



# 2010 Minerals Yearbook

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BOLIVIA [ADVANCE RELEASE]

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# THE MINERAL INDUSTRY OF BOLIVIA

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Bolivia's primary role in the global mineral industry was as a supplier of minerals in raw form (ores and concentrates). The country was estimated to have produced about 8% of the world's total mine output of tin in 2010; that of silver, about 6%; antimony, about 4%; boron and zinc, about 3% each; lead and tungsten, about 2% each; and bismuth, about 1%. Bolivia was the leading exporter (by way of pipelines to Argentina and Brazil) and one of two third-ranked producers (tied with Brazil) of natural gas in South America. Bolivia's mineral resources have not been fully explored or developed, so there are substantial uncertainties concerning the country's mineral resources. In addition to the minerals listed above, Bolivia is believed to have globally relevant resources of cadmium, chromium, gold, indium, iron ore, lithium, nickel, palladium, platinum, potash, and tantalum. In 2010, more than 70% of Bolivia's mine output of tin, as well as substantial proportions of the country's mined copper, gold, and silver; some antimony; and small amounts of a few other mined minerals were estimated to have been smelted or refined within the country. Most of the volume of Bolivia's mineral production, however, was exported in raw form by rail to ports on the coasts of Argentina, Brazil, Chile, and (or) Peru and then shipped to processing facilities located in Asia, Europe, and North America, including approximately all the country's mine output of bismuth, tantalum, tungsten, and zinc (including any contained indium and other byproduct minerals). In addition, about 80% of Bolivia's marketable production of natural gas appears to have been exported (table 1; Arce-Burgoa and Goldfarb, 2009; Angulo, 2011; BP p.l.c., 2011b, p. 22, 28; Brooks, 2011; Carlin, 2011a–c; Guberman, 2011; Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 11, 17, 19–20, 34–37; Shedd, 2011; Tolcin, 2011).

## Minerals in the National Economy

According to preliminary estimates for 2010 and revised estimates for 2009, the value of output of the mineral extraction sector (mining and quarrying plus production of crude petroleum and natural gas) of Bolivia accounted for 14% (\$2.78 billion<sup>1</sup>) of the country's gross domestic product (GDP) in 2010 compared with 13% (\$2.26 billion) in 2009. The mining and quarrying sector accounted for 8.86% (about \$1.76 billion) of the GDP, and the oil and gas sector accounted for 5.16% (\$1.02 billion) in 2010 compared with 7.94% (about \$1.39 billion) and 5.02% (\$0.88 billion), respectively, in 2009. In 2010, mined zinc led all the nonfuel minerals in Bolivia in terms of both the tonnage and the value of production. Preliminary data indicated that the value of the country's

production of mined zinc was \$887 million followed by that of silver (\$815 million), tin (\$414 million), gold (\$252 million), and lead (\$156 million). Ulexite (a boron mineral) led all the industrial minerals in Bolivia (not including manufactured products, such as cement) in terms of both the tonnage and the value of production. In terms of the value of production, the country's top three industrial minerals were ulexite (valued at about \$16 million), boric acid (\$6.5 million), and amethyst (\$1.1 million) (International Monetary Fund, 2011; Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 1; Instituto Nacional de Estadística, Bolivia, undated a).

The hydrocarbons sector was the leading source of tax revenue for the Government. In constant 1990 prices, the real value of Bolivia's production of crude petroleum and natural gas increased by 14% in 2010 compared with that of 2009 after decreasing by 13.5% in 2009 compared with that of 2008. Of the sectors that contributed to the estimated 4% growth in the real GDP in 2010, the oil and gas sector ranked second only to the transportation and storage (warehousing) sector. On the other hand, the real value of the country's total production of metallic and industrial minerals decreased by 4% in 2010 after increasing by 10% in 2009 (Amcham Bolivia, undated; Instituto Nacional de Estadística, Bolivia, undated a).

In 2009 (the latest year for which data were available), the total labor force employed in mining was estimated to be about 65,100. Of these workers, an estimated 51,900 were officially registered with a cooperative, 5,550 were estimated to be employed by medium-scale mining companies (private or joint ventures with state-owned Corporación Minera de Bolivia [COMIBOL]), and at least 2,450 small-scale and artisanal miners were estimated to be working (Ministerio de Minería y Metalurgia, Bolivia, 2010e, p. 59).

Preliminary data from the Banco Central de Bolivia (BCB) indicate that the flow of foreign direct investment (FDI) into the exploration for and production of crude petroleum and natural gas decreased to \$310 million in 2010 compared with about \$325 million in 2009, and the flow of FDI into the mining and quarrying sector increased to \$220 million compared with about \$92 million in 2009. In 2010, the inflow of FDI into the oil and gas sector accounted for about 34% of the total flow of FDI into Bolivia, and the inflow of FDI into the mining and quarrying sector accounted for about 24%. In 2010, the leading sources of FDI into the Bolivian economy were (in order of decreasing inflows of FDI) Spain, Sweden, and France compared with the United States, Spain, and Brazil, respectively, in 2009 (Banco Central de Bolivia, 2011b, p. 26–28).

For Bolivia, the value of trade in minerals may include the value of some transportation and (or) pipeline services. A possible estimate of the mineral trade balance (not including imports of many chemical and pharmaceutical substances, construction materials, or primary materials for agriculture that may have been heavily or exclusively mineral based)

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<sup>1</sup>Where necessary, nominal values have been converted from Bolivian bolivianos (Bs) to U.S. dollars (US\$) at an annual average exchange rate of Bs6.97=US\$1.00 for 2009 and an estimated Bs6.96=US\$1.00 for 2010. All values are nominal, at current prices, unless otherwise stated.

increased to \$4.24 billion in 2010 compared with a revised balance of about \$3.04 billion in 2009. The leading mineral export of Bolivia (by value) was natural gas, and the value of natural gas exports increased to \$2.8 billion compared with about \$2 billion in 2009. The country's leading mineral import expenditures were for fuel oils and lubricants, and the cost of its imports in this category increased to \$615 million compared with \$470 million in 2009. Zinc in concentrates remained the leading nonfuel mineral export in 2010, and the value of exports of zinc increased to \$887 million compared with \$690 million in 2009. Production and exports of silver were of increasing economic importance, and the value of the country's exports of silver (mostly contained in concentrates) was reported to be \$797 million compared with about \$610 million in 2009. The leading nonfuel mineral import category (by far) was "imports of mineral raw materials and products for industrial use," and the cost of these imports increased to \$504 million compared with about \$410 million in 2009 (Banco Central de Bolivia, 2011b, p. 8–10; 41–42, 68; Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 12, 17).

### Government Policies and Programs

On January 25, 2009, Bolivians approved a new Constitution, which was enacted on February 7. The new Constitution contains provisions that could allow the Government to exercise greater control over the management of Bolivia's natural resources, including exploration, production, processing, transportation, and marketing of minerals, but how the principles of the Constitution are implemented and the timing of implementation appear to depend upon the drafting and passing of subsequent regulations by the Government. During all of 2010, the Government continued to work out a first draft of a new mining law to replace the Mining Code of 1997 (law No. 1777 of March 17, 1997), and the draft was completed in January 2011. The new draft mining law was expected to continue to be debated and revised throughout 2011 (Ministerio de Minería y Metalurgia, Bolivia, 2010a; 2010e, p. 25, 37–39, 64–65, 67, 75–78, 93, 114–116, 124; 2011b, p. 7, 2011c, p. 18, 122, 139–143).

In mid-2010, it appeared likely that mining companies operating mineral concessions in the country would have to change over to a new mining contract system by the end of the year, in accordance with the principles of the new Constitution and the expected provisions of the new mining law (despite the new mining law still being preliminary). These new contracts could be either leasing or joint-venture contracts with the Government, depending on the level of state participation. Some companies (such as Coeur d'Alene Mines Corp. of Idaho) already appeared to have similar types of contracts with the Government, regional governments, and (or) local cooperatives. The Government had still not determined which Federal agency or other institution would oversee the contracts. With the issuing of Supreme Decree No. 0726 on December 6, 2010, the Government reaffirmed that there would be a transition period (of indeterminate length) to move from the existing mining concessions structure towards public-private contracts that would be consistent with the Constitution and the draft

mining law. The negotiation of such contracts between at least a few of the most significant mining companies in Bolivia (including Glencore International AG of Switzerland) and the Government appeared to be ongoing through the end of the year (Beltrán, 2010c; Ministerio de Minería y Metalurgia, Bolivia, 2010a, b; Coeur d'Alene Mines Corp., 2011, p. 6, 18; Glencore International AG, 2011, p. 72).

