



# 2015 Minerals Yearbook

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**NICKEL [ADVANCE RELEASE]**

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# NICKEL

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Reported nickel consumption (primary plus secondary) in the United States in 2015 decreased slightly to 199,000 metric tons (t) compared with that of 2014 (table 1). U.S. apparent consumption of primary nickel was 120,000 t, or about 6% of world consumption, based on the 1.88 million metric tons (Mt) reported by the International Nickel Study Group (INSG). Stainless steel production accounted for 42% of U.S. primary consumption in contrast with 66% globally. This was likely a reflection of the large number of specialty metal companies and a readily available supply of stainless steel scrap in the United States (table 4). U.S. industry reported melting 90,100 t of nickel contained in scrap, a slight decrease from 90,900 t (revised) in 2014 (table 3) (International Nickel Study Group, 2016, p. A-1; Nickel Institute, 2016, p. 14).

World mine production of nickel was 2.28 Mt of contained nickel in 2015, a slight decrease from that of 2014 (table 10). The London Metal Exchange Ltd. (LME) average monthly cash price for nickel metal trended downward throughout 2015 and averaged \$8,689 per metric ton in December. As reported by Platts Metals Week, the LME average annual price was \$11,831 per metric ton in 2015, a 30% decrease compared with the average annual price of \$16,865 per metric ton in 2014 (table 1). The 2015 average price was the lowest average annual cash price since 2003. Daily stocks of nickel metal increased in LME-sanctioned warehouses and ended the year at 441,342 t.

Stainless steel accounted for about 66% of global primary nickel (nickel produced from the refining of mined material rather than that recovered from recycled scrap) consumption. World production of stainless and heat-resisting steel was 41.5 Mt in 2015, essentially unchanged from 2014. China was the leading producer of stainless steel, accounting for about 52% of world output, as well as the leading consumer of primary nickel (International Stainless Steel Forum, 2017, p. 8, 13). On a global basis, nonferrous alloys accounted for about 10% of primary nickel use; electroplating and other surface finishing, 9%; alloy steels other than stainless, 8%; foundry products, 3%; and batteries, catalysts, and specialty chemicals, 4% (Nickel Institute, 2016, p. 14).

## Legislation and Government Programs

**U.S. Coinage.**—The U.S. Mint increased circulating coin production in 2015 for the sixth consecutive year. Dimes, half dollars, nickels, one-dollar coins, and quarters contain nickel in the form of either cupronickel or manganese-brass alloy. Total nickel consumption for coin production was 3,998 t in 2015, a 48% increase compared with 2014 (U.S. Mint, undated a, b).

## Production

The United States had one nickel mine in operation—the underground Eagle Mine in the Upper Peninsula of Michigan, which began operation in 2014. The Eagle Mine continued to ramp up operations in 2015, producing 27,200 t of nickel in concentrate compared with 4,300 t in 2014 (table 1) (Lundin Mining Corp., 2016b, p. 2). Limited quantities of byproduct nickel were recovered at some copper and precious metal refineries, particularly the Stillwater Mining Co. (Billings, MT) base metal refinery. Leading processors of recycled nickel included International Metals Reclamation Co. Inc.'s (INMETCO's) [owned by Horsehead Holding Corp. (Pittsburgh, PA)] secondary smelter in Ellwood, PA, that processed nickel-containing scrap and Gulf Chemical & Metallurgical Corp.'s (Freeport, TX) [owned by ERAMET Group (Paris, France)] facility in Freeport, TX, that processed spent catalysts from petroleum refineries. The refinery and secondary recovery data were included with scrap statistics to avoid disclosing company proprietary data (tables 1–5).

No ferronickel was produced from ores in the United States in 2015. Almost all U.S. ferronickel exports were either reexports or material upgraded for special purposes.

**Michigan.**—Lundin Mining Corp. (Toronto, Ontario, Canada) mined the Eagle deposit—a chalcopyrite-pentlandite-rich peridotite intrusion historically known as the Yellow Dog peridotites. The ore was processed at the associated Humboldt mill, which produced separate concentrates of copper and nickel sulfides. The two sulfide concentrates were railed on a dedicated spur from Humboldt Township to the Canadian National Railway line, and then to smelters in Canada or to ports for shipment overseas (Lundin Mining Corp., 2016a, p. 22–25).

In June, the company announced that exploration drilling had intersected a new zone of high-grade massive and semimassive copper-nickel sulfide mineralization named the Eagle East discovery. Lundin continued drilling to further delineate the deposit. At yearend 2015, the company lacked sufficient data to develop a resource estimate but planned to continue exploration of Eagle East in 2016 (Lundin Mining Corp., 2016a, p. 11, 23, 25).

**Minnesota.**—PolyMet Mining Corp. (Vancouver, British Columbia, Canada) was waiting for approval to begin developing the copper, nickel, and platinum-group-element (PGE) Northmet deposit, located 10 kilometers (km) (6 miles) south of the town of Babbitt in St. Louis County. Ore mined from a proposed open pit would be shipped to the reconditioned Erie mill near Hoyt Lakes, MN, for processing by flotation to

produce a marketable concentrate. In phase 2 of the project, the concentrate would be processed in a new hydrometallurgical plant at the Erie site (PolyMet Mining Corp., 2016, p. 14–24).

In November, the final Northmet Environmental Impact Statement was released for public comment by the Minnesota Department of Natural Resources. In addition, the U.S. Forest Service issued a draft Record of Decision approving a proposal to exchange private lands within the Superior National Forest for Federal lands overlying the Northmet deposit. The purpose of the exchange was to resolve discrepancies between mineral and surface rights (Cherry, 2015; Myers, 2015).

**Byproduct Smelter and Refinery Production.**—In 2015, Stillwater Mining Co. sold 660 t of nickel in crystalline sulfate, essentially unchanged from 2014. Stillwater mined PGEs from the J-M Reef in Montana’s Beartooth Mountains. Concentrates from the company’s two mills (East Boulder and Nye) were trucked to Stillwater’s smelting and refining complex at Columbus, MT, where a PGE filter cake and byproduct crystalline nickel sulfate containing minor amounts of cobalt were produced (Stillwater Mining Co., 2017, p. 7–8, 21, 49).

**Secondary Production.**—INMETCO operated the only secondary smelter in North America dedicated to recovering chromium- and nickel-containing waste and scrap. The smelter at Ellwood City, PA, produced an iron-base remelt alloy that typically averaged 13% chromium and 12% nickel. Stainless steel producers used the remelt alloy as a substitute for ferrochromium and ferronickel. INMETCO was capable of processing a wide range of nickel-bearing wastes including flue dust, grinding swarf, mill scale, and shot blast generated during the manufacturing of stainless steel. The complex also accepted filter cakes, plating solutions, spent pickle liquor, sludges, and all types of spent nickel-containing batteries (Horsehead Holding Corp., 2015, p. 8–10).

Gulf Chemical & Metallurgical Corp. was one of a limited number of companies worldwide that processed spent catalysts from petroleum refineries. The Freeport facility treated nickel-molybdenum and cobalt-molybdenum hydrotreating catalysts that had been “poisoned” by nickel and vanadium contained in the crude oil. Gulf Chemical first roasted and leached the spent catalysts to recover the molybdenum and vanadium. The nickel-and-alumina residue was then converted to a marketable nickel-cobalt-molybdenum alloy in a direct-current electric arc furnace. Catalyst processing was expected to increase in North America as the result of the increase in natural gas and oil production from shale and other low-permeability formations (Gulf Chemical & Metallurgical Corp., 2013a, b, 2014; Sieminski, 2014).

## Consumption

Apparent primary nickel consumption in the United States was 120,000 t in 2015, a 19% decrease from a revised 147,000 t in 2014 (table 1). The estimated value of apparent primary nickel consumption was \$1.42 billion, a 43% decrease from 2014, owing to both the decrease in apparent consumption as well as a 30% decrease in the average annual LME cash price. U.S. industry consumed 14,700 t of ferronickel in 2015, of which more than 80% was used in stainless, heat-resisting, or specialty alloy steels (table 4).

