THE MINERAL INDUSTRY OF

PORTUGAL

By Harold R. Newman

The Iberian Peninsula is one of the most mineralized areas of Western Europe and is geologically very complex. Massive sulfides linked to synorogenic vulcanism in the southwestern part of the Iberian Peninsula are well known internationally. The metallogenic province stretches about 250 kilometers (km) from Seville, Spain, to the southwestern coast of Portugal. Portugal has a long history of development of metallic minerals starting about 2000 B.C. Deposits were extensively worked, mainly for gold and silver, from the gossan material overlying the pyrites ore bodies and were the main source of precious metal for the Roman Empire and a stimulus to trade on the Mediterranean.

In 1998, the mineral industry of Portugal was modest by world standards; however, its growth rate during the past few years has made minerals one of the country's dynamic industrial sectors. This was mainly because of the discovery and development of the rich copper and tin deposits of Sociedade Mineira de Neves-Corvo S.A. (Somincor) at Neves-Corvo. The deposit was discovered by follow-up drilling on an anomaly picked up on a University of Toronto Electromagnetic (UTEM) regional geophysical survey and remains the largest "blind" ore body to be discovered in the Iberian Pyrite Belt (IPB). This discovery, in 1977, made it possible to define a new ore body model in the IPB in which copper and tin metal grades are very high.

The Government continued with the country's privatization program and was proceeding with legislation that would privatize many public companies. The privatization issue was part of a broader program to reduce the role of the state and to restructure the Portuguese economy to one that is more market driven.

The Neves-Corvo Mine of Somincor and the Panasqueira tungsten mine of Beralt Tin and Wolfram (Portugal) Ltd. were the two major operations in the metal mining sector. Pirites Alentejanas S.A.R.L. was the country's largest producer of pyrite, and Siderúrgia Nacional S.A.R.L. produced iron and steel. Cimentos de Portugal, S.A. (CIMPOR), an important producer of cement, was one of the companies included in the Government's privatization plans. With the exception of copper, dimension stone, ferroalloys, tin, and tungsten, which were of international importance, production of other minerals and related materials had only domestic significance. Portugal was the largest producer of mined copper in the European Union (EU) in 1998. (See table 1.)

About 32,000 people were employed by the mineral industry, including mining and processing. Most of the large mineral-related companies were owned or controlled by the Government, although there were some privately owned operations. (See table 2.)

Somincor was 51% Government-owned through the mining conglomerate Empresa de Desenvolvimento Mineiro (EDM). The minority partner was Rio Tinto Ltd. of the United Kingdom, which owned 49% of the joint venture. By using a drift-and-fill mining method, the underground mine was designed to produce 1.5 million metric tons per year of raw ore yielding a concentrate averaging 26% copper content. A conventional drilling, blasting, and mucking cycle was used. Primary crushing of ore was underground, and the ore was moved via conveyor to a vertical shaft where it was hoisted to the surface for secondary crushing and treatment. The life of the mine was expected to be 20 years on the basis of estimated proven reserves, (Richards and others, 1991).

The Neves-Corvo complex consisted of five ore bodies—Graça, averaging 10% copper; Corvo, ranging from 7% to 10% copper; Neves, averaging 1% copper; and the Zambujal and Lombador complex sulfide ore bodies, not mined in 1998. Zinc and tin also occur in the deposits. Recovery of tin-in-concentrate varied because Neves-Corvo was primarily a copper mining operation, and tin was considered to be a byproduct.

Gold exploration activities were continuing in the Jales-Tres Minas gold district by the joint venture of Sociedade des Mines du Bourneix (SMB), a wholly owned subsidiary of Compagnie Générale des Matières Nucléaires of France and EDM. The area includes the ancient Jales Mine and is 150 km east of Oporto. SMB was a 70% majority partner in the project. Jales-Tres Minas was probably the most important gold district in Portugal.

Hydrothermal auriferous quartz veins were found along faults cutting the Middle to Late Paleozoic peraluminous granites and Paleozoic graphite schist, mica schists, quartzites, and greywacke. The subvertical veins strike north-northeast to west-southwest, may reach 2.5 km long, and range in width from a few centimeters to a meter. Gold and electrum (a naturally occurring gold-silver alloy) were found within the quartz and the sulfides, mainly arsenopyrite, pyrrhotite, sphalerite, chalcopyrite, and galena. In the core of the vein, the average gold grade was 37 grams per metric ton (g/t) gold, but was reduced to 11 g/t over a 1-meter (m) width. Five paragenetic stages with distinct alteration features were identified. The Jales Mine was in production early in this century, and by the close of its operation, the mine had produced more than 25 metric tons (t) of gold and more than 100 t of silver and reached a depth of 630 m (Neiva and others, 1989).

