



2006 Minerals Yearbook

ECUADOR

THE MINERAL INDUSTRY OF ECUADOR

By Steven T. Anderson

In 2006, the total value of production by the mineral industry of Ecuador was almost entirely (98.67%) accounted for by the value of production of crude petroleum. Ecuador was the fifth ranked producer of crude petroleum in South America. Production of limestone for cement and glass manufacture was of significant value within the mining sector of Ecuador, as was the production of other industrial minerals, such as, in order of decreasing value, feldspar, pozzolan, pumice, kaolin, and barite. Of these, however, only Ecuador's production of natural pumicite was of global significance (approximately 5% of the world's combined production of pozzolan and pumice). The potential for establishing a more-diverse mineral industry in Ecuador was beginning to attract increasing flows of foreign direct investment (FDI), especially with respect to exploration for metallic minerals, but this increased investment had not yet resulted in the establishment of any proven or probable reserves of metals for production using modern methods (Banco Central del Ecuador, 2007b; Dirección Nacional de Hidrocarburos, 2007).

A number of firms were engaged in exploration for nonfuel minerals. Most of these firms were primarily exploring for gold, although some made significant investments in exploring for other metals, such as copper, molybdenum, silver, and zinc. Although some firms appeared to be able to conduct exploration operations in an orderly fashion, many were disrupted by public protests. Through the end of 2006, no companies had reported any proven reserves for any metals (Sutcliffe, 2007).

Minerals in the National Economy

The value of the country's production of crude petroleum and natural gas during the year was about \$9.3 billion¹ and accounted for about 23% of the gross domestic product (GDP) compared with \$7.4 billion and 20% of the GDP in 2005. The value of mine production of nonfuel minerals was about \$108 million compared with \$100 million in 2005 (Banco Central del Ecuador, 2007b, c).

Crude petroleum dominated mineral exports, and imports of refinery products dominated mineral imports. The net mineral trade balance for all minerals was positive and valued at about \$4.6 billion compared with \$3.7 billion in 2005. The value of Ecuador's exports of crude petroleum was about \$6.9 billion and accounted for about 55% of the total value of Ecuador's exported goods during the year compared with \$5.4 billion and 53%, respectively, in 2005. Exports of petroleum refinery products were valued at \$610 million compared with \$473 million in 2005. Ecuador was a net importer of petroleum refinery products, and the value of these imports was about \$2.3 billion compared with \$1.7 billion in 2005. The value of exports of nonfuel minerals was about \$37 million compared with \$16 million in 2005, but separate data were not available for the value of imports of nonfuel minerals (Banco Central del Ecuador, 2007a, c).

¹All values in this chapter are given in current (nominal) U.S. dollars unless otherwise noted. The U.S. dollar has been used since 2000 as legal tender and for financial reporting purposes in Ecuador.

In 2006, FDI in mining and the extraction of crude petroleum in Ecuador totaled \$1.84 billion compared with about \$1.45 billion in 2005. These amounts accounted for about the same percentage (88%) of total FDI in the country during both years, and investment in exploration, development, and further processing of minerals, including investment in exploration for or refining of mineral fuels, was not explicitly included in these figures. The Dirección Nacional de Minería (DINAMI) reported that about 4,800 people were employed in the mining of gold, silver, and industrial minerals in 2006. The Instituto Nacional de Estadística y Censos reported that about 50% of all people employed in the extraction of all minerals, including mineral fuels, were employed in the petroleum sector; therefore, an estimated 9,600 people (at least) were employed in mineral extraction in 2006. This estimate still does not include other employees in the mineral industry of Ecuador who may have been involved in exploration, development, or minerals processing (such as cement or steel manufacturing or petroleum refining activities). Such additional mineral industry employment figures were not publically available at the time of this writing (Banco Central del Ecuador, 2007a; Dirección Nacional de Minería, 2007; Instituto Nacional de Estadística y Censos, 2007)

