THE RIO TINTO MINE ITS HISTORY AND ROMANCE

W. G. NASH. F.R.C.I.

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GENERAL VIEW OF SOUTH LODE OPEN-CUT, LOOKING EAST.

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BY
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Excitet invisus magnæ Butulis umbras

LONDON
SIMPKIN MARSHALL HAMILTON KENT & CO LTD
1904

BUTLER & TANNER,
THE SELWOOD PRINTING WORKS,
FROME, AND LONDON.

PREFACE

IT is with genuine and deep-seated diffidence that I have elected to publish the records, existing at present only in Spain, concerning the famous Rio Tinto Mine.

As a literary task it should manifestly have been undertaken by a more competent authority; but on considering the substantial interest the locality has had for so long a period for so many of our countrymen, and, too, that the subject matter is important enough in itself to entitle it to be established on record in this form—and its lengthy history so preserved to us—I have determined upon its publication.

The reader will, I sincerely trust, very generously overlook all the many defects and errors committed by me in its compilation, and admit some justification for the effort; and, in that manner, condone my failure to make it such a success as, in my humble opinion, the matter itself has deserved.

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THE very ancient, celebrated, and hitherto Royal Mine of Rio Tinto is to be found situated at about 37° 43′ north latitude, and 6° 52′ west longitude, in the north-central part of the Province of Huelva, formerly included in that section of Andalucia known to early writers as Bœtica and Turdetania, a district or province which extended from Malaga (Malaca) and Cadix (Gadis or Gad'r) on the south-east, to Ayamonte, situated at the mouth of the Guadiana (Anas).

It is distant in a direct line from Sevilla (Italica) about 40 miles, from the capital of the province Huelva (Ounba), about 30 miles, and is now in direct communication with both these seaports—for Sevilla may now be said to be such—by railroad.

Until quite a recent date this mine had for centuries been more or less subject to the municipal administration of the neighbouring town of Zalamea

la Real, but is now possessed of independent municipal authority, and has come under the judicial control of the town of Valverde del Camino—those places being distant from Rio Tinto five and fourteen miles respectively. With the town of Zalamea la Real, Rio Tinto is also now in direct communication by rail; from whence there extends a "second-class" well designed and constructed "macadamized" carretera or road, southwards to Valverde and Huelva, and northwards to the Province of Badajoz—traversing the Sierra de Morena, or ancient "Montes Marianis."

The spur of this mountain range on which the mine occurs is a somewhat distinct land-mark, and, excepting to the west, the ground falls rapidly away to the levels of the rivers Odiel and Rio Tinto or Jarràma.

It is actually a huge mass of mineral, sub-divided —as shown in the plan—into four semi-distinct bodies or deposits, covered with a comparatively thin blanket of a ferruginous conglomerate, the crest of the range being slightly broken or sub-divided into four peaks—variously named "Cerro Salomon," "Cerro Colorado," "Cerro Retàmar," and "Cerro San Dionisio"—extending some 3,500 yards in a west-north-westerly direction, its singular appearance having attracted the deepest attention and curiosity at all times.

The record of this mine's existence, its exploration and importance in the industrial world, may well be entitled to rank as "historical" matter. A merely superficial inspection of it will serve to show that it is replete with numerous and sub-

stantial evidences of the past, though that evidence may, to some extent, be said to be fast disappearing under the influence of rapid modern exploration.

It is said that Byron, in his peregrination from Badajoz to Sevilla, visited Rio Tinto, and made the singularly trite and happy remark about it :—

"The dust we tread upon was once alive."

On all sides exist many signs and ruins of work of very great antiquity—of pre-historic activity and industry. But it is not to the practical-minded people of to-day so much a matter of fanciful admiration, although the thirty centuries forming the record of the Rio Tinto Mine would almost seem to compel one, on contemplating such a history, to move at once into the world of romance and fiction, as it is a scene of absorbing practical interest and concern.

From the summit of the highest of the four peaks comprising the Mountain of Rio Tinto (it is quite an isolated formation)—the Cerro Colorado, which is some 530 métres (1,725 feet) above sea-level—the general configuration of the surrounding country below is seen at a glance, and one is lost in an ocean of conjecture in contemplating the immense and innumerable evidences of extraordinary—one might say, herculean—labour and toil, as to how and when the panorama had been created and brought about.

And if the view of the neighbourhood—that to the north, west, and east, particularly, which appears as though a vast sea of mud had suddenly congealed —does not appear to be very striking or interesting, the attention of the geologist, the chemist, the miner —even the ordinary traveller—must be very much

attracted by the multitude of hills of "escoriae" scattered over a square league of ground, some of immense size, that would seem to have been the work of a race of Titans, the toil of centuries of time.

An early writer, Rodrigo Caro (1634), has described the place as having "a terrorizing aspect, a simple glance at it causing apprehension and dismay to the casual and infrequent visitor."

In truth, the solitary, isolated and broken aspect of the hills constituting the mines—the profundity of its "barrancos," or gullies and valleys, the many ruinous hollows and sinkings, the almost innumerable shafts of a pre-historic period, the numerous and immense "hills" of black "escoriae"—incontestable proof of a gigantic and unknown, or at least unrecorded, exploration; the solitude and quite sepulchral silence of the peculiarly suffocating atmosphere, deserted even by bird-life, the complete absence of vegetation, and the many ruins visible at a first glance, scattered broadcast, of Roman, or earlier, sepulchres and works in and about these hills of "escoriae"—these details in a startling scene of desolation and ruin, whilst they excite the traveller who passes by, with a deep sense of admiration and appreciation of what a vastly different condition of activity, life, and prosperity must have at one time prevailed there, must move him also to conceive, with feelings of dismay, of the misery and desolate condition of life of those thousands of wretched beings—slaves—who had perished in and about those enormous subterranean and yet superficial labours—some succumbing to sickness and fatigue, others to the harsher pangs of hunger, but

SECTION OF SOUTH LODE OPEN-CUT.

many more sinking under the harder physical cruelty and associated unhealthy condition of life imposed by those inhuman captors and oppressors, who in those early days were placed in charge of these and other similar "depôts" during, at least, the period of the sway of imperial Rome.

The condemnation of an offender "to the mines" was thus the equivalent to a sentence of death as much as was the alternative—"to the galleys."

The people usually employed in working mines in those days were either criminals or slaves.

The illustration shows how these "slaves" work to-day.

Pliny (vol. xxxiii. c. 4.) records the existing law or regulations as to the number of slaves or "sentenced criminals" who might be employed by any person owning and working a mine.

These numerous masses of "escoriae" are but the ruins and indications of infinite underground labour —of foundries of metal—ruins of pre-historic time almost—no less gigantic in proportion than those which, in Europe and elsewhere, have excited the wonder and admiration of the world for generations.

And if one compares those heaps of "escoriae," the result of some twenty-five years' operations by the present proprietary company, and those "hillocks" in existence on the north side or base of the Cerros Colorado and Salomon, the effects of skilled labour under modern scientific direction, with those built up by unwilling slave labour, driven under harsh military or other despotic control, we must undoubtedly be led to believe, with feelings of astonishment, the incontrovertible fact of the great length

of time and of the enormous quantity of labour required to bring about such very striking results.

It has been found impossible to fix a date or even indicate with any degree of precision when, or at what period of history, work was first commenced at the Rio Tinto mine. Its birth is shrouded in the mists of antiquity; a record of its discovery, early youth, development, decay (and re-discovery), has yet to be written—*at present it is quite unknown.*

The earliest piece of evidence of a reliable nature about the place only takes one back to the time of Nerva, about 100 B.C., however much romance and tradition may have contributed to the providing of less authentic information.

From the earliest days of the Christian era many distinguished writers have accumulated "in the respectable pages of their writings" diverse and confusing data concerning the history of the mining industry in Spain in general, and more particularly as to that referring to Rio Tinto.

The Phœnicians apparently were the first civilizers to arrive at the coasts of Spain, sowing gradually throughout the peninsula their ideas of commerce and industry, of navigation, and of those domestic arts which were known to them, by these means bringing about a radical modification of the rude habits of the original Iberian inhabitants, and giving them a degree of civilization, although of a very imperfect nature.

They have been credited with having arrived at and formed colonies and settlements on the coast of Bœtica — ancient Huelva — somewhere about the end of the eleventh century B.C., though very

probably this part of Spain had been known to them for a considerable period previously, as there seems to be no doubt that they had established a colony on the opposite shore, in Africa, at Tangier, some centuries before. Procopio, says Lafuente (vol. i. 9–13), found at that place a Phœnician inscription which should be taken as reliable evidence. It was to the effect: "aqui llegamos nosotros, huyendo del ladron Josue, hijo de Nave"—"here we have arrived fleeing from the thief Joshua, son of Nave."

It may safely be assumed that their object in going there was to open up new sources of trade, and it has also been alleged that they "already knew of the existence of mines in this part of the Iberian Peninsula" (Figueroa).

On the arrival of these descendants of Canaan on the coast of Iberia, they founded many colonies and settlements—at Malaga, Sevilla, Cordoba, Martos Adra, and other places in Andalucia—some of which exist to-day, others having disappeared entirely.

These centres were soon frequented by the original inhabitants when they found that the newcomers came with peaceful intent, anxious to barter or sell the many natural products of the country for the more useful articles of domestic utility, which were manufactured and thus brought to them from the markets of industrious Tyre and Sidon.

Of early writers Festus Avienus makes particular allusion to the trade and commerce of Tartissus with the "Tin Islands" of the North Atlantic and the continuing of it by the Carthaginians.

In his *Orae Maritimae* (lib. 3, Geog :), from verse 110, he goes on to say—

Haec inter undas multum cespitis jacet,
Eamque lati Gens Hibernorum colit.
Propincua rurus Insula Albionum patet;
Tartissiisque in terminus Oestrymnidum,
Negociando *mos* erat, Cartaginiso
Etiam Colonis, y vulgus inter Herculis
Agitans Columnas haec adibant aequora.

