Other countries	26	10140	++	1230

Table – 6: Exports of Cobalt & Alloys (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**70**	**54905**	**25**	**52460**
Finland	13	10129	9	16473
USA	26	29667	4	13858
Iran	++	1056	2	13264
Germany	++	117	1	2561
Sri Lanka	++	739	1	2345
Hungary	++	267	++	1342
UK	3	2682	2	921
Bangladesh	2	108	6	625
Turkey	++	800	++	421
Netherlands	-	-	++	411
Other countries	26	9340	++	239

Table – 7: Exports of Cobalt Waste & Scrap (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**10**	**8373**	**12**	**4260**
Canada	-	-	8	2008
Slovenia	-	-	3	1046
Germany	2	1044	1	1008
Kuwait	-	-	++	198
UK	8	7329	-	-

Table – 8: Exports of Cobalt Powder (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**1**	**4120**	**3**	**15338**
Iran	++	1056	2	12555
Sri Lanka	++	681	1	2345
Turkey	++	800	++	418
Germany	-	-	++	15
Singapore	-	-	++	5
USA	1	1583	-	-

Table – 9: Exports of Cobalt (Other Articles) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**24**	**35718**	**22**	**37120**
Finland	13	10129	9	16473
USA	5	21817	4	13858
Germany	++	117	1	2546
Hungary	++	267	++	1342
UK	3	2682	2	921
Iran	-	-	++	709
Bangladesh	2	108	6	625
Netherlands	-	-	++	411
Mexico	-	-	++	100
Swaziland	-	-	++	49
Other countries	1	598	++	86

Table – 10: Exports of Cobalt Unwrought (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**45**	**15067**	**++**	**2**
Morocco	-	-	++	2
UAE	24	7549	-	-
USA	20	6267	-	-
Belgium	1	1251	-	-

Table – 11 : Imports of Cobalt Ores & Conc. (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**25**	**44193**	-	-
Congo, Dem. Rep.	20	37196	-	-
Germany	3	3735	-	-
Australia	2	3262	-	-

Table – 12: Imports of Cobalt & Alloys (Including Waste & Scrap) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**813**	**1799262**	**902**	**1972147**
USA	114	327936	126	365785
Belgium	100	247433	104	243135
Canada	100	182684	116	206584
Congo Dem. Rep.	168	249126	132	201847
UK	33	99344	50	136660
Norway	-	-	78	135949
China	44	109047	58	134875
Morocco	61	109829	72	133884
France	32	108532	32	112616
Germany	10	61988	6	65082
Other countries	151	303543	128	235730

Table – 13: Imports of Cobalt Powder (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**205**	**515187**	**248**	**593648**
Belgium	65	154259	81	183604
USA	35	99101	46	129501
China	29	72580	41	95154
Japan	7	19299	17	44459
South Africa	20	48440	17	39080
France	12	34877	15	39012
UK	9	22488	12	23677
Finland	11	17012	13	19093
Germany	5	19151	1	7630
Canada	5	11042	4	7446
Other countries	7	16938	1	4992

Table – 14: Imports of Cobalt (Other Articles) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**324**	**813566**	**241**	**681192**
USA	71	208262	65	195370
UK	22	74036	37	111926
France	17	65638	14	66175
Belgium	35	93174	23	59531
Germany	5	42324	5	57452
Morocco	27	47895	28	50304
Finland	20	46161	19	38072
China	12	28438	16	35507
Congo Dem. Rep.	64	99327	18	28789
Canada	4	10479	9	19555
Other countries	47	97832	7	18511

Table – 15 : Imports of Cobalt (Unwrought) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**284**	**470509**	**413**	**697307**
Canada	91	161163	103	179583
Congo Dem. Rep.	104	149799	114	173058
Norway	-	-	78	135949
Morocco	34	61934	44	83580
USA	8	20373	15	40914
Congo Peo. Rep	20	22967	30	35296
Brazil	-	-	20	20521
Singapore	++	690	1	9610
France	3	8017	3	7429
China	3	8029	1	4214
Other countries	21	37537	4	7153

Table – 16: Imports of Cobalt & Alloys (Including Waste and Scrap) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**813**	**1799262**	**902**	**1972147**
USA	114	327736	126	365785
Belgium	100	247433	104	243135
Canada	100	182684	116	206584
Congo Dem. Rep.	168	249126	132	201847
UK	33	99344	50	136660
Norway	-	-	78	135949
China	44	109047	58	134875
Morocco	61	109829	72	133884
France	32	108532	32	112616
Germany	10	61988	6	65082
Other countries	151	303543	128	235730

Table – 17 : Imports of Cobalt (Scrap) (By Countries)

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**++**	**200**	-	-
USA	++	200	-	-

FUTURE OUTLOOK

India does not have any primary cobalt resources. Two possible secondary sources are nickel-bearing laterite deposits in Odisha and copper slag produced by HCL, which have been under R&D studies for commercial applications over the years. The cobalt refiners in India have catered to the market for chemical applications or where the cobalt metal or salt is dissolved and converted to cobalt oxide for cutting tools application.

Due to specialised nature of applications and difficulty in substitution, the future demand for cobalt is likely to follow an increasing trend. The bulk demand for cobalt in the world would be in cemented carbides used in cutting tools, catalysts in Petrochemical Industry, drying agent in Paint Industry and in super alloys used mainly in jet engine parts. The demand for cobalt is estimated to go up manifolds with use of super-alloys in civil aviation, catalysts for gas-to-liquid production of synthetic liquid fuels, rechargeable batteries for hybrid electric vehicles, cellular telephones, aerospace and energy generation industries. The global demand for lithium-ion batteries has grown rapidly as a result of the increase in demand for mobile phones, portable PCs & electronic devices. The demand projection for refined cobalt as per CRU was expected to exceed 1,00,000 tonnes in 2016, while cobalt consumption was forecasted to grow by a staggering 68% in the period between 2015 and 2025.

In India, cobalt will find major applications in metallurgy due to greater demand in special alloys/ super-alloys and in cutting tools and as an alloy in permanent magnets. Cobalt powder demand will continue to grow as it is extensively used in the manufacture of bonded tools that are used in the Diamond Industry.