**Stainless Steel and Low-Alloy Steels.**—In 2015, stainless steel producers accounted for 42% of reported primary nickel consumption, 65% of total nickel consumption, and 93% of nickel-containing scrap consumption in the United States (table 4). Alloy steels—other than stainless—accounted for an additional 3% of U.S. primary nickel use. Production of raw stainless steel and heat-resisting steel in the United States decreased slightly to 2.59 Mt. Nickel-bearing grades, which accounted for 69% of total stainless steel production, decreased by 5% to 1.78 Mt (American Iron and Steel Institute, 2015, 2016).

In December 2015, Allegheny Technologies Inc. (ATI) (Pittsburgh, PA) announced that it intended to idle its standard stainless melt shop and sheet finishing operations in Midland, PA. The company cited increasingly challenging market conditions for commodity flat-rolled products, including inventory reductions by consumers, global excess capacity, and increasingly low-priced imports from China into the United States (Allegheny Technologies Inc., 2015a).

**Superalloys and Related Nickel-Base Alloys.**—Of the primary nickel consumed in the United States in 2015, approximately 23% was used to make high-performance superalloys and related nickel-base alloys, primarily for the aerospace, electric power, and petrochemical industries.

At yearend 2014, ATI was preparing to commission a new \$1.2 billion hot-rolling and processing facility at Brackenridge, PA. Siemens VAI Metals Technologies GmbH designed and engineered the new facility, which occupied 10 hectares (25 acres) north of Pittsburgh. Construction began in 2011, and the new facility was officially integrated into ATI’s existing operations at Brackenridge in March 2015. Completion of the facility was a critical component of the company’s strategy to meet expected increased demand for nickel-base alloys by diversifying its product offerings (Gannon, 2015; Allegheny Technologies Inc., 2016, p. F–3, F–23).

In June, ATI announced its intention to expand its nickel-base superalloy powder production capabilities near Monroe, NC, in order to meet strong demand in the additive manufacturing and aerospace jet engine markets. The expansion would supplement the company’s existing superalloy powder production in Oakdale, PA, which was operating near full capacity (Allegheny Technologies Inc., 2015b).

## Stocks

Stocks of nickel in LME-approved warehouses increased to 441,342 t by December 31, 2015, a 6% increase compared with 414,900 t at yearend 2014. Approximately 40%, or 178,050 t, was stored at Johor, Malaysia. An additional 132,444 t, or 30%, was held in Rotterdam, the Netherlands—the traditional LME storage point for the European Union and Russia. All stocks in LME warehouses were Class I material (refined products with a nickel content of 99% or greater) (London Metal Exchange Ltd., 2015).

Data collected by the INSG (International Nickel Study Group, 2016, p. A1–A2) indicated that, at yearend 2015, world nickel producers (excluding those in Austria, China, Kosovo, Macedonia, and the Ural region of Russia) held an additional 85,300 t of primary nickel stocks, a 7% decrease from 2014.

About 73%, or 62,400 t, was Class I material. The remaining 27%, or 22,900 t, was Class II material (products with nickel content less than 99%), which could include ferronickel, nickel pig iron (NPI), oxide sinter, and East Asian utility nickel. At yearend 2015, U.S. consumer stocks of primary nickel totaled 10,600 t, a 6% decrease from the revised 11,200 t held at yearend 2014 (tables 1, 5).

## Prices

In January 2015, the LME monthly mean of the cash buyer and settlement prices was \$14,767 per metric ton. Prices decreased for most of 2015, ending the year with a December mean of \$8,689 per metric ton. The average annual LME price for 2015 was \$11,831 per metric ton (\$5.37 per pound)—30% less than the 2014 average.

## World Review

Global nickel mine production decreased slightly to 2.28 Mt, and global plant production decreased by 3% to 1.93 Mt in 2015 (tables 10, 12). According to the INSG, world consumption of primary nickel was 1.88 Mt (International Nickel Study Group, 2016, p. A-1).

**Australia.**—Australia was the fourth-ranked nickel-producing country in the world in terms of mine output. Australia was ranked fifth in plant output and predominantly produced refined metal (tables 10, 12). All nickel ore production was based in Western Australia, with approximately 60% of production from sulfide mines. The quantity of Australia's nickel sales has trended downwards since 2012 reflecting the downward trend in nickel price [Department of Mines and Petroleum (Western Australia), 2015, p. 29; 2016, p. 35].

First Quantum Minerals Ltd. (Vancouver, British Columbia, Canada) produced intermediate nickel-cobalt hydroxide containing 40% nickel and 1.4% cobalt at its Ravensthorpe nickel-cobalt laterite mine and hydrometallurgical processing plant in Western Australia. A 27% decrease in nickel production in 2015 was attributed to a structural failure in an atmospheric leaching tank 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 (First Quantum Minerals Ltd., 2016, p. 12; undated).

Panoramic Resources Ltd. (Perth, Western Australia, Australia) mined the Deacon sulfide orebody at its Lanfranchi project, 42 km south of Kambalda, Western Australia. Owing to depletion of reserves and increased seismic activity, operations were suspended in August before the mine was formally placed on care-and-maintenance status. The company, however, discovered a new zone of mineralization and developed a new decline to facilitate further drilling and testwork and future mining operations (Panoramic Resources Ltd., 2016, p. 2, 4, 11).

**Brazil.**—Four companies mined nickel ore in Brazil—Anglo American Níquel Brasil Limitada, Grupo Votorantim, Mirabela Nickel Ltd., and Vale S.A. The four companies extracted a total of 16.0 Mt of ore containing 174,000 t of nickel [Departamento Nacional de Produção Mineral (Brazil), 2016, p. 3-4, 13]. Ferronickel accounted for approximately 60% of plant production, and the balance of production was refined nickel.

During the first half of 2015, Mirabela Nickel Ltd. produced nickel sulfide concentrate from its Santa Rita open pit mine and concentrator in Bahia State. In September, the company was placed under voluntary administration. Production was cut back beginning in late October 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 (Williams, 2015; Mirabela Nickel Ltd., 2016).

Anglo American completed reconstruction of both furnaces at its Barro Alto mining and smelting complex in Goiás State. Both furnaces were damaged during rampup in 2013, and company management subsequently decided to rebuild both furnaces in order to correct inherent design problems. Anglo American shut down one furnace in October 2014 for 7 months for rebuilding and upgrading. In September 2015, Anglo American restarted deliveries from its second furnace (Spinetto, 2013; Anglo American plc, 2015; 2016, p. 22).

**Canada.**—Canada was the third-ranked nickel-producing country in the world in terms of mine output and ranked fourth in plant output (tables 10, 12). Four Provinces had active nickel mines in 2015—Manitoba, Newfoundland and Labrador, Ontario, and Quebec—with a total ore output of 235,000 t of contained nickel (table 10).

Vale Canada Ltd.'s operation at Thompson, Manitoba, processed refined nickel from ores extracted from the Birchtree and Thompson Mines. The Thompson operation also smelted concentrates shipped from Vale's mining operation near Voisey's Bay in northern Newfoundland and Labrador. Vale was considering phasing out smelting and refining at Thompson owing to Canadian sulfur 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 (Vale S.A., 2016, p. 37, 42).

**China.**—China was the leading producer of primary nickel but ranked eighth in mine production (tables 10, 12). In 2015, China's total production of primary nickel products decreased by 14% compared with that of 2014. Production of ferronickel and NPI, chemicals and other unspecified forms, and metal decreased by 18%, 10%, and 6%, respectively. In June, the Shanghai Futures Exchange approved the registration of three brands of electrolytic nickel from PJSC MMC Norilsk Nickel (Shanghai Futures Exchange, 2015).

According to INSG data (International Nickel Study Group, 2016, p. A-6), China was the world's leading consumer of nickel, accounting for 52% of world consumption in 2015. China's imports of unalloyed, unwrought nickel increased by 125% to 293,000 t. Imports from Russia accounted for 73% of the increase.

