Chapter 15
Gray Footprint and Mining: Impact of Metal Extraction on Water

Germán Santacruz-de León and Francisco J. Peña-de Paz

Abstract Mining comprises the development phase, start-up and stripping activities for surface mining; it requires the construction of access roads, the work construction of water supply and electricity. In the first phase, the operation stage includes mineral extraction; the second phase involves processes of benefit and disposal of liquid and solid waste. The last stage involves the restoration and rehabilitation of the site. An underground mine design comprises three aspects: development, preparation, and exploitation; this type of mining allows to exploit seams that lie beneath the surface. It leads to lower noise emissions and dust is limited to the externally generated. In contrast, it requires greater technical complexities, it is more complicated, costly, and dangerous for the miners, so there is the tendency to abandon underground mining and to prefer open-pit mining (Buitelaar 2001). Currently, the largest mining activity takes place in the north-central region of Mexico; some estimates calculate that metal mining uses 53.5 million m^3 (Mm^3) of water, from surface or underground sources (López et al. 2001) and the volume of wastewater generated is estimated at 26.2 Mm^3, which is poured into water bodies or municipal drainage networks. Thus, mining affects quality and quantity of the liquid. Acid mine drainage is present in underground and open-pit mining and it is not only present in operating mines, but also after their closure. It is considered as the most serious and persistent mining environmental problem.

Keywords Gray water footprint · Mining · Semi-arid Mexico

15.1 Presentation

Because of the lack of reliable and detailed data on direct and indirect water consumption in the mining extraction processes and because of the diversity of extracted materials and of the processes used to do it, currently, it is not possible to establish the magnitude of the mining water footprint in terms of profit and volume consumed by the extraction process and—this is very important—the polluted effluent left by it and the material deposits that continue to affect aquifers and surface bodies, for many years even after mining companies have ceased operations.

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As discussed above, this work is exploratory and methodological. We propose an approach to water footprint defined as the amount of water used directly and indirectly for a given type of mining, precious metals, and we suggest a methodology that not only considers water as an input in the production process to achieve metal separation, but also it incorporates medium- and long-term effects that this extractive activity has due to geomorphological changes it causes and that directly impact on the basin hydrological regime, both in terms of runoff types (direction, speed, permeability, etc.) and water quality, because wastes are added or removed during extraction and processing of metals. Both elements increase significantly the water volume used by metal mining.

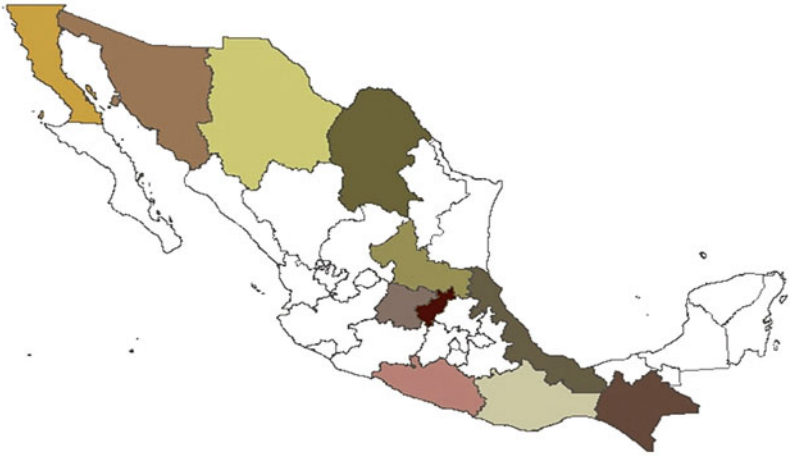
After providing a framework for identifying the economic importance of this mining type, we will focus on an extractive mode, open-pit mining, because it is the dominant trend due to its profitability. Using the example of Minera San Xavier (MSX) in San Luis Potosi, we approach the impacts that an extraction mode has on water uses. After a schematic overview of the parts involved in mining extractive system, in the first part the existing statistics are analyzed in relation to mining in northern Mexico. In the second part, environmental and social impacts of mining are analyzed. Finally, it is made an inventory of the type of effects that mining has on water availability.

