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NON-FERROUS METALS INDUSTRY:

CASE STUDY FOR PORTUGAL (1986)*

by

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0.INTRODUCTION

0.1.Scope of work

As much as possible the analysis of the present status of Portuguese non-ferrous (NF) metals industries will be undertaken in agreement with the document "Study of the Non-Ferrous Metals Industries: Objectives, Methodology and Terms of Reference", by Mr. Cristian GILLEN, issued by UNIDO/Negotiations Crunch, in April 1985.

According to previous UNIDO methodology (85)*, following metals are to be examined in each appropriate section, although for some of them (vg. nickel) primary and secondary activities in Portugal are negligible:

- aluminium
- copper
- nickel
- lead
- zinc
- tin

However, special references will also be made to the complex polymetalic sulphides, important potential source of basic NF metals (vg. copper, zinc and lead) as well as of precious metals (silver and in a lesser degree gold) and other elements . These ores are typically present in the "Iberian Pyrite Belt" as an "outstanding geochemical anomaly (...) forming several lenses or bodies of massive sulphides which are estimated to have totalled in excess of 1000 million tonnes (...) and in which current known resources and reserves exceed 650 million tonnes, about 40% of them in the Portuguese part of the Belt" - what is considered to be "the main stock of base metals and the largest mining district of Western Europe"

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* The relative position of metals was somewhat changed

0.2- A brief comment on the Portuguese non-ferrous metals sector

Some recent studies prepared by Governmental Departments related with non-ferrous metals industries (7, 48, 49, 50) refer a somewhat broader concept for Portuguese non-ferrous metal sector, also including in it following two elements:

- metallic silicium
- tungsten (wolfram)

for which Portugal is a net exporter.

If these two positive contributions attenuate somewhat Portuguese trade balance in terms of non-ferrous metals, the fact is that large deficits are sistematically found; for the period 1980 to 1983 (reporting only primary metals and "semis", except for tungsten) refer to the figures of the table next page.

This table can base some immediate conclusions:

- the deficits of Portuguese trade of non-ferrous metals and "semis" show a progressive gravation for the period 1980 to 1983 with average annual increases in the range of 14 to 16 pct;

- final deficit represents abt 70 to 80 pct of the negative (import) contributions made up by 5 common metals (aluminium, copper, lead, zinc and tin);

- these important contributions are particularly relevant for aluminium and copper imports, that roughly correspond to abt 50 pct and 35 pct of the negative contributions of the five metals;

- the only positive contributions are due to silicium and tungsten exports (some meaningful foreign participations take place in representative companies for these two productions: in tungsten, the important Anglo-American Corporation as final holder of Beralt for Panasqueira mines - see under tin item U.S.A. in silica the Pechiney direct participation in the electrical

TABLE I: Portuguese trade balances for NF - metals
(1980 to 1983)

	1980			1981			1982			1983		
	I	E	B	I	E	B	I	E	B	I	E	B
Aluminium	-4,631	+ 342	-4,289	-6,120	+ 297	-5,823	-6,982	+443	-6,539	-9 727	+849	-8,878
Copper	-3,534	+ 173	-3,361	-3,582	+ 182	-3,400	-4,027	+345	-3,682	-5,632	+259	-5,373
Lead	- 959	+ 5	- 954	- 942	+ 26	- 916			n.a.			n.a.
Zinc	- 822	+ 1	- 821	- 796	+ 7	- 789	- 942	+ 12	- 930	-1,116	+ 3	-1.113
Tin	- 524	+ 9	- 515	- 397	+ --	- 459			n.a.			n.a.
			-9,940			-11,387			-11,151(2)			-15,364(2)
Tungsten(1)	- 3	+1,632	+1,629	- 11	+1827	+1,816			n.a.	- 342	+1,669	+1,327
Silicium	-	+1,204	+1,204	-	+ 644	+ 644	-	+790	+ 790		+9[illegible]	+ 943
			+2,833			+2,460			+ 790(3)			+2,270
Total			-7,107			-8,927			-10,361(4)			-13,094(2)

Sources: (48,50)

E= export (positive sign)
I= import (negative sign)
B= balance(+=surplus; -=deficit)
Value in 10^6PTE

(1) including concentrates
(2) not including lead and tin
(3) not including tungsten
(4) not including lead, tin and tungsten

furnaces of Setubal, operated by Eurominas);

- the relevance of the negative (import) contributions of the 5 metals (3 in 1982) can be demonstrated by its proportion to the value of overall Portuguese mining production in same years:

in 1980	114 pct	(5 metals)
in 1981	101 pct	(5 metals)
in 1982	84 pct	(3 metals)

i.e. even with a significative increase of the production value for the total Portuguese extractive industries, the imports of non-ferrous metals may get very close to an equivalent amount.

This situation, naturally also emphasized in other studies (43, 86, 87), can be well precised by this quotation from LOPES in one of those references (43):

"Portugal has been almost entirely depending from abroad in what concerns respective supply of non-ferrous metals. A so dangerous situation, unavoidable for the present context of the (Portuguese) mining industry, may result structurally changed if some potential developments with relevant dimension get to be realized for the exploitation of domestic mining reserves and the processing in them of recoverable resources".

0.3. The Portuguese non-ferrous mining sector

If metal imports almost equal in value the current overall mining output of Portugal, the establishment of today's positions for the non-ferrous metals mining sector relative to the overall mining sector may also be of interest.

Corresponding figures for the year 1974 and the period 1979/1982 (7) are given herunder.

Table II: Overall and NF metals mining sector
Relevant data for Portugal (1974-1982)

	1974	1979	1980	1981	1982
Mining output (thousand tonnes)	30,583				
extractive industry	30,583	37,498	40,455	40,552	40,489
non ferrous metals*	8	7	8	7	7
Mining output, (10^6PTE)					
extractive industry	2,004	6,822	8,692	11,307	13,203
non ferrous metals*	513	1,687	1,976	2,087	2,234
Ratio "gross added value/gross product value" (pct)					
extractive industry		86.3	84.3	83.8	80.4
non ferrous metals*		92.4	91.2	89.6	85.0
Employment extractive industries					
white collars	1,333	1,244	1,258	1,323	1,347
miners & workers	15,153	15,753	16,174	16,280	15,528
pct in non ferrous metals*	21	17.9	17.1	17.8	19.6
Average monthly wages, PTE/worker					
extractive industry		10,608	13,215	16,960	21,450
non ferrous metals*		15,820	20,004	24,243	30,097
Economical productivity, 10^3PTE/ /worker constant prices 1979					
extractive industry		346.5	320.9	332.4	311.4
non ferrous metals*		512.9	460.4	368.3	284.7

Source: (7)

A decomposition of production figures may be helpful to discriminate relative contributions (7); see Table , next page.

These figures demonstrate a relatively discrete position of today's extractive industry when related to the overall industrial figures of Portugal; as a matter of fact the output of the total extractive industries only accounts for 0.89 pct of the Gross National Product (at the cost of factors) in 1981. For same year 1981, the output of non-ferrous metal ores and pyrites mined in Portugal accounts for abt 0.19 pct the Gross National Product.

However these relatively small contributions have to be considered with a certain care. As a matter of fact similar figures availabe for Spain, F.R. Germany and USA also point to relatively small ratios, in the range of 1.0 pct for the first two countries and

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* excluding complex pyrites

Table III:

Production of non ferrous metal ores, tonnes (10^6 PTE)

Portugal, 1974 and 1976 to 1982

	1974	1979	1980	1981	1982
Berilium	15(0.12)	12(0.15)	20(0.32)	18(0.33)	12(0.87)
Copper	2,460(19.9)	2,103(48.0)	3,007(24.7)	2,437(33.1)	2,002(45.2)
Tin	606(85.5)	346(173.2)	421(229.3)	506(299.3)	585(403.6)
Manganese	21(0.11)	-	-	-	-
Molybdenium	0.4(0.02)	0.4(0.20)	-	-	-
Tantalum and miobium	9(1.74)	3(5.78)	4(11.27)	9(14.60)	6(10.93)
Gold and Silver	2,266(51.6)	1,751(301.7)	1,134(294.1)	1,123(232.1)	1,058(274.9)
Titanium	274(0.04)	390(0.06)	384(0.06)	400(0.06)	585(0.09)
Tungsten	2,483(354.0)	2,348(1,158.4)	2,670(1,416.1)	2,365(1,502.6)	2,300(1,498.2)
Production of Pyrites:	510,573(162,7)	349,172(277,6	382,171(355.5)	286,622(307.3)	262,142(404.6)

slighty above 1,5 pct for the U.S.A. (45). Second they only refer to extraction levels and therefore do not represent the apparent consumption ores as well as non-ferrous metals; as already mentioned the contribution of the metals is itself in the range of the overall mineral industry.

Third, the statistical ground in which some of these figures are based asks for several remarks and justifies certain reserves as later will be emphasized.

And a fourth and very important factor if the importance of the processing industries based in these raw materials is considered in addition to respective mining activities, therefore a much larger significative amount of Portuguese industrial product is interested by corresponding overall operations (86,87). This brings to the essential problem of mineral raw material supplies being Portugal strongly dependent upon external sources of raw materials even when still prevailing the low "per-capita" consumptions that characterize Portuguese industrial economy today. Any expected development in industrial consumptions will, therefore, result in an increase of dependence if no internal productions or recycling are meanwhile increased.

In a recent communication, when reporting to "raw-materials of close mineral origin" (see item 0.4) it was concluded that respective consumer sectors correspond in 1981 to abt (not including oil refining) (89):

13.3 pct of overall industrial establishments,
16.7 pct of overall employment,
22.8 pct of gross production value,
16.4 pct of gross added value.

Although these figures refer to sectors consuming all kinds of mineral raw materials under consideration, it may be concluded that for the non-ferrous metals similar "multiplicative" coefficients, may result, and therefore underline respective interest for Portuguese industrial economy.

Besides the developments that may sahe place in Portugal regarding the mining production of non-ferrous metal ores are perhaps the most representative for the outlook of mining industries and may immediately increase the importance of respective sector.

0.4. Statistical problems

When studying the problems of raw materials and raw material supplies several difficulties may be found in correction to present Portuguese statistical structure.

Relevant statistical data may be collected from several sources namely:

- the national statistical reports for Industry issued by the Instituto Nacional de Estatistica in Lisbon, in two volumes (1st volume: extractive industries, 2d volume: processing industries), as well the External Trade Statistics;

- the official reports of the Direcção Geral de Geologia e Minas, refering to mines and published in Boletim de Minas;

- the sectorial studies of the Direcção Geral da Industria;

- Some unofficial data published by Banks (in monographic studies), industrial organizations, etc.

The main difficulty of these statistics, besides a certain delay, is that they do not cover uniformly all possible interesting flows, bringing relatively low help when establishing an overall metal balance for a case-metal (vg in evaluating secundary sources, establishing specific relations, defining recycling and interconnecting amounts). A certain progress could be made if, for instance, some integrated criteria used in well-known and experienced external sources, such as the USBM Mineral Yearbook or even in publications issued by certain metallurgical corporations (vg.90) could provide the regular establishent of yearly balances specially for non-ferrous or ferrous metals .

– However, for some substances other than non-ferrous metals, statistical problems may even show themselves harder to solve.

This situation is not at all simplified by the imperfect dichotomy prevailing in the splitting of Portuguese industrial activies by the respective administrative authorities, although both generally placed under the same Ministery (but for severa times under differen: Vice-Ministers) thus:

- dichotomy, because extractive industries (and some primary smelting placed nearby the mines) are supervised by a different "Direcção Geral" (General Directorate)than Processing industries (including a great part of other primary smelters.

- imperfect, because two primary smelters of same kind may found themselves under different General Directorates if, for instance, one of them belongs to a mining company and, being in direct connection with the mine, may be called "mining appartenances", being the other not in such conditions.

- however, external trade is under a different General Directorate, etc.

To overcome as much as possible those difficulties and trying to get solutions for the problem of establishing balances and matrix relationships when working with available statistics, several recent texts (43, 86, 87, 88, 89) proposed identification concepts broader than those currently used in mine statistics and hence making an access towards the more sophisticated concepts of classification and evaluation of dependence and criticaly in raw materials supplies. Examples of these concepts are the "product with mineral base called by LOPES (43), the "raw material with close mineral origin (except fuel)" mentioned by SILVA (86, 89), etc. Although the relevant progress made by some of these works and by studies carried out under the Portuguese Mining Plan ("Plano Mineiro Nacional"), the problem of effective raw material balances and regular revision is still far from being reasonably solved.

0.5. Prospects for the non-ferrous metal sectors

Based in own criteria, LOPES, in 1981, established forecasts for mining products, therefor including provisions for non-ferrous metal consumptions (43): these are hereunder compared with primary consumption figures from the Annuaire Minemenet 1982 for the year 1982 (90) as well as from other sources quoted in this work

TableIV: NF consumption figures for Portugal (tonnes)

	Annuaire Minenet(90)	Other sources	year: 1982 Primary consumption per year 2000 tonnes	yearly increases pct
Copper	14,200	abt 35,000(1)	40,000	4.0
Lead	18,000	abt 18,000	25,000	2,5
Zinc	16,000	abt 17,000	35,000	4.5
Tin	400	abt 900(2)	1,100	0.6
Aluminium	25,500	abt 30,000	100,000	5.0

sources: see above

Specifically for copper, forecasts also established and quoted in item 2.2.1 of this study, point out three possible forecast scenarios:

Table v: Forecast figures for copper (Portugal)

	forecast, tonnes/year (final level)		
	optimistic	intermediate	pessimistic
1986/1990	34,000	32,000	28,000
1991/2000	69,000	50,000	43,000

(1) first processing and semis for wrough copper= 16,000 tonnes

(2) tin is perhaps the major discrepance of both sources, that surely exclude imported metal tin

COSTA (87) replacing term forecasts by an estimate of demand if Portuguese "per capita" consumption approached those of the EEC countries, gave following results:

Table VI: Estimate of "equivalent to EEC" consumptions Portugal

	domestic production tonnes	external supply tonnes	coefficient of dependence pct	average consumption equivalent to EEC per-capita	ratio
	(1981) (A)	(1981) (B)	(1981)	tonnes/year (C)	C/(A+B)
Copper	2,900	25,000	90	100,000	2.15
Aluminium	-	54,000	100	170,000	3.15
Zinc	-	13,500	100(1)	60,000	4.44
Tin	350	560	56	62,700	2.97
Lead	-	29,200	100	50,000	1.72

Source: (87)

All these figures suggest a reasonable potential increase of the non-ferrous metals demand in Portugal, requiring a careful examination of availability and use of materials - as well as for Portuguese primary developments. Factors as the recent adhesion of Portugal to the EEC also may bring consequences to this evolution.

Listing potential primary (mining) production, REIS et al (45), in 1984, have adressed up a table of production profiles given hereunder with some slight modifications:

(1) circunstance changed next year with the cnset of Quimigal production

Table VII:

Potential NF primary (mining) productions in Portugal

	Present potential		future potential	
	tonnes	value 10^6PTE (1983 values)	tonnes	value 10^6PTE (1983 values)
Copper				
Quimigal	1,500	300[b]		
Aljustrel			5,000	1,000
Neves-Corvo			75,000-100,000[d]	15,000-20,000
	1,500	300	80,500-91,500	16,000-11,000
Zinc				
Quimigal	10,000	1,500[b]		
Aljustrel			14,000	2,000
Neves-Corvo			50,000	7,000
	10,000	1,500	64,000	9,000
Lead				
Aljustrel			3,500	200
Neves-Corvo			10,000	600
	-	-	13,500	80.
Tin				
Panasqueira et al	250	300		
Neves-Corvo			to consider[a]	to consider[a]
Argimela(45)[c]			2,000-3,000	2,400-3,600
	246	300	2,000-3,000 +Neves-Corvo	2,400-3,600 +Neves-Corvo

(a) Quantity difficult to forecast due to its nature

(b) Assumed of working in future periods with generaled potential

(c) Included in the te t of REIS et al (45) but not in the original table. in which remains here included

(d) Increase according to more recent figures

I.e. for the majority of metals under study (except for aluminium and nickel, in which Portugal has no resource a very sensible increase is to fore seen, multiplying by factor of 14-15 present outputs. Fore seen requirements in these product, could also result duply.

In the light of these possible improvements, a revision of tables already present shows a rather different situation:

Table VIII: Potential NF primary (mining) productions and prospectives in Portugal

	coeficiente of dependence (1981)	consumption forecast A	production potential B	coeficiente of theoretical dependence (A-B)/A	coef. of net exporting capacity (B-A)/B
	pct			pct	pct
Copper	90	50,000	81,500-100,000	0	39-50
Aluminium	100	100,000	-	100	0
Zinc	100[a]	35,000	64,000	0	45
Tin	56	1,100	2,000-3,000	0	45-63
Lead	100	25,000	13,500	46	0
Source	COSTA(87)	LOPES(43) increased for copper (53)	prior table.		

As a conclusion to this table: developments under consideration by the mining industry in Portugal albeit only represented by three major projects:

- Neves-Corvo (Cu, Zn, Pb, Sn, Ag)
- Aljustrel (Cu, Zn, Pb, Ag)
- Argimela (Sn).

(a) to decrease in following year by the onset of Quimigal operation

may represent a very sharp changement of present Portuguese dependence in non-ferrous metals. Not only Portuguese dependence coefficients may show a quite different pattern (only remaining unchanged the 100 pct dependence on aluminium), but also Portugal may be a net exporter of copper, zinc and tin (besides present export position in tungsten and uranium), raw materials in which, for instance, EEC countries are net importers.

The development of Neves-Corvo and Aljustrel projects also will provide to Portugal an extra availability of sulphur sources (as pyrite and other sulphides):
considering the present interest on sulphur/sulphuric acid and the geographical location of Portugal in relation with potential consuming centers, this fact is also to emphasize.

0.6. Brief notice about locations in Portugal

To avoid a frequent reproduction of maps, a single geographical map with the placement of "concelhos" is given in next page. "Concelho" is in the Portuguese administrative system the immediate territorial division under the district and may be accepted as reasonably suited for location purpose.

Therefore after first detailed mention in the text of each location respective "concelho" will also be entered as well as corresponding district, for the sake of an easier retrieval. In the map of next page the head and denomination of each district are denoted by an external circle and bigger capital letters.

Assuming the country divided in three parts of approximatively equal lenght, following distribution of districts is met:

North Portugal: Viana do Castelo, Bragança, Braga, Vila Real, Porto, Aveiro, Viseu, Guarda.
Central Portugal: Coimbra, Leiria, Castelo Branco, Santarém, Portalegre, Lisboa.
South Portugal: Setubal, Évora, Beja, Faro.
(this distribution has no administrative meening).

1.EXPLOITED MINES

1.1. Aluminium

No mines of common aluminium ores are registered in Portugal and not even significative occurrences or prospects may be reported for them.

However Portugal is rich in alumino-siliceous minerals, such as kaolin, clays and nephelines, whose utilisation for the obtention of basic aluminium chemicals (and even metallic aluminium) has been studied. Particular focusing was made upon the nephelinic sienites from Monchique area (in Monchique South Portugal), with features that suggested nepheline processing for alumina, soda ash and Portland cement (2).

The energy-intensive characteristic of required processes, the cumbersome amounts of by-products generated by some of them and the value granted by alternative and simpler uses of raw materials (from ceramic industry to decorative rocks) left these studies without any practical realization.

1.2. Copper

1.2.1. Copper ores and complex sulphides

The discussion of Portuguese copper resources requires the direct connection of most of them to the complex sulphides of the Iberian Pyrite Belt. As a matter of fact the traditional copper production both in Portugal and Spain during or before the 19th century was based in great mining centers such as Rio Tinto and Tharsis, in Spain, and S.Domingos and Aljustrel, in Portugal, amongst others, all of them located within that metalls genetic province (3,4,5,6).

This situation is still valid today for Portugal, since only small amounts of copper concentrates are obtained in centers out of the Pyrite Belt, as by-products of tin and tungsten mining,

such as Panasqueira and Borralha (see 1.2.2).

Besides, some of the references currently made for "copper mines" in Southern Portugal are connected to copper-enriched near surface sulphidic or oxydized occurences near or into the Pyrite Belt, such as Aparis, Miguel Vacas, Carro das Ferrarias and, more recently, to the rich but deepnew sulphide finding of Neves-Corvo that also includes significative amounts of complex pyrites.

However, and for the sake of a systematical approach, descriptions to be made under this item will include complex pyrite mines even when the use of its products has as primary current adress the industry of sulphuric acid.

Thus following descriptive sequence will be observed:

i - copper concentrates production in Portugal outside the Pyrite Belt (item 1.2.2.)

ii - mining activities in the Portuguese part of the Iberian Pyrite Belt:

a. smaller copper mines (item 1.2.3.)
b. complex pyrite mining (item 1.2.4.)
c. the Neves-Corvo mining project (item 1.2.5)

1.2.2. <u>Coper concentrates production in Portugal outside the "Pyrite Belt"</u>.

As already mentioned this small production is restricted to copper-containing by-products of tin and tungsten mining and confined to the mining centres of Borralha (in Montalegre and Vieira do Minho, respectively districts of Vila Real and Braga) and Panasqueira (in Covilhã, Fundão, in Castelo Branco district and Pampilhosa da Serra, in Coimbra district, see 1.6).

Following data describe respective activity for the 10-years period from 1975 to 1984:

I. Production figures (combined output of both mines):

Table IX:
Production of copper concentrates in Borralha and Panasqueira mines

Year	total concentrates produced	total copper contained	total value (current)
	tonnes*	tonnes copper	10^3c=10^6PTE**
1975	1397	283.0	8.00
1976	1761	386.6	13.05
1977	1432	330.0	7.75
1978	1370	327.0	10.12
1979	2103	508.2	48.04
1980	3007	743.0	24.66
1981	2437	555.2	33.10
1982	2002	451.1	45.22
1983	1735	375.1	39.01
1984	1654	370.9	34.20

Source: (7)
The major part of this production (abt 90 pct in copper contained and 96 pct in value) corresponds to the Panasqueira mine.

II. Typical analysis of obtained concentrates

Panasqueira mines produce copper concentrates with abt 22 to 25% Cu; however in Borralha, the copper content in concentrates is only in the range of 15% Cu.

Some typical analysis (only mentioned as indicative examples) (13):

* 1 tonne = 1 metric ton
* 1 PTE = 1 Portuguese Escudo
* 1 c = 1"conto" i.e. accounting unit equivalent to 1,000PTE

Table X:
Typical analysis of copper concentrates from
Borralha and Panasqueira mines

	Cu	Fe	S	As	Zn	Au	Ag	Sb	Bi
Borralha	13-15%	29%	35%	0.3%	1.2%	0.15	250-300	0.01%	0.58%
Panasqueira	24-25%	30%	14%	1.5-3.0%	1.9%	(a)	500-700	0.01%	.06%

(a) not available

III. Envolved corporations

Borralha - Minas da Borralha, SARL
(Mines de Borralha, S.A.)
Borralha
P-4700 Correio de Braga

main activity: mining of wolframite and scheelite

Mines de Borralha SARL was recently owned by the following corporations:

. OPEMEDIN - Operações de Medições Internacionais, Ld 80.5 pct

. SPE - Sociedade Portuguesa de Empreendimentos, SARL 19.5 pct

Prior to its purchase by OPEMEDIN the ownership of the correspondent quota of Borralha was related to the foreign shareholder of Panasqueira (see under 1.5. Tin); presently the situation of that quota in Borralha is not very clear, since its transaction was recently refered in Portuguese press.

Panasqueira - Beralt Tin and Wolfram (Portugal) SARL
Barroca Grande
Aldeia de S.Francisco de Assis
P-6225 Minas da Panasqueira

main activity: mining of wolframite and cassiterite
(for ownership see under 1.5., Tin)

IV. Product destination

Borralha and Panasqueira concentrates are essentially consumed by the Quimigal copper smelter in Barreiro (Barreiro district of Setubal); some minor export may also have had place.

V. Personnel

Being essentially mines for tungsten (Borralha) and tungsten + + tin (Panasqueira) the indication of personnel directly attached to copper production is not contained in available statistics.

VI. Technological features:

In Borralha, the main mineralization in composed by wolframite (abt 25%) scheelite (abt 7%) and pyrite and other sulphides (abt 60%), these including chalcopyrite and molybdenite. This hydrothermal orebody is exploited to feed an ore dressing plant with 50 tonnes hourly capacity of run-of-mine (with average productions of 3 to 4 kg of 70% WO_3 concentrate and 0.6 to 0.7 kg 15% Cu concentrate per tonne of run-of-mine fed). After a three stage comminution, the ore is separated first in jigs, then, after classification, in tables. The overflows of the mechanical classification systems are joined in a thickener and then floated in cells for the removal and recovery of copper contained sulphides (8).

In Panasqueira, after preliminary grinding and concentration operations (heavy media and hydrogravity classification), the concentrates that include tungsten as wolframite and tin as cassiterite, as well as sulphides in a complex mineralization, are further treated by grinding followed by the separation of sulphides in tables. These sulphides, including copper, are then upgraded in flotation cells, were they are joined with the "floated" material from the treatment of "fines" in other groupsof cells. Technical developments introduced in Panasqueira in the first half of the 70's provided an increase of quantity (and metal content) in produced copper concentrates (9). Panasqueira mining center, with all its individual concessions, is today one of the most representative tungsten mines of the World and surely having an upmost importance in Europe. It has to be recalled here that Portugal covers 3 pct of the World production of tungsten (and 32.2 pct of the production of Western Europe) in the period 1979--1982. In 1982, Portugal exported abt 1000 tonnes of equivalent W

in tungsten concentrates, with an export value of abt 12 million USD (10). This was, in 1982, slighly above 50% of the overall value of non-ferrous metals mining production in Portugal, evaluated in for or fos mine-site terms.

More recently, tungsten crisis seriously affected the economy of its mining in Portugal - with the additional blow of tin crisis adding its own consequences to agreat number of local W-Sn mines. If Panasqueira, with its dimensions, follows operations the exploitation in Borralha has been provisionally shut the beginning of current year (1986) Borralha, in the period 1980--1983, was employing 550 to 600 people (with 20 to 25 "white --collars"), what represented a sensible fixation of populations in a relatively dispossessed region, in terms of alternative employment.

1.2.3. Mining activities near the Portuguese part of the Iberian Pyrite Belt: smaller copper mines

Near or in connection to the Iberian Pyrite Belt, several smaller copper enriched occurrences have been mined since long and some of them are still under mining rights. These are either non-deep sulphide deposits or oxydized material with generally small known reserves. Copper from sulphide ores is obtained as copper concentrates, after suitable mineralurgical treatment; from oxydized ores, copper is generally leached by an acid (sulphuric acid) and then precipited as copper cement by reduction with iron scrap.

The first situation described above could be quoted for Aparis mine (in Barrancos, district of Beja), in which mining is suspended since 1975; the second is represented by the current operation of Miguel-Vacas mine, (in Vila Viçosa, district of Évora) started in 1982. Other concessions in the area, such as Cerro das Ferrarias (in Almodovar, district Beja), had no recorded production for the 10-Years period 1975-1984.

Available statistics (7) combine the copper cement output of

Miguel-Vacas with the cement produced in Aljustrel (see under 1.2.4.) from the treatment of mine waters containg copper. These "mine waters" pumped to the surface, are circulated through the great thick-layed extent of slags, coming from metallurgical activities up to Roman times, and collected in acid proof brick cementation tanks with iron and steel scrap: precipitated copper cement is removed by "cleaning operations" carried on manually from time to time. Actually this cement may be reported as the specific copper raw material being obtained at Aljustrel, since the main product of those mines (complex pyrite) is sent to the Portuguese sulphuric acid industry as a "source of sulphur" and only part of its contained copper will be recovered in the "pyrite cinderstreatment operations" in Quimigal, Barreiro (district of Setubal).

Therefore, following statistical data combine (since 1982) the cement productions of Miguel Vacas and Aljustrel; up to 1982, only the cement production of Aljustrel in recorded:

I. Production figures:

The production of cement copper in Aljustrel was reasonably stable for the greater part of considered period. However the three last years (1982, 1983, 1984) include increasing amounts of cement produced in Miguel Vacas (in 1983 abt 50 pct of the total in 1984 abt 80-90 pct), with a certain decrease in Aljustrel output; up to 1982 orly the cement production of Aljustrel is recorded (see Table XI).

II. Typical analysis of obtained concentrates:

Aparis concentrates were somewhat richer then the chalcopyrite -classical type, above 25% copper content and with a relatively low amount of nuisible inpurities.

Copper cements from Aljustrel and Miguel Vacas are typical oxydized products with abt, respectively, 60 to 70 pct copper and 54 to 60 pct copper.

Table XI: Production of copper concentrates in Aparis mine and of copper cements in Aljustrel and Miguel Vacas (period 1975-1984)

year	Concentrates (Aparis) prod.			Cement prod. (Aljustrel+M.Vacas)	
	tonnes	contained copper tonnes	total value	contained copper tonnes	total value current
			10^3c		10^3c
1975	667	192.8	4.45	20.2	(b)
1976		-		19.5	(b)
1977		-		37.1	(b)
1978		-		53.4	(b)
1979		-		46.3	2.54
1980		-		49.1	2.69
1981		-		37.8	2.7 (a)
1982		-		72.9	5,9 (a)
1983		-		42.2	4.1 (a)
1984		-		154.2	26.1 (a)

(a) for average contents
(b) not available

(source 7,12)

The production of cement copper in Aljustrel was reasonably stable for the greater part of considered period. However the three last year (1982, 1983, 1984) include increasing amounts of cement produced in Miguel Vacas (in 1983 abt 50 pct of th total in 1984 abt 80-90 pct), with a certain decrease in Aljustrel output.

Table XII: Typical analysis of copper concentrates from Aparis and cements from Aljustrel and Miguel-Vacas (13): (indicative examples)

	Cu	Fe	S	As	Zn	Cl	Sb
Aparis	32%	23%	26%	0.65%	0.44%	(a)	(a)
Aljustrel cement	65%	(a)	3%	0.93%	(a)	0.35%	0.01%
Miguel Vacas cement	55%	(a)	(a)	(a)	(a)	(a)	(a)

(a)=not available

III. Envolved corporations

in Aparis - Minerália - Sociedade de Empreendimentos Mineiros, Lda.
(stop of work in 1975; concession abandoned in 1977 by depletion)

in Aljustrel - Pirites Alentejanas, SARL
Aljustrel
(see under 1.2.4.)

in Miguel Vacas - Minargol, Complexo mineiro de Argozelo, SARL
Av. 5 de Outubro, 89
P-1000 LISBOA

IV. Product destinations

Aparis concentrates were smelted in Quimigal (Barreiro), premises: Aljustrel and Miguel Vacas cements have also been smelted there or exported.

V. Personnel

Aljustrel will be dealt in item 1.2.4.; for Miguel Vacas, available data indicate abt 40 employees 1984 (5 white-collars). No reliable data remain available for Aparis operations, closed in 1975.

VI. General technological features as previously described

1.2.4. Complex pyrite mining

The approach to this subject will be carried according to following plan:

1.2.4.1. Characterization of complex pyrites
1.2.4.2. Historical background
1.2.4.3. Current pyrites mining operations
1.2.4.4. The C.P.P. Project
1.2.4.5. The development of a flotation process for Aljustrel

The frequent reference to pyrite mining centers (present or historical) within the "Iberian Pyrite Belt" suggests the presentation of its global development in the map of next page (14).

