Conflict Minerals from the Democratic Republic of the Congo—Tin Processing Plants, a Critical Part of the Tin Supply Chain

The U.S. Geological Survey (USGS) analyzes mineral and metal supply chains to identify and describe major components of material flows from ore extraction, through intermediate forms, to a final product. Supply chain analyses may be used (1) to identify risks to the United States associated with the supply of critical and strategic minerals and metals and (2) to provide greater supply chain transparency so that policymakers have the fact-based information needed to formulate public policy. This fact sheet focuses on the post-mining/pre-consumer-product part of the tin supply chain. The USGS National Minerals Information Center (NMIC) has been asked by governmental and nongovernmental organizations to provide information about tantalum, tin, tungsten, and gold (collectively known as "3TG minerals") processing facilities worldwide in response to U.S. legislation aimed at identifying and removing the supply chain links between the trade in these minerals and civil unrest in the Democratic Republic of the Congo (DRC) and adjacent countries.

Post-beneficiation processing plants (generally called smelters and refineries) for 3TG mineral ores and concentrates were identified by company and industry association representatives as being a link in the 3TG mineral supply chain through which these minerals can be traced to their source of origin (mine). The determination of the source of origin is critical to the development of a complete and transparent conflict-free mineral supply chain (U.S. Government Accountability Office, 2012, p. 19). Tungsten processing plants were the subject of the first fact sheet in this series published by the USGS NMIC in August 2014 (Bermúdez-Lugo, 2014). Background information about historical conditions and multinational stakeholders' voluntary due diligence guidance for minerals from conflict-affected and high-risk areas was presented in the tungsten fact sheet. Tantalum processing plants were the subject of the second fact sheet in this series published by the USGS NMIC in December 2014 (Papp, 2014). This fact sheet, the third in the series about 3TG minerals, focuses on the tin supply chain by listing selected processors that produced tin materials commercially worldwide during 2013–14. It does not provide any information regarding the sources of the material processed in these facilities.