15.2 Metal Extraction Activities

Mining comprises the development phase, start-up, which covers the preparation of shafts and tunnels in underground mines, and stripping activities for surface mining: construction of access roads, work construction of water and electricity supply. In the first phase, the operation stage includes mineral extraction; the second phase involves processes of benefit and disposal of liquid and solid waste. The last stage comprises, according to mining manuals, the restoration and rehabilitation of the site (Anonymous, s.a.; Jiménez et al. 2006). As shown in Fig. 15.1, currently in Mexico there are several places where social mobilization has given attention to the type of mining exploitation being done or planned and its environmental effects, mainly those on water.

According to the shape and location of the ore body, mining methods can be divided into four basic types: (1) underground mines, using tunnels and galleries; (2) surface mines by opencast; (3) drill holes and; (4) undersea mining or dredging (UNEP 1994).

Underground mining selection is based on the deposit characteristics, such as size and dimensions, distribution and mineral mechanical characteristics, economic benefit criteria, etc. (UNEP 1994). An underground mine design comprises three aspects: (1) Development, involving work for deposit access, (2) Preparation, which consists of dividing the deposit into blocks, and (3) Exploitation, which are mineral extraction works (Jiménez/Molina 2006). This type of mining allows to exploit



CONFLICT	STATE	PROJECT	COMMUNITY AFFECTED
Baja California says no to Paredones Amarillos of Vista Gold Corp.	🟧	Paredones Amarillos	Todos los Santos
Cananea, Group Mexico and Mining Union	🟫	Cananea	Inhabitants of Cananea
Communities in the municipality of Ocotlan claiming illegal mining concessions of Minera Natividad	⬜	Natividad Mine	Community of Calpulalpan de Mendez
Pasta de Conchos collapse	🟩	Pasta de Conchos Mine	
Ejidatarios rise against barite Chicomuselo Mine	🟫	Minera Caracol, Chicomuselo	Chicomuselo. Ejidatarios of Grecia, Monte Sinai, Nueva Morelia
The spill of Minera María	🟫	Minera María	
Great Panther contaminates dams	🟫	Cata Mine	Inhabitants of Cata
Oro Nacional Mine (Canadian) vs inhabitants of Mulatos, Sonora, Mexico	🟫	Oro Nacional Mine	Mulatos
Mineinders usurped lands from Ejidatarios of Huizopa	🟨	Minera Dolores	Ejidatarios of Huizopa
Minera contaminated water with arsenic in Cocula	🟥	Cocula	Indigenous people of Tlamacazapa
Minera San Javier operates outside the law	🟩	Cerro San Pedro	Ejidatarios of the Cerro San Pedro
Motozintla municipality, Chiapas, opposes Oro Mine in Ejido Carrizal	🟫	Motozintla	Ejidatarios of Grecia, Ejido Carrizal
Opposition to antimony plant in Queretaro	🟥	Flotation Plant	San Antonio de la Cal
La Luz project threatens to destroy the "Cradle of the Sun" for the Huicholes	🟩	La Luz	Real del Catorce
Veracruz opposes gold project within 3 kilometers of Nuclear Power Plant	🟩	Caballo Blanco	Veracruz

Fig. 15.1 Distribution of social conflicts by impacts of recent mining activity in Mexico. *Source* The Observatory of Mining Conflicts in Latin America, OCMAL, 2010

seams that lie beneath the surface; underground mining methods are generally classified into naturally supported cameras, artificially supported cameras and sinking (Gratzfeld 2004; Jiménez/Molina 2006; UNEP 1994).

Underground mining causes lower noise emissions and dust is limited to the externally generated. In contrast, it comprises advanced technology and skilled workers; it requires greater technical complexities and it involves high risks for workers. Thus, underground mining is more complicated, costly, and dangerous for miners (McMahon/Remy 2003). Because of this, it is preferred to use any of the superficial methods whenever it is possible; so there is a tendency to abandon underground mining and to prefer open-pit mining (Buitelaar 2001).