1.2.4.1. Characterization of complex pyrites

The Iberian Pyrite Belt contains considerable reserves of massive polymetallic sulphides concentrated in orebodies with generally big dimensions. Pyrite is the mineral largely dominant in these formations, that also show variable amounts of copper, zinc, lead, gold and silver mineral, as well as many other oligo--constituents.

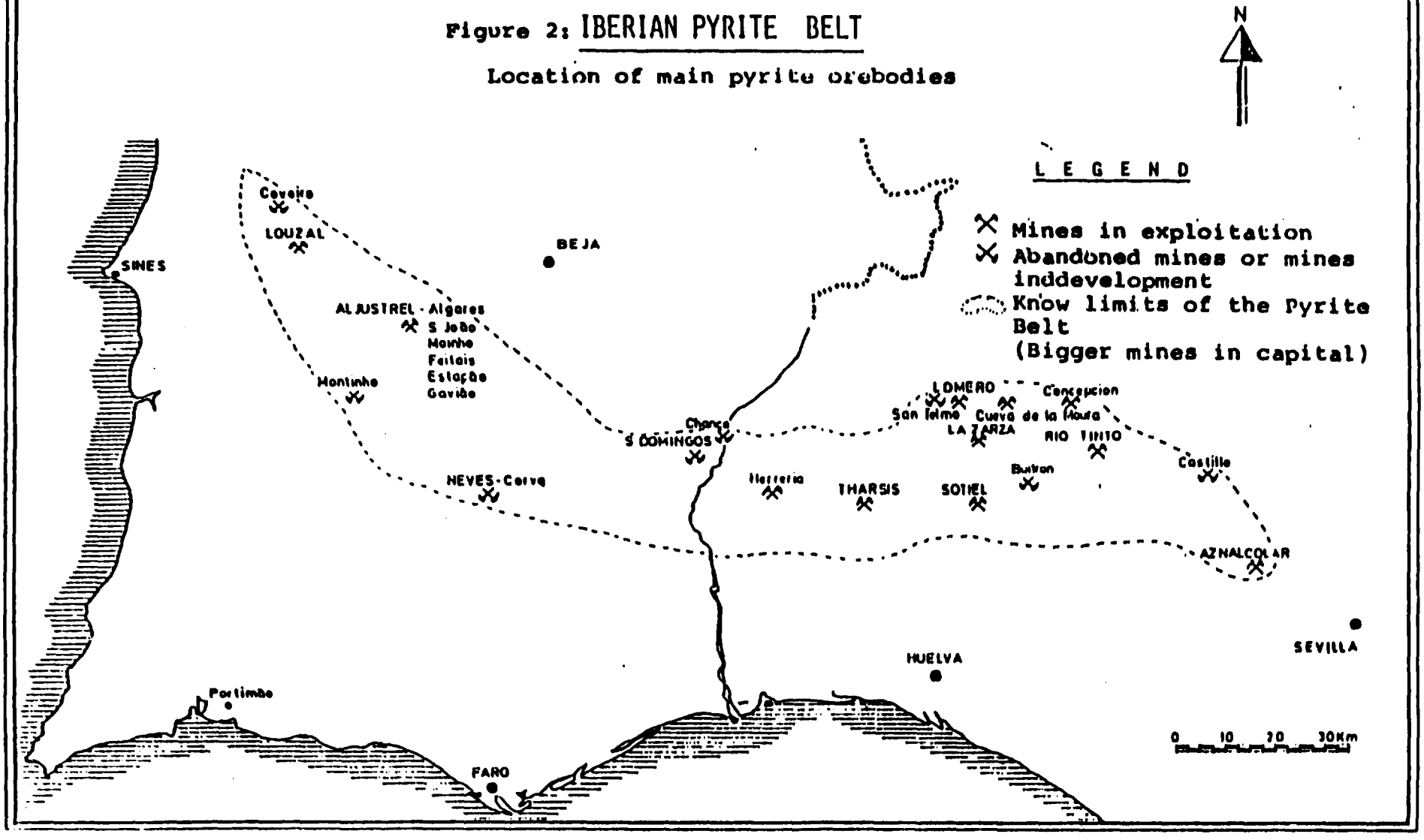
The most representative known orebodies in Portugal are, from east to west, S.Domingos, now considered as an exhausted mining center, Neves-Corvo(Neves Corvo, Graça, Zambujal, A. do Pires), Aljustrel area (S,João, Algares - this also exhausted, Moinho, Feitais, Gavião and Estação), Lousal and, already near Grândola, Serra da Coveira.

Although the composition (both chemical and mineralogical) of the sulphides may well differ from orebody to orebody, and even inside the same orebody, the main mineral constituents of these complex sulphides are

pyrite, already mentioned as prevalent,
sphalerite,

Figure 2: IBERIAN PYRITE BELT

Location of main pyrite orebodies



Source: (14)

chalcopyrite,
galenite

secondary constituents include:
arsenopyrite
copper sulpho-salts (as tetraedrite, bournonite and tenantite and other minor constituents)
pyrrotine,
cobaltite,
silica,

and, as minor constituents,
stanite
cassiterite,
greenochite,
magnetite and hematite
etc.

Certain sympathies and antipathies between minerals may be established. Silver is an interesting value-increasing component whose concentration is possible; on the contrary, gold shows itself in discrete amounts and disseminated in all mineralisation, reason why it was not possible to obtain its recovery with meaningful yields up to now. The presence of tin (both as stanite and as cassiterite) is a common feature and for Neves-Corvo orebodies significative amounts propose the difficult challenge of tin recovery.

A difficult feature of these polymetallic sulphides is it fineness, showing commonly grain dimensions in the range of 20 micra or less. This implies for mineallurgical purposes, the need of a very fine grinding.

Following table characterizes the chemical composition of some complex pyrites from Aljustrel ore bodies (15), that well exemplify this type of ore. Following characteristics may be emphasized:

. the predominant pyrite constitution, related to the Fe and S contents:

. copper contents in the range of 1.0 to 1.5 pct (lowe contents for the so called "lean pyrite"):

. zinc contents well above the copper level, and in the range of 3 to 4 pct;

. lead content in the range of 1 pct;

. the combined NF metals content (Cu+Zn+Pb) in the range of 4 to 6 pct (some Authors consider that the designation "complex pyrites" should be reserved for ores with basic NF overall contents above 3.0 pct, like these, keeping for lower contents the designations of "lean pyrite" or "crude de pyrite");

. significative presence of silver as a possible contribution to recovery processes but also meaningfull contents in "negative constituents" such as arsenic, mercury, antimony and bismut.

As explosed later, some of these minor constituents determined serious process restrictions for the roasting of pyrites, when pyritic residues or cinders were purified for their use as an alternative raw-material for iron-making (besides the associated recovery of NF metals).

However the most characteristic feature of complex pyrites, th strongly marked the evolution of their industrial use, is certainly its ratio of sulphur to NF metals: as a matter of fact, for 100 pct theoretical recovery, 1 tonne of complex pyrite with the average composition described (45pctS; 5 pct NF metals) would produce 1,38 tonnes of sulphuric acid and only 50 kgs of contained metals. With practical processing yelds, this relation 138:5 may even be substantialy increased to abt 125:3 or similar range. What means that for an economical integrated recovery of pyrite constituents with full S transfering to sulphuric acid, one would have to face following dilemma:

Table XIII: Chemical analysis for Complex Pyrites from Aljustrel orebodies

Element	MOINHO (1)	FEITAIS (1)	GAVIÃO (1)	ESTAÇÃO (2)
S %	47	45	47,5	45
Fe %	40	38	40	38
Cu %	1,15	0,6	1,5	0,3
Zn %	3,2	3,0	3,0	3,6
Pb %	1,2	1,2	1,0	1,1
As %	0,5	0,6	0,5	0,9
SiO_2 %	3,0	3,5	3,7	2,8
Co g/t	400	100	n.a	n.a
Ni g/t	60	35	n.a	n.a
Cd g/t	100	100	n.a	n.a
Au g/t	0,8	0,6	0,8	0,3
Ag g/t	35	40	35	37
Hg g/t	90	110	100	n.a
Sb g/t	700	1050	2000	n.a
Bi g/t	210	110	n.a	n.a
Sn g/t	300	300	n.a	n.a

Source: (15)

(1) statistical figures

(2) indicative figures

n.a = not available

- or the production of sulphuric acid in one center or area is enough developed to provide for a suitable minimum dimension for NF metallurgical works ("acid drive");

- or, "mutatis mutandis", the requirement of a minimum dimension for NF metallurgical works would either impose a large offer of sulphuric acid or suggest all alternative ways to "deal the metals" keeping the sulphur whenever possible in a non sulphuric acid acceptable form ("metals drive").

The first alternative ("acid drive") includes the classical examples of the big cinders treatment plants of St. Hellens, Duisburg, Bremen, Bilbao and Barreiro, in Europe, Wilmington, in the USA, as well as the Japanese purification and pelletizing plants (Kowa-Seiko process). In those cases, or the cinders treatment units were owned or connected to nearby big sulphuric acid producers or collected cinders from several pyrite roasters within a certain area. In some cases (vg.Duisburg), the cinders treatment center made the acquisition and import of crude pyrites, contracted its distribution by the sulphuric acid producers (that payed for the sulphur removed during roastig) and got back the roasted haematitic cinders and other solid residues (Cotrell dusts,etc) containing the non-ferrous and precious metals, to recover.

The second alternative, was already present in the practice of "burning pyrites" in the open air during the XIX century, where the release of SO_2 provided a "confortable" but ecologically incompatible way to get rid of the sulphur surplus. In much more recent times, as we may see later, this "metals drive" was aggravated by the increase of metallurgical minimal dimensions and suggested solutions not only in the ore beneficiation stage (such as the removal from pyrite and concentration of the minerals containing NF metals) but also in other steps of pyrite processing (such as total or partial recovery of elemental sulphur, the hydrometallurgical treatment leaving untouched the pyrite matrix, etc). Besides, the jumboing of metallurgical capacities put the "acid drive" acid cinders combinations under very strong pressures,

from which only some particular cases emerged and still remain in operation.

This requirement of bigger unit dimensions, due to increased competitive behaviour of producers and markets and to "energy sensivity", also emphasized the "energy content" of pyrites (as well as other sulphide ores) as a potential and meaningfull credit to their processing (16).

1.2.4.2. Historial background (2,3,4,5,6 and bibliographical references there quoted)

Being exploited for copper and silver even before the Roman period, the historical activity in the Portuguese and Spanish mines of South-west Iberia up to our times can be summarized in a common structure with four cycles, each one overlaping in a certain time extent the new comer or leaving a relative large gap in its sequence:

I - primitive exploitation and metallurgical treatment of the oxydized (upper) zones of the orebodies, for the recovery of copper and silver ("primitive copper cycle");

II - selective recovery of copper with environmentally agressive sulphur removal by burning in open air or by natural oxydation/cementation processes ("XIX century copper cycle");

III - use of pyrites as source of sulphur for sulphuric acid industry and adding up systems for the recovery of non-ferrous and precious metals (as well for the purification and use of cinders as iron-ore in blast furnaces and for the recovery as steam of available waste heat released during processes) ("sulphur/iron / /copper cycle");

IV - (more recently) development of processes that may overcome the original relation sulphur/recoverable non-ferrous metals contained in the complex ore, either by concentration of the non-ferrous containing minerals (and discard of pyrite to the

tailings disposal -for use just as required for sulphuric acid production), or by the production as elemental sulphur of part of the sulphur contained in the complex pyrite, or even by selective leaching of the useful mineral constituents, leaving the lean--pyrite (FeS_2) matrix untouched - or minimally touched ("selective non-ferrous metals recovery cycle").

Second cycle, as mentioned, is well separated from the primitive uses of pyrite and corresponds to:

- the use of new technologies for copper recovery from solutions (cementation processes):

- the "recognition" and use of old mining centers, that passed from pratically abandon to big mining ventures employing in some places more than 2000 miners and deeply changing the social pattern of the area;

- large employment demand, proposal of integrated projects (some of them establishing already the transition to third phase and including the production of fertilizers), development of communications and definition of export centers (Mértola, Setúbal and Barreiro, in Portugal; Huelva in Spain);

- increase of concession applications by foreign companies and gradual transition to foreign ownership that praticall remained untouched up to the 60's or even the 70's of this century.

As a matter of fact, with the gradual closure of smaller uneconomical exploitations and the failure of the Transtagana project (a corporation that was operating in Aljustrel around 1981 and that closed activities after the decrease of copper prices resulting from the first boom of Chilean copper), pratically the three main Portuguese pyrite mines (S.Domingos, Lousal and Aljustrel) were to stay frequently under non-Portuguese interests as per following table:

Table XIV: Portuguese complex pyrite mines: recognition data, non Portuguese interests and present situation

Mine	Recegnition date	Non Portuguese interests	Present Situation
S.Domingos (Mértola, dist. Beja)	1854	1855 to the Spanish (with French interest Company "La Sabine" that rented the mine to the British Company Masons and Berry	exhausted between 1960-1970; Mason and Berry abandoned the concession, but La Sabina remained with concession rights up to 1984, when they were revoked
Aljustrel (Aljustrel, dist. Beja)	1849	1849-1854 Spanish interests; 1854 -1867 British interests 1898 Belgian interest (Portuguese interests between 1867 and 1898)	in 1973 in created a Portuguese Company after purchase of Belgian interests; Belgian minority rights (abt 5%) still remain in this mine)
Lousal (Grandola dist. of Setubal)	1883	1885-1899 French interest; 1934 - today Belgian interests (from 1899 to 1934, Portuguese interests)	mining rights fully under Belgian control

A quite similar table could be dressed for Spain, where French interests, present at first and replacing original Spanish interests, gave gradually place to British corporations (viz. Rio Tinto and Tharsis) and where a sensible increase of Spanish active participations could also be drawn in much more recent times.

If the "XIX century copper cycle" was necessarily represented by the "integrated mine / metallurgy " concept, searching for greater overall added value and by a real affection to the mine site, the "sulphur / iron / copper cycle" brought a much greater "chemical drive" for potential expansion. Although keeping the copper recovery and iron-ore production from pyrite cinders in selected centers of collection**, where operative dimension would stay above break-even, the industrial units of this third cycle became much more sensitive to an easier acess to imported raw materials (like phosphate rock) and to the relevant consumer markets, placing themselves according to different criteria and much often having no direct partnership relation from (or to) became the mining companies. Pyrite became a commodity and pyrite miners sellers or exporters of grain crushed pyrite, with no other major beneficiation***. Barreiro where CUF - Companhia União Fabril (one of the companies that, after its nacionalization in 1975 formed Quimigal) operated, and Setúbal, where the Belgian group

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* Good examples of this policy were the Spanish copper smelting unit at Rio Tinto, as well as the copper "water-jacket" unit and the sulphur producing Orkla plant of S.Domingos, in Portugal. Integration in Aljustrel never passed from the cement producing stage, in definitive terms - up to the newest ideas already in the 4th cycle.

** Like St. Hellens in Great Britain, and Duisburg, in Germany latter added with Barreiro, in Portugal, and Bilbao, in Spain.

*** So important was the pyrite trade that in 1923 was established in London the P.P.A. - Pyrite Producers Association (with 4 Spanish, 1 Norwegian producers and Mason and Barry, that had the exploitation right for S.Domingos); this Association turned, befor the 30's, to the E.P.C., European Pyrite Corporation.

Sapec, owner of Lousal mines, has fertilizer plants, are good examples for that new concept.

But the dependence of pyrite mines on exports would give a handicap to its survival when in the European markets, traditionally opened to that source of sulphur, pyrite became gradually replaced by the use of elemental sulphur for an easier and cheaper sulphuric acid production*. The decrease of pyrite demand in the earlies 70's marked the onset of several recovery measures to Aljustrel, such as affording a public participation in its equity and the launching of projects to increase mine production namely the CPP project to be refered later. These measures and conscience of pyrite natural limitations imposed by its own composition and structure, would also bring the key of the fourth and more recent cycle, already in our time.

However the use of pyrite for the sulphuric acid production remains pratically the sole output for the extracted ore in Portugal, reason why the item "Cuprecus iron pyrites" is kept in Portuguese mining statistics under the more general caption "Minerals for Chemical and Fertilizer Industry" or, less correctly, "Non metalic ores and industrial rock ".

1.2.4.3. Current pyrite mining operations

Reference will be made to following mining centers with actual signification:

A - S.Domingos (Mértola, Beja district)
B - Aljustrel (Aljustrel, Beja district)
C - Lousal (Grândola, Setubal district)

No detailed reference will be made to the mining centre of Serra da Caveira, near Grândola (district of Setúbal), since

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* Situation that nowadays with current sulphur prices gave on its turn a serious handicap to European sulphuric acid producers, now looking again to pyrites with a certain interest ...

long out of regular exploitation. This orebody has been concessioned in 1936 to another company of the same Group that detains the mining rights for Lousal and that, subsequently, joined both mines under the control of Lousal corporation (in 1979).

Also no reference will be made in this point to the Neves-Corvo orebodies , although they contain not only the higher grade copper ore that made this discovery internationally known but also complex pyrites and lean pyrites. A special reference to them will be considered under item 1.2.5.

Next page summarizes, in graphical form, the production of complex pyrites in Portugal, between 1960 and 1981 (15). These data may be completed with the productions (and respective values) recorded for the period, 1982 to 1984 (7,12):

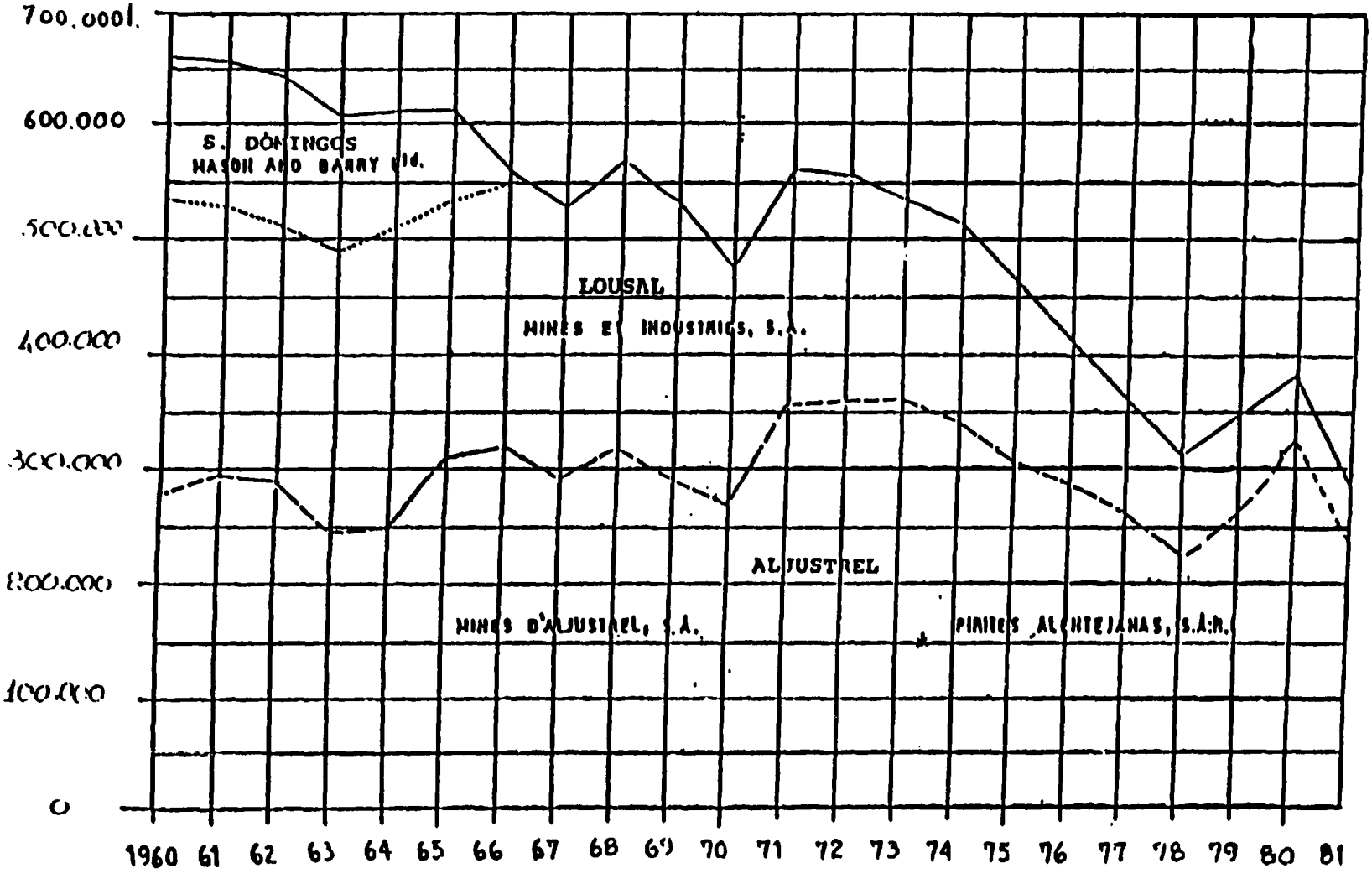
TABLE XV: Pyrite production in Portugal (years 1982, 1983, 1984)

year	1982	1983	1984
Aljustrel, 10^3 tonnes	216.5	245.8	291,7
Lousal	45.6	34.2	42,7
Total	262.1	280.0	334,4
Overall value $10^3c=10^6$PTE	404,6	544,1	847,4
Average value PTE/tonne	1544.	1943.	2534.

From this figure, following conclusions may be drawn:

- S.Domingos mine, spent all the ore in conditions of exploitation, was shut down in 1986. This closure raised a major social problem in the area from which still remain evident distortions and testimonies like the "ghost villages" around Corte do Pinto and Pomarão (Mértola, district Beja). After a glorious mining life, S. Domingos became an example of several situations to avoid

Figure 3 : Production of Portuguese Pyrites(1960-1980)
By Mining Centers (1960-1980)



(Source: 15)

- or to prevent by foreseeing them with enough anticipation
- and makes a theme that from time to time is quoted in the pages of Portuguese papers:

- there is a strong evidence of an overall decline in pyrite production for the represented time period: a great contribution for that fact was the successive reduction of export in the years 60's and 70's.

- there is also an evident decline in Lousal production: this decline is combined with low sulphur (35-42) and iron contents and most probably shows a certain state of depletion in the mine.

- finally, the evolution of prices shows a continuous increase between 1982 and 1984, being the price of 1983 25.8 pct above the price of 1982, and the price of 1984 30,8 pct above 1983 (in current terms).

The examination of each center follows:

A.S.Domingos (6,17)

I. Location: in S.Domingos, "concelho" of Mertola, district of Beja, at abt 9km from the Spanish border. The mine, that had already Roman mining works nearby, was recognized in 1854.

II. Production figures: the level of pyrite extraction, that in the begining of this century was around 400.000 tonnes/year, was near the end of the 50's begining of the 60's in the range of 150.000 - 200.000 tonnes/year.

Following data describe dramatically (in terms of ore production and of employment) the last period of S.Domingos mine (7):

Year	Production 10^3 tonnes	Employment
1960	123.9	1359
1961	124.9	1315
1962	115.4	1256
1963	109.3	1016
1964	98.9	876
1965	64.5	517
1966	0.56	140

Table XVI: The declive of S.Domingos pyrite mine

Year	Production 10^3 tonnes	Employment
1960	123.9	1359
1961	124.9	1315
1962	115.4	1256
1963	109.3	1016
1964	98.9	876
1965	64.5	517
1966	0.56	140

III. Characteristics of the produced pyrite:

Massive complex fine-grained pyrite with chemical compositions within the range of figures already presented for typical pyrites of the Aljustrel orebodies.

IV. Characteristics of the

A single bulky mass of pyrite that near surface was exploited for a lenght of 560m and for a width abt 60 to 80m, with strike paralel with the slates and a vertical attitude (3). That lenght of the mass reduced progressively with depth, having 380m at level-200m and then giving place to two separate portions whose lower limits were estimated for levels-360m and 400m.

V. Explcitation methods

EISSLER, in 1902(3), reported impressive open cast works developing these down to level - 75m, with a system of galleries already worked out down to level - 222m; descriptions of 1953 refer depths of abt - 300m and thicknesses in the indicated range, "always above 20m". The open-cast works required the removal of a sterile layer with a thickness between 30 and 50 meters.

Upper levels of sulphide mineralization lead very promising copper contents, up to the range of 4% Cu. In depth, however, these copper values decreased somewhat, down to the current range of

1.0 - 1.5 pct that characterizes the massive complex pyritic ore from other orebodies in the PyriteBelt (with a remarkable exception opened for Neves-Corvo). In the begining of this century, the contents of level - 112 were near 1.5 pct copper and S.Domingos was producing in the range of 3000 yearly tonnes of copper.

Mining methods included initially open cast, as already mentioned, and for underground works room-and-pillar at first, to be followed in a later stage by cut-and-fill,,this enabling a more complete extraction of the orebody.

VI. Associated processes for the extractive metallurgy of copper:

Roast-heap pyrite burning in open atmosphere was the first process used in the XIX century Portuguese pyrite mines (S.Domingos, Aljustrel in the same extent it was being used in the other side of the Spanish border. Description of these practices is well provided in several sources (3,4,6 among others). The agressive discharge of SO_2 and the strong demand of firewood soon required different practices.

Natural cementation "heap leaching" were extensively used processes and several "millions of tons of wash-depleted pyrite with contents of 45 to 50 pct sulphur and 0.20 to 0.25 pct copper have built up in available land" (6).

In 1934, Mason and Barry installed in S.Domingos an Orkla -type unit for the production of abt 16,000 tonnes per year of elemental sulphur. The Orkla process was developed in Norway, abt 1928, envisaging the removal and recovery of elemental sulphur from pyrite in a reductant atmosphere with addition to the pyrite of coke (reductant) and silica (for slag formation), and co-generating a low-copper matte that, in S.Domingos, was treated for further concentration in a "water-jacket" unit followed by converting.

Gases from the Orkla furnace were passed over dessublimating condensing chambers, where elemented sulphur was recovered (with a relatively low content of impurities, such as cinders and minor amounts of arsenic and selenium) and, in S.Domingos, simply discharged to the atmosphere*

Copper cement produced at the mine was fed to the water-jacked and/or onverter, this increasing the prodution of blister, or even sold as so.

VII. Pyrite expedition

The pyrite exploited in S.Domingos had following destinations:

- local treatment (Orkla furnace for elemental sulphur and copper low matte production) or leaching in place (heap leaching for the recovery of copper, as already described;

- export for consumers abroad via a norrow-gauge mining railway connecting the mine to the inner harbour of Pomarão (district Beja) in the Guadiana river;

- expedition for national consumers (namely CUF, in Barreiro) also via Pomarão.

Coarse and lump pyrite was dispatched from the mine via a narrow-gauge private railway (of abt 20km) to the harbour of Pomarão, 55km up the Guadiana river; however only relatively small ships could pass the mouth of the Guadiana, bringing a certain restriction to pyrites trade from S.Domingos.

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* In Orkla, Norway, they were further trated in a Claus process unit and in Rio Tinto, Spain already in the 60's, they were fed to two sulphuric acid units, engineered by Chemiebau-Zieren of Cologne, Federal Republic of Germany, that due to the complex gas mixture (envolving SO_2, SH_2, COS, S_2C, etc) had several starting-up and performance problems.

CUF (now Quimigal) works at Barreiro have currently been fed up to mine closure by pyrites from S.Domingos and had special - - sized ships for making the "pyrite-shuttle" Pomarão - - Barreiro.

S.Domingos never was connected to the national railway grid.

VIII. Envolved corporations

La Sabina - corporation established in Madrid but with French interests (at first) that detained since pratically their recognition up to their revoke by Portuguese authorities in 1984 the mining rights for S.Domingos;

Mason and Barry, Ltd - corporation under British Law that, also pratically since the La Sabina concession (in 1855-1856) up to mine closure (in 1968), has rented S.Domingos mine from La Sabina. With recognition of mine depletion, Mason and Barry tried to develop several regional actions including the mine itself (vg. underground leaching of copper) or nearby (vg. yatch shipyards near Guadiana mouth), but without pratical survival.

When the mining rights of La Sabina were revoked (1984), this company was claimed in several Portuguese papers to represent West German interests.

IX. Personnel

As pratically all important mines of the Pyrite Belt, S, Domingos called to the Mertola region and specifically to a low- -resources location near the border, a great number of outside workers. Two small towns (Minas de S.Domingos and Corte do Pinto) have developed and, as alrealy mentioned, five years before mine was shut (shut down in 1986) the employment volume was still in the range of 1315 workers.

This circonstance may give an idea of the problems that still remain in that area, when an important activity was almost suddenly stoped.

B. Aljustrel

I. Location:

in Aljustrel, "concelho" of the same name, Beja district.

II. Production figures, ore bodies and reserves:

Production figures for the last 24 years are given (part of them graphically) in the foreword of this item 1.2.4.3.*; official figures of production and stocks for pyrite and copper cement (see reference to production of copper cement in Aljustrel in item 1.2.3.) are given hereunder for the period 1975-1984 (12):

Table XVII: Production of Aljustrel mines (1975-1984)

Year	Production tonnes		stocks tonnes (the 31th Dec.)	
	Pyrite	Copper cement	Pyrite	Copper cement
1975	305.559	32.5	111 527	70.1
1976	280 468	31.5	130 077	101.6
1977	257 105	59.9	112 012	54.7
1978	225 034	86.2	112 372	18.8
1979	268 930	74.7	138 285	93.6
1980	331 915	79.2	180 782	172.8
1981	234 678	60.9	177 604	210.9
1982	216 437	102.2	155 895	6.2
1983	245 756	29.6	125 336	35.7
1984	291 735	35.5	62 489	71.2

In recent times, production is only centered in two ore bodies - Moinho and Feitais - prevailing the following situation to the other 4 ore bodies of the Aljustrel area:

S.João - included in the concession to Pirites Alentejanas S.A.R.L., like Moinho, Feitais and Algares. After being explored in former times, and intensively in the XIX century (open east process),

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* a correlation of Aljustrel pyrite production in the period 1900-1980 with main external and internal circunstances was made by GOMES and FARIA (19).

S.João still has enough untouched reserves with copper contents that renders it interesting for future exploitation. Due to the proximity of the Great Alentejo Fault (or Messejane Fault) the ore masses have a certain fragmentation that renders mining activity more dificult. S.João orebody is presently in a stand by situation for future developments integrated in the Aljustrel project.

Algares - also concessioned to Pirites Alentejanas, S.A.R.L. Its intensive exploration in Roman and later times left the ore-body pratically exausted. A large volume of Roman slags may provide a suitable recovery situation. Copper impregnations (stockwerk) and precious metals in gossans are under investigation. Near this mine, under the slags, were found the two unique bronze tables containing part of the Roman mine reglementation for Vipas Vipasca, the Roman name for Aljustrel.