Auspex Minerals Ltd. announced results of gold exploration programs underway in Portugal. The Montemor gold concession, held in a 50-50 joint venture with European Gold Resources Inc. (formerly Montemor Resources Inc.), was the

most advanced of the company's four gold properties. A substantial amount of exploration was conducted by Rio Tinto from 1984 to 1992. Drilling was continuing on the prospect. Five main gold belts have been mapped corresponding to belts of shearing along favorable zones. Thirteen deposits with potential economic gold mineralization have been identified and considered significant (Auspex Minerals Ltd., April 1998, Gold Exploration in Portugal, press release, accessed June 24, 1999, at URL http://www.auspex-min.com/portugal.html).

The Portuguese iron and steel operation was nationalized in 1975 to function as a public entity incorporated as Siderúrgia Nacional Empresa de Productos Planos (SN-Planos). The Government changed SN-Planos into a public limited company as a major step toward privatization.

Auspex Minerals and joint-venture partner International Vestor Resources Ltd. were encouraged by the results of a prefeasibility study that confirmed their expectation that, on the basis of development of a new deposit, the Aljustrel mine/mill complex could be brought into production relatively quickly as a low-cost zinc producer. Although several minable deposits occur within the Aljustrel mining lease, the prefeasibility study was based on mining and processing primarily from the Feitasis deposit (Auspex Minerals Ltd., December 1998, Positive prefeasibility report on Aljustrel project, press release, accessed June 24, 1999, at URL http://www.auspex-min.com/120298.html).

The Aljustrel properties, consisting of Feitais, Gaviao, Moinho, and São Joao, were undergoing a 25,000-m surface and underground drilling program. These deposits—historically mined for pyrite—host copper, gold, lead, and zinc mineralization. The bulk of the drilling was focused on the Feitais deposit. This deposit was estimated to contain a resource of 54 million metric tons grading 3.43% zinc, 1.12% lead, and 0.43% copper (Northern Miner, 1998).

Beralt Tin and Wolfram (Portugal) Ltd. was the only producer of tungsten in 1998. Beralt completed most of the development work at the Panasqueira Mine at Barroca Grande. Most of the work was directed toward the final treatment of concentrates and toward preparations for the mining of new areas of Level 3. The treatment plant for concentrates was moved to the main zone of operation and modernized to increase capacity. A new $3.4 million shaft was commissioned. These measures were expected to improve efficiency and to increase the life of the mine. The company expected that completion of capital projects underway at its operations in Peru, Portugal, and the United States would take it into the next century as one of the largest and lowest cost producers of tungsten concentrates in the world (Mining Journal, 1998a).

Anaconda Uranium Corp. of Canada formed a joint venture with EDM to develop and exploit the Nisa uranium deposit located in the Alto Alentjo area east of Lisbon. Empresa Nacional Uranio SA (ENU) completed a feasibility study of the deposit, which consists of eight shallow uranium mineralization zones with total estimated reserves of 2,250 t of ore at a grade of 0.13% U_3O_8. The study considered mining and heap leaching operations at the Nisa mine site and transportation of loaded resin to ENU's Urgeirica ion-exchange yellowcake plant located about 150 km from the Nisa deposit. Average production rate would be 115 metric tons per year (t/yr) of U_3O_8 initially with plans to increase this in the future to 170 t/yr of U_3O_8 (Mining Journal, 1998b).

Portugal's industrial minerals sector was a modern and efficient producer of a variety of materials, most notably ceramics and dimension stone. The dimension stone industry continued to be an important segment of the mining industry in terms of value and trade.

Marble was the most valuable of the stone products and accounted for the majority of stone production. The main area for marble mining continued to be the District of Evora. There was potential for increased production of granite, marble, and slate.

Demand for cement continued as the building and construction industry maintained its level of activity. This situation was expected to continue with the substantial volume of work in coming years to develop Portugal's infrastructure.

