

## MEXICO

*By Victor Flores*

**A**s a result of the sluggish global economic environment and its impact on the Mexican economy, Mexico's mining sector struggled relative to 2001, and the production of most key mineral products declined in the year 2002. Despite the improvement in the price of gold, output of this precious metal declined by almost 7%, while silver output grew by 1% even as silver prices remained lacklustre.

The base metals sector suffered as a result of lower commodity prices, with a 24% fall in lead production and a slight decline in zinc output (-3%). Copper production fell by just over 10%. The production of arsenic, bismuth, cadmium, and molybdenum declined, although antimony production increased sharply.

The production of non-metallic minerals was mixed, with increased output of feldspar (+6%), fluorspar (+6%), gypsum (10%) and silica (8%). Barite production, which has been in a downtrend since 1997, declined by a further 7%, despite the high prevailing oil prices. Graphite production declined by over 25%. Sulphur production remained essentially flat.

The country's economy recovered during 2002 despite the slowdown in the US and Europe, although growth remained sluggish. The country's GDP is estimated to have grown by 1.8% in 2002, an improvement over the contraction of 0.3% in 2001. A further improvement is expected for 2003, with GDP estimates of the order of 3.4%. Inflation remained broadly in check at 5.0%, compared with 4.5% in 2001, and is estimated by private economists to average some 4.5% in 2003. The government is estimating 3.0%, and a tightening bias from the central bank could see this goal achieved. The government's plan to maintain a small budget deficit in order to help the economy along was aided by higher oil prices, and the government is expected to achieve a modest budget deficit (as a percentage of GDP) of 0.65% in 2002. The budget deficit is estimated at 0.5% of GDP in 2003, although this is based on a relatively conservative oil price estimate of US\$18/bbl.

The Mexican peso/dollar exchange rate, which averaged MP9.6 to the dollar in 2002, fell to MP10.37 by year-end 2002. Despite the weak economic environment, foreign direct investment was estimated to have increased by 11% in 2002, to US\$13.6 billion. An average exchange rate of about MP10.5 is estimated for 2003.

Opposition President Vicente Fox, who represents the National Action Party (Partido Acción Nacional), has had to contend with a global economic slowdown and a fractious relationship with the Congress. The latter has stalled several initiatives, among them labour and fiscal reforms. With the

election of the country's first president from an opposition party, the mining industry has made a series of proposals with respect to mining taxation aimed at improving the country's competitive position vis-à-vis other mining countries. The proposals touch on areas such as accelerated depreciation, fiscal stability agreements, and tax credits for exploration. Electricity reform, however, is one of the initiatives that has been stalled in Congress.

Mexico's mining regulations have completely opened the mining sector to foreign and domestic investment. Exploration concessions are now granted for a period of six years, but may not be extended. Exploitation concessions are now good for 50 years and can be extended for a like period. In addition, the exploitation concession also confers the right to process and beneficiate any minerals recovered. Mining and exploration leases are now granted in less than six months, and leases are freely tradable. The previous restriction on the exploration for, and development of, sulphur, phosphates, potash, iron ore, and coal have been lifted, as have been the previous restrictions on exploration along the country's coastline and continental shelf, international borders, islands, and reefs.

The Dirección de Minas, responsible for regulating the mining industry, is now part of the recently renamed Secretaría de Economía (SE) (formerly Secretaría de Comercio y Fomento Industrial, SECOFI). The Dirección General de Promoción Minera promotes the development of the mining industry by providing investors with general information about the country's mining industry, guidance for investors, and studies on the Mexican and international mining industry.

The Consejo de Recursos Minerales, or Mineral Resources Council (CRM), continues the process of transferring its leases to the private sector, as part of its goal of becoming purely a geological survey. The CRM has even set up a computer database that allows parties interested in mineral exploration to obtain information on potentially attractive properties. This database is managed by the Centro de Documentación Sobre los Recursos Minerales, CEDOREM. The country's register of mining leases is also on a computerised database. The CRM continues to pursue an aggressive mapping programme designed to provide geological and geochemical information of the country's most prospective ground on a 1:50,000 scale. The Fideicomiso de Fomento Minero (Fifomi) provides financing for the small and medium-size mining companies. During 2002, Fifomi focused on restructuring its loan portfolio, which had a 32% non-performing loan ratio at the end of 2001.

The government continues to reduce the number of hectares of prospective exploration ground held within the National Mining Reserve system, aided by a new set of bidding procedures established by SE. During 2002 the government also proposed a further simplification of the mining law, eliminating the distinction between exploration and exploitation concessions.

The Cámara Minera de México, Mexico's Chamber of Mines, represents the interests of Mexico's private mining sector. At present, one of the chamber's principal priorities is to work with the regulatory agencies to establish clear,

fair environmental laws. The Chamber now sponsors symposia every two years on ecology and mining, and has concluded agreements with the National Environmental Institute (Instituto Nacional de Ecología) to implement measures to reduce lead emissions in accordance with guidelines issued by the OECD.

The chamber also participated in the discussions that led to the amendments to the country's environmental protection laws (Ley General del Equilibrio Ecológico y Protección al Ambiente — LGEEPA). The amendments require an environmental risk assessment and a programme to mitigate accidents, as well as increased penalties for violations of the LGEEPA. The chamber also contributed to the development of regulations concerning effluent standards and emissions of diesel-powered vehicles. The chamber continues to work with the authorities to develop standards for the siting, design, construction, and operation of tailings dams, and the creation of specific environmental regulations for exploration projects.

With respect to taxation, the chamber continues to lobby for the elimination of the asset tax during the pre-production period. On the transportation and infrastructure front, the mining industry originally applauded the much awaited privatisation of Ferrocarriles Nacionales, the government railroad monopoly, but is now lobbying against what it claims are indiscriminate rate hikes. The chamber continues to fight against proposed changes to the rules governing the classification of roadways and the allowable weight of freight trucks. The chamber continues to work with the governmental entity responsible for regulating explosives in order to reduce the restrictions on the use of explosives in mining. The chamber recently successfully lobbied the government to renew the diesel tax credit for the mining sector (Impuesto Especial sobre Producción y Servicios). The industry also obtained a renewal of the favourable water use fees for the mining sector.