And there is therefore ample room to suppose that the Erythrians or Carthaginians from their coast colonies and towns—Onuba inter alia—dealt with the Tartessians in copper, tin, and lead, and silver from the "Montes Marianae," as had been done before them by Phœnicians.

Ulloa, in his *Cromlogia para la Historia de España*, makes the supposition that the Phœnicians arrived in Spain about 1449 B.C., whilst Florian de Ocampo, "Cronica general de España," mentions 822 B.C. as the probable date.

Almost all the cities and villages of the Mediterranean and Atlantic littoral were thus originated by the Phœnicians, and were comprehended under the collective name of Thartessus or Turdetania.

The many names given to the Iberian Peninsula are far better known than their origin, and their etymology is hardly clear or satisfactory.

To take "Iberia"—even supposing it to have been given or appearing for the first time in the *Periplus* of Scilax of Caryanda, about 350 B.C., or as having been derived from that of the river "Iber" or "Iberus," or, as pretended by Astarloa, from the Basque words, *ibaya eroa*—spumos river—it would appear to be more natural to suppose it to have

been so styled as given to the country occupied by people known in those days as " Iberos."

That of " Spania," given according to common opinion by the Phœnicians, may be derived—on the authority of Lafuente also—from the Phœnician " span "—hidden, meaning a country or locality very remote or hidden away from access. According to Figueroa, quoting Varro and Pliny, the present name Spain is derived from " spanja," in Hebrew " sapam," and Hoefer was of opinion that the early titles meant a country " whose peoples worked in mines." Spania was transformed by the Latins into Hispania—later changed to España ; to-day the poetic name is still Iberia. Volumes entire have been written on the subject, the bulk being a recapitulation of mere conjecture and of indefinite allusion and speculation.

The great centre of Phœnician civilization and colonization was the western half of the Mediterranean, and the Atlantic coasts to the north and south of the Straits of Gibraltar.

In especial, the trade with Tarshish, i.e. the region of the Tartessus (River Guadalquiver), *was what made* the commercial greatness of the Phœnicians, for here they not only had the profitable fisheries, but *above all*, rich mines of silver and other metals, to which the navigable rivers, Guadiana (Anas) and Guadalquiver (Bœtis) gave easy access.

The untutored natives had little idea of the value of metals ; for a long time there was no competition, and so the profits must have been enormous ; it is said that even the anchors of ships returning from Hispania were of silver.—(Disdoro, v. 35.)

In Spain the Phœnicians encountered a country, vast and fertile as compared with their own limited possession in Palestine, rich in precious and valuable metals of unknown value or utility to its inhabitants, and as their primary concern in exploiting a new country was the discovery and working of mines, they went as far as the coast of Britain for tin ; they soon established themselves and extended their researches to the immediate interior, whence such important results were obtained.

Nor is it at all impossible that wandering and searching westwards from the Erythrian colony of Cadix they heard of, or perhaps saw, the dark coloured and mineralized waters (hence the name Rio Tinto) of the " Ibero " —distant, at its confluence, with the Odiel (Luxia) and the Atlantic, near Palos, at the foot of the elevation crowned by the Convent of Rabida, so celebrated in the history of Columbus, only some 35 miles—and explored it to its source.

The River Tinto (Rio Tinto) was known by the Romans as the " Urium," as well as " Ibero," and later, by the Saracens, as the "Saquia " or "Azequia."

Its coloured and apparently mineralized condition and appearance, from the remotest times, was the reason undoubtedly for the name it received —whether given by the original inhabitants, Romans, Saracens, or as from the Middle Ages.

Its chief sources are situated some five leagues to the north-east of the mine, where it is still styled the " Jarràma," until it becomes the actual Rio Tinto, the confluence forming a perennial stream.

The local saying fully explains the matter : " el-

'Rio Tinto' si lleva la fama y el 'Jarràma' le da el agna" : "the 'Rio Tinto' takes the credit or fame, but the 'Jarràma' supplies the water."

From the sources of the Jarràma to its exit near Palos the river runs about some 120 kilomètres.

Erythrea-Gades-Cadix was founded before Utica, B.C. 1101, and Strabo (vol. i. p. 48) dates the settlements beyond the Pillars of Hercules as from soon after the Trojan War.

Tyrians are also said to have settled at Onuba (Huelva), at the estuary of the Rivers Odiel and Rio Tinto, both having a common source, the Rio Tinto Mine, before they founded Cadix.

That they themselves worked these mines there is no positive evidence. They were content, probably, with the acquisition of the products of Bœtica and of other parts of Spain, by barter, on probably highly satisfactory terms to themselves, although many Phœnician coins have been met with in the Province of Huelva.

There is every reason to suppose that the original inhabitants of the Iberian Peninsula, or at any rate those occupying the country prior to the arrival there of the Phœnicians and Vandals, worked, not only at Rio Tinto, but also at other mines in the Provinces of Huelva, Cordoba, Sevilla and Malaga, in the southern portion of the peninsula.

From Rio Tinto, from Tharsis and Aroche, and from almost all the ancient workings in the Province of Andalucia, as well as from others in the adjoining Province in Portugal, innumerable examples have been met with of stone implements and stools, certainly pre-Roman and of great antiquity.

This part of Bœtica or Vandalucia was also called " Beturia " or " Betulia " (Figueroa), and tradition made reference to the sources of the " Ibero " (Rio Tinto), known as " Gran Bitania."

Ezquerra, in his admirable work *Memoria de las Minas Nacionales de Rio Tinto*, written after he had for some time been in charge of them, copies a document alleged to have been found in the Archives of the Ayuntaimento (Municipality) Offices of Zalamea la Real, in the month of October, 1816.

It ran as follows :—

" Bœtica (the Province) took its name from Bèto, sixth King of Spain, who succeeded Tago ; this latter followed Brigo, who was the fourth King, having succeeded Imbal. Ibero preceded Imbal, and followed Tubal, who was the first King of the Province. The King Bèto was appointed 1822 years before the advent of Jesus Christ, and reigned 31 years. Founded Batulia at the source of the River Ibero (Rio Tinto) ; worked with prodigious energy in the extraction of metals from the ruins of a ' Volcan,' which had in ancient times burst out in that Mountain, and worked and followed the veins, (' betas ' or ' vetas '—so named from the King).

" The wisest of Kings, Solomon, who flourished 992 years B.C., had sent his fleets to Spain. His people had penetrated these mountains, finding the ruins of Betulia and the ' escoriales ,' and worked diligently to obtain the metals. On the summit of the mountain they built a castle, of which to-day traces are to be seen, and named it ' Castillo de Salomon.'

" From the slopes of that Hill is born the River

Ibero (to-day Rio Tinto). A league and a half to the westward they founded a Town and called it Salomea, now Zalamea la Real, and in the general maps of Spain, Zalamea of the Archbishop."

Unfortunately these assertions, otherwise very interesting and important, lack confirmation from other and more authentic source.

Lafuente, quoting Herodotus, says, "that as early as the 8th Century B.C. a 'bajel' ship from Samos, pressed by the 'levanti' or easterly wind, was the first to pass the Strait (Gibraltar) and arrive at the coast of Tartesso, where they made satisfactory dealings with the natives, and as a result set apart a tenth of the product and dedicated it to Juno." Reference was also made to Argantonio, who was alleged then to reign over the "Tartesios" or people of Turdetania or Bœtica, first historical note or vestige of the government of these parts in those remote days.

Again, as to the inhabitants preceding the Phœnicians, and who very probably worked in the mines in this district or Province of Andalucia, Ezquerra, in the same work, says: —

"In the year 1845, in a Mine called Potosi, near to the Town of Guadalcanal in the Province of Sevilla, were discovered the human remains of some seventeen 'Celtibiros'—Celts—Iberians—the ancient inhabitants of Spain, also together with them various stone-hatchets, cooking utensils of fireproof clay, and various bones (tibias) of sheep, sharply pointed."

Rua Figueroa also refers to a later discovery made in a mine near to Cala, a town some 35 miles north of Rio Tinto, of remains undoubtedly of pre-Phœ-

nician work or period. Cala is the Callentum of the Romans, and was spoken of by Pliny (vol. xxxiv. c. 14) as being celebrated for the excellence of its bricks.

But the actual origin of the primitive work of the Rio Tinto Mine appears to be absolutely lost in the obscurity of time. Ample room is left for conjecture and supposition : it is safe to suppose, however, that the mines had been worked by the inhabitants of the country before the arrival of the Phœnicians, some thirty centuries ago.

To the domination of the adventurers from Tyre and Sidon succeeded that of Carthage. The exploitation of the mine by the Phœnicians was followed by that of the Carthaginians, and various historians of that time attributed to them a very great development of the mining industry in the Iberian Peninsula.

Strabo and Pliny both referred to the famous shafts of Hannibal in a mine near to Carthago Novanow Cartagena, on the south-east coast of Spain, one of which was reported to have yielded some 300 pounds weight of pure silver daily.

Diodoro de Sicilia, in writing of the mines of Iberia, stated that "the avarice of the Carthaginians led them to seek for and work mines in all parts of the Peninsula, and that it was from this source they obtained the means with which to combat, and for a long period stubbornly resist, the ultimately superior forces of mighty Rome."

The destruction, however, of the power of Tyre and of Carthage did not immediately relieve the country from the spoiling hand of the invader or

spare it the evils of war; the Cæsars and their legions disputed with the Carthaginians and the original occupiers of the country the not inconsiderable advantage of the possession of such immense wealth and power as had been proved to be in existence there. And the dawn of the Christian era saw but a change of masters. Spain was still to be nothing but a "bone of contention," the spoil of the conquering—most powerful—adventurer.

The unfortunate country was to feel the heavy, the iron hand of foreign military governance for a further term of 500 years.

It is very singular, and worthy of note, that the original inhabitants of the country left no clear history, and but few traces of their existence, in a land so highly favoured by Nature in so many varied conditions. According to tradition only are we aware that they knew of the value and use of the baser metals; no precise record is extant.