With technological advances, open-pit mining started to be employed more often. Surface mining is done by advancing horizontally on land cover, and it is called by different names depending on the type of extracted material: *open-pit mines* for metals; *open-cast mine* for coal or lignite; *quarries* for construction and industrial materials (sand, granite, slate, marble, gravel, clay, limestone, shale, quartz, talc, phosphate, salt, potassium, sulfur, etc.); and *pleasure mines* for heavy metals (gold and silver, platinum, iron, chromium, titanium, copper, tin, lead, zinc, etc.) and minerals (Gratzfeld 2004).

Open-pit mines consist of terraced pits, deep and wide, which regularly have a circular shape; extraction starts with the drilling and dynamiting of rock that, once classified, it is transported to the processing plants. In pleasure mines, low-compacted deposits of sand, gravel, silt, or clay are exploited, separating precious metals from them by sieves and laundries; they tend to be located in riverbeds or near them (Anonymous, s.a.; Matamoros and Vargas 2000).

15.3 Gold Mining Contribution to National Economy

In the first decade of the twenty-first century, the high mineral prices remained, stimulating an investment increase in exploration. Globally, 10,500 million dollars were invested in this task, exceeding by 40 % the expended in 2006. In Latin America, the main recipients of that investment were Mexico, Peru and Chile, which together received 24 % of it. In the same year, 4,410 million dollars were allocated for gold exploration (Anonymous 2008).

Currently, the largest mining activity takes place in the north-central region of Mexico (Fig. 15.2). The main mining centers are located in the states of Sonora, which is the largest producer of gold and copper; Coahuila, main producer of antimony and bismuth; Zacatecas, first in production of silver; Chihuahua, which is a leading producer of cadmium, zinc, and the only one with tungsten deposits. Baja California Sur, San Luis Potosi, and Durango are also noteworthy; they are states where significant metal deposits have been located (Coastal 2008).

The figures are revealing. In 2000, the mining sector contributed between 1.17 and 1.5 % to the gross domestic product (GDP) and it participated with 1.5 % of national employment. On the other hand, the large-scale mining generated 84.1 % of the total value of domestic mining–metallurgical production; medium and small mining contributed 13 and 2.9 %, respectively (Center for Competitiveness Studies 2004).

Fig. 15.2 National position of producing states of conceivable minerals* in northern Mexico, 2007. *Source* based on data from Anonymous 2007. *Minerals with this name, according to the Mining Law of Mexico, are those that can be exploited only with permission or concession granted by the Secretariat of Economy

In 2005, Mexico ranked first in silver and celestite production; it was ranked among the top five producers of cadmium, arsenic, and bismuth. It is also among the ten largest producers of gold, manganese, and antimony. In the same year, mining–metallurgical production amounted to 53,954 million pesos; the states of Sonora, Zacatecas, Coahuila, Durango, San Luis Potosi, and Chihuahua stood out for their production value (Mining Chamber of Mexico 2006); however, other figures show that the value of mineral production in 2005 totaled 71,800 million pesos (Anonymous 2007). This contributed 1.6 % to GDP. 912 million dollars were invested and 120 million dollars were spent for exploration of new deposits (Mining Chamber of Mexico 2006; Jiménez et al. 2006).

In 2007, gold production amounted to 72,600 kg (Fig. 15.3), which is the most dynamic production due to investment flows for opening new mines and to high international prices.

The investment increment or decrement is reflected in the number of jobs created. In 2007, people employed in mining increased to 292,993; however, in 2009 and 2010, the mining sector employed 269,501 and 283,800 people, respectively (Fig. 15.4). Mining of metallic minerals, which corresponds to branch 13, generated 6,543 of those jobs (Anonymous 2010).

