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53

COBALT FROM THE DR CONGO – POTENTIAL, RISKS AND SIGNIFICANCE FOR THE GLOBAL COBALT MARKET [1]

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Cobalt hydroxid from Tenke Fungurume (Picture: BGR)

INTRODUCTION

Compared to other metals, international attention on cobalt has increased substantially over the last few months. This is due to expectations by market participants following increasing global demand and a relatively tense market situation for cobalt where most of the production originates from the Democratic Republic of the Congo (DRC). Cobalt represents an important metal used in the fabrication of batteries, super alloys, carbides, dyes and magnets (Fig. 1). From 2010 to 2015 global cobalt demand increased from 65,000 t to more than 90,000 t per year. Over the same period the mean compound annual growth rate for cobalt demand was 7.5 % while the demand for cobalt-based chemicals increased at an even steeper rate of 10.6 % (CRU 2016). The CRU commodity consulting agency forecasts a rise in global cobalt demand up to 155,000 t by 2025. The study "Commodities for Future Technologies", recently commissioned by the Federal Institute for Geosciences and Natural Resources (BGR), points out that even when only considering the emerging technologies market (and especially lithium-ion batteries used in electric cars), annual cobalt metal demand should rise to 122,000 t by 2035 (Marscheider-Weidemann et al. 2016).

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BGR Bundesanstalt für Geowissenschaften und Rohstoffe
DERA Deutsche Rohstoffagentur
Bundesanstalt für Geowissenschaften und Rohstoffe

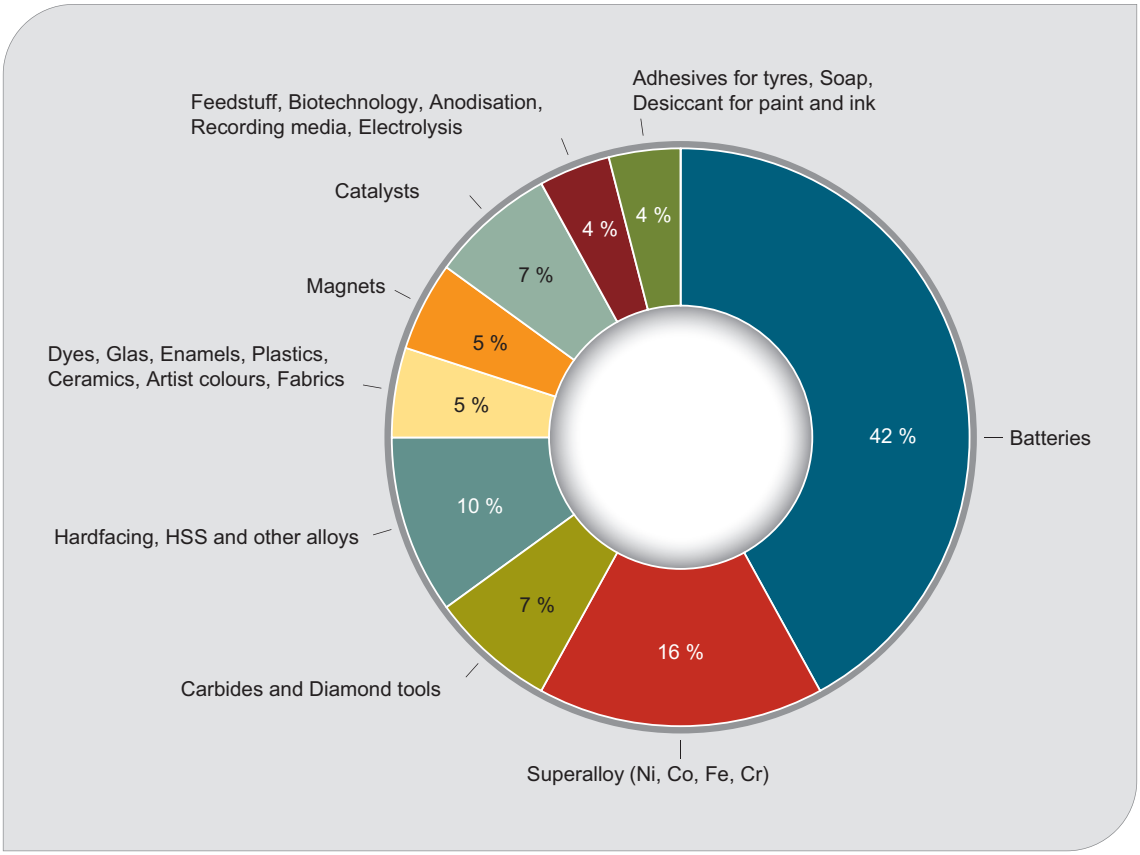

Figure 1: *Share of cobalt use by different applications in 2014 (CDI 2016a).*

While cobalt demand and its relevance for emerging technologies are continuously increasing, mine supply is currently limited to few countries with the DRC representing the main producer. This constellation implies increasing supply and price risks for cobalt.

Additionally, planning the future supply is affected by the fact that the DRC's cobalt mine production partly originates from artisanal and small scale mining (ASM) sources, in addition to industrial mines. In recent years, there has been repeated criticism by civil society regarding the circumstances of cobalt ASM production and trade in the DRC. International cobalt supply chain stakeholders sourcing from the DRC were requested to step up their due diligence efforts in order to manage social problems such as child labor or unacceptable labor conditions.

This report serves to illustrate relevant facts on cobalt production and trade in the DRC on the background of the international cobalt market.

MINE AND REFINED COBALT PRODUCTION

In 2015, global mine production of cobalt amounted to ca. 138,500 t (cobalt bulk metal content without consideration of processing losses). With a total production of 84,400 t cobalt (~ 60 % of global production), the DRC was the largest producer, followed by China, Canada and Australia (Fig. 2). Cobalt is primarily being mined as a byproduct of nickel and copper mining. CRU (2016) estimates that 61% of cobalt mine production represents a byproduct of copper mining whereas 37 % are the byproduct of nickel mining. Only 2 % of global cobalt production is extracted in mines with cobalt as the primary commodity; the latter refers to a mine in Morocco and selective artisanal cobalt mining in the DRC. Losses from cobalt processing commonly vary from 15 – 50 %, depending on the composition of the original ore. Generally, the main product is a concentrate with < 1 – 3 % cobalt content; extraction of cobalt is then performed by either hydro-, pyro or electrometallurgy.