The numerous records of Roman writers teem with allusion to the mineral wealth of the Iberian Peninsula. Whilst many refer to the large quantities of gold and silver brought from Bœtica and Galicia to Rome, but little reference is to be found to the exploration or working of the inferior metals—of copper, lead, tin, quicksilver, and iron—none at all to the working of the Rio Tinto mine for copper. This silence, perhaps, may be explained in part by the fact that these inferior metal were employed in the industrial arts and occupations—"sordidae artes"—being severely condemned rather than encouraged amongst freemen, and were therefore not deemed to be worthy of notice or record.

But looking at the enormous quantities, "*hills*" of "escoriae" accumulated at that part of the mine of Rio Tinto called "Escorial" and "Dehesa," in very many years if not centuries of labour, and undoubtedly created after the occupation of and the working of these mines by the Phœnicians and Romans, it is very remarkable that no direct or positive reference should have been made by the numerous contemporary historians and writers of those days to the very large and important official and industrial colony that must have there been established worked on a huge scale, producing large quantities of copper.

Many writers of this country very positively affirm the existence of two distinct "epocas" of "escoriae," pre-Phœnician and "Phœnician and Roman," and allege further that there appears sufficient reason to believe that the Romans actually *re-smelted* the "escoriae" they found at Rio Tinto.

Again, whilst silent as to the copper or other products of Rio Tinto, reference was made by Pliny and Sirdoro de Sicilia to the cinnabar found at Almadero, the same lodes of which mine are still being worked by a foreign banking house under an arrangement with the Government, after twenty centuries of exploitation—"plumbum nigrum," tin, from Galicia and Lusitania, "plumbum album," lead, as a constituent of the argentiferous ores that with others constituted the principal object of Phœnician and Roman commerce with the Iberian Peninsula; and lastly, iron, "finely tempered by the waters of Calatayud" (Asturias) and Tarragona (Cataluña), and of the "forges of Galicia," which so ably served

Hannibal—as notable for the excellence of its "temper," as were those blades and other arms some centuries later forged in the smithies of Toledo and Cordoba. In like manner, too, Justinian, Diodoro, and later Hoefer, all referred to the excellence of the arms forged by the "Celtiberos and Galicians," and to the knowledge and cunning of these people in the forging of fine steel.

It is estimated that at the outset of the conquest and occupation of the Iberian Peninsula, the Romans did not themselves pay much direct or personal attention to the beneficial working of the Rio Tinto and other mines, unless of gold or silver; they were probably content to leave the working and extraction of the many rich minerals in which the country abounded, to the conquered, under the vigilance of "Procuratores-metallorum"; at any rate, it is curious to note that no coin or other official evidence has been found of an earlier date than the era of the Cæsar Nerva—about 96 A.D.—of Roman official occupation of these mines.

Some of the mines undoubtedly were reserved for and directly worked by the Cæsars (Lafuente, vol. i, p. 234), probably those of gold and silver—the rest being leased to companies of "publicanos," who again sub-let them to local "caciques" or head-citizens. They also granted the subjected natives liberty to continue working the mines and then obtained the benefit of their labours by imposing very heavy tribute or tax—probably, however, not very much heavier than that imposed by the State to-day—some 2,000 years later.

It would seem also that in their legislation the

Romans referred chiefly—if not entirely—to the exploration of mines known and being worked, particularly to the rights of the Government in them, without making much provision for or assisting the people in the discovery, development and proper exploration of new mines (Titus *Liv. lib.* iv. *art.* 18).

Again, Pliny and Strabo refer to the body of the "Censoræ" as being qualified and authorized to grant mining licences, and to fix the type of contribution to be paid by the lessee or worker; this, according to an authority, being one-tenth to the State and also one-tenth to the owner of the property or freehold (Justinian, *lib.* xi. *tit.* 6, *leg.* 1). "De metallaris et metallis et procuratoribus metallorum" has it, "Cunctique, per privatorum loca, saxa laboriosis effosionibus persequuntor, decimas fisco, decimas etiam domino repræsentent."

At this period it is believed that the comparative security and tranquillity which for some time had attended the Roman occupation, in this part of the Peninsula more particularly, brought about a great increase of activity in mining, clearly evidenced and finding eloquent testimony in the ruins of mines and mining townships scattered broadcast throughout the country.

Whilst it can be but too plainly deduced from a consideration of the many authorities and much authentic evidence at sight, that it is quite impossible to determine the period—even approximately—of the earliest workings of the Rio Tinto, Tharsis, and other pre-historic mines in the ancient Province of Bœtica—of the various "Conventos Juriditicos" known as "Gaditani," "Hispalensi,"

"Astigitano," "Cornubensi," and "Emeritense"—it seems equally hopeless to be able to calculate, or even estimate approximately, the amount of labour employed by the original inhabitants, the Celto-Iberians, Phœnicians, and Romans, in the extraction and treatment of the mineral from which the enormous quantities of "escoriae" were formed—scattered broadcast throughout this part of Andalucia.

Gonzalo Tarin, a highly intelligent and very competent authority, has, however, attempted some such an estimate (vease, *Memorias*, p. 57), calculating that these "escoriales" of Rio Tinto and Tharsis contain some 4,000,000 cubic metres—about 30,000,000 tons of mineral. He was of opinion, too, that the extraction and production of that quantity of "escoria" involved the employment of, or was obtained at the expense of, some $\frac{450}{540}$ millions of units of labour, which would represent the labour of some 10,000 labourers for $\frac{150}{180}$ years of 300 days, or of 5,000 labourers for $\frac{310}{360}$ years—probably something near the period of the Roman occupation of this locality on peaceful terms.

He was also of opinion that the mineral or ore treated was of an average value of four per cent, which again would give a total yield of about 12,000,000 tons of fine copper extracted from this part of Spain—"Beturia Celtica" (Cean Bermudez)—by the first workers, the Phœnicians and the Romans; and he further calculated and attributed to the "Roman Period" only the extraction or manufacture of seven-eighths of that quantity.

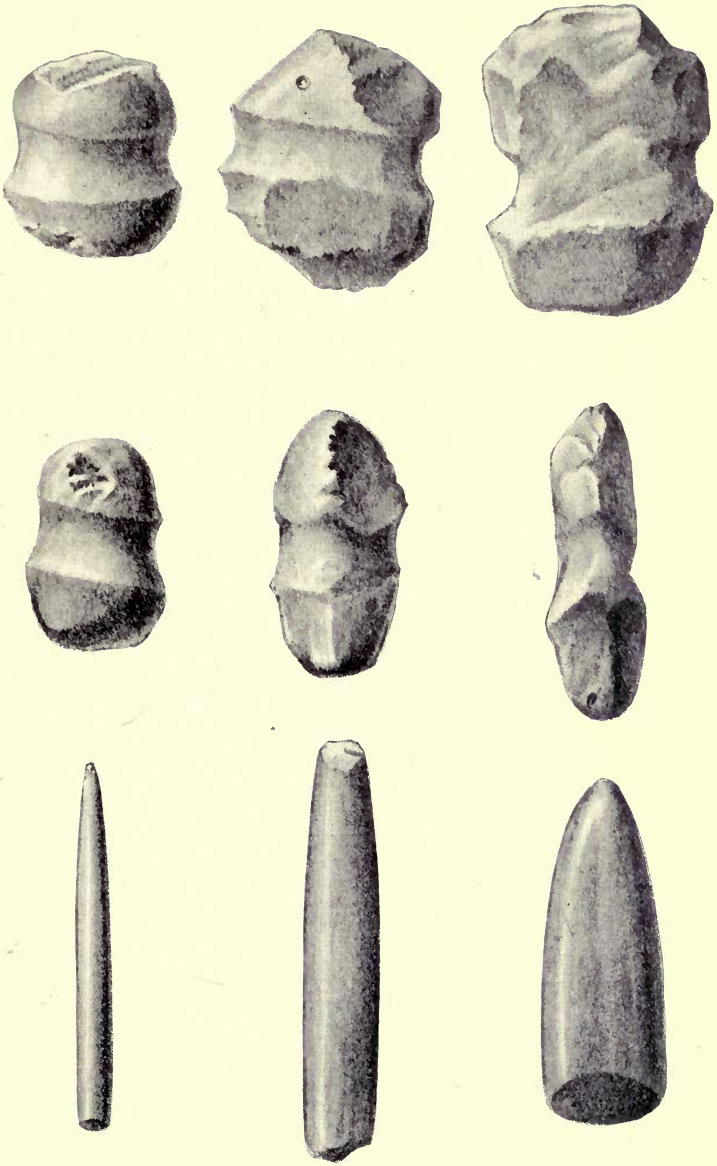
These latter estimates must be deemed to be the

merest surmise and conjecture, and can be based on no very reliable data, as it is plainly almost impossible to distinguish and estimate the separate or respective quantities of Phœnician and Roman "escoriae." It is again clearly impossible to distinguish or estimate the quantities of "escoriae" derived from the smelting of argentiferous and other ores, undoubtedly forming an appreciable part of all these mountains of slag brought to Rio Tinto from other mines in the "Montes Marianae," and there treated.

According to Pliny—quoted by Cean Bermudez and Tarin—some 20,000 slaves were employed in mines in the Province of Bœtica, and the ruins, still plainly visible, scattered broadcast over a very large area below the northern slopes of the Cerros "Salomon" and "Colorado"—sites near to which the "Dehesa" and "Escorial" villages are now built—could safely be taken to indicate the existence of a town there of some $\frac{10}{15}$ thousand inhabitants, such as has been elsewhere referred to.

The utter desolation, ruin, and nakedness of the surroundings of these "escoriales" cannot prevent us from being struck by the magnitude and importance of the smelting operations carried on here, as elsewhere in the Iberian Peninsula.