The above comparison (Fig. 15.4) is done with the premise that the mineral mining corresponding to branch 11 is more environmentally friendly, and it generates more jobs, compared with the negative environmental impact resulting from metallic mineral mining.

Mining sector contributes 1.5–2.5 % to GDP; however, no official statistic indicates the environmental costs of that contribution. In recent years, mining has contributed 1.52–1.94 % of total national employment.

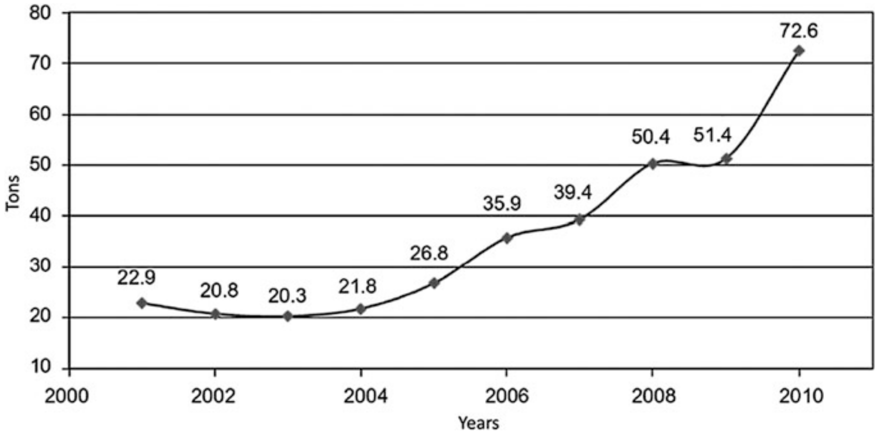


Fig. 15.3 Gold production (ton) in Mexico, 2001–2010. *Source* Anonymous, 2010

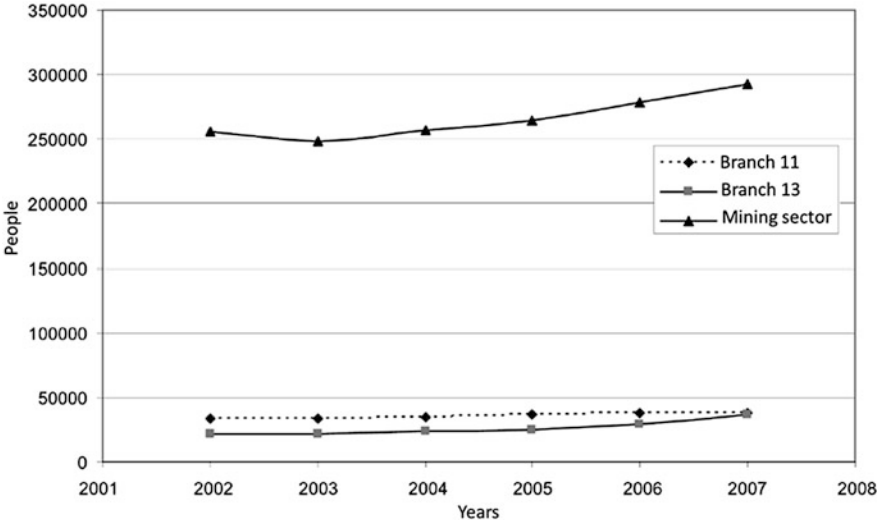


Fig. 15.4 Number of jobs created by mining sector in Mexico, 2001–2007. *Source* Anonymous 2007

For comparison, it can be seen that official statistics show that sand and gravel extraction—which is within the mineral extraction industry—generated at least from 2003 to 2005, similar economic wealth to the one produced by gold and silver extraction. In the period 2003–2010, the states of Sonora, Chihuahua, and Zacatecas account for most of the mining production and, thus, with the largest generation of economic resources of the branch. These three states, in conjunction with San Luis Potosi, Sinaloa, are the major gold producers in northern Mexico.