Effective on May 2, 2010, the Government announced that it had nationalized the Vinto antimony plant (operated by Compañía Minera Colquiri S.A., which was a subsidiary of Glencore), and that the plant would be operated by state-owned Empresa Metalúrgica Vinto (EMV). At the time of nationalization, the antimony plant apparently was not operating. The Government planned to rehabilitate and reactivate the plant, but information concerning a definitive timeline for restarting production there was not available. Reportedly, law No. 32 of August 6, 2010, allocated necessary land for Jindal Steel & Power Ltd. (Jindal) of India to construct a direct-reduced iron plant, an iron ore pelletization plant, and a steel plant near the one-half of the El Mutun iron ore deposit that was being developed by the company (Jindal Steel & Power Ltd., 2010; Kosich, 2010a, b; Ministerio de Minería y Metalurgia, Bolivia, 2010c, d; Ore, 2010).

During all of 2010, the main mining law was still the Mining Code of 1997. In 2007, this mining code was modified to allow for restructured royalties (mining-specific taxes) and other taxes to be charged to mining companies. The 2007 law (law No. 3787 of November 24, 2007) included measures that (1) require companies to pay an additional income tax of 12.5% if the prices of the minerals produced exceed certain thresholds (specific to each mineral), and (2) restructure both the royalty rates and the percentages of redistributions (to local, State, or Federal entities) of Government royalty and tax revenue from private mining companies in the country. In 2010, the Government's combined revenues from mining royalties and other taxes on mining companies were estimated to have increased to about \$290 million compared with about \$105 million in 2009 and about \$150 million in 2008. The increase in Government revenue from the mining sector in 2010 was mostly owing to an increase in royalties to about \$120 million compared with about \$83 million in 2009. During 2010, it appeared that the main law governing private investment (including FDI) was still law No. 1182 of September 17, 1990, even though some provisions of this investment law may conflict with related provisions in the new Constitution. The main environmental law was still law No. 1333 of March 27, 1992 (Ministerio de Minería y Metalurgia, Bolivia, 2007; 2010e, p. 57, 95; 2011a, p. 52, 58; 2011b, p. 39; 2011c, p. 135; U.S. Commercial Service, 2010, p. 3, 8, 15, 28–35).

During 2010, the Hydrocarbons Law of 2005 (law No. 3058 of May 17, 2005) was still in effect. On May 2, 2007, operations contracts came into effect for private oil and gas companies in accordance with the terms of the Government's program to nationalize the sector. These operations contracts were approved as part of the Hydrocarbons Law of 2005, which also allowed for two other new types of contracts between private companies and the state—production-sharing contracts and association

contracts. Under all three types of contracts, oil and gas reserves and any production belongs to the state, and the contractor (private company) must deliver the full amount of production to the state-owned oil and gas company, Yacimientos Petrolíferos Fiscales Bolivianos (YPFB). These contracts were designed to replace risk-sharing contracts, which existed under the previous Hydrocarbons Law of 1996 (law No. 2689 of April 30, 1996). In effect, the contractors bore all of the risks and costs for the exploration and production of hydrocarbons under the risk-sharing contracts but were allowed to claim ownership of production and sell it on the open market, subject only to paying royalties and taxes. On May 1, 2006, the President issued Supreme Decree No. 28701 to nationalize the hydrocarbon resources of Bolivia. Following this decree, the Government negotiated operations contracts with existing private producers of oil and natural gas in the country, and the contracts were approved by the Government on April 23, 2007. These contracts still require the private contractors to bear the risks and costs of production. In addition, however, the private companies cannot claim ownership of oil and gas reserves in the country and must rely on reimbursement by the Government to cover any recoverable costs and (or) be compensated for any profits they might earn (Vargas, 2007; U.S. Commercial Service, 2010, p. 3, 13–14, 29–35).

## Production

Data on mineral production are in table 1. In 2009, production of most mineral fuels, most industrial minerals, and some metallic minerals (such as antimony, gold, and tungsten) decreased significantly compared with production in 2008. In 2010, production of mined lead, silver, and zinc decreased after actually increasing in 2009, possibly owing to protests that could have affected production at the San Bartolomé Mine, the San Cristóbal Mine, and other mines in the Potosí region. Production of mined antimony and tungsten increased by 67% and 18%, respectively, in response to an increase in global demand and prices for these metals. Bolivia's production of gold continued to decrease, however, mostly owing to decreased production at the Don Mario Mine, where gold production was in transition from the depleted lower-mineralized zone to the upper-mineralized zone during all of 2010. Bolivia's mine output of tin continued to increase (by 3%), and the increase was mostly owing to increased production by small-scale and cooperative mining operations in the country; the increase in tin production was slight compared with the 13% increase in 2009, which was primarily owing to increased production at the state-owned parts of the Huanuni Mine (table 1; Asociación Nacional de Mineros Medianos, 2010, p. 96–97; Ministerio de Minería y Metalurgia, Bolivia, 2010e, p. 52, 85–90; 2011a, p. 1; 2011b, p. 10, 27–33; 2011c, p. 39; Orvana Minerals Corp., 2010, p. 8; Quiroga, 2010; Sumitomo Corp., 2010b).

In 2010, none of the indium that was estimated to have been contained in some of the metallic ores and concentrates (possibly including those of silver, tin, or zinc) produced in Bolivia was reported to have been recovered domestically, so any indium content was instead recovered in the countries that imported these indium-bearing metallic mineral raw materials

from Bolivia. Estimates of the volume of indium contained in the mine output of Bolivia are included in table 1 as a result of new information on the indium content of mine output produced in the country (particularly of zinc concentrates). In 2010, mine output of indium in Bolivia was estimated to have increased by about 18% mostly owing to an increase in production of zinc in concentrates at the San Vicente Mine, although the owner of the mine (Pan American Silver Corp. of Canada) did not report any indium byproduct credits for exports of these concentrates. Reliable information was not available regarding the destination(s) for refining of any concentrates produced at the San Vicente Mine, or whether any indium was recovered during further processing of these concentrates (Ishihara, Murakami, and Marquez-Zavalia, 2011; Pan American Silver Corp., 2011, p. 36).

Production of antimony metal (including antimony trioxide) reportedly decreased by 82%. Based on export data, reported production for 2010 appears not to include production of antimony trioxide (if any), whereas that for 2009 and earlier years does. Production of silver metal was estimated to have increased by about 580%. More reliable information concerning either the estimated production in 2009 (based on export data) or the reason for such a dramatic increase was not available, but it could be that silver mined at the San Bartolomé Mine and further processed within Bolivia to produce silver metal or refined silver was accurately reported for the first time in 2010. Information concerning the causes of some of the other large year-to-year percentage changes in many of the data series for metals in table 1 was not available. Many of these changes are large in percentage terms but do not involve globally or even regionally significant volumes of production because of the still small level of production of these (minor) metals in the country (table 1; Asociación Nacional de Mineros Medianos, 2010, p. 98; Ministerio de Minería y Metalurgia, Bolivia, 2010b, p. 47–48, 87–88; 2010c, d; 2011a, p. 11, 20; Coeur d'Alene Mines Corp., 2011, p. 22–23).

Since about 2003 and through 2010, Bolivia's construction sector increased its annual sales, and domestic demand for minerals and mineral materials used in construction presumably also increased. The country's production of cement increased accordingly, but production of gypsum increased dramatically in 2007 only to decrease almost as dramatically in 2009 and to below even the 2006 level in 2010. These relatively abrupt changes in gypsum output could be because cement is a manufactured product that can be produced with imported clinker and other imported raw materials, whereas Bolivia's production of mined gypsum is constrained by the available gypsum mine capacity within the country. Boron was the only industrial mineral for which Bolivia accounted for greater than 1% of the world's production, and production of ulexite (a mined boron mineral) and boric acid each increased by about 14% compared with their volumes of production in 2009. Most of (and possibly all) the ulexite was produced in the salars of the country, including the Salar de Uyuni, but further information concerning the production of ulexite or other boron materials (or rock salt, or any other mineral that might be produced from the salars) in Bolivia was not available (table 1; Asociación Nacional de Mineros Medianos, 2010, p. 82–83, 94–97;



Ministerio de Minería y Metalurgia, Bolivia, 2010e, p. 38–39, 80–83, 122; 2011a, p. 1; 2011c, p. 22–24; Amcham Bolivia, undated; Instituto Boliviano del Cemento y el Hormigón, undated).

Production of the gemstone ametrine reportedly increased by greater than 6,000%, but this is from a historically small amount of production reported in 2009. It appears that the reported figures for the production of gemstones are based on export control data, and the data for any given year could reflect production that actually took place the previous year but was not reported by the export-control authorities until the current year, or could include production that actually took place 2 or more years before the current year if the gemstones were exported (illegally) and this was not discovered or accounted for until the current year. More reliable information concerning Bolivia's gemstone production was unavailable (table 1; Asociación Nacional de Mineros Medianos, 2010, p. 94–97; Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 1).