The chamber has also initiated a programme to work more closely with agrarian communities located in those areas where exploration and mining take place. The strong increase in exploration activity has led to instances of friction between owners of surface rights and the mining companies. Some of these conflicts are due to ambiguous interpretations between the Agrarian Law (Ley Agraria) and the country's mining law. This remains a priority issue for the mining sector.

Mexico's mining industry can be broadly divided into three categories, large domestic producers, small domestic producers, and foreign firms. A fourth category, state-owned mining companies, disappeared with the last of the privatisations in 1993.

There are four large domestic producers operating in Mexico – Industrias Peñoles, a diversified producer of precious and base metals and the world's largest producer of refined silver; Grupo México, also a diversified producer, responsible for over 90% of the country's copper production; Empresas Frisco, also a diversified producer of precious and base metals; and Luismin, the smallest of the four and devoted exclusively to precious metals.

Mexico is an important producer of a number of mineral products. It is ranked number one for the production of silver, bismuth, and celestite, and is one of the world's top five producers of fluor spar, arsenic, cadmium, graphite, and molybdenum. Mexico ranks among the world's top ten in the production of barite, manganese, salt, lead, and zinc. Mexico's exports of mineral products (including value-added beneficiation) reached an estimated US\$1.63 billion in 2002 (US\$1.97 billion in 2001), whilst imports totalled an estimated US\$1.53 billion (US\$1.58 billion in 2001), providing the country with a positive balance on mineral products of approximately US\$100 million.

### **Copper**

After posting significant growth in previous years, Mexico's copper production declined in both 2001 and 2002, with last year's output totalling 308,338 t, a decrease of 10%. The country's two largest producers, Cananea and La Caridad are located in the north of the state of Sonora. Both operations are part of Grupo México, which last year struggled to refinance its debt in the aftermath of its hostile take-over of US-based Asarco in 1999; a final debt restructuring agreement, however, was reached at the end of 2002. The company was unable to meet scheduled interest and principal repayments due to the low price of copper. Despite this setback, production was largely unaffected. With the completion of the smelter and refinery complex at the nearby La Caridad mine, production at Cananea improved by 11.7% to 153,290 t during 2002. The orebody has a reserve estimated at 1,600 Mt averaging 0.61% Cu, plus an additional 1,550 Mt of leach material averaging 0.26% Cu. The project's SX/EW capacity is currently 35,000 t/y, but this is expected to increase to 85,000 t/y with the construction of additional capacity. Schedule for completion by the end of the year 2000, delays pushed back the start-up to August 2001.

A strike at Cananea in late 1998 prompted the closure of the smelter, which was due to be closed as part of the environmental protocols that accompanied the signing of the North American Free Trade Agreement. Production at La Caridad declined by 31%, to 115,219 t, in 2002 due to a strike which affected production during March and April. This deposit has a reserve of 426 Mt averaging 0.52% Cu and leach ore totalling 187 Mt averaging 0.24% Cu. The concentrator has a capacity of about 170,000 t/y and the new SX/EW facility has the capacity to produce 22,000 t/y of copper cathode.

The smelter at La Caridad began to produce at its expanded capacity of 300,000 t/y at the beginning of 1997. The expansion includes the construction of new sulphuric acid and oxygen plants. In addition to the expansion of La Caridad smelter, Grupo México completed work on the copper refinery, with annual capacity of 300,000 t, which reached full capacity in early 1999. The facility is adjacent to the smelting facilities at La Caridad and includes a gold and silver refinery, and a copper rod plant. Grupo México, through its IMMSA subsidiary, also operates a copper smelter in the city of San Luis Potosí.

The state of Zacatecas is also an important copper producer, boasting production from Industrial Minera México's polymetallic operation at

Sombrerete, where copper production fell marginally, to 21,927 t, in 2001. In Chihuahua, production is centred at Santa Bárbara (7,476 t in 2002, a decrease of 12%), the polymetallic San Francisco del Oro deposit (closed in 2002 due to low commodity prices) operated by Empresas Frisco, and Fresnillo's Naica operation in Saucillo (10% decline in production to 2,256 t). Output at Industrial Minera México's polymetallic operation at Charcas in San Luis Potosí was steady at 16,529 t. Minor copper production was reported by the states of Durango, Hidalgo, Michoacán, the state of Mexico, and Sinaloa.

Grupo México owns El Arco, a deposit located in Baja California. The deposit has a reserve of 1,000 Mt averaging 0.50% Cu and 0.2 g/t Au, containing both sulphide and oxide ores. The original development plans envisioned an operation treating 2.1 Mt/y to produce a sulphide concentrate. A development decision continues to be deferred as a result of low metals prices.

Peñoles continues to advanced the Milpillas project in Sonora, which now has an indicated resource of 30 Mt averaging 0.25% Cu. The company has initiated project development, with a total capital commitment of US\$180 million and production of 60,000 t/y of cathode copper expected by 2005.

### **Gold and Silver**

A favourable investment climate, coupled with a favourable financing environment, led to a boom in gold exploration in Mexico in 2000. Although gold prices turned up in 2002, production declined by almost 7% last year, with the largest impact felt by the smallest producers.

Production in 2002 fell to 23.3 t (747,616 oz), although production from the state of Sonora, which had firmly held on to first place among Mexico's gold-producing regions, has fallen off dramatically. The Penmont joint venture, owned 56% by Peñoles and 44% by Newmont Mining, manages the state's largest producer, La Herradura near Puerto Peñasco on the Gulf of Cortez. This large, low-grade deposit has a proven and probable reserve of 64.1 Mt of ore at an average grade of .029 oz/t Au. Production in 2002 totalled 145,000 oz at a cash cost of US\$176/oz.

At Peñoles' La Ciénega project, located in the state of Durango, production increased by about 13%, to 3.7 t in 2001. This project has a total reserve of 4.2 Mt at a grade of 5.85 g/t Au, 120 g/t Ag, 1% Pb and 0.8% Zn.

The sale of San Luis' mining interests in early 2002 for US\$90 million put these projects, held by mining subsidiary Luismin, into the hands of Canadian producer Wheaton River. The San Martín mine in the state of Querétaro, which came on stream in 1993, produced approximately 1.1 t last year, while the company's La Guitarra mine in the state of Mexico produced 220 kg. The San Dimas mine in the state of Durango produced 1.35 t in 2002.