Table 15.1 Major operating mines of metallic minerals in San Luis Potosi, 2007

Name	Company	Municipality	Mineral
Cerro de San Pedro	Minera San Xavier	Cerro de San Pedro	Au, Ag
El Rey-Reyna	Industrial Minera Mexico	Charcas	Au, Ag, Zn, Pb
San Acasio y Pilar	Minera Santa María de la Paz	La paz	Au, Ag, Cu

Source Based on data from SMG (2008d)

Next, the main characteristics of mining production in some of these states are indicated, with emphasis on the type of mining used.

In 2007, the state of San Luis Potosi occupied nationally the fifth place in the production of metallic minerals, and fourth place as gold producer. This state has great potential of metallic minerals such as gold, silver, copper, lead, zinc, manganese, tin, iron, mercury, and antimony (SGM 2008c). It has three active mines, in each of them gold and other metals such as silver, lead, zinc, and copper are extracted (Table 15.1 and Annex).

15.4 Mining Environmental Impact: Effects on Water Availability

In mining, the most important stage is the metallic mineral extraction, which in the mining slang it is known as profit. The mined rock contains valuable components of economic interest and sterile components—known as bargains—that regularly have no economic value (Anonymous, s.a.). Mineral processing can be simple or may involve complex processes; this activity can be done on site or can be carried out elsewhere. Whatever the condition, it still implies significant amounts of water (Fig. 15.5), which can be difficult to access in arid and semi-arid areas (Gratzfeld 2004).

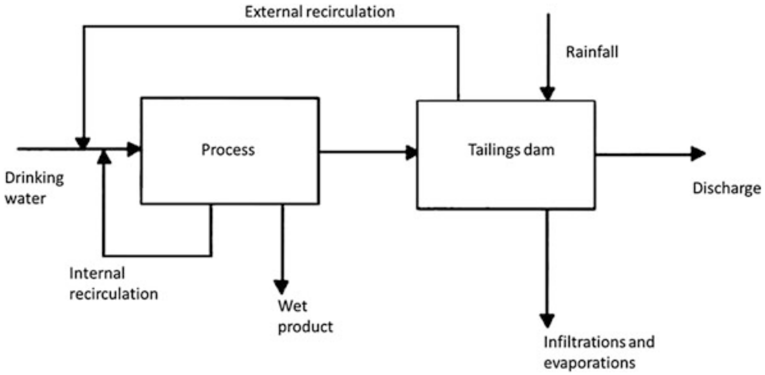


Fig. 15.5 General flow diagram of water use in the mining industry. *Source* Taken from Rao and Finch (1988), quoted in Pacheco and Duran (2006)

Table 15.2 Water use in metal mining in Mexico

Mining branch	Extraction (m^3/year)	Recirculation (m^3/year)	Demand (m^3/year)	Consumption (m^3/year)	Descharge (m^3/year)
Precious metals	25,632,534	20,511,451	46,144,015	11,676,303	13,956,232
Nonferrous metals	6,810,026	16,041,354	22,851,350	2,685,910	4,124,115
Steel minerals	21,149,833	37,107,785	58,257,618	12,991,538	8,168,298
Total (m^3/year)	53,592,393	73,660,590	127,252,983	27,353,751	26,248,645
Equivalent population	734,142	1,009,049	1,743,192	374,709	359,570

Source Modified from López et al. (2001)

Some estimates calculate that Mexican metal mining uses 53.5 million m^3 (Mm^3) of water, from surface or underground sources (López et al. 2001). This volume would be sufficient to provide 200 l of water per day for one year to a population of 734,000 inhabitants. The volume of wastewater generated is estimated at 26.2 Mm^3 (Table 15.2), which is poured into water bodies or municipal drainage networks.