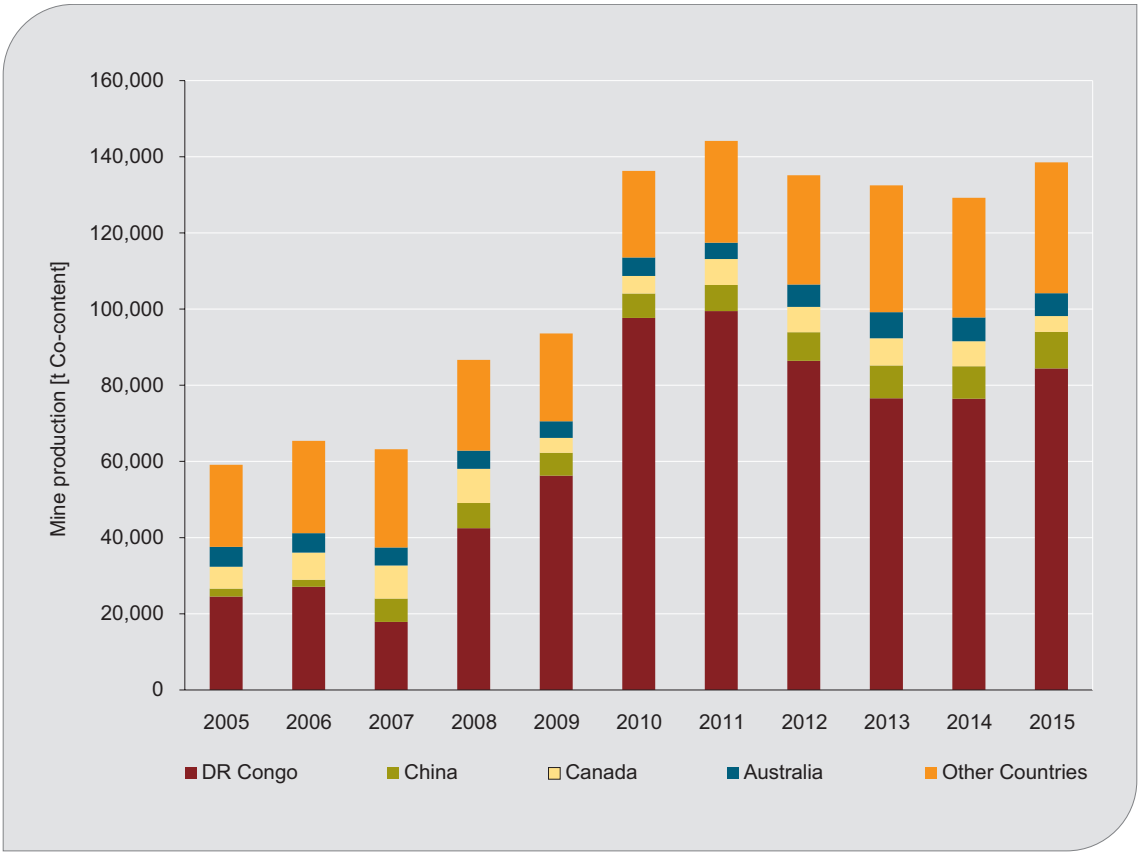

Figure 2: *Cobalt mine production from 2005 to 2015 (BGR 2017).*

Global production of refined cobalt was 98,100 t in 2015 (CDI 2016b), with ca. 50 % of refined cobalt originating from China, followed by Belgium, Finland and Canada (Fig. 3).

Around 60 % of refined cobalt is processed into cobalt-based chemicals while 40 % are processed into metal or powder. Outside of China, Glencore plc, Umicore NV/SA, Sumitomo Chemical Co. Ltd as well as Sherrit International Corporation represent the most important producers of refined cobalt (cf. annex Table 1).

PRICE DEVELOPMENTS

Since the 1960s, cobalt mine production has been focused on the DRC. The DRC's political and economic destabilization has led to a relatively high cobalt price volatility and significant price peaks, compared to many other commodities. Increasing cobalt prices since 2006 mainly reflect increasing demand from China which abruptly collapsed during the financial crisis in 2008/2009. After a brief rise in 2010, the cobalt price fell to a low of 23 USD/kg in December 2015, followed by a substantial price recovery continuing to date. From December 2015 until February 2017, the average monthly cobalt price rose by more than 90 % to 44 USD/kg (Fig. 4).

Being largely a byproduct of copper and nickel mining, cobalt production is linked to the global production of these commodities. Cobalt output is directly affected by production cutbacks of copper and nickel mines and refiners; in 2016, this happened, for instance, in Australia (Yabulu Nickel Refinery), Brazil (Niquelandia Nickel Refinery) and in the DRC (Kamoto and Tilwezembe mines of Katanga Mining Ltd.). Increasing cobalt demand, therefore, cannot be met without concomitantly increasing demand for copper or nickel. Steep cobalt price increases, such as the one observed in early 2017, are the result.