The price of China's NPI declined throughout 2015. In many cases, sales prices were below production costs, leading to the suspension of activities at higher cost operations. The number of NPI producers in China reportedly fell to approximately 30 from over 300 in previous years (Nickel & Stainless Steel Data Monthly, 2016, p. 8, 11, 18).

Low NPI production was likely related to other changes in China's trade and stocks of nickel ore and concentrates and ferronickel. In 2014 and 2015, gross weight imports of ferronickel (which likely included NPI) increased substantially

(by 45% and 131%, respectively), but gross weight imports of nickel ore and concentrates decreased (by 33% and 26%, respectively). Stocks of NPI reportedly declined by 40% in the second half of 2015 from a high of 490,000 t earlier in the year, and stocks of nickel ores at 12 major ports reportedly decreased by 17% from February 2015 to yearend 2015 (Nickel & Stainless Steel Data Monthly, 2016, p. 11, 25, 26).

**Indonesia.**—The Government of Indonesia continued to enforce its ban on the export of key unprocessed metalliferous ores. The regulations, originally enacted as Law No. 4 in 2009, effectively halted all sales of Indonesian nickeliferous direct shipping ore to overseas producers of ferronickel and NPI. The intent of the ban was to stimulate development of processing facilities that would produce higher valued products (Lederer, 2016). Indonesia's reported exports of nickel ores and concentrates were zero.

Chinese companies invested heavily in the development of joint mining and smelting projects in Indonesia, with numerous projects under construction or planned for commissioning in 2015 and 2016 (Nickel & Stainless Steel Data Monthly, 2016, p. 16–17). One example was the PT Indonesia Morowali Industrial Park [Shanghai Decent Investment (Group) Co., Ltd. and PT Bintangdelapan Group], a nickel pig iron and stainless steel complex at Bahodopi in Central Sulawesi. The park's first NPI project, financed by the China Development Bank, was commissioned in January 2015. The project had a capacity of 300,000 metric tons per year (t/yr) (gross weight) of NPI with a nickel content of 10%. A second project that had a capacity of 600,000 t/yr was under construction, and construction of a 1,000,000-t/yr stainless steel slab facility began in July 2015 [Shanghai Decent Investment (Group) Co., Ltd., undated].

Perusahaan Perseroan (Persero) PT Aneka Tambang Tbk was in the process of expanding its ferronickel production complex at the port of Pomalaa, Southeast Sulawesi, and continued construction of a processing complex at East Halmahera, North Maluku. In June, the company commenced production from its new furnace at Pomalaa, which was expected to increase capacity to 27,000 to 30,000 t/yr of nickel in ferronickel from the previous capacity of 18,000 to 20,000 t/yr. The East Halmahera plant was to be constructed in two stages, with each stage having a capacity of 13,500 to 15,000 t/yr of nickel in ferronickel. Construction was scheduled to be completed in 2018 [Perusahaan Perseroan (Persero) PT Aneka Tambang Tbk, 2016, p. 15–16, 75, 109–110].

**New Caledonia.**—Koniambo Nickel SAS continued to ramp up operations at its mining and smelting project in the North Province. Operations at the facility were halted in late December 2014 owing to a hot-metal leak in one furnace. The furnace was subsequently rebuilt and was expected to restart production in January 2016. Construction of a second furnace was well underway when the first furnace malfunctioned. After receiving regulatory approval, the second furnace started operation in January 2015 but was slated to be taken out of service and rebuilt once the first furnace returned to operation (Regan, 2014; Glencore plc, 2016, p. 55).

**Philippines.**—The Philippines was the leading producer of mined nickel, accounting for approximately 24% of world production. Because of a lack of processing facilities, the

country exported most of its production as direct shipping ore. However, two companies operated hydrometallurgical processing plants that produced mixed sulfide compounds that were shipped to Japan for refining. In 2015, mine and intermediate production decreased by 5% and 3%, respectively.

**Russia.**—Russia was ranked second in both nickel mine and plant production. PJSC MMC Norilsk Nickel, Russia's leading producer, was in the process of upgrading the Nadezhda Metallurgical Plant in order to process all concentrate produced by the company's Polar Division. The company planned to close the refining capabilities of its Polar Division in 2016 (PJSC MMC Norilsk Nickel, 2016, p. 11–14, 74–76).

**Spain.**—Lundin mined sulfide ore from the Aguablanca Mine in the Province of Badajoz to produce nickel-copper concentrate. The company intended to transition from open pit to underground mining but was notified by the Government of Spain in July that the transition would require a full environmental evaluation. The mine's operations were suspended in October. Lundin later concluded that the operation was no longer financially feasible and announced its intention to permanently close the mine (Lundin Mining Corp., 2016b, p. 23).

**Turkey.**—After the commissioning of a high-pressure acid-leach plant in late 2014, Meta Nikel Kobalt A.Ş. (Meta Nikel Kobalt Madencilik Sanayi ve Ticaret A.Ş. and Zorlu Holding A.Ş.) began commercial production in 2015. The ore was trucked from the company's mines at Gordes and Eskisehir. The plant's initial design capacity was 10,000 t/yr of nickel equivalent in mixed nickel-cobalt hydroxide product, and all production was shipped to China (Vestel Elektronik Sanayi ve Ticaret AŞ, 2016, p. 47; Meta Nikel Kobalt A.Ş., undated).

## Outlook

From 2005 to 2015, global nickel consumption has had a compound annual growth rate of approximately 4% (International Nickel Study Group, 2016, p. A–1). Stainless steel is expected to continue to be the leading end use of primary nickel. World stainless melt shop production has had a compound annual growth rate of about 6%, climbing from 1 Mt in 1950 to 45.8 Mt (gross weight) in 2015. Chromium-nickel grades (300 series) constitute more than 50% of stainless steel production (International Stainless Steel Forum, 2017, p. 4, 15).

Increased demand for more-fuel-efficient engines is expected to increase demand for nickel in the transportation manufacturing sector. In the aerospace market, the use of nickel alloys allows for more-fuel-efficient jet aircraft engines by reducing weight while allowing for more thrust and higher operating temperatures. In the automotive sector, austenitic stainless steels have been shown to reduce the weight of individual components by 20% compared to carbon steels, leading to improved fuel efficiency (Nickel, 2006, p. 13; 2008, p. 6).

The electric power industry is expected to remain an important consumer of austenitic stainless steel and various nickel-base superalloys—both for new construction and renovation. Global demand for electricity continues to increase and is accelerating as the population of the world increases. According to the U.S. Energy Information Administration (2014, p. MT–16), electricity consumption in the United States

alone is expected to increase by at least 29% between 2012 and 2040. To meet demand, utilities will need to build more generating capacity, irrespective of whether the plants operate on fossil fuels, renewable energy (geothermal, hydropower, solar, or wind), or nuclear reactors. The increased capacity would require large tonnages of nickel-bearing stainless steel and superalloys.

The use of nickel in batteries has been estimated at 3% to 4% of total global consumption. Although there is significant opportunity for increased demand for nickel in battery applications, the battery market is highly competitive and evolving rapidly, particularly in vehicle electrification. Increased consumption of nickel in battery applications depends on a variety of factors such as how widely electric vehicles are adopted and which battery technologies are used. Many of the non-plug-in hybrid electric vehicles on U.S. highways use nickel-metal hydride batteries. Nickel has recently begun to be used in lithium-ion cathode materials, primarily as nickel-cobalt-manganese and nickel-cobalt-aluminum. Lithium-ion batteries are primarily used in consumer electronics, but the larger capacities required for vehicle electrification are expected to accelerate demand for nickel in the sector (Roskill Information Services Ltd., 2017).