Marketable production of natural gas is estimated to have increased by about 17% compared with that of 2009, and this increase appeared to be owing primarily to a supply response to increased demand for imports of natural gas by Brazil. Preliminary figures indicate that the total volume of Bolivia's natural gas exports to Brazil increased by 21.1% compared with that of 2009, and those to Argentina increased by 7.65%. Production of crude petroleum did not increase by nearly the same percentage as production of natural gas, but the 19% increase in the production of natural gas liquids helped make up for the only slight (about 2.3%) increase in crude oil production (BP p.l.c., 2010b, p. 30; 2011b, p. 22, 28; U.S. Energy Information Administration, 2011; Instituto Nacional de Estadística, Bolivia, undated b).

### Structure of the Mineral Industry

Table 2 is a listing of the major mineral industry facilities, together with the major owners and (or) operators. The vast majority of the mining workforce in Bolivia consists of miners working for small-scale mining operations or cooperatives, and these small-scale operations often manage to combine to produce more of many minerals than the few medium-scale mines. In 2010, small-scale and cooperative miners accounted for 100% of mined bismuth, industrial minerals, and tungsten production and about 68% of antimony, 62% of gold, about 42% of tin, about 30% of copper, 27% of silver, about 23% of zinc, and about 14% of lead; medium-scale mining operations accounted for the remainder of mined metal production in Bolivia, except for copper and tin. State-owned mining companies accounted for 48% of mined tin production and about 43% of mined copper production (Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 1).

With respect to medium-scale mining in the country in 2010, Empresa Minera San Cristóbal S.A. was the leading privately owned mining company (in terms of the value and volume of mined minerals produced), and it was the leading producer of mined lead, silver, and zinc in Bolivia. The company's production was from the San Cristobal Mine, which the company's owner (Sumitomo Corp. of Japan) claimed was

the third ranked producer of mined silver and the sixth ranked producer of mined zinc in the world in 2009. The second ranked producer of mined zinc in Bolivia was Sinchi Wayra (a subsidiary of Glencore), and the second ranked producer of mined silver was Empresa Minera Manquiri S.A. (a 100% subsidiary of Coeur d'Alene Mines) (table 2; Sumitomo Corp., 2009; 2010a, p. 3, 39; Asociación Nacional de Mineros Medianos, 2010, p. 72–75; Ministerio de Minería y Metalurgia, Bolivia, 2010e, p. 46–51; Coeur d'Alene Mines Corp., 2011, p. 2, 22; Glencore International AG, undated).

On March 26, 2008, the Government issued Supreme Decree No. 29486, which set a deadline of April 30, 2008, for the transfer of ownership shares in various oil and gas companies operating in Bolivia to YPFB, such that YPFB would own at least 50% plus one of the voting shares in these companies (as stipulated in Supreme Decree No. 28701 of May 1, 2006). On January 23, 2009, the Government issued Supreme Decree No. 29888 to nationalize all shares of Pan American Energy (PAE) (60% owned by BP p.l.c. of the United Kingdom and 40% owned by BRIDAS Corp. of Argentina) in Empresa Petrolera Chaco S.A., to change the name of Empresa Petrolera Chaco S.A. to YPFB Chaco S.A., and to have this new subsidiary of state-owned YPFB assume full control of all operations. On April 12, 2010, PAE registered arbitration proceedings against the Government with the International Centre for Settlement of Investment Disputes, to try and obtain what PAE considered to be adequate compensation for the nationalization of Empresa Petrolera Chaco. Information concerning the final resolution of this arbitration was not available. In BP's 2010 annual report, the company mentions that the nationalization of Chaco took place in 2009 (with compensation payable), so table 2 has been updated to reflect Chaco's new company name and ownership structure (BP p.l.c., 2010a, p. 23–24, 26; 2011a, p. 44, 52–54, 163, 221; Diaz, 2010; Ore and García, 2010).

### Mineral Trade

In 2010, Bolivia exported about 9.82 billion cubic meters of natural gas to Brazil and 1.83 billion cubic meters of natural gas to Argentina compared with about 8.11 billion cubic meters and 1.7 billion cubic meters, respectively, in 2009. In decreasing order of export value in 2010, the country's top six nonfuel mineral exports were zinc in concentrates, silver (in concentrates and metal), tin (in concentrates and metal), lead in concentrates, gold (in concentrates and dore), and antimony (in antimony trioxide, concentrates, and metal); by far the leading industrial mineral exports were ulexite and boric acid, respectively (in terms of export value). In tonnage, exports of tin increased to about 17,900 metric tons (t) compared with 17,609 t in 2009; ulexite, to about 97,303 t compared with 85,530 t in 2009; boric acid, to 12,619 t compared with 11,114 t in 2009; and antimony, to about 4,980 t compared with about 2,990 t in 2009. Exports of zinc decreased to 410,322 t compared with about 428,959 t in 2009; lead, to 73,291 t compared with a revised quantity of 84,880 t in 2009; silver, to 1,272 t compared with 1,324 t in 2009; and gold, to about 2,400 kilograms (kg) compared with about 3,700 kg in 2009 (BP p.l.c., 2010b, p. 30; 2011b, p. 28;

Banco Central de Bolivia, 2011a, p. 32–34; Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 12, 17, 19).

In decreasing order of export value in 2010, the leading country destinations for Bolivia's combined nonfuel mineral exports were Japan, Belgium, and the Republic of Korea. Country-specific information on Bolivia's nonfuel mineral exports by commodity was not available, but the country exported about 235,000 t of zinc in concentrates (including any indium that could have also been contained in those concentrates) to Asia, 136,000 t to Europe, and about 38,800 t to other countries in the Americas. The leading regional destinations for Bolivia's exports of silver were the Americas (472 t), Asia (about 466 t), and Europe (about 273 t); the leading regional destinations for exports of tin were the Americas (about 10,500 t), Asia (about 5,250 t), and Europe (2,170 t) (Banco Central de Bolivia, 2011a, p. 36, 40; Ministerio de Minería y Metalurgia, Bolivia, 2011a, p. 31–36).

## Commodity Review

### Metals

**Antimony.**—EMV planned to work on rehabilitating the Vinto antimony plant during the second half of 2010, and the state-owned metallurgical company also planned to encourage exploration efforts to increase antimony reserves and feed for the plant. In December, EMV appeared to be in the process of securing the equipment necessary to upgrade and restart the Vinto antimony plant. The initial design capacity of the antimony smelter at Vinto was reportedly 6,000 metric tons per year (t/yr), but it does not appear to have produced more than 100 t/yr of antimony metal (regulus), if any, during recent years. The Government's plan was for the Vinto antimony plant to be able to produce about 3,600 t/yr of antimony metal, depending on the availability of feed. In 2010, the annual average price of antimony was estimated to have increased by about 57% compared with that of 2009 owing to antimony mine and plant closures in China (which could continue into 2011). In 2010, Bolivia increased mine output of antimony by about 67%, and EMV hoped to restart the Vinto antimony plant sometime in 2011 (tables 1, 2; Beltrán 2010a, d; Waldmeir, 2010; Carlin, 2011a; Metal Bulletin, 2011; Ministerio de Minería y Metalurgia, Bolivia, 2010c; 2011a, p. 7, 49–51; 2011b, p. 17, 28, 34, 38; 2011c, p. 55–57).

**Indium.**—Although the San Cristobal Mine was the leading producer of zinc in the country in 2010, Ishihara and others (2011) estimated that a sample taken from the ore deposit underlying the mine contained only about 11 parts per million (ppm) indium. Thus, it was assumed for the purposes of estimating possible run-of-mine production of indium for this report that any indium content associated with the production of zinc in concentrates at the San Cristobal Mine was negligible, and run-of-mine production of indium at the San Cristobal Mine was estimated to be zero. For the mines that were considered as possible producers of indium in table 2, examples of the estimated indium content of selected samples taken by Ishihara and others (2011) from the deposits underlying these mines include 2,730 ppm indium in a sample of ore from the Bolivar

deposit, 1,290 ppm indium in a sample of ore from the San Vicente deposit, and 821 ppm indium in a sample of ore from the Porco deposit. Estimates by Ishihara and others (2011) of the quantity of indium (in proportion to the quantity of zinc) in samples of ores and concentrates from some of the deposits that appeared to have a higher indium content form the basis for the estimates of the country's possible run-of-mine production of indium in table 1 (tables 1, 2).

Although only three medium-scale mining companies were included as producers of indium in table 2, Ishihara and others (2011) estimated that various levels of indium are present in many of the tin-polymetallic base-metal deposits in the Eastern Cordillera of Bolivia. Consequently, other mining operations that produced minerals from these deposits could theoretically have produced at least some (undetermined amount of) indium as part of their mine output. Sometime in 2011, South American Silver Corp. of Canada expected to restart prefeasibility studies at the company's Malku Khota silver-indium project in Bolivia (table 2; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 43; South American Silver Corp., 2011).