Gavião - discovered in 1970 under more than 60m of Terciary sedimentar deposits of the Sado valey Gavião stays in relation to S.João/Moinho astride the Messejana fault, the evaluation of the net slip of this fault (abt 2.5Km) making then possible to project currently the first deep diamond drill hole. This remerkable geological work was carried on by S.M.S. Sociedade Mineira de Santiago, S.A.R.L., then a corporation of the CUF Group, and that was nationalized in 1975, giving origin in 1979 to EMMA, E.P. (see under VIII, hereunder), The concession of Gavião belongs to EDMA, the state owned mining corporation resulting from EMMA, and the orebody has not yet preparatory direct works for exploitation, being considered as a potential reserve to Aljustrel developments under study,

Estação - discovered in 1968, this orebody is not yet fully known. Its concession was demanded by EDMA, after works of exploration carried under permission in the Aljustrel area.

It has to be mentioned ther besides S.João and Algares, Known since antiquity the two orebodies of more ectual interest in Aljustrel were only discovered in relatively recent times. Still in 1927 a description guide of South Portugal mentioned that between S.João (also known as S.João do Deserto)

and Algares there was but a fully sterile area (18). Moinho was discovered in 1953/55 by electromagnetic "TURAM", drilling and mining operation from S.João mine; Feitais was discoved in 1963 by gravimetry combined with mining operations and explorative drilling - being active, in both cases, the then concessionary of Aljustrel mines, Mines d'Aljustrel S.A. Relevant data on Aljustrel and other findings in the Iberian Pyrite Belt are reported by Carvalho (1).

The location of mentioned orebodies of Aljustrel area in given in the following page (Figure 4) as well as an indication of respective reserves (Table XVIII).

III. Characteristics of the produced pyrite:

Average characteristics for the orebodies, that for Moinho and Feitais correspond to the average production, were given under 1.2.4.1.

IV. Characteristics of the orebodies:

All the orebodies in Aljustrel show a subvertical attitude that may reach thicknesses up to 100m (Moinho), combined with considerable runs of ore up to 1320m along strike. These orebodies, that may be regarded as fully containing complex pyrites, are known in depth down to-500m and production is actually centered in the 265m level (15). For geological considerations see LEITAO and therein quoted references(20).

V. Expoitation methods

Cut-and-fill method both in Moinho and Feitais. No underground works are presently being carried in the other orebodies, as already mentioned (15).

Studies were carried on to develop a more productive although less selective, mining method such as "sub-level stoping", when the Aljustrel project and/or other consumers make a greated demand

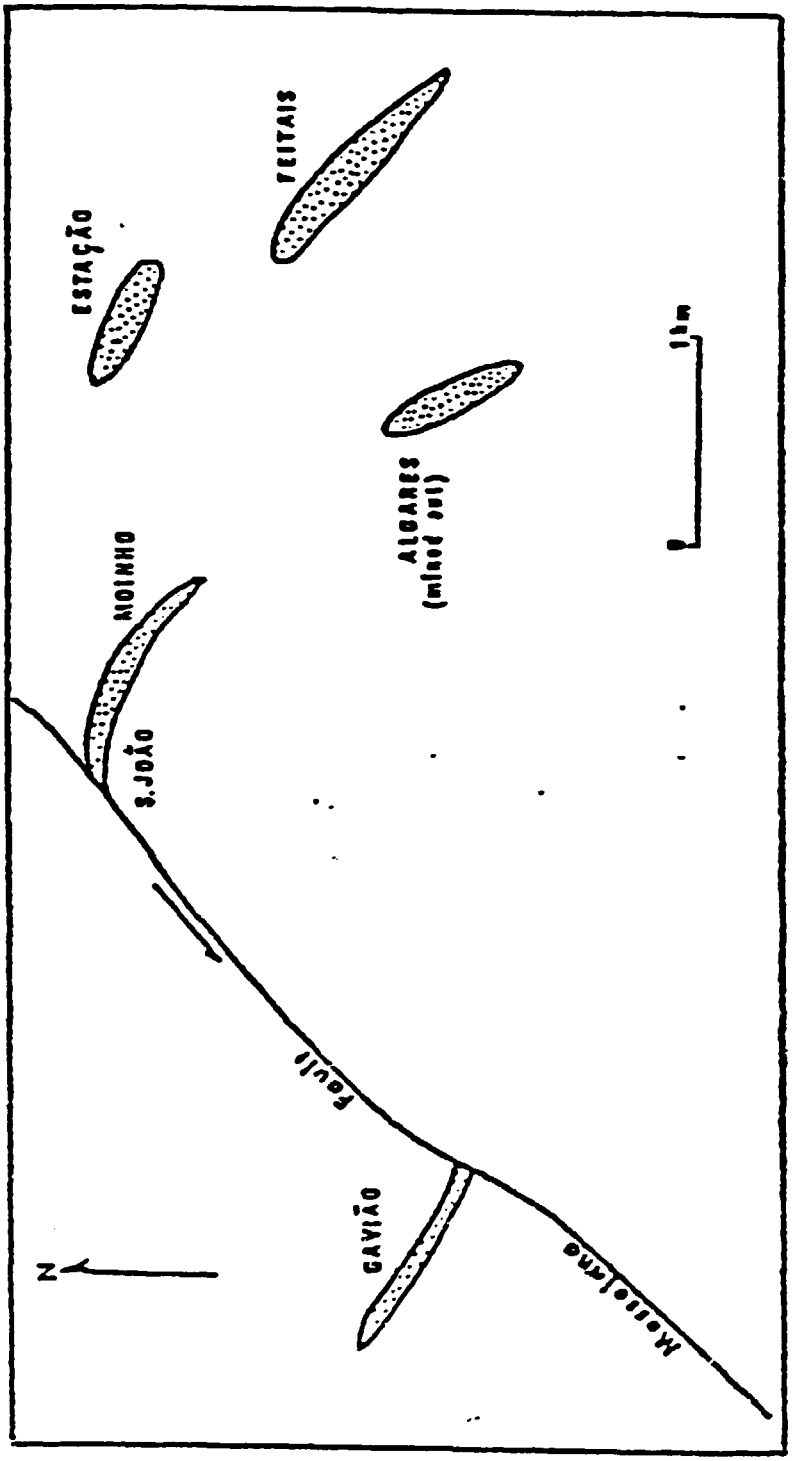

Figure 4: Complex pyrite orebodies in the Aljustrel area

Table XVIII: Complex pyrite·ore reserve in Aljustrel area (Million Metric.tonnes)

Orebodies :	MOINHO	S JOÃO	GAVIÃO	FEITAIS	ESTAÇÃO	TOTAL
Proved Reserves	34	2	16	40	-	92
(in brackets prepared reserves for stoping)	(5)	(2)	-	(7)	-	(14)
Indicated Reserves	25	5	4	11	20	65
Demonstrated Reserves	59	7	20	51	20	157
Inferred Reserves	5	10	3	10	20	48
TOTAL RESERVES	64	17	23	61	40	205

Following the definition of reserves of the U.S. Bureau of Mines & U.S. Geological Survey, 1974

for pyrite. As a matter of fact, Aljustrel production is being tailored to satisfy Portuguese domestic demand, that remains in the range of 300-400 thousand tonnes per year. The limited number of consumer and their prevailing connection to the fertilizer industry, where prices have been under administrative regulations, makes the demand figure highly sensitive to fluctuations registered in respective down-stream market conditions (15).

Pirites Alentejanas, S.A.R.L., has envisaged - in accordance to the requirements set forth in 1958 to 1960 by the Governmental plans of development in the non-ferrous metals sector - a sensible increase of its production. This capacity increase, from abt 0,5 million tons to 1.0 million tons of ore extraction, was carried on up to now and the fact of having it performed according to a schedule commitment ther had no counterpart in the consumer side brought to Pirites Alentejanas the balance of two opposite situations:

- the financial burden of an investment without return, but

- the preparation of the mines to face next development situation, and even a greater pyrite demand for sulphuric acid manufacture due to the current high prices of sulphur.

VI. Associated facilities

Pyrite output is crushed down to-6mmm in a crushing plant included in mine premises (down lump crushing before lifting by skip and then outside fine crushing up to these dimensions); this is the general consumer specification.

The mine also contains cementation facilities and all other pertinent requirements.

A railway connection (standard gauge) to the national railway network (that replaced a prior connection in reduced gauge, see reference (4) and (18)) and an exporting pier with loader at Setubal harbour also belong to Pirites Alentejanas.

VII. Pyrite expedition

Railway transport up to the client premises (Quimigal sulphuric acid plants in Barreiro, district Setubal, and Estarreja, district of Aveiro, and Sapec sulphuric acid plants in Setubal). Railway connection to Sines industrial park is also possible, as well as to the exporting pier of Pirites Alentejanas, in Setubal harbour.

VIII. Envolved corporations

In connection to Aljustrel mines, several corporations have already been mentioned For the sake of a better understanding of more recent developments, their listing will be made here, with a certain chronological order.

Aljustrel	CUF(Quimigal)+SMS(EDMA)
	1865-Alfredo da Silva incorporates in Lisbon the CUF - Companhia União Fabril SARL that would become the diversified private Portu Portuguese Group CUF - Companhia União Fabril wouldstay as the industrial component of the Group in fertilizers, chemicals and metallurgical activities
1898-Belgian interest purchase the mining rights in Aljustrel orebodies (S.João and Algares) incorporating the Societé Anonyme Belge des Mines d'Aljustrel	
	1908-Begining of industrial activity in CUF Barreiro works using pyrite for sulphuric acid production (S.Domingos?)

1934-the S.Annyme Belge des Mines d'Aljustrel purchases the mining rights of Lousal mine. Aljustrel and Lousal became operated by the same corporation

1936-split of Belgian interests. S.Anon Belge des Mines d' Aljustrel follows with Aljustrel: Mines et Industries S.A, also Belgian, follows with Lousal mine.

1956-the Belgian corporation Mines d' Aljustrel S.A. replaces S.Anon Belge des Mines d'Aljustrel

1960-70 the CUF Group, that already had copper mining interests in Angola (ECA= Empresa do Cobre de Angola), is willing to get a controling position in pyrite mining. Besides, the announcements (and then the feet) of S.Domingos closure, made CUF consider

-the incorporation of a 100% owned mining society SMS - Sociedade Mineira de Santiago, S.A.R.L, for active exploration in Alentejo.

-the participation of CUF Group in Aljustrel by purchase of a leading part of Belgian equity

	SMS	CUF
	1968-SMS discovers Gavião orebody in Aljustrel	
	1970-SMS discovers Estação orebody in Aljustrel	
	1972-pursuant to separate demands and the action of Portu Portuguese authorities to combine their requirements, SMS and French interests (Peñarroya and BRGM) form an explorating group and begin drilling in a large area of Beja district (from which Neves--Corvo finding in 1977 would result).	
1973-after the bids of CUF group and Portuguese Government to Mines d'Aljustrel, a new corporation with Portuguese majority, Pirites Alentejanas SARL, is formed: 45% CUF 45% State owned equity 10% Belgian interest		1973-CUF bids for purchase of majority in Mines d'Aljustrel S.A.; the Portuguese Government anticipates in the business and gets with CUF an equal position in the majority of the Portuguese company then formed

1974-after Portuguese revolution, Pirites Alentejanas private Portuguese participation is nationalized, remaining therefore 90% State owned equity 10% Belgian interest

1974-79-the Belgian interests don't follow share capital increases, why their participation remains reduced to presently abt 5 pct (Belgian interests are represented by SOGEMINDUS - Société de Gestion Miniéres et Industrielles)

1979-the Stated-owned participation in Pirites Alentejanas (abt 93-95pct) reverts to EMMA (then to EDMA)

1974-SMS is nationalized together with the private Portuguese part of Pirites Alentejanas, remaining S.M.S. S.M.S. therefore (and later EMMA/EDMA) remains for the future fully independent from CUF/Quimigal.

1977: discovery of Neves-Corvo.

1979-the Government forms EMMA-Empresa Mineiro Metalúrgica do Alentejo, E.P., 100% State owned for having mining and metallurgical activities in connection with copper findings, and acting as an holding to state participations in corporations exploiting sulphides in Portugal (26).

1974-after the nationalization of SMS and the private Portugueses part of Pirites Alentejanas, CUF is also nationalized.

1976- CUF is merged with other 2 fertilizer corporations also nationalized, incorporating Quimigal - Quimica de Portugal E.P., 100% State owned.

	1980-Incorporation of SOMINCOR - Sociedade Mineira de Neves-Corvo SARL 51 pct EMMA 24.5 pct BRGM 24.5 pct Penarroya (see evolution under Neves-Corvo)	
	1980-82- EMMA prepares the launching of the metallurgical projects.	
	1982-Portugueses Government decides to remove (to the control of Quimigal) the metallurgical activies from EMMA, whose denomination passes to EDMA - Empresa de Desenvolvimento Mineira do Alentejo, E.P., also 100 pct State owned* (27).	1982-Quimigal receives the full control of the metallurgical activities represented by its own plants and the undertaking commitments detached from EMMA*
1986-EDMA is urged to place in the stock market part of its shares in Pirites Alentejanas keeping however a substancial majority.	1986-If is announced thar EDMA will encharge its activities by incorporation of the other State mining company Ferrominas (iron and coal) changing again its denomination to EDM-Empresa de Desenvolvimento Mineiro, E.P. (100 pct State owned)	

* instead of a possible coordination of metallurgical actions, that was stated in some texts, the 1982 Government decided to break vertical integration, with split of mining and metallurgical activies.

IX. Commercial terms and activites; corporation performance:

Pyrite is sold to customers of Portuguese domestic market according to a formula where following variables and conditions are considered (per tonne of pyrite)

- dry basis:
- content of sulphur (value calculated pro-rata to 48 pct sulphur content) multiplied by sulphur reference price as a first adding component;
- content of copper: second adding price component, estimated in the base of copper content less a certain constant deduction, multiplied by a certain estimated copper yeld and by copper price (LME) deduced from a certain tratment charge;
- no other components applied to cost evaluation, nor penalties or deductions (although a certain dialogue may be established between mine and consumers if contents of certain components go to abnormal ranges);
- Coeficients have been fixed with yearly frequency; however no obligation of an early revision of settled values is imposed This situation of prices - "contracted price" system implying negociations between seller and buyer and then reference of the settled conditions to the pertinent authorities - replaced in 1981 the former and much more administrative bound "maximal price" system that has been applied since 1974, as pyrite was considered one of the main components in the formation of Portuguese fertilizer prices (through the production of sulphuric acid).

A brief idea of the of the volume of transactions by Pirites Alentejanas and of values attained for pyrite in Portuguese domestic market* can be supported following table, in which is explained their sales value between 1975 and 1984, not only in current (historical) values but also estimated in constant values 1984 (12).

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* during the period of this table, pratically no pyrite export took place.

Table XIX: Aljustrel commercial activity 1975 to 1984

	Pyrite (tonnes)	Copper cement (tonnes)	Total Current Prices (contos)	Total constant Prices (1984 basis) (contos)
1975	297 007	-	110 040	723 953
1976	261 881	-	124 077	683 416
1977	275 170	106.8	147 972	626 365
1978	224 674	121.5	153 404	508 534
1979	243 017	-	206 325	536 651
1980	289 418	-	272 813	646 976
1981	237 856	22.8	260 956	502 406
1982	238 146	306.9	400 004	642 606
1983	275 766	-	581 200	741 030
1984	355 130	-	889 963	889 963

The decline of pyrite exports was specially due to

- concurrence moved by elemental sulphur, with lower prices (situation no more prevailing today);
- concurrence moved by recovered sulphuric acid ("smelter acid" and other forms of by product acid);
- lower investments and costs required by sulphur-burning sulphuric acid plants;
- problems caused by the disposal of effluents connected to pyrite roasting and SO_2 - gas purification;
- problems raised about some minor constituents of pyrite;

and its effects were stongl felt in Portugal and Spain. As already mentioned this situation seems to change and the production of sulphuric acid from pyrites, be it in the Peninsula (with return of effluents as mine fillings) or abroard, by reassumed export of pyrite, seems not far from a possible revival.

After a period of certain difficulties caused by such a decrease of exports and the impact of financial charges from the investments that in a certain way were imposed to meet in schedule a consumption that never appeared, thus not providing the

Table XX: Main indicators of corporate performance for the Aljustrel concession holder, Pirites Alentejanas, SARL

	1982	1983	1984
Share capital, 10^3contos	1218	1218	1873
Reserves, 10^3contos	426	367	450
Capital and reserves, 10^3 contos ("Networth")	1549	1564	2306
Amortizations and depreciations for the year, 10^3contos	137	124	293
Gross Results, 10^3contos (before deduction of taxes)	-31	10	15
Cash flow, 10^3contos	106	137	353
Investments, 10^3contos	250	304	423
Gross Added value, 10^3contos	454	548	809
Sales value of pyrite, 10^3contos	382	581	890
Mining productivits, tonnes/man/day	4.19	4.83	5.76
Employees (31th Dec)	740	706	680
Remunerations to the Personnel 10^3contos (including all direct remunerations)	244	279	323
Social charges on remunerations (including subsidies and insurances payable by employer), 10^3 contos	90	110	133

necessary return. Pirites Alentejanas SARL entered in a relatively stable performance, as per following main indicators (12):

However this situation is not to be regarded as calm in the medium term: with the availability of "floated pyrite" already in Spain (by the flotation of complex pyrites for NF metals recovery) and Soon in Portugal (by the treatment of cupriferous ore of Neves Corvo with pyrite matrix), low value pyritic residues will be made available in much cheaper conditions for the production of sulphuric acid - and then sulphuric acid producers will be moved to employ such fine raw-material, in adapted units*, instead of present coarse pyrite. Besides, the eventual erection in Portugal of a reasonably sized copper metalurgy may well provide enough sulphuric acid for domestic needs or for the more important export markets.

This puts Pirites Alentejanas with a strong challenge, facing already in a count-down procedure the risk of its own survival The guidelines observed for turning around this crucial stage will be described.

X. Personnel

As already stated, Aljustrel mines employ presently abt. 680 workers being the major single employer of Aljustrel area and ore of the biggest employers in Portuguese mining.

The reduction in the number of workers in latest years is due to efforts for racionalization, mechanization and increased productivity mine**.

From the above mentioned number, 290 to 300 are envolved in underground operations; from the remaining number abt 70 are white collars, being the balance made up by surface workers.

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* That already exist in operation in Huelva (Foret S.A.) and Calañas, province of Huelva, near the mine of Sotiel (MASA - Mines)

** The employment in historical times has been larger, by the intensive use of labour required by bigger extractions of ore. In 1916 the mine had 1986 workers and in 1927 "more than 1000 "(18).

XI. Other concessions owned by Pirites Alentejanas SARL:

In the Pyrite Belt, Pirites Alentejanas owns some other minor concessions to be listed:

- Herdade do Montinho, Ourique district Beja, where mining activies have been suspended in 1965 after minor operations;

- 7 other mining concessions for copper in the "concelhos" of Évora, Viana do Alentejo and Beja, also with suspensed mining activies.

As a matter of fact, Aljustrel remains the mining certer where Pirites Alentejanas is applying its maximum mining and development efforts.

C. Lousal

I. Location:

near Ermidas, in Grândola, Setúbal district.

II. Production figures orebodies and reserves:

Lousal produces its pyrites directly for the use of the sulphuric acid plants of his "mother-company" Sapec, in Setubal. The recent purchase of part of Aljustrel production by Sapec, leading to an "increase strongly marked in relative terms of Setúbal consumptions "for 1984 (12) may signify a certain reduction in the output of Lousal (at least in terms of contained sulphur), since the capacity of the acid units has not been increased.

Lousal production may be deduced from the figures of total pyrote production and Aljustrel pyrite production, in recent years (only the two mines were then in operation):

Table XXI: Estimation of Lousal complex pyrite production

Year	Lousal production (approx figures by difference) 10^3 tonnes
1975	155
1976	130
1977	103
1978	85
1979	81
1980	49
1981	74
1982	46
1983	34
1984	43

The market reduction of Lousal output seems evidenced.

III. Characteristics of produced pyrite

Complex pyrite with lower sulphur and copper contents than in Aljustrel orebodies (except for copper, Feitais).

Sulphur contents between 39 and 43 pct and copper contents between 0.6 and 0.8 pct are reported.

IV. Characteristics of the orebodies

Subvertical attitude Several masses have been recently discovered (1) such as

1966 Massa António (about 2 million tonnes of pyrite)
1974 Massa José and Fernando (about 4 million tonnes of pyrite

however demanding in the exploration of lately recognized reserves a certainly large extension of mining works. For the descriptive geology of the orebody, CARVALHO (1) quotes the works of STRAUSS, that has been connected to above mentioned findings.

CARNEIRO in 1971, estimated Lousal reserves in 4.5 million tonnes

of pyrite - figure that masses José and Fernando, in 1974, could make double.

V. Pyrite extraction and expedition

Pyrite extracted in Lousal is sent via railway to the Setubal consuming center. Lousal is connected to the railway network in Ermidas (Grandola, Setubal).

VI. Envolved corporations

For how Belgian interests came to Lousal (as well as to Serra da Caveira) mine, the scheme developed for discription of Aljustrel includes relevant data.

The mining rights of Lousal, as well as of Serra da Caveira also in the concelho of Grândola (district Setubal), belong to Mines et Industries S.A., a Belgian corporation 100 pct owned by the also Belgian SAPEC (Société Anonyme de Produits et Engrais Chimiques du Portugal) Group. The SAPEC Group has, through its mother society SAPEC, fertilizer plants in Setubal; besides Mines et Industries owns a producing unit for tungsten-hardened material in the north of Portugal (district of Aveiro).

Although there is no statement of direct enpagement of SAPEC Group in Tharsis (Spain), the report of Compañia de Minas de Tharsis for the year 1984 mentions at least two (or three) name of members of the respective Board that bear also relevant positions in the SAPEC Group (21).

VII. Commercial terms, data on performances

As already mentioned the consumption of pyrite extracted in Lousal is 100 pct captive to SAPEC sulphuric acid production, making a real case of vertical integration (although reduced in effects by the decrease of potential of Lousal mines).

The performance of Mines et Industries has shown negative

return on gross assets for the period 1981-83: this dificult situation combined with the trend of other rata and the indication of decreased operations in Lousal (combined with increased purchases of Aljustrel pyrites), puts a question mark to the future of this mine, particularly if additional investments are not carried on to provide the access and exploitability of extra-reserves (and even for the prospection of other potential resources) or if the exploitation philosophy, itself, is not changed (vg. to provide copper concentrates production from "stockwerken" as well as in Serra da Ceveira mine).

VIII. Personnel

This situation is even more sensible to the fact that, although with a progressive reduction of personnel, Lousal mine still remains with abt 200 employees (from which 38 white collars). Considering an overall productivity index (yearly tonnes of pyrite/employee) Lousal is in the range of 215 tonnes/men. year in 1984, i.e. abt-only 41,1 pct of the same overall ratio Aljustrel, for the same year.

Besides, Lousal also faces the same risks for the consumer development to fine pyrites that were already outlined for Aljustrel, what gives to the examination of Lousal future an accrued criticality in relation to the situation already stated for the Aljustrel mine.

IX. Other concessions owned by Mines et Industries SA in the Pyrite Belt:

The mining rights for an historically important promising mine in the Pyrite Belt, Serra da Caveira (in Grândola, Setúbal), also belong to Mines et Industries since 1979 (5). As a matter of fact the concession of this mine was acquired in 1936 by another society of "Sapec Group", Empresa Exploradora de Minas, from which were transmited later to Mines et Industries.

Serra da Caveira was a promising site with remarkable vestiges of primitive mining and smelting and that in the end of last century developed a good deal of expectations, with proposals for a chemical-fertilizer complex in the near by Sado valey. However, the activity of that mine never reached a notorious degree and pyrite extraction was suspended in the early 40's (or even in 30's).

1.2.4.4. The C.P.P. project

In the begining of the 70's, Portuguese Government took in a favourable regard the development of complex pyrites and decided to begin efforts towards this objective through some official departments, namely the Sines Area Authority (Gabinete da Área de Sines - GAS) - regardless of investigations and proposals made by then private groups, as CUF and SAPEC*.

Some technological processes were then investigated by GAS, as well as some other decisions were taken - among them the irruption of the public sector in the negociation for the purchase of a majority in Aljustrel by Portuguese private interests. as already mentioned (in 1973).

In 1976 after main nationalizations have been made and conscious of the aggravation of pyrite export decreases and getting from prior studies the problem the outline of future prospects to complex pyrites, the Portuguese Government created a commission under the Ministry of Industry, ther would be known by Pyrite Programme Commission (C.P.P.) and whose objectives were to examine carefully all issues of future development of Portuguese pyrites and to propose suitable schemas for respective implementation.

This Commission, joining a staff from all main envolved entities, submited its main conclusions to the Portuguese Government in 1980 and was consequently dissolved in 1982. During this time, it developed a multi-face approach to the pyrite problem, with careful

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* So strange was each one of these lines to the others that one official publication of that time blamed the private sector for having proposed turbulent layer roasting technologies for pyrites ... and that just when a turbulent layer roasting unit was start-up in Barreiro!

examination of all aspects, from mining to ore dressing, pyro and hydrometallurgical processing alternatives for produced fractions, infrastructural requirements, societary framework to implement the projects etc. Centered initially in the development of Aljustrel orebodies, the discovery of Neves-Corvo in 1977 and the first ideas about these new and promising resources every day evolving in a positive sense, brought to the conclusions of CPP the need of a certain flexibility, to include in them the potential advantages of the new resources so added.

A general description of CPP works and methodology, with a statistical list of processes investigated and of international international support granted was made elsewhere (15, 19, 22, 23).

In general terms, CPP dressed plans (PAIP= Programme for the Integrated Value -raising of Pyrites) included:

- development of Aljustrel mine to an yearly extraction of 1 million tonnes of complex pyrite, later to increase by a second phase;

- a first ("prioritary") phase of pyrite processing in Sines, by Outokumpu's pyrite flash smelting process followed by sulphatizing roasting of the iron matte (pyrrotine) so produced and recovery of metals; iron residue would be in suitable conditions to send to the iron works as iron ore; sulphur from the pyrite would be obtained part as sulphuric acid, part as elemental sulphur;

- the incorporation in this metallurgical complex of a 50,000 tonnes/year copper smelter working with Neves-Corvo copper concentrates (the resources known up to then would not afford bigger capacities and the economical interest of that smelter and refining would arise from its integration in a bigger complex, then sharing advantage only certain common infrastructural facilities and premises);

- a second phase, ther would envolve pyrite flotation for the obtention of non-ferrous metals concentrate bulk, or bulk, with separation of a low-value pyrite concentrate or floated pyrite that could be used as required for sulphuric acid production, as well as of suitable metallurgical processes for treating these concentrates up to the marketable metals (22, 57).

By all the extensive testing carried on, that included all the relevant technical aspects known at the time and the collaboration of industrial and research entities and development of promotial institutions in Sweden, Finland, France, Canada, Norway, Spain, F.R. Germay, U.K., France, U.R.S.S., etc., envolved Portuguese technical staff got a particularly broad knowledge of the "state-of-the-art" for suitable technologies at the begining of the 80's.

An estimate for the overall project, with inclusion of provisions for the production in Neves-Corvo mine was disclosed in 1982 together with its technological description and analysis of obtained products (15). Respective anticipated levels of production are reported in the table of next page, The metallurgical complex foreseen for the 1st phase whose diagram is given hereunder, was self-producer of energy, recovered from the generation of steam, up to an yearly level of 344 GWh (16).

The foreseen time schedul was (in 1982) the following:

Mining projects	Foreseen start-up date
Aljustrel mine developments	3d Quarter of 19[illegible]
Corvo new mine and concentration project: copper ore	end of 1986
bulk concentrates	after 1989

Chemical & metallurgical projects	
copper smelting and pyrite complex (1st phase)	3d Quarter 1986
Bulk concentrates processing	after 1989

There is no need to emphasize how optimistic this schedule was, even in what concerns Neves-Corvo mining project now envisaged to produce copper concentrates in the second half of 1988.

The magnitude of estimated investments in 10^6 PTE (1980 terms) was stated in following amounts (23):

- Mining projects
  - Aljustrel 1st phase 3,500
  - Corvo 7,500
- Chemico-metallurgical projects
  - Pyrite (Sines, 1st phase)..... 15,500
  - Copper smelter 60.000 tpy copper integrated in the complex 6,000

In connection to this programme (24), several measures were taken, namely the incorporation of EMMA in the end of 1979 (26), the onset of mining works in Aljustrel, the extensive testing of processes in Finland and Spain for 1st phase of metallurgical works (i.e. the pyrite flash smelting and metals recovery) in 1980-81 the performance of tests in most representative ore dressing schemes and hydrometallurgical processes and the decision of building a flotation pilot plant with suitable dimensions in Aljustrel.

However, in 1981-82 all the 1st phase of the plan would be "frozen" by a set circumstances, namely the financial situation of Portugal, the different governmental priorities (by also a different Government; (23), (31), the stand-still of the

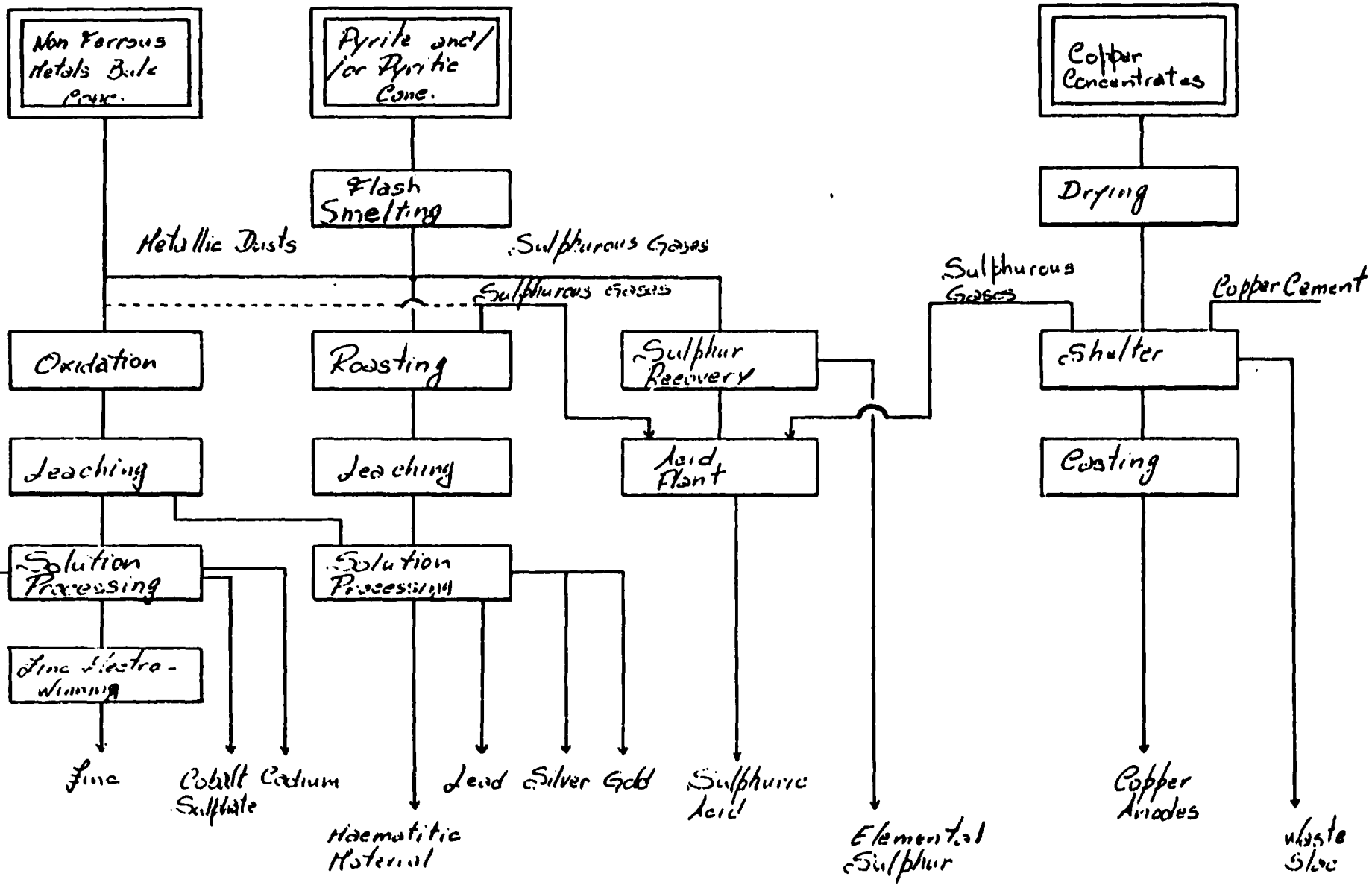
Table XXIA: Foreseen production levels for the overall project
in tonnes per year except unless indicated

	ALJUSTREL MINES			NEVES-CORVO MINES	
	Current production	1st expansion (addit. production)	2nd expansion (addit. production)	Production Forecast	
A - Mining area Run of mine (T/A)	400 000	725 000	1 030 000	1·000 000	
				Copper Concent.	Pyrite Concent.
B - Processing areas					
B.1 - Metals					
Purified haematitic ore	340 000	350 000			
Copper	4 000	6 650		82 000	2 800
Zinc	11 000	18 000		-	4 000
Lead	-	7 950		-	-
Gold (kg)	-	365		-	120
Silver (kg)	-	20 000		26 000	9 000
Cobalt	-	120		-	7
B.2 - Chemicals					max. possible
Sulphuric Acid	600.000	515,000		335 000	430 000
Sulphur	-	95 000			77 000

REMARK : Foreseen production figures, as given here above shall be regarded as additionals to present current productions, also reported. It must be understood that, during the life of an overall programme of this size and characteristics, several modifications may be produced in current production levels.