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TABLE 1  
SALIENT NICKEL STATISTICS<sup>1</sup>

(Metric tons of contained nickel unless otherwise specified)

	2011	2012	2013	2014	2015	
United States:						
Production, concentrate	--	--	--	4,300	27,200	
Secondary recovery from purchased scrap:						
From ferrous scrap	78,900	82,300	81,100	82,500 <sup>r</sup>	85,000	
From nonferrous scrap	11,200 <sup>r</sup>	7,410 <sup>r</sup>	7,520 <sup>r</sup>	8,410 <sup>r</sup>	5,050	
Shipments of purchased scrap <sup>2</sup>	134,000	127,000 <sup>r</sup>	123,000 <sup>r</sup>	108,000 <sup>r</sup>	115,000	
Exports:						
Ores and concentrates <sup>3</sup>	1,880 <sup>r</sup>	760	1,010 <sup>r</sup>	3,320	25,400	
Primary	12,400	9,130 <sup>r</sup>	10,600	10,400	9,580	
Secondary	64,100 <sup>r</sup>	59,600 <sup>r</sup>	61,100 <sup>r</sup>	56,300 <sup>r</sup>	51,900	
Imports for consumption:						
Ores and concentrates <sup>3</sup>	1	(4)	3	92	24	
Primary	138,000	133,000	126,000	156,000	130,000	
Secondary	21,300	22,300	26,300	39,000 <sup>r</sup>	27,100	
Consumption:						
Reported:						
Primary	110,000	110,000 <sup>r</sup>	110,000 <sup>r</sup>	115,000	109,000	
Secondary, purchased scrap	90,100 <sup>r</sup>	89,800 <sup>r</sup>	88,600 <sup>r</sup>	90,900 <sup>r</sup>	90,100	
Total	200,000	200,000 <sup>r</sup>	199,000 <sup>r</sup>	206,000 <sup>r</sup>	199,000	
Apparent, primary	124,000	125,000	111,000 <sup>r</sup>	147,000 <sup>r</sup>	120,000	
Apparent primary plus reported secondary	215,000	215,000 <sup>r</sup>	199,000 <sup>r</sup>	238,000 <sup>r</sup>	210,000	
Stocks, yearend:						
Producers and traders <sup>c</sup>	6,650	6,380	10,000	9,030	10,300	
Consumer, primary	11,400	10,200 <sup>r</sup>	11,800 <sup>r</sup>	11,200 <sup>r</sup>	10,600	
Consumer, secondary	6,740 <sup>r</sup>	6,570 <sup>r</sup>	6,660 <sup>r</sup>	12,100	8,560	
Total	24,800	23,200 <sup>r</sup>	28,400 <sup>r</sup>	32,400 <sup>r</sup>	29,500	
Price, cash, London Metal Exchange:						
Average annual	dollars per metric ton	22,890	17,533	15,018	16,865	11,831
Average annual	dollars per pound	10.383	7.953	6.812	7.650	5.367
Price, Type 304 stainless steel scrap, gross weight: <sup>5</sup>						
Average annual	dollars per metric ton	2,276	1,859	1,574	1,714	1,240
Average annual	dollars per long ton	2,312	1,889	1,599	1,742	1,260
World, mine production	2,340,000 <sup>r</sup>	2,570,000 <sup>r</sup>	2,790,000	2,350,000 <sup>r</sup>	2,280,000	

<sup>c</sup>Estimated. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits except prices; may not add to totals shown.

<sup>2</sup>Defined as scrap receipts less shipments by consumers plus exports minus imports plus adjustments for consumer stock changes.

<sup>3</sup>Nickel ores and concentrates (Harmonized Tariff Schedule of the United States code 2604.00.0040). Source: U.S. Census Bureau.

<sup>4</sup>Less than ½ unit.

<sup>5</sup>Derived from the monthly averages of the consumer buying price in Pittsburgh, PA, as published in American Metal Market.

The price represents Type 304 solids and clips containing 18% to 20% chromium and 8% to 12% nickel.



TABLE 2  
NICKEL RECOVERED FROM PURCHASED SCRAP  
IN THE UNITED STATES,  
BY KIND OF SCRAP AND FORM OF RECOVERY<sup>1</sup>

(Metric tons of contained nickel)

	2014	2015
<b>Kind of scrap:</b>		
Aluminum-base	1,860 <sup>r</sup>	1,780
Copper-base	1,360	1,320
Ferrous-base <sup>2</sup>	82,500 <sup>r</sup>	85,000
Nickel-base	5,190 <sup>r</sup>	1,970
<b>Total</b>	<b>90,900 <sup>r</sup></b>	<b>90,100</b>
<b>Form of recovery:</b>		
Aluminum-base alloys	1,860 <sup>r</sup>	1,780
Copper-base alloys	2,410	2,350
Ferrous alloys	85,600 <sup>r</sup>	85,100
Nickel-base alloys	996 <sup>r</sup>	871
<b>Total</b>	<b>90,900 <sup>r</sup></b>	<b>90,100</b>

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Primarily stainless and alloy steel scrap consumed at steel mills and foundries.

TABLE 3  
REPORTED U.S. CONSUMPTION OF NICKEL, BY FORM<sup>1</sup>

(Metric tons of contained nickel)

Form	2014	2015
<b>Primary:</b>		
Metal	96,200 <sup>r</sup>	91,100
Ferronickel	15,800 <sup>r</sup>	14,700
Oxide and oxide sinter <sup>2</sup>	228 <sup>r</sup>	308
Chemicals	1,070	W
Other	1,400 <sup>r</sup>	2,880
<b>Total</b>	<b>115,000</b>	<b>109,000</b>
Secondary, scrap <sup>3</sup>	90,900 <sup>r</sup>	90,100
<b>Grand total</b>	<b>206,000 <sup>r</sup></b>	<b>199,000</b>

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes chemical-grade oxide.

<sup>3</sup>Based on gross weight of purchased scrap consumed and estimated average nickel content.

TABLE 4  
REPORTED U.S. CONSUMPTION OF NICKEL, BY USE<sup>1</sup>

(Metric tons of contained nickel)

Use	2015							Grand total	Grand total in 2014
	Metal	Ferronickel	Oxide and oxide sinter	Chemicals	Other forms	Total primary	Secondary (scrap)		
Cast irons	41	--	--	--	3	44	161	205	272 <sup>r</sup>
Chemicals and chemical uses	1,570	--	W	196	5	1,770	--	1,770	2,120 <sup>r</sup>
Electric, magnet, expansion alloys	192	W	--	--	--	192	(2)	192	227 <sup>r</sup>
Electroplating, sales to platers	7,490	--	--	W	--	7,490	--	7,490	8,100 <sup>r</sup>
Nickel-copper and copper-nickel alloys	W	--	(2)	--	41	41	2,200	2,240	2,300
Other nickel and nickel alloys	13,000	17	1	--	32	13,000	W	13,000	15,000
Steel:									
Stainless and heat resistant	33,100	12,400	65	--	112	45,600	83,300	129,000	133,000
Alloys, excludes stainless	3,290	30	--	--	--	3,320	1,570	4,890	4,960 <sup>r</sup>
Superalloys	25,300	120	--	--	W	25,400	251	25,600	25,700 <sup>r</sup>
Other <sup>3</sup>	7,150	2,140	242	260	2,230	12,000	2,550	14,600	13,900 <sup>r</sup>
Total	91,100	14,700	308	455	2,430	109,000	90,100	199,000	206,000 <sup>r</sup>

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Less than ½ unit.

<sup>3</sup>Includes batteries, catalysts, ceramics, coinage, other alloys containing nickel, and data indicated by symbol W.