In 2008 (the latest year for which data were available), by far the leading destinations for Bolivia's exports of zinc in concentrates were the Republic of Korea (419,000 t), Japan (166,000 t) and Belgium (about 140,000 t), and these countries were estimated to have ranked second, third, and fifth, respectively, in global refinery production of indium. Depending on the source deposit (in Bolivia) for the exports of zinc in concentrates to these three countries, they could have been among the leading refinery producers of indium byproduct output from Bolivian mines in 2010. The fourth ranked destination for Bolivian exports of zinc in concentrates (in 2008) and the estimated fourth ranked producer of refined indium in the world in 2010 was Canada, so Canada could also have been a significant location for recovery of indium from Bolivian mine output (López and Ferrufino, 2009, p. 68; Tolcin, 2011).

Near the end of 2010, the Bolivian Government planned to award contracts for the construction of two new zinc smelters to increase the future value of zinc exports. Increasing zinc processing capacity domestically could also increase Bolivia's capacity to recover indium (and other byproducts, such as cadmium) from zinc concentrates if circuits for the recovery of these metals are part of a refinery that could be included in the design of new zinc smelting (and refining) facilities. Inclusion of a zinc refining circuit was supposed to be part of the project to refurbish, modernize, and activate the Karachipampa lead-silver smelter (which had been inactive since its initial construction in 1985). This project was still ongoing through the end of 2010, however, and information regarding whether the proposed zinc refinery would include a circuit to recover indium was not available. In 1993, EMV planned to start a project to build a plant at the Vinto smelting and refining complex to chemically treat tin metal and recover high-purity indium metal from the resulting solution by electrolysis, but information about whether that project or any other project to recover indium at Vinto was ever completed was unavailable (table 2; Empresa Metalúrgica Vinto, 1993; Beltrán, 2010b; Ministerio de Minería y Metalurgia, Bolivia, 2010e, p. 48, 123; 2011b, p. 12, 26, 34; 2011c, p. 59–63; Ishihara and others, 2011).

**Iron Ore.**—Jindal reported that the company had mined some iron ore at the El Mutun Mine during 2010 but did not specify the exact quantity or the metal content of any ore produced. The Ministerio de Minería y Metalurgia, Bolivia (MMM) reported that there was 18 t of iron production by small-scale and cooperative miners, but information about whether this production of iron was at El Mutun, represented the gross weight of the ore, or reflected the Fe content of production was not available. Jindal reported that it expected to begin shipments of iron ore produced at El Mutun by sometime around mid-2011. The company planned to export initial production of iron ore mainly to China, the Middle East, Europe, and other countries in South America by way of the Parana Paraguay Hidrovia riverway. In 2010, Jindal reported that it had begun construction of a plant to produce 10 million metric tons per year (Mt/yr) of iron ore pellets, a plant to produce 6 Mt/yr of sponge iron, and a plant to produce 1.7 Mt/yr of crude steel; these new plants were projected to become operational by 2014 or 2015. Jindal also reported plans to construct a natural gas-based direct-reduced iron (DRI) plant with a capacity to produce 2.52 Mt/yr of DRI, but it was unclear whether the DRI plant was expected to be part of the planned sponge iron plant or not (Jindal Steel & Power Ltd., 2010; 2011, p. 9, 15, 38, 75; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 1; 2011c, p. 31–34).

**Lead, Silver, and Zinc.**—Sumitomo reported that the protests that affected production of lead, silver, and zinc at the San Cristobal Mine were aimed at changing the redistribution of revenue from mining royalties by the Government of Bolivia and the Potosi regional government and demanding that improvements to the infrastructure in the area be made; the protesters also targeted Empresa Minera San Cristóbal S.A. (a 100% subsidiary of Sumitomo) concerning the way the company used water for the San Cristobal Mine (Sumitomo Corp., 2010b).

Coeur d'Alene Mines reported that the San Bartolomé Mine (which is located on the flanks of the Cerro Rico Mountain) produced about 210,000 kg of silver in 2010 compared with about 230,000 kg of silver in 2009, but that on October 14, 2009, the Government had suspended mining activities on Cerro Rico above the elevation of 4,400 meters (m) above sea level, which placed a significant constraint on Coeur d'Alene Mine's mining plan for the San Bartolomé Mine. In March 2010, Empresa Minera Manquiri began mining operations in the Huacajchi deposit above the 4,400-m level on Cerro Rico under an agreement with the Cooperativa Reserva Fiscal (a local mining cooperative). Although the Government restriction on mining above the 4,400-m level continued through the end of 2010 (at least), the Huacajchi deposit was reportedly confirmed by the Government to be excluded from this restriction (Coeur d'Alene Mines Corp., 2011, p. 2, 22–25).

**Tin.**—In 2010, production of tin at the Huanuni tin mine decreased to 9,751 t compared with 9,968 t in 2009, but this was still substantially higher than the 7,875 t of tin production at the Huanuni Mine in 2008. The substantial increase in 2009 appeared to be partly owing to smaller scale Government investments to increase the capacity of an existing mill (apparently one of at least two older mills at the mine) to achieve a throughput of about 1,200 metric tons per day (t/d) of ore compared with an average

rate of about 1,000 t/d in 2008, and to the use of about 300 t/d of throughput capacity at another mill nearby that had previously been used by separate small-scale tin mining cooperatives. In 2010, the slight decrease in tin production could have been owing to slowdowns or temporary stoppages of existing mills (either at Huanuni or nearby), or it could have been owing to a strike by Huanuni miners over a compensation dispute with the state-owned tin mining company Empresa Mineral Huanuni (EMH) at the beginning of the year. EMH planned to expand the throughput capacity at the Huanuni Mine by about 3,000 t/d of ore by constructing a new mill, and completion of this new mill combined with expansion of output of ore at the mine could increase tin production capacity at the Huanuni Mine to 14,000 t/yr from an estimated 10,000 t/yr during 2010. This project was delayed through all of 2010, however, while the Government issued two unsuccessful calls for tendering this investment (ITRI Ltd., 2010a, b; 2011a, b; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 7–10, 16, 23, 27, 33–38; 2011c, p. 37–39, 123, 132).

In 2010, state-owned EMV decreased production of refined tin at the Vinto smelting and refining complex to 11,520 t compared with 11,800 t in 2009; the decrease could have been mostly owing to a decrease in the supply of tin in concentrates to Vinto from the Huanuni Mine. The Government planned to install a new tin-smelting furnace (together with Ausmelt Ltd. of Australia) and plant at Vinto with the capacity to produce between 17,000 and 18,000 t/yr of tin metal; the new plant was expected to be completed by sometime in 2012. Much of the expected increase in production of refined tin at Vinto could be dependent on completion of the expansion at the Huanuni Mine (ITRI Ltd., 2011c, d; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 7, 16–17, 33–38; 2011c, p. 55–57, 123, 132).

### *Industrial Minerals*

**Boron, Lithium, and Potash.**—Construction of a pilot plant for lithium processing in the Salar de Uyuni was expected to be completed in 2010. There was no reported production of lithium in Bolivia, however, and it appeared that the plant had not yet been completed or started production by the end of the year. The pilot plant had been designed to have an output capacity of 500 t/yr of lithium carbonate, but initial production was expected to be only sample-sized volumes for testing. The Government's pilot lithium project was expected to be the first stage of a project eventually to produce lithium carbonate on a larger scale as well as other mineral resources from the salar, such as boron, magnesium, and potassium. The complex chemistry of the brines of the Salar de Uyuni, however, as well as environmental factors (such as possibly higher rainfall and lower rates of evaporation than in other salars where lithium is already produced), led at least some analysts to project that producing lithium carbonate on a commercial scale from this salar could be more challenging and costly than elsewhere. In addition to the lithium carbonate plant(s), COMIBOL expected to complete development of a mine and facilities that would have the capacity to produce about 12,000 t/yr of potash (potassium chloride) at the Salar de Uyuni by the end of 2011. The increases in the country's production of boric acid and



ulixite in 2010 compared with that of 2009 were probably partly owing to greater exploration, development, and investment as part of the Government's lithium and potash development projects in the Salar de Uyuni (table 1; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 8, 14–15, 26–28; 2011c, p. 21–25, 66, 123, 146–147; Watts, 2011).