In the various activities involved in mining of metallic materials—extraction and processing—there are adverse impacts on water resources where the mine is located, but usually occur differentially (Calva 1994). Thus, mining affects quality and quantity of the liquid. Benefit plants and tailings dams, where the mining waste is dumped, are a source of environmental pollution; in these plants, metals of interest are separated from the rocks, so the amount of wastes generated and the degree of contamination depend on the mineralogical composition of the mine and the benefit technique (Jiménez et al. 2006). In accordance with EIM, in the Cerro de San Pedro mine project, located in San Luis Potosi, one million cubic meters of water per year are required (Santacruz 2008), following the procedure of equivalent population, this volume would provide 200 l per capita per day to a population of 13,697 inhabitants. MSX originally proposed the use of treated wastewater; however, it has applied for the authorization to acquire water rights for agricultural use to the National Water Commission (Conagua in Spanish). Thus, one million cubic meters will be extracted from the aquifer from which the water is obtained to meet the liquid needs of the city of San Luis Potosi. Most of the water will be used in leaching pads and dust suppression systems; MSX states that there may be an extraordinary water consumption, which would increase to 1.3 Mm^3.

To meet the water needs of the city of San Luis Potosi, the intermunicipal operating organism has allocated 85 Mm^3/year (Peña 2006). There is a recharge of 78.1 Mm^3/year, although there are controversies about which part of the system aquifer receives this recharge. Currently, it is said that this volume feeds the shallow aquifer; in general, 149.34 Mm^3/year is allocated, implying a deficit of 71.4 Mm^3/year (Conagua 2002). During the time period covered by the MSX project, the extracted volume for mining purposes will be added to the latter. Since 1961, the low water availability in San Luis Potosi caused the prohibition of the aquifer for any purpose other than domestic use; groundwater extraction is considered, by MSX in its *Environmental Impact Manifestation*, as significant adverse.

Water can be a mining input; but in many cases, it can be seen as a problem by mining companies.

Underground mining causes less visible effects, but no less harmful to the environment than open-pit mining. It causes aquifer abatement because of the continuous water pumping from inside the mine (Coll-Hurtado et al. 2002); in the mining slang, wasted water is known as acid mine drainage (AMD), which, if not adequately treated, will contaminate the soil or water bodies where it is poured; this reduces its quality for human consumption or agricultural use.

Acid mine drainage is present in underground and open-pit mining. It is caused by the oxidation of minerals containing sulfide, producing sulfuric acid (H_2SO_4) with pH between 1.5 and 7; thus, this substance can dilute easily metals such as iron, cadmium, copper, aluminum, and lead (Fernández 2008; Gratzfeld 2004; Jiménez et al. 2006). AMD can be defined as the inorganic chemical pollution of water, resulting from the oxidation of minerals containing sulfide (UNEP 1994).

AMD is not only present in operating mines, but also after their closure. It is considered the most serious and persistent mining environmental problem; although it occurs in most mining exploitations, it is magnified in areas where rainfall is considerable (Anonymous 2002).

The discharge of acid drainage into water bodies causes their pollution and thus, the incorporation of metals in the food chain; it can also pollute the aquifers, causing the water contained in them to be inadequate for human consumption. Contamination incidents are serious when acid drainage, stored in underground abandoned mines, contaminates aquifers that are the source of water for domestic consumption (Anonymous 2002; Tovar, s.a.).

Regarding the AMD, the Minera San Xavier case can be mentioned, which states that in the operation stage, in the realization of the pit, and according to information from more than 200 exploration boreholes, the water table of the region will not be not intersected until the maximum depth of the planned pit (Santacruz 2008). However, in the *Environmental Impact Manifestation*, it indicates that: “As the pit development proceeds and particularly towards the final stages of the same, it is expected that some outcrops of potentially acid generating rock will be exposed to oxidation with the consequent possibility that it will help in the generation of acidic pH solutions and it can contain metals in solution and dissolved and suspended solids” (Behre Dolbear 1997:328).

In addition, Carrillo (2005), quoting Alloway (1995), indicates that the elements associated with gold extraction are silver, tellurium, arsenic, antimony, mercury, and selenium; and in the case of silver, elements such as copper, antimony, lead, tellurium, and zinc are associated. In that sense, the EIM of MSX mentions that of the 117 million tons of dump, about 600,000 tons of material known as intrusive porphyry with sulfide will go to the dumps, “with the risk of generating, in the long-term and during the period of total sulfide oxidation, solutions with an acid pH that may contain metals in solution and affect aquifers [sic] of the region” (Behre Dolbear 199:328).