TABLE 5  
NICKEL IN CONSUMER STOCKS IN THE UNITED STATES,  
BY FORM, DECEMBER 31<sup>1</sup>

(Metric tons of contained nickel)

Form	2014	2015
Primary:		
Metal	10,400 <sup>r</sup>	9,930
Ferronickel	W	W
Oxide and oxide sinter	30 <sup>r</sup>	76
Chemicals	W	W
Other	846 <sup>r</sup>	608
Total	11,200 <sup>r</sup>	10,600
Secondary, scrap	12,100	8,560
Grand total	23,400 <sup>r</sup>	19,200

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 6  
U.S. EXPORTS OF NICKEL PRODUCTS, BY CLASS<sup>1</sup>

Class	2014		2015	
	Quantity (metric tons of contained nickel)	Value (thousands)	Quantity (metric tons of contained nickel)	Value (thousands)
<b>Primary:</b>				
Unwrought:				
Cathodes, pellets, briquets, shot	2,010 <sup>r</sup>	\$35,900 <sup>r</sup>	2,440	\$34,900
Ferronickel	110 <sup>r</sup>	3,070 <sup>r</sup>	118	3,270
Powder and flakes	1,710	59,700	1,470	54,500
Metallurgical-grade oxide <sup>2</sup>	1,970	22,000	1,620	22,400
Chemicals:				
Catalysts <sup>3</sup>	3,430 <sup>r</sup>	315,000 <sup>r</sup>	2,990	285,000
Salts <sup>4</sup>	1,210	29,400	948	14,200
Total	10,400	465,000 <sup>r</sup>	9,580	414,000
<b>Secondary:</b>				
Stainless steel scrap	41,100	674,000	38,500	638,000
Waste and scrap <sup>5</sup>	15,200	125,000	13,400	107,000
Total	56,300 <sup>r</sup>	799,000	51,900	745,000
Grand total	66,800	1,260,000	61,500	1,160,000
<b>Wrought, not alloyed:</b>				
Bars, rods, profiles, wire	224 <sup>r</sup>	9,390	213	9,760
Sheets, strip, foil	246 <sup>r</sup>	9,830 <sup>r</sup>	255	10,000
Tubes and pipes	210	4,640	58	1,620
Total	680	23,900	526	21,400
<b>Alloyed, gross weight:</b>				
Unwrought alloyed ingot	5,350	128,000	6,050	116,000
Bars, rods, profiles, wire	20,600	676,000	19,600	663,000
Sheets, strip, foil	12,700	372,000	15,200	471,000
Tubes and pipes	2,360	155,000	2,310	149,000
Other alloyed articles	4,220 <sup>r</sup>	480,000	3,330	409,000
Total	45,200	1,810,000	46,500	1,810,000

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Nickel content is assumed to be 77%.

<sup>3</sup>Typical catalyst is assumed to have a nickel content of 22%.

<sup>4</sup>Nickel contents are as follows: chemical-grade oxide, sesquioxide, and hydroxide, 65%; chlorides, 25%; sulfates, 22%; and other salts, assumed to be 22%.

<sup>5</sup>Waste and scrap content is assumed to be 50% nickel; stainless steel scrap, 7.5%.

Source: U.S. Census Bureau.

TABLE 7  
U.S. EXPORTS OF NICKEL PRODUCTS, BY COUNTRY<sup>1</sup>

(Metric tons of contained nickel)<sup>2</sup>

Country <sup>3</sup>	2015							Total in 2014	Wrought nickel in 2015 <sup>5</sup>	
	Cathodes, pellets, and briquets (unwrought)	Powder and flakes	Ferronickel	Metallurgical- grade oxide <sup>4</sup>	Waste and scrap	Stainless steel scrap	Chemicals			Total
Australia	--	11	--	(6)	513	8	8	541	1,220	2
Belgium	--	21	--	263	10	196	59	549	289 <sup>r</sup>	4
Brazil	90	52	1	--	--	12	106	260	480	3
Canada	57	142	24	873	9,070	1,860	977	13,000	14,500	34
China	1	174	1	23	226	11,300	728	12,400	10,400	41
Denmark	--	4	--	--	--	--	151	155	199	(6)
Finland	--	--	--	--	37	583	--	620	(6)	1
Germany	--	325	3	17	28	80	30	482	782 <sup>r</sup>	45
Hong Kong	--	6	--	4	--	1,180	10	1,200	939 <sup>r</sup>	9
India	118	57	(6)	1	424	4,290	358	5,250	3,010	13
Japan	1	92	73	--	602	1,490	26	2,290	4,130 <sup>r</sup>	15
Korea, Republic of	(6)	65	--	4	12	2,240	85	2,410	3,070 <sup>r</sup>	19
Malaysia	--	1	--	1	--	181	46	229	110 <sup>r</sup>	35
Mexico	1,650	78	--	(6)	90	139	74	2,040	2,290 <sup>r</sup>	48
Netherlands	--	1	5	--	239	164	134	543	446 <sup>r</sup>	(6)
Pakistan	47	1	--	--	10	4,030	(6)	4,090	5,690	--
Russia	--	3	--	--	--	--	270	273	82	4
Singapore	(6)	154	(6)	2	6	45	51	259	183 <sup>r</sup>	7
Spain	--	3	--	(6)	--	1,350	1	1,350	35 <sup>r</sup>	(6)
Sweden	--	(6)	--	--	1,340	129	--	1,470	695 <sup>r</sup>	1
Taiwan	5	21	2	1	16	8,700	36	8,780	13,700	23
Thailand	--	63	(6)	--	2	179	69	313	615 <sup>r</sup>	1
United Arab Emirates	--	7	--	--	--	54	70	132	94	1
United Kingdom	316	71	--	378	712	38	81	1,600	2,080	88
Venezuela	--	1	--	--	--	(6)	205	206	70	27
Other	146	120	9	49	29	294	362	1,010	1,710 <sup>r</sup>	104
Total	2,440	1,470	118	1,620	13,400	38,500	3,940	61,500	66,800	526

<sup>1</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>The nickel contents are assumed to be as follows: metallurgical-grade oxide, 77%; waste and scrap, 50%; and stainless steel scrap, 7.5%. The "Chemicals" category contains the following: chemical-grade oxide, sesquioxide, and hydroxide, 65%; chlorides, 25%; and sulfates, 22%. Other salts and various catalysts are assumed to be 22% nickel.

<sup>3</sup>Countries listed were the leading export recipients in 2015 in terms of quantity (contained weight).

<sup>4</sup>Chemical-grade oxide is included in the "Chemicals" category.

<sup>5</sup>Not included in "2015, Total."

<sup>6</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 8  
U.S. IMPORTS FOR CONSUMPTION OF NICKEL PRODUCTS, BY CLASS<sup>1</sup>

Class	2014		2015	
	Quantity (metric tons of contained nickel)	Value (thousands)	Quantity (metric tons of contained nickel)	Value (thousands)
<b>Primary:</b>				
Unwrought:				
Cathodes, pellets, briquets, shot	126,000	\$2,100,000	109,000	\$1,410,000
Ferronickel	20,500	313,000	11,100	139,000
Powder and flakes	5,730	125,000	5,230	98,500
Metallurgical-grade oxide <sup>2</sup>	851	17,300	895	18,500
Chemicals:				
Catalysts <sup>3</sup>	1,750 <sup>r</sup>	99,500 <sup>r</sup>	2,740	89,700
Salts <sup>4</sup>	1,030	25,700	949	16,900
Total	156,000	2,680,000 <sup>r</sup>	130,000	1,770,000
<b>Secondary:<sup>5</sup></b>				
Stainless steel scrap	24,700	426,000	14,400	165,000
Waste and scrap	14,300	216,000	12,700	173,000
Total	39,000 <sup>r</sup>	642,000	27,100	337,000
Grand total	195,000	3,330,000	157,000	2,110,000
<b>Wrought, not alloyed:</b>				
Bars, rods, profiles, wire	288	8,310	260	7,060
Sheets, strip, foil	356	10,200	427	10,300
Tubes and pipes	82	2,470	103	2,430
Total	727 <sup>r</sup>	20,900	790	19,800
<b>Alloyed, gross weight:</b>				
Unwrought alloyed ingot	13,300	221,000	10,600	173,000
Bars, rods, profiles, wire	12,500 <sup>r</sup>	329,000 <sup>r</sup>	13,200	317,000
Sheets, strip, foil	4,310	95,000	3,700	84,100
Tubes and pipes	1,630 <sup>r</sup>	99,300	1,820	106,000
Other alloyed articles	1,770 <sup>r</sup>	180,000 <sup>r</sup>	2,950	207,000
Total	33,500 <sup>r</sup>	924,000 <sup>r</sup>	32,200	887,000

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Nickel content from Australia, 90%; elsewhere, 77%.