### **Mineral Fuels**

**Natural Gas and Petroleum.**—Oil and gas companies and consultants surveyed by the Fraser Institute considered Bolivia to have the most substantial barriers to private investment in exploration for and production of crude petroleum and natural gas among 133 jurisdictions worldwide in 2010. According to YPFB, investment in Bolivia's hydrocarbons sector was about \$800 million in 2010 compared with \$612 million in 2009. Of the total investment in the sector in 2010, YPFB (headquarters) accounted for \$108 million compared with \$29 million in 2009; YPFB subsidiaries (including YPFB Andina S.A. and YPFB Chaco) accounted for \$354 million compared with \$332 million in 2009; and private companies (including those operating in Bolivia under operations contracts with state-owned YPFB, but excluding YPFB Andina and YPFB Chaco) accounted for \$338 million (according to preliminary figures) compared with \$251 million in 2009. Near the end of 2010, BG Group plc of the United Kingdom, PAE, and Repsol YPF, S.A. of Spain had reportedly agreed to invest \$1.3 billion (combined) from 2011 through 2015 to expand output at the Margarita Field and further develop the Huacaya field (Angevine, Brown, and Cervantes, 2010, p. 5, 15–16, 52; Mapstone, 2010; U.S. Energy Information Administration, 2011; Yacimientos Petrolíferos Fiscales Bolivianos, 2011, p. 38).

In March 2010, the Governments of Argentina and Bolivia agreed on gradual increases of natural gas exports to Argentina from the current maximum of 7.7 million cubic meters per day to about 19 million cubic meters per day by 2014, about 25 million cubic meters per day by 2019, and a maximum of about 27 million cubic meters per day by 2021. It was expected that most of the increase in production of natural gas in Bolivia to enable increasing exports to Argentina would have to come from the Margarita field. Also, increasing Bolivia's natural gas exports to Argentina to 27 million cubic meters per day would require completion of the Gasoducto del Noreste Argentino (GNEA) pipeline. By the end of 2010, however, Argentina's national energy company Energía Argentina Sociedad Anónima (ENARSA) was still attempting to tender a contract for constructing the GNEA pipeline. The smaller Juana Azurduy natural gas pipeline from the Margarita field to the Refinor refinery in Campo Duran, Argentina, was expected to be completed sometime in 2011 and eventually to be connected to the GNEA pipeline. In the meantime, the Juana Azurduy pipeline could allow Bolivia's exports of natural gas to Argentina to increase to a maximum of 10.4 million cubic meters per day by 2012 (Ore, Quiroga, and Garcia, 2010; Fox News Latino, 2011; U.S. Energy Information Administration, 2011).

### **Reserves and Resources**

The reserves estimates in table 3 include proven and probable reserves as of the end of 2008 (where possible) and were compiled from company, Government, and other published sources. In 2009, the Government contracted with the Ryder Scott Co. petroleum consultants to quantify and certify Bolivia's reserves of natural gas and petroleum. Data on the country's reserves of natural gas and petroleum had apparently not been updated (at the national level) since 2005. In 2010, some controversy remained concerning the results of the Bolivian natural gas reserves assessment by Ryder Scott, which listed Bolivia's current proven natural gas reserves at about 300 billion cubic meters of natural gas compared with the previous figure of about 750 billion cubic meters (table 3; BP p.l.c., 2011b, p. 20; U.S. Energy Information Administration, 2011).

Ishihara and others (2011) estimated that the total amount of indium resources contained in Bolivian tin-polymetallic base-metal deposits could be more than 12,000 metric tons (t) of In content. They consider these resources to be inferred indium resources for Bolivia, however, and the figure may include some indium that had already been extracted. The figure also appears to include indium resources at inactive mines or in deposits that are not currently being mined. More accurate information concerning how much indium in the country might be (currently) economically exploitable without developing new mines or rehabilitating closed mines, or what current reserves of indium might be, was not available (table 3).

### **Outlook**

Public and private investments in the mining, metallurgy, and oil and gas sectors during 2010 were not expected to have a significant effect on Bolivian mineral production during 2011 (compared with annual levels of production in either 2009 or 2010), but it could extend the productive lives of some mines that appeared to be producing close to estimated capacity. Many mines and other mineral production facilities were considered by Bolivia's Ministerio de Minería y Metalurgia to be producing close to capacity in either 2009 or 2010, including the Huanuni, the San Bartolomé, and the San Cristobal Mines; the Vinto tin smelting and refining facilities; and others. The Fraser Institute's ranking of Bolivia as a desirable destination for investment by private companies in the mining and quarrying sector was 76 out of 79 jurisdictions worldwide in 2011, and it appeared that the Government might have to take a leading role as an investor in the mineral industry to proceed with certain projects, such as expanding production of boron and developing the capacity to produce lithium carbonate and potash in the Salar de Uyuni (and investigating the possibility of doing the same in the Salar de Coipasa); expanding the production of mined tin at the Huanuni Mine; developing domestic capacity to produce primary refined zinc (and possible byproducts indium and cadmium); and restarting production of antimony metal at the Vinto antimony plant (McMahon and Cervantes, 2011, p. 7, 12, 43; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 6, 12, 16, 25–28, 36; 2011c, p. 17, 21–25, 62–63, 132–133; Watts, 2011).



In 2011, Bolivia could produce about as much lead, silver, and zinc as it did in 2009 if issues that contributed to the decreases in the country's 2010 production of these minerals do not recur and new (or similar) issues do not arise, such as public issues with water use at the San Cristobal Mine, Empresa Minera Manquiri continuing to be restricted to mine only below the elevation of 4,400 m above sea level at the San Bartolomé Mine on the flanks of Cerro Rico, and further (disruptive) public protests around these and other mines and facilities that produce lead, silver, or zinc in the country. In such a scenario, Bolivia could produce about 430,000 t of zinc in concentrates, 85,000 t of mined lead, and 1,300 t of mined silver in 2011. Production of mined silver and zinc in 2011 (and beyond) could be even slightly higher if Pan American Silver Corp. continues to increase production at the San Vicente Mine. In 2010, the San Vicente Mine produced 4,661 t of zinc in concentrates and about 94.3 t of silver in concentrates compared with 2,803 t and 81.7 t, respectively, in 2009; Pan American Silver expected to produce between 5,000 t and 5,800 t of zinc in concentrates and between about 99.5 t and 103 t of silver in concentrates at the San Vicente Mine in 2011. Ishihara and others (2011) estimated the indium content in a sample of ore from the San Vicente deposit to contain 1,290 ppm indium, which might indicate that concentrates produced at the San Vicente Mine could contain significant amounts of indium. If so, significant increases in production of zinc in concentrates at the San Vicente Mine could result in increases in the estimated run-of-mine production of indium in table 1 of this report (Coeur d'Alene Mines Corp., 2011, p. 2, 22–25; Sumitomo Corp., 2010b; Pan American Silver Corp., 2011, p. 26, 36).

Production of mined antimony already increased substantially in 2010, and Bolivia's capacity to produce antimony metal in the country could increase by about 6,000 t/yr of antimony metal (regulus) if the Government is successful in restarting the Vinto antimony plant (expected sometime in 2011). Because completion of the Ausmelt furnace at the Vinto tin plant was not expected until sometime during the second half of 2012, total production of tin metal in Bolivia could still be about 11,500 t in 2012, but could increase to 16,000 t in 2013, 17,000 t in 2014, potentially to 20,000 t in 2015, and possibly achieve an approximate maximum of 21,000 t of tin metal in 2016 (and afterward). After completion of the Ausmelt plant, the production capacity at Vinto could approach a maximum of about 32,000 t/yr of tin metal if EMV were to continue to use the older furnaces that it used to produce tin metal at Vinto in 2010; however, it does not appear that the company will have enough feed to run all the furnaces at Vinto at full capacity, and maintaining production from the older furnaces might not be cost effective. (It has been estimated that the production capacity at Vinto could reach as high as 38,000 t/yr if further modernization at Vinto were to be approved and implemented.) Initially, any increases in tin metal production were expected to be only from processing a greater percentage of mined tin domestically, because expansion of production to between an estimated 13,000 and 14,000 t/yr of tin in concentrates at the Huanuni Mine (where 2010 production capacity was estimated to be about 10,000 t/yr of tin in concentrates) was not expected to happen until sometime in 2014, and information concerning

any other expansions of mined tin production was not available (ITRI Ltd., 2010a, b; 2011a–d; Metal Bulletin, 2011; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 6–7, 10, 16–17, 27–28, 32–34; 2011c, p. 37–39, 55–57, 66–67).

The Ministerio de Minería y Metalurgia reported a small amount of iron ore and manganese production in 2010 (possibly from sampling and testing during the development of El Mutun), and Jindal expected that a marketable quantity of iron ore could be produced at El Mutun by 2012. Reliable information about what that possible marketable level of iron ore production could be or what the actual timeline to achieve consistently commercial levels of iron ore production at El Mutun might be, however, was not available. Production of crude steel, DRI, or sponge iron at El Mutun was not expected to take place until 2014, 2015, or later, and this timeline was still highly uncertain. Although many private companies had shown substantial interest in developing the lithium resources in the Salar de Uyuni, the Government decided to develop them itself. Reliable information concerning timelines for any possible marketable production of lithium in Bolivia was not available (Metal Bulletin, 2011; Ministerio de Minería y Metalurgia, Bolivia, 2011b, p. 8, 14–15, 17–18, 26–28, 33; 2011c, p. 21–25, 31–34, 66–67).