Government Policies and Programs

In April 2006, the Government amended the hydrocarbons law to raise the share (royalty percentage) of foreign oil company "windfall revenues" to 50% when the price per barrel exceeds the reference prices listed in foreign companies' participation contracts with the Government. Windfall revenues are the difference between company income at current market prices and what the company's income would have been at the reference price in the contract. The reference price level can be adjusted (depending on market conditions), but only through renegotiation of a company's participation contract. In 2005 and up until this 2006 amendment to the hydrocarbons law, the average tax rate on sales of all foreign production of crude petroleum was about 20%, including taxes on any windfall revenues. On May 15, 2006, the Government cancelled the operating contract of Occidental Petroleum Corp. (OXY) of Los Angeles, California, claiming that OXY had transferred a 40% stake in its Ecuadorean operations to EnCana Corp. of Canada (in 2001) without proper Governmental authorization (Economist, The, 2006; Petroleum Economist, 2006; Occidental Petroleum Corp., 2007, p. 15, 24, 49; U.S. Energy Information Administration, 2007).

Production

Private companies produced about 105 million barrels (Mbbbl) of petroleum compared with 123 Mbbbl in 2005. In 2006, the state-owned petroleum company Empresa Estatal Petróleos del

Ecuador (PetroEcuador) accounted for about 90 Mbbl of crude petroleum production and 46% of the country's total production of crude petroleum compared with 71 Mbbl and 37% of total production in 2005. This dramatic increase was mostly owing to the Government's transfer of ownership and operational control of all oilfields owned by OXY in the country to PetroEcuador on May 18 (Empresa Estatal Petróleos del Ecuador, 2007, p. 66-70; U.S. Energy Information Administration, 2007).

In 2006, the artisanal production of gold, silver, and some associated metals was estimated to have increased slightly compared with that of 2005, although no copper or lead content of mine output was reported to DINAMI. Total production capacity for mine production of gold by the many small-scale operations in the country has been estimated to range from about 8 metric tons per year (t/yr) to 10 t/yr, but the levels of gold and other metal mine production listed in table 1 are based solely upon figures reported to DINAMI, including the estimates for 2006. The International Iron and Steel Institute (IISI) reported that production of continuously cast crude steel in electric arc furnaces from imports of ferrous raw mineral materials in 2006 continued to increase compared with that of 2005. Cement companies, including Holcim Ecuador S.A., appeared to be shifting production of pumicite increasingly toward pozzolan for cement manufacture and away from pumice for other uses, which could account for the substantially greater increase in production of pozzolan as compared with pumice since 2003 (table 1; Dirección Nacional de Minería, 2007; Holcim Ltd., 2007, p. 25, 53; International Iron and Steel Institute, 2007, p. 11, 14, 16, 22, 24, 40; Sutcliffe, 2007).

Structure of the Mineral Industry

Information on the structure of the mineral industry in Ecuador is presented in table 2. The most notable change in ownership took place when the Government expropriated (and turned over to PetroEcuador) all the productive Ecuadorean operations of OXY, including the Block 15 field, the Eden Yuturi field, and the Limoncocha field. OXY retained its 14% ownership interest in the Oleoducto de Crudos Pesados (OCP) oil export pipeline, but had to prepay \$95 million toward the debt used to finance the construction of the OCP. This debt was to be paid down annually with shares of sales from continuing production of crude petroleum from OXY's fields in Ecuador, but the contingent contracts for OXY to do this were "ship or pay" contracts. Thus, although OXY earned \$109 million in after-tax revenue from production and shipments of crude petroleum during the first 5 months of 2006, OXY was still contractually obligated to make the payment once the Government expropriation eliminated all of OXY's share of upstream production of crude petroleum in Ecuador. Although the Government was reportedly searching for a different company to manage the expropriated fields, PetroEcuador was still listed as the owner from May through the end of the year (Economist, The, 2006; Petroleum Economist, 2006; Dirección Nacional de Hidrocarburos, 2007; Occidental Petroleum Corp., 2007, p. 15, 24, 49).