<sup>3</sup>Typical catalyst is assumed to have a nickel content of 22%.

<sup>4</sup>Nickel contents are as follows: chemical-grade oxide, sesquioxide, and hydroxide, 65%; chlorides, 25%; sulfates, 22%; and other salts, assumed to be 22%. Excludes nickel carbonate.

<sup>5</sup>Waste and scrap is assumed to be 50% nickel; stainless steel scrap, 7.5% nickel.

Source: U.S. Census Bureau.

TABLE 9  
U.S. IMPORTS FOR CONSUMPTION OF NICKEL PRODUCTS, BY COUNTRY<sup>1</sup>

(Metric tons of contained nickel)<sup>2</sup>

Country <sup>3</sup>	2015							Total in 2014	Wrought nickel in 2015 <sup>5</sup>	
	Cathodes, pellets, and briquets (unwrought)	Powder and flakes	Ferronickel	Metallurgical- grade oxide <sup>4</sup>	Waste and scrap	Stainless steel scrap	Chemicals			
Australia	10,300	470	--	883	251	--	--	11,900	16,100	--
Belgium	--	91	--	--	--	(6)	240	331	483 <sup>r</sup>	9
Brazil	6,220	--	2,200	--	200	120	1,240	9,980	9,560	--
Canada	49,500	3,240	(6)	(6)	3,310	6,980	71	63,100	72,100	5
China	208	59	200	--	652	14	7	1,140	1,580 <sup>r</sup>	11
Colombia	--	--	2,520	--	(6)	34	--	2,550	7,960	--
Denmark	--	--	--	--	--	--	243	243	211	--
Finland	9,570	45	--	--	--	--	118	9,730	10,600	--
France	68	10	291	--	1,040	2	230	1,640	1,970	114
Germany	--	38	--	--	852	2	335	1,230	1,850	417
Guatemala	--	--	1,290	--	--	8	--	1,290	741 <sup>r</sup>	--
India	--	--	(6)	(6)	38	2	339	379	376	60
Japan	3,270	86	--	6	1,120	6	141	4,630	4,110	33
Korea, Republic of	--	--	--	--	240	(6)	37	278	203	--
Madagascar	7,250	--	--	--	--	--	--	7,250	4,610	--
Mexico	1	1	--	--	923	7,040	13	7,980	10,700	--
Netherlands	18	--	--	1	--	--	293	313	2,830	1
New Caledonia	--	--	3,020	--	--	--	--	3,020	6,090	--
Norway	13,000	--	--	--	8	--	--	13,100	18,600	--
Russia	8,540	241	--	--	65	--	(6)	8,840	13,000	--
South Africa	755	478	--	--	--	--	14	1,250	1,510	--
Taiwan	--	--	(6)	--	223	3	12	238	328	(6)
Turkey	--	--	--	--	270	12	--	282	315	--
Ukraine	--	--	1,060	--	--	--	--	1,060	938	--
United Kingdom	166	449	17	4	2,580	24	222	3,470	4,670	14
Venezuela	--	--	502	--	--	--	--	502	1,360	--
Other	--	21	--	--	888	173	126	1,210	2,040 <sup>r</sup>	126
Total	109,000	5,230	11,100	895	12,700	14,400	3,690	157,000	195,000	790

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>The nickel contents are assumed to be as follows: metallurgical-grade oxide from Australia, 90%; elsewhere, 77%. The "Chemicals" category contains the following: chemical-grade oxide, sesquioxide, and hydroxide, 65%; chlorides, 25%; sulfates, 22%. Other salts and various catalysts are assumed to be 22% nickel. Waste and scrap is assumed to be 50% nickel; stainless steel scrap, 7.5% nickel.

<sup>3</sup>Countries listed were the leading exporters to the United States in 2015 in terms of quantity (contained weight).

<sup>4</sup>Primarily oxide, rondelles, and sinter.

<sup>5</sup>Not included in "2015, Total."

<sup>6</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 10  
NICKEL: WORLD MINE PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons of contained nickel)

Country and products <sup>3</sup>	2011	2012	2013	2014	2015
Albania, laterite ore <sup>c</sup>	3,000	1,000	2,100	4,900	6,100
Australia, ore and concentrate	215,000	244,000	234,000	245,000	222,000
Botswana, matte	15,675	17,948	22,848	14,958	16,789
Brazil, ore	131,673	139,531 <sup>r</sup>	104,829	167,063	160,000 <sup>c</sup>
Burma, laterite ore <sup>c</sup>	800	5,000	9,000	21,000	26,400
Canada, concentrate	219,025	211,701	227,743	228,867 <sup>r</sup>	234,936
China	94,500	103,860	107,160 <sup>4</sup>	94,101 <sup>r,4</sup>	92,900
Colombia, laterite ore:					
Mined <sup>c</sup>	76,000	84,000	84,700	NA	NA
Dry <sup>5</sup>	NA	NA	NA	44,100	40,400
Cuba, recoverable laterite: <sup>c</sup>					
Limonitic	38,100	35,700	34,500	26,300	NA
Serpentinitic	34,400	32,500	31,500	24,100	NA
Total	72,500	68,200	66,000	50,400	56,400
Dominican Republic, laterite ore	21,693	25,590	15,825	--	--
Finland	18,800	19,590	19,440	18,730	9,700
Greece, laterite ore	21,710	21,980	19,100 <sup>c</sup>	21,405	19,610
Guatemala, laterite ore <sup>c</sup>	--	2,400	12,500 <sup>r</sup>	46,800 <sup>r</sup>	52,400
Indonesia, laterite ore	564,400	648,400	834,200	177,100	129,000
Kazakhstan, laterite ore <sup>c</sup>	500	450	--	--	--
Kosovo, laterite ore	7,728	4,436	7,606	6,724	7,418
Macedonia, laterite ore <sup>c</sup>	3,600	1,680	NA	NA	--
Madagascar, laterite ore (mixed sulfide) <sup>c</sup>	(6)	8,300 <sup>r</sup>	27,200 <sup>r</sup>	37,400 <sup>r</sup>	45,500
Morocco, nickel sulfate	217	288	175	220	250 <sup>c</sup>
New Caledonia, laterite ore	128,732	131,693	164,406	178,080	186,065
Norway, concentrate	339	351	350 <sup>r</sup>	350 <sup>r,c</sup>	350 <sup>c</sup>
Papua New Guinea, laterite ore (mixed hydroxide)	--	5,283	11,369	20,987	25,582
Philippines, laterite ore <sup>7</sup>	349,000 <sup>r</sup>	455,000 <sup>r</sup>	466,000 <sup>r</sup>	586,000 <sup>r</sup>	554,000
Russia, marketable mine production:					
Laterite ore	41,777	26,620	10,000 <sup>c</sup>	11,200	--
Sulfide concentrate	281,690 <sup>r</sup>	270,030 <sup>r</sup>	270,700 <sup>r</sup>	271,950 <sup>r</sup>	269,310
Total	323,467 <sup>r</sup>	296,650 <sup>r</sup>	281,000 <sup>r,c</sup>	283,150 <sup>r</sup>	269,310
South Africa, concentrate	43,321	45,945	51,208	54,956	56,689
Spain, concentrate	--	2,398	7,574	8,631	7,213
Turkey, laterite ore <sup>c</sup>	4,300	3,500	1,200	3,200 <sup>r</sup>	9,600
United States, concentrate	--	--	-- <sup>r</sup>	4,300	27,200
Venezuela, laterite ore <sup>c</sup>	14,000 <sup>r</sup>	8,100 <sup>r</sup>	-- <sup>r</sup>	3,600 <sup>r</sup>	3,700
Vietnam	--	-- <sup>r</sup>	1,166	6,854	8,607
Zambia, concentrate	2,724	--	--	--	--
Zimbabwe, concentrate	7,992	7,899	12,962	16,633	16,108
Grand total	2,340,000 <sup>r</sup>	2,570,000 <sup>r</sup>	2,790,000	2,350,000 <sup>r</sup>	2,280,000
Of which: <sup>8</sup>					
Mined from laterite ore	1,310,000 <sup>r</sup>	1,500,000 <sup>r</sup>	1,730,000 <sup>r</sup>	1,210,000 <sup>r</sup>	1,160,000
Mined from sulfide ore <sup>9</sup>	570,000 <sup>r</sup>	556,000 <sup>r</sup>	594,000 <sup>r</sup>	607,000 <sup>r</sup>	637,000
Mined from undifferentiated and other <sup>10</sup>	461,000 <sup>r</sup>	508,000 <sup>r</sup>	466,000 <sup>r</sup>	525,000 <sup>r</sup>	485,000

<sup>c</sup>Estimated. <sup>r</sup>Revised. NA Not available. -- Zero.