Petróleo Brasileiro S.A. (Petrobras) of Brazil expected to develop the new Itau field and to begin production of between 1 and 1.5 million cubic meters per day there sometime in 2011 and to ramp up production to about 5 million cubic meters per day by sometime in 2015. Also, the planned investment in the Margarita field by a private consortium was expected to increase production of natural gas to about 8 million cubic meters per day from about 2 million cubic meters per day in 2010. Reliable information concerning a definitive timeline for expansion of the Margarita field was not available. State-owned YPFB (together with private partners in operations contracts) planned to invest about \$4 billion in development projects within the natural gas sector from 2009 through 2015 (Mapstone, 2010; Yacimientos Petrolíferos Fiscales Bolivianos, 2010, p. 21, 67; Petroleum Economist, 2011; U.S. Energy Information Administration, 2011).

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TABLE 1  
BOLIVIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	2006	2007	2008	2009	2010	
<b>METALS<sup>3</sup></b>						
<b>Antimony:</b>						
Mine output, Sb content	5,460	3,881	3,905	2,990	4,980	
Metal, including Sb content of trioxide	2,782	2,862	2,984	2,340	419	
Arsenic, mine output, arsenic trioxide, arsenic sulfide	120 <sup>f</sup>	--	74	115	155	
<b>Bismuth:</b>						
Mine output, Bi content	155	147	28	54	87	
Metal, smelter	1	(4)	92	73	--	
<b>Copper:</b>						
Mine output, Cu content	218	606	731	882	2,063	
Metal, primary	--	--	8 <sup>e</sup>	215 <sup>f</sup>	895	
<b>Gold:</b>						
Mine output, Au content <sup>5</sup>	kilograms	9,628	8,818	8,405	7,217	6,394
Metal, including Au content of bullion and doré	do.	6,513	5,551	5,067	3,667	2,430
Indium, run of mine, In content <sup>e</sup>		70	75	65	50	60
<b>Lead:</b>						
Mine output, Pb content	11,955	22,798	81,602	84,538 <sup>f</sup>	72,803	
Metal, smelter, primary	318	301	473	418	310 <sup>6</sup>	
<b>Silver:</b>						
Mine output, Ag content <sup>7</sup>	kilograms	472,208	524,989	1,113,764	1,325,729 <sup>f</sup>	1,259,388
Metal, including Ag content of bullion and doré	do.	21,561	23,657	35,861	33,000 <sup>e</sup>	225,211
Tantalum, tantalite	do.	8,000 <sup>e</sup>	3,914	161	--	3,416
<b>Tin:</b>						
Mine output, Sn content	17,669 <sup>f</sup>	15,972	17,320	19,575 <sup>f</sup>	20,190	
Metal, smelter	14,089	12,251	12,666	14,995	14,975	
Alloys, Sn-Pb alloyed metal	1,030 <sup>e</sup>	473	--	--	--	
Tungsten, mine output, W content	868	1,107	1,148	1,023	1,204	
Zinc, mine output, Zn content	172,747	214,053	383,618	430,879	411,409	
<b>INDUSTRIAL MINERALS</b>						
Barite	8,943	8,245	10,900	2,069	7,845	
Bentonite	--	--	1	323	440	
Borax	56 <sup>e</sup>	8,245	297	1,124	485	
Boric acid	12,136	15,032	10,539	11,114	12,619	
Cement, hydraulic	thousand metric tons	1,636	1,739	1,985	2,292	2,414

See footnotes at end of table.

TABLE 1—Continued  
BOLIVIA: PRODUCTION OF MINERAL COMMODITIES<sup>1</sup>

(Metric tons unless otherwise specified)

Commodity <sup>2</sup>	2006	2007	2008	2009	2010	
INDUSTRIAL MINERALS—Continued						
Gemstones, rough						
Amethyst <sup>8</sup>	kilograms	175,715 <sup>9</sup>	135,439 <sup>r</sup>	228,397 <sup>r</sup>	503,045 <sup>r</sup>	485,390
Ametrine	do.	33,675	8,933	20,629 <sup>r</sup>	10 <sup>r</sup>	669
Quartz, pink	do.	3,756	38	67	12,001	10,000 <sup>e</sup>
Emerald	do.	2,219	--	--	--	--
Gypsum, crude		617	4,458	4,108 <sup>r</sup>	1,931	556
Lime		80 <sup>r</sup>	75 <sup>r</sup>	75	26	111
Salt, natural, all types <sup>c</sup>		45,000	45,000	45,000	45,000	45,000
Of which, rock salt		688	1,545	1,415	1,947	1,218
Stone, natural:						
Flint	kilograms	4,427	25	--	--	--
Granite		119	205	-- <sup>r</sup>	62	44
Limestone as dimension stone		--	(4)	75	26	111
Marble		102	81	(4)	32	65
Slate (pizarra)		192	233	266	190	63
Sulfur, native		3	--	508	3	--
Ulexite		38,591	64,499	55,710	85,530	97,303
MINERAL FUELS AND RELATED MATERIALS						
Gas, natural:						
Gross	million cubic meters	14,689	15,230	15,375 <sup>r</sup>	13,411 <sup>r</sup>	15,227
Marketable (net)	do.	13,434	14,301	14,895	12,787	14,923
Natural gas liquids	thousand 42-gallon barrels	2,694 <sup>r</sup>	2,862 <sup>r</sup>	2,645 <sup>r</sup>	2,541 <sup>r</sup>	3,022
Petroleum:						
Crude	do.	14,882	15,027	14,233	12,329 <sup>r</sup>	12,607
Refinery products:						
Liquefied petroleum gas	do.	855	895	685 <sup>e</sup>	645 <sup>e</sup>	945
Gasoline:						
Aviation	do.	28	32	25 <sup>e</sup>	20 <sup>e</sup>	25 <sup>e</sup>
Motor	do.	3,877	4,558	5,390 <sup>e</sup>	5,530 <sup>e</sup>	5,492
Jet fuel	do.	1,076 <sup>r</sup>	992	950 <sup>e</sup>	900 <sup>e</sup>	1,102
Kerosene	do.	153 <sup>r</sup>	131	130 <sup>e</sup>	100 <sup>e</sup>	127
Distillate fuel oil	do.	4,615 <sup>r</sup>	4,880	5,050 <sup>e</sup>	4,100 <sup>e</sup>	4,043
Lubricants:						
Oil, automotive	do.	102	105	100 <sup>e</sup>	80 <sup>e</sup>	100 <sup>e</sup>
Oil, industrial	do.	10	8	5 <sup>e</sup>	3 <sup>e</sup>	5 <sup>e</sup>
Greases <sup>10</sup>	do.	4	3	3 <sup>e</sup>	2 <sup>e</sup>	3 <sup>e</sup>
Asphalt <sup>10</sup>	do.	15	13	10 <sup>e</sup>	8 <sup>e</sup>	10 <sup>e</sup>
Paraffin oil <sup>10</sup>	do.	1	--	-- <sup>e</sup>	-- <sup>e</sup>	-- <sup>e</sup>
Total	do.	10,736	11,617	12,300 <sup>e</sup>	11,400 <sup>e</sup>	11,900 <sup>e</sup>

<sup>e</sup>Estimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. <sup>r</sup>Revised. do. Ditto. -- Zero.

<sup>1</sup>Table includes data available through January 23, 2012.

<sup>2</sup>In addition to the commodities listed, a variety of industrial minerals (clays, crushed and broken stone, dimension stone, and sand and gravel) are produced, but available information is inadequate to make reliable estimates of output.

<sup>3</sup>Unless otherwise specified, data represent actual production by Corporación Minera de Bolivia and small- and medium-sized mines.

<sup>4</sup>Less than 1/2 unit.

<sup>5</sup>May include production of metallic gold.

<sup>6</sup>Gross weight of primary metal alloys believed to contain lead.

<sup>7</sup>May include production of metallic silver.

<sup>8</sup>May include production by previously unregistered miners whose production was not officially accounted for prior to 2007.

<sup>9</sup>The units of the reported data were assumed to be in grams instead of kilograms (as was assumed in previous volumes of the Minerals Yearbook).

<sup>10</sup>Reported figures were converted from metric tons to equivalent barrels.