In some degree, too, it is remarkable that not any tools, of iron or bronze or implements, have been discovered in and about these ruins and "hills" of slag, with which the innumerable ruined columns, capitals, and other pieces must have been cut out of the exceedingly hard ironstone or ferruginous conglomerate of which they are composed. It is



STONE HAMMER-HEADS AND DRILLS.

exceedingly hard and difficult to dress, and ordinary iron tools are soon rendered useless in the operation of extracting and dressing them.

Huge and massive must have been the buildings, temples, and edifices, of whatever character, the ruins of which are still so numerous and evident; and they will ever remain, whilst other and softer material used generally in buildings has long since perished—indestructible evidence and proof of the great antiquity of their origin, and of the ancient workings of this pre-historic mine of Rio Tinto.

Without any doubt, the labours of the Asiatics —the earliest settlers from the East—workers of the numerous mines within the territory forming the Province of Bœtica—now Huelva—achieved a degree of very considerable magnitude and activity, and at least they obtained from those mines they explored and opened out no inconsiderable quantity of copper, which they transported to Onuba, now Huelva, the capital and chief seaport of the province, and there loaded their "bajeles" for the Levant.

It is credited by early writers that at this port there visited vessels from the coasts of Galicia and Asturias, laden with timber and gold there purchased, and others from the "Cassiterides" with tin, whence, after taking up the copper produced in the "Beturia Celtica," they continued their voyage under convoy to Tyre.

This probably took place about $\frac{1200}{1000}$ B.C., at which period (1013 B.C.), when under Hiram, King of Tyre, and Solomon, King of Jerusalem, the prosperity and trade of the Phœnicians reached its maximum development and importance.

Without further reference to the many ancient and modern authorities on this particular, it will be sufficient to say that in substance they go to establish that at the epoch indicated, there undoubtedly existed in this part of the Iberian Peninsula an active and very considerable development of the mining industry, and if it has not been possible to determine those parts of the ancient workings which correspond respectively to the Celto-Iberian and Phœnician periods of exploration, it has been because, as usually follows, the starting point of the labours of the one was but a continuation of those of the other, both in the process of time having become indistinguishably blended.

Equally may this be said as to the difficulty of identifying Phœnician from Roman work, especially in the underground workings. Gonzalo Tarin is of opinion (*Memorias*, p. 27) that nevertheless there exist marked characteristics which distinguish and reveal the type of work peculiar to the Phœnician and Roman, and although it cannot be pretended to estimate or calculate in a clear and definite way, as many have pretended to do, the quantity of mineral extracted and treated during the earlier of these two periods in this territory of the "Beturian Tartessius,"—undoubtedly it must be agreed that such marked differences exist between the "escorias antiguas" as to justify the view that almost incontrovertibly there existed distinct types, at least of exploration and labour, of two distinct and separate epochs.

The portentous "escoriales"—deposits of slag—that exist in diverse sites in the various mines of Rio Tinto, Tharsis, Zarza, Sotiel Coronada, Cueva

de Mora, and Castillo de las Guardas, and in even almost all others of copper pirites known in this district, come to justify the supposition maintained by historical record of the existence of two grand epochs of production. The difference between the two "slags" is marked, the Roman having the appearance of having been a slag *resmelted.*

But this difference, whilst easily detected in this instance, is hardly appreciable in the general appearance of these "escoriales."

Tarin, again, is of opinion that a careful study of many examples of both kinds of "slag" reveals the fact that the lower or sub-stratum, ascribed to the Phœnicians, is of quite a distinct form and appearance. These inferior "slags" are certainly more "rugosas" (wrinkled), and less perfectly smelted. At times they are even spongy in appearance and of a brownish colour (parduzeo), contrasting strongly with the superior or surface slag, which, as a general rule, is more compact or "close," with crystallizations in its "orquedades" or interstices, is a metallic black in colour, and, in analysis, shows but very slight traces of copper. Though, as to this latter feature, both seem to be singularly free from any appreciable quantities of either copper, lead, or silver.

Others, again, who are personally acquainted with the locality of these "escoriales"—are of opinion that there undoubtedly is a *third* and pre-historic accumulation of "escoria," easily distinguishable from that of the Phœnicians and the Romans, and equally curious in the one respect, that only the very slightest traces of copper are found in testing

it. The processes of smelting of those days, some thirty centuries ago, however little suited to the form and requirements of to-day, apparently were very complete and effective, whether that of the Celto-Iberian, the Phœnician, or the Roman.

But even if academic research aids us but little, the practical investigation of the localities, as those ancient mines are to-day developed, occasionally brings to light some valuable and reliable information.

In the month of May, 1876, an exceedingly interesting record and positive evidence of the Roman occupation of this part of Bœtica or Andalucia, was discovered buried in some ancient "escoriales" —at the mine of "Algares," situated a little to the south of Aljustrel in the adjacent kingdom of Portugal, some 60 miles to the west of Rio Tinto and practically on the line of continuation of its metalliferous-cupriferous formation.

It moreover affords an excellent insight into the conditions of the Roman mining and municipal law then in practice in this part of its "Imperio."

Aljustrel is held by Cean Bermudez (*Antiquidades Romanas*, Madrid, 1832) to have been situated in that part of Bœtica which was within the jurisdiction of the "Convento Hispalense." The town castle and district appertaining were ceded by Sancho II., March, 1255, to the "Order of Santiago," shortly after he had succeeded in driving the Moors from this locality; but he cautiously reserved to the Crown the actual ownership of the mines and its appurtenances, allotting to the Order only one-tenth of the products.

The subject matter of this bronze tablet thus opportunely discovered, has been lucidly dealt with by the capable and erudite Estacio de Veiga in his work, *A Tabula de Bronce do Aljustrel*, presented by him to the "Real Academia de Ciencias, Lisbon," in the year 1800, of which body he was a corresponding member; and also by Gonzalo Tarin in his *Memorias*, vol. 2; and in substance and effect is as follows:—

The "plancha" or tablet of bronze discovered in a mound of slag (escorial) at the mine of Algares, near to Aljustrel, corresponds to an epoch probably not anterior to that of Augustus Cæsar, he having been the creator of the tribute "Centesima" referred to in the first clause or section; is the *third* of a series whose number it is not possible to define or estimate, and the "capitals" or epigraphs which are contained in this fragment of the "Codigo Juridico" of "*Vicus Vispasciencis*, are those—nine in number—now demonstrated and interpreted.

I. "CENTESIMÆ ARGENTARIÆ STIPULATIONIS."—Under this section or epigraph it was ordained that the "rematante" or purchaser at auction for the time being of the rents and taxes of the "Fisco" or Exchequer, his agent or partner ("conductor socius actorve ejus") should or might collect and receive from each and every seller, the "Centesima," or one per centum of the value or of the proceeds obtained by the sales (of metal), taking place within the "circumscripcion minera" of "*Vicus Vispasciencis*" (*infra fines metalli Vispasciencis*), except as regarded those sales effected by the Admin-

istrator of the Mines—"*Procurator Metallorum*" (*Luistaniæ ?*). If the latter made any sales, then the responsibility of paying the "Centesima" fell upon the "comprador" or purchaser. But, again, in variation of this rule or prescription it was permitted to the two parties—the buyers and sellers—to arrange between themselves which of them should pay this tax.

A similar contribution was also declared to be payable by those, who, offering products (of the mines) for sale, sold them away from the "plaza" or market within ten days after they had been removed from that place.

It was finally established that the "arrendatario" or lessee of the taxes, his partner or agent, (Socio u Agente), might impose and collect double taxes if his dues were not paid and satisfied within three days from the date of their becoming due.

II. "SCRIPTURÆ PRÆCONII."—By this section it was provided and determined that the person undertaking the service of "public crier," should always have a "crier" at hand; that this "arrendatario"—renter—should be entitled to collect and receive two "centesimas" in respect of every sale by auction not less than 50 (x.l.) "dineros" in value, and not exceeding double that amount (x.c.), and only one "centesima" from or off those which exceeded this latter price. It determined also "that there should be paid to the 'arrendatario,' his partner or agent, by those who sold slaves by auction . . . [the condition of the tablet does not permit the deciphering of the amount per

capitem—if not more than five—and three 'dineros' per head for each one beyond that number."

It also stipulated that the administrator of the mines, when he had any occasion to sell anything, should be provided a "crier" by the contractor for this service, to whom should be paid one "dinero" (x.i.) by those selling, in respect of each and every sale, of whatsoever class of material or substance.

In this section, or "capitulo," was reiterated the obligation to pay one "centesima" to the lessee or contractor of the "fixed rents" by those who might purchase "pozos de minas"—literally prospectors' shafts or mineral properties—from the administrator (*Procurator Metallorum*), it being stipulated that double payment should be made and enforced, if the payments were not effected within three days. Further, it was provided that the "arrendatario" or lessee, his partner or agent, might demand a deposit or security from the debtor (*conductori socio actorive ejus—pignus cape (re) liceto*). And, finally, 3 "dineros" (x.iii.) were entitled to be paid in respect of each goat, mule, donkey, horse, and mare sold at public auction—those slaves and effects which, having been sold, might be resold within a period of thirty days, incurring or being liable to a similar contribution.

III. BALINEI FRUENDI.—By this section it was disposed, that the "arrendatario," or lessee of the "public baths," or his partner or agent, should have, every day throughout the year—counting from the first of July—the baths heated and prepared for use at his own expense, those for females from

the first until the seventh hour of the daytime, those for males from the eighth until the second hour of the night, according to the orders and regulations dictated from time to time by the Administrator of the Mines (*Procurator Metallorum*). (The hours of the service varied with the seasons of the year.)

The obligation was imposed upon the "arrendatario" or lessee ("*conductor*") of the baths of providing water for those "salas calientes"—hot baths—built over or upon the "*hipocaustos*" (heating chambers), sufficient to fill them to the height marked in them (*summam ranam?*), and of providing a free and continuous current of water to the "tina" (*labrum*), baths especially set apart for men and women.