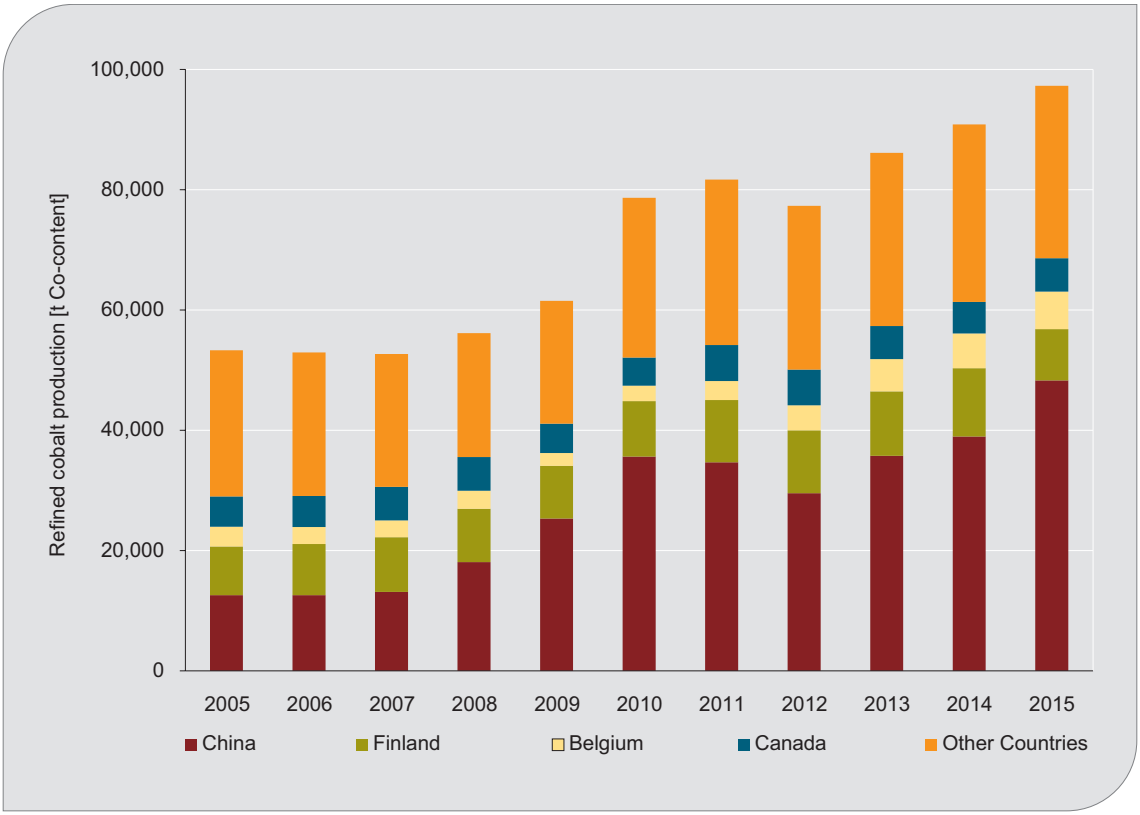

Figure 3: *Refined cobalt production from 2005 to 2015 (BGR 2017, CDI 2016b).*

SIGNIFICANCE AND RISKS OF COBALT SOURCING FROM THE DRC

With an estimated 48 % of global reserves, the DRC should likely continue to play a key role for global cobalt supply. Geologically, cobalt is mainly associated with copper mineralization in the central African Copper Belt. There, copper-cobalt mineralization is hosted by the Roan Group as part of an 880 million years old stratigraphic formation, the Katanga Supergroup. This region forms one of the world's largest mining provinces extending over 800 km along the border of Zambia and the DRC where it covers large parts of the former Katanga administrative province (Fig. 5).

Cobalt has been mined since 1924 from primary and secondary deposits as well as from historical mine tailings. During the long mining history of the DRC, industrial cobalt mining was organized by parastatal and private companies operating at a large scale. The collapse of the DRC's mining sector in the 1990s, accompanied by the decline of parastatal enterprises caused by war, crisis and economic mismanagement led to a rise of artisanal and small scale mining of copper and cobalt. With the gradual rehabilitation of the DRC's private mining sector over the last decade, cobalt production is nowadays a by-product of copper mining in industrial open pit mines. However, part of the cobalt production derives from the poorly regulated ASM sector, partly also taking place on historical tailing deposits of industrial mine sites.

Numerous UN-reports documented the links between mining and trading of gold, tin, tantalum and tungsten ores and illegal financing of armed groups in eastern DRC, coining the term "conflict minerals" for these commodities. Laws and regulations requesting international mineral consumers to comply with certain due diligence and reporting obligations in their supply chains were established in the United States in 2011 (Dodd-Frank Act, Section 1502) and in the European Union in 2017 (European Parliament 2017, Killiches et al. 2014). The OECD Guidance for Responsible Supply Chains of Minerals from Conflict-affected and High-Risk Areas provides recommendations