Source: (15)

Figure 5 PAIP Programme:
Outline block flow diagram
pyrite and copper project (overall)



Source: (15)

siderurgical expansion and of the iron ore project of Moncorvo, district of Bragança (with pelletizing units in Seixal, district of Setubal, to which the fine purple ore of the PAIP 1st phase would be added) and the prevision of depressed values for metals. As a result, Pirites Alentejanas would have to face their partial envolvement in investments for Aljustrel getting no pay-back, and substancial part of the "metallurgical M" of EMMA would hence be torn out, contributing to the changement to EDMA of its designation in 1982 (27). Simultaneously the "National Metallurgical Plan" foreseen in 1979-80 at Governmental level for basic non-ferrous metals development in Portugal (in connection with the components of the PAIP project i.e. Aljustrel, Neves-Corvo and Sines) has also been plainly shelved (25).

Several ministerial instructions, at the end of 1982, brought again some interest to these pending projects: however their impact only had effective consequences upon the development of Neves-Corvo and its connection with the proposed copper smelter project (28).

Some positive contributions remained, however, from the CPP work and PAIP project:

- a good knowledge of advanced techniques in obtaining from complex ores and treating unconvencional concentrates, such as grinding, floating and carrying on hydrometallurgical and pyrometallurgical processes;

- an increased capacity for the output of Aljustrel mine, as well as a clear conclusion on the need of facing with alternative solutions the "fatal" competition that floated pyrite from Corvo would inevitably bring to the classical use of complex pyrite in the "sulphur cycle", i.e. for sulphuric acid production;

- the concentration of actions in the Neves-Corvo and Aljustrel projects, now turned to be, together, the main new ventures regarding non-ferrous metals in Portugal.

1.2.4.5. The development of a flotation process for Aljustrel

Resulting directly from the last conclusion of prior item, Pirites Alentejanas, (concessionary of Aljustrel mines) and EDMA remained well aware of the risks pending on the classical output of complex pyrite. The search of an alternative solution for Aljustrel complex pyrites, in the line of the 2nd phase of CPP's proposed project, i.e. by removal and concentration of non-ferrous containing sulphides from the basic matrix of pyrite, was then envisaged - and decision was taken by the board of EDMA to built a flotation pilot plant in Aljustrel to meet following objectives:

- reproduce in a suitably large dimension the tests already carried on for complex Aljustrel pyrites in foreign technical institutions or operating companies for the CPP project;

- test new methods for that same purpose;

- apply to the grinding and dressing of ores from other origins, such as for instance Neves-Corvo, other mineral materials from the Pyrite Belt as well as from other origins (thus providing specialised services);

- produce of samples for metallurgical testing;

- create a technical staff with specialized skills in Aljustrel for the ore dressing area.

All these objectives seem to have been acceptably met or even surpassed by the pilot unit decided in the end of 1980 by EDMA and that stated operations in August 1982, with a total investment of 225.10^6 PTE (1982 basis) split as follows (29):

Table XXII: Split of investment for the Alhustrel ore dressing pilot-plant (values 1982 basis)

	Portuguese deliveries	Non-Portuguese deliveries
	10^3PTE	10^3PTE
.Buildings and civil works	29,000	-
.Equipment and assembly	29,000	108,000
.Services (studies, engineering supervising, insurances, formative actions to the personnel, financial charges)	43,400	15,600
Total	101,400	123,600
	(45pct)	(55pct)

The description of this plant was completely made by FERRAO (29) but a brief resumé will be made here:

a). purchase of engineering and equipment double bidding procedure similar to that prescribed by the World Bank guidelines (although the World Bank had no part in this development) but without open prequalification; detailed ITB's were sent to 11 representative potential suppliers.

b). supplier selected: SALA International AB, Sweeden.

c). plant capacity: 2 tonnes/hr (feed) for bulk flotation
1,5 tonnes/hr (feed) for differential flotation
(dimensions imposed by the miminum size of the grinding equipment to afford suitable scale-up, particularly for the autogeneous grinding).

d). plant overall dimensions (building): 31x22m

e). capacity of the tailing pond attached (800m far from the plant): 20,000 cubic meters.

f). material feed: the ore is received in a park, transported

into lorries:

a preliminary dimensional classification may take place:

3 bins fed with frontal payloader:

extraction from bins by belt conveyor, automatic controlled by weight.

g). grinding:

1 autogenous mill Ø 150Cmm (suitable to pebble milling)

1 pebble-mill Ø 120Cmm (suitable to ball or bar-milling)

1 ball-mill Ø 100Cmm

2 regrinding mills

possible operation for the primary grinding to operate in closed circuit with type- Krebbs hydrociclones, fed by variable--speed pumps.

h). flotation:

4 double-battery of cells, with 61 cells of the SALA type an and 5 cells of Outokumpu type;

reagent addition with automatic control.

i). thickening and filtration:

3 traditional thickeners

1 SALA lamella thickener

1 vacuum filter, drum conventional type

1 pressure KURITA filter

j). control equipment; analytical equipment; testing lab equipment.

K). flexible connection by reinforced rubber hoses, to provide to the plant all required flexibility.

l). erection schedule:

invitation to bid	December 198C
approval of contract	September 1981
financing agreement aproval	November 1981
begining of civil works (foundations)	December 1981
begining of the building structure	February 1982

main foreign equipment arrivals	March/April 1982
begining of mechanical erection	April 1982
begining of electrical erection	May 1982
end of mechanical erection	July 1982
end of electrical erection	August 1982
startup operations & commissioning	August 1982
official inauguration	November 1982

m). financing: inequal proportions EMMA self financing and external debt; included in the external debt is the financing of 85pct of supplies and services from SALA by Scandinavian Bank Ltd. of London.

The results of extensive pilot plant trating, carried on for Pirites Alentejanas with Aljustrel complex pyrites in the described pilot plant, have already brought to some decisive conclusions on its differential floatability, that based some recent prospectives for launching an independent Aljustrel project (14,30); see table XXIII in next page.

The Aljustrel ore could therefore be considered as suitable for the route of differential (or selective) flotation as has been proposed and put in practice for other ores in the Pyrite Belt (Sotiel, Aznalcollar), and hence not restricted to the limitations of bulk flotation and semi-bulk flotation in which lab tests performed before the operation of the pilot plant proposed to confine it.

This allows a new philosophy for Aljustrel operation that, according to MOURA E SILVA (30), shall met following criteria:

i). the recovery of basic non-ferrous and precious metals, with special reference to zinc and silver makes the basic support for the value of ore treatment;

ii). the non-ferrous metals concentration procedure shall provide, as a first-in-priority requirement, the economical production of marketable products, thus affording to the mining

Table XXIII:

Results obtained in Aljustrel ore dressing pilot plant for the differential flotation of Aljustrel complex pyrites

	Weights (pct)	Contents				Yelds, pct			
		Cu (pct)	Pb (pct)	Zn (pct)	Ag (pct)	Cu	Pb	Zn	Ag
Pyrite fed	100	1.19	1.33	4.10	43	100	100	100	100
Cu concentrates	4.15	20.88	3.58	2.80	130	72.8	11.2	2.8	12.5
Pb concentrates	1.94	1.40	30.14	5.44	750	2.3	44.0	2.6	33.8
Zn concentrates	6.88	2.12	1.35	48.00	63	12.3	7.0ç	80.6	10.9
Pyritic residues	87.03	0.17	0.59	0.66	22	12.4	38.6	14.0	44.5

Minor elements:

	Contents						
	Sb %	As %	Ni %	Co %	Bi %	Cd %	Hg %
Cu concentrates	0.37	0.18	70	140	410	51	60
Pb concentrates	00.05	0.40	18	100	1200	110	140
zn concentrates	0.03	0.20	15	60-19	170	900	770

Sources: 14, 30

activity the maximum independence in relation to the market of industrial operations;

iii). the eventual utilization of pyritic residues for the production of sulphuric acid and/or elemental sulphur shall be essentially guided by the market of these products and by the competitivity of its production costs, in the base of a zero--value (or even negative-value) consideration for the generated pyrite cinders;

IV). the possible interest of the impure pyrite cinders is simultaneously determined by their content in iron and in impurities, what restricts their use under present conditions to cast-iron producing processes leading to a product with quality only compatible with a limited set of applications;

According to obtained results, a first evaluation of Aljustrel project is being presently submited to a techno-economical audit by a well-known mining engineering company and will be proposed very soon. Following contours for the Aljustrel project were recently disclosed by Pirites Alentejanas (19):

I. pyrite extraction: 1 million tonnes/year from Moinho mine.

II. products

	quantity tonnes/year	contents
copper concentrates	26,000	20% Cu; 150g/t Ag
zinc concentrates	55,000	45% Zn
lead concentrates	20,000	25% Pb; 500g/t Ag

and also 900,000 tonnes/year of residual (floated) pyrite with 47% of S, from which 600,000 yearly tonnes will be in condition of direct supply to sulphuric acid/fertilizers producers.

III. starting up date: foreseen for 1989-90.

IV. investment: 5,800 10^6PTE (1985).

V. expected sales value for produced concentrates: 3,000 10^6 PTE/year to be increased with 900.10^6 PTE/year from the supply of 300.000 tonnes of coarse pyrite to Quimigal and Sapec, if that supply follows.

VI. required personnel: 150 workers.

1.2.5. The Neves-Corvo mining project

1.2.5.1. The discovery of Neves-Corvo orebodies

As already mentioned in item 1.2.4.3. where the evolution of corporation acting in current pyrite mining was described, in the year 1972 active exploration was started in the Alentejo region (Beja district, mainly), within the Pyrite Belt, by an association formed by the Portuguese corporation S.M.S. Sociedade Mineira de Santiago, then of CUF Group, and the French Compagnies Société d'Etudes, Recherches et d'Exploitations Minières (SEREM), of the BRGM entrepreneurial Group, and Sociedade Mineira e Metalurgica de Peñarroya Portuguesa Lda (SMMPP), this one (although its Portuguese designation and incorporation law) directly attached to the Société Minière et Metallurgique de Peñarroya and therefore to the IMETAL Group. The contract of prospection and exploration was settled between this Association and the Portuguese General Directorate for Mines (then DGMSG - Direcção Geral de Minas e Serviços Geológicos), from the Ministry of Economy (that included the direction of industrial and mining activities), stating a split of investment in the range 60:40 respectively to the French and Portuguese associates, as well as a set of other obligations, including the requirement of incorporating a mining company for the exploitation of any eventual finding with proved economical interest. According to the Portuguese law then prevailing*, such a company for the exploitation of mineral resources only should be incorporated if with Portuguese majority in the distribution of shereholder's equity.

The changement of status of S.M.S. by its nacionalization in 1975 has also been reported. However this fact would not change

* and still not changed

the relation of participants and their activity within the Association and as a reward to the large amount of effort done in a wide area and with several prospecting methods including drilling to depthes up to then unconventional (according to a re-reading of geological data) Neves-Corvo orebodies were first touch in May 1977 in the common borderline of the "concelhos" of Castro Verde and Almodovar (district of Beja).

Data collected up to the end of 1979 could prove, with a first feasibility assessment, that the Neves-Corvo finding had a strong potential, and hence a "Preliminary study on the Neves--Corvo Exploitability" was forwarded to the Portuguese Government by the Association in February 1980. This would open the negociations for the incorporation of Somincor - Sociedade Mineira de Neves-Corvo SARL (32).

A full chronological sequence of Neves-Corvo finding and development is given by CARVALHO (32), as hereunder reproduced as well as a description of the geological aspect of that finding:

1950-66 - Short-cut geological recognition: geophysical coverage (electrical methods) by the Serviço de Fomento Mineiro (Mining Development Service) of DGGM

1966-70 - Geological studies by "Mining Explorations International" (with no results, works have been abandoned by M.E.I.)

1970-71 - Gravimetric and geochemical coverage by the Serviço de Fomento Mineiro. Detection of the gravimetric anomaly corresponding to the orebodies.

6th June 1972 - signature of the contract for prospection and exploration between the Association (SMS, SEREM, SMMPP) and the Portuguese State, represented by DGGM, for a period of 3 years prorogable by three sucessive period of 1 year each, and covering an initial area of 4000 sq.Km.

29th January 1973/March 1973 - Begining and end of first drilling (N1) up to the depth of 244m, with negative.

1975 - Nacionalization of SMS and of CUF

1st April 1977 - Begining of drilling N2, 50m far from N1

15th May 1977 - N2 drilling cuts mineralization (complex pyrites rich in zinc) between - 350m and -403m

1st October 1973 - End of CV1 drilling, 1km away from N2, that cuts 45m of massive sulphides, including 15m with 7,4 pct Cu content

12th June 1978 - New contract for prospection and exploration between the Association and the State, for a period of 1 year prorrogable by a second period of 1 year, and particularly including the area into which mineralization was found.

1978-80 - Intensive drilling campaign allows for a better knowledge of the orebody

24th December 1979 - Incorporation of EMMA - Empresa Mineirae Metalurgica do Alentejo, E.P. (100% owned by the State) that succeeds to SMS.

February 1980 - The Association forwards to the Government the Report "Preliminary Study on the Exploitability of Neves--Corvo orebodies"

24th July 1980 - Incorporation of Somincor - Sociedade Mineira de Neves-Corvo, SARL, with 51% EMMA and 49% SEREM+SMMP (in equal parts)

4/5 August 1980 - Demand by Somincor of 14 concessions covering the full area Neves-Corvo - Graça - Zambujal

30 August 1980 - Publication of Somincor by-laws in the

official paper "Diário da Republica", III Séries

4th September 1980 - 1st General Meeting of shareholders of Somincor with designation of the Board and Supervisory Board

17 July 1981 - Publication in the Official Paper, Diário da República, III Séries, of the titles for mining concessions

18 November 1981 - Begining of the mining works for access to the orebodies: begining of the ramp access

20 January 1982 - Begining of shaft sinking

1982/1985 - Project construction

1986 - (now 1988-89) Foreseen project start up with copper concentrates production.

To this complete chronological information, only small comments or complements are to be added:

- the second contract for prospection and exploration, in sequence to the first, included clauses on royaltees payable for futureexploitation of the orebodies, with differentation of royaltees payable to extracted copper ore and to complex ore (this ones also submited to the condition of its economical treatability);

- with the demand of the concessions, also a new demand for a contract of prospection and exploration was presented by Somincor. This contract was granted and Somincor still pursuits active drilling operations not only in the concessioned area (where new findings are to be noticed but also in the thereby contracted areas.

- a provisional protocol of Foreign Investment, between Somincor its shareholders and the Portuguese State (represented by the Institute of Foreign Investment) was signed also the 24th

July 1980. This protocol gave place to the Investment Contract, signed the 21th December 1981 and that gave the indication of the obligation of the parties and of benefits granted for that direct foreign investment in Portugal:

- the overall schedule of the project, as well as the general contracted obligations of Somincor, include the obligation of also exploring the complex pyrite ore, also present in Neves-Corvo in substancial amounts. First schedule provided for complex development and start up of exploitation of zinc-bearing pyrite up to the end of 1990 (i.e. 4 years later than the copper exploitation). These time-targets, have been optimistic and copper concentrates will be produced only in 1988-89: a corresponding postponement is to be expected also for the complex ores.

At first disclosures after this discovery (15,32). Neves-Corvo orebodies were described as "four disc shaped orebodies - Neves Corvo, Graça and Zambujal - of irregular contour, within on area of about 6 sq.km., (...) having a sub-horizontal attitude (from 10 to 25º), at depths relative to the surface ranging from 300 to 700m and with maximun recognized mineralization thicknesses of 50m (Neves), 80m (Corvo), 90m (Graça) and 50m (Zambujal). These orebodies included three basic ore types

- copper ores;
- complex pyrites;
- crude pyrite (with overall amount of Non Ferrous Metals lower an 3.5 pct)

being pratically all these three types of ore present in each of the individual masses, although in different relative proportions.

Geological reserves disclosed in the d of 1984 (36,41) were the following:

copper containing ores	26.8 million tons with	8.64 pct Cu
complex copper/zinc ores	8.3 million tons with	4.87 pct Cu
		2.33 pct Zn
complex zinc ores	32.9 million tons with	.43 pct Cu
		5.71 pct Zn
		1.49 pct Pb

as well as important amounts (abt 50 million tons) of crude pyrite (under 3.5pct total NFM abt 48% S). Geological reserves are to be understood as identified reserves, without recovery yelds and dilution criteria used to determine explorable reserves (41).

The importance of exploration works carried on by the Association up to the incorporation of Somincor may be described by an entire lenght of 50 000 metres, with 1200 sq. Km of geological cartography, 520 sq Km of gravimetric studied area, 95 Km electrical profiles and 124 km magnetometric profiles (32) and by an overall disbursement of abt 420.10^6 PTE (in 1980 basis).

In 1983 the obtained reserves were evaluated after 138 positive drillings and 2496 meters of intersection with the ore. In 1984, 40 drillings were also carried on (23 from the underground works), in a total of 13,071 meters (41).

1.2.5.2. The incorporation of Somincor (1980)

Description already made frequently refers to the incorporation of Somincor in 1980, after negociations between EMMA and its French partners, with presence of representatives of the Portugueses Ministery of Industry and of the Institute of Foreign Investment (IIE).

As also mentioned, these negociations were closed the 24th July of that same year, with the establishement of Somincor by-laws, the decision of demanding the mining concession and of the application for a contract to pursuit exploration, and the

signature of two protocols, one refering to the relations between partners the other to the granting ofbe nefits and the precision of duties by and towards the Portuguese tate, represented y the IIB. This last protocol would be replaced by the formal contract near the end of 1981.

Not entering in details, some of the principles regulared by the partner's protocol were the following:

- replacement of first Agreement (6th June 1972), with full transition of rights, obligations and assets to Somincor;

- agreement on the incorporation and by-laws of Somincor (established with an initial shareholders capital of 700.10^6 PTE) and on the proportions of participation of each shareholder:

EMMA 51 pct
SEREM 24.5 pct
SMMP 24.5 pct

- rules of preference in shares transmission to third parties, stating no preference rights of the French partners for any transmission Portuguese/Portuguese but with preference of the Portuguese partner in the transmission from any of the French Partners to a third party if that party makes not part of the respective Group and binding of eventual third parties to the protocol;

- constitution and performance rules for the Board of Director (4+3 members), description of the specific duties of the 3 members of the executive commission (President and Financial Director, to be appointed by the Portuguese partner; Industrial Director to be appointed by the French partners); decision covered by minority protection;

- rules about expatriated personnel at the service of Somincor (namely its progressive reduction), and of technical support and assistance to be supplied to Somincor by French

partners:

- rules about the industrial and commercial policy of Somincor namely the following general guidelines (32)

i - altain as quick as possible the production targets:

ii - reduce the technical risks connected to the exploitation of complex ores:

iii - integrate the overall project in the National Metallurgical Plan (see reference under 1.2.4.4.)

iV - exploit as much as possible the resources of the orebodies, having in mind its optimized utilisation by ore dressing (carried on local or other concentation plants) within the intent of an overall industrial rationality and the priority of Somincor interest:

- industrial objectives of Somincor, in connection with above mentioned guidelines and refering not only to copper ore but also to complex pyrites, these depending from process developments for its processing and requiring a certain constitution of reserve for respective R&D if required:

- definition of commercial policy of Somincor in order to obtain, at the outlet of respective facilities selling conditions not under those prevailing at the international markets for such product with deduction of freights up to those markets and taking into account all other economical and financial components in the formation of prices (if international conditions for pricing are not praticable, Somincor will look for formulae transponible by adaptation to its products):

- priority in the supply of Portuguese metallurgical plants:

- rules for the demand of offers from traders outside Portugal including those pertaining to the Groups represented by the parties

but always keeping the principles of fair competitivity:

- willing of French partners to examine the posibilities for having participation in the metallurgied units eventually to create in Sines;

- set up of financial structure of the project:

- settlements between parties for the compensation of made expenses in different proportion:

- general regulations and hardship clauses.

Some of the exploitation principles stated in The Partner's protocol (and in the Portuguese mining law then prevailing), such as the preference of national smelters and the development of complex ores, were also mentioned in the concession titles.

The Investment Contract signed in the sequence of above mentioned protocol reproduces some of the conditions therein contained and sets for others, such as:

- evolution of state capital (minimal figures) up to 1986;

- production minimal targets:

1st phase (1986-1989) - 1 million tonnes of copper contain containing ore "Corvo type" to obtain in principle 200,000 yearly tonnes of concentrates corresponding to approx. 50,000 tonnes of copper and abt 16 tonnes of silver;

2nd phase (1990-2000) - 1 million tonnes of copper ore as per above, plus 1 million tonnes of complex pyrites "Neves type", to obtain in principle 150,000 yearly tonnes of bulk concentrates corresponding to approx 45,000 tonnes of zinc 9,000 tonnes of copper and 20 tonnes of silver.

3rd phase (2001-2017) - 2 million tonnes of complex pyrite ores corresponding to 270,000 tonnes/year of concentrates and 70,000 tonnes zinc, 14,000 tonnes of copper , 8,000 tonnes of lead and 55 tonnes of silver.

thus granting to Corvo and Neves the minimum exploration period of 15 and 28 years (as already reported, a certain delay has to be presently considered for this schedule).

- objectives and its evaluation for each partner;

- fiscal incentives awared according to the then prevailing Portuguese law (34), and other Portuguese State obligations;

- dispositions on external financing;

- necessary relation between targets and incentives; investment follow-up; contractual times; force majeure, applicable law and hardship clauses.

1.2.5.3. The cession of foreign participations in Somincor (1984/5)

Up to 1984, no use has been made of Protocol and Contractual clauses on transfer of property of the shares in Somincor, except for the full transfer of Serem titles fo Coframines - Compagnie Française des Mines, also member of the BRGM Group and therefore giving no preference to the Portuguese partner.

However in October 1984 the French partners in Somincor entered in an agreement with RTZ Metals Ltd, from the RTZ Group, establishing the terms of transmission of their entire participation in Somincor and asked to the Portuguese partner its position regarding the exercice of preemption rights and to the Portuguese relevant Authorities theirapproval to the transfer of rights (35).

The Portuguese Government decided to proceded to a prospection

in the international market, having in view the study and appraisal of other opportunities to place the investment participation detained by French corporations - however not getting enough results to decide otherwise than instructing Edma not to exert its preemption rights and to agree to that transmission of shares, after the agreements set forth with the French shereholders were revised "under the experience got in the development of the mining project", as well as for introduction of several modifications in localized questions, such as the provisions of fiscal incentives (to adapt them to the results of negociations of adhesion of Portugal to EEC). The contractual text was also adapted to the new circumstances (35).

Therefore, with the purchase of that 49 pct participation and the approval of the new contract of investment, a new protocol has been also established between partners to cover the following new share-capital distribution of Somincor:

51% Edma
49% RTZ Group, represented by Tinto Investments Bristol Ltd and with a representative participation RTZ (Metals) Limited*.

In the contractual terms newly settled (August 1985), the schedule proposed for the mining project is the following:

- copper containing ores: ore dressing start-up with production of concentrates commercialy saleable in the 4th quarter of 1988. and attaining a treatment level of not under 1 million tons of extracted ore in the 4th quarter 1990;

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* Recently RTZ (Metals) and Tinyo Investments Bristol incorporated in Lisbon and in the proposition of 9:1 in share capital of 50 million PTE, the company "RIOMINAS - Serviços Técnicos e Financeiros Lda, whose specific purposes are the supply of technical and financia· services to mining corporations"(44).

- complex pyrite ores: considering the studies to undertake prove the technical, economic and financial feasibility of this exploitation, Somincor will start the treatment of such ores 30 monthes after decision (as well as altain maximum level production in 48 monthes).

The purchase of the French rights in Somincor was a controversial fact not well understood in France (36), deeply commented in the Portuguese press (40), as well as in the international reviews of the speciality (37, 38, 39 among others).

The main objection raised in all the published comments remain in an eventual "suffocation" of the attempts to develop a Portuguese based smelter by exporting the copper concentrates to Huelva, Spain and increasing the capacity of the copper smelter there existing, owned by Rio Tinto Minera (49 pct RTZ, 49 pct Spanish UERT) and that needs the import of abt 60 pct of its concentrates from external sources (namely, RTZ Group participated mines in Bougainville and Palabora). With the purchase of Somincor and replacing by Portuguese concentrates current supplies from other far-placed mines (to Huelva and/or other smelters in Europe) an increase of capacity in Huelva and an optimized concentrate distribution in alternative (and perhaps nearer) markets is a conceptual idea suggested by those recent comments and perhaps not to discard (46), albeit the preference to local smelters remain in the newly-agreed formal texts.

1.2.5.4. - <u>The Neves Corvo Project</u>

The main features of the Neves Corvo Project have already been mentioned in prior description and therefore this section only will report other elements collected from available sources (33,36,44), giving some general aspects:

ore production (1st phase) 1 million tons copper ore

(Report 1985 of Somincor mentions the possibility of an increase in this production level up to 1,3 million tonnes)(91)

equivalent copper content for 1 million ton ore	70,000 tons
cut off considered in 1982(33)	2 pct Cu
initial investmen (1st phase)	257.8 million USD (1984 basis)
position of the shaft sinking in 31 st December 1984	473 m
total lenght foreseen for shaft	530 m(eventually 700m)
diameter of shaft	5 meters
capacity of extraction via shaft (skip)	3 million tonnes of ore/year
position of the ramp in 31st December 1984	2447 m (level - 200m)
location of the ramp mouth	0 m (level+210)
sectional area of the ramp	17 m^2
gradient of the ramp	18º
pavement of the ramp	concrete
problems met	water

mining concept (36): cut and fill, vertical slices with hydraulic filling

concentration yeld (copper) (33)	above 90%
content of copper in concentrate (33)	abt 25%
water supply to the ore dressing plant	abt 2×10^6 cubic meters/ /year

transport of concentrates:	
by truck up to de railway	30Km
by railway up to the export or smelter point:	Sines (90Km) or Setubal (120km)
flotation (copper)	in testing very time grinding necessary
technical audit	in progress
personnel (foreseen)(36)	1st phase: 308 underground 78 surface

royalties(36):

0.5 pct of the value of products (at mine premises)) for the Mining Development Fund

3 pct of the value of products or concentrates for the State (reduced to 2% if complex sulphides) or 10 pct of liquid profit from exploration, after taxes, if above. that amount.

A more detailed description and references to Neves Corvo project are available from other sources (33, . Relevant data about the mining project were also published with Somincor's report 1984(41).

With the concentration of copper ores by flotation from pyrite--matrix rich copper ores, a significant amount of by-produced floated fine-ground pyrite will be simultaneously available - that (together with the availability of floated pyrite also from Aljustrel project) may well contribute to change present pattern of Portuguese sulphuric acid production from complex pyrites as already mentioned.

1.3. Nickel

No nickel primary resources are reported for Portugal. A slight reference is made to geochemical anomalies (2) and to the interest of investigating nickel in connection to basic and ultra-basic

formations (43).

1.4. Lead/Zinc

With the shut down of Terramonte mine abt 1973, by exaustion of reserves, the Portuguese mining production of lead and zinc concentrates had no pratical sequence (except for the complex lead, gold and silver-containing sulphides of Jales, exploited specifically as a source of precious metals and now treated outside Portugal). Even then the interest of Terramonte was mainly on the silver content of its lead concentrates.

This justifies the viempoints of SOARES CARNEIRO (2), already in 1971 ("In our oppinion, in present conditions, the economical possibilities of a great part of our resources for lead and zinc, of the filbonean type (...)are scarce, not to say null", but calling attention to the stratiform formations of the Southern Portugal and to the lead and zinc recovery from complex pyrites) and of REIS et al (42), in 1984 (zinc and lead productions "never have been very representative since for lead concentrates never more then 7000 tonnes/year and for zinc 3000 tonnes/year were exceeded", and also reverting to the future exploitation from complex pyrites).

No production of lead and zinc are reported in the statistics of the mining sector since 1973; lest available figures (5 years) (45):

Table XXIV: Statistical figures available on lead and zinc concentrates production in Portugal

	lead concentrates		zinc concentrates	
	tonnes	values 10^6 PTE	tonnes	values 10^6 PTE
1968	2,541	26.1	724	5,4
1969	3,212	18.5	2,272	5,4
1970	2,465	18.5	2,660	6.1
1971	2,155	12.8	3,550	9.5
1972	1,830	12.5	3,060	8.4
1973	715	5.5	1,159	4.8

(since 1973: no production recorded for lead and zinc concentrates)

Source: (45)

The production of lead from lead sulphate muds and from Cottrell dusts of the sulphuric acid plants roasting pyrites was carried out by CUF (and post-1975 Quimigal) in Barreiro since 1926 and later "enriched" by the addition of Jales concentrates in order to produce precious metals. However this indirect production of lead from pyrites, restructured in 1953, has been discontinued since 1977 due to economical and environmental problems also related with occupational health.

In what regards zinc, the situation of primary "indirect" production is not exactly the same, due to the possible recovery in the Quimigal works at Barreiro of up to 11,000 tonnes/year of zinc metal from the treatment of pyrites (see section 2.2.1.).