TABLE 2  
BOLIVIA: STRUCTURE OF THE MINERAL INDUSTRY IN 2010

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity <sup>e</sup>
Antimony		Empresa Minera Unificada S.A. (EMUSA) (private, 100%)	Caracota, Chilcobija, and Espiritu Santo Mines, Potosi Department	1,100.
Do.		Small-scale mining operations and cooperatives (private, 100%)	San Jose Mine, Oruro Department; Mines in Caracota District, Nor Chichas, Quijarro, and Sud Chichas Provinces, Potosi Department	4,500.
Antimony, metal (regulus)		Empresa Metalúrgica Vinto (Government, 100%)	Vinto antimony plant, <sup>1</sup> Carretera Vinto, Oruro Department	6,000. <sup>2</sup>
Antimony, metal		Operaciones Metalúrgicas S.A. (OMSA)	Huajara Industrial Park, east of the City of Oruro, Oruro Department	3,000.
Do.		Fundestño de Oruro S.A. (Empresa Minera Unificada S.A., 100%)	City of Oruro, Oruro Department	1,100.
Antimony trioxide		Empresa Minera Bernal Hermanos S.A. (private, 100%)	Palala smelter, Tupiza, Potosi Department	1,900.
Bismuth		Cooperativa Minera Locatarios Tasna Ltda.	Tasna Mine, near City of Oruro, Oruro Department	200.
Bismuth, refined		Corporación Minera de Bolivia (COMIBOL) (Government, 100%)	Telamayu bismuth refinery, Telamayu, Potosi Department	350.
Do.		Empresa Metalúrgica Vinto (Government, 100%)	Vinto smelting complex, <sup>1</sup> Carretera Vinto, Oruro Department	90.
Cement	thousand metric tons	Sociedad Boliviana de Cemento S.A. (SOBOCE) (Grupo Cementos de Chihuahua S.A. de C.V., 47.02%, and other private, 52.98%)	El Puente (near city of Tarija), EMISA (near city of Oruro), VIACHA (near city of La Paz), and WARNES (near city of Santa Cruz) plants	1,510 cement; 760 clinker.
Do.	do.	Fábrica Nacional de Cemento S.A. (Sociedad Boliviana de Cemento S.A., 33.34%; Municipal Government of Sucre, 33.33%; Universidad San Francisco Xavier de Chuquisaca, 33.33%)	Cal Orcko industrial complex near city of Sucre, including grinding plant, and FANCESA cement plant near city of Chuquisaca	630 cement; 620 clinker.
Do.	do.	Cooperativa Boliviana de Cemento Ltda. (COBOCE)	Irpa Irpa Plant, near city of Cochabamba	470 cement; 330 clinker.
Do.		ITACAMBA Cemento S.A.	Plant, Santa Cruz Department	200 cement.
Copper		Compañía Minera PAS (Bolivia) S.A. (Pan American Silver Corp., 95%, and Empresa Minera Unificada S.A., 5%)	San Vicente Mine, Potosi Department	350.
Do.		Corporación Minera de Bolivia (COMIBOL) (Government, 100%)	Coro Coro Mine, and a pilot plant to produce copper cathodes, La Paz Department	3,000.
Do.		Small-scale mining operations and cooperatives (private, 100%)	Mining operations in Chuquisaca, La Paz, Oruro, and Potosi Departments	650.
Gemstones, ametrine		Minerales y Metales del Oriente S.R.L.	Anahi Mine, Santa Cruz Department	NA.
Gold	kilograms	Empresa Minera Paititi S.A. {Orvana Minerals Corp. [Fabulosa Mines Ltd. (Minera S.A., 100%), 52.5%, and other private, 47.5%], 100% }	Don Mario Mine, <sup>3</sup> Chiquitos Province, Santa Cruz Department	2,100.
Do.	do.	Golden Eagle International Inc. (private, 100%)	Cangalli Mine, <sup>4</sup> Santa Cruz Department	150.
Do.	do.	Grupo Minero La Roca S.A. (private, 100%)	La Paz Department	200.
Do.	do.	Mining Cooperatives (private, 100%)	Tipuani, Guanay, Mapiri, Huayta, Kaka, and Teoponte Rivers, La Paz Department	4,350.
Gold-silver doré, bullion	do.	Empresa Minera Inti Raymi S.A. (Compañía Procesadora de Minerales S.A., 88%, and Empresa Minera Unificada S.A., 12%)	Kori Chaca open pit mine and Kori Kollo leaching plant, near city of Oruro	2,300 gold; 1,800 silver.
Indium, run of mine		Sinchi Wayra S.A. (Glencore International AG, 100%)	Bolivar, Porco, and San Lorenzo Mines, Oruro and Potosi Departments	70.
Do.		Compañía Minera PAS (Bolivia) S.A. (Pan American Silver Corp., 95%, and Trafigura Baheer B.V., 5%)	San Vicente Mine, Potosi Department	15.
Do.		Compañía Minera Colquiri S.A. (Sinchi Wayra S.A., 100%)	Colquiri tin and zinc mine, Inquisivi Province, La Paz Department	5.
Lead		Sinchi Wayra S.A. (Glencore International AG, 100%)	Bolivar, Colquechaquita, Poopo, Porco, and San Lorenzo Mines, Oruro and Potosi Departments	15,000. <sup>2</sup>
Do.		Empresa Minera San Cristóbal S.A. (Sumitomo Corp., 100%)	San Cristobal Mine, southwestern Bolivia	82,000.

See footnotes at end of table.

TABLE 2—Continued  
BOLIVIA: STRUCTURE OF THE MINERAL INDUSTRY IN 2010

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity <sup>c</sup>
Lead—Continued		Small-scale mining operations and cooperatives (private, 100%)	Cerro Rico Mine, Potosi Department, and in areas immediately surrounding the San Cristobal Mine	10,200.
Do.		Empresa Minera La Solución Ltda.	Asientos and Monserrate lead-silver-zinc mines, <sup>4</sup> Cochabamba Department	610.
Do.		Empresa Minera Santa Lucia Ltda.	Santa Lucia lead-silver-zinc mine, Potosi Department	200.
Lead, metal		Empresa Metalúrgica Vinto (Government, 100%)	Vinto smelting complex, Carretera Vinto, Oruro Department	120.
Do.		Empresa Metalúrgica de Karachipampa (Atlas Minerals Inc., 65%, and Corporación Minera de Bolivia, 35%)	Karachipampa lead-silver smelter, and zinc refinery, <sup>5</sup> Potosi Department	30,000.
Natural gas	million cubic meters	Operated by Empresa Petrolera Andina S.A. (YPFB Andina S.A. [Government, 100%], 51.08%, and Repsol YPF, S.A., 48.92%) and owned by Empresa Petrolera Andina, S.A., 50%, Petróleo Brasileiro S.A., 35%, and Total S.A., 15%	Los Sauces, Rio Grande, Sirari, Vibora, and Yapacani fields, Santa Cruz Department	2,700.
Do.	do.	Operated by Petróleo Brasileiro S.A. (Petrobras) (Brazilian Government, 32.2%, and private, 67.8%), and owned by Empresa Petrolera Andina S.A., 50%; Petróleo Brasileiro S.A., 35%; Total S.A., 15%	Sabalo field, San Antonio Block; San Alberto field and Block, Tarija Department	7,200.
Do.	do.	Operated and owned by YPFB Chaco S.A. (Government, 100%)	Vuelta Grande field, Chuquisaca Department; Bulo Bulo, Carrasco, and Kanata fields, on the border of Cochabamba and Santa Cruz Departments	2,200.
Do.	do.	Operated by Repsol YPF, S.A., and owned by BG Group plc., 37.5%, Repsol YPF S.A., 37.5%, and Pan American Energy LLC (BP p.l.c., 60%, and BRIDAS Corp., 40%), 25%	Margarita field, Caipipendi Block, Tarija Department; Paloma field, Mamore Block, Cochabamba and Santa Cruz Departments	1,300.
Do.	do.	Operated and owned by BG Group plc., 100%	La Vertiente, Escondido and Taiguati fields, La Vertiente Block; Los Suris field and Block, all in Tarija Department	630.
Do.	do.	Operated by Pluspetrol Bolivia Corporation S.A. (owned by Pluspetrol S.A., 100%)	Bermejo and Madrejonas fields, Tarija Department; Tacobo field, Santa Cruz Department	520.
Do.	do.	Operated by Vintage Petroleum Boliviana Ltda. (owned by Occidental Petroleum Corp., 100%)	Chaco Sur and Ñupuco fields, Tarija Department; Naranjillos field, Santa Cruz Department	350.
Petroleum	thousand 42-gallon barrels	Operated by Empresa Petrolera Andina S.A. (YPFB Andina S.A. [Government, 100%], 51.08%, and Repsol YPF, S.A., 48.92%) and owned by Empresa Petrolera Andina, S.A., 50%, Petróleo Brasileiro S.A., 35%, and Total S.A., 15%	Los Sauces, Rio Grande, Sirari, Vibora, and Yapacani fields, Santa Cruz Department	2,100.
Do.	do.	Operated by Petróleo Brasileiro S.A. (Petrobras) (Brazilian Government, 32.2%, and private, 67.8%), and owned by Empresa Petrolera Andina S.A., 50%; Petróleo Brasileiro S.A., 35%; Total S.A., 15%	Sabalo field, San Antonio Block; San Alberto field and Block, Tarija Department	7,500.
Do.	do.	Operated and owned by YPFB Chaco S.A. (Government, 100%)	Vuelta Grande field, Chuquisaca Department; Bulo Bulo, Carrasco, and Kanata fields, on the border of Cochabamba and Santa Cruz Departments	2,900.
Do.	do.	Operated by Repsol YPF, S.A., and owned by BG Group plc., 37.5%, Repsol YPF S.A., 37.5%, and Pan American Energy LLC (BP p.l.c., 60%, and BRIDAS Corp., 40%), 25%	Margarita field, Caipipendi Block, Tarija Department; Paloma field, Mamore Block, Cochabamba and Santa Cruz Departments	5,000.
Do.	do.	Operated and owned by BG Group plc., 100%	La Vertiente, Escondido, and Taiguati fields, La Vertiente Block; Los Suris field and Block, all in Tarija Department	610.