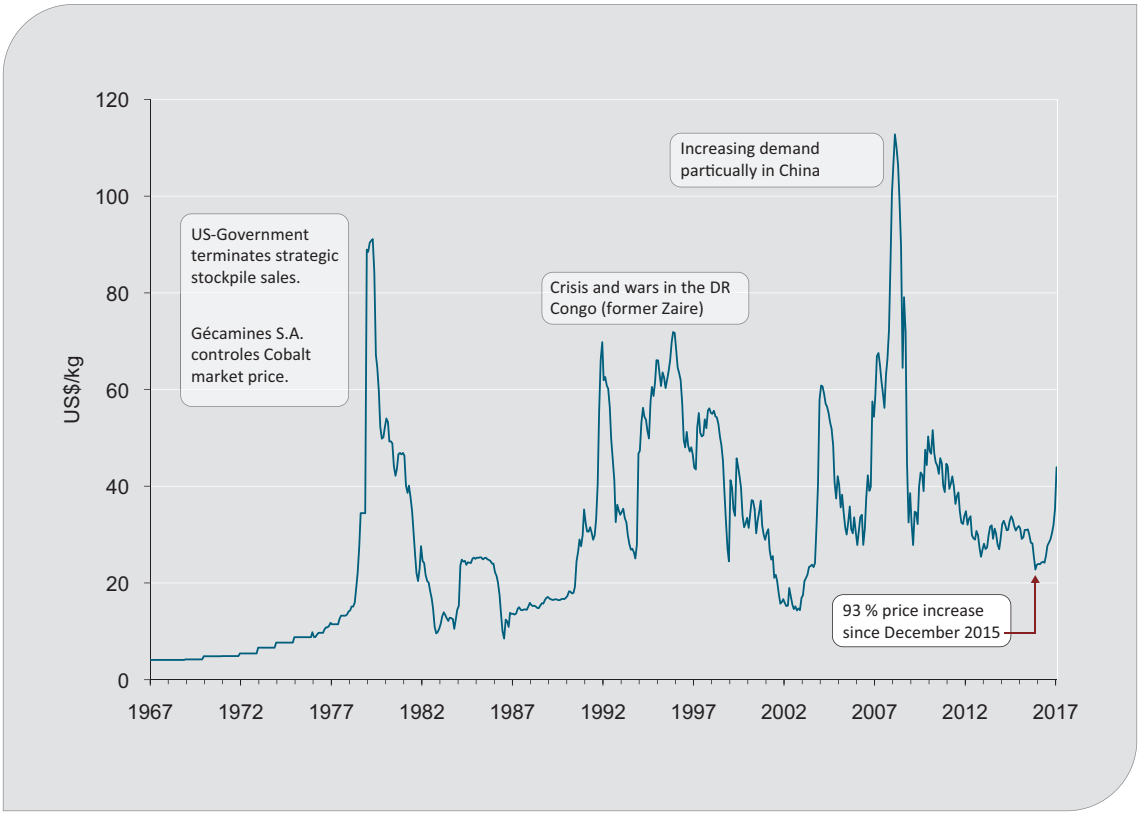

Figure 4: *Mean monthly cobalt price (99.8 % free market) from 1967 to February 2017 (BGR 2017).*

for managing supply chain risks for all mineral commodities, including cobalt. Although cobalt is not defined as a "conflict mineral" in a strict regulatory sense, given its geographical and environmental sourcing framework, similar risks do apply for cobalt supply chains originating from the DRC. A number of companies and industry associations in the downstream cobalt supply chain emphasize the importance of implementing adequate due diligence. The Chinese Chamber of Commerce for Metals, Minerals & Chemicals (CCCMC), together with other internationally operating companies, founded the Responsible Cobalt Initiative (RCI) which aims at supporting the implementation of the OECD Due Diligence Guidance in cobalt supply chains.

When sourcing cobalt from the DRC, two major risk categories apply. Firstly, there are supply chain-related risks, to be considered in the context of due diligence and the company's reputation. International press and civil society repeatedly denounced unacceptable conditions such as child labor or hazardous working conditions; they have called on international mineral consumers to increasingly assume responsibility for these conditions in their supply chains (e.g. Öko-Institut E.V. 2011, Amnesty International 2016, Somo 2016, Washington Post 2016). Secondly, beyond supply chain-specific risks, mineral sourcing from the DRC is generally related to an elevated country risk due to weak administrative structures, volatility of the country's security situation as well as the current political constellation, which could affect even relatively stable regions like the former Katanga province, the main area of copper and cobalt production in DRC.

HISTORICAL DEVELOPMENT OF COBALT PRODUCTION IN THE DRC

At the beginning of the 20th century, cobalt production was under the monopoly of the Union Minière de Haut Katana (UMHK). At that time cobalt was merely considered as an associated impurity in copper ores. In contrast, since 1924, cobalt was

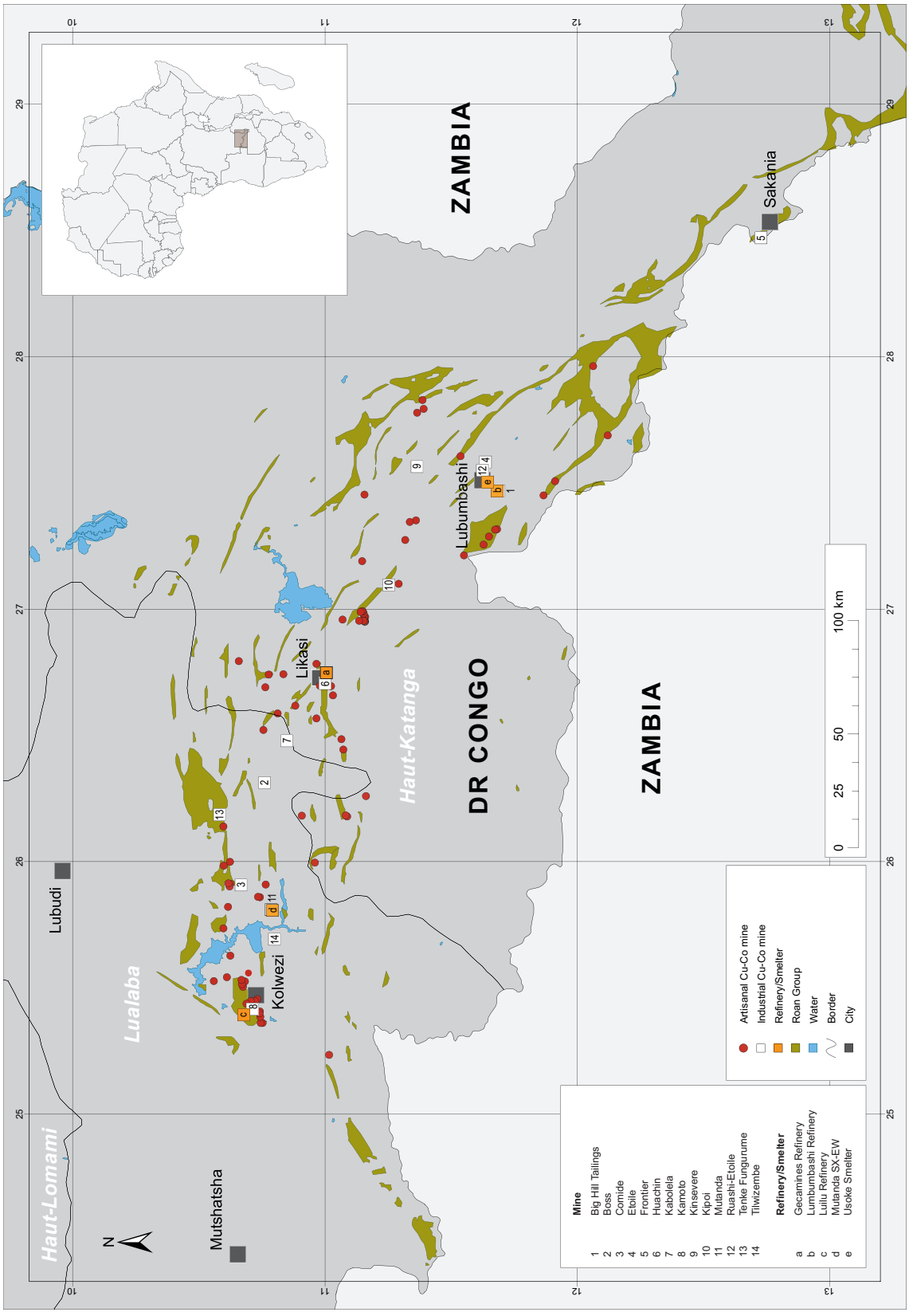

Figure 5: *Map of the Central African Copper Belt giving an overview of DRC's industrial and artisanal copper-cobalt mines as well as refineries and smelters (BGR 2017, S&P 2017)*