Production from the state of Guanajuato is still centred around the Torres Mine, operated by Minera Las Torres, a subsidiary of Peñoles. Due to a declining reserve profile, production declined by 22% in 2002, to 2.4 t.



Gold is also produced as a by-product or co-product at many mines throughout the country, including Fresnillo's operations in Zacatecas, which produced 853 kg in 2001, Santa Bárbara in Chihuahua (231 kg), and Real del Monte near Pachuca in the state of Hidalgo (112 kg).

Other gold production is derived from smaller operations in Durango and San Luis Potosí, usually as a by-product of silver production.

Minas de Bacis, operator of mines at El Herrero in the Otáez district of Durango reported lower production of 775 kg, a decline of over 25%. The Panuco de Colorado and Guanaceví districts (Durango) reported 2001 production of 1 kg (168 kg in 2001) and 29 kg, respectively. Gold by-product from the copper porphyry at Cananea fell again, to 235 kg, while by-product gold from La Caridad also suffered, falling to 135 kg. The Villa de la Paz district (San Luis Potosí) reported production of 845 kg in 2001, a decline of 28 kg on the previous year.

A number of projects that led to Mexico's gold boom are now at the end of their lives. Geomaque Explorations, a Toronto-based company, completed mining at the San Francisco property north of Hermosillo, and is currently decommissioning the operation. The project produced 180 oz in 2002. Empresas Frisco's San Felipe underground mine, located at the northern end of Baja California, closed at the end of 2001 when the project's reserves were exhausted.

A number of other projects remain on hold, due in part to a lack of funding. Cambior has written off its US\$14 million investment in the Metates property, where it is earning a 50% interest from Luismin. This large, low-grade deposit, located in the northwest corner of the state of Durango, hosts a resource of some 434 Mt averaging 0.75 g/t Au and 18.6 g/t Ag. The mineralisation is hosted by sediments, believed to be of Cretaceous age, and by quartz-feldspar porphyry.

Meanwhile, work has been suspended at the Paredones Amarillos project at the southern end of the Baja California peninsula. Echo Bay Mines sold its 60% interest in the project in October 1999 to partner Viceroy Resources for a 2% royalty and the joint venture's interest in the mill. The partners had outlined a reserve of 44.5 Mt at a grade of 1.1 g/t Au in La Paz crystalline complex.

Having completed a prefeasibility study on its Guadalupe de los Reyes gold property in Sinaloa, Northern Crown sold the property to Meridian Gold. Northern Crown had reported a resource of 5.8 Mt averaging 1.35 g/t Au, but Meridian will now pursue the project as a low-tonnage, high-grade target.

The Penmont joint venture between Peñoles and Newmont Mining has suspended work on the Bermejil deposit at its Mezcala project in the state of Guerrero. Located less than 500 m from the Nukay/Teck deposit at Los Filos, reserves at Bermejil total 62.5 Mt averaging 0.8 g/t Au.

Despite the closure of some operations, the recent improvement in the price of gold has improved the fortunes of a number of gold projects that had been on hold. During 2002, Glamis Gold acquired Francisco Gold, owner of the El Sauzal gold project in southern Chihuahua. A reserve calculation completed by Glamis subsequent to the transaction indicates a proven and probable reserve of 2.0 Moz, based on an average grade of 3.37 g/t Au. Glamis has begun the US\$100 million development of a project with annual throughput of 1.7 Mt, for annual production of 170,000 oz at a cost of US\$115/oz.

Metallica Resources recently completed the acquisition of an additional 50% interest in the Cerro San Pedro project, near the city of San Luis Potosí, from partner Glamis Gold for US\$18 million in phased payments. In December 2000, the joint venture announced the results of an updated feasibility study, based on a reserve of 49.2 Mt averaging 0.57 g/t Au and 23 g/t Ag. The feasibility study envisages a run-of-mine heap leach operation with production of 118,800 oz of gold equivalent, with cash costs of US\$129/oz gold equivalent and capital costs of US\$45 million. During the 2001, the joint venture completed the construction and relocation of the village of La Zapatilla, although for some time the work was suspended due to low gold prices and the untenable management structure.

Teck Cominco and Miranda Mining of Mexico City have identified geological resources in excess of 2.2 Moz on their joint venture ground in the state of Guerrero. Feasibility work is ongoing to confirm the extent of the reserves and to establish conceptual project economics for Los Filos, a project that contains an indicated resource totalling 55.0 Mt averaging 1.25 g/t Au. Miranda's adjacent Nukay project produced 14,435 oz in 2002 from the Nukay and La Agüita open pits. At the end of 2002, Miranda acquired the 30% of the project held by its partner, Teck Cominco.

Minefinders Corp. continued the economic evaluation of the Dolores project in southwestern Chihuahua during 2002. The gold and silver mineralisation at Dolores is associated with a series of brecciated and stockwork veined felsic dykes, and recent work has identified a number of higher-grade feeder structures. Drilling has better defined the resource into measured, indicated and inferred categories, and now includes economic parameters as well. A resource audit conducted in 2002 confirmed a total resource of 115.5 Mt averaging 1.47 g/t Au equivalent at a cut-off grade of 0.3 g/t. Recent work has provided the company with a better geological model of the region, leading to the development of new targets.

Queenstake Resources has begun production at the Magistral project in Sinaloa, which was acquired when the company merged with Santa Cruz Gold in 1999. The four open pits have a total reserve of 6.15 Mt averaging 1.86 g/t Au, with additional material contained in tailings. Moreover, recent drilling has extended the mineralisation. The project is expected to produce 38,000 oz/y over seven years at a cash cost of US\$180/oz. The capital cost is estimated at US\$12.5 million. Queenstake has also exercised an option to acquire the Santa Gertrudis gold project in the state of Sonora from Campbell Resources. The project has been on care-and-maintenance since late 2000

as a result of the low gold price, and Queenstake plans to use the equipment at Santa Gertrudis to develop Magistral.

The Mulatos project, located in the southeast corner of Sinaloa state, was sold by joint venture partners Placer Dome (70%) and Kennecott (30%) at the end of 2000, and is now owned by Alamos Gold (itself the product of a merger between Alamos Minerals and National Gold). The project, renamed Salamandra, has a geological resource of 1.99 Moz (51.2 Mt at 1.2 g/t Au), although recent work has focused on the higher grade Estrella Zone, which contains an estimated 1.8 Moz.