Coal accounted for about 4% of total energy consumption. Most coal was imported although there were some domestic reserves. Empresa Carbonifera de Douro S.A.R.L.'s Germunde Mine at Castello de Pavia closed because of high production costs and difficult mining conditions. Coal demand was growing because the electricity sector was switching from oil to coal. The two major cement producers, CIMPOR and Companhia Geral de Cale Cimento S.A., also used coal as a major fuel source. Portugal had no natural gas reserves and no nuclear powerplants. Hydropower accounted for about 45% of electricity generation. The Government sought to diversify its energy sources and to increase electrical power capacity to meet consumption growth.

The Government was planning to invest about $22.4 billion in infrastructure improvements during the next few years. The main thrust would be the modernization of the country's ports. Major seaports were Lisbon, Porto, and Sines, which were considered to be very important in a country where the main movement of goods was by sea. Other areas to be improved included the highways and bridges of the national motorway network.

The present structure of the mineral industry could change in the near future because of significant mining exploration by several foreign companies. Copper, gold, kaolin, lead, lithium, pyrites, and tin were some of the minerals targeted for exploration. The IPB is the prime area for exploration activity and would appear to have an above-average potential for success on the basis of district's record of about 90 documented mineralized deposits, an unusually high number of large sulfide deposits (Auspex Minerals Ltd., 1998, Production and exploration opportunity in Portugal, press release, accessed June 24, 1999, at URL http://www.auspex-min.com/projects1.html).

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Major Sources of Information

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TABLE 1
PORTUGAL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity		1994	1995	1996	1997	1998 e/
METALS						
Arsenic, white e/		125	125	100	50 r/	50
Beryl concentrate, gross weight e/		4	4	4	5	5
Copper, mine output, Cu content		133,629	134,181	107,773	106,479 r/	114,637 2/
Iron and steel:						
Iron ore and concentrate:						
Gross weight, manganiferous		14,330	14,535	18,620	18,905 r/	18,000
Fe content, manganiferous		5,409	5,417	7,876	6,800	6,800
Metal:						
Pig iron	thousand tons	415	411	421	431	385 2/
Crude steel	do.	749	829	871	905 r/	903 2/
Lead, refined, secondary e/		13,000	7,700	5,900	6,000	6,500
Manganese, Mn content of iron ore e/		500	500	500	500	500
Silver, mine output, Ag content	kilograms	31,800	38,600	33,700 r/	33,900 r/	34,000
Tin:						
Mine output, Sn content		4,332	4,627	4,637	2,667 r/	3,000
Metal, primary and secondary e/		100	100	100	100	100
Titanium, concentrates: e/						
Gross weight		20	--	--	--	--
Content of TiO_2		5	--	--	--	--
Tungsten, mine output, W content		73	1,103	826 r/	1,104 r/	1,000
Uranium conentrate, U_3O_8		28	22	17	18	16
Zinc, smelter, primary e/		4,200	4,000	3,600	3,600	3,600
INDUSTRIAL MINERALS						
Barite e/		50	--	--	--	--
Cement, hydraulic	thousand tons	7,500	7,500	7,200	7,400	7,400
Clays:						
Kaolin 3/		181,933	180,000 e/	177,423	180,000	180,000
Refractory e/		431,967 2/	300,000	392,148 2/	300,000	300,000
Diatomite e/		2,150	1,780	1,550	1,540 r/	2,000
Feldspar		92,440	106,559	98,596	121,380 2/	100,000
Gypsum and anhydrite		450,000 e/	450,000 e/	520,722	500,000 r/ e/	500,000
Lime, hydrated and quicklime e/		200,000	200,000	200,000	200,000	200,000
Lithium minerals, lepidolite		11,352	8,740	7,626	6,883 2/	8,000
Nitrogen, N content of ammonia e/		57,900	155,100	197,600	195,600	204,400 2/
Pyrite and pyrrhotite (including cuprous), gross weight		14,000	12,000	10,000 e/	10,000 e/	10,000
Salt:						
Rock		519,432	544,647	609,639	596,000 2/	600,000
Marine e/		125,000	--	--	--	--
Total		644,432	544,647	609,639	596,000 2/	600,000
Sand e/		5,000	5,000	5,127	5,000	5,000
Sodium compounds, n.e.s.: e/						
Soda ash		150,000	150,000	150,000	150,000	150,000
Sulfate		50,000	50,000	50,000	50,000	50,000
Stone: e/						
Basalt	thousand tons	530	100	100	100	100
Calcareous:	do.					
Dolomite	do.	471 2/	500	510	500	500
Limestone, marl, calcite	do.	33,134 2/	15,000	35,370 2/	15,000	15,000
Marble	do.	935 2/	800	945	900	900
Diorite	do.	1,029 2/	1,000	282	1,000	1,000
Gabbro	do.	132 2/	100	147	100	100
Granite	do.	17,360 2/	10,000	252	10,000	10,000
Graywacke	do.	138 2/	20	60	20	22
Ophite	do.	110	50	50	50	50
Quartz	do.	14 2/	28	14	14 r/	15
Quartzite	do.	526 2/	500	594	500	500
Schist	do.	273 2/	100	260	100	100
Slate	do.	40	30	20	30	30
Syenite	do.	58 2/	25	39	25	25
Sulfur: e/						
Content of pyrites		5,000	5,000	5,000	5,000	5,000
Byproduct, all sources		4,000	4,000	4,000	3,000	3,000
Total		9,000	9,000	9,000	8,000	8,000
Talc		8,367	8,400 e/	8,277	8,236 r/	8,400
MINERAL FUELS AND RELATED MATERIALS						
Coal, anthracite e/	thousand tons	148 2/	140	--	--	--
Coke, metallurgical	do.	150 e/	329	332	330 e/	330
Gas, manufactured e/	million cubic meters	125	125	125	125	125

