COBALT

(Data in metric tons of cobalt content unless otherwise noted)

Domestic Production and Use: In 2016, a nickel-copper mine in Michigan produced cobalt-bearing nickel concentrate. Most U.S. cobalt supply comprised imports and secondary (scrap) materials. Six companies were known to produce cobalt chemicals. About 45% of the cobalt consumed in the United States was used in superalloys, mainly in aircraft gas turbine engines; 8% in cemented carbides for cutting and wear-resistant applications; 16% in various other metallic applications; and 31% in a variety of chemical applications. The total estimated value of cobalt consumed in 2016 was $250 million.


Production:
Mine* — — 120 760 690
Secondary 2,160 2,160 2,200 2,750 2,700
Imports for consumption 11,100 10,400 11,300 11,400 11,900
Exports 3,760 3,850 4,500 3,830 4,200
Shipments from Government stockpile excesses 1 — — — — —

Consumption:
Reported (includes secondary) 8,660 8,090 8,560 8,780 8,900
Apparent* (includes secondary) 9,540 8,650 8,710 10,300 10,400

Price, average, dollars per pound:
U.S. spot, cathode 3 14.07 12.89 14.48 13.44 11.90
London Metal Exchange (LME), cash 13.06 12.26 14.00 12.90 11.50

Stocks, yearend:
Industry 980 1,080 1,420 1,330 1,300
LME, U.S. warehouse 51 41 9 165 195

Net import reliance* as a percentage of apparent consumption 77 75 75 73 74

Recycling: In 2016, cobalt contained in purchased scrap represented an estimated 30% of cobalt reported consumption.

Import Sources (2012–15): Cobalt contained in metal, oxide, and salts: China, 18%; Norway, 14%; Finland, 10%; Japan, 9%; and other, 49%.

Tariff: Item Number Normal Trade Relations 5

Cobalt ores and concentrates 2605.00.0000 Free.
Chemical compounds:
Cobalt oxides and hydroxides 2822.00.0000 0.1% ad val.
Cobalt chlorides 2827.39.6000 4.2% ad val.
Cobalt sulfates 2833.29.1000 1.4% ad val.
Cobalt carbonates 2836.99.1000 4.2% ad val.
Cobalt acetates 2915.29.3000 4.2% ad val.
Unwrought cobalt, alloys 8105.20.3000 4.4% ad val.
Unwrought cobalt, other 8105.20.6000 Free.
Cobalt mattes and other intermediate products; cobalt powders 8105.20.9000 Free.
Cobalt waste and scrap 8105.30.0000 Free.
Wrought cobalt and cobalt articles 8105.90.0000 3.7% ad val.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile:

Stockpile Status—9–30–16

<table>
<thead>
<tr>
<th>Material</th>
<th>Inventory</th>
<th>Disposal Plan FY 2016</th>
<th>Disposals FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cobalt</td>
<td>301</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithium cobalt oxide</td>
<td>0.145</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithium nickel cobalt aluminum oxide</td>
<td>0.089</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared by Kim B. Shedd [(703) 648–4974, kshed@usgs.gov]
COBALT

**Events, Trends, and Issues:** Congo (Kinshasa) continued to be the world’s leading source of mined cobalt, supplying more than one-half of world cobalt mine production. With the exception of production in Morocco and artisanally mined cobalt in Congo (Kinshasa), most cobalt is mined as a byproduct of copper or nickel. In 2016, global cobalt mine production decreased, mainly owing to lower production from nickel operations. Growth in world refined cobalt supply was forecast to increase at a lower rate than that of world cobalt consumption, which was driven mainly by strong growth in the rechargeable battery and aerospace industries. As a result, the global cobalt market was expected to shift from surplus to deficit. China was the world’s leading producer of refined cobalt and the leading supplier of cobalt imports to the United States. Much of China’s production was from ore and partially refined cobalt imported from Congo (Kinshasa); scrap and stocks of cobalt materials also contributed to China’s supply. In 2015 and 2016, China’s State Reserve Bureau purchased cobalt for its stockpile. China was the world’s leading consumer of cobalt, with nearly 80% of its consumption being used by the rechargeable battery industry.

**World Mine Production and Reserves:** Reserves for Australia, Canada, New Caledonia, the Philippines, South Africa, the United States, and “Other countries” were revised based on company or Government reports.

<table>
<thead>
<tr>
<th>Mine production</th>
<th>Reserves7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015</td>
</tr>
<tr>
<td>United States</td>
<td>6,760</td>
</tr>
<tr>
<td>Australia</td>
<td>6,000</td>
</tr>
<tr>
<td>Canada</td>
<td>6,900</td>
</tr>
<tr>
<td>China</td>
<td>7,700</td>
</tr>
<tr>
<td>Congo (Kinshasa)</td>
<td>63,000</td>
</tr>
<tr>
<td>Cuba</td>
<td>4,300</td>
</tr>
<tr>
<td>Madagascar</td>
<td>3,700</td>
</tr>
<tr>
<td>New Caledonia9</td>
<td>3,680</td>
</tr>
<tr>
<td>Philippines</td>
<td>4,300</td>
</tr>
<tr>
<td>Russia</td>
<td>6,200</td>
</tr>
<tr>
<td>South Africa</td>
<td>3,000</td>
</tr>
<tr>
<td>Zambia</td>
<td>4,600</td>
</tr>
<tr>
<td>Other countries</td>
<td>11,600</td>
</tr>
<tr>
<td>World total (rounded)</td>
<td>126,000</td>
</tr>
</tbody>
</table>

**World Resources:** Identified cobalt resources of the United States are estimated to be about 1 million tons. Most of these resources are in Minnesota, but other important occurrences are in Alaska, California, Idaho, Michigan, Missouri, Montana, Oregon, and Pennsylvania. With the exception of resources in Idaho and Missouri, any future cobalt production from these deposits would be as a byproduct of another metal. Identified world terrestrial cobalt resources are about 25 million tons. The vast majority of these resources are in sediment-hosted stratiform copper deposits in Congo (Kinshasa) and Zambia; nickel-bearing laterite deposits in Australia and nearby island countries and Cuba; and magmatic nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada, Russia, and the United States. More than 120 million tons of cobalt resources have been identified in manganese nodules and crusts on the floor of the Atlantic, Indian, and Pacific Oceans.

**Substitutes:** In some applications, substitution for cobalt would result in a loss in product performance. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron, or nickel-iron alloys in magnets; cerium, iron, lead, manganese, or vanadium in paints; cobalt-iron-copper or iron-copper in diamond tools; copper-iron-manganese for curing unsaturated polyester resins; iron, iron-cobalt-nickel, nickel, cermets, or ceramics in cutting and wear-resistant materials; iron-phosphorous, manganese, nickel-cobalt-aluminum, or nickel-cobalt-manganese in lithium-ion batteries; nickel-based alloys or ceramics in jet engines; nickel in petroleum catalysts; and rhodium in hydroformylation catalysts.

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5Estimated. — Zero.
7The sum of U.S. net import reliance and secondary production, as estimated from consumption of purchased scrap.
8As reported by Platts Metals Week.
9Defined as imports – exports + adjustments for Government and industry stock changes for refined cobalt.
+Tariffs for certain countries and items may be eliminated under special trade agreements.
See Appendix B for definitions.
See Appendix C for resource and reserve definitions and information concerning data sources.
For Australia, Joint Ore Reserves Committee-compliant reserves were about 480,000 tons.
Overseas territory of France. One company reported zero reserves owing to recent nickel prices, although it continued to produce from that deposit.