Despite the ongoing weakness in silver prices, Mexico's silver production in 2002 increased by 1% to 2,852 t (91.7 Moz), primarily as a result of the expansion at Sabinas and Fresnillo. Peñoles' operations in Torreón account for some 1,500 t/y of refined silver.

Peñoles remains the country's largest silver producer, and production at its Proaño operation near Fresnillo in the state of Zacatecas totalled 912 t as a result of the project's expansion. Three vein systems – Santo Niño, San Ricardo, and San Mateo – are exploited by cut-and-fill methods, and during 2001 the expansion from 0.9 Mt/y to 1.2 Mt was completed.

Of Peñoles' other silver operations, the US\$40 million Rey de Plata mine in the Taxco region, a joint venture with Dowa Mining of Japan, boasts reserves of 2.9 Mt averaging 239 g/t Ag and 8% Zn. Commercial production commenced in the last quarter of 2000 at a rated capacity of 330,000 t of ore. The project was put on care-and-maintenance in December of 2001 as a result of low commodity prices and reported no production in 2002.

Las Torres, in the state of Guanajuato reported production of 153 t, a decline of almost 7%, while output at Naica, in the state of Chihuahua, rose by 6%, to 157 t. In Hidalgo, the Zimapán mine contributed 34 t to Peñoles' silver output in 2002, although production at this operation declined by 13%. Production from Peñoles' gold-silver mine at La Negra near Cadereyta, Queretaro, was marginal. Reopened in 1995 at an annual rate of 300,000 t/y the project has exhausted its reserves.

Industrial Minera México is also an important producer of silver, although most of it is recovered as a by-product or co-product at its polymetallic operations. Production at the Charcas operation in the state of San Luis Potosí decreased to 56 t in 2002 (64 t in 2001), while at Taxco in Guerrero production increased, to 63 t (59 t in 2001). Production at the operations in Chihuahua fell with respect to the previous year. Production at Santa Bárbara fell by 19% to 139 t, while San Francisco del Oro remains on care-and-maintenance.

IMMSA's San Martín operation, also in Zacatecas near Sombrerete, reported a decrease in production of almost 6%, to 199 t.

Production at the historic Real del Monte mine in the state of Pachuca continued to decline, falling to 32 t in the year 2002. Project operator Real del



Monte Mining, part of the GAN Group, has suffered from a lack of working capital and is unlikely to proceed with previously announced expansion plans.

Real de Angeles, part of Grupo Frisco, remained closed during 2000 whilst Minas de Bacis, located in the state of Durango, produced 63 t, a 35% decline in production with respect to 2001. Silver by-product production from Peñoles' La Ciénega mine totalled 72 t in 2002, unchanged with respect to the prior year.

The San Dimas mine, now owned by Canada's Wheaton River, produced 122 t in 2002, a 20% improvement. Smaller mining operations, which once produced a significant amount of silver in the largely artisanal districts of Cuencamé, Guanaceví, and Panuco de Coronado, reported virtually no production during 2002.

Pan American Silver of Vancouver continued to develop its La Colorada mine, in the state of Zacatecas. The company reports reserves of 2.64 Mt averaging 455 g/t Ag, hosted by veins, or 38.6 Moz of contained silver. Additional drilling has extended the deeper, replacement-style mineralisation, now totalling 5.0 Mt averaging 108 g/t Ag. The US\$20 million project is expected to be complete in July 2003, with annual production of 3.8 Moz/y of silver. The company also acquired the Alamo Dorado project in the state of Sonora (through the merger with Corner Bay Minerals), which contains a proven and probable reserve of 35.5 Mt averaging 68 g/t Ag, or 78 Moz. During 2003, Pan American will focus on feasibility level work for an open-pit operation; a feasibility conducted by Mintec on behalf of Corner Bay indicated a project capable of producing 6 Moz of silver over eight years at a capital cost of US\$45 million.

### **Lead and Zinc**

Although one of the world's most important producers of lead and zinc, Mexico was not immune to the low commodity prices prevailing during 2002. Year-on-year zinc production in 2002 fell by 3% to 391,711 t as higher production at Charcas and Naica, and steady output at Tizapa, were offset by lower production at Zimapán, Bismark, Santa Bárbara and other operations. The first full year of production at Francisco I. Madero also helped make up for these losses.

The Charcas mine in the state of San Luis Potosí, produced 67,843 t last year, up from 63,860 t a year earlier. The San Martín mine in Zacatecas reported lower production in 2002 of 51,440 t, the result of a strike early in the year. The Tizapa operation in the state of Mexico, a joint venture between Peñoles (51%) and Dowa Mining (49%), came on stream at the end of 1994 and has reserves of 3.2 Mt averaging 250 g/t Ag, 8.5% Zn and 1.3% Pb, plus minor amounts of gold. This underground operation produced 30,527 t of zinc in 2002, virtually unchanged with respect to 2001.

Chihuahua remains the country's largest zinc-producing state. Peñoles' Bismark underground mine is the state's largest producer, and reported production of 46,126 t in 2002 (compared with production in 2001 of 51,293 t).

Production was affected by a 40-day shutdown due to flooding after mining activities broke across a fault. This polymetallic skarn deposit has reserves of 3.75 Mt at an average grade of 6.7% Zn, 0.42% Pb, 0.39% Cu, and 40 g/t Ag. A cut-and-fill mining method is employed to feed a 2,400 t/d concentrator. The Santa Bárbara mine also delivered lower production, reaching 37,050 t in 2002 (44,551 t in 2001). At Naica, in the Saucillo district of Chihuahua, zinc production in 2002 improved by almost 20% to 38,127 t. Grupo México's Santa Eulalia mine remained on care-and-maintenance as a result of low prices, despite the benefits of a previously-announced expansion. Also in Chihuahua, San Francisco del Oro (1,608 t in 2001 and 21,785 t in 2000) remained closed as well, pending a recovery in zinc prices.

The country's newest zinc producer, the Francisco I. Madero mine in the state of Zacatecas, started up on schedule in July 2001. The orebody has reserves of 30 Mt averaging 5.2% Zn and 1.10% Pb and, at full capacity, the mine will process some 3 Mt/y of ore for the production of 110,000 t/y of zinc. During 2002 the mine produced approximately 84,209 t, but by year-end was rapidly building up towards its rated production. The project was brought on stream at a total capital cost of US\$125.8 million, slightly below budget.