Thus complex pyrites are to be regarded as present and/or future potential domestic sources of lead and zinc in Portugal, having REIS et al (45) established in 1984 the following perspectives of production at a middle term:

in tonnes/year	Lead	Zinc
Neves-Corvo	10,000	50,000
Aljustrel	3,500	14,000
Quimigal	-	10,000
	13,500	74,000

Even with somewhat lower prospects, that seems to be advisable as deduced from latest data on the Somincor (2d phase) and Aljustrel projects, as well as from the practical reduction of Barreiro output today, the fact is that the complex pyrites will provide, (if these two projects follow) substantial amounts of concentrates of these two metals.

The occurrence of other potential sources of lead and zinc as well as the possibilities of certain traditional orebodies (Preguiça in Moura, district of Beja) should not be neglected. The "abnormal" contents of copper in Neves-Corvo finding makes not easy to exclude potential "exceptions" for other metals.

Although the relative meaning of each of them some concessions for lead and zinc are however reported in 1984 (including the complex pyrite orebodies of Beja district).

1.5. Tin

The production of cassiterite concentrates in Portugal has shown a discrete decline during the 10-years period 1975-1984 (7,45):

Table XCV:Cassiterite production in Portugal

	Cassiterite concentrate (abt.69-71 pct Sn)	
	tonnes	value 10^6 PTE
1975	529	62
1976	974	73
1977	379	109
1978	403	153
1979	346	173
1980	421	229
1981	506	299
1982	585	403
1983	495	454
1984	453	558
average	459	

These figures are well below the yearly averages recorded for previous decades:

1945 - 1954	1473	tonnes/year (average)
1955 - 1964	1450	
1965 - 1970	781	

what may be related to the exaustion of some important mining resources (45). Although some authors remember Portugal as a "big producer" in the begining of the 40's, getting occasionally to the range of 4000 tonnes/year of concentrates, present situation is already far from the "moderate producer"

Portugal could be called in the 50's.

However tin mining in Portugal, in current days, still keeps some relevant features: about 10 pct of the value of total mining output in 1983 could be related to tin production (8 pct in 1984) and a great number of existing concessions (abt 43 pct) is connected to tin mining (see table in next page). Albeit this statistic may be put in question because of the heterogenity of the concessions counted, it may be useful for getting some conclusions:

- about the location of tin mining: tin mining is dominant in North and Central Portugal, and specially inland, corresponding to the area of hercinic granitizations. The southern location of tin resources, with exception of the two cases associated with complex pyrites, is in Portalegre district and is also related to a local granitization;

- about most common associations of tin: approx. one half of this locations refer associations with other mining resources. Tipically for the tin mining, in Portugal, is the association with tungsten, other associations to record: titanium, columbium, tantalum, litium, etc. Particularly interesting is the association to complex pyrites, to which special reference will be made later;

- about the dimension of tin mining: a so divided activity, with so much concessions, surely must follow the general feature of Portuguese mining concessions - i.e. small units, dispersed grografically and sometimes with very difficult access and questionable rentability (situation aggravated with present crisis of tin and for relevant cases of "double mining", of tin and tungsten). It is not surprising that, with a so impressise list of registered concessions, the number of centers significatively producing in 1983 was in the range of 14, corresponding to about 250-270 concessions, within following types (7):

Table XXVI:

Tin mining concessions registered in Portugal (1984)

District	Total concessions	Tin concessions			
		Sn	Sn+W	Sn+others	Total
Aveiro	86	-	11	-	11
Beja	52	-	-	2(a)	2
Braga	58	9	-	-	9
Bragança	163	30	25	4	59
Castelo Branco	95	28	14	5	47
Coimbra	24	-	3	3	6
Évora	27	-	-	-	0
Faro	10	-	-	-	0
Guarda	224	41	11	114	166
Leiria	12	-	-	-	0
Lisboa	2	-	-	-	0
Portalegre	29	-	1	19	20
Porto	98	33	1	1	35
Santarém	13	-	-	-	0
Setúbal	36	-	-	-	0
Viana do Castelo	106	51	11	2	64
Vila Real	199	90	16	12	118
Viseu	131	13	28	3	44
	1365	295	121	165	581

(a) Sn contained in complex pyrites (Source:7)

Table XXVII: Distribution by types of centers active in Portugal for tin mining:

I) Vein type	significative producing centers (1983)	estimated portion of total production
Ia) tin	2	13 pct
Ib) tin + tungsten	5	50 pct
II) Placer type	7	37 pct

with exception of the greater producing centre, the "fragmentation" of tin mining (as well as tungsten mining) in Portugal may well suggest a "small mining approach". In all mentioned mines, tin is present as cassiterite giving concentrates whose tin content is within the range 69-71 pct. The only exception for this rule is tin present in complex sulphide ores, particularly in Corvo ore, where stannite and cassiterite are present, with probable generalized prevalence of the first. Contents of tin in the fractions from flotation of copper ore to produce copper concentrates have recorded as 3150g/ /tonne in copper concentrates and 6000g/tonne in pyritic residues (15) (what brings to a bulk ore content of abt 5200 g tin/tonnes). For Moinho Complex pyrite, tin concentrations are reported between 300 g/tonne (15) and 600 g /tonne (22), i.e. much lower than for the refered copper ores. The recovery of tin from these ores puts a very serious challenge to mineralurgy and metallurgy. As a matter of fact - and if no mineralurgical separation of tin is feasible - the recovery of this metal will stay very doubtful in mineral processing, this because:

- tin is very divided and follows the general difficulty of separation of mining components of these ores;

- a great part of the tin would remain in pyritic residues by a conventional treatment, as per above information;

- in pyrometallurgy, a significative part of the tin eventualy present in furnace feed would pass to slags if common processes are used;

- in hydrometallurgy, a great part of the tin present in treated concentrates would follow the iron residue, if common processes are used.

The importance of this problem can be easily visualized: with 1 million tons Corvo copper-ore, accepting the average content as above, the quantity of tin present is in the range of 5000 tonnes/year (equivalent to abt 7150 tonnes of cassiterite concentrate i.e. more then 15 times Portuguese production from tin mining in 1984 ... what also means that with a tin recovery of no more then ... 10%, a pratically equal production to 1984 figure could be afforded only from Corvo).

Returning to conventional tin mining, following main Portuguese mining centers have to be quoted:

A) Panasqueira (in the "concelhos" of Covilhã and Fundão, district of Castelo Branco, and Pampilhosa da Serra, district of Coimbra):

This important mining center, producing tungsten and tin concentrates (as well as the copper concentrates already reported) and including 42 concessions is exploited by Beralt Tin and Wolfram (Portugal), Lda.

The resources are of the vein type (W+Sn), with underground mining, and Panasqueira production in the latest years is in the range of 25 pct or above of the total Portuguese tin output from mining. Panasqueira also owns a sensible part of tin evaluated tin reserves.

Beralt Tin and Wolfram Portugal, SARL has the following shareholders

Beralt Tin & Wolfram, Limited (ultimate holder Anglo American Corp)	80.5 pct
IPE - Investimentos e Participações do Estado, S.A.R.L.	19.5 pct

with a sharecapital of 300.10^6 PTE since 1981.

Besides its important tin production, Panasqueira mining output corresponds to abt 81 pct of Portuguese production of tungsten concentrates and, as already mentioned, to some amount of copper concentrates.

With an employement level not far from the 1000 people, Panasqueira is a single case of dimension in the mining of tin in Portugal. As a matter of fact for Panasqueira, as well as for other small centers already mentioned, the tin and tungsten mining cannot be separated and therefore the mining center has to be considered as a whole.

B) Argozelo (in the "concelho" of Vimiosa, district of Bragança), including 6 concessions.

Exploited by Minargol - Complexo Mineiro de Argozelo SARL, join venture of

Geomines S.A., from Belgium	(49 pct)
SPE - Sociedade Portuguesa de Empreendimentos, SARL	(24 pct)
Others	(27 pct)

The situation of this company (with a share capital of 183.10^6 PTE in 1979) in what refers to its Belgian partner is not very clear at the moment, since Gecmines, S.A. was recently reported as having got out of business.

Argozelo produces tungsten, tin and silver, from a vein type resource.

Minargol also owns mining rights for copper in South Portugal, as already reported (Miguel Vacas mine)

Besides, Minargol is owner of one of the two main tin furnaces

that in Portugal produce metallic tin from cassiterite concentrates, as will be mentioned later.

C) Montesinho ("concelho" and district of Bragança), with 20 concessions, exploited for tin by

Sociedade Mineira de França, Lda
(47 pct owned by SPE and 53 pct by three other private Portuguese partners)

Mining is carried out by open shaft and underground works, in a tin-veined type resource.

D) Mave de Haver ("concelho" of Almeida and Sabugal, district of Guarda), including 93 concessions exploited for tin and titanium by

Borstin - The Portuguese Spanish Tin Mining SARL
[illegible] ed by S P: 7% by other small Portuguese partners).

This mining center is in operation since 1960 and belongs to the placer type.

These four mines, with Gaia (now shut down), produced more then 15 pct of the total tin output from Portuguese mines in last 5 years period. Except for Panasqueira, the average production of each of the fine mines was at the same range.

Other companies mining tin in Portugal:

a) Bastos & Marcolinos, Lt.
(concessions rented to Alfredo Pinto Correia)
district of Viseu; tin-tungsten vein resources

b) Sociedade Mineira Alegria, Lda.
district of Viseu; cassiterite from placers

c) Minemaque - Minérios, Máquinas e Metais, Lda
district of Portalegre: placer type

d) Bejanca - Sociedade Mineira das Beiras, SARL
reprocessing old mining rejects and vei s (W+Sn) plus stockwerk

e) José Rodrigues C. Sousa
(rented from Minas de Cassiterite de Sobreda, Lda). Tin and titanium: district of Coimbra: placer type.

With the addition of these 5 minor producers, Portuguese mining production of tin gets covered by more than 95 pct (as well as for considered resources, evaluated in more than 40 years at the average mining output of last decade, not including potencialities as Argimela and Corvo).

Before 1984, Gaia mine ("concelhos" of Belmonte and Guarda, in the district of Guarda, and Covilhã in the district of Castelo Branco), of the placer type (cassiterite + ilmenite) also could be mentioned as a major producer.

Exploited by

Dromin, Exploração de Minas, Dragagens Lda.
(40 pct Neoestano, SARL: 5 pct Banco Português do Atlântico: 55% others)

this resource got exausted and the operations by dredging has been shut (45).

Mention shall be made, in this moment, to the substancial potential resource of Argimela ("concelhos" of Gois and Pampilhosa da Serra, district of Coimgra) with the capability of producing 200 to 300 tonnes of cassiterite concentrates per month, i.e. 2000-25000 tonnes/year of tin-metal (45).

In common terms, the economy of tin mining in Portugal is much dependent from its industrial structure (really) small mines, requiring the revision of extraction processes) and from the output of other substances generally present (tungsten, titanium, etc.).

The overall employment related to the tin and tungsten mining in Portugal is of abt 2500 peoples.

2. EXISTING PROCESSING OPERATIONS

2.1. Aluminium

The absence of a primary aluminium production in Portugal implies a relevant activity in importing as well as in secondary and downs tream activities for this metal however still with a low consumption "per capita".

Taking care of the general reserves for the use of Portuguese statistical information when metals are dealt, and so looking to reliable informations, following figures may be quoted for 1983(47)

Table XXVIII: External trade of aluminium, all forms Portugal 1983

Total imports	abt 58,000 tonnes	abt $10,300 \times 10^6$ PTE
including:		
bulk metal	19,300 tonnes	$2,900 \times 10^6$ PTE
aluminium alloys	23,000 tonnes	$3,600 \times 10^6$ PTE
aluminium plats & foil		
thick, above 0.20mm	11,200 tonnes	$2,340 \times 10^6$ PTE
below 0.20mm	920 tonnes	460×10^6 PTE
tubes	650 tonnes	140×10^6 PTE
Total exports		
including:	abt 15,230 tonnes	abt $2,390 \times 10^6$ PTE
bars and shapes		800×10^6 PTE
cuttings		440×10^6 PTE
scrap		270×10^6 PTE

These figures demonstrate the relative weight of aluminium in Portuguese imports, with a marked dependence on foreign supplies and a distribution by categories reflecting the demand by downstream activities. Thus , more than 70 pct of the imports may refer to primary metal and abt 60 pct may consist in imported billets as a supply to aluminium processing industries. Abt 20 pct of imports covera luminium foils not yet produced in Portugal.

Considering the activities related to aluminium in Portugal, following sub-sectors will be briefly outlined (43, 48):

A) Extension industries

This sub-sector, producing aluminium shapes, demonstrates a rapid increase in recent years (49):

1970 - abt 13200 tonnes produced
1980 - 15800
1981 - 21233

keeping a relativaly good utilization of an installed capacity of abt 31,300 yearly tonnes (up to 1982) and 33,000 yearly tonnes after 1982.

As a matter of fact, in 1982 Porjalex started its own extrusion plant with abt 1,100 tonnes capacity and an investment of abt 40×10^6 PTE.

Figures available in 1984 for the two corporations that together represent more ther 85% of Portuguese production fully confirm this trend (50):

1982 - abt 21000 tonnes produced
1983 - 25000

Five main companies are operating in the sub-sector; the bigger producer has correspond. to the first abt 70% of the overall out output and the first two cover, as already mentioned, more than 85% of production:

- Pillar Portuguese (Alumínio), Portalex, SARL
- Extrusal, Companhia Portuguesa de Extrusão, SARL
- Fundição de Oeiras
- A Perfiladora, SARL
- Porjalex - Sociedade Comercial de Aluminio, Lda (since 1983)

Other statistical parameters 1979/1981 for the four corporations (operating in 1981 (49) as well for the first two (more then 85 pct of production) in 1982/1983 (50)

Table XXIX: Major aluminium transformers in Portugal

year	1979	1980	1981	1982 first	1983 first
number of corporations	4	4	4	2	2
value of production (10^6PTE)	1362	2284	3252	3243	4859
gross added value (10^6PTE)	449	694	1044	983	1074
investment, assets (10^6PTE)	97	131	40	488	331
employment (31th December)	294	341	383	367	394

Source: (50)

These industries import billets in suitable aluminium alloys from Spain, France, UK, Norway and Canada and supply Portuguese domestic market with grades and product qualities compatible current European requirement Portuguese consumption is somewhat below current instaled capacity. Abt 20 to 25% of extrusion residues are produced during the process, reason why remelting may be an important complementary feature to extrusion units: in 1982, Pillar had a 5000 tonnes/year remelting unit with horizontal casting and was considering its increase by 60 pct; besides Extrusal was envisaging the investment in its own remelting unit. In the meantime, all the extrusion residues produced in the extrusion units but in Pillar (Portalex) were being exported for remelting abroad. In 1984 the investments foreseen by Pillar and Extrusal for remelting were not yet in service (50).

Brief notes on the first (and main) producer above mentioned (51).

Pillar Portugal (Aluminium), Portalex SARL is installed in Cacem, near Lisbon (abt 16 Km), and since 1972 extrudes aluminium billets for shapes. With 2 extrusion presses of 1600 and 2000 tonnes/year Pillar currently supplies abt 70 pct of the Portuguese market using aluminium alloy 6063 as main raw material (72).

Its production in 1983 was of abt 16,000 tonnes of shapes, with co-production of abt 5000 tonnes of scrap recycled in-house . A third extruder was in consideration in 1984, to increase overall capacity to 20,000 yearly tonnes.

Pillar (Portalex) promoted in 1978 the incorporation of first Portuguese extrusion die plant - Aluport Matrizes de Portugal, Lda - in Agueda, Aveiro district. This die plant now supplies abt 70 pct of home market, replacing prior 100 pct imports and already performing in the export market.

Pillar (Portalex) is owned by Rollip Aluminium Ltd, 100 pct subsidiary of the Pillar Aluminium Group, Gloucestershire, United Kingdow, this Group being 100 pct subsidiary of Rio Tinto Zinc Corporation.

Share capital in 1985: 300×10^6 PTE
Employees (1984) : abt 130

A wider share distribution is mentioned to Extrusal, established in 1975 in Aveiro, Aveiro district. Extrusal capacity is quoted as 8,000 tonnes per year of aluminium extrusion (72).

B) Aluminium rods wire and cable

Three Portuguese producers are active in this sub-sector, with a combined capacity of 31,500 tonnes (47,48):

. Quintas & Quintas, SARL
. Solidal - Condutores Eléctricos, SARL
. CPC - Companhia Portuguesa de Cobre, SARL

with 96 pct of the capacity belonging to the first two. Other informations suggest to CPC somewhat higher capacity, equalizing Solidal in the overall capacity (13).

Using primary aluminium imported from Spain, France and Holland , this production is currently integrated with downstream

manufacture of electric cables in same industrial premises. Produced cables not only supply domestic market but also are exported in a considerable extent.

The expression of this sector, however, doesn't follow the same trend noticed for aluminium profiles, as figures, hereunder demonstrate for the two major producers above quoted (49, 50):

Table XXX: Aluminium rods, wire and cable: outputs Portugal 1979 to 1983

	Aluminium tonnes	for rod wire and cable: sales* export component in pct of overall production values
1979	10,500	46.5
1980	15,000	48
1981	11,000	34
1982	16,150**	19
1983	10,983**	57

* including sales in cable
* production 1982 15004 tonnes
1983 11013 tonnes

Other pertiment statistical data for the two major producers mentioned (above 96 pct of production)(49,50):

Table XXXI: The 2 major product, of aluminium rods, (unit and (unit and cable)

	1979	1980	1981	1982	1983
production value (10^6PTE)	1076	1885	1793	1648	2072
gross added value(10^6PTE)	273	444	426*	281*	315
investment, (10^6PTE)	137	79	69	29	14
employment (31th December)	170	187	219*	55*	57

* this difference results not clear from available sources: most possibly figures for 1979/1981 include cabling manufacture.

The capacity of Quintas & Quintas plant in Povoa de Varzim, for aluminium wire is mentioned as being of 18,000 yearly tonnes; this plant also produces copper wire od and copper wire (72).

C) Aluminium foil

A small production of aluminium foil (of abt 1,000 tonnes/year very far from supplying current Portuguese demand, is carried out in 1984 by the company Aluminio de Portugal (Angola),Lda. (47)

D) Aluminium based foundry

Also a limited production of injected foundry components in alluminium alloys was recorded for 1984 (47). Main products from this activity were adressed to the motorcat, mechanical equipment, metallic furniture and similar industries. At the end of the 70's, an estimate of aluminium consumption for foundry purposes was of about 2,000 yearly tonnes.

E) Secondary aluminium production

In a metal market fully dependent from foreign supplies, like aluminium in Portugal, the economical recycle of metal values gets an enchanced interest.

This obvious situation implies the consideration of re-melting units for scrap. Mention was already made to the captive unit performing in Pillar (Portalex) extruding plant as well as to the plans for its development and of considerations of a similar facility for Extrusal. However - and having in mind that the recycle market in Portugal is nor yet full covered and may still offer additional potencialities - some small-sized producing facilities for secondary aluminium and aluminium alloys are already in operation in Portugal. Among these the major producer to quote is Alpor, Empresa Produtora de Alumínio, SARL, that recovers 2,000 yearly tonnes of red Susion of aluminium" reducing (by recycling) the amount of imports.

F) Non metallurgical uses of aluminium

The main non-metallurgical uses of aluminium in Portugal are related to the following activites:

- porous light blocks for civil construction (by reaction of aluminium powder) specially in ytong Portuguesa, SARL, in Barreiro, district of Setubal. This plant was recently shut-down by causes related to the lack of demand determinated by Portuguese housing recession;

- production of aluminium sulphate from imported alumina and locall produced sulphuric acid: a plant with a capacity of 14.000 yearly tonnes is currently operated by Quimigal in Barreiro.

2.2. Copper

2.2.1. General features

The present dependence of Portugal from external copper supplies is well demonstrated by the tables of next two pages.

Following preliminary considerations may be established:

i - Portugal is dependent in basic raw materials, for copper domestic primary production, as the copper balances to show later also despict;

ii - this dependence is even more sharp for wrought copper metal, what suggests a certain unbalance between domestic primary production and secondary copper processing industries; as a matter of fact Portuguese primary production is confined to a single smelter with very discrete capacities, although secondary consumer units are already equiped with capacities that in some product are already suited for competitive international performance;

iii - if the domestic demand in copper wire is pratically covered by Portuguese production (with substancial capacity for

Table XXXII:

Portuguese external dependence in copper (period 1980-81)

	Apparent consumption (tonnes)			External dependence* (pct)		
	1980	1981	1982	1980	1981	1982
1.Raw materials						
. basic new materials	8283	7189	5245	18	55	32
. scrap	5190	6757	8888	3	3	2
2.Wrought copper metal						
. primary refined (thermal copper, "wirebar" cathodes)	15776	13898	13614	66	62	67
. second fusion (copper-alloys)	1903	2765	2862	30	12	5
3.Products of first processing or semis						
. long	27750	29748	29636	25	34	33
-wire	12349	12526	12896	0	5	4
-shapes	13136	15110	14446	45	56	55
-tube	2265	2112	2294	51,	52	54
. plates	6909	5848	5909	76	80	80
4.Others (oxides, sulphates)	1576	1209	1302	14	4	5

* evaluated on Imports - Exports / Apparent consumption

Source: (51)

Table XXXIII:

Portuguese imports and exports for copper raw materials and copper alloys

	Imports								Exports							
	tonnes				value, 10^6 PTE				tonnes				value, 10^6 PTE			
	1980	1981	1982	1983	1980	1981	1982	1983	1980	1981	1982	1983	1980	1981	1982	1983
1. Raw materials																
. Scrap	233	221	276	188	10	7	12	16	60	17	104	1200	7	1	9	48
2. Wrought copper metal	11190	9576	11310	13947	1310	1086	1339	2621	-	-	2108	152	-	-	218	22
3. First processing (semis)																
. Long	8030	10966	10379	6347	1227	1547	1543	1478	1084	882	730	1293	140	128	113	232
.flat(plates)	6726	6136	6160	6050	1071	994	1145	1533	25	48	54	22	6	7	14	5

sources: (50, 51)

exports), significative dependence still exists in copper shapes and tubes.

iv - The non-metallurgical demand of copper (in chemical compounds) is pratically covered by domestic production.

v - The potential interest of Portuguese copper processing operations may be relevantly enchanced the development of a large production of primary copper, situation naturally to relate in its prospectives with the evolution and consequences for Portugal of the Neves Corvo discovery: as a matter of fact, the scarce primary production of copper metal may be regarded as a bottleneck for the overall development of a full integrated industrial line.

Although the "per-capita" consumption of copper in Portugal, currently of about 3kg/ inhabitant year, is well below the level of 14kg/ inhabitant.year some countries have already attained (52,71), its is possible to forecast the evolution of the Portuguese market for refined copper as per following table (53):

Table XXXIV: Forecast for Portuguese market of copper

Period	Optimistic		Intermediate		Pessimistic	
	yearly increase pct	level of consumptions tonnes/year	yearly increase pct	level of consumptions tonnes/year	yearly increase pct	level of consumptions tonnes/year
1986/1990	8	34,000	7	32,000	4	28,000
1990/2000	8	69,000	5	50,000	3	43,000

The establishement of a domestic primary processing of copper concentrates may also potencialize current(as well as other) copper uses just starting or yet uncommon in Portugal (vg. copper tubing in houses, copperroofing), increasing the demand of this metal.

Therefore, copper industry seems, to show appreciable prospectives for a Country that, like Portugal, will be a newcomer to the list of modern significative copper mining producers However copper was the key for several industrial development, related to complex sulphides, as already mentioned (see item 1.2.4.) and that still today strongly marks the industrial pattern of this country - reason why a reference will be made now to pyrite current operations.

2.2.2. The processing of complex pyrites for sulphuric acid production in Portugal

The processing of complex pyrites as a source of sulphuric for the production of sulphuric acid was already mentioned and had industrial application in Portugal since the 2nd half of last Century (4,5,55)*.

However only after the development of Barreiro works by Companhia União Fabril (CUF) in 1908, this utilization got a decisive development and marked the definitive ingress of Portugal in the full-scale processing of pyrites in centers of maritime access and relatively distant from mine-site, that characterized what was called hereabove as the "sulphur/iron/copper cycle".

The potential recovery of other valuable products from such domestic raw material, soon made Barreiro (in front of Lisbon, the southern bank of river Tagus) to be quoted as an example of the "integrated utilization" of pyrites that still today remains active

* Pyrites processing at mine-site for the production of copper and sulphur was already mentioned

and that added copper, zinc lead, precious metals and hematitic iron-ore to its productions. An historical approach to Barreiro and other pyrite consuming centers in Portugal was made by SILVA (5) the evolution of mainly pyrite-based sulphuric acid production in Portugal was described by OLIVEIRA (58). A list of the currently operating Portuguese sulphuric acid units is given in next page (53), from which following general conclusions may be drawn for the units using pyrite as raw material:

- about 89 pct of listed capacity is operated by QUIMIGAL, (state-owned chemical, fertilizer and metallurgical company already mentioned); from this QUIMIGAL capacity, 87 pct are located in Barreiro complex;

- pyrite remains a very representative raw material for the Portuguese production of sulphuric acid; the listed S-based plant has to face the high current prices of elemental sulphur, not competing with pyrites;

- the Portuguese sulphuric acid industry still using coarse pyrite has been directed towards dearsenifying roasting processes (multiple earth roasters, BASF - two stage turbulent layer roasters) due to the interest of recovering dearsenified hematitic purified cinders (purple ore) as a raw material to the nearby iron-making shaft furnace of Siderurgia Nacional, in Seixal. As we shall see, this same trend motivated other investme investments in Barreiro;

- the "pyrite cinders treatment units" are connected both to the economies of metal recovery and to the need of purificating cinders for the iron-making purposes above stated. Its incorporation in Barreiro complex, downstream of the sulphuric acid units, made from Barreiro a traditional "collector" of Portuguese available cinders and also a non-ferrous metallurgical center, where since long have converged other available raw materials (copper mattes from Angola, lead-gold-silver ores from Jales, copper concentrates and cements from already mentioned mines, etc);

Table XXXV:

LIST OF PORTUGUESE PLANTS FOR SULPHURIC ACID PRODUCTION

COMPANY	LOCATION	UNIT	TYPE & CAPACITY	START-UP YEAR
Quimigal	Barreiro	Contact 5	MR + SC 500 Tonnes/day	1966
		Contact 6	TR + DC 625 Tonnes/day	1972
		Contact 7	SF + DC 716 Tonnes/day	1978
		Treatment of tail gas of NH_3 plant	WC (b) 80 tonnes/day	1984
	Estarreja	Contact 1	MR + SF + SC 140 tonnes/day	1951
		Contact 2	MR + SF + SC 140 tonnes/day	1961
SAPEC	Setúbal	Plant 1	MR + NI 140 tonnes/day	1928
		Plant 2	MR + NI 140 tonnes/day	1962
TOTAL CAPACITY			2,100 tonnes/day (a) 693,000 tonnes/year	

Plant Types:

MR - Multiple-earth (pyrite) roasters
TR - Turbulent layer (pyrite) roasters
SF - Elemental sulphur burning furnace
SC - "Single conversion" (i.e. single absorption)
DC - "Double conversion" (i.e. duble absorption)
WC - Wet catalysis
NI - Nitration process (chambers or towers)

(a) based in 330 eff days/year at nominal capacity

(b) capacity 110 tonnes/day sulphuric acid

Source: (53)

- present pattern of Portuguese sulphuric acid industry shows already old units, whose roasting technologies keep the "state of the art " of the 60's but that requires complex coarse (grain--sized up to 6mm) pyrite to performe as and are conceived to provide cinders with a reasonable (for that time) acceptance;

- if the mines are now directed to dress pyrites for the "in-situ" separation of non-ferrous containing minerals (see "Aljustrel Project") or if enough quantity of floated pyrite is to be available from the flotation of copper minerals from rich copper ores with pyritic-matrix, like in Neves Corvo will happen after the end of the 80's then sulphuric acid producers may shift from the use of coarse pyrites towards the easier roasting of cheaper flotation pyrites in adequate new plants; these provided the actual lack of interest by iron producers for respective cinders as a source of iron, may not be restrained by the process limitations considered up to now and so reverte to more simplified conception (56). Fine produced cinders may be returned to the mine for underground filling instead of building-up in useless land-mobilizing and dust-causing environmentally unconfortable heaps near the roaster units;

- the Portuguese sulphuric acid industry based on pyrites is, therefore, at cross roads between the conceptions observed up to now and the milestones in mining development and in related activies (vg. the copper smelter project for Sines) that may soon determine its changement ;

- simultaneously, the traditional role of sulphuric acid industry as a first processual stage for the production of non--ferrous metals from pyrites will obviously be secondarized, according to the new specifications of raw-materials to be met (30).

Considering the amounts of pyrites sold by the mines in 1984, on overall equivalent production of sulphuric-acid of abt 390,000 tonnes based on pyrites is estimated, from which abt 20 - 25 pct produced at Setubal, 15-20 pct producer at Estarreja and the balance in Barreiro.

2.2.3. The recovery of non-ferrous metals from pyrite roasting

Barreiro is to be regarded as a unique example of "integral and integrated" processing of complex pyrites in Portugal, as already mentioned. The importance of this processing is well demonstrated by its traditional "collecting role" for roasted pyrites from other centers (Estarreja and Setûbal*) by following figures:

Table XXXVI: Products obtained at Quimigal from pyrite processing (59)

	yearly production	
Sulphuric acid	390,000	tonnes
Iron (contained in hematitic pellets)	205,000	tonnes (b)
Zinc (electrolytic grade)	11,000	tonnes (a)
Copper (electrolitically refined)	700	tonnes (c)
Copper sulphate	7,000	tonnes
Gold	90	kg
Silver	8,700	kg
Sodium sulphate	12,000	tonnes
Steam (45 bars, 425ºC)	300,000	tonnes

(a) installed capacity
(b) potential production
(c) not mentioning copper from non-pyrite sources

Description of Barreiro pyrite processing were recently disclosed by PEREIRA et al (59) and in a great detail, by GUEDES and RODRIGUES (60); an also a detailed description for the begining of the 60's is available from PINEDO-VARA (6).

* part of current Setûbal and Estarreja cinders productions are not being sent to Barreiro, today.

Following plants are to be mentioned besides the already quoted sulphuric acid units:

A. Pyrite cinders treatment plant (60), Henderson/Duisburger Kupferhutte process (continous roasting of pyrite cinders with salt in fuel - burning multiple hearth roasters and batch percolating leaching of non ferrous metals in dens):

Raw materials: major part of pyrite cinders from dearsenifying roasting in Quimigal and Sapec premises (the other part goes directly to fed the Kowa-Seiko unit), salt, fuel oil, iron & steel scrap;

Products: copper cement, purple ore (used directly for steel making until the early 70's when the Portuguese iron and steel Corporation decided to stop its consumption claiming high residual non-ferrous contents) and a copper exausted liquour with zinc, sodium, chloride and sulphate ions (amoung others minor contents including cobalt, whose recovery has been considered) recovered precious metals are present in the copper cement.