On February 28, 2006, EnCana voluntarily sold all of the company's ownership interests in Ecuador to Andes Petroleum

Co. Ltd. (a subsidiary of China National Petroleum Corp.), including a 36.3% ownership interest in the OCP. By the end of 2006, the ownership structure of the OCP was Andes Petroleum, 36.3%; Repsol YPF S.A. of Spain, 29.6%; OXY, 14%; Petróleo Brasileiro S.A. of Brazil, 11.4%; Agip Petroleum Ecuador Ltd. of Italy, 4.5%; and Perenco plc of France, but listed in the United Kingdom, 4.2%. The OCP was constructed to transport crude petroleum mostly from foreign-operated wells to an export terminal located on the Pacific coast, and PetroEcuador primarily used the Sistema Oleoducto Trans-Ecuatoriano (SOTE) pipeline (which was 100% owned and operated by the Government through PetroEcuador) for the same purpose (table 2; Chinese National Petroleum Corp., 2007, p. 51; Dirección Nacional de Hidrocarburos, 2007; EnCana Corp., 2007, p. 5, 23, 26, 44).

Ecuador's petroleum fields are located in the Amazon Basin in the northeastern part of the country. The most productive field was Eden Yuturi, which accounted for about 13% of the total production of crude petroleum in Ecuador. The other leading fields were, in order of production of crude petroleum in 2006, Shushufindi (9%), Sacha (8%), and Dorine (6%). This production was mostly transported to the Pacific coast via two domestic pipelines and one international pipeline. The main domestic pipeline was the SOTE, which terminated in the petroleum terminal at the Port of Balao on the Pacific coast. The other domestic pipeline was the OCP, which follows the path of the SOTE for the most part. The international pipeline was the Oleoducto Trans-Andino (OTA), which was also owned and operated by PetroEcuador. The OTA links Ecuador's fields to the Pacific Port of Tumaco, Colombia, but reportedly had not been in use since the completion of the OCP (Dirección Nacional de Hidrocarburos, 2007; Empresa Estatal Petróleos del Ecuador, 2007, p. 51-54; U.S. Energy Information Administration, 2007).

The only other noticeable change in ownership during 2006 was that Holcim Ltd. of Switzerland increased its ownership share in Holcim Ecuador to 92.1% compared with 83.5% in 2005. Production of aggregates and pumicite was mostly controlled by the cement companies. Holcim Ecuador controlled the majority of the domestic market. Primary production of crude steel in Ecuador was by one company, Acerías Nacionales del Ecuador S.A. (ANDEC), and secondary production was by a subsidiary of ANDEC, Fundiciones Nacionales S.A. (FUNASA) (Holcim Ltd., 2007, p. 25, 52-53; Federación Ecuatoriana de Industrias del Metal, undated).

Mineral Trade

In 2006, Ecuador exported approximately 137 Mbbl of crude petroleum compared with about 132 Mbbl in 2005, which accounted for about 70% of the country's total production of crude petroleum compared with about 71% in 2005. By far, the leading export destination for crude petroleum produced in Ecuador was the United States. The United States was the destination for about 75% of Ecuador's crude petroleum exports in 2006 compared with 67% in 2005. In 2006, the United States was followed by Peru (12.7%) and Chile (6.25%) (Banco Central del Ecuador, 2007c).

The nonfuel mineral exports of Ecuador have traditionally consisted mostly of industrial minerals and some gold and silver, but also included some base metals (export credits for copper and lead contained in concentrates). In 2006, Ecuador exported about 28,000 metric tons (t) of industrial minerals, 5,900 t of copper and lead contained in concentrates, and 91 t of gold and silver concentrates compared with 14,000 t, 580 t, and 5 t, respectively, in 2005 (Banco Central del Ecuador, 2007a).

Commodity Review

Metals

Copper.—In December 2006, public protests were held to be partially responsible for the suspension of the mine development activities of Canada-based Corriente Resources Inc.'s Mirador copper project. In addition, the company received news that the Government was going to review further the environmental impact assessment (EIA) for the proposed copper mine, which had initially been approved in May (Corriente Resources Inc., 2007, p. 1, 3-4, 12-13).

Gold.—Existing mine production of metals was dominated by small-scale gold mining operations that employed artisanal methods. These operations mined mostly low-sulfidation epithermal, polymetallic, and skarn deposits, which also produced trace amounts of metals other than gold, such as copper and silver. Gold has been mined in Ecuador since precolonial times and continued to dominate exploration targets during the year (although a few companies were also engaged in extensive exploration for deposits of copper, molybdenum, silver, and zinc). Some diverse types of metallic mineral deposits have been discovered in Ecuador, including copper and copper-gold porphyries, high- and low-sulfidation epithermal gold deposits, and gold-rich volcanogenic massive sulfide (VMS) deposits (Sutcliffe, 2007).