Mexico's lead production is estimated at 112,244 t in 2002, a year-on-year decline of 23.6%. The bulk of the country's lead is produced in the northern state of Chihuahua.

Production at Fresnillo's Naica unit in Saucillo increased by almost 11% in 2002, to 48,931 t (2001: 44,268 t), while output at Santa Bárbara fell to 18,475 t (2001: 20,809 t). As mentioned, San Francisco del Oro did not report any production, as operations at the mine were suspended. The same occurred at Santa Eulalia, which was closed. The Real de Angeles mine in Zacatecas also remained closed during 2002, having last been in operation in 1998.

Two other important lead producers are Zimapán in the state of Hidalgo and San Martín in the state of Zacatecas. Zimapán reported lower production of 5,388 t, while production at San Martín actually rose to 9,387 t. The new Francisco I. Madero mine also contributed a small amount as the operation hit full production in 2002. The Charcas project in San Luis Potosí contributed an additional 4,308 t in 2002, a 12% decline with respect to the prior year.

Peñoles is Mexico's largest producer of refined lead and zinc. The company operates a refinery in Torreón, state of Coahuila, which includes a silver-lead refinery with annual capacity of 150,000 t and an electrolytic zinc refinery that can produce 220,000 t/y of zinc. This facility also recovers cadmium, bismuth, antimony, ammonium sulphate, sulphur dioxide and sulphuric acid. The company completed a US\$130 million expansion of the refinery at the end of 2000, which has lifted annual capacity to 220,000 t. The facility has been under scrutiny by the environmental authorities as a result of elevated levels of lead in the surrounding communities.

Industrial Minera México operates a zinc refinery in San Luis Potosí with the capacity to produce 100,000 t/y of high-grade zinc, as well as sulphuric acid

and refined cadmium. The facility was the subject of a brief strike during 2002. The company's 85,000 t/y capacity lead refinery at Monterrey, in the state of Nuevo León, has been converted into a facility to recover gold and silver from anode slimes.

Teck Cominco has put the development of the San Nicolás project in the state of Zacatecas on hold due to the low prevailing zinc price. During 2001, the company completed a feasibility for the project but decided to defer a production decision as a result of low commodity prices. The most recent resource includes 1.88 Mt in the measured category averaging 3.76% Zn and 0.73% Cu, 78 Mt in the indicated category averaging 1.8% Zn and 0.9% Cu, and a further inferred resource of 7 Mt averaging 1.4% Zn and 0.14% Cu.

At the Campo Morado project in the state of Guerrero, work by Farallon Resources on the precious metals-rich massive sulphide deposits remains suspended pending the resolution of an ownership dispute.

### **Iron and Steel**

Despite the financial problems experienced by the country's principal producer, Mineral del Norte (Minosa), the steel tariffs imposed by the US (which exclude Mexico due to its NAFTA status), helped both the iron ore and steel industries. Mexico's iron-ore production increased to 5.75 Mt in 2002, compared with 5.54 Mt in 2001. Mexico's largest reserves of iron ore are found at Hércules (168 Mt) and Peña Colorada (131 Mt), which has been the subject of a border dispute between the states of Colima and Jalisco. (The state of Jalisco claims that the deposit falls within its state boundary, a dispute the state of Jalisco has apparently lost because even production from Las Encinas is now reported under Colima in the official statistics.)

The Peña Colorada mine in the state of Colima has an annual capacity of 3.0 Mt of concentrates that are pelletised at the company's facilities at the nearby port of Manzanillo. Output at the pelletising plant totalled 2.19 Mt in 2002, an increase of 6% from the previous year. Las Truchas in the state of Michoacán, operated by a subsidiary of Villacero, reported production of 0.82 Mt, a decline of 37% with respect to 2001. This was the result of a strike in January and a subsequent explosion in one of the converters at the steel plant.

The Hércules mine in the state of Coahuila produced 1.95 Mt in 2002, a decline of 9%. The development of a tailings retreatment project will allow the mine to maintain an annual capacity of around 2 Mt/y, while the discovery of the Ulises deposit will extend the life of the project by over 20 years.

Minosa, which had resumed operations at the Cerro de Mercado mine in the state of Durango during 2000, reported no production in 2002. The project has an annual capacity of 3.0 Mt and delivered production of 400,000 t during 2000. La Perla mine in the state of Chihuahua, which is also owned by Minosa, did not resume production in 2002 either. Las Encinas, in the state of Jalisco, was closed at the end of September 2000 but operated during most of 2002, with production of 0.78 Mt. Reserves at Las Encinas have been increased to 157 Mt following the discovery of 24.3 Mt of additional mineralisation at Cerro Nahuatl.

Steel production increased in 2002 to 14.1 Mt despite the difficult macro-economic environment. As noted, the tariffs on steel passed by the Bush administration helped the Mexican steel industry, which was exempted from the Section 201 tariffs as a result of its NAFTA (North American Free Trade Agreement) status. Mexican steel producers have also argued that Asian and Eastern European steel producers have been 'dumping' steel onto the Mexican market. In early 2002 the government announced that it would be raising tariffs by 35% on steel imports from several Asian and European countries with which Mexico does not have trade agreements.

The privatisation of the steel industry has resulted in the formation of five large steel producers and a handful of mini-mill producers. Grupo Acerero del Norte (GAN) controls Altos Hornos de México (AHMSA) and Fundidora de Monterrey. The company's principal product is sheet steel, production of which fell to 2.5 Mt in 2002, whilst production of raw steel was slightly greater than 2.9 Mt and accounted for 23% of national raw steel output. The start-up of a third blast furnace should see production increase during 2003. AHMSA's restructuring was bogged down when the talks between the company and its creditors broke down, although the company's operations have been largely unaffected.

In 1995, GAN purchased Aceros Nacionales (ANSA), the largest and most modern producer of steel wire in the Mexico City area, but this facility was sold to Grupo DeAcero for US\$68 million during 1998. In May 1999, GAN and AHMSA declared bankruptcy and were awarded protection from creditors whilst a financial rescue package was implemented. Spanish steel producer Aceralia was interested in entering a deal with AHMSA, but backed off upon closer examination of the company's financial status.