It fixed the tariff for the use of the baths—each male paying half an "*as*," females double that amount; but freemen, servants of public affairs, (*servi artificum qui in officio erunt*), minors and soldiers, were exempt from such entrance fee or charge.

It stipulated that the "arrendatario," his partner (socio) or agent, should, on the termination of the term of his lease or holding, hand over the buildings with all his outfit—"utensilios"—in a good state of preservation, excepting such as might have been rendered useless by ordinary wear. Ordained that the copper cooking-vessels of the kitchen (*vasa acua*) should be monthly thoroughly cleaned and then rubbed with grease, "cebo," before being put by or stored. It provided that in case of repairs being necessary that might possibly interrupt the

service and use of the baths, the equivalent loss to the "arrendatario," might be taken into account and deducted from the rent, but that nothing should be credited to him on account or by reason of the interruption caused by any work, not necessarily repairs, but which might be undertaken for the simple betterment of the baths.

It prohibited the "arrendatario" from selling firewood suitable for the furnaces of the baths except such "ramos"—branches—unsuitable to such service, under a penalty of 100 "sestercios." And he was liable to be fined by the Administrator of the Mines (*Procurator Metallorum*) to the extent of 200 "sestercios" on every occasion on which he should be found not to have the baths and their auxiliaries in good serviceable condition. Finally, it obliged the "arrendatario" to keep in stock a sufficient supply of suitable firewood for the service of the furnaces (*hipocaustos*) of the baths.

IV. SUTRINI.—In this "capitulo" or section it was provided, that the person who might desire to make boots, shoes and "correaje," leathern straps and such similar matter, make or sell nails for soldiers' boots ("clavom caligarem") or whatsoever other article shoemakers only were accustomed to make and sell, should pay to the "arrendatario" or his "socio"—partner or agent—the double value of that they would have fetched on sale by the person properly and exclusively entitled. It stated that only to the "arrendatario"—by virtue of the law, "*Ferrariarum Locato*" (lex ferraiorum) is it permitted to sell "*clavom*," nails, and by that right he or his "socio" or agent held the right of

"hipoteca" ("pignoris copio"), "*pignus capere liceto,*" against all other would-be salesmen. Furthermore, it was added, that to no one was permitted the right to contract or undertake to supply boots and shoes (calzado) without the consent of the "arrendatario"; but provided, that as long as this latter possessed more in stock or store, then each individual might be at liberty to purchase as and when he pleased.

V. TONSTRINI.—It was determined by this section or clause, that within the limits of the "*Vico metalli Vipasciencis*" and its territory, none might practise the calling of "barber" under penalty of x—[illegible as to amount] to the "arrendatario of his service," his partner or agent, together with the forfeiture of his tools or instruments of his calling and occupation,—except the slaves who cut the hair of and shaved their masters and owners and companion slaves (*dominus aut conservos suos*): and that those barbers who came from elsewhere to exercise their calling, and practised it without the licence of the "arrendatario" might by him, his "socio" or agent, be "embargados," or distrained upon (*pignoris copio*). That, finally, those who should be obstructive in this matter, for every fault should pay five "dineros" (x.v.), and, that for the purpose of the due discharge and performance of this domestic calling, the "arrendatario" or his agent should always have (available) one or more "*Oficialis idoneos.*"

VI. TABERNARUM FULLONIARUM.—By this section it was ordained that only the "arrendatario," his agent or partner, or other person duly authorized by

him, was permitted to prepare wearing apparel; and that those who did the contrary should be compelled to pay on every occasion three "dineros" (x. III.), and be liable to "embargo" (*pignus capere liceto*).

VII. SCRIPTURÆ SCAURARORIUM ET TESTARIORUM. —It was determined by this section that those who, within the limits of the territory of the "circumscripcion metallifera" (see note) prepared for sale, by weight or measurement (*ad mesuram pondusue vendere*) "escoriae" of silver or copper and other mineral residuum—by cleaning, separating, reducing, sifting and washing, or in whatever method they worked in the quarries of "pizarra"—declare within the space of three days how many slaves or mercenaries he held or employed in this service, for that, at the end of each month should be paid for each one so employed, to the "arrendatario," . . . "dineros" [the "plancha," or tablet, fails to say how many], and that when that should not be done, double the amount should be due. That he or those who from outside this mine, brought silver or copper ores to the "arrendatario," his "socio" or agent, should pay one "dinero" [the "plancha" or tablet does not state if by weight, measure, or monthly quota] before the Kalends (IN P.C. $\frac{V}{\Lambda}$ I.). That he who, in attendance upon or in satisfaction of this law, owed to the "administrator," his "socio" or agent, and failed to pay within the period stipulated, should pay doubly, the right remaining to either creditor to "embargo"—foreclose—(*pignus capere liceto*) on all and every mine being worked, and also over the work effected in the "pizarras." From these

dispositions it will be seen that the foremen and slaves working with the "smelters" for and on account of the masters and patrons were hardly excepted.

NOTE.—The "plancha" or metal tablet at this place presents an "hiatus" (laguna)—"Qui in finibus metallorum . . . . scaurias etc.," in which reference might have been made to the "metallarii," whose functions were limited to those of operatives and artificers actually engaged in the preparation and treatment of the mineral; unless it might be that in another "plancha," or tablet, of the same series or issue the functions and obligations of this "Officio," or class of workmen, might have been specifically indicated: in this "tablet" allusion would probably be made to the exclusive or singular processes of treating the "escoriae" of silver and copper [would this allude to the treatment of ancient Phœnician or even Pre-Phœnician "escoriae" ?]—"*scuarias argentarias acrarios pulver scaureis*," etc.

The expression "testariorum," it would appear, might have referred to the exploradores, prospectors of the pizarras or slate (?) used in the construction of buildings or "calzadas," roads and highways (referring either to slates for domestic purposes or larger pieces useful in the making of roads), for there are no notices extant of the "slate" as used for the roofing of houses; perhaps the words had a wider signification even though this "plancha" does not distinctly so indicate, as, it being a fact that in the district and neighbourhood of this mine ("Ribeiro do San Joas" etc.) there then existed smelting furnaces, it was necessarily indispensable that the deposits of refractory earths should be used,

in the which fabrication it is very possible that they made use of the "residuos di pizarras."

VIII. LUDI MAGISTRI.—By this section the schoolmasters were held to be immune as regards the rights of the Administrator of the Mine, "*Procurator Metallorum*," that is, free from obligation to pay any of these taxes and imposts.

IX. USURPATIONES PUTEORUM SINE PLITTASIARIUM.—It was by this section stipulated that whoever might occupy or work in a shaft (pozo), or in a place with the object of opening out a "mine" within the limits of a mining district, in conformity with the law concerning that matter (lege metallis), should give account of his doing so to the "Arrendatario," his "socio," or agent, to whom he should pay . . . (hujus vestigalis profiteatur et solvat . . .)."

Here the "plancha" or tablet concludes.

In all these sections of this fragment of Mining Law the absolute monopoly enjoyed by the "Procurator Metallorum," which extended, apparently, to and over all industries and dealing exercised within the limits of the territory in which he held dominion or control, is clearly revealed and demonstrated without anything being discernible of protection or assistance to the Mining Industry, or, indeed, anything, which might have stimulated or encouraged the discovery and investigation of new lodes of mineral, not even protection or consideration to those engaged in those existing.

As a single proof of the Roman occupation of the Rio Tinto Mine, the following may be instanced.

On July 31, 1772, when Francisco Sanz directed the exploration or working of the Rio Tinto Mine, a small plate of copper, ·002m· in thickness, was found attached to the wall of an adit some 112 metres from its mouth, and 16·50 metres from the surface, containing the following inscription:—

IMP. NERV, CÆSARIÆ AG.
PONTIFI. MAXIMO, TR.
POTEST. P.P. COS. III.
AVG. IIII. PVDENS. AVG. LIB.
PROCVRATOR.
SVO. POSIT

This has been amplified by Rua Figueroa, Administrator of these Mines some time in the middle of the last century, in this way:—

Imperatore Nervæ, Cæsari Augusto
Pontifice Maximo, Tribunitis
Potestatis, Patri Patriæ, Consuli III,
Augustus IIII. Pudens Augusti Libertus
Procurator
Suo Posuit.

Cean Bermudez, in his *Sumario de Antiguedades*, gives the date of its finding as 1762, and in that matter he is also in harmony with Bowles' *Introduction to the National History of Spain.*

In many and various parts of the works, both subterranean and superficial, numbers of Phoenician coins have been discovered, whilst others have been met with—gold, silver and bronze—of the Emperors Nerva, Theodosio, Claudio, Constantino, Trajano, Honorio, and others. Imperial Rome is almost entirely represented in such a "numismatic mus-

eum." In Appendix A will be found a detailed description of many coins in the older parts of the works—a history in themselves.

Many other proofs of Roman occupancy and work have been brought to light both here and in other mines in this province. Interesting undoubtedly are the examples shown of an excellently well preserved example of an archimedian screw—of wood—discovered only a short time back in the ancient workings of the mine of "Sotiel Coronada," which is situated about six leagues to the south-west of Rio Tinto; and of the water-wheels found at Tharsis and also quite recently in the old subterranean workings in the "North Lode" at Rio Tinto;—undeniable evidence of the prescience, activity and skill with which the Romans conducted their labours and developments in mining.

All these wheels are of the same size and pattern, being 4·50 metres in diameter, the parts being also interchangeable; it would seem that they were made in another part of Spain and mounted "in situ," as the wood (pine) is of a kind different from that peculiar to the locality or province; they were brought from the coasts of Galicia, most probably.