Yelds: pratically quantitative in iron; of abt 92 pct and 93 pct respectively in copper and zinc (copper in cement; zinc in leach liquour)

Start up data: end of 50's (enlarged twice since then)

Capacity: abt 190,000 tonnes purple ore per year;

Special remarks: a plant of this type is also working at Metalquimica del Nervion, Bilbao, Spain (see in PINEDO-VARA)(6); both plants use processes engineered by Duisburger Kurpferhutte whose plants were operated in Duisburg, Federal República of Germany;

B. Purple ore / pyrite cinders purification and pelletization plant (60), "Kowa-Seiko process"

Decided after the refusal of purple ore by Portuguese iron and steel maker and after the turbulent layer dearsenifying roasting of Contacto 6 increased the amount of "fines" in roasted pyrite, this plant uses the Japanese Kowa-Seiko process, engineered by Toyo Engineering Corporation.

The plant includes following sections:

i - pretreatment section: cinders and purple ore mixed and dried;

ii - kneading and balling section: providing suitable comminution, mixing with calcium chloride and green ball formation in disk-type pelletizers;

iii - green pellet drying section, with strict temperature control;

iv - chloridizing volatilization section, in a rotary kiln, 45t/h capacity, 0.2 to 0.8 rpm, residence times 3 hours, size 5.1m diax24m lenght plus 4.4m diax28m lenght, temperature profiles between 600º and 1250ºC, where burnt pellets are formed (and subsequently air-cooled) and non-ferrous metal chlorides are volatilized;

v - gas treatment section: gas from the kiln is cooled in two stages, for condensation of metal chlorides; mist and lead salts are removed by wet Cotrell; lead is recovered as a lead sulphate cake (gold concentrates here);

vi - by-product recovery section: for the extractive removal of metals contained in the liquour from the gas treatment section. Excess sulphates are precipitated as gypsum by adding chalk powder; copper is then cemented (silver concentrates here); iron is precipitated; still remining lead and copper are removed by sulphide precipitation; lean liquour is then sent to the nearby zinc recovery plant;

vii - calcium chloride recovery and concentration section: where calcium chloride containing liquour after zinc removal is concentrated.

Raw materials: purple ore from Duisburger Kupferhutte plant; the balance in pyrite cinders; calcium chloride make-up; chalk powder; other reagents; iron and steel scrap; fuel oil.

- Products: iron hematitic pellets; copper cement; lead sulphate cake; lead and copper sulphide cake; iron hydroxide cake; gypsum; zinc containing liquour

Yelds: balances are given by GUEDES and RODRIGUES (60) as well as specifications for produced pellets. The removal and recovery of non-ferrous metals are very complete.

Start-up date: 1980

Capacity: 340,000 tonnes/year hematitic pellets with 60 pct Fe

Investment: 6,400 . 10^6 PTE (recorded in 1981) (61)

Employment: 215 employees (62)

Additional remark the energy-intensive operation of this plant, conceived before the two "oil-shocks", gives raise to several economical troubles accrued by the lower prices prevailing in the market of non-ferrous metals and iron ores*; recent references in press reported it as in "stand by" and foresaw its definitive shut-down; from Quimigal recently disclosed report for the operation year 1984: "During 1984, studies and tests to reduce the performance costs of "Kowa Seiko" and negociations with Siderurgia Nacional (the Portuguese steel producer, 100 pct owned by the State) to reach agreement on prices and quantities, have been persued. The carried tests, albeit always progressing towards better costs and qualities, had to be interrupted due to cost reasons before the stability of performance was attained. An eventual solution for this problem may envolve a three-parties agreement: Government, Quimigal and Siderurgia Nacional" (63).

And some pages later in this Report: "The high energy costs, that continuously have increase, determined a careful assessment of the feasibility of iron oxide pellets production in the Kowa--Seiko unit (...). These studies led to the conclusion that, at the prevailing level of prices for said product, the respective production process is by no means rentable. As a consequence, the suspension of operations for this plant and its keeping under a "stand-by" condition was decided, with searching, in the meantime, of alternative solutions (63).

* as well as the suspension of a capacity-increase project for Potuguese steel-mills, to which this pelletizing capacity was related.

C. Sodium sulphate recovery plant: recovering sodium sulphate by concentration and salting-out from the copper exhausted liquour produced in the pyrite cinders treatment plant. This liquour is added with salt and undergoes evaporation in vacuum crystallizer. Crystallized Glauber salt is separated by centrifugation and zinc containing liquour is sent to zinc recovery plant. Performance conditions of crystallizers have been studied by JUSTINIANO (64). Glauber salt is melt in its own crystallization water and very pure anhydrous sodium sulphate separates as a solid phase, being removed by centrifugation (65).

Raw materials: spent liquour from the pyrite cinders treatmen plant; salt; steam (for the vacuum ejectors in evaporators--crystallizers and the indirect heating of Glauber salt).

Products: very pure anhydrous sodium sulphate; spent liquour to zinc recovery.

Start up date: 1965 (65)

Capacity: 15,000 tonnes/year anhydrous sodium sulphate

Remarks: This plant works in direct connection with the Cinders Treatment Plant.

Quimigal also produces in other plants a different type of anhydrous sulphate, by direct reaction of sulphuric acid with salt.

D. Zinc recovery plant by ZINCEX process, developed by Technical Reunidas, S.A., of Madrid, Spain.(66)

Description of this plant was also made by VIEGAS (67) NOGUEIRA et al (68) and LIRIO and DUARTE (69).Sulphate and chloride zinc containing liquours from respectively the Kowa--Seiko and the Cinders Treatment plants undergo three basic operations:

- solvent or liquid-liquid extractions (purification step)

-"electrowinning" of zinc (producing zinc cathodes)

- melting of the zinc cathodes (producing zinc slabs)

The first step above mentioned is quite effective, giving a very pure zinc electrolyte: following sequence is envolvad:

(i) - selective fixation of zinc as $ZnCl_4^{2-}$ by means of an anionic extraction agent:

(ii) - transfer of zinc ion to the aqueous phase, with co--regeneration of the organic phase:

(iii) - selective fixation of zinc ion by a cathionic extractive agent:

(iv) - transfer of zinc to a new aqueous phase (spent electrolyte), with co-regeneration of the second organic phase.

Operations (iii) and (iv) are common to zinc ions from both Duisburger and Kowa Seiko process liquours; operation (i) and (ii) only refer to Duisburger zinc liquours. The high purity level of the electrolyte affords a high quality product that, as a minimum, accomplishes "High Grade" specification, according to BS 3436-1961, attaining up to 99.99 pct Zn (66).

Raw materials: zinc containing liquours from the Kowa Seiko and the Duisburger plant (after sodium sulphate recovery); lime solvent make-up; reagents.

Products: electrolytic zinc; spent liquour to Duisburger plant (the recovery of cobalt was considered); calcium chloride liquour to return to Kowa Seiko plant.

Yelds: pratically all zinc present in the received liquours is recovered in this plant

Start-up date: 1980

Capacity: 11,000 tonnes/year of produced zinc

Investment: $2,200.10^6$ PTE (recorded in 1981) (61)

Employment: 47 employess (62)

Additional remarks: The first industrial recovery of zinc in Barreiro industrial complex was envisaged in 1973, with the start-up of a 5,000 tonnes/year zinc oxyde recovery plant processing zinc liquours from the Duisburger process unit (after

sodium sulphate recovery). This plant was suitably replaced by the unit hereabove described.

However, the production of zinc in Barreiro is far from attaining the foreseen capacity due to the mentioned "stand-by" of the Kowa Seiko unit, that deprives this plant from a considerable zinc imput.

A similar ZINCEX plant for the recovery of zinc in connection with a Duisburger kupferhuitte pyrite cinders treatment plant is in current operation at Bilbao, Spain (70).

After this general description of main plants in Barreiro for non-ferrous metals recovery from Portuguese Complex pyrites, following conclusions may be established:

- Barreiro is, in itself, an heavily integrated complex. Therefore the sequence of its interlinked industrial operations, in what refers to complex pyrites, is very sensitive to major changement in operational philosophy;

- one of these changements - i.e. the refusal of receiving purple ore by Portuguese steel producer in the begining of the 70's - determined the peletizing option, however (and by other reasons produced in the meantime) with results still detrimental to the overall economy of related operations;

- efforts and studies carried out from 1980 up to now to change this situation haven't yet reached a satisfactory solution and therefore the pelletizing plant follows in a stand-by shut-down up to a definitive decision; expected zinc recovery was sensibly reduced as a consequence;

- announced alternatives for complex pyrite flotation and for copper ore dressing and processing operations may well demand a careful assessement of respective reflex in a so integrated complex as Barreiro, as well as imply a suitable development effort directed towards foreseen new products.

2.2.4. Plants processing copper raw materials in Barreiro industrial complex

Besides mentioned pyrite processing units, Barreiro chemical complex, owned by CUF up to its nacionalization (1975) and to its incorporation in Quimigal (1976), traditionally processes copper raw materials for the production of

- copper cathodes, in the sole copper smelter and electrolytical refinery now operating in Portugal;

- copper sulphate mainly for use as a fungicide in the treatment of vineyards.

These two units will be briefly described hereunder:

A. Copper smelter and refinery

Since the first decades of its operation in Barreiro, CUF has been producing metallic copper. Up to 1957 this metal was obtained as copper shot, for use in copper sulphate manufacture. The start-up of new metallurgical plants, including an electrolytical refinery, directed this copper production to a different market, i.e. to copper demand by producers of electrical cables and appliances. At same time CUF Group took an important position in the main copper secondary processor - CPC - Companhia Portuguesa do Cobre, in Oporto. The then existing thermal refining capacity suited to meet the demand for copper sulphate production at that time (4,500 tonnes of copper, equivalent to 18,000 tonnes of copper sulphate) suited to an electrolytical capacity of 3,600 yearly tonnes of copper cathodes (12 groups) what was reasonably compatible with a certain market state and with the availability of domestic raw materials up to the onset of the 60's. A certain capacity increase (to 3,900 yearly tonnes of cathodes with 11 groups) was achieved in the meantime, removing 1 group for the lead electrolysis that was operated in Barreiro at that time (73, 74).

However the lack of economical dimension and the needs of improving operation and of meeting larger demands imposed a smelter and refinery revamping up to 5,900 yearly tonnes of cathodes (and increase of thermal refining) that started-up in 1979-1980.

The plant is now composed by a raw materials preparation (with blending and pelletizing), a water jacket shaft furnace, a converter, a rotating and tilting thermal refining furnace, with an anode moulding "carroucel", an electrolytical refinery with 112 cells in 14 group (some of these cells are directed to the production of starting sheets). A detailed descriptuon of the overall smelter and refinery was given by ABRANTES (74). Prior production of wirebars was more recently discontinued, due to no more demand from processers (see under CPC).

Electrolytically refined copper of high quality is sold as cathodes: the co-produced slimes, containing precious metals, are treated in a Precious Metals Metallurgical Plant also included in Barreiro Chemical complex or exported.

Raw materials: Imputs for Barreiro copper operations in the years 1982 and 1983, including the production of cathodes and copper sulphate (average production as sulphate in 1980/82 corresponding to 1,250 tonnes/year of contained copper for an overall operating capacity of abt 2,500 tonnes of contained copper).(50):

Table XXXVII: Data on Barreiro copper works (years 1982 and 1983)

	in tonnes of copper	
Domestic market	1982	1983
Copper cement (including own production)	334	1432
Panasqueira concentrates	47	41
Scrap	1666	1876
Others	37	-
	2084	3349
Imports		
Copper cement	1086	-
Blister copper (with precious metals)	2996	3492
	4082	3492
Grand total	6166	6841

Products:

Overall production and sales as metallic copper for same years 1982 and 1983 (50):

	1982	1983
Production	4556	4561
Sales	5220	5448
wirebars	52	0
cathodes (domestic market)	3262	4193
exports (copper cement, black copper, anodeic slimes)	1906	1255

Employment: of abt 110-120 (50).

Additional remarks: the small dimension of Quimigal smelter and its energy intensive processes surely make a continuous challenge to a minimally economical operations.

As already mentioned, part of this plant was used for lead extractive metallurgy during the 60's: this lead processing opera operations were however shut down in the first half of the 70's. A considerable overcapacity in thermal refining (16.000 yearly tonnes of copper) relative to the electrolysis is to be noticed, after the revamping of 1976 (51).

B. Copper sulphate production

Several grades of commercial copper sulphate are currently produced in Barreiro, with an overall capacity reported as of 10,000 tonnes of sulphate (equivalent to 2,500 tonnes of contained copper) and an yearly utilization (average 1981/2) of abt 50 pct.

However Barreiro plant has operated years before with bibher capacities and producing levels, answering to then existing domestic demands. Besides production of this chemical was the first industrial use of the copper obtained at Barreiro works and as available cement; even imports of blister copper were directed, via copper shot, to copper sulphate production.

Current consumers of copper sulphate have stabilized to present levels of production but eventual irruptions of vineyard pests potentially controlable by "classical" means may well determine a certain increase in demand.

The production of copper sulphate is essentially made by cement oxydation in multiple hearth roasters, followed by sulphatation with sulphuric acid and by solid/liquid removal of sulphatation slimes (that concentrate precious metals and therefore are sent to respective metallurgical section). Copper bearing liquours so produced are passed to static and/or vacuum crystallizers, where copper sulphate pentahydrate is separated. Classification of crystals and types produce the different brands currently supplied to the domestic market.

A small portion of copper sulphate is partially dehydrated and micronized for use as an additive to cattle food production.

This brief description closes the overall analysis of existing complex pyrite and copper primary processing units in Barreiro. For this metal, it has to be stressed the small capacity of existing industrial facilities and the practical limitations to consider their increase. A new copper unit with larger capacity may well replace these smaller sized operations, specially if based in the availability of domestic raw material that were not supposed to exist in the earlier 70's. If not, it is very difficult to forecast a success to Barreiro copper plant when facing the competitive profiles of today's copper industry, after a medium-term challenging effort to transitionally cope with. The way recoverable copper will be available from complex pyrites, if new pyrite dressing processes are adapted in Aljustrel, or how the pyrite tailings are to be treated in Neves-Corvo, may also bring an influence to draw up such future pathes.

2.2.5. Copper smelter and refinery project

Reference was already made to the copper smelter and refinery conceived in direct connection with Neves-Corvo mining

developments (item 1.2.5.2 and 1.2.5.3. above). By Ministerial Order nº88/82, of the 16th December 1982(28), Quimigal was commited with the set up of final feasibility and implementation studies for that project, as well as of prospecting and evaluating potential private participations (of Portuguese or Foreign origin) for this new venture.

In the accomplishement of that commitment, confirmed by more recent Ministerial orders (76), Quimigal issued the end 1985 a public invitation for the prequalification of general contractor (77), that renewed already existing (and already mentioned) controversy around such a proposed venture.

Quimigal reafirms the interest and rentability of such an unit, when considering the competitive purchase of raw materials at mine premises, and is currently building-up a full consideration of such a project to minimize respective risks by a more complete definition of its technical, economical, financial, commercial and entrepreneurial factors. Respective conclusions will be submited to the Portuguese Government in the first quarter of 1987, with a final "go" demand for the definitive project progression - and already with appointed engineering and contractor precions (40, 78).

Descriptions of this project have recently been issued (53, 54, 79), as well as view points from copper consumers (52), metal traders (71), government departmentals (51) and former ministerial officers (78), only to mention some positive expressions of support - with the pre requisite of confirmation by considerations underway of the attractive figures already disclosed. Negative viewpoints were also expressed and already quoted in Portuguese and Foreign press (37,38,39,80).

From recent short descriptions, following key-data were summarized:

Basic project objectives (79):

- maximun upgranding of domestic resources having a strategical general interest by its vertical integrated processing;

- guarantee of copper supply to fulfill Portuguese demand, with reversal of the present situation of external dependency and achieving an exporting profile;

- provision of a basic support to the Portuguese non-ferrous metals industry, allowing for its sectorial development in a competitive level;

- guarantee of the required competitivity of the Portuguese fertilizer industry (phosphatic fertilizers) at international level by its supply with a suitable quantity of co-produced sulphuric acid in interesting conditions of quality and price.

Project description (79):

Conventional flash smelting unit, with enriched blast and heat recovery, followed by conversion of copper matte and electrolytical refinery of copper anodes; sulphur recovery from gases by sulphuric acid production, after demercurization; integrated power generation.

Copper capacity (cathodes "higher grade"): 100,000 tonnes/ye /year (the range 80,000 to 100,000 tonnes/year was investigated; partial blister production with corresponding decrease in cathodes output also under study, as an alternative).

Sulphuric acid: 400,000 yearly tonnes H_2SO_4 98.4 pct

Anodic slimes: for the full load of electrolysis, abt 600 tonnes/year, containing precious metals

Electrical power demand (own consumption): 63,000 Mwh/year

Table XXXVIII:
Technical features (53)

PROJECT SECTION	NOMINAL CAPACITY
. Raw material preparation	450,000 tonnes/year of copper concentrates and cements
. Flash smelter	50 tonnes/hour of copper concentrates and cements
. Converter aisle	540 tonnes/day of copper matte (60 per cent copper)
. Sulphuric acid plant	1,400 tonnes/day H_2SO_4
. Slag treatment	950 tonnes/day slag
. Anode casting	120,000 tonnes/year anodes
. Electrolytic refining	100,000 tonnes/year cathodes "higher grade"
. Power station (recovery process waste heat)	9 MW
. Oxygen plant	260 tonnes/day O_2

Since directly and exclusively supporting the PROJECT, following infrastructures are also to be considered as making integral part of it:

- railroad terminal,
- fire fighting system,
- connection to the nacional power network, main switchgear transformer station and internal distribution network for electric power,
- harbour terminal,
- process fluid network, including salt water intake and distribution systems;

Table XXXIV:
Economical indicators (53):

Investment	56.1×10^9 PTE conditions including working capital	
Sales value	approx 37×10^6 PTE/year	
Ratio operating costs/sales value		11 pct*
Ratio gross added value/sales value		27 pct*
Economical project life		15 years

* in a year of stabilized plant operation

IRR (before taxes, constant 1986 prices)	between 12 and 17 pct
Paynout time	between 5 to 6 years

Extension of Portuguese quoted participation in fixed assets: abt 52 pct (53)

Decomposition of foreseen investment (in 1986) (53)

Table XL (a)

	pct
engineering, licences, knowhow	5
equipment	41
construction and	18
infrastructures	10
personnel training	1
contingencies	1
start-up expenses	4
interest during construction	5
working capital	6
	100 pct

Approximate distribution of operating costs (1986) (53)

Table XL (b)

personnel	51 pct
maintenance	17 pct (including main repairs)
power and fuels	38 pct
others	24 pct

Personnel distribution (53):

Table XL (c)

management	24 employees
foremen+shift leaders	48
workers	453
office & admin. staff	40
total	565

Social and local impacts:

- Diversification of activities at local (regional) level
- Use of existing infrastructures
- Industrial and commercial dinamization
- Promotion of mining activities (Aljustrel)
- Direct employement: 565 (see distribution above)
- Temporary employment demand during construction: 4,000
- Indirect employment (local): services and auxiliaries
- Professionel formation in the sector
  - better technological level
  - increase productiving

Proposed location: in Portuguese west coast in a place with railway connection to mine loading station (Sines area was investigated as well as alternative location.

Project schedule (in 1986) (53) (see fig.6, next page).

As a closure to these considerations, if is interesting to quote the references made by ROONEY and STOHN (81) directly to Portugal as one of the most interesting potential locations for new major copper smelting complex).

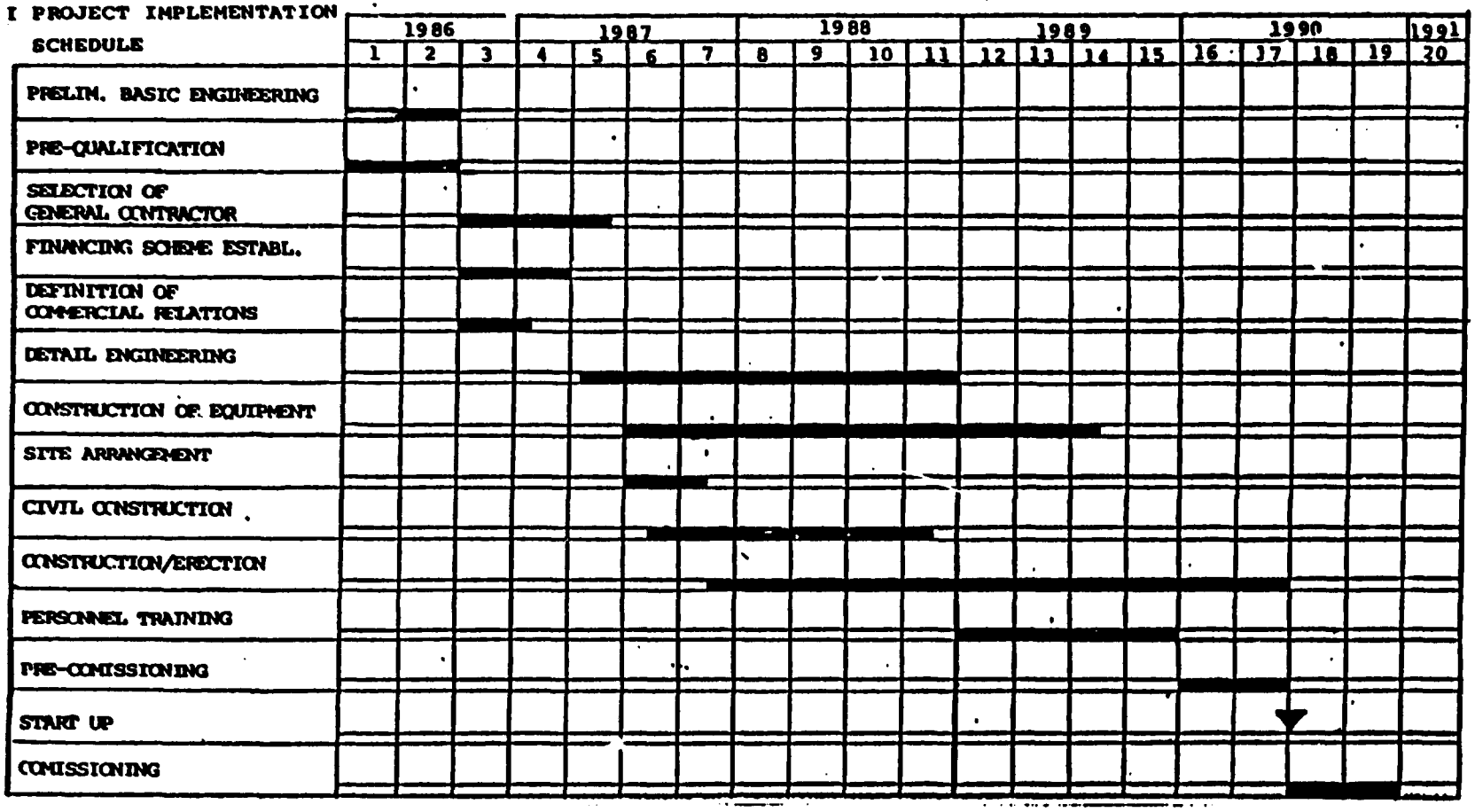
2.2.6. Integrated pyrite processing in Sines (C.P.P. Projects)

As already mentioned (see section 1.2.4.4.), the first phase of this CPP Project was "frozen" in 1981/82.

The second concept for respective timewise implementation (i.e. pyrite flotation and hydrometallurgical treatment of concentrates) is in the line of presently proposed developments.

Therefore no further reference will be made here to these pro projects.

Figure 6: Copper smelting and refinery project



Source: (53)

2.2.7. Secondary copper alloy refiners

As described, copper primary production in Barreiro includes a partial recirculation of copper as copper scrap.

However some small exclusive secondary refining activity exists in Portugal, specially producing copper alloys such as bronzes and brasses by a recycling of residues These plants, with some quality control problems and facing limited financial capabilities of respective potential customers are respectively:

. Refinaria de Metais Luso-Italiana, Lda.
. Alberto da Silva Barbosa & Filhos, Lda.

Overall capacity in the range of 3,000 tonnes/year of brass and 2,000 tonnes/year of bronze, is only partially used (abt 50 pct); however a certain increase in production was reported for the period 1980/82 (51).

2.2.8. Secondary copper processing industries

"Semis" and "alloy" producers, placed between smelting and primary refining and final copper users, are generally refered as secondary copper processing industries.

This secondary sector is pratically full covered, in Portugal, by the industrial activities of C.P.C. - Companhia Portuguesa do Cobre, SARL, from Oporto, with manufacturing lines for copper wirerod, copper and brass sections and shapes and cold-laminated plates. After the start-up in 1983 of a continuous "dip-forming" unit for wire rod, with a rated capacity of 36,000 tonnes/year of copper and with a foreseen investment of a abt 500×10^6 PTE, (1982 basis). , the overall capacity of CPC is in the range of 60,000 tonnes/year copper and brass "semis" (51).

Individual maximum available capacity for each separated line and type of product are described in detail by CAPELO (51).

CPC semis output for the period 1980/82 were reported in the range of 21,000 to 22,000 tonnes/year, corresponding to gross production values well above $3,0x10^9$PTE, with a certain equilibrium between supply and demand. Following figures describe CPC operation in 1982 and 1983 (50):

Table XLI: CPC operations (1982 and 1983)

Operating year	1982	1983
Production, tonnes	22,637	21,603
Sales, tonnes	22,896	22,303
domestic market tonnes	22,280	21,564
export tonnes	616	739
Production value, 10^6PTE	3,373	4,612
Gross added value, 10^6PTE	776	1,312
Investments, tangible assets, 10^6PTE	430	79
Employment (the 31 Dec)	827	803

CPC report for 1985 operating year, recently issued (32), demonstrates a certain reduction in the overall production, to a abt 18,400 tonnes (with a corresponding value of abt $5,260x10^6$PTE) - although with a relatively higher export quota (1,408 tonnes).

This was specifically atributed to a certain ineficacity in the implementation of rules that project some copper "semis" under the clauses of "new industries" and considering the recent admission of Portugal in the EEC.

Overall personnel costs in 1985: $601x10^6$PTE, inclusive o of all social charges and expenses. Direct purchases and sales to Foreign countries demonstrate a clear currency balance deficit, although atenuated that year by larger exports:

direct purchases (imports)	$1,960x10^6$PTE
direct sales (exports)	$494x10^6$PTE

The ownership of CPC includes following entities:

. Trefimetaux, from France (with 25 pct)
. IPE - Instituto de Participações do Estado, SARL, keeping

the shares of the Portuguese public participation of abt 34 pct (83)

. private shareholders (Portuguese) abt 41 pct for a share capital of $1,0x10^9$ PTE.

The ownership of IPE participation in CPC was somewhat discussed during the years 1981/1982, when the interest of Quimigal in controlling a leading position in CPC was apparent. As a matter of fact, the activities of CPC are directly connected to the metallurgical activies of Quimigal.

Moreover, the CPC participation now under the control of IPE was originally owned by the CUF Group and only some hazardous consequences from the nacionalization processes carried out during the years 1975 and 1976 had broken such a natural tie. A possible reaffirmation of Quimigal interests was recently mentioned again.

Although CPC is itself represented in the final copper market by a small portion of its own products, the main part of its output is directly supplying final consuming industries such as:

. cable manufactures, with several industrial plants of reasonable capacity and range of products
. electrical equipment producers and electrical erection and assembling companies;
. alloy manufacturers;
. small coper-based foundry;
. copper retail sellers;
. other industrial units employing copper or copper alloys.

Other recent but smaller producers of "semis" in copper and copper alloys, generally recycling available scrap and residues, may be enumerated (50,51):

. abt 5,000 yearly tonnes of brass bar produced by continuous casting and/or by mechanical drawing, in several small companies (in which the main producer is Alberto da Silva Barbosa & Filhos, Lda, whith capacity commissioned in 1982/1983);

. abt 4,700 yearly tonnes of brass bar also by continuous casting, foreseen in 1981/1982 by Tecnocobre - Sociedade Industrial de Cobre, Lda (including a 1,200 tonnes production from pressed products);

. abt 900 tonnes/year of bronzes (bars and sleeves) Contibronzes - Fundição Contínua e Centrifugada, SARL, covering domestic market and also considering exports.

A careful evaluation of the Portuguese foundry industry for copper and copper alloys was published in 1985 by the Direcção Geral da Industria (84); this text well demonstrates the potencial development of these industries for domestic supply and active exporting to the EEC and other areas.

This foundry sector, however, shows itself very heterogeneous, with a great number of companies (107 units with a great dispersion in their dimensions, i.e. 52,3% under 10 employees), with technological problems associated to some segments of that distribution, but also with considerable employment (abt 3,800 workers) and production range (abt 5,600 tonnes in 1983, with a reported value of abt 4.3×10^9 PTE.

This brief reference to Portuguese secondary copper processing industries underlines following major aspects:

- the concentration of major production in one single operator with a significative capacity, although other minor producers were recently reported;

- the loss of some vertical integration apparently existing prior to the nacionalization processes of 1975/1976, without evident capacity (or will) to re-established logical holding relations, at least for the State-owned sector;

- pratical utilization of available processing capacity;

- lack of significative exports, although the protecting

provisions for a "new industry" in EEC may cover some of products (copper wire rod) and help some exporting activity;

- potential sensibility to a substantial increase and development, if a major primary copper industry is established in Portugal:

- that sensibility is pratically due to its clear dependency from foreign supplies; whith an overall apparent consumption of abt 30,000 to 40,000 tonnes of copper in all forms, the country imports abt 25,000 to 30,000 tonnes of copper. Present primary copper production, with partially recycled and imported raw materials, is on the range of 5,000 tonnes/year and a recycle of 10 pct of the apparent consumption brings no more that 3,000 to 4,000 tonn tonnes/year; these "domestic productions" a clearly not enough to answer to domestic demand, if no extra-capacities are to be considered.

- in some fields (vg. electrical cables) copper products face the competition of aluminium, whose consumption in Portugal has remarkably increased; the development of a copper industry based in Portuguese resources may well intensify copper consumption, instead of aluminium, in the conditions where those metals are near equivalent for respective users, The employment of optical fibers is not regarded as a major risk for Portuguese copper industry.

2.3. Nickel

No relevant processing operations are reported for nickel in Portugal.

LOPES (43) estimated in 1981 that the Portuguese nickel consumption could reach up to the year 2000 an increasing rate of 5.5 pct/year thus attaining then abt 2,000 tonnes as primary consumption, up to 5,500 tonnes as total maxinun consumption.

2.4. Lead

Portugal is sensibly dependent from Foreign supplies to cover respective lead demand, with imports of lead ingot that in the begining of the 80's were placed in the range of the 18,000 tonnes/year (49). A domestic secondary production was also reported with mention to the capacity of lead recycling by Metal Portuguesa, SARL, up to 7,000 tonnes/year (but only producing in the range of 5,000 tonnes). Total lead consumption in Portugal is therefore in the range of 23,000 tonnes year.

Consumers of lead in Portugal were distributed by following sectors:

- battery industry (abt 35 pct of primary lead consumption, and also secondary lead)
- capsules and cabling (abt 20 to 25 pct of primary lead consumption)
- lead salts, as pigments (main consumer of secondary lead, specially in Metal Portuguese)
- fabrication of lead plate, tubes, lead shot and other similar uses (all-together, abt 15 pct of primary lead consumption) (49)
- alloys, fluxes, solders, etc.