See footnotes at end of table.

TABLE 1--Continued
PORTUGAL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity		1994	1995	1996	1997	1998 e/
MINERAL FUELS AND RELATED MATERIALS--Continued						
Petroleum refinery products:						
Liquefied petroleum gas	thousand 42-gallon barrels	4,600	4,768 2/	4,338 2/	4,500	4,500
Gasoline	do.	15,000	23,826 2/	21,828 2/	15,000	15,000
Jet fuel	do.	5,000	8,000	7,500	7,000	7,000
Kerosene	do.	225	400	400	225	225
Distillate fuel oil	do.	20,000	20,000	20,000	20,000	20,000
Residual fuel oil	do.	20,000	20,000	20,000	20,000	20,000
All other products	do.	9,000	9,000	9,000	10,000	10,000
Refinery fuel and losses	do.	3,500	3,500	3,500	3,000	3,000
Total	do.	77,325	89,494	86,566	77,525	77,525

e/ Estimated. r/ Revised.
1/ Table includes data available through June 1999.
2/ Reported figure.
3/ Includes washed and unwashed kaolin.

TABLE 2
PORTUGAL: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of facilities	Annual capacity
Cement		Cimentos de Portugal S.A. (CIMPOR) (Government, 100%)	10 plants, various locations	6,000
Coal		Empresa Carbonifera de Douro S.A.R.L. (ECD) (Government, 100%)	Germunde Mine at Castello de Pavia (closed--maintenance standby)	150
Copper concentrate		Sociedade Mineira de Neves-Corvo S.A. (Somincor) (Government, 51%; Rio Tinto Ltd., 49%)	Neves-Corvo Mine near Castro Verde	500
Diatomite		Sociedade Anglo-Portugesa de Diatomite Lda.	Mines at Obidos and Rolica	5
Feldspar		A.J. da Fonseca Lda.	Seixigal Quarry, Chaves	10
Ferroalloys		Electrometalúrgia S.A.R.L.	Plant at Setubal	100
Petroleum, refined	barrels per day	Petroleos de Portugal (Petrogal) (Government 100%)	Refineries at Lisbon, Porto, and Sines	300,000
Pyrite		Pirites Alentejanas S.A.R.L.	Plant at Setubal	100
Steel, crude		Siderurgia Nacional S.A.R.L. (SN) (Government 100%)	Ironworks and steelworks at Seixal and Maia	1,000
Tin		Somincor (Government, 51%; Rio Tinto Ltd., 49%)	Neves-Corvo Mine near Castro Verde	5
Tungsten		Beralt Tin and Wolfram (Portugal) Ltd. (Avocet Mining Plc. 100%)	Panasqueira Mine and plant at Barroca Grande	1,600
Uranium	tons	Empresa Nacional de Uranio S.A. (Government 100%)	Mines at Guargia, plant at Urgeirica	150
Zinc, refined		Quimigal E.P. (Government 100%)	Electrolytic plant at Barreiro	11