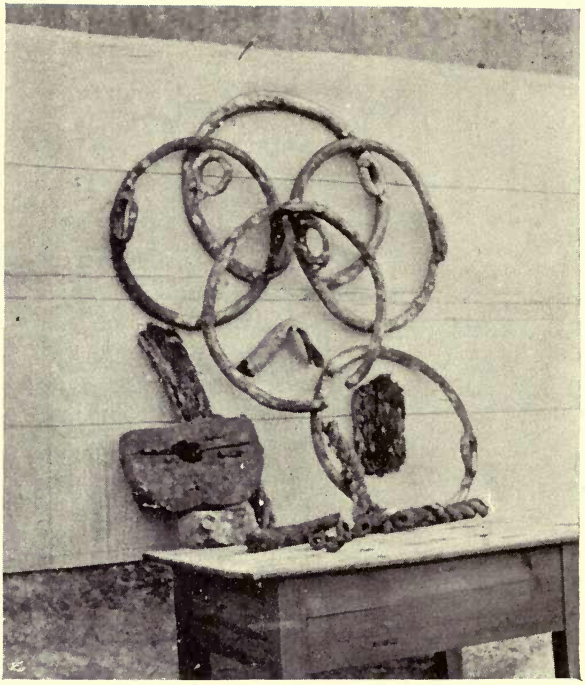
But in addition to the numerous deposits of "escoriae" on the north side of the locality there exists another very substantial proof of the magnitude of the operations—whether Iberian, Phoenician or Roman—in the enormous extent of the old underground workings. Gonzalo Tarin states that "no less than thirteen 'socabones de disague,' draining adits or galleries, have been met with,

established at different levels and undoubtedly constructed at different periods."

These 8,000 yards—and more—of subterranean work, independent of multiple auxiliary and exploratory labours, amply demonstrate the extent and importance of the operations of those days, and taken together, fully account for the presence of the huge deposits of escoriae at the North Lode. Of the thirteen adits, nine are to be found on the south side of "Cerro Salomon," the remaining four on the north side. In addition, in and about the various lodes are to be found a thousand "pozos" (shafts), and a multitude of other labours forming large subterranean "cavis."

The Roman Caesars also granted lands to certain towns for their enjoyment and assistance and until quite a recent date many still retained them on the sole condition that the people would work certain lead mines for the benefit of the State in the first instance. Those authorized to work them were generally large property holders, "caciques," who held in their service a large number of "dependientes," condemned to work under the most onerous and wretched conditions.

This led to inconsequential and prejudicial work and exploration, for an illustration of which one has but to examine the remains of their labours in this and many other mines, now rapidly disappearing under the modern system of exploration and extraction. Of course the work of "forced" labour could hardly be expected to bear comparison with that of free, of voluntary labour, looking to ultimate results. They worked hopelessly and



BRONZE RIMS OF BASKETS. FROM THE BOTTOM OF SHAFT AT SAN DIONISIO.

without those stimulants which excite the activity, the intelligence and zeal of the freeman.

Still the work, badly performed as it was, was prodigious in its quantity, character and effect.

The silence of the history of those days cannot make dumb the eloquence of the ruins here left by the Romans and Phoenicians on all sides, nor prevent any one from forming a very high conception of the extraordinary amount of work actually done by them and their predecessors.

It is to be gathered from the written history of the Roman occupation of the Iberian Peninsula from about 210 B.C. until the end of its domination in the reign of Honorius, about 425 A.D., upwards of six centuries, that they concerned themselves chiefly with seeking for and extracting the richer patrician metals—gold and silver.

Little or no reference is made to the huge industry in copper they must have had established. What enormous quantities of copper or bronze coins were coined by them in Spain! What immense quantities of the former metal must have been sent to Rome during those six centuries to supply domestic requirements; and yet not a word about such output has yet been met with in any work!

Pliny devotes the whole of chapter iv. of lib. 33 to a detailed account of three methods employed in Spain for the extraction and treatment of auriferous ores, and Diodoro de Sicilia, Strabo, and others occupied themselves in the same direction. Reference is only occasionally made to the treatment of copper, and then only in relation to the extraction of silver.

Another historian, Polybius, testifies to the employment of some 40,000 men in the working of the mines of "Carthago Nova," whilst another—quoted by Figueroa, p. 37—asserted that the quantity of silver annually sent to Rome from that place alone was some 3,772 kilos.—about 85,000 ounces. Again, if Pliny and Titus Livius are to be relied upon, as much as 20,000 pounds weight of gold was, for many years, annually extracted from the mines of the Iberian Peninsula—not a word is written as to the quantity of copper taken at the same time, and for which Rome had such unstinted use.

For many centuries previous to the arrival of the Romans in Spain—from the days of Ptolomy and very probably before—romance and tradition had, in no uncertain voice, vaunted the existence of such riches, and fiction told of the voyage of the Argonauts to, and the battles of Hercules in, this, what many believed to be, and what was called, "Campo Eliseo."

This very large exportation of gold and silver seems rather difficult of belief to-day, as there are but few substantial indications existing of the gold mines. Silver was known to exist and is still mined for, but the only mines in Spain now worked on a large scale are those of copper, iron, lead, silver, quicksilver, manganese, and coal.

Upwards of six centuries passed with Spain labouring under the iron governance of the Caesars, and then it entered into another and a consequential period of dispute and distraction in the fight for the possession of its enviable soil.

The last page of the history of the Roman occupa-

tion is written under the name of Honorius. Imperial Rome had then been disporting its immense riches for an equal period to that enjoyed by the Republic of Carthage.

The advent of Alaric and his hordes—Goths, Vandals, and others in their train—was the signal for the outbreak of a general war against civilization and Christianity, and from the end of the fourth century until the close of the sixth, all Europe was convulsed and shaken—industry, art, commerce, and progress remained paralyzed and abandoned.

For the space of three centuries after the retirement of the Roman legions, Spain was the seat of war and the object of the struggle for mastership between the various hordes of invading forces, which had from time to time over-run the whole of Southern Europe, and even at the hands of the Goths, the most illustrious of the many "nations of invaders," the country suffered harshly, and all industry and domestic art was suffocated if not destroyed.

Thus, races from the colder North were far more congenially engaged in disputing the riches and general national prosperity so highly and happily developed by the Romans in their long period of ownership, and to which they, in the colder climate of the harsher North, had hitherto been total strangers.

"The 'barbarie' of those epochs," says a modern writer, "of disorder, waste, and misery, had almost completely interrupted in all parts, not only work in mines, but also all other industries and occupations. In no other epoch of history had the precious metals

been so rare as in the centuries of the dominion of Southern Europe by the 'barbarous hordes from the wild North.' This part of Spain was then properly called 'Vandalucia.'"

Thus three centuries passed and a new and seemingly interminable struggle for dominance, originating from Africa again, was entered upon in the unfortunate country. The close of the seventh century witnessed the destruction of Carthage, soon to be followed by the invasion of Spain by the fanatical followers of Mohammed.

At this period the Saracens had extended their power and territory and occupied the whole of the north coast of Africa, and from the walls of Stamboul in the east to beyond the pillars of Hercules in the west.

To quote the words of the Arabian historian :—

"The sons of Islam had long heard of its delicious temperament, its clear and serene sky, of its many riches, the fine quality and excellence of its plants and fruits, of the comparative mildness of its climate in all seasons, its seasonable rains, perennial streams and rivers, never-failing springs, its highly fertile soil and populous cities.

"To them—coming from a desert country in the dry East, encountering others in the course of their progress through Libya and Mauritania far worse in natural conditions—it was a 'Promised Land' in the excellence of its soil and climate. Felix Arabia in its temperature, India in its flowers and aromas, Persia in its fruits and garden produce, Cathay in its precious and abundant mines—a very Elysium and quite unfit for infidels."

In the year 710 A.D. they seized upon a favourable opportunity, when internal dissension, war, and treason even, had rendered the country defenceless against an invader, to cross the Strait of Gibal-Tarik (now Gibraltar) and carry out what was intended by Muza-ben-Nosseir, the then Saracenic Governor of North Africa, to be but a simple plundering raid, but which, because of the feeble defence of the Spaniards, in the following year, 711 A.D., was succeeded by an invasion by them, headed by Muza in person, on a very considerable scale, resulting in the conquest by the Arabs of almost the whole of the Peninsula—certainly all the better portion of it; and their lengthened stay and occupation was to be of vast influence upon the future of Spain, if not upon the whole of Europe.

A new civilization penetrated and dominated the country with its thorough occupation by the Saracens, and from the eighth until the thirteenth centuries of the Christian era, whilst the whole of the rest of Europe was sepulchred in the most abject condition of desolation and barbarism, Spain was destined to be the fortunate shelter, school, and home of science and art. The few illustrious personages of the day throughout Europe visited the seats of learning, fine art and science at Cordoba, Toledo, Salamanca, Sevilla, and Granada; and undoubtedly in that way the saving of much knowledge in art, science and industry was fortunately obtained and secured.

But the fanatical followers of Mohammed—Sons of Islam—were not, however, of the same calibre as the Celts or Phoenicians—they were not miners.

Very few indications have been met with of work or exploration in mines in this district that could be attributed to them, and neither from the ruins nor other evidence of those days in which the country abounds, can be found any very substantial or numerous indications that could be taken to signify the permanent and practical occupation of this province by the Sons of the Desert; and in eight centuries of use and dominance in an age or period so near to the time of to-day's writings, traditions, and historical records, of which not a few dealing with other places near to—like Niebla—are to be found in the archives of Sevilla, it would be impossible that these vestiges, ideas and thoughts should not have been recorded and perpetuated, had they occupied and themselves worked in these mines—it would have been impossible even in epochs more remote and with domination less thorough and prolonged.

Neither does contemporary history contain any notice of exploration or of work in the Rio Tinto mine during the periods of the occupation of this part of Spain by the Goths and Arabs, nor does even tradition give us any indication or evidence of the domination of these races in this region, so far as the working of mines is concerned.

The seal of "forgotten" had been impressed in the reign of Honorius on the copper lodes of Rio Tinto, the door of "abandonment" closed upon the subterranean and other immense workings and labours of the Iberians, Phoenicians, and Romans; and that "seal" was not to be broken and that "door" was not to be opened until the close of the sixteenth century.