Industrial Minerals

Cement.—Holcim Ecuador completed an EIA for the construction of a third kiln at its Guayaquil plant, but was experiencing difficulty in acquiring enough fuel to produce enough cement in the presence of increased demand in the country. During the year, the company used substantially more waste oil and even used old drill cores produced by the petroleum industry as fuel for its cement kilns (Holcim Ltd., 2007, p. 52-53).

Mineral Fuels

Petroleum.—In 2006, Repsol was the leading privately owned producer of crude petroleum in Ecuador (21.7 Mbbbl), followed by Andes Petroleum (17.1 Mbbbl), and OXY (13.6 Mbbbl). Note that the total amount of production during the year by OXY in Ecuador represents production only through mid-May, when its fields were expropriated. During the remainder of the year, production from the fields previously owned by OXY was counted as production by PetroEcuador. In 2006, PetroEcuador's annual production of crude petroleum increased for the first

year since at least 2002, and this increase appeared to be mainly owing to the state-run company's acquisition of OXY's previously owned fields. Private companies have combined to increase production of crude petroleum following completion in 2003 of the OCP pipeline in Ecuador. Before completion of the OCP, companies had complained that reliance on the SOTE pipeline was creating a bottleneck in the production of crude petroleum for export and domestic use. Although production of crude petroleum continued to increase in 2006 compared with that of 2005, the OCP was still not being used at a rate of much more than one-third of its capacity. Of the total of 184 Mbbbl of crude petroleum transported through the OCP and SOTE pipelines in 2006, 126 Mbbbl was transported through the SOTE and 58 Mbbbl was transported through the OCP. The designed annual transportation capacity for the OCP was about 160 million barrels per year (Mbbbl/yr), and that for the SOTE was between 130 Mbbbl/yr and 140 Mbbbl/yr, depending on the specific gravity of the crude petroleum being transported (tables 1, 2; Empresa Estatal Petróleos del Ecuador, 2007, p. 66-70, 88-92; OCP Ecuador S.A., 2007, p. 6; U.S. Energy Information Administration, 2007).

Any increases in Ecuador's total reserves of crude petroleum were expected to come from development of the Ishpingo-Tapocochoa-Tiputini (ITT) block of potential petroleum fields. The ITT Block is located further east than the major existing fields in the Amazon region, and it was estimated to contain about 900 Mbbbl of proven reserves. Private foreign investors had shown mixed interest in developing the ITT Block, however, because of uncertainty concerning revisions to the hydrocarbons law and because the ITT fields reportedly contain an extremely heavy variety of crude petroleum that would require blending with lighter mineral fuels before it could be transported through Ecuador's pipelines. Also, protests against increasing crude petroleum production in the Amazon region have repeatedly obstructed exploration and production by all petroleum companies, including PetroEcuador (U.S. Energy Information Administration, 2007).

In August 2006, the Chilean national mineral fuels company, Empresa Nacional de Petróleo (ENAP), signed an agreement with PetroEcuador to invest an additional \$36 million to drill new wells and improve facilities at ENAP's Mauro Davalos Cordero field, and to increase production by about 3,000 barrels per day at the field. The contract between the two state-run companies allows PetroEcuador to keep 90% of the total amount of crude petroleum production from this field, and ENAP to receive 10%. ENAP also reportedly expressed interest in aiding PetroEcuador in managing the new fields that it took over from OXY in May. In 2006, ENAP controlled about 7 Mbbbl/yr of production capacity in Ecuador (table 2; Verdezoto, 2006).

Outlook

The major economic activities in the mineral industry of Ecuador are expected to continue to center around the efforts of PetroEcuador to find joint-venture partners and to reactivate some of the marginal petroleum fields under its control. Foreign petroleum and mining companies are also expected to continue to face uncertainties concerning taxation, environmental

regulations, possible expropriation of fields or mines, and ongoing public protests that are disruptive to both exploration and production activities.