15.5 Conclusions

During the last decade, concessions and projects to open new mining extraction of metals, particularly gold and silver, have increased in the central and southern Mexico. These projects have brought the mobilization of multiple communities whose environmental security and, in particular, that concerning the availability of good quality water is threatened.

The North is where the principal mines are located, especially those intended for the metallic mineral extraction. Currently, to increase the profitability of several of the sites historically engaged in the extraction, the open-pit mining method is chosen, being the method that generates greater negative environmental impact. Technological advances—the use of sophisticated equipment for exploration and the use of metallurgical processes such as cyanidation that allow the extraction porphyry metal deposits—have allowed open-pit mining to be the most used by mining companies.

Although these methods are presented as methods that consume less water due to the reuse of cyanidation systems for metal separation, open-pit mining has a greater geomorphological impact because it modifies large surfaces to extract the mineral. Changes of this magnitude also affect runoff type, speed, recharge capacity, direction of surface currents and, especially, it threatens water quality because large amounts of waste are kept without proper management.

On the one hand, mining water footprint calculation requires public and accurate record of the volumes used directly and indirectly in the processes of obtaining the mineral and its benefit. But above all, it requires special attention to changes affecting availability of good quality water and the disturbance of basins and subbasins where such types of companies are established. Mining is a typical case of expanded use of water concessions received. They are extended in space and time, because their effects on watercourses and, thus, on the water they use, remain beyond the extraction period (via pollution, for example) and amplify their influence in space due to the intervention on the geomorphological basin configuration.

Annex: Extraction Yields of Various Mining Products by Federal State

State	2007	2008	2009	2010	2011
Baja California					
Gold (kg)	–	–	–	358	645.8
Silver (kg)	–	–	–	14284.00	10920.00
Aggregates	4476043.00	634737.00	16421163.50	17642572.35	12840479.10
Clays	66456.00	66456.00	46800.00	45000.00	46000.00
Sand	1836109.90	1329054.06	21299489.84	21285569.84	18857962.50

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State	2007	2008	2009	2010	2011
Limestone	354432.00	1025992.80	249600.00	240000.00	240000.00
Gravel	1358726.10	868862.80	481728.00	463200.00	463200.00
Gypsum	22152.00	43336.00	15600.00	15000.00	15000.00
Chihuahua					
Gold	12891.30	13140.60	15221.80	18256.60	15262.30
Silver	451292.00	466242.00	580271.00	783081.00	794238.00
Cadmium	362.45	350.03	341	–	–
Copper	13633.00	13914.00	13433.00	13132.00	12468.00
Iron	378213.00	381661.00	106807.00	438421.00	212399.00
Lead	58657.00	56235.00	53169.00	46308.00	47053.00
Zinc	136437.00	142035.00	150211.00	133734.00	122254.00
Aggregates	5300.00	27020.00	48750.00	41285.00	640529.00
Clays	30878358.00	31115142.75	1036691.50	945019.00	640529.00
Sand	3686715.00	2366234.00	3403784.00	2849376.00	3009015.00
Barite	–	–	–	850	600
Limestone	3623393.00	5208263.00	3048784.00	4142418.00	1582704.00
Kaolin	72000.00	107005.00	61500.00	106000.00	106500.00
Dolomite	–	–	–	6001.00	4771.00
Gravel	4020182.40	3021217.00	4430550.00	4767639.00	3885050.00
Perlite	365	180	31	29	–
Slate	518035.00	437581.00	400000.00	447593.00	388222.00
Dimensionable rocks	11140.00	55700.00	8570.00	9678.00	8450.00
Salt	3000.00	7500.00	7930.81	5450.00	4320.00
Gypsum	156000.00	157304.25	120800.00	168000.00	138050.00
Zeolite	200	–	–	–	–
Coahuila					
Gold (kg)	1.1	1.2	0.2	–	0.1
Plata (kg)	35134.00	41988.00	38860.00	122602.00	134452.00
Antimony	414	380	74	71	5
Bismuth	1170.00	1132.00	854	863	875
Cadmium	–	–	–	863	875.64
Copper	9	9	2	–	–
Tin	19	15	–	–	–
Iron	3233568.00	3838719.00	5179379.00	4595325.00	3601546.00
Lead	568	1340.00	1154.00	964	30
Zinc	–	4	–	–	–
Aggregates	–	1233966.86	618696.00	629927.00	851631.00
Sand	3907928.00	3204500.00	2798574.00	3082474.00	2436000.00
Barite	29977.00	26265.00	30675.00	22161.00	28023.00