See footnotes at end of table.

TABLE 2—Continued  
BOLIVIA: STRUCTURE OF THE MINERAL INDUSTRY IN 2009

(Metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity <sup>c</sup>
Petroleum — Continued	thousand 42-gallon barrels	Operated by Pluspetrol Bolivia Corporation S.A. (owned by Pluspetrol S.A., 100%)	Bermejo and Madrejones fields, Tarija Department; Tacobo field, Santa Cruz Department	160.
Do.	do.	Operated by Vintage Petroleum Boliviana Ltda. (owned by Occidental Petroleum Corp., 100%)	Chaco Sur and Ñupuco fields, Tarija Department; Naranjillos field, Santa Cruz Department	140.
Silver	kilograms	Empresa Minera San Cristóbal S.A. (Sumitomo Corp., 100%)	San Cristobal Mine, southwestern Bolivia	525,000.
Do.	do.	Empresa Minera Manquiri S.A. (Coeur d'Alene Mines Corp., 100%)	San Bartolomé Mine, by Cerro Rico, near Potosi Potosi Department	280,000.
Do.	do.	Small-scale mining operations and cooperatives (private, 100%)	Candelaria and other mines, Cerro Rico deposit, as well as in areas immediately surrounding the San Bartolomé Mine (under construction), Oruro and Potosi Departments	280,000.
Do.	do.	Sinchi Wayra S.A. (Glencore International AG, 100%)	Bolivar, Colquechaquita, Poopo, Porco, and San Lorenzo Mines, Oruro and Potosi Departments	180,000.
Do.	do.	Compañía Minera PAS (Bolivia) S.A. (Pan American Silver Corp., 95%, and Trafigura Baheer B.V., 5%)	San Vicente Mine, Potosi Department	100,000.
Do.	do.	Empresa Minera Santa Lucia Ltda.	Santa Lucia lead-silver-zinc mine, Potosi Department	30,000.
Do.	do.	Empresa Minera Paititi S.A. {Orvana Minerals Corp. [Fabulosa Mines Ltd. (Minera S.A., 100%), 52.5%, and other private, 47.5%], 100% }	Don Mario Mine, <sup>3</sup> Chiquitos Province, Santa Cruz Department	7,500.
Do.	do.	Empresa Minera La Solución Ltda.	Asientos and Monserrate lead-silver-zinc mines, <sup>4</sup> Cochabamba Department	2,000.
Silver, metal		Empresa Metalúrgica de Karachipampa (Atlas Minerals Inc., 65%, and Corporación Minera de Bolivia, 35%)	Karachipampa lead-silver smelter, and zinc refinery, <sup>3</sup> Potosi Department	310.
Do.		Empresa Minera Manquiri S.A. (Coeur d'Alene Mines Corp., 100%)	San Bartolomé Mine and plant, by Cerro Rico, near Potosi, Potosi Department	NA.
Do.		Empresa Metalúrgica Vinto (Government, 100%)	Vinto smelting complex, Carretera Vinto, Oruro Department	2.
Tin		Empresa Minera Huanuni [Corporación Minera de Bolivia (Government, 100%), 100%]	Huanuni Mine, Dalence Province, Oruro Department	10,000.
Do.		Compañía Minera Colquiri S.A. (Glencore International AG, 100%)	Colquiri tin and zinc mine, Inquisivi Province, La Paz Department	6,000. <sup>2</sup>
Do.		Empresa Minera Barrosquira Ltda. (private, 100%)	Caracoles Mine, Inquisivi Province, La Paz Department	500.
Do.		Small-scale mining operations and cooperatives (private, 100%)	Caracoles, Huanuni, Viloco, and other current or former Corporación Minera de Bolivia mines, in Oruro, Potosi, and La Paz Departments	10,000.
Tin, refined		Operaciones Metalúrgicas S.A. (OMSA)	Huajara Industrial Park, east of the City of Oruro, Oruro Department	3,360.
Do.		Empresa Metalúrgica Vinto (Government, 100%)	Vinto smelting complex, Carretera Vinto, Oruro Department	12,000.
Tin-lead alloys		do.	do.	200.
Tungsten, W content		Small-scale mining operations and cooperatives (private, 100%)	Bolsa Negra, Enramada, Reconquistada Mines, near the former International Mining Company's Chojilla Mine, Sud Yungas Province; Chambilaya and Chicote Grande Mines, Inquisivi Province; Mercedes, San Antonio, Ucumarini Mines, Larecaja Province, La Paz Department	1,200.
Zinc		Empresa Minera San Cristóbal S.A. (Sumitomo Corp., 100%)	San Cristobal Mine, southwestern Bolivia	270,000.
Do.		Sinchi Wayra S.A. (Glencore International AG, 100%)	Bolivar, Colquechaquita, Poopo, Porco, and San Lorenzo Mines, Oruro and Potosi Departments	205,000. <sup>2</sup>

See footnotes at end of table.

TABLE 2—Continued  
 BOLIVIA: STRUCTURE OF THE MINERAL INDUSTRY IN 2010

(Metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity <sup>e</sup>
Zinc—Continued	Small-scale mining operations and cooperatives (private, 100%)	Cerro Rico Mine, Potosi Department, and in areas immediately surrounding the San Cristobal Mine	85,000.
Do.	Compañía Minera Colquiri S.A. (Glencore International AG, 100%)	Colquiri tin and zinc mine, Inquisivi Province, La Paz Department	14,000.
Do.	Empresa Minera Santa Lucia Ltda.	Santa Lucia lead-silver-zinc mine, Potosi Department	12,000.
Do.	Compañía Minera PAS (Bolivia) S.A. (Pan American Silver Corp., 95%, and Trafigura Baheer B.V., 5%)	San Vicente Mine, Potosi Department	6,000.
Do.	Empresa Minera La Solución Ltda.	Asientos and Monserrate lead-silver-zinc mines, <sup>4</sup> Cochabamba Department	1,300.
Zinc, refined	Empresa Metalúrgica de Karachipampa (Atlas Minerals Inc., 65%, and Corporación Minera de Bolivia, 35%)	Karachipampa lead-silver smelter, and zinc refinery, <sup>5</sup> Potosi Department	150,000.

<sup>e</sup>Estimated; estimated data are rounded to no more than three significant digits. Do., do. Ditto. NA Not available.

<sup>1</sup>There was no reported production of refined antimony or bismuth at the Vinto smelting complex in 2010. (Source: Ministerio de Minería y Metalurgia, Bolivia, 2011, Cuadro No. 9, Anuario estadístico minero metalúrgico 2010: La Paz, Bolivia, Ministerio de Minería y Metalurgia)

<sup>2</sup>Reported figure.

<sup>3</sup>An undisclosed proportion of the gold and silver production from this mine was in the form of metal contained in dore or bullion.

<sup>4</sup>Inactive during all of 2010.

<sup>5</sup>Inactive since completion of construction in 1985; through 2010.



TABLE 3  
 BOLIVIA: ESTIMATED RESERVES OF MAJOR MINERAL COMMODITIES IN 2010<sup>1</sup>

(Thousand metric tons unless otherwise specified)

Commodity	Reserves	World ranking	World percentage
Antimony, metal content	310	4	15
Bismuth, metal content	10	3	3
Gold, metal content	metric tons 28	NA	(2)
Lead, metal content	1,600	8	2
Natural gas <sup>3</sup>	billion cubic meters 750	29	(2)
Petroleum <sup>3</sup>	million 42-gallon barrels 465	45	(2)
Silver, metal content	metric tons 22,000	8	5.5
Tin, metal content	400	6	7
Tungsten, W content	53	5	2
Zinc, metal content	6,000	9	3

do. Ditto. NA Not available.

<sup>1</sup>Combined proven plus probable reserves estimated from a combination of company, Government, and secondary sources.

<sup>2</sup>Less than 1/2 unit.

<sup>3</sup>Proved reserves only. Source: U.S. Energy Information Administration, [undated], International energy statistics—Natural gas—Reserves: U.S. Energy Information Administration. (Accessed August 6, 2010, at <http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=3&aid=6>.)