The continuation of higher prices in 2006 for metallic minerals targeted by mining exploration companies in Ecuador, and a few discoveries by some, resulted in increased investment in exploration for reserves of metallic minerals in 2006, and this trend is expected to continue at least into 2007 (barring significant decreases in prices or an increase in estimated uncertainty). A few of these exploration projects approached more-advanced stages in 2006, including two or three that claimed to be at the feasibility stage. However, definitive timelines for eventual production from any proposed mines remained unclear (International Minerals Corp., 2006, p. 2, 4, 34-35, 44; Aurelian Resources Inc., 2007, p. 2-3, 16-21; Corriente Resources Inc., 2007, p. 1, 7-9, 12-14).

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TABLE 1
ECUADOR: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	2002	2003	2004	2005	2006 ^c
METALS					
Copper, mine output, Cu content	--	--	242	-- ^r	--
Gold, mine output, Au content	2,750	4,819	5,128 ^r	5,338 ^r	5,500
Silver, mine output, Ag content	96	-- ^r	372	283 ^r	300
Steel, crude, continuously cast, electric furnace ^c	68,743 ²	79,794 ²	72,000	84,000 ^r	87,000
INDUSTRIAL MINERALS					
Barite	-- ^r	2,139	3,695	-- ^r	--
Carbon dioxide (CO ₂)	752	329	685	589 ^r	600
Cement, hydraulic ^c	3,000	3,100	3,000	3,000	3,000
Clays: ³					
Common	382	340	903	1,318 ^r	1,300
Kaolin	8,483	11,884	5,646	25,078 ^r	25,000
Feldspar	31,254	44,268	53,469	38,250 ^r	38,000
Gypsum, crude	4,730	-- ^r	232	1,311 ^r	1,300
Pozzolan	519,090	190,747	612,256	540,318 ^r	550,000
Pumice	130,459	88,830	183,119	107,178 ^r	110,000
Salt, common ^c	75,000	75,000	75,000	75,000	75,000
Sand:					
Silica (quartz) sand	40,880	38,856	32,148	37,790 ^r	38,000
Ferruginous	10,000 ^c	10,000 ^c	11,325	9,252 ^r	9,300
Stone, sand and gravel:					
Limestone ³	5,712	4,688	4,700	4,855 ^r	4,900
Marble	265	1,890	1,431	3,033 ^r	3,000
Sand and gravel, for construction	4,467	3,272	5,834	5,662 ^r	5,600
Travertine ^c	--	--	--	7,250	7,000
Sulfur: ^c					
Native	4,000	4,000	4,000	4,000	4,000
Byproduct, petroleum refining	3,000	3,000	3,088 ²	3,008 ²	3,000
Zeolites	1,883	1,679 ^r	3,300 ^r	2,400 ^r	2,000
MINERAL FUELS AND RELATED MATERIALS					
Gas, natural:					
Gross	1,085	1,287	1,181 ^r	1,347 ^r	1,309 ²
Of which, marketable	86	249	240	262	281 ²
Liquefied natural gasoline	603	514	542	458	500
Petroleum:					
Crude	143,758	153,539	192,517	194,169	195,948 ²
Refinery products:					
Liquefied petroleum gas	2,199	2,358	2,412	2,259	2,300
Gasoline	9,883	9,338	8,816	6,954	7,000
Jet fuel	1,820	1,897	2,235	2,500	2,500
Distillate fuel oil	13,174	11,752	13,397	13,064	13,000
Residual fuel oil	23,465	23,622	22,851	21,255	21,300
Asphalt	1,087	1,200	1,158	990	1,000
Turpentine	19	8	19	23	25
Solvents, including rubber solvent	42	13	21	32	35
Other, including oils and lubricants	87	64	88	102	100
Total	51,776	50,252	50,997	47,179	47,260

^cEstimated; estimated data are rounded to no more than three significant digits; may not add to totals shown. ^rRevised. -- Zero.

¹Table includes data available through November 2007.

²Reported figure.

³No reports of separate quantities for clay or limestone used in cement production were available.