produced in the smelters of Luilu (Kolwezi) and Shituru (Likasi) as a significant byproduct of copper ore processing from the Kambove, Kamoto and Musonoi mines (Fig. 5). UMHK, a consortium under Belgian control, was nationalized following Congolese independence (1960) and the Katangan secession (1963). The parastatal company Gécamines S.A. took control over UMHK's operations in 1967, extending production capacities and optimizing smelting. The year 1974 marked a record cobalt production peak of 17,545 t, an amount not to be exceeded until 2004. For a certain time period, Gécamines S.A. was the world's largest cobalt and fourth largest copper producer, exercising significant control on the cobalt market and its price dynamics.

As a result of the protracted crisis and war between 1992 and 2000, accompanied by widespread mismanagement of state-controlled mines, the DRC's mining sector suffered a significant decline in cobalt production. In 1993 industrial cobalt production reached a low of 2,200 t; recovery was slow, reaching an annual production of 27,100 t in 2006. During this period of reduced industrial production, the significance of ASM cobalt production rose sharply, further reinforced by miners previously discharged from or not getting paid by state-owned mining companies. Between 1998 and 2006 nearly 90% of total Congolese cobalt production originated from the ASM sector (Öko-Institut 2011). Since 2006 the mining sector has seen a steady increase in industrial copper-cobalt production (Fig. 6) with multiple international enterprises actively involved (cf. annex Table 2).

A cobalt production peak was reached in 2011 when the DRC mine production amounted to 98,000 t (Fig. 2). Since then, cobalt production has somewhat stagnated or decreased, amounting to 76,475 t and 84,400 t in 2014 and 2015, respectively (Ministère Des Mines 2016). When evaluating the DRC's cobalt production statistics, it is important to consider the meaning and accuracy of data from different sources. For a given year, variations of reported production figures up to 20 % appear to be the norm. The DRC Chamber of Mines (Chambre des Mines 2015) reported a cobalt production of 69,328 t for 2015, whereas CRU (2016) indicated a production of 66,120 t; finally, the DRC Ministry of Mines reported a cobalt production of 84,400 t. This variation may be due to the fact that the Chamber of Mines represents an association of industrial producers, therefore not reflecting artisanally produced cobalt in its statistics. CRU (2016) estimated that artisanal cobalt production in 2014 and 2015 amounted to 8,000 t and 10,500 t, respectively.

Cobalt is mainly extracted via electrolysis as either cobalt hydroxide or cobalt carbonate at 33 – 35 % cobalt content; the products are then exported and refined abroad. Refined cobalt production (at 99.6 % cobalt content) in the DRC itself only amounts to 3,300 t corresponding to 3.4 % of total global refined cobalt production (CDI 2016b).

INDUSTRIAL COBALT PRODUCERS IN THE DRC

Cobalt production focuses on the southeastern region of the former Katanga province. Outside of the Copper Belt, only two deposits exist in the Kasai West Province – the cobalt-containing nickel-chromium deposits of Nkonko and Lutshatsha. In 2015 the biggest industrial cobalt producers in the DRC were Glencore plc, Freeport-McMoran and the Eurasian Resources Group (mines and concessions of Boss Mining). Together, these enterprises represent around 43 % of total cobalt production (Fig. 6). The state-controlled company Gécamines S.A. maintains minority shares in all mines.

Glencore plc holds the license for the Mutanda deposit and an 86 % share of Katanga Mining, exploiting the Kamoto, Tilwezembe and Kananga mines. In September 2015 Katanga Mining suspended production for a preliminary period of 18 months but has not resumed work until the present day (April 2017). Glencore's cobalt production was therefore limited to the Mutanda deposit in 2016. Despite this, Glencore increased its total cobalt production by 48 % to 24,500 t (Glencore Plc 2017), making Glencore the world's largest cobalt producer in 2015-2016.

In 2015, Tenke Fungurume Mining (TFM) extracted 15,900 t of cobalt from their Tenke-Fungurume deposit (Freeport-Mcmoran 2016). In May 2016, China Molybdenum Co. Ltd. bought a 56 % share on this deposit from Freeport-McMoran for 2.65 billion USD.