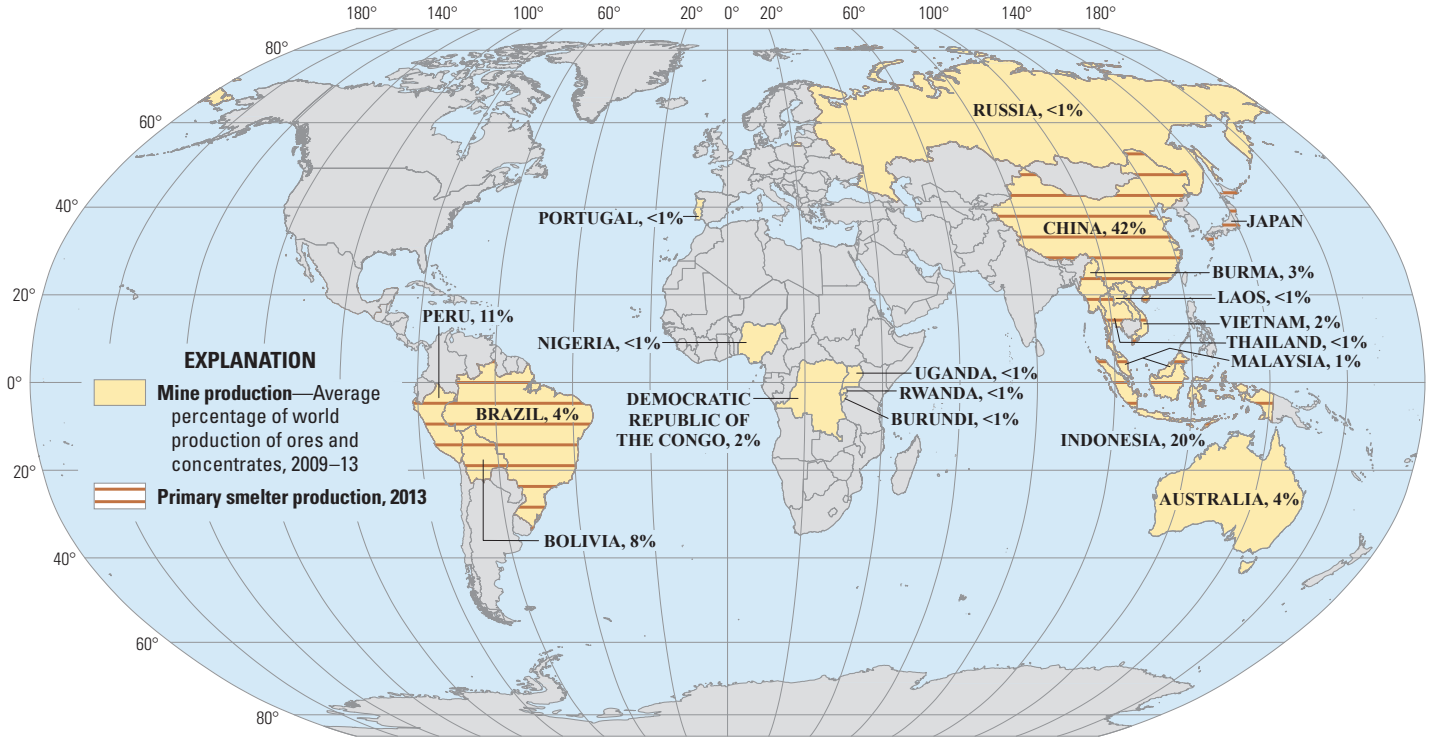

Figure 1. Global producers of tin industrial products in 2013 and percentage of 2009–13 average world tin mine production by country.

Table 1. Selected global tin refineries and smelters in 2013.

[Additional small-scale smelters may be in operation in Indonesia, but their status could not be confirmed. Facilities were active unless otherwise noted]

Country	Location	Operator/owner	Facility type and status (if applicable)
Australia	Greenbushes, Western Australia	Global Advanced Metals Pty Ltd.	Smelter (on care and maintenance since 2012)
Belgium	Beerse	Metallo-Chimique N.V.	Smelter
Belgium	Hoboken, Antwerp	N.V. Umicore S.A.	Smelter
Bolivia	Oruro, Oruro Department	Operaciones Metalúrgicas S.A. (OMSA)	Smelter
Bolivia	Vinto, Oruro Department	Empresa Metalúrgica Vinto S.A.	Smelter
Brazil	Coopersanta, Bom Futuro, Ariquemes, Rondônia	Coopersanta	Smelter
Brazil	White Solder, Rondônia	White Solder Metalurgia e Mineração	Refinery
Brazil	Pinpora, Sao Paulo	Mineração Taboca S.A.	Smelter
Brazil	Ariquemes, Rondônia	Estanho de Rondônia S.A.	Smelter
China	Chenzhou, Hunan Province	Chenzhou Smelter	Smelter
China	Gejiu, Yunnan Province	Yunnan Chengfeng Nonferrous Metals Co. Ltd.	Smelter
China	Gejiu, Yunnan Province	Yunnan Tin Co. Ltd.	Smelter
China	Hezhou, Guangxi Province	Guihuacheng Smelter	Smelter
China	Huogudu, Yunnan Province	Yunnan Geiju Zili Metallurgy Co. Ltd.	Smelter
China	Laibin, Guangxi Province	Guangxi China Tin Group Co. Ltd.	Smelter
China	Nankang, Jiangxi Province	Nanshan Tin Co. Ltd.	Smelter
Congo, Democratic Republic of the	Lubumbashi	Malaysia Smelting Corp. Bhd.	Smelter (not operational in 2013)
Indonesia	Bangka Belitung Province	CV Duta Putra Bangka	Smelter
Indonesia	Bangka Belitung Province	CV Justindo	Smelter
Indonesia	Jalan Rungkut, East Java Province	CV Makmur Jaya	Smelter
Indonesia	Bangka Belitung Province	CV Nurjanah	Smelter
Indonesia	Bangka Belitung Province	CV Prima Timah Utama	Smelter
Indonesia	Bangka Belitung Province	CV Serumpun Sebalai	Smelter
Indonesia	Pangkalpinang, Bangka Belitung Province	CV United Smelting	Smelter
Indonesia	Bangka Belitung Province	PT Artha Cipta Langgeng	Smelter
Indonesia	Bangka Belitung Province	PT Babel Inti Perkasa	Smelter
Indonesia	Bangka Belitung Province	PT Babel Surya Alam Lestari	Smelter
Indonesia	Bangka Belitung Province	PT Bangka Global Mandiri International	Smelter
Indonesia	Bangka Belitung Province	PT Bangka Kudai Tin	Smelter
Indonesia	Bangka Belitung Province	PT Bangka Putra Karya	Smelter
Indonesia	Bangka Belitung Province	PT Bangka Timah Utama Sejahtera	Smelter
Indonesia	Bangka Belitung Province	PT Belitung Industri Sejahtera	Smelter
Indonesia	Bangka Belitung Province	PT Billitin Makmur Lestari	Smelter
Indonesia	Bangka Belitung Province	PT Bukit Timah Tbk	Smelter
Indonesia	Bangka Belitung Province	PT Donna Kembara Jaya	Smelter
Indonesia	Bangka Belitung Province	PT DS Jaya Abadi	Smelter
Indonesia	Bangka Belitung Province	PT Eunindo Usaha Mandiri	Smelter
Indonesia	Bangka Belitung Province	PT Fang Di Multindo	Smelter
Indonesia	Koba, Bangka Island, Bangka Belitung Province	PT Koba Tin	Smelter
Indonesia	Bangka Belitung Province	PT Mitra Stania Prima	Smelter