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State	2007	2008	2009	2010	2011
Bentonite	47000.00	23500.00	40000.00	15000.00	–
Calcite	16000.00	8000.00	96000.00	84000.00	72000.00
Limestone	3821178.00	5654069.00	6816231.00	5505391.00	2778084.00
Coal	17299221.00	10402658.00	9496189.00	11246639.00	13718159.00
Celestite	96902.00	29621.00	36127.00	31429.00	40699.00
Dolomite	760079.00	813812.00	781398.00	1161069.00	2462119.00
Fluorite	133578.00	139429.00	108930.00	121833.00	119516.00
Gravel	5201658.80	4265300.00	3724296.00	3727381.00	3242400.00
Dimensionable rocks	194735.00	424143.70	506328.70	726328.70	1200.00
Salt	620000.00	18261.00	19309.93	31761.00	–
Silica	736100.00	738467.00	777863.00	814591.00	760940.00
Magnesium sulfate	33900.00	43053.00	34700.00	39400.00	45598.00
Sodium Sulfate	605000.00	618000.00	606000.00	620000.00	630500.00
Gypsum	348447.50	400653.00	270031.00	299113.00	276216.00
San Luis Potosi					
Gold (kg)	1689.00	3588.60	4346.90	4794.50	5619.00
Silver (kg)	109068.00	135123.00	152441.00	179895.00	162084.00
Arsenic	513	–	–	–	–
Cadmium	–	–	–	600.57	609.37
Copper	20198.00	19742.00	19907.00	21632.00	21128.00
Iron	–	–	–	–	693
Lead	3534.00	5608.00	5210.00	4189.00	3736.00
Zinc	65610.00	63463.00	62463.00	58040.00	53489.00
Aggregates	120000.00	2600000.00	1350000.00	462000.00	910000.00
Clays	780090.00	850000.00	950000.00	923000.01	1115000.00
Sand	6628669.00	7492040.00	8398200.00	7777020.00	5405100.00
Bentonite	4800.00	5100.00	6000.00	5800.00	6800.00
Calcite	326016.00	193950.00	197600.00	178600.00	188100.00
Limestone	4160480.00	4462310.00	6375200.00	4802800.00	4675200.00
Quarry	2	21728.00	24600.00	15400.00	17635.00
Kaolin	1760.00	3200.00	3600.00	6300.00	7300.00
Fluorite	799783.00	918220.00	937010.00	945553.00	1087391.00
Phosphorite	6 000.00	–	–	–	–
Gravel	10067726.40	13024000.00	14182020.00	13094500.00	9251300.00
Dimensionable rocks	110560.00	51500.00	48900.00	53000.00	53000.00
Salt	100000.00	8000.00	8459.53	8000.00	8000.00
Silica	31189.00	33657.00	32253.00	34727.00	41682.00
Tepetate	1200000.00	600000.00	3500.00	3500.00	3500.00

(continued)

(continued)

State	2007	2008	2009	2010	2011
Tezontle	1200000.00	600000.00	600000.00	10000.00	2500.00
Gypsum	260030.00	427000.00	1362213.00	461200.00	287756.00

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