Portuguese production of primary lead was stopped during the 70's, when CUF shut down its Barreiro operations. Lead production in Barreiro was carried out in connection with the treatment of some Portuguese gold and silver ores adding (as an important lead input for the production) the Cottrell-dusts from sulphuric acid production by pyrite roasting, as well as the lead sulphate muds from the then still-working sulphuric acid chamber plants. Considerations of occupationel hygiene and of overall economy, as well as technical limitations related to the use for lead

production of part of primary equipment designed for processing copper raw materials, have brough to the mentioned shut down.

However the study of new ways to process lead sulphates got a clear mention in Quimigal Report for 1984(63), specially in connection to the lead sulphate fractions expected to be produced in the Kowa-Seiko unit. The "stand-by" situation of this plant surely discouraged such a development effort - but the new conception of differential flotation of complex sulphides (see section 1.4. above), will potencially provide in a medium term, the availability of abt 13,500 tonnes of lead, contained in lead concentrates (specially interesting by their precious metals contents) and will perhaps remake the consideration of primary lead availability in Portugal from domestic resources.

The mentioned secondary lead producer - Metal Portuguesa SARL - - was established in 1944 and its industrial operations are located in Vila Franca de Xira, Lisbon district. Its ownership includes a 51 pct participation by Ferro Corp., with the remaining 49 pct with private shareholders. Vila Franca plant includes:

. a lead melting and recovery plant, consuming battery scrap and other lead scrap.

Production capacity: 7,000 tonnes/year refined lead (including alloyed lead):

output 1981-82 in the range of 5,800 tonnes/year.

. a lead oxide plant thermal process, using pure lead and with producing range of abt 3,600 tonnes of lead oxides in 1981-1982 (plant capacity of abt 5,000 tonnes/year lead oxides).

. zinc oxide plant, thermal process, starting from galvanizer scrap, with a capacity of 4,000 tonnes/year and production level, on same period of abt 3,800 tonnes (72).

2.5. Zinc

"The more relevant fact recently verificd in the Portuguese internal market of zinc was the transition from a situation of no domestic production of zinc ingot to its production by Quimigal (...), with an installed capacity of abt 11,000 tonnes/ /year"(49). Mention to this new plant, commissioned in 1980, and to its operation was already made in this case-study (see item 2.2.3.D above): produced zinc is recovered from leaching liquors from pyrite cinders treatment plants, in Barreiro industrial com complex, joining together recovered zinc values from the Henderson - Duisburger Kupferhutte process (abt 40% of total zinc production) and from the Kowa-Seiko pelletizing process (abt 60% of zinc production).

However and as also already stressed - the shut down of that second plant deprived Quimigal's zinc unit from a relevant part of its supply, abt 60% of total,lowering sensibly its possible output and therefore not atenuating in the same amount the dependency in this metal. Following figures refflect recent operation of this unit (50):

Table XLII: Barreiro zinc operations (1982 and 1983)

Year	1982	1983
Production tonnes	4,214	4,427
Sales, tonnes (totally in domestic marker)	4,536	3,905
Production value, 10^6PTE	193	220
Gross Added Value, 10^6PTE	88	103
Employment (the 31th Dec)	37	34

The balance of imports and exports of zinc and zinc alloys for these same years also demonstrates mentioned import dominant situation.(50)

Table XLIII: Portuguese zinc balance (1982 and 1983)

	1982		1983	
	Import	Export	Import	Export
Raw materials				
scrap and residues, tonnes	174	98	381	-
(10^6PTE)	(6)	(5)	(17)	(-)
Zinc metal, tonnes	10,774	1	10,642	1
(10^6PTE)	(762)	(-)	(922)	(-)
1st Processing, semis				
long products, tonnes	1,634	213	1 306	313
(10^6PTE)	178	(12)	(193)	(3)
plates, tonnes	21	1	6	1
(10^6PTE)	(2)	(-)	(1)	(-)

These figures are somewhat below a previous estimate of an internal consumption of abt 30,000 tonnes of zinc/year (49) but considering the recycle extent of zinc and zinc alloys may well place Portuguese consumption in the range of abt 20,000 tonnes of overall zinc and zinc products.

The development of the production of zinc concentrates from complex pyrites will surely require a revision of the production pattern of zinc metal in Portugal, and of the possible saturation of the capacity existing in Quimigal even if a final decision on Kowa Seiko prospects and/or the changement from grain-size pyrites may impose modifications in upstream performing units). The possible availability of 64,000 tonnes of zinc contained in concentrates, as mentioned in item 1.4 (with abt 14,000 to 25,000 tonnes zinc from Aljustrel project) may place Portugal in the situation of net exporter of zinc values. Any development in Portuguese zinc production, however, shall take in consideration not only Portuguese zinc demand but also the excess of zinc capacities in Europe.

Portuguese zinc consumers may be distributed by following activity sectors (49):

. brass producers, absorbing from 15 to 25 pct of primary zinc input namely:

- Companhia Portuguesa de Cobre, SARL:
- Alberto da Silva Barbosa & Filhos, Ld.
- Metálica - Companhia Internacional de Fundição e Laminagens Lda.

. zinc alloys (injected molding and special zinc foundry), namely Zamak type alloys (an import of abt 2,000 yearly tonnes of Zamak is reported):

. zinc laminated products, with an internal demand of abt 4,000 tonnes/year, 20 pct of which produced in Portugal by Compagnie Royalle Arturienne des Mines, the 80 pct balance being imported:

. zinc oxide production, by Metal Portuguesa SARL, as already mentioned, that annualy gets to abt 4,000 tonnes of zinc oxides using for that production zinc scrap and low-value zinc containing residues available in the Portuguese market.

An estimate of approximate zinc consumptions by these activities is available from an other study issued in middle - -1983 (48):

Table XLIV: Zinc consumption by activities, Year 1983

galvanizing	abt 10,000 tonnes/zinc
brass semis	2,000
laminated products	1,000
zinc alloys, incl. Zamak	2,000
zinc oxides	4,000

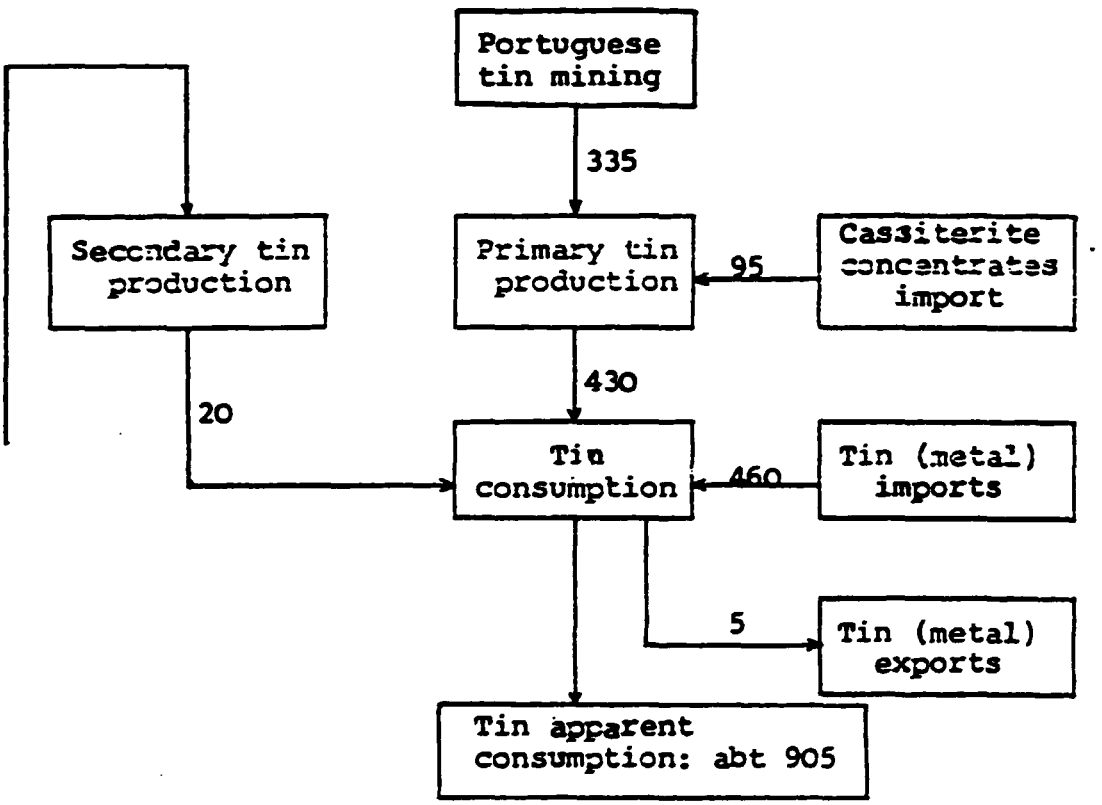
2.6. Tin

Portuguese tin processing operations show a characteristic feature not found up to now for the metals previously studied: being Portugal a medium-sized tin ore producer, as already mentioned, the capacity provided for the operating tin smelters

is well above domestic ore production, reason why Portugal is a net importer of cassiterite concentrates to keep the performance of some of is primary metallurgical units. Besides, Portugal has been a net importer of tin metal to cover its own requirements.

Working with average yearly amounts for the 5 years period 1979/1983 that show relatively constant figures (7), following tin balance can be drawn:

Fig.7: Portuguese tin balance (average 1979/1983)



Source: adapted from (5)

i.e. Portugal shows a coefficient of dependence of abt 61 pct, determined by the ratio (in quantities) of overall imports and apparent consumption. The decline in cassiterite production may have reinforced in more recent years this situation.

Existing primary smelters for cassiterite concentrates are operated respectively by:

. Minargol - Complexo Mineiro de Argozelo, SARL, already mentioned in item 1.5.B, in the "concelho" of Vimuoso, district of Bragança. Minargol is a join venture of Portuguese SPE - - Sociedade Portuguesa de Empreendimentos, SARL (24 pct), other partners (abt 27 pct) and the Belgian Geomines S.A. (49 pct)

However, as noticed, problems with Geomines S.A. were recently reported.

This small smelter produces tin ingot at a level of abt 4 to 5 tonnes/month, mainly using Minargol own concentrates as raw material.

Minargol, therefore, has an integrated production of tin, in the sense that respective activity is exerted both in mining and

. Neoestano - Nova Empresa Estanífera de Mangualde, SARL, in Mangualde, Viseu district, join venture of

SPE	abt 30 pct
Banco Português do Atlântico State owned bank with main office in Oporto	abt 70 pct

Neoestano has no mining activities and obtains abt 85% of the Portuguese primary production of tin ingot, currently operating one of its three electric (are) furnaces, with current monthly output of abt 25 to 30 tonnes of metal. The capacity of Neoestano smelter is therefore well above to respective production level and even to overall domestic concentrate production, reason why Neoestano needs, for its performance, to purchase cassiterite concentrates actual abroad.

. Sociedade Mineira de Paiva, also owned by SPE (30%) and Banco Português do Atlântico (70%), in Bodiosa, near Viseu, with an electric furnace (capacity 1,500 tonnes Sn/year);

. Borralha, already mentioned, whose electric furnaces may be adapted for tin operation.

From these units, only Minargol and Neoestano may be considered as currently operating. In 1983 the Banco Português do Atlântico tried to sell its participation both in Neoestano and Sociedade Mineira de Paiva; however no bidder reached the minimum value accepted for bidding (88). These units demonstrate an impressive smelter over-capacity, directly connected with the too optimistic forecasts built up in years 50's and earliest 60's too favourable demand metal prices and concentrate outputs from Portuguese mines.

Main users of tin, in Portugal, can be included into following groups (7):

. tin coated plate, for "cans" and "tins" no doubt the major consumer with abt 40 to 55 pct of tin total consumption. The amount of tin commonly used per ton of coated plate of standard gauge is of abt 5.5 kg tin/tonne of plate produced; however an analysis of available statistics suggests a specific employment of tin by Siderurgia Nacional of 40-50 pct above this figure. Siderurgia Nacional, E.P. , the State-owned iron and steel producer is the main producer of tin coated plate in Portugal, importing its own requirements in this metal.

This is a sector where the development of materials alternative to tin-coated plate may result in a decrease of tin consumption.

. tin alloys, with abt 40 pct of tin consumption, including solders (60 pct of this sector) and other alloys, namely antifriction alloys (white metal), bronzes, brass and pewter

. tin coatings, with abt 5pct, for the electrical equipment and cable industries.

. chemicals and other uses.

The development and full exploitation of important cassiterite resources, like Argimela, as well as the access to tin values contained in the copper and complex pyrites of Neves Corvo, may

shift present tin importing dependence. However present situation of the international tin market (combined to the wolfram own situations that associates depressive effects to several Portuguese mining ventures), while pervisting, is by no means encovraging.

3. NATURE AND ORGANIZATION OF THE LINKS BETWEEN THE NON-FERROUS METALS SECTOR AND THE OTHER SECTORS OF THE ECONOMY

3.1. Main flows between the non-ferrous metals sector and the other sectors of the economy

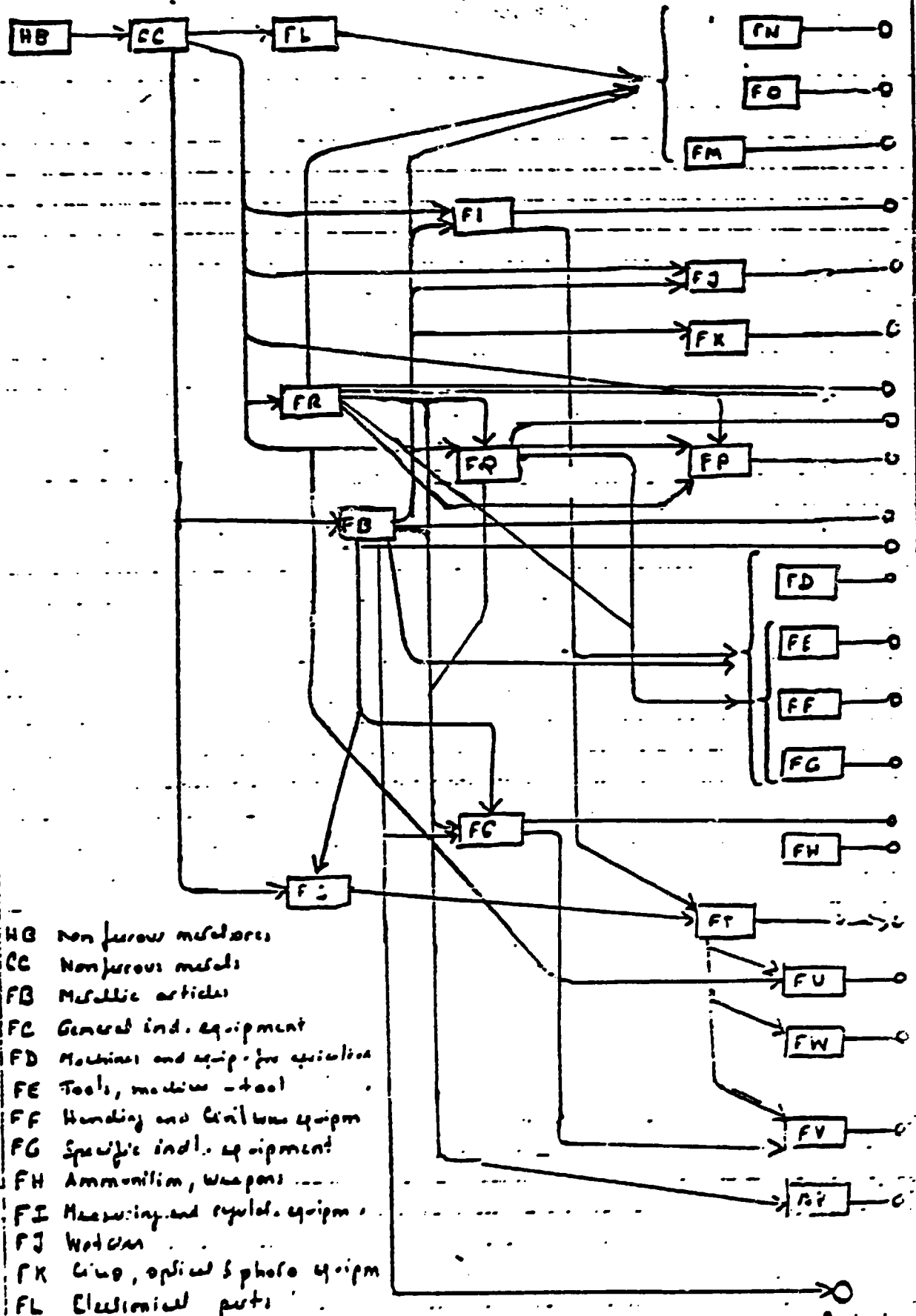
A general outline of these relations has been suggested for each metal in prior chapters.

An interasting systematic approach by RODRIGUES et al (92) presented a diagram for the main flows in the Portuguese producing system, from which the pertinent network for the non--ferrous metals sector was extracted and is raproduced in next page.

However the larger scope of that work suggested the definition of bigger systems (v.g. "Agrochemical systems", "Metallic systems", etc.) grouping several activies; these systms were divided in sub system b inging to more detailed conclusions (vg. Minero--metallurgical, Metal constructions and equipments, Automobile, Mechanical Tool and Instrumentation as some of the subsystems included in the Metal system), but with pratically no segregation of the non-ferrous metals from the corresponding iron & steel act.·rities. Anyhow, this study may be quoted as a good reference for an overall consideration of the metallic sector (as well as other productive sectors) in Portugal.

A greater split of activies, however, would bring to the statistical difficulties already mentioned - specially when the imports or movements (or recycles) of metals are not systematically

Figure 8 : Non ferrous metal users in a diagram for the metals flows of Portuguese producing systems



HB Non ferrous metal ores
CC Non ferrous metals
FB Metallic articles
FC General ind. equipment
FD Machines and equip. for specialized
FE Tools, machine-tool
FF Handling and civil work equipm
FG Specific ind. equipment
FH Ammunition, weapons
FI Measuring and regulat. equipm.
FJ Watches
FK Clinic, optical & photo equipm
FL Electronical parts
FM Electronical equip. used on
FN Telecommunications equipm.
FO office equipm, computers
FP Electrical equipm., home
FQ Electrical equipm, heating
FR Electrical equipm, general
FS Car parts
FT Cars and motorcycles
FU Railway and other transport (non road) vehicles
FV Shipyards
FW Aeronautics
AZ Buildings, housing, civil works

evaluated in order to produce yearly metal balances for each metal. Besides it is not easy (and in certain cases even not possible) to track the destination of some imports of metals or metal parts when they are primaly connected to the activity of intermediates such as traders and therefore don't relate to a specific industry; similar attitude may be refered for situations in which designations by a part of article denomination "hides" respective metal contents.

A simplified analysis could be based in the two first groups, of fig.8, i.e. HB (Non ferrous metal ores) and CC(Non ferrous metal metals), whose relation with items having statistical significance seems possible; however the two first industrial activities with statistical meaning for non-ferrous metals (i.e."basic industries of non-ferrous metals" and "production of non ferrous metals and alloys" shall be carefully regarded by their definitions to avoid miunderstandings. The spkit of mining and smelting (metallurgical) activities brings no remarkable contribution to a better clarification. The analysis established for the two group HB and CC periods 1972-1979, 1972-1976 and 1976-1979 are coherent with some of the conclusions here presented;however they remain already too a in time to be now developed in detail. No evident relation is worked out in the flow diagram to emphasize the "sulphur contribution" of metal-bearing sulphides, such as complex pyrites; however this fact was mentioned and considered in respective work (being "basic inorganic chemicals" and "fertilizers" two sub--systems of the "Agrochemical Sector").

A general qualitative description of the flows of non-ferrous metals and products in Portugal could briefly be outlined by following considerations, based in already present evidence:

- except for tungsten, Portugal is essentially dependent from metal imports;

- the role of Foreign suppliers and of traders is very decisive in this part of metallic trade; Portugal imports metals in all forms, from ores to semis or even to metallic manufactured products;

- the evolution of dependence in recent times is negative (i.e. towards increased dependence) in what regards tin and lead; a certain positive evolution is connected to zinc: good forecasts exist for copper (as well as for the other metals except aluminium, where the dependence is almost total);

- the secondary circuit of recycling is not yet fully operating, specially for certain metals (vg. aluminium): scrap collection and trading is an important commercial field;

- with the increase of consumptionsand the (up to now) slight or localized increase of capacities, Portugal remains vulnerable in terms of foreign trade of non-ferrous metals;

- commonly, there is a direct contracting between mines and Portuguese primary consumers and between these and respective clients; however even in domestic transactions a trading action may take place;

- such a direct relation implies that existing smelter (primary or secundary) or alloy producers may have to deal with a large variety of client types and sizes; the relatively small dimension of metal producing units still allows for a certain subsistence of this situation;

- the developments of local resources, the trend to bigger units, the technical and competitive requirements arising from the full membership of Portugal in EEC, the selective market demands and a more precise statistical specialized backing, will surely bring to structural modifications in the non-ferrous metal industries in Portugal and to the systematic reporting of respective flows.

3.2. Effect of the mines or processing units in the national economy

As already mentioned, vertical integration mine/smelter has not been the rule for recent activies envolving non-ferrous metals in Portugal. Only for tin (and even for a smaller part of smelter

capacity) this vertical relation

Moreover,all efforts made during decades to build-up integrated concepts have colapsed, by one reason or another. The story of complex pyrite based industries in modern times, with its frequent changements and even regressions in adopted policies, is surelya good example for these situations. However complex pyrites ore, perhaps, one of the areas where integrated development efforts have been pursued farther and should be regarded as a "must". More institutional links between producers and domestic primary consumers may result very useful - and surely not only in pyrites.

The present and potential importance of mines or processing units on the national economy are identified for each metal in chapters 1 and 2 above. The different pattern of mine dimension and corresponding mining technologies may require specific mining policies. Thus the consideration of "small-mining" attitudes,specificaly for the case of tin, may cohexist in Portugal with bigger mines for copper and pyrites,envolving other types of local and regional concerns.

4. ANALYSIS OF THE MAIN SECTORS

4.1. Introduction

Also in chapters 1 and 2 a certain development in the presentation of main actors in the non-ferrous metal sector was worked out. Therefore, present chapter will pratically consist in a systematic return of entities already mentioned.

4.2. Governmental entities

The main Governmental entities connected with the non--ferrous metals sector belong to the Portuguese Ministry of Industry and Commerce, whose official denomination has changed several times.

Following entities were refered:

- DGGM - Direcção Geral de Geologia e Minas
- DGI - Direcção Geral da Indústria
- IIE - Instituto do Investimento Estrangeiro
- CPP - Comissão parao Lançamento de Programa de Aproveita Aproveitamento Integrado de Pirites (PAIP)
- GAS - Gabinete de Area de Sines

A) DGGM - Direcção Geral de Geologia e Minas (General Directorate of Mining and Geology), that cover following activies:

- Geological Services;
- Mining Promotion and Development Services;
- Laborat ry;
- Technical Support;
- Administrative and Technical Organization and Fiscalization of the Mining Sector;
- Publications (including the "Boletim de Minas" and an excelent introdutory "Guide to the Citizen")

Mining activities under the authority of DGGM include exploration, concession, exploitation, ore dressing and mine direct plants such as export facilities (terminals) and integrated smelters - designated in current mining law as "mining annexes".

Presently, DGGM is establishing a "National Mining Plan"(89), together with a full remake of Portuguese Mining Law. These two efforts may strongly contribute to a greater development and updated organization of the mining activities in Portugal.

If also intervenes in the trade movement of ores and to the granting of benefits to activities under its scope.

B) DGI - Direcção Geral da Indústria - General Directorate of Industry), covering all activites related to manufacturing industries, including smelters and downstream plants.

C) IIE - Instituto de Investimento Estrangeiro (Foreign Investment Institute) this Institute, depending from the Ministry of Finance, has direct intervention in the establishement of agreement and incentives for direct Foreign investment in Portugal.

D) CPP - Comissão para o Lançamento do Programa do Aproveitamento Integrado de Pirites (PAIP) specialized Comission nominated under the Ministry of Industry and Technology to consider and propose practical solutions to the treatment of complex polymetallic sulphides (complex pyrites) of Portugal.

Designated in 1976, this Commission proposed practical solutions in 1979-1980 and, having ceased its assigned functions, was dissolved in 1982. See items 1.2.4.4, 1.2.5.2 and 2.2.6.

E) GAS - Gabinete da Area de Sines, development authority for the Sines area (in the South of Setubal district). G.A.S. sponsored some pyrite development before CPP and, as local Sines area authority, was envolved in the local consideration of Sines Area projects (see 1.2.4.4., 1.2.5.4., 2.2.6. and 2.2.5.).

Very recently, the liquidation of GAS was announced by the Portuguese Government.

4.3."National entreprises"

4.3.1. State-owned companies (100% State owned):following state owned companies will be listed under this item:

- EDMA - Empresa de Desenvolvimento Mineiro do Alentejo, E.P.
- IPE - Investimentos e Participações do Estado, S.A.R.L.
- QUIMIGAL - Química de Portugal E.P.
- Ferrominas, E.P.
- Siderurgía Nacional, E.P.
- BPA - Banco Português do Atlântico

A) EDMA - Empresa de Desenvolvimento Mineiro do Alentejo, E.P.

Its incorporation from prior Sociedade Mineira de Santiago and its evolution through EMMA was already mentioned in item 1.2.4.3.B above. EDMA may not yet consist in the "stabilized form" of the State-owned mining holding, being recently announced is near-to-be merge with Ferrominas E.P. (the other state owned mining corporation connected with coal and iron activities) to incorporate a larger entreprise to be called E.D.M. - Empresa de Desenvolvimento Mineiro, E.P. EDMA owns mining rights for Gavião and claimed mining rights for Estação, two orebodies in Aljustrel area. EDMA also has been granted with exploration rights for an area around Aljustrel as well as shares with SPE and French SEREM a large exploration area around Grandola. The major participation of EDMA are

- Pirites Alentejanas, above 95 pct
  (recently, shares have been offered in Lisbon stock exchange)
  see item 1.2.4.3.B;

- Somincor, with 51 pct participation
  see item 1.2.5.;

The staff of EDMA is relatively small, for abt 50 to 70 people - including the personnel employed in its ore dressing pilot plant in Aljustrel.

B) IPE - Investimentos e Participações do Estado S.A.R.L.

Established in the 70's as an holding for State owned participations in several companies, IPE is connected to a large variety of activies, including mining and metallurgical sectors.

From the great number of its participations, following companies are specially to quote for the non-ferrous metals sector:

- Beralt Tin and Wolfram (Portugal) with 19.5 pct
  (see under 1.5.);

- S.P.E. - Sociedade Portuguesa de Empreendimentos, SARL with ab 18.3 pct
  (see under 4.3.2.A);

- CPC - Companhia Portuguesa do Cobre, with abt 34 pct
  (see under 2.2.8)

C) QUIMIGAL - Quimica de Portugal E.P.

This chemical and fertilizer multidivisional corporation and head of a group of compagnies was already mentioned several times in chapters 1 and 2 above. Its industrial activities related to non-ferrous metals include the integrated treatment of pyrites, in Barreiro, the production of sulphuric acid, in Barreiro and Estarreja, copper smelting and refinery, precious metals recovery and refining and metallic zinc production. Also in Barreiro works Quimigal has been commited in 1982 with the study and preparative actions for the implementation of a bigger copper smelter largely based in the concentrates to be produced from Neves-Corvo orebodies.

Quimigal leads a large group of associated compagnies in which following join ventures are included:

- QUIMIBOL, a sulphuric acid trading company incorporated in Switzerland in which Quimigal owns 50 pct, and a company from the Sweedish Bolidens Group the other equal part;

- QUIMIBRO, a trading company incorporated in Lisbon, in which Quimigal owns 60 pct and the Swiss corporation SBMA the remaining 40 pct; its activities include brokerage and other international trading activities

Although QUIMIGAL and its predecessor CUF (see 4.3.2.E) have been insistently looking for complemented action in non-ferrous metal activities, namely in copper, its position in mining was not yet achieved (see under 1.2.4.3.B and 1.2.5.). Besides, CUF's Group participations in CPC have been passed, after the turmoil of the economical changements of 1974-76, to the control of IPE.

This makes Quimigal to insist, not without the assistance of a certain reason, in the interest of really achieving an "integrated file" for non-ferrous metals industries and therefore a closer relation which CPC would appear as a logical projection to its current metallurgical operations.

For further references to Quimigal see 1.2.4.3.B., 1.2.5.4., 2.1.F. and 2.2. (and subdivisions), 2.4. and 2.5. above; see also reference to CUF under 4.3.2.E..

D) Ferrominas, E.P.

This mining company is actively engaged in the development of Moncorvo iron orebodies and has, in the earlier 80's, been commited with the development of Portuguese coal resources. Its merger with EDMA to incorporate a sole mining State-owned company, - Empresa de Desenvolvimento Mineiro, E.P., was very recently announced but has not yet progressed.

Ferrominas developed a big iron ore exploitation and pelletization project to supply Siderurgia Nacional (S.N.) capacity enlargement with haematites from Moncorvo; in connection to this project pyrite purified cinders to be produced in Sines by "CPP Project" (see 2.2.6.) would be co-pelletized and therefore incorporated in Portuguese iron-production. The successive scale--down of S.N. new capacity, as well as lower costs prevailing for iron ores, froze "Ferrominas project" and contributed to the also freezing of the "CPP Project" in Sines.*

E) S.N. - Siderurgia Nacional, E.P.

The primary iron and steel producer, in Portugal, S.N. was nationalized in 1975. It has been connected with the integral pyrite utilization, since its purchase conditions directed up to recent times the determinant decisions related to the supply of "purple ore" to S.N. (see 2.2.2., 2.2.3., 2.2.4.).

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* the same may be said to the prospects of placing the full amount of "Kowa Seiko unit" pellet output from Quimigal Barreiro works.

A projected increase of capacity has gradually been deflated in a controversial process that brough consequences to other projects related with complex pyrites, and therefore with non--ferrous metals production in Portugal (93, 94).

F) BPA - Banco Português do Atlântico

State owned commercial bank (nationalized in 1975) with headquarters in Oporto.

It is majority shareholder in Neoestano as well as in Sociedade Mineira do Paiva (see under 2.6), Although its participations (70 pct in each) have been already offered for sales in 1983.

4.3.2. Private companies

According to Portuguese law, corporations in which the State owns only part of shareholder's equity ("mixed" compagnies) are considered private companies; therefore they will be mentioned in this section. Corporations with Foreign majority will be designated as "Foreign interests" (see item 4.4. hereunder).

Following corporations will be briefly reviewed here:

- SPE - Sociedade Portuguesa de Empreendimentos, SARL
- CPC - Companhia Portuguesa de Cobre, SARL
- Pirites Alentejanas SARL
- Somincor - Sociedade Mineira de Neves-Corvo, SARL

with listing all other minor (or no more existing) corporations under a common title F ("Other Portuguese Corporations").

A) SPE - Sociedade Portuguesa de Empreendimentos, SARL:

This company was incorporated in 1979 with the assets in Portugal of Diamang (former Companhia dos Diamantes de Angola) and therefore corrected to respective shareholders (shareholder's capital $1,103 \times 10^6$ PTE). Main shareholders of SPE, in 1983, were the following:

- IPE (see 4.3.1.B. above) abt 18.3 pct
- Foreign participations (including Belgian interests and others) abt 20.4 pct
- Other Portuguese participations, divided abt 61.3 pct

Both IPE and Belgian interests nominated 1 representative each in a Board of 7 Directors.