Ispat Mexicana was established when Indian interests purchased Siderúrgica del Balsas, part of the facilities that comprised the Siderúrgica Lázaro Cárdenas (Sicartsa II) complex. Ispat's main facilities include a 4 Mt/y pelletiser plant and two DRI plants with annual capacities of 2.3 Mt and 1.5 Mt, respectively. The company's furnaces have the capacity to produce 5.3 Mt/y of liquid steel.

Ispat, which produces hot and cold-rolled sheet and steel slab, primarily for the export market, has signed a deal to supply 1 Mt of slab to galvanised steel producer Industrias Monterrey (IMSA). For its part, Industrias Monterrey (IMSA) plans to increase its production of hot-rolled steel to 2.2 Mt/y, and in the year 2000 announced the acquisition of BHP Steel's operations in the US.

Grupo Villacero, the largest rebar producer in North America, operates the Sicartsa I unit, producing primarily rebar, which is then processed further by the company's plants in Monterrey (Simisa), Guanajuato (Sibasa), Mexico City (Camsa), Veracruz (Metaver), and El Paso, Texas (Border Steel). Production in 2002 was affected by an explosion in one of the converters early in the year and by a strike in the fourth quarter. Overall, Villacero operated at 40% of capacity in 2002. The company's other production subsidiaries include Tubería Nacional (steel tubing), Cintacero (steel belts),

and Zincacero (galvanised steel). Speciality products, primarily steel mesh, are produced by two subsidiaries, Viga Trefilados in Michoacán and Temple in Veracruz.

Hylsa, the steel making subsidiary of Grupo Alfa, produces hot and cold-rolled sheet, galvanised steel, steel rod and rebar. The company's direct reduction plant in Monterrey, completed during 1998 at a cost of US\$400 million, has an annual capacity of 700,000 t. The company also completed the expansion of its mini-mill that will have an annual capacity of 1.5 Mt. Shipments of Hylsa's finished products increased moderately in 2002 to 2.78 Mt, up from 2.34 Mt in the year 2000. As a result of improved demand the company restarted an additional furnace with annual capacity of 600,000 of pig iron and a hot-rolled sheet facility with annual capacity of 350,000 t. During 2002, the company finalised an agreement with its creditors on a financial restructuring package after suspending debt repayments at the end of 2001. At the end of 2002 the company's debt was upgraded by Fitch.

Tubos de Acero de México (Tamsa) is Mexico's only producer of seamless steel pipe, used primarily in the petroleum industry. During 1995, Argentine seamless pipe producer Siderca acquired a 37% interest in Tamsa and took over management control, creating the world's second largest producer of seamless drilling pipe. During 2002, Tamsa was taken over by Tenaris, a Luxembourg-based seamless company created by Techint of Argentina to house its seamless pipe holdings, including Tamsa, Siderca and Dalmine of Italy. The company produced 590,350 t of steel pipe in 2002, down from 616,017 t in 2001, as reduced international drilling activity led to a decrease in demand. Production in 2002 was curtailed as a result of flagging demand.

Several mini-mill firms are also producing a variety of steel products. Industrias Campos Hermanos (ICH) is a producer of speciality steels, steel alloys and welded pipe. The company's 120,000 t/y capacity mini-mill has been operating below capacity, as has the acquired 185,000 t/y welded pipe facility at Monclova, Nuevo León.

ICH completed the acquisition of an 82% stake in Grupo Simec for US\$285 million during the first quarter of 2001. Grupo Simec, a division of Grupo Sidek, produces both steel and aluminium products. The company has a total capacity of 840,000 t/y at its plants in Guadalajara, state of Jalisco, and Mexicali, state of Baja California Norte. Production in 2002 totalled 609,202 t. The company's principal products are steel bars and rebar. Following the acquisition, ICH announced that it intends to invest US\$190 million in the company.

### **Manganese**

Minera Autlán is Mexico's primary manganese producer. Having been a state-owned enterprise, the company was privatised in 1993. The purchaser, Grupo Ferrominero, committed to invest US\$66 million in the operation over the next five years as part of the purchase package. Despite the positive results following the privatisation, production has suffered as a result of weaker demand from the steel sector and high natural gas prices. Production in 2002



fell by 37%, to 391,711 t, having already fallen by 34% in 2001. Operations were affected in 2002 by low demand. During 2002, Autlán continued its financial restructuring process.

The company's principal operations are located in the state of Hidalgo. The Molango deposit is a manganiferous limestone averaging approximately 27% Mn; the processing facilities produce manganese nodules.

Elsewhere, the deposits in the Tetzintla area occur as manganese oxides and average 38% Mn. The company's mine at Terrenates, in the state of Chihuahua, produces ore with a high Mn:Fe ratio. The company produces ferroalloys at three different plants. The Tamós plant in the state of Veracruz produces silicomanganese and ferromanganese, as does the Gómez Palacio plant in Durango. The former benefited from an US\$8 million investment to boost production by 18,000 t/y, but was also shut down as a result of high fuel prices. The Tezuitlán plant in the state of Puebla, which produces silicomanganese, was reopened in mid-2002 as a result of improving market conditions.

### **Molybdenum**

The majority of Mexico's molybdenum is produced as a by-product of copper production at La Caridad copper porphyry mine in Sonora, and molybdenum concentrates are exported to the US, the UK, the Netherlands and Germany.

Output in 2002 is estimated at 3,428 t, a 37% decrease with respect to 2001. The country's molybdenum production had been growing since 1997 as a result of the expansion of the molybdenum plant at La Caridad, prompted by an increase in the molybdenum grades being mined. The country's second producer is Molymex, located in the Cumpas district of Sonora, which during 2002 completed the installation of an acid plant as part of a long-term plan to reduce the emission of pollutants.

### **Antimony**

Antimony production arrested what had previously been a steep decline, rising by 124% (having declined 61% in 2000 and by 79% in 1999) to 208 t, but still a fraction of the 1,800 t produced in 1995. Mexico's primary producer is Minera y Refinadora Mexicana, which mines stibnite ores in the Real de Catorce district in the state of San Luis Potosí. Antimony is also produced in the Tejocotes region of Oaxaca, and resources of this metal are known to occur in the states of Puebla, Sonora, and Zacatecas. Antimony trioxide is produced at Peñoles' facility in Bermejillo, Durango, and at Industrial Minera México's refinery in Monterrey. Production is exported primarily to the US.