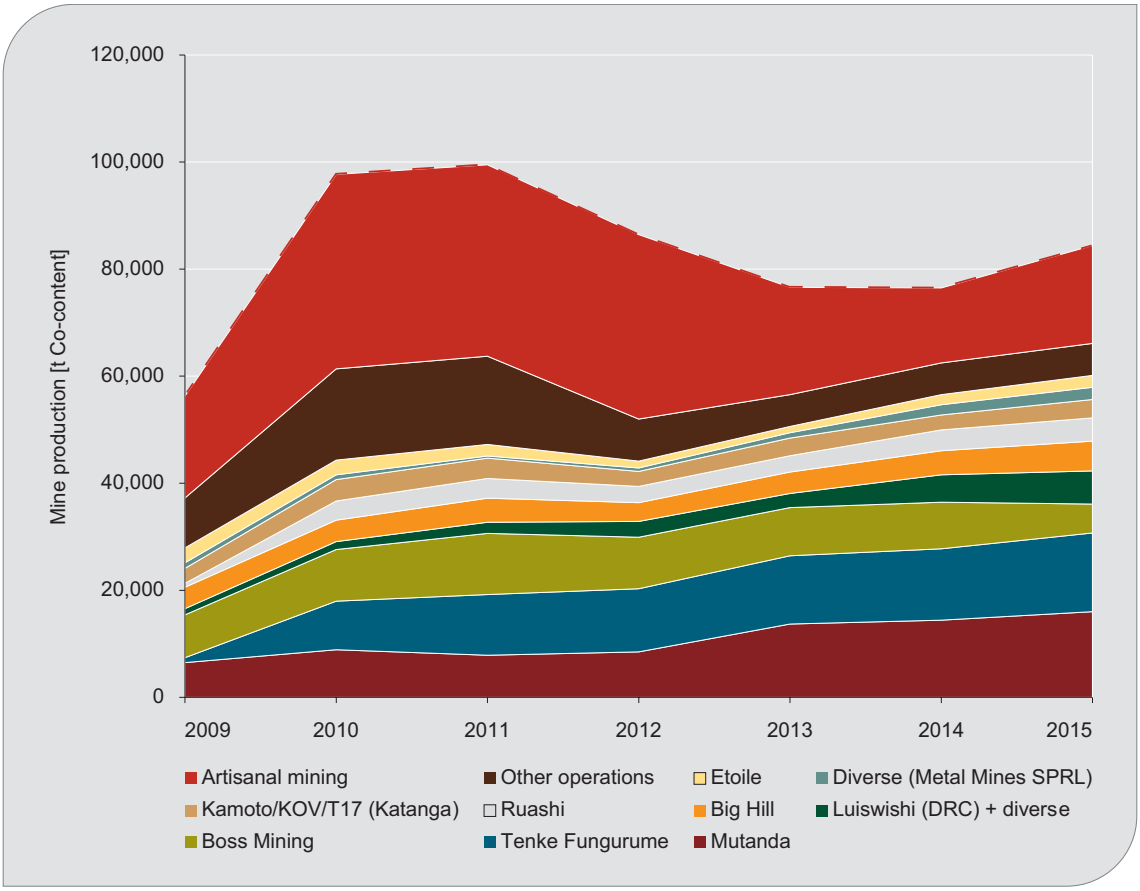

Figure 6: *Cobalt mine production in the DRC from 2009 to 2015 (CRU 2016, BGR 2017).*

The Luxemburg-registered Eurasian Resources Group (ERG) is currently producing copper and cobalt in 24 mines in the DRC; the majority of cobalt production originates from the Comide, Frontier and Boss Mining deposits between Kolwezi and Sakania. Production has slightly declined since 2014 with a total production of 9,700 t (S&P Global Market Intelligence 2017). Table 2 (annex) provides an overview of major industrial cobalt producers in the DRC.

ARTISANAL COBALT MINING IN THE DRC

When referring to "cobalt mining", one should keep in mind that artisanal and small-scale mining mostly refers to mixed cobalt-copper ore or tailings (although, usually, miners only get paid for the cobalt content in the concentrate). Artisanal and small-scale cobalt mining represents an essential livelihood in the Haut-Katanga and Lualaba provinces (parts of the former Katanga province). In the period after the second Congo war (2002) an estimated 90 % of all cobalt mining was done artisanally. Back then, up to 120,000 people were involved in artisanal mining. In 2011, it is estimated that 67,000 to 79,000 persons were involved in all-year ASM activities; when additional seasonal mining activities are taken into account, the total number of ASM cobalt miners in 2011 was estimated at 90,000 – 108,000 persons (Öko-Institut E.v. 2011). Currently (2015 – 2016), a share of 15 – 20% of the DRC's total cobalt production is estimated to originate from ASM mine sites (Fig. 6), corresponding to an amount of approx. 12,000 – 18,000 t of cobalt at an export value of 330 – 500 Mio USD. Amnesty International (2016) assumes that 110,000 – 150,000 people are currently involved in artisanal cobalt mining.

Even though the figures above mainly represent mere estimates, it is obvious that artisanal and small-scale cobalt mining involves a substantial number of people. The number of cobalt miners

is comparable to the number of people working in the eastern DRC's "conflict mineral" sector (gold, tin, tantalum and tungsten ores) which has received considerable international attention over the past few years (e.g., "blood coltan"). The actual share of ASM cobalt production in the DRC's total cobalt production for a given year is highly variable, largely depending on developments in the industrial cobalt mining sector as well as the international market.

In contrast to industrial mining where cobalt is extracted as a by-product of copper mining, artisanal and small-scale cobalt mining tends to selectively focus on cobalt extraction (hetegorenite); this is done through cobbing, hand picking and manual panning or sluicing (Fig. 7). These manual mining and processing methods often result in high cobalt-copper ratios in concentrates, which are, therefore, an indicator of the artisanal provenance of the material. Consequently, market price volatility is a factor that strongly influences expansion or reduction of ASM activities and their share in total cobalt production.

Mineral extraction is done underground as well as through open pit mining and on historical tailings. Cobalt ores and concentrates are sold to local traders and then further sold to traders and mineral processors who are frequently of Chinese, Indian or Lebanese origin or business connections. During these domestic sales transactions, undocumented mixing of material originating from ASM and industrial mining sources may take place. Several hundred intermediaries and trading centers, partly officially registered, are active in mining centers like Musompo and Kisanfu (Amnesty International 2016).

SUSTAINABILITY RISKS IN COBALT SUPPLY CHAINS

According to recommendations by the OECD Due Diligence Guidance (2016), international traders sourcing cobalt from the DRC and their customers should ensure that mineral extraction and processing meet due diligence standards such as complying with the legal framework, avoiding the worst forms of child labor and conflict financing risks while ensuring traceability along their mineral supply chains. Compliance with due diligence standards and procedures should be evaluated critically, in particular in cases where an ASM origin of the ores has been documented or is suspected. Due diligence risks need to be assessed for all supply chains, including for supply chains where it is assumed that cobalt is exclusively of industrial origin as these supply chains may have been variably contaminated by cobalt from ASM sources. It is important to note that an ASM origin in itself is not problematic – as long as there is a verification and, if applicable, improvement of the conditions of ASM cobalt production (OECD 2016).