SPE participates in a series of corporations acting in mining and metallurgical activies, related with non-ferrous metals namely:

- Porstin (capital $32,000 \times 10^3$ PTE) with 93.6 pct;
- Companhia Mineira do Norte de Portugal (capital $40,000 \times 10^3$ PTE) with 70.2 pct;
- Sociedade Mineira de França (capital $10,000 \times 10^3$ PTE) with 47 pct;
- Minas de Tarouca (capital $8,500 \times 10^3$ PTE) with 70,3 pct;
- Minas da Borralha (capital $100,000 \times 10^3$ PTE) with 19.5 pct;
- Minargol (capital $192,500 \times 10^3$ PTE), with 24.3 pct;
- Neoestano (capital 300×10^3 PTE), with 30 pct;
- Sociedade Mineira do Paiva (capital $1,200 \times 10^3$ PTE), with 20 pct;

All these compagnies perform in tin-tungsten sector, in which they have mining activies (exception to Neoestano, whose activities are only smelting, and Minargol and S.M. Paiva, that join mining to smelting); Minargol and Borralha are also related to copper mining.

SPE also shares prospection and exploration rights in two areas:

- consortium SPE/SEREM - (a French corporation of the BRGM Group) in following proportion

  SPE 60 pct
  SEREM 40 pct

  for tungsten ores, in the North of Portugal;

- consortium "Grandola", around Grandola, south Portugal, with

following participations:

SEREM	52.3 pct
SME	34.2 pct
EDMA	13.5 pct

for complex polymetallic sulphides.

B) CPC - Companhia Portuguesa do Cobre, SARL

Based in Oporto. See under 2.2.8. (big secondary copper processor).

Shareholders:

Trefimetaux	abt 25 pct
IPE	abt 34 pct
Several Portuguese Shareholders	abt 41 pct

A potential connection of CPC to Quimigal interests is since long claimed.

C) Pirites Alentejanas S.A.R.L.

Pyrite mining company in Aljustrel. See, for details, 1.2.4.3.B, 1.2.4.4., 1.2.4.5. above.

Shareholders:

EDMA	above 95 pct
Belgian interests (SOGEMINDUS)	5 pct

Shares being currently submited to Lisbon stock-market.

D) SOMINCOR - Sociedade Mineira de Neves-Corvo, SARL

Copper mining operations in Neves-Corvo mines, see under 1.2.5. presently:

EDMA	51 pct
Rio Tinto Group	49 pct

E) CUF - Companhia União Fabril SARL:

Big chemical and fertilizer industrial company set up in Portugal in1865 and head of a proeminent private Group up to its nacionalization in 1975. CUF, as a nationalized company was subsequently incorporated with two other fertilizer producers in Quimigal (see above). Interests and participations of the CUF Group not nationalized with CUF were spread by several holders, namely IPE. This is the case of CPC participations, amon others. SMS - Sociedade Mineira de Santiago and a significative share in Pirites Alentejanas also were included in the participations of the CUF Group. See 1.2. 1.2.4.3.B., 1.2.5., 2.4., and 2.5.

F) Other Portuguese Corporations

Several other Portuguese corporations mentioned in this study are listed hereunder, by the order of this first mention in this text:

- Minas da Borralha: tungsten-tin concentrates producer and also copper concentrate producer. See under 1.2.2., 1.5. and 4.3.2.A owned by OPEMEDIN (80.5 pct) and SPE (19.5 pct) but presently owner ownership situation-openedin part - is not very clear, with respective mining operations being shut down with a strong negative social impact in a relatively deprived area.

- OPEMEDIN - Operações de Medições Internacionais, Ld:has been one of the owners of the mining rights for the Minas da Borralha, having 80.5 pct equity. Is a successor to Foreign participations connected to the Beralt Group; presently the ownership/control of Borralha is not very clear. Refer to "Minas da Borralha", directly

above.

- Minerália - Sociedade de Empreendimentos Mineiros, Ld: concessionary of the mining rights for the copper mine of Aparis (see 1.2.3. above) up to its shut-down in 1975, followed by abandon of concession in 1977.

- Minargol, Complexo Mineiro de Argozelo, SARL: concessionary of the mining rights for the copper mine of Miguel Vacas (see 1.2. 1.2.3. above) as well as of Argozelo tin mines (see 1.5. above): Minargol also operates tin primary smelting, in relation to the Arcozelo mining (see 2.6.) Minargol is a join venture of

Géominas S.A. from Belgian	49 pct
SPE	abt 24 pct
Others	27 pct

The present situation of the Belgian partner is not very clear, with recent reports of respective getting out of business by insolvency share capital of 183×10^6 PTE in 1979 and 192.5×10^6 PTE in 1983.

- Sociedade Mineira de Santiago SARL
  Mining society of the CUF Group, nationalized in 1975 and antecedent to EMMA. ... 1.2.4.3.B., and 1.2.5.

- Sociedade Mineira de França, Ld.
  Tin mining company at the Bragança district. Share capital (1983): 10×10^6 PTE
  Partners:

SPE	47 pct
Other Portuguese partners	53 pct

  see 1.5., above.

- Porstin - The Portuguese - Spanish Tin Mining, SARL
  Tin mining company at the Guarda district. Share capital (1983): 33×10^6 PTE

Partners:

SPE	abt 93 pct
Other Portuguese partners	abt 3 pct

see 1.5., above.

- Dramin - Exploração de Minas e Dragagens, Lda.
  Tin and titanium mining company at the Guarda district, whose operations are actually shut (since 1984).
  Partners:

Neoestano	40 pct
Banco Português do Atlântico	5 pct
Others	55 pct

see 1.5., above.

- Bastos & Marcolinos (concessions rented to Alfredo Pinto Correia):
  minor tin-tungsten mining operations; see 1.5.

- Sociedade Mineira Alegria
  minor tin mining operations, see 1.5.

- Minemague - Minérios, Máquinas e Metais
  minor tin mining operations, see 1.5.

- Bejanca - Sociedade Mineira das Beiras, SARL
  minor tin mining operations, see 1.5.

- Minas de Cassiterite da Sobreda, Lda (concessions rented to José Rodrigues C.Sousa)
  minor tin mining operations, see 1.5.

- Extrusal, Companhia Portuguesa de Extrusão, SARL
  aluminium extruder and also envisaging secondary aluminium production, see 2.1.A and E;
  wide distribution of shares

- Fundição de Oeiras
  minor aluminium extruder see 2.1.A.

- A Perfiladora, SARL
  minor aluminium extruder: see 2.1.A.

- Porjalex - Sociedade Comercial de Alumínio, Lda.
  aluminium extruder, see 2.1.A.

- Quintas & Quintas, SARL
  aluminium rod wire and cable, see under 2.1.B: also copper cable producer

- Solidal - Condutores Eléctricos, SARL
  aluminium rod wire and cable producer, see under 2.1.B.

- Alumínio de Portugal (Angola), Lda.
  aluminium foil producer, see under 2.1.C.

- Alpor, Empresa Produtora de Alumínio, SARL
  secondary aluminium producer, see under 2.1.E.

- Ytong Portuguesa, SARL
  see under "non-metallurgical uses of aluminium", item 2.1.F.

- Alberto da Silva Barbosa & Filhos, Lda
  copper "semis" producer (brass bar) and alloy refiner; see under 2.2.7 and 2.2.8.

- Refinaria de Metais Luso-Italiana. Lda
  secondary copper alloy refiner (see under 2.2.7)

- Tecnocobre - Sociedade Industrial do Cobre, Lda.
  copper "semis" producer; see under 2.2.8.

- Contibronzes - Fundição Contínua e Centrifugada, SARL
  copper "semis" and alloys producer; see under 2.2.8.

- Neoestano - Nova Empresa Estanífera de Manqualde, SARL
  tin smelters, see under 2.6.;

Shareholders:

SPE	abt 30 pct
Banco Português do Atlântico	abt 70 pct

- Quimibro
trading company for non ferrous metals, and other commodities; see under "Quimigal" above.

Shareholders:

Quimigal	60 pct
SBMA (Switzerland)	40 pct

- Quimibol
trading company for sulphuric acid, based in Switzerland; see under "Quimigal" above.

Shareholders:

Quimigal	50 pct
Boliden Group (Sweeden)	50 pct

4.4. Foreign interest

A) RTZ - Rio Tinto Zinc Group

Present RTZ interests in Portugal are represented by:

- 49% participation in Somincor, by recent purchase of prior French participations (see under 1.2.5.3. above);

- 100% ownership of Pillar Portuguesa (Alumínio), Portalex, SARL, main aluminium extruder in Portugal (see under 2.1. above);

- 100% ownership of RIOMINAS - Serviços Técnicos e Financeiros Lda, with headquarters in Lisbon and whose specific purpose is the "supply of technical and financial services to mining corporations" (44)

- intervention in prospection and exploration for complex polymetallic sulphides in Almodovar and Mertola areas (district of Beja), Montemor-o-Novo (district of Évora and tungsten-tin-gold in Fundão-Penamacor (district of Castelo Branco), see under 6.1.

B) Beralt Tin and Wolfram (Portugal)/Anglo American Corp.

Beralt Tin and Wolfram (Portugal) (see under 1.2.2. and 1.5.) is quoted as the more representative participation of the Anglo American Corp in Portugal and is the main Portuguese producer of tungsten concentrates, as well as of tin. The participation in this company are:

Beralt Tin & Wolfram, Ltd	**80.5 pct**
IPE	**19.5 pct**

with a share capital of 300×10^6 PTE since 1981.

Beralt Tin and Wolfram also keeps exploration authorisations and contracts for an important area near the Panasqueira concessions (see 6.1.). Anglo American was reported by the Portuguese press as one of the interested entities in the Neves-Corvo bidding after the announcement of the sale of French participations (see 1.2.5.3.).

Beralt interests have also been associated to a majority control of Borralha mines (80.5 pct) up to respective transaction to OPEMEDIN (see 4.3.2.F.)

C) Sapec Group

Belgian interest represented by the Sapec Group are identified hereunder:

- Mines et Industries pyrite concessions of Lousal and Serra da Caveira: see 1.2.4.3.C. (Mines et Industries also has tungsten concessions and tungsten metallurgical activities in North Portugal);

- SAPEC fertilizers complex of Setubal (see under 1.2.4.3.C. and 2.2.2.),

in both corporations with 100 pct participation.

D) Soqemindus - (Société de Gestion d'Entreprises Minières et Industrielle)

This Belgian Corporation is owner of less than 5 pct equity in Aljustrel pyrite mines (see under 1.2.4.3.C). Since the sale of the majority of Belgian participations to Portuguese interests, incorporating Pirites Alentejanas, SARL, the extent of Foreign residual participation has been decreasing from 10 pct onwards.

E) Geomines

Belgian interest in Minargol are represented by this company, with 49% participation (see 4.3.2.F.); however recent informations mention Geomines as having got out of current business.

F) Other Belgian interests

Other Belgian interests are presented in SPE (see 4.3.2.A.)

G) Tréfimetaux / Group Pechiney

This French Company, currently mentioned as included in the Pechiney Group, has a significative participation (25 pct) in CPC (see 4.3.2.B.).

Another significative French participation, though Pechiney, is in the silicon and ferro-alloys unit of Eurominas, in Setubal (see 0.2.).

H) Peñarrova / Group Imétal

S.M.M. Peñarroya established in Portugal the Sociedade Mineira de Peñarroya Portuguesa, Lda, that actively participated in the exploration group that discovered Neves-Corvo orebodies (see 1.2.5.1 and 1.2.5.2.). As a consequence of that discovery and Somincor incorporation Peñarroya got 24.5 pct participation in Somincor up to sale of French participation to the RTZ Group.

No current activities of Peñarroya and/or other companies of the Imétal Group are currently reported in Portugal.

I) Group BRGM

The Bureau de Recherches Geologiques et Miniéres of France, by its entrepeneurial branch, has been present in some recent developments in Portugal. With Peñarroya, the BRGM by its participated SEREM (Société d'Etudes, Recherches et Explcitations Miniéres), was also active in the discovery of Neves-Corvo ore body, getting 24.5 pct participation in Somincor. This participation was subsequently transfered to Coframinas - - Compagnie Française de Mines, of the BRGM Group, and finally sold to RTZ interests.

SEREM is participating, with SPE and EDMA, in the so called "Grandola consortium" (52.3 pct SEREM participation), and with SPE in "SPE/SEREM consortium" for tungsten ores, in the North Portugal.

H) Elf - Aquitaine

Elf Aquitaine is currently evolved since 1981 in the exploration of complex polymetallic sulphides in the South of Portugal. See 6.1.

I) Ferro Corporation

Though Metal Portuguesa, SARL, the Ferro Corporation (with

51pct participation) is present in the Portuguese market of secondary lead, lead pigments and zinc oxydes and other compounds (see 2.4. and 2.5.).

J) Rovalle Asturienne

Production of zinc laminated products (see 2.5.)

K) Bolidens

With other participations in Portuguese companies, not directly envolved in non-ferrous metals activities, the Swedish Group Bolidens has with Quimigal a 50:50 partnership, incorporated in Switzerland, for the trade of sulphuric acid: QUIMIBOL (see 4.s 4.3.1.C.)

L) SMBA

This Swiss corporation participates with Quimigal in the 40:60 trading Company QUIMIBRO, directly envolved in the trade of non-ferrous metals (see 4.3.1.C)

M) BILLITON

An entreprise of the Shell Group, Billiton has been present in several exploration activities (see under 6.1.):

- for tin-tungsten, in Macedo de Cavaleiros, North-Portugal, in the period 1980-1984;

- for complex polymetallic sulphides, in two areas (Ervidal and Mertola), both in Beja district, since 1981, later added with other areas.

N) B.P. Minerals

Active in exploration of complex polymetallic sulphides in the south of Portugal since 1984 (See 6.1.):

O) Utah

A contract of exploration to Utah, for complex polymetallic sulphides in the South of Portugal, was issued in 1981 and revoked in 1983 (see 6.1.).

P) Foreign interest associated to the mine of S.Domingos

An originally Spanish corporation - La Sabina - was set forth to the exploration of complex pyrite in the S.Domingos mines in 1855; having then essentially French capitals, it was mentioned as representing Germany (Federal) capitals when its concession was revoked in 1984. Since 1855 up to mine exhaustion, in 1968. La Sabina rented S.Domingos exploitation to Mason and Barry, an English - based corporation. (see 1.2.4.3.A.).

Q) Foreign participations in the Copper Smelter Project

Besides the preparatory actions for the implementation of the "Copper Smelter Project" (see item 2.2.5.), Quimigal is commited to promote, obtain and analyse private participations - Portuguese and/or Foreign - in such a project.

4.5. Industrial associations

The corporate interests of the Mining Industry are represented by APIM - Associação Portuguesa das Indústrias Mineiras; a similar association is to be incorporated within a few days for the non--ferrous metal producers and transformers (APIMNF - Associação Portuguesa das Industrias de Metais Não Ferrosos). Both Associations are to be related to the corresponding "Liaison Co Committees" (CDL) to acceed to the EEC organization as well as to represent corporate interest to the Portuguese Governmental and to the Trade Unions concerned.

4.6. Trade Unions

Several Trade Unions ("Sindicatos") represent the interest of workers of the mining and of the metallurgical industries described. Besides the geographical organization of Trade Unions (in general North and South) and their application in Federations and Centrals (two main centrals existing in Portugal), some Trade Unions represent all the workers of a certain industry or industrial branch regardless of their position and task, and other represent only certain professional class or group of workers, in all the industrial activities they participate.

Work agreements are negociated and established between Associations and Trade Unions, with possible intervention of the Government only in certain circunstances and generally for conciliatory purposes before arbitration.

Portuguese law also established workers representation inside entreprises by "Workers Committees", in principle independent from Trade Unions organization and representation.

5. LEGAL AND INSTITUTIONAL ASPECTS

5.1. Mining laws

Portuguese mining law is still based in the Decrees 18,713 (of the 1st August 1930) and 29,725 (of 1939), although with modifications that about half a century of a continuous application have required; a Portuguese majority in mine exploitation, and rules for the access of Foreign capital to exploration works, were ruled by Decree-law 46,312 (of April, 1965).

The modifications experienced for mining activies as well as the Portuguese membership to EEC determined the interest of a more modern and adequate mining law, already submited to the Parliament for approval. The project of mining law was published in "Boletim de Minas" and may be available from DGGM.

A new regulation for occupational hygiene and safety in mining works was recently issued (Decree-law nº.18/85 of the 15th January 1985).

In very general terms, the access to non-ferrous metals mining follows the requirements of "concessible substances", i.e. metal-containing substances"of 1st class".

By issuing adequate legislation, the Government may define "captive areas", i.e. areas in which existing knowledge may suggest mineral resources of interest and where both exploration and/or concession rights may be subjected to the formulation of a contract. The definition of "captive areas" takes in due consideration the rights already established for interest locations prior to respective declaration (95).

Abandoned concessions may be again atributed by public bidding or by direct negociation.

The general rule for the atribution of mining rights for concessible substances is the"dominial principle", i.e. concession (limitation time) for exploration of resources belonging to the Portuguese State.

Therefore, access to the concession rights may take place, according to current law, in following circumstances:

i - ownership of a register of discovery ("registo de manifesto") in free area, presented to the local Camara Municipal (Town Hall for the Concelho area);

ii - use of provisions set forth in a prospection and exploration contract in captive area;

iii - Application for orebodies discovered in captive area

iv - attribution of abandoned concessions.

Several requirements and processual formalities are demanded in each case: a first introdutory description was issued by DGGM (85).

5.2. The contract for prospection and exploration: the concession contracts

In the access to mining rights, the contractual relations seems to be the trend proposed in more recent legislation, although not yet approved. However, contracted relations may already take place for prospection and exploration in captive areas, as well as for the access to abandoned mines and for transmission of mining rights.

In broad lines, a contract established for prospection and exploration purposes may include: definition of initial area and successive area reductions; contractual duration and possible extension ; minimal works and investments; provisions for the case of possible findings, i.e. right and conditions for concessions establishement of exploitation, conditions for exploitation, royalties and redevances, preemption rights to local consuming activities, other pertinent conditions; information and transmission of results; access to prior information (if existing); taxes and payments; Portuguese participation in works; environmental conditions and obligations; transmission conditions; force majeure; etc.

Concession contracts for the particular situations above mentioned (abandoned concessions or transmisson of rights) may include provisions such as: general conditions, including preemption rights to local consuming activities and direct action in exploitation duties ; special conditions, such as: duration, startup data, specification and minimum investments in preparative and explorative works, startup data for exploitation, requisits for the yearly established exploitation plans, obligations in exploitations, obligations of information, obligations in development of local uses (if possible), rights (in equal conditions) to Portuguese industries and activies (96).

A certain similitude exists therefore for the two contractual types, duly adapted for each special situation described.

5.3. Access to the processing industries

As a general principle an open access is granted to the processing industries, only requiring respective formal registration .

An "authorization demand for industrial installation" is to be submited to pertiment authorities with description, details and other data assuring the observation of the "Regulation for Industrial Activities (RILEI)" and of the respective environmental obligations. Local authorities may also formulate specific demands, reason why DGI or DGGM may be consulted for respective prior definition. These demands are usually granted with no major problems but paperwork, if the required conditions were observed.

After the erection of the plant and before respective start-up is made, one "comproval of operative conditions" is also required: this is made by demand of a local inspection sent to the interested authorities.

5.4. Incentives provided to National industries

Several incentives (fiscal and financing) provided to national industries are now in general revision to conform, with EEC regulations. Reference to pertiment authorities is therefore recomended for each particular case.

5.5. Direct Foreign investment

Direct foreign investment in Portugal can be covered by

- general regime or
- contractual regime.

The contractual regime is deemed for those projects that show special value to the Portuguese economy. Access to this regime

formalized in an "investment contract" stating the incentives to be granted and the major purposes and targets of the project (investment, financing, employment, balance of payments), is decided case by case according to above quoted purposes and targets, as well as of technological impact, access to new markets and products, project location and other special features that may apply. A negociation process between IIE (Institute of Foreign Investment, see 4.2.) and the interested corporations takes place: IIE acts on behalf of the Portuguese Government and the final agreement will be subjected to formal governmental approval.

The IIE may provide, upon suitable requests, information on:

- features of the general regime;
- investment contract outline;
- list of information required by the IIE;

and/or other data of interest for each particular case.

6. Strategics of development and cooperation

Although pratically depending from external supplies in all the listed non-ferrous metals, the features of each situation are different, as well as respective prospects. This requires a diversified effort, case by case, adequated to corresponding requirements and to the development of Portuguese non-ferrous metals industry, from mining (if resources exist) to metal users before final utilization.

6.1. Non-exploited deposits

The discovery of Neves-Corvo may be regarded as the onset of a generalized interest for prospection and exploitation both in the Portuguese and Spanish portions of the Iberian Pyrite Belt, now looking specially for deep orebodies. Demand and contractual relations have been established since then, covering almost all possible areas for new findings of deep sulphides orebodies (1). A full listing and description of all activities engaged is presented by GOINHAS (97), covering also other exploration

areas and target-substances.

Following corporations or groups have been active in sulphide exploration in the south of Portugal in the period 1980-1984:

Year 1980:

Somincor: exploration of envolving areas to Neves-Corvo ore-bodies (386 km^2)
(it has to be stressed that the economic forecasts for Neves Corvo were submited to the Portuguese Government only at the end of 1979).

Year 1981:

Utah: abt 40 to 50 km^2 near Alvalade, Grândola; contract revoked in 1983 with no findings;

EDMA: abt 43 km^2 around Aljustrel concessions; some interesting findings in the connection with Aljustrel area;

Selection Trust, then B.P. Minerals: abt 635 km^2 in the basin of Sado river; contract revoked in 1984 after 47 intersection drillings (9000 meters overall drilling lenght).

Rio Holdings Norway: abt 380 km^2 in Almodovar; one of the areas was left in 1984; activities now reduced to a small area near Ervidel (mine da Juliana).

Billiton:-abt 420 km^2 in Ervidel and Mértola; Ervidel area was left in 1983; in Mértola area, near the old mines of Chança and S.Domingos, an intensive prospection follows.

Elf - Aquitaine: abt 1,300 km^2 in Cercal do Alentejo and Ourique; in progress (although with reduced area).

Year 1982:

no applications for the Pyrite belt

Year 1983:

Billiton: abt 1,500 km^2 near the prior area and to the south (by the Guadiana river)

Ric Artezia: 83 km^2 near Mertola: contract revoked in 1984.

SPE/SEREM/EDMA: 605 km^2 from Grandola to near the Lousal site: in current exploration.

Year 1984:

Rio Artezia: 176 km^2 in the Montemor-o-Novo area for complex sulphides and precious metals (gold).

B.P. Minerals: 1,500 km^2 from Montemor-o-Novo to Viana do Alentejo, for complex sulphides and gold.

Other exploration activities by entrepneurial initiative for the same period 1979-1984 were addressed to tungsten (2 contracts) tungsten - tin (9 contracts), tungsten-tin-gold (1 contract), precious metals (3 contracts), talc/asbestos (1 contract), salt (2 contracts) and uranium (1 contract); an active exploration effort has been developed in paralel by the DGGM, namely covering the big tin resources of Argimela and also certain areas of the Pyrite belt for tin exploration. Following entrepeneurial contracts were reported:

1979

- Minemaque, Sn+W placers, Campo Maior 56 km^2, revoked in 1985.

- SPE/SEREM, Sn+W, 4,080 km^2, large area in the Bragança district, obtained results, in progress:

- Casminex, Sn+W at Valpeças, 132 km^2, contract revoked in February 1982:

- Billiton, Sn+W, Macedo de Cavaleiros, 2,000 km^2, contract revoked in 1983:

1980

- Prominas, 500 km^2, Sn+W, north eastern part of Bragança district, contract revoked in 1982:

1981

- Companhia Mineira do Norte de Portugal, Sn-W, Boticas, 90 km^2, contract revoked in 1984:

1982

- Beralt Tin, 650 km^2 for Sn+W, around Panasqueira, in progress:

- Volfrex, 66 km^2 for Sn+W in Arouca in progress

1983

No explorations for tin demanded

1984

- Minemaque, Sn+W, 48 km^2, near Pinhel:

- Rio Artezia, Sn-W-Au, 523 km^2 in Fundão and Penamacor (Castelo Branco district):

Foreseen and effective investments for exploration contracts are also listed GOINHAS (97).

Figures in Table XLV, next page, were selected from that list to evaluate average minimum obrigatory investments (B/A) and over-run ratio (C/B) for several explorations related to tin/tungsten and complex pyrites (values of 1983).

As a brief conclusion, the difference between specific ammounts for each group of minerals is stressed and much depends from specific characteristics of each area and from the technologies and resources required.

According to above listing, the prospection and exploration activities in Portugal were well in progress for complex sulphides and tin; as also included non-ferrous metals, tungsten is to be mentioned (pratically always associated with tin), as well as uranium; aditionally a recent growing interest for precious metal, namely gold, is evidenced.

These lists also demonstrate a large and sustained international activity - including several presences from the big transnational mining groups.

Exploration activities are granted coordinated grated and fiscalized by DGGM.

6.2. Envisaged or feasible projects

6.2.1. Mining

Specific references were already made to the main mining projects for non-ferrous metals, that are already in development or may take place in a near future. These are:

- for copper and complex ores:
  Somincor project (see 1.2.5.4.), is full scale progress;

Table XLV: Data on selected exploration contracts (1979-1983); values of 1983

Entreprise	Contract data	Area Km^2 A	Mininear obligatory investment 10^3PTE B	Actual investment 10^3PTE C	B/A 10^3PTE km^2	C/B
Tin-tungsten						
Minemage	1979	56	4800	4150	85.7	0.865
SPES/SEMEM	1978	4080	50000	234730	12.3	4.695
Casminex	1980	132	7000	14240	53.0	2.034
Billiton	1980	2000	52500	69020 ç	26.3	1.315
Promines	1980	500	7000	3800	14.0	0.543
CNNP	1981	90	5000	3620	55.6	0.724
Beralt	1982	650	10000	25130	15.4	2.513
Volfrex	1982	89	7500	7500	84.3	1.000
Sulphides						
Somincor	1980	386	50000	263410	129.5	5.268
Utah	1981	100	15000	20700	150.0	1.380
Edma	1981	43	10000	21890	232.6	2.129
Seltrust	1981	635	300840	128450	158.8	1.274
Rio Holdings Norway	1981	330	10000	72410	30.3	7.241
Billiton	1981	420	56000	161510	133.3	2.884
Elf Aquitaire	1981	1300	108900	197550	83.8	1.814
Billiton	1983	1500	25000	45970	152.0	1.835
Rio Artezia	1983	83	2000	5540	24.1	2.720
SPE/SEMEN/EDMA	1983	605	1500	17660	24.8	1.177

- for basic non-ferrous metals (copper, zinc and lead) from complex pyrites:

  Aljustrel project (see 1.2.4.5.), in the feasibility after pilot testing;

- for tin:

  Argimela project (see 1.5.), pre-feasibility stage;

  Somincor project (see 1.2.5.4. and 1.5), at preliminary research stage;

As a consequence of pyrite flotation required by the two first projects above listed, big quantities of by-produced rich pyrite tailings may be available as a potential source of sulphur (vg. as sulphuric acid); this may change the pattern of sulphuric acid production in Portugal (whether combined or not with the acid from the Copper Smelter Project) and/or represent (together with similar production in Spain) a potential sulphur source for external consumers in near-by areas.

6.2.2. Primary processing

Several metallurgical projects were already mentioned. However only the most relevant primary processing projects will be recalled now, since they may represent the more relevant prospective achievements in this sector:

- for copper smalting and refining: the copper smelter and refining project (see 2.2.5): this unit, conceptually based in the production of Neves-Corvo, may collect all other copper fractions (primary and/or secondary) available in Portugal.

Its production, in terms of sulphuric acid, is also a very important contribution.

- for bulk or mixed concentrates: although current philosophy of complex pyrite treatment in Portugal is directed towards the production of separate concentrates for each basic metal, as already explained, it is obvious that the production of bulk concentrates could be easier and rewarding, if proper metallurgical methods were available for such non-commodity

mining products.

Besides the quest for a suitable process carefully carried on by C.P.P. with the support of international cooperation (see 1.2.4.4. and 2.2.6), development efforts have been pursuited in this trend. Quimigal and the State's Industrial Laboratory LNETI are currently investigating an original version of RLE process, also with international support (57), SAPEC is also proceeding to research and development these areas.

- for pyritic residues (or "floated pyrite"): an active analysis of this "sulphur availability" is being done in Portugal.

- for separate metal concentrates: the studies of the metallurgical possibilities of differential metal concentrates is also under consideration, in connection to their potential availability and possible processing routes - these including available facilities,whenever possible.

- for tin smelting: a certain racionalization of surplus smelting capacity is to expect in relation with respective mining evolution.

6.2.3. Semis and secondary processing

The recent insertion of Portugal in a larger integrated economical space i.e. the E.E.C.,will imply a careful examination of Portuguese industry capabilities for passing beyond the classical "dimension constrain" that up to now has sensibly affected Portuguese metallurgical industries.

Such a situation, particularly relevant for metals like aluminium, in which no immediate prospects of natural resources can be called upon, is also connected with secondary processing by collection of scrap and recycling.

A greater utilization of available capacities, in some plants (vg. aluminium extruders, copper wire rod) may be the effect of

also a greater agressivity and diversified offer in foreign and/or domestic markets. This requires also a very active marketing effort in a Country where the production has been somewhat protected in the past, and surely traditional. The availability of certain time-limited regressive protection clauses under E.E.C., on the basis of "new industries" principle for some of the outputs, is just a reason to a timely ordered effort to obtain competitivity. A revision of national information system and statistics is also a must for a positive evolution, as well as the reformulation of certain areas with "atomized" industries with lower technological content.

6.3. International cooperation

In pratically all these lines, a characteristic of Portuguese experience is having remarkable skills but keeping a certain "shyness" for selling abroad own technologies. This complex situation, that got deep roots from Portuguese industrial traditions, demands a strong cultural modification of the intervening agents to be changed. Therefore a "first key" to international cooperation results from the technological needs at least for their onset in almost all industrial achievements described (with remarkable exceptions, however).

Other cooperative actions, either with institutional or supranational organizations or envolving bilateral relationships, have been put in work. C.P.P. projects gave a good (but, helas, unknown) example of how to act successfully in a frame work of industrial relations (22), and some of the trends of basic non-ferrous metals industries in today's Portugal are a consequence of that common effort. Emphasis is put in how to keep alive and well productive all the technological contributions arising from those active exchange of experience. International cooperation in technical and financial grounds was applied for and keeps favoured several investigations currently in progress (57).

Permanent dialogue also follows with neighbour Countries, such as Spain (98,99), where significative amounts of similar natural

resources do exist, and Morocco (100), in which case several areas of common interest can be found.

6.4. As a conclusion

In basic non-ferrous metal industries (aluminium, copper, nickel, lead, zinc and tin) Portugal is today remarkably dependent from external supplies.

The availability of natural resources, although envolving specific technological difficulties, may (in a medium term) clearly change that situation.

A big effort and coherently sustained viewpoints about non-ferrous metal industrial policies, with realistic objectives and enough flexibility to take into account the evolution of metal markets and consumptions will be required to achieve that changement with a maximum of national utility.

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