<sup>1</sup>Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Insofar as possible, this table represents recoverable mine production of nickel. Where actual mine output was not available, data related to a more highly processed form have been used to provide an indication of the magnitude of mine output and this was noted.

<sup>3</sup>In addition to the countries listed, North Korea may have had an active nickel mine, but information was inadequate to make reliable estimates of output.

<sup>4</sup>Beginning in 2014, mine production was as reported by South32 Ltd.

<sup>5</sup>Data for fiscal year ending June 30 of the year stated.

<sup>6</sup>Buildup of ore stockpile.

<sup>7</sup>Nickel content of imported nickel ore and concentrates (Harmonized Tariff Schedule of the United States code 2604) into Australia, China, and Japan from the Philippines.

<sup>8</sup>An effort has been made to characterize a country's mine production by ore type (laterite, sulfide, undifferentiated and other), but the data may include a small amount of production from other deposit types.

<sup>9</sup>Includes Botswana, matte; Canada, concentrate; Russia, sulfide concentrate; South Africa, concentrate; Spain, concentrate; United States, concentrate; Vietnam; Zambia, concentrate; and Zimbabwe, concentrate.

<sup>10</sup>Includes Australia, ore and concentrate; Brazil, ore; China; Finland; Morocco, nickel sulfate; and Norway, concentrate.

TABLE 11  
NICKEL: WORLD PRODUCTION OF INTERMEDIATE PRODUCTS FOR EXPORT, BY COUNTRY<sup>1,2</sup>

(Metric tons of contained nickel)

Country	2011	2012	2013	2014	2015
<b>Matte:</b>					
Australia <sup>3</sup>	56,200	66,294	68,999	61,545	68,400
Botswana	15,675 <sup>r</sup>	17,948	22,848	14,958	16,789
Brazil <sup>4</sup>	13,703	14,345	11,641	-- <sup>r</sup>	--
Canada <sup>5</sup>	69,774 <sup>r</sup>	69,605 <sup>r</sup>	70,670 <sup>r</sup>	71,075 <sup>r</sup>	78,833
Finland	16,088	12,915	8,662	8,363	17,000
Indonesia <sup>6</sup>	67,800 <sup>r</sup>	69,000 <sup>r</sup>	78,800 <sup>r</sup>	78,700 <sup>r</sup>	79,500
New Caledonia	13,780	13,417	13,279	8,241	6,761
Russia	65 <sup>7</sup>	1 <sup>7</sup>	--	--	-- <sup>e</sup>
South Africa	--	--	5,800	7,700 <sup>r</sup>	400
Zimbabwe <sup>8</sup>	3,519	3,787	3,909 <sup>r</sup>	4,830 <sup>r</sup>	3,887
<b>Total, matte</b>	<b>257,000 <sup>r</sup></b>	<b>267,000 <sup>r</sup></b>	<b>285,000 <sup>r</sup></b>	<b>255,000 <sup>r</sup></b>	<b>272,000</b>
<b>Other:</b>					
Cuba: <sup>e,9</sup>					
Nickel-cobalt sulfide	34,816 <sup>10</sup>	34,325 <sup>10</sup>	33,900 <sup>r</sup>	34,000 <sup>r</sup>	34,000
Ammoniacal liquor precipitate and unspecified	2,400	2,300	1,400 <sup>r</sup>	-- <sup>r</sup>	--
<b>Total, Cuba</b>	<b>37,200</b>	<b>36,600</b>	<b>35,300 <sup>r</sup></b>	<b>34,000 <sup>r</sup></b>	<b>34,000</b>
New Caledonia, nickel-cobalt hydroxide <sup>11</sup>	7,374	3,378	7,557	12,464	9,685
Papua New Guinea, nickel-cobalt hydroxide <sup>11</sup>	--	5,283	11,369	20,987	25,582
Philippines	22,794	23,890	26,021	50,647	49,151
<b>Total, other</b>	<b>44,600</b>	<b>45,300</b>	<b>54,200 <sup>r</sup></b>	<b>67,500 <sup>r</sup></b>	<b>69,300</b>
<b>Grand total, matte and other</b>	<b>324,000 <sup>r</sup></b>	<b>336,000 <sup>r</sup></b>	<b>365,000 <sup>r</sup></b>	<b>374,000 <sup>r</sup></b>	<b>390,000</b>

<sup>e</sup>Estimated. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data represent nickel content of matte and other intermediate materials produced that were destined for export.

<sup>2</sup>Estimated data and totals are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Figures exclude toll-refined material.

<sup>4</sup>Represents the output of the Fortaleza smelter. All of the Fortaleza matte was shipped to Finland for further processing.

<sup>5</sup>Nickel content of reported exports. Matte from the smelter at Falconbridge typically assayed 55% nickel.

<sup>6</sup>Represents the nickel output of the Sorowako smelter. The Soroako matte was shipped to Japan for further processing and contains on average 78% nickel.

<sup>7</sup>Primarily exports to China. Sources: International Nickel Study Group (INSG) and United Nations Statistics Division. The average nickel content of the exported matte was estimated to be 25%.

<sup>8</sup>Zimplats matte shipped to the Impala Refinery at Springs, South Africa.

<sup>9</sup>Corrected to remove byproduct cobalt.

<sup>10</sup>Reported figure.

<sup>11</sup>Often called mixed hydroxide product or MHP by industry.



TABLE 12  
NICKEL: WORLD PLANT PRODUCTION, BY COUNTRY<sup>1</sup>

(Metric tons of contained nickel)