Table 1. Selected global tin refineries and smelters in 2013.—Continued

[Additional small-scale smelters may be in operation in Indonesia, but their status could not be confirmed. Facilities were active unless otherwise noted]

Country	Location	Operator/owner	Facility type and status (if applicable)
Indonesia	Bangka Belitung Province	PT Refined Bangka Tin	Smelter
Indonesia	Bangka Belitung Province	PT Stanindo Inti Perkasa	Smelter
Indonesia	Mentok, Bangka Island, South Sumatra	PT Tambang Timah Tbk	Smelter
Indonesia	Kundur Island, Bangka Belitung Province	PT Timah Tbk	Smelter
Indonesia	Bangka Belitung Province	PT Tinindo Inter Nusa	Smelter
Indonesia	Bangka Belitung Province	PT Yinchendo Mining Industry	Smelter
Malaysia	Butterworth, Penang	Malaysia Smelting Corp. Bhd.	Smelter
Peru	Pisco, Ica Department	Minsur S.A.	Refinery and smelter
Rwanda	Gisenyi	Metal Processing Association	Smelter (not operational in 2013)
Rwanda	Karuruma	Phoenix Metals Ltd.	Smelter (not operational in 2013)
Thailand	Phuket, Phuket Province	Thailand Smelting and Refining Co. Ltd. (Thaisarco)	Refinery and smelter
Vietnam	Thai Nguyen City, Thai Nguyen Province	Thai Nguyen Nonferrous Metal Co.	Refinery

Background

Tin is a metal often found in nature in its oxidized form, as the mineral called cassiterite (SnO_2). Cassiterite has been the primary source of tin throughout history, and it remains the primary source of tin today. Small amounts of tin are also recovered from sulfide minerals such as stannite. Cassiterite is found in alluvial deposits and can also be found in lode deposits in association with other metallic minerals. In descending order of production, China, Indonesia, Peru, Bolivia, Brazil, and Burma were the leading global producers of tin mineral concentrates in 2014. China and Indonesia are major suppliers, accounting for more than 60 percent of the world supply. The DRC and surrounding countries account for only 3 percent of the global supply of tin. Although the estimated deposits in the DRC are substantial, the mining capabilities are not developed enough to have a notable effect on world tin production. Figure 1 shows the share of 2009–13 world mine production of tin by country and the global processors of tin concentrate to the first products, tin metal, tin powder, and solder, in 2013.

In the DRC, tin mining is conducted mostly by artisanal methods in the Katanga, Maniema, Nord-Kivu, and Sud-Kivu Provinces. Most of the remaining regional tin production comes from Rwanda, also using artisanal mining methods. Estimates of tin reserves in the DRC region are not available, but are believed to be substantial. The largest reserves are found in the Kivu region. In January 2015, a new tin smelter in Rwanda started a 10-day pilot program. The new plant, operated by Phoenix Metals Ltd., reportedly has a capacity of 2,200 metric tons per year (t/yr) of tin. The owners of the new smelter are seeking a conflict-free certification, and the final phase of that audit is expected to be completed in July 2015. As of May 2015, the Lubumbashi smelter in the DRC, which is capable of producing 3,600 t/yr and had closed because of unreliable power supplies, had reportedly resumed operations.

Cassiterite is mined by the dredging of alluvial deposits, which takes place when the ore is broken up by either high-pressure water or an excavator, or by hard-rock mining methods, usually from underground mines. The ore is then concentrated, usually in co-location with the mine, through a combination of flotation, gravity, and magnetic processes to produce a cassiterite concentrate containing 70–77 percent tin. Tin concentrate is then smelted by heating it in the presence of carbon to 1,200–1,300 degrees centigrade, reducing the cassiterite to tin metal and releasing carbon dioxide. Following the smelting process to produce tin metal, the remaining impurities are removed through a refining process, usually at a facility co-located with the smelter. Refining involves heating impure tin to temperatures just above the tin melting point, allowing impurities to drop out as solids and the pure liquid tin to be skimmed off. Impurities within the slag can include economically recoverable amounts of tantalum, another conflict mineral (Papp, 2014). Refining is done through heat treatment or electrolytic processes. Heat treatment uses carbon-based fuel as a main heat source, usually in a reverberatory furnace. Heat treatment is more widely used, but produces 99.85 percent tin. Electrolytic processing involves inserting electrodes into the tin concentrate and running electricity through it in order to heat the concentrate to just above the tin melting point. Electrolytic processing is more expensive than heat treatment, but provides up to 99.9999-percent tin (Geoscience Australia, 2012).