A first starting-point for a supply chain risk assessment may be the distribution of artisanal and small-scale cobalt mining in the DRC since the late 1990s. The relative share of cobalt of ASM origin is not constant but changes through the years, reflecting developments in the industrial mining sector and at the international market. While a theoretical value of the ASM cobalt production can be calculated, the actual grades of the concentrates are often only estimated during initial sales transactions; consequently, prices received by individual miners are poorly known.

Estimates of the total number of artisanal and small-scale miners cannot be used to calculate the exact proportion of artisanal cobalt production with confidence. While many miners work full time, others dig either seasonally (in addition to agricultural activities) or "part-time". Some ASM mines or cooperatives may operate in a rather organized way within a formal and legal or semi-legal framework while others lack any kind of administrative structure. Due to these circumstances, international companies sourcing cobalt from the DRC should attempt to trace their supply chains and associated risks with particular care.

Both Öko-Institut E.V. (2011) and Amnesty International (2016) reported the widespread existence of child labor in the DRC's artisanal and small-scale cobalt mining sector. Their estimates, indicating the involvement of around 40,000 children in cobalt mining, are mainly based on a study published by UNICEF in 2011, and references cited therein. Estimates for the total number of children in the entire Katanga region represent extrapolations based on a significantly smaller sample size. Although the presented estimates are hence associated with a significant

Figure 7: *Industrial (left: Kwatebala Mine of Tenke Fungurume, Haut Katanga province) and artisanal (right: Kamwale Mine, Lualaba province) copper-cobalt mining in the DR Congo and its associated products cobalt hydroxid and cobalt-copper-concentrate (Pictures: BGR).*

statistical uncertainty, it is clear that there is a large number of children involved in artisanal and small-scale cobalt mining in the DRC. The study by Öko-Institut E.v. (2011) further distinguishes between different age groups as, according to Congolese law, light work is considered legal for children aged 15 and above. The "worst forms of child labor" are defined in cases where hard or hazardous labor has to be performed or in case children are exploited or abused and cannot attend school. Musao (2009), using a small statistical sample in the Kolwezi area, illustrates that about half of the children working in cobalt mines perform hard and hazardous labor. Therefore, artisanal cobalt mining activities in the DRC imply significant risks that the worst forms of child labor do occur in the sector. In accordance with OECD Due Diligence Guidance, international cobalt consumers hence have a responsibility to closely monitor supply chain risks and support improvement of the situation in the DRC.

Besides child labor, many civil society organizations (e.g., Global Witness 2006, Öko-Institut E.v. 2011, Somo 2016, Amnesty International 2016) reported additional severe risks associated with ASM cobalt mining and supply chains, such as:

- Hazards and risks affecting the occupational health and safety of artisanal miners (e.g., respiratory and skin problems due to the lack of appropriate personal protective equipment); linked to this problem is the exposure of workers to elevated radiation levels due to the fact that many copper-cobalt ores are associated with high uranium contents;
- Accidents, often fatal, due to insufficient safety measures (e.g. cave-ins in underground tunnels);
- Illegal taxation (e.g. by members of Congolese administration and security forces) as well as violent clashes between miners and private or public security forces.

The risks in the DRC's ASM cobalt sector identified by Amnesty International (2016) and other organizations are, in many cases, similar to observations made by BGR in the context of German-Congolese development cooperation. Commissioned by the Federal Ministry for Eco-

nomic Cooperation and Development (BMZ), the technical cooperation project centers on auditing and building capacities of ASM operations in the eastern DRC. The project focuses on problems associated with artisanal and small-scale mining of gold, tantalum, tin and tungsten ores.

The Certified Trading Chains (CTC) approach, developed by BGR and implemented together with its Congolese partners, is based on facilitating joint responsibilities for improving the conditions of mineral extraction and trade, including through mineral producers themselves (e.g., ASM cooperatives) as well as associated international partners and specific supply chain stakeholders.

The CTC initiative focuses on mitigating severe health and safety risks while also facilitating a socially adequate local framework, e.g. with regards to fair and transparent payment of miners or managing environmental risks. The CTC approach directly focuses on specific pilot supply chains. Indirectly, CTC is supposed to exert a positive influence on the surrounding area beyond directly involved pilot supply chains. This implies the need for improving state control and governance of the ASM sector, for instance through mining inspections. BGR is currently evaluating whether the CTC approach could also be applied in the ASM cobalt sector in the DRC.

CONCLUSIONS & OUTLOOK

Considering the rapidly growing electric car industry and the required supply of lithium-ion batteries, global demand for cobalt is most likely to increase significantly. The DRC, as the world's largest cobalt miner, is set to be in the focus of attention not only of battery makers but also car manufacturers. Significant price and supply risks exist due to the dominant position of a single country, the DRC, in global cobalt production. In order to ensure that a given cobalt supply chain in the DRC does not aggravate social problems such as the worst forms of child labor, cobalt-consuming companies need to implement adequate risk management and exercise due diligence.

The DRC hosts almost 50 % of global cobalt reserves and features an increasingly functional industrial mining infrastructure. Therefore, the country will most likely remain the world's most important primary cobalt producer and play an important role as key supplier to meet the global cobalt demand. In this context, both industrial and artisanal and small-scale mining will remain relevant –their respective contributions to the DRC's total cobalt output were highly variable in the past. Cobalt extraction as a byproduct of copper mining currently accounts for ca. 80 % of total cobalt production; 20 % of the DRC's cobalt production originates from ASM sources, representing an essential livelihood for the local population in the eastern DRC.

Cobalt is not the primary economic target metal in most industrial mining operations. As such, cobalt prices do not significantly affect industrial mine production patterns; the latter are rather driven by copper price developments. In contrast, the artisanal and small-scale cobalt sector is more susceptible to cobalt price fluctuations. Estimated ASM production in the years of 2010 – 2011, at cobalt prices of 35 – 50 USD/kg, was significantly higher than in the years 2012 – 2014 when cobalt prices were somewhat lower. Given the current, positive cobalt price development and assuming that no fundamental changes of the political and legal mining framework in the DRC will occur, artisanal and small-scale cobalt production should be expected to increase even further. Poverty is a main driving force for ASM activities in the DRC. Therefore, in case of future cobalt price declines, it should not automatically be assumed that the total number of ASM miners involved in cobalt exploitation will be substantially reduced. The existence of alternative livelihoods and local cobalt price dynamics – set by intermediaries in the DRC – are additional factors impacting on the intensity of ASM activities.