### **Other metals**

Mexico is an important producer of a number of other ferrous and base metals. Arsenic production decreased 18% to 1,945 t in 2002 from 2,381 t in 2001 although output remains depressed, having reached a peak of 4,450 t in 1993. Arsenic is recovered from the refining of base metals at the Met-Mex refinery of Peñoles in Torreón and at Industrial Minera México's refinery in San Luis Potosí.

Mexico remains the world's largest producer of bismuth, even though production has been erratic in recent years. Bismuth is recovered from the processing of base and precious metals at the Met-Mex refinery in Torreón and by Industrial Minera México. From an output level of over 1,600 t in 1997, production in 1999 plunged to 560 t, then recovered to 1,080 t in 2000, and grew further to 1,391 t in 2001. Production in 2002 continued this erratic trend, falling 19% to 1,126 t. As Mexico's consumption of bismuth is only around 50 t/y, the rest is exported, primarily to the US and Belgium.

Cadmium production fell only slightly in 2002 to 1,399 t, but is still well below the 1,891 t recorded in 1997. The Charcas mine in the state of San Luis Potosí, and the San Martín mine in the state of Zacatecas account for the bulk of Mexico's production. Refined metal, meanwhile, is recovered at the Met-Mex refinery in Torreón and at Electrolítica de Zinc's refinery in San Luis Potosí. Cadmium oxide, once produced at Industrial Minera México's now-idled Chihuahua base metal refinery, is now recovered at Peñoles' facility at Bermejillo, in the state of Durango. Mexico consumes about 180 t/y of cadmium and exports the remainder.

Mexican tin production, which has declined dramatically in the past decade, remains at depressed levels. Having once produced 600 t/y, production in 2002 was only 12 t. Tin is recovered as cassiterite from small alluvial operations.

Mexico's tungsten production has plummeted. Having produced 173 t in 1997, no production has been reported since 1999.

### **Barite and Celestite**

Mexico's production of barite, which had bounced back in 2000, fell again in 2002, to 132,836 t. The largest consumer of Mexican barite has and continues to be the state-owned oil company, Petróleos Mexicanos; national capacity, at 400,000 t, was developed solely to satisfy Pemex's ambitious oil exploration and development plans. Despite the rebound in the oil price and Pemex's much improved finances, barite demand remains depressed.

Baramín produced 111,801 t at its facilities in Galeana in the state of Nuevo León, a 10.8% increase with respect to 2001. The remaining producers are Barita de Santa Rosa and Barita de Parral, in Coahuila, all of which had reduced output during 2002. Barita de Sonora, one of the country's primary producers, has been suspended since 1998.

Celestite production declined significantly after experiencing several years of growth driven by strong demand from the electronics sector and an improved competitive position due to the devaluation of the currency. Mexico is the world's largest producer of celestite, accounting for some 25% of global production. Output in 2002 totalled 109,314 t. Celestite is produced by Estroncio de México at its Cuatrociénegas facility and by Minas de Estroncio at its Coahuila unit, both in the state of Coahuila.

Production of strontium carbonate for export takes place at a facility in the city of Reynosa along the border with the US. This operation has a capacity of over 22,000 t/y. Minera La Valenciana, in the state of Coahuila, is the country's primary producer of this strontium mineral, which is refined to strontium carbonate at the company's facilities in Torreón.

### **Fluorspar**

Mexico's production of fluorspar grew by 5.8% to 666,379 t in 2002. Although still well below the country's peak output of nearly 1.0 Mt during the 1980s, the strength in worldwide demand for acid-grade fluorspar for the production of the new generation of refrigerants, as well as higher prices, has helped improve Mexico's competitive position. The two principal producers in San Luis Potosí are Minera Las Cuevas and Fluorita de Río Verde, and the companies' operations produced 517,051 t in 2002, an increase of 11.5% over 2001.

Minera Las Cuevas, Mexico's largest producer of fluorspar, operates a high-grade operation with a capacity of 430,000 t/y. In response to demand for higher quality concentrates, the company has invested US\$25 million in a new calcine plant.

Fluorita de Río Verde, meanwhile, also located in San Luis Potosí, has an annual capacity of 160,000 t. Fluorita de México produces fluorite from its underground operations at Muzquiz, Coahuila, where mining is carried out by room-and-pillar methods. The project produced 95,217 t in 2001. The Acuña district contributed an additional 37,008 t.

### **Graphite**

Graphite production in 2002 fell to 15,956 t, a 26% decrease with respect to the previous year. The country still ranks as one of the world's top five graphite producers, but its resource base of 3.1 Mt place it second in the world. Virtually all of the country's production is centred near the city of Hermosillo in the state of Sonora. Mexico's principal producer is Grafitos Mexicanos, which accounts for about 45% of the country's output. Another important producer in Sonora is Minera Internacional Midas. About 95% of the country's production is in the form of amorphous graphite. An additional 5,000 t of crystalline graphite is produced by Grafito de México in the San Francisco Telixtlahuaca region in the state of Oaxaca.

### **Salt**

Mexico's production of salt is estimated at 8.58 Mt in 2002, a slight decline with respect to 2001. Most of Mexico's salt production comes from the Guerrero Negro Complex, located on the Pacific coast in the state of Baja California Sur. Exportadora de Sal, operator of Guerrero Negro, is a joint venture between the Mexican Government (51%) and Mitsubishi (49%). The proposed US\$120 million Salitrales de San Ignacio expansion project remains on hold as a result of strong environmental opposition, although the government continues to study the potential environmental impact of the project. Production includes several grades of salt, including table salt, industrial salt, and salt for de-icing. Approximately 99% of the production is

destined for the export market, primarily to Japan, South Korea, New Zealand, Canada and the US. The country's remaining production can be attributed to Salinera de Yucatán, Azufrera Panamericana, and a handful of small producers.