Tin metal is found in everyday life. It is the primary component of solder, a fusible metal alloy used to connect two pieces of metal with a melting temperature below that of either piece. In electrical applications, it is conductive, allowing an electrical charge to flow across the connection. Tin is also a primary component in food-grade tin cans manufactured from tin plate. Tin plate is made by annealing molten tin onto a steel sheet. Tin used in chemicals includes organo-tin chemicals,

commonly used as stabilizers in polyvinyl chloride manufacturing to prevent heat degradation and the release of hydrogen chloride. Tin is also used in copper-base alloys, such as bronze and brass; other tin-containing alloys including babbitt, a low-friction metal often used in engines; and terne metal, a coating for metal roofs used to inhibit rust (Roskill Information Services Ltd., 2015).

Tin Processing Facility Data

More than 25 primary tin smelters were part of the global tin supply chain during 2013 (table 1). The USGS does not have complete data on the source materials or processing methods of these tin-processing companies and (or) plants and therefore cannot verify whether these facilities consumed tin concentrates and, if so, whether or not those concentrates were sourced from conflict-affected areas. Other forms of tin such as recycled products, tin slag, tin scrap, or intermediate products may be used as source materials. The table excludes companies and (or) plants that were known to only process recycled materials.

The data were compiled and evaluated by the NMIC from sources that include company reports, foreign Governments, industry analysts, industry associations, inter-governmental organizations, nongovernmental organizations, and trade journals. Company information, such as name, location, and products produced, were verified via company Web sites, which were the authoritative sources for company name and location. The intent was to include all major concentrate-consuming companies and plants; however, some may not have been listed. Small tin facilities associated with artisanal mining in Indonesia and not equipped to process imported material were excluded. Some large companies have multiple plants, which were not described in sufficient detail to identify their location or the tin material that was processed. For example, many companies that were reported to have been tin suppliers could not be confirmed, as companies changed names, were referred to imprecisely, changed ownership, or went out of business.

World Tin Flows

From 2011 to 2013, China, Malaysia, and Indonesia dominated the tin supply chain. These countries produced 63 percent of tin ores and concentrates, imported 95 percent of global tin ores and concentrates, and accounted for 95 percent of global primary tin smelter production, which averaged about 300,000 t/yr during the 3-year period. In contrast, the DRC and adjacent countries accounted for only 3 percent of global mined production. According to the United Nations Comtrade database (United Nations, Department of Economic and Social Affairs, Statistics Division, 2015), the leading global importers of tin ores and concentrates from the DRC from 2011 to 2013 were China (53 percent), Malaysia (39 percent), and Rwanda (7 percent).

A detailed look at the global flow patterns highlights the dominance of China as not only a producer but also a consumer in the market. China sourced 157.8 million metric tons of tin ores and concentrates from 2011 to 2013, which represented about 59 percent of reported global imports of tin ores and concentrates from Burma, Bolivia, and Tanzania. However, according to the United Nations Comtrade database (United Nations, Department of Economic and Social Affairs, Statistics Division, 2015), China was not a leading exporter of tin and articles. China was also an importer of tin and articles, sourcing about 6 percent of global tin and articles exports from Malaysia and Indonesia.

Malaysia, having less domestic mining capability than China, imported about 33 percent of global tin ores and concentrates during the 3-year period from Australia, Rwanda, and Nigeria. Malaysia supplied 12 percent of the global exports of tin and articles and shipped them primarily to the Republic of Korea (19 percent), India (14 percent), and China (13 percent).

Indonesia produced 20 percent of global tin ores and concentrates and supplied 28 percent of the global exports of tin and articles, which were shipped predominantly through Singapore to China, Malaysia, and the Netherlands.

In addition to primary tin producers, numerous secondary tin producers throughout the world use secondary (recycled) materials to produce tin products. These secondary tin producers are not the subject of this fact sheet and are not included in table 1 even though they are an important component in the analysis of the tin supply chain.

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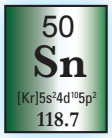

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ISSN 2327–6916 (print)
ISSN 2327–6932 (online)
http://dx.doi.org/10.3133/fs20153022