As part of their due diligence responsibilities, international buyers of cobalt and processed cobalt components, and their clients, should investigate whether the cobalt originated in the DRC and, if so, verify the applicable local standards of cobalt production, transport and processing with regards to international expectations. This includes tracking and tracing mineral supply chains while implementing due diligence (OECD 2016). Purchasing minerals from ASM sources does not represent a problem in itself; boycotting such material would not stop ASM activities but rather lead to a decrease in transparency and deterioration

of living and working conditions of artisanal cobalt miners and their families in the DRC. Instead, companies should closely monitor the conditions of cobalt mining and trade and seek to improve performance along their supply chains. The feasibility of such measures has already been demonstrated in comparable supply chains of tin and tantalum (BGR 2016).

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ANNEX

Table 1: *Producers of refined Cobalt 2015 (CDI 2016).*

Company	Country	Project/Refinery	Production 2015 [t Co-cont.]	Share of global production 2015
China	China	diverse	48,719	49.7 %
Freeport Cobalt (China Molybdenum Co.)	Finland	Kokkola Finland	8,582	8.7 %
Umicore	Belgium/China	i. a. Olen refinery	6,306	6.4 %
Sumitomo	Japan	Niihama refinery	4,259	4.3 %
Sherritt International	Cuba/Canada	Moa JV	3,734	3.8 %
Ambatovy	Madagascar	Ambatovy Refinery	3,464	3.5 %
Glencore	Australia	Murrin Murrin	3,300	3.4 %
Glencore	Canada	Nikkelverk/Raglan/ Sudbury	3,100	3.2 %
Chambishi Metals	Zambia	Chambishi	2,997	3.1 %
Glencore	DR Congo	Katanga	2,900	3.0 %
Norilsk	Russia	Polar Division/Kola MMC	2,040	2.1 %
Vale	Canada	Port Colborne	1,858	1.9 %
QNPL (Queensland Nickel)	Australia	Yabulu Refinery	1,850	1.9 %
CTT (Compagnie de Tifnout Tighanimine)	Marocco	Bou-Azzer	1,722	1.8 %
South Africa	South Africa	Shu powders	1,300	1.3 %
Votorantim	Brasil	Niquelandia & Sao Miguel Paulista	1,300	1.3 %
Gecamines	DR Congo	various	400	0.4 %
India	India	Nicomet	150	0.2 %
Eramet	France	Havre-Sandouville	133	0.1 %
Total			**98,114**	**100.0%**

i. a. = inter alia

Table 2: *Cobalt producers in the DRC.*

Company	Mine/Deposit	Production [t Co-cont.]	Reserves [t Co-cont.]	Artisanal share of total prod.	Source
China Molybdenum Co. Ltd former owner: (Freeport-McMoRan)	Kwatebala, Tenke Fungurume, Sefu, Fwaulu	15,876 (2015)	569,000	no	Freeport-McMoRan (2016) S&P (2017)
Glencore plc	Mutanda, Kansuki	24,500 (2016)	1,144,000	no	Glencore Plc (2017) S&P (2017)
Eurasian Natural Resources Group	Boss, Frontier, Kalukundi, Lonshi, Kabolela, Kambove, Lodja, Dezita, RTR, Comide, SMKK	5,400 (2014)	1,120,000	no	S&P (2017) CRU (2016)
Groupe Forrest International S.A. (Entreprise Générale Malta Forrest))	Lubumbashi Tailings, Big Hill	4,600 (2010)	NA	no	S&P (2017) Groupe Forrest International S.A. (2017)
Shalina Resources Ltd	Etoile, Etoile HMS 1, Etoile HMS 2	1,800 (2015)	82,000	partially	Shalina Resources Ltd (2017) S&P (2017) CRU (2016)
Jinchuan Group International Resources Co. Ltd Gecamines SARL	Ruashi-Etoile	3,400 (2016)	29,000	no	S&P (2017)
Katanga Mining Ltd Gecamines SARL	Dikuluwe, Kamoto East, Tilwezembe, Kananga, Kolwezi, KOV, KTC, KTO, Luilu, Mashamba, Mashamba East, Musonoi, T17	2,901 (2015)	645,000	no	Katanga Mining Ltd (2016) S&P (2017)
Zhejiang Huayou Cobalt Co. Ltd	Luiswishi + weitere	6,200 (2015)	63,000	partially [1]	S&P (2017) CRU (2016)
Shanghai Pengxin Mineral Industry Investment	Shituru	1,100 2015)	NA	NA	S&P (2017) CRU (2016)
Societe Miniere du Katanga (SOMIKA)	Lubumbashi, Kimpe, Kasenga, artisanal	995 (2015)	NA	partially [1]	CRU (2016)
Huachin Mining SPRL	NA	810 (2015)	NA	NA	CRU (2016)
Compagnie Miniere du Sud Katanga (CMSK)	Luiswishi, Luishia + weitere	480 (2015)	NA	no	CRU (2016)
La Sino-Congolaise des Mines (SICOMINES)	Dima (Dikuluwe), Mashamba	100 (2015)	NA	NA	CRU (2016) ITIE (2014)
Volcano Mining	Kawama, Lumbumbashi	1,300 (2012)	NA	Yes (100 %)	BGR internal Data
Congo International Mining Corporation (CIMCO)	Luisha	2,000 (2012)	NA	partially	BGR internal Data
Congo MJM Co Ltd (Jiayuan)	NA	380 (2015)	NA	NA	CRU (2016)
Tiger Resources Ltd	Kipoi	0 (2015)	46,000 [2]	no	Tiger Resources Ltd (2017)
Nanjing Hanrui Cobalt Co Ltd	NA	1,900 (2015)	NA	NA	CRU (2016)

NA = not applicable, [1] Zhejiang Huayou Cobalt and Societe Miniere du Katanga (SOMIKA) are sourcing cobalt from artisanal and smale scale mining, [2] Reserves & Resources