Referring to evidence of Arabic work, so characteristic in itself, Hoefer says :—

"The Romans constructed the towers of their fortresses in a circular form, with the object of rounding off, or lessening the force of the blows and attacks of the engines of war; and the shafts of their mines, whether the result of custom or of principle, were always circular in form. The Arabs, on the contrary, invariably adopted the quadrangular form, whether of tower, fortress, or well."

It may be contended that the long period of the Saracenic occupation of this part of Spain—upwards of seven centuries—was totally unproductive of any work in mines by them by way of exploration, or of any new development. True it is that in certain parts of this province—Huelva—especially in the Sierra Morena, and not infrequently in the immediate neighbourhood of the various copper mines, Arab coins have been met with, one, of silver, having been found in what undoubtedly was an Arab sepulchre, near to the Rio Tinto mine (Gonzalo Tarin, p. 38); but the small number of those discovered, and the finding of them almost at the surface of the ground—for very few, if any, have been found *within* the mine—does little or nothing to testify to the exploration of this, and of other near to, by the Arabs.

On the other hand, it is undoubtedly true that in the adjacent kingdom of Portugal the Arabs did actually work and explore certain mines already referred to in the district of Aljustrel (Alentejo). Mines, castle, and district were taken by Don Sanchos the Second from the Arabs, and by him, in March,

1235, granted to the Order of Santiago, reserving a royalty of one-tenth of the produce of the mines there—an indication clear enough that they were then being worked and were worth being taken into account. It is but natural to suppose that this district, and its equally well known environs, were also, perhaps to some limited extent only, worked by the Arabs.

It is also on record that the Arabs were reputed to have worked for silver in the " Sierra de Aroche," by which name the whole of the north-western part of the Province of Huelva was known, and there are still some few indistinct indications of their having done so.

Given the exceeding few and unimportant proofs of Arab exploration, it may be taken that even in this retired corner of Andalucia, or " Andelo," where they lived in almost undisturbed possession for some six centuries, they paid little or no attention to mining, and that industry remained neglected and dormant.

Very many sites, buildings, and works have been credited to Arabic construction, originating in the custom, current in Spain, of attributing to the Saracens all that which was of an antiquity superior to their personal knowledge or record, in all matters of tradition and repute.

If the mine of Rio Tinto were worked at all during the period now under observation, it must have been treated by the Arabs on the lines established by the Romans, and no new system of working was introduced.

Perhaps the most substantial piece of evidence met with of their occupation of these mines is their

work at the site called "Huerta de la Cana," on the north-east side of the Cerro Salomon (see Plan). Here they made an elaborate attempt to obtain a supply of fresh water; the work is still good, was substantial and of utility. It consists of an adit driven into the hill on the farther side of the Rio Tinto for some 140 yards; a cross-cut was put in at every fifteen yards, either arm extending eight yards. At each of these junctions a well was sunk, and so on regularly through the whole length of the adit. The work is quadrangular in form, and has the local reputation of being Arabic in origin; but probably the Arabs only bettered the condition of some much older work. Of the few permanent and substantial sources of supply this was one of the most important, and no doubt was always carefully looked after.

Here and there throughout the cities, towns, and villages of Andalucia the Saracen has left his mark in various other ways. Many names of persons, places, and things are distinctly Arabic in origin and type; and, although we do not find any distinct evidence of Arabic work in the mines throughout Spain, their presence and long occupation was extremely beneficial to the country generally, and their forcible expulsion at the end of the fifteenth century was so disastrous as to have been styled by Spaniards themselves a great and irremediable national disaster.

The departure or ejectment of the Arab and the return to the old order of things—misrule, waste and anarchy—could not be reconciled with the development of art, industry, and science, any more

than the iron roadway and the locomotive could exist together harmoniously with the martyrs' fires of Torquemada. Art and industry could not live, certainly not make any progress, without the skilful help of intelligent workmen.

In the year 1500 Spain had lost the most capable and diligent of its citizens—adepts in the mechanical arts, sciences, and agriculture—and the whole of the better parts of the country remained uncultivated and wasted; its forests were destroyed, its cities left in ruins, its workshops remained deserted and silent, its sources of public prosperity dried up and were almost permanently ruined.

The expulsion of the Arab was, economically considered, the greatest adversity that Spain could possibly have suffered, and in the midst of the calamitous times which ensued and lasted for centuries, the development of the mining industry—a true barometer or indicator of the material progress of a country, the result of peace, public order, and good government—was rendered an impossibility. But the Arab, however skilful in architecture, medicine, and agriculture, did not work in mines, and the Spaniards themselves seem to have completely forgotten or abandoned all interest in mining.

In the ten centuries that had passed over the vast and quite forgotten subterraneous workings, nothing had been done to bring to light the hidden evidence of the work and dominion of the Phoenician and Roman, nothing to rediscover and utilize those enormous lodes of ore which had for many centuries been a source of almost inexhaustible wealth and prosperity.

The wretched efforts of the Spaniards themselves have been well described, in bitter terms, by a late writer, and he eloquently endeavoured to arouse a sense of the importance and necessity of a greater national interest being taken in mining and metallurgy, and lamented the want of progress and application of his countrymen. He writes: "Retrace 1800 years of the Christian era, raise from their sepulchre those legions of slaves and prisoners who, though hampered and tortured in iron chains, perforated the bowels of the earth without the powerful auxiliary of powder and without the assistance of the theodolite; re-establish those crude furnaces with whose products were built up the marvels of the temple and the protecting gates of Rome; lift those generations, gigantic even in their helplessness, to an equality in condition with that of the nineteenth century, and consider *when* has material progress been the more backward in the annals of history."

Strike out from the catalogue of social progress the art of extraction of metals from the interior of the earth, and you at once eliminate the patron of development in science, art, and commerce. Interrogate History as to what has been the influence of mining and metallurgy, and she will furnish an endless list of reply and instance. She will tell you that the extraordinary civilization of Greece was but the outcome of the genius of Cadmus and of the art of working in blueing, smelting and refining metals; that the progress and great prosperity seen to-day in Bilbao or other industrial cities of the Peninsula is but the direct result and fruit of that

great industry whose germs were thrown upon the coasts of Iberia by the intrepid merchants of Tyre and Sidon; that Athens owed her decadence to the laws of Lycurgus prohibiting the exploration of mines and the pursuit of the mechanical arts; whilst, again, Sparta owed her prosperity to the help and protection she afforded to them.

The invasions of the savage hordes of the middle ages throttled with the oppressive force of ignorance and fanaticism the spirit of intelligent skill and industry, and the mechanical genius of the inhabitants remained dormant in the arms of impotency, ignorance, and disorder.

With the exhaustion of the nations on the field of battle man returned once again to seek, in the interior of the earth, the elements of prosperity, power, and peacefulness. Since then what prodigious strides have been made—how magnificent a picture is a record of developments due entirely to the mining industry and her sister and coadjutator, scientific metallurgy!

How Schaeffer, Fust, and Guttenburg discover and bring to light the perpetuity of mechanical writing. Then Tribellius and Torricelli measure for the first time the grades of temperature and of atmospheric humidity. Franklin tears from the clouds the mysteries they held, and Volta, arming his cells, puts into play the fluid which in its day is to be the chief and governing power.

Davy finds means to save infinite numbers of workmen from a certain and awful death; Daguerre fixes on the sheets of his apparatus the image of whatever is presented to it; Stephenson, with his iron horse, and Wheatstone, with his metallic language,

BRONZE STATUETTE OF "FORTUNE."
FOUND IN OLD ROMAN WORKINGS AT RIO TINTO.

circumscribe the entire world, all having gone to the arsenal of the metallurgist for the means and the weapons with which to make their imperishable conquests.

Leave untouched and dormant in the depths of the earth her inexhaustible lodes of wealth and comfort, and you take away from even the mighty Great Britain all her power, glory and prosperity.

Return to the clouds of obscurity and ignorance our knowledge and skill in working metals—in iron and copper—and you must tear up from the ground those metallic lines for the iron horse which, with wings of steam, convey us safely and rapidly to all parts of the globe, and destroy the metallic threads which to-day serve to re-echo the subtle flash of human understanding, knowledge and intelligence.

But so little assistance was given by the State by legislation during the centuries the Peninsula was almost wholly engaged in civil war, or in vain attempts to expel the Moors, that until the close of the fourteenth century the condition of the mining laws or customs was such that no gold, silver, lead, or other metal or mineral could be sought for or extracted without the previous permission of the "Crown," and then under very onerous conditions.

In the year 1387, the Cortes of Alcala had sanctioned a law (Leg. ii. tit. 28, part 3) to the effect that " Todas las minas de oro ò de plata ò de plomo ò de otra guisa qualquier minera sea en al Señorio del Rey, ninguno non sea osado de labor en ella, sin mandado del Rey." The mineral fruits and products of all territory belonged by primordial right to the owner of the State, the King. Again,

the onerous conditions imposed, the vague terms employed with respect to the rights and principles in mining property, left an "open door" for the ready admission of endless abuses by the Crown and its officials. Not a single phrase existed to indicate or signify protection to the miners' interests—not a single clause to establish a property in the industry to the actual worker.

A few years afterwards under John the First, a modification of the mining law was established to the effect that "Any person could dig, search for and take out silver, gold, lead, quicksilver, tin, and other minerals and stones in whatever site and place, not inflicting any prejudice, one to the other, in his work, and also after procuring a licence or 'permiso' from the owner or holder of the property." (Leg. 8a., libro. vi., tit. xii.)

In this alteration may be found some slight improvement—at any rate, a comparativelyfree right and liberty to search for and extract minerals and metals, and some definition of the position and rights of both the owner of the property and the miner.

But the international struggles and wars which had for more than three centuries previous to this period—1400—agitated and devastated the whole of the Peninsula; the utter inability of its sovereigns to attend to the care or advancement of this class of State interest—mining legislation; the grants of territory indiscriminately made to various clerical authorities and other magnates of the realm; the actual spirit and operation of the existing laws and the backward condition, both in-

tellectual and industrial, of the mass of the inhabitants of Spain ;—were more than sufficient to prevent the mining industry from taking any practical step forward—a step then, as now and always, of such vital importance to the development, prosperity, and happiness of a country and of its people.