TABLE 2
ECUADOR: STRUCTURE OF THE MINERAL INDUSTRY IN 2006

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity ^e
Cement		Holcim Ecuador S.A. (Holcim Ltd., 92.1%, and other private, 7.9%)	Cerro Blanco Plant, Guayaquil, Guayas Province, and San Rafael grinding plant, Latacunga, Cotopaxi Province	3,500
Do.		Cementos Selva Alegre S.A. (Lafarge S.A., 98.2%, and other private, 1.8%)	Cement plant near capital city of Quito, Pichincha Province	700
Gold	kilograms	Small-scale and artisanal mining operations (private, 100%)	Western and eastern Cordilleras, southern Ecuador	8,000
Petroleum:				
Crude	thousand 42-gallon barrels	Owned and operated by Empresa Estatal Petróleos del Ecuador (PetroEcuador) (Ecuadorian Government, 100%)	About 28 active fields, led by Sacha, Sucumbios Province, and Shushufindi, Napo Province	71,000
Do.	do.	Operated by Sipetrol S.A. (Empresa Nacional del Petróleo S.A., Chilean Government, 100%)	Biguno, Huachito, Mauro Davalos Cordero, and Paraiso Fields, Napo Province	7,000
Do.	do.	Owned and operated by Andes Petroleum Co. Ltd. (Chinese National Petroleum Corp., 100%)	Mostly Dorine Field but 6 others, led by Fanny 18-B and Alice Fields, Tarapoa Block, Sucumbios Province	20,000
Do.	do.	Owned and operated by City Oriente Ltd., 100%	Three fields, led by Tipishca-Huaico, Block 27, Sucumbios Province	1,500
Do.	do.	Owned and operated by Empresa Estatal Petróleos del Ecuador (PetroEcuador) (Ecuadorian Government, 100%)	Most production from Eden Yuturi Field, Block 15, Napo Province, but also from Indillana and Yanaquincha wells; Limoncocha Field, Block 15, Sucumbios Province	37,000
Do.	do.	Owned and operated by Petrobell Inc., 100%	Tiguino field, Block 30, Pastaza Province	1,700
Do.	do.	Owned and operated by Petróleos Sudamericanos S.A., 100%	Mascarey Field, Block 11, Sucumbios Province	2,400
Do.	do.	Owned and operated by Andes Petroleum Co. Ltd. (Chinese National Petroleum Corp., 100%)	Hormiguero, Nantu, Sunka, Wanke Fields, Block 14, Napo Province; fields in Block 17, Napo and Pastaza Provinces	3,200
Do.	do.	Owned and operated by Perenco plc	About seven fields, led by the Coca-Payamino Field, Block 7, Napo Province, and the Yuralpa Field, Block 21, Pastaza Province	8,100
Do.	do.	Owned and operated by Repsol YPF S.A.	Amo, Bogui-Capiron, Daimi, Ginta, and Iro Fields, and three other small fields, Block 16, Napo Province	19,300
Do.	do.	Owned and operated by Agip Petroleum Ecuador Ltd. (Eni S.p.A., 100%)	Villano Field, Block 10, Pastaza Province	7,600
Do.	do.	Operated by Ecuador TLC S.A. (Petróleo Brasileiro S.A., 100%)	Palo Azul and Pata Fields, Block 18, Napo Province	11,700
Do.	do.	Operated by TecpEcuador S.A.; owned by Tecpetrol S.A. (Techint S.A., 100%)	Bermejo Field, Block 11, Sucumbios Province	3,100
Refinery products	do.	Owned and operated by Empresa Estatal Petróleos del Ecuador (PetroEcuador) (Ecuadorian Government, 100%)	Esmeraldas refinery, Esmeraldas Province	40,200
Do.	do.	do.	Libertad refinery, Guayas Province	16,800
Do.	do.	do.	Amazonas refinery and gas plant, Napo Province	7,300
Sand and gravel (aggregates)		Holcim Agregados S.A. (Holcim Ecuador S.A., 100%)	Two plants near Manta and Portoviejo, Manabi Province, and one plant near the capital city of Quito, Pichincha Province	2,500
Steel, crude	metric tons	Complejo Siderurgico ANDEC-FUNASA (Acerías Nacionales del Ecuador-Fundiciones Nacionales S.A.) (Holdingdine S.A. and other private, 100%)	Complex of plants in Port of Guayaquil, Guayas Province	91,000

^eEstimated; estimated data are rounded to no more than three significant digits.