Country and product <sup>2</sup>	2011	2012	2013	2014	2015
<b>Australia:</b>					
Metal	97,655	115,796	133,019	130,799	122,000
Unspecified	12,558	12,963	8,500	7,901	10,500
Total	110,213	128,759	141,519	138,700	132,500
<b>Austria, ferronickel and ferronickel molybdenum<sup>c</sup></b>	700	800	800 <sup>r</sup>	1,000	1,200
<b>Brazil:</b>					
Ferronickel	16,750	31,342	34,501	37,237	30,300
Metal	20,521	21,437	19,823	21,000	20,100
Total	37,271	52,779	54,324	58,237	50,400
<b>Burma, ferronickel<sup>3</sup></b>	--	--	1,237 <sup>r</sup>	15,340 <sup>r</sup>	15,588
<b>Canada, unspecified</b>	142,445	146,850 <sup>r</sup>	152,728 <sup>r</sup>	149,486 <sup>r</sup>	146,233
<b>China:<sup>4</sup></b>					
Ferronickel and high-nickel pig iron	248,400	353,200	480,000	470,000	385,000
Metal	175,000	197,000	227,000 <sup>r</sup>	247,000 <sup>r</sup>	232,000
Chemicals and unspecified	8,900	9,000	9,000	21,000	19,000
Total	432,000	559,000	716,000 <sup>r</sup>	738,000 <sup>r</sup>	636,000
<b>Colombia, ferronickel</b>	37,817	51,595	49,320	41,221 <sup>r</sup>	36,671
<b>Cuba, oxide sinter and oxides</b>	19,186	25,702	15,279	13,000 <sup>r,c</sup>	13,000 <sup>c</sup>
<b>Dominican Republic, ferronickel</b>	13,528	15,186	9,400	--	--
<b>Finland:</b>					
Metal, electrolytic, including cathode and briquets	43,840	40,131	39,500 <sup>r</sup>	36,500 <sup>r</sup>	37,000
Chemicals and unspecified, including powder, salts, solutions, and other	5,983	6,144	4,700 <sup>r</sup>	6,100 <sup>r,c</sup>	7,365
Total	49,823	46,275	44,200 <sup>r</sup>	42,600 <sup>r,c</sup>	44,365
<b>France:<sup>5</sup></b>					
Metal	11,697	11,311	10,300 <sup>c</sup>	7,141	5,500 <sup>c</sup>
Chemicals	2,039	1,927	1,821	1,263	990 <sup>c</sup>
Total	13,736	13,238	12,100 <sup>c</sup>	8,404	6,490 <sup>c</sup>
<b>Greece, ferronickel</b>	18,527	18,632	16,890	18,481	17,114
<b>Guatemala, ferronickel</b>	--	--	--	5,000	10,826
<b>India, ferronickel magnesium<sup>6</sup></b>	107	114	200	200 <sup>c</sup>	200 <sup>c</sup>
<b>Indonesia, ferronickel</b>	19,690	18,373	18,249	16,851	17,211
<b>Japan:</b>					
Ferronickel	62,773	73,248	80,554	70,070	74,224
Metal	41,290	41,944	46,405	56,129	64,221
Oxide sinter	50,437	51,999	48,873	45,907	48,197
Chemicals	2,383	2,362	2,191	5,673	6,147
Total	156,883	169,553	178,023	177,779	192,789
<b>Korea, Republic of:</b>					
Ferronickel	19,011	20,858	25,376	22,799	39,000
Metal	(7)	(7)	(7)	(7)	(7)
Total	19,011	20,858	25,376	22,799	39,000
<b>Kosovo, ferronickel</b>	7,728	4,436 <sup>r</sup>	7,606 <sup>r</sup>	6,724 <sup>r</sup>	7,418
<b>Macedonia, ferronickel</b>	17,292	19,247	20,001	18,054	17,699
<b>Madagascar, metal</b>	--	5,695	25,148	37,053	47,271
<b>Morocco, chemicals, including nickel sulfate</b>	(8)	(8)	(8)	(8)	(8)
<b>New Caledonia:</b>					
Ferronickel	40,015	43,030	40,459	54,863	56,486
Nickel oxide sinter	--	2,353	7,911	7,366	21,044
Total	40,015	45,383	48,370	62,229	77,530
<b>Norway, metal</b>	92,427	91,687	91,017	90,500	91,200
<b>Russia:<sup>c</sup></b>					
Ferronickel:					
High-nickel	16,899 <sup>9</sup>	9,782 <sup>9</sup>	--	--	--
Other <sup>10</sup>	5,360	3,110	--	--	--
Total, ferronickel	22,300	12,900	--	--	--
Metal	264,900 <sup>9</sup>	255,000 <sup>9</sup>	241,800 <sup>9</sup>	231,000	223,000
Chemicals	2,900	2,700 <sup>r</sup>	2,700 <sup>r</sup>	2,700	2,900
Total, Russia	290,000	271,000	245,000 <sup>r</sup>	234,000	226,000

See footnotes at end of table.

TABLE 12—Continued  
NICKEL: WORLD PLANT PRODUCTION, BY COUNTRY<sup>1</sup>

(Metric tons of contained nickel)

Country and product <sup>2</sup>	2011	2012	2013	2014	2015
South Africa:					
Ferronickel, high-nickel	575	658	650 <sup>c</sup>	NA	NA
Metal	35,900	32,900	33,200 <sup>r</sup>	34,100 <sup>r</sup>	42,000
Chemicals	5,564 <sup>11</sup>	5,093 <sup>11</sup>	5,100 <sup>c</sup>	3,500 <sup>r,c</sup>	5,400
Total	42,039	38,651	39,000 <sup>r,c</sup>	37,600 <sup>r,c</sup>	47,400
Taiwan, metal <sup>c</sup>	(7)	(7)	(7)	(7)	(7)
Ukraine, ferronickel <sup>12</sup>	14,640	20,628	21,184	18,615	15,516
United Kingdom, metal <sup>13</sup>	37,400	34,300	42,400	39,100	39,100 <sup>c</sup>
Venezuela, ferronickel <sup>c</sup>	13,300	8,100	--	4,000	4,000
Zimbabwe, metal, toll refined from imported nickel feed <sup>14</sup>	3,715	1,754	2,845	2,915 <sup>r</sup>	617
Grand total	1,630,000	1,810,000 <sup>r</sup>	1,980,000	2,000,000 <sup>r</sup>	1,930,000
Of which:					
Ferronickel, including ferronickel magnesium, ferronickel molybdenum, and high-nickel pig iron	553,000	692,000 <sup>r</sup>	806,000 <sup>r</sup>	800,000 <sup>r</sup>	728,000
Metal	824,000 <sup>r</sup>	849,000 <sup>r</sup>	912,000 <sup>r</sup>	933,000 <sup>r</sup>	924,000
Oxide sinter	69,600	80,100 <sup>r</sup>	72,100 <sup>r</sup>	66,300 <sup>r</sup>	82,200
Chemicals, including nickel sulfate	12,900	12,100 <sup>r</sup>	11,800 <sup>r</sup>	13,100 <sup>r</sup>	15,400
Unspecified	170,000	175,000 <sup>r</sup>	175,000 <sup>r</sup>	184,000 <sup>r</sup>	183,000

<sup>c</sup>Estimated. <sup>r</sup>Revised. NA Not available. -- Zero.

<sup>1</sup>Grand totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Several countries produced nickel-containing matte and other intermediate nickel products, but output of nickel in such materials has been excluded from this table to avoid double counting. Countries that produced matte for export are listed in table 11.

In addition to the countries listed, North Korea may have had an active mine and was thought to have produced metallic nickel and (or) ferronickel, but information was inadequate to make reliable estimates of output.

<sup>3</sup>Imports to other countries of ferronickel from Burma, assumed 26% nickel content.

<sup>4</sup>Figures for ferronickel and chemicals were derived from data published by Beijing Antaike Information Development Co. Ltd. Figures for electrolytic and other class I nickel are based on data provided by the China Nonferrous Metals Industry Association and the International Nickel Study Group. China also produced nickeliferous pig iron from lateritic ores imported from Indonesia, New Caledonia, and the Philippines.

<sup>5</sup>Reported by ERAMET Group for the Sandouville plant. Includes a small amount of cobalt that was not recovered separately. Does not include secondary production from spent rechargeable batteries.

<sup>6</sup>India's fiscal year ending March 31 of the year stated.

<sup>7</sup>Utility<sup>8</sup> Nickel production figures for the Republic of Korea and Taiwan were not included because the production was derived wholly from imported metallurgical-grade oxides and to include them would result in double counting.

<sup>8</sup>Most of the nickel sulfate was a byproduct of the concentrating, smelting, and refining of domestically mined copper ores. Some production, however, may have been derived from imported nickeliferous raw materials that were blended with the domestic copper concentrates.

<sup>9</sup>Reported figure.

<sup>10</sup>Includes ferronickel chromium and nickel-resist cast iron.

<sup>11</sup>Includes nickel sulfate plus exported metal in concentrate.

<sup>12</sup>May include nickel in remelt alloys derived from scrap.

<sup>13</sup>Includes nickel contents of chemicals.

<sup>14</sup>Data represent production from matte imported from Botswana and nickel sulfate imported from South Africa.