### **Other non-metallic minerals**

Mexico's gypsum production, which reached a high of 4.2 Mt in 1997 as a result of healthy growth due to healthy construction in the US, rebounded by 10% in 2002, to 3.12 Mt. The country's principal producer is Yeso San Marcos, with annual capacity of 2.0 Mt. Minera Caopas recovers gypsum from its facilities at Santa Rosalía in the state of Baja California Sur. The project has reserves of around 150 Mt and an annual capacity of 1.0 Mt. The completion of a 4 km conveyor and a 1,250 t/h loading facility will enable Caopas to increase its production to 2.0 Mt/y. Yeso Mexicano produces approximately 175,000 t/y, while the balance of the country's production comes from small producers.

The production of phosphates plunged by 55% in 2002 to 460,000 t. Production had reached record levels after the country's largest producer, Roca Fosfórica Mexicana, was successfully privatised. The operation, however, was devastated by a hurricane and the operations remain closed while the company attempts to obtain a US\$80 million insurance settlement (which apparently was paid by re-insurers but embezzled by employees of the principal insurance company). Roca Fosfórica has traditionally accounted for about 75% of the country's phosphate production. Minerales no Metálicos de Puebla produces about 150,000 t/y.

Mexico's sulphur production grew by 1% in 2002 to 885,492 t. The country's two producers, Azufrera Panamericana and Compañía Exportadora del Istmo, shut down their Frasch sulphur facilities at the end of 1993, and these operations remain in government hands (technically, they are owned by state-owned oil monopoly, Pemex) after a failed privatisation effort in 1994. The country's primary source of production is the recovery of sulphur from oil and gas production. The majority of the country's production comes from the southern states of Tabasco and Chiapas, which contributed 369,065 t and 311,968 t, respectively, in 2002. Sulphur production was also reported from the states of Veracruz, Oaxaca, Guanajuato, Nuevo León and Tamaulipas. Pemex announced in 2002 a US\$30 million investment in a new sulphur production facility in the state of Veracruz.

Mexico's kaolin production is in the hands of a number of small producers scattered throughout the states of Guanajuato and Jalisco. Mexico's production has risen sharply, to 89,883 t (from 21,069 t in 2000).

Mexico's production of feldspar increased by 6% to 348,670 t in 2002. The country's principal producer is Materias Primas y Minería, a unit of Vitro, and accounts for about 65% of the country's production.

## Coal

Mexico's total steam coal production fell by 15%, to 6.12 Mt, in 2002, primarily as a result of a government crackdown following a fatal accident at La Espuela mine, located in the country's main coal-producing region. Several smaller mines were ordered shut and others were subjected to safety-related scrutiny. The country's largest producers are Minera Carbonífera Río Escondido (Micare) and Minerales Monclova (Mimosa), both subsidiaries of Mexican steel producer Grupo Acerero del Norte. These two companies were formed when government-owned Micare was privatised in 1992. Micare produces the bulk of the country's steam coal from the Sabinas and Fuentes-Río Escondido basins in the state of Coahuila, and consists of two open-pit and three underground operations with reserves totalling 208.6 Mt. As a result of GAN's financial troubles, Micare has been put on the auction block. Mimosa produces coking coal and operates five underground mines in the Sabinas region. In early 2000 it opened its Mina V coal mine, also in Coahuila, in order to supply the Federal Electricity Commission (CFE). Development work has also commenced on Mina VI, which has a reserve of 27 Mt. The company's contracts with CFE were curtailed due to questions about the tendering process, and a portion of the contracts awarded to foreign producers.

Mexico's production of coke declined by 20% in 2002, to 1.66 Mt. Production is centred around the coking coal facilities at Monclova in the state of Coahuila and at the Lázaro Cárdenas-Las Truchas metallurgical complex in Michoacán. Coking coal is produced primarily in the state of Coahuila. Industrial Minera México produces approximately 250,000 t/y of coking coal at its Nueva Rosita complex in Coahuila, and production is primarily destined for the company's smelters. Production fell in 2002 as a result of a sympathy strike with other Grupo México operations.

Carbonífera de San Patricio, another important producer of coking coal, operates three underground mines and is developing a fourth, all located in the state of Coahuila. La Luz and El Gavilán mines are located in the Saltillito Basin and have a capacity of 360,000 t/y and 90,000 t/y, respectively. The company's '4-1/2' mine is located in the Esperanza Basin and has a capacity of 24,000 t/y. The development of La Caballada will increase the production from the Esperanza Basin to 96,000 t/y. The company's washing plant feeds a coking facility at Cloete, Coahuila, with an annual capacity of 96,000 t, and which produced 84,936 t in 2002.

Last year, Grupo Acerero del Norte produced only 84,936 t of coke at Las Truchas steel complex in the state of Michoacán, a decline of 84% with respect to the prior year.

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## Mineral Production

	2001	2002	% Change
<b>Precious Metals</b>			
Gold (kg)	24,902	23,254	-6.6%
Silver (kg)	2,824,219	2,852,138	1.0%
Gold (oz)	800,599	747,616	-6.6%
Silver (oz)	90,798,641	91,696,237	1.0%
<b>Base Metals (t)</b>			
Antimony	93	208	123.7%
Arsenic	2,381	1,945	-18.3%
Bismuth	1,391	1,126	-19.1%
Cadmium	1,436	1,399	-2.6%
Copper	343,446	308,388	-10.2%
Lead	146,832	112,244	-23.6%
Molybdenum	5,478	3,428	-37.4%
Tin	7	12	71.4%
Zinc	402,328	391,711	-2.6%
<b>Ferrous Metals and Coal (t)</b>			
Coal	7,194,223	6,116,270	-15.0%
Coke	2,081,525	1,656,437	-20.4%
Iron	5,539,944	5,750,563	3.8%
Manganese	104,298	65,483	-37.2%
<b>Industrial Minerals (t)</b>			
Barite	142,017	132,836	-6.5%
Celestite	145,789	109,314	-25.0%
Dolomite	231,050	518,412	124.4%
Feldspar	329,591	348,670	5.8%
Fluorite	629,637	666,379	5.8%
Graphite	21,442	15,956	-25.6%
Gypsum	2,848,269	3,125,755	9.7%
Kaolin	99,410	89,883	-9.6%
Phosphate	1,025,134	458,710	-55.3%
Salt	8,953,521	8,575,896	-4.2%
Silica	1,696,716	1,826,665	7.7%
Sulphur	878,177	885,492	0.8%
Wollastonite	39,830	28,259	-29.1%