At the time of John the First, the "Catholic King," and of Charles the Fifth, the laws promulgated with the ostensible view of the betterment of the mining industry were quite ineffective and insufficient. Concessions were granted to the heads of the Church in the various provinces, of all minerals that might be discovered, and of known deposits, and the contributions to war and the system of vassalage and service to feudal authority, usurped and absorbed the few privileges which occasionally a generous and well-intentioned monarch granted or conveyed; while the voices of art and industry, of peace and prosperity, were suffocated and lost "in the crash of arms, the tumult of war, and the shouts of victory."

CHAPTER II

RE-DISCOVERY OF THE MINE—16TH CENTURY—EARLY REPORT ON ITS CONDITION—EFFORTS OF MENDOZA AND DELGADO—FIRST CONCESSION OF THE MINE—PROGRESS IN MINING IN THE 17TH CENTURY

A CONCESSION to work this Rio Tinto Mine was claimed by the town of Zalamea la Real to have been granted to it early in the seventeenth century, under the terms of a royal decree or concession conceded to the diocese of Sevilla; and even down to the present day that town has not failed, on very many occasions, strongly and energetically to assert its "rights."

The history of the Ayuntaimento or municipality of this township has, from the date of its origin to 1841, been that of a very long and bitter struggle against the pretended dominion of the authorities and people of Zalamea; it has only been since the segregation that the substantial development has commenced, which has been so remarkably successful and beneficial to Spain.

The records of the Ayuntaimento of Zalamea itself are full of instances of unscrupulous and determined opposition to the creation of any independent life or authority, in the mine itself, from early in the seventeenth century down to the date referred to,

and to which reference will be made more fully later on.

Still, in spite of the restrictive laws and onerous tribute and conditions that, in the sixteenth and seventeenth centuries, weighed heavily on the mining industry, in spite of the many obstacles, both moral and material, which had to be contended with by that class of interest, still there were to be found persons willing and desirous to search for, open out, and bring to the light of day, the suspected and traditional subterraneous mineral wealth of the country, and in particular that concealed beneath the highly mineralized crest of "Salomon's Mountain."

The change and progress now instituted was not so much the result of favourable legislation and governmental assistance, as it was the natural outcome of the necessitous condition of the country.

The cost of maintaining the numerous and costly military expeditions to Peru, Chili, and Mexico, the prolonged wars in the Low Countries as well as nearer at home with Portugal, the constant and terrific strain upon the unfortunate country in finding "the sinews of war," all contributed to the enforced search for, and discovery of, the reputed, though concealed, wealth.

The finding and successful development of the rich silver-lead mines of Guadalcanal in the Province of Sevilla and not far removed from this locality, in the year 1551, according to Carranza (Madrid, 1629) and others, in 1555, fomented hopes of the discovery of other such valuable and material aids to the national exchequer. And very shortly after-

wards, in 1556, Philip the Second commissioned one Francisco de Mendoza "to visit, inspect, and determine the lettings of the mines," both discovered and to be found, in various provinces.

Directing his attention to Sevilla and to this district, he undoubtedly may be said to have been the "re-discoverer" of the Rio Tinto Mine; and although he himself, because of the considerable number of his engagements, could not find time and occasion minutely to examine all the mines reported to him, he nominated others to assist him to do so.

Mendoza started on his important missions from Guadalcanal, and inspected the districts of Aracena, Zalamea la Real, Valverde del Camino, etc.; found persons to assist him in pointing out the various and numerous sites of mines, and formulated a register of many new discoveries, soon to be of considerable advantage and assistance to the country in her then condition of dire extremity.

On June 26, 1556, he wrote to the King from Guadalcanal as follows: "I have sent several persons, at your majesty's orders and cost, to search for new mines, but not as many as I could have wished, as it is of little use searching for them until the rains set in."

In the execution of his researches his attention was called to the striking display of the immense ruins and the unlimited number of "hills" of "escoriae" at Rio Tinto; but not then being in a position personally to examine carefully the various localities, he nominated one Diego Delgado to do so in his stead. This Delgado was a priest by calling,

and was perhaps attached to the party of Mendoza on account of some strong personal interest and influence, rather than on account of his being possessed of any special intelligence, or of any technical knowledge of mining or metallurgy.

He appears to have very promptly become aware of the necessity for having capital, at any rate sufficient to provide for preliminary works, costs, and outlay; for, shortly after his appointment, he wrote to the King, "for in order that I may the better and more effectually serve you in this important charge, I pray you grant me means, for I am a priest and not possessed of any means or income."

On his return from Rio Tinto to Aracena he wrote an account or report, probably one of the earliest of its kind extant, in which is plainly evident the pedantry of the man of letters, but which nevertheless is full of highly interesting and important matter. It seems reasonable to assume that by it, in a very great measure, was again brought to the light of day, and restored to the memory of man, the forgotten existence of those historical, gigantic, and so long abandoned explorations. In substance, the document is as follows :—

"Report dated at the City of Aracena the 15th of August, 1556, by me, Diego Delgado, priest, a citizen of Madrid, concerning the mines that, by order of Don Francisco de Mendoza, I was commissioned to see and examine in company with Don Pedro de Aguilar, of Castro Nuño, located in the district of Zalamea la Vieja, as well as others" [mines] "in various parts of this province" [Huelva].

" Those mines already inspected by Don Francisco Mendoza in these parts, showed abundant evidence of immense ancient labours, of works and buildings, shafts and explorations, enormous mounds or hills of ' escoriae,' and other proof of ancient work, and to us was particularly committed the responsible task of examining the place very carefully and minutely, to re-discover the veins of metal, for that, when determined and brought to light, Don Francisco de Mendoza could direct what should be done with the greatest advantage to His Majesty, the King.

" In virtue of our instructions we left the town of Aracena for the district of Zalamea at the end of July, 1556, and proceeded to and stopped at a place called Rio Tinto " [now the town of Nerva] " about a quarter of a league from the various works of the ancients. The day following we went to the cave called ' Salitre ' " [to-day called Tabacco] " and entered and examined it. This cave extends back from its entrance some sixty paces, having a width of more than eighty paces, its height is that of a church, and it has an arched roof or ceiling. From it extended many passages, some of them leading toward the highest part of the hill above. Several shafts too were found, and descending one to ascertain its object, I found a vein of mineral half-hidden by the earth which had evidently been intentionally thrown upon it to conceal it.

" Removing the earth with my own hands, I fully exposed the lode (vena) and took from it about an ' arroba ' (twenty-five pounds weight) of mineral. I noticed the evidence of work done on this same

vein, and from the condition and appearance of things concluded that the works here were of very great antiquity. Returning from the shaft we searched the whole of the cave, and found that the ancients had been extracting four or five different kinds of metal, all of which were taken from the one mother vein or lode.

"Finding, however, that it was impossible to 'discover' the lode on account of the immense mass of earth, rock, and rubbish to be removed, I determined to make search elsewhere on the hill above, although the surface was very rocky and precipitous and covered with a dense scrub or brushwood.

"On the day of San Lorenzo" [10th of August] "ten days after our arrival at the place, I went with a labourer with pick and shovel to a site where, on making a search, I discovered signs of mineral, and where, with slight effort, I found the lode. I got out and took away some twenty-five pounds of it as a sample and sent it on to Don Francisco de Mendoza.

"Ascertaining then, that the metal found in the cave and in the shaft, and that which I had discovered higher up the slope of the hill, were one and the same thing, and also that the ancients had known of it and had worked there, I felt that I could confidently assure Don Francisco of the great importance of this re-discovery, for him to take such steps as, under the circumstances, might be found to be most advantageous, to benefit by it.

"In the same way we determined, by continuous search, the existence of the sites of many large

works and buildings; of furnaces and of deposits of 'escoriae'; all the result of labours of very great antiquity. Of the 'escoriae' we found (covered with dense brushwood) such enormous quantities that they actually formed small 'hills' which covered two square leagues of ground.

"Continuing, we found another cave called Cueva del Lago, full of water, from which a stream escaped (named by the people of the neighbourhood 'Rio Tinto') the stream being named so because of its constantly coloured appearance—evidently springing from a body of mineral—of iron and copper. I ascertained that throughout its course it is very strongly coloured, especially in the summer, that it formed strongly tinted deposits of a material on its banks which during the months of August and September, the people living near to the river were obliged to recover, and with it pay a certain tribute to the Archbishop of Sevilla, who claimed to be the only person entitled to this 'usufruct'; persons depriving him of any of it being liable to punishment.

[This material so deposited referred to is still collected in the summer and sold to painters or colourmen, by those who care to take the trouble to do so, generally by a few millers residing near to the railway stations of Gadea and Niebla, about half-way to Huelva.]

"Here the people do not appear to know the actual cause of this permanent discolourment of the water, being content with attributing it to the water proceeding from the mineral veins of iron or 'caparrosa,' although there is another point or explana-

tion of the matter, *which I have kept secret*; this river has apparently always been known as the 'rio tinto' or 'cloud-river.' In it no kind of fish or any sort of life can exist, neither may persons, nor animals, drink of it with impunity, nor can it be utilized for any of the ordinary purposes of domestic life. It has nevertheless several curious and meritorious properties. If any person drink a small quantity of this water he will be relieved if troubled with any internal difficulty arising from the presence of anything like 'hydotids'; it is also reported to be highly curative of some disorders of the eyes and of cutaneous ailments such as 'herpes.' Its medicinal properties seem to be well-known and are very generally made use of.

"This water has another and very distinctive peculiarity or property, that *if iron be placed in it, in a few days the iron disappears*; this I proved.

"No sand is found in the river bed, nor any loose stones or rocks, inasmuch as the water has the peculiar power of binding everything in it into a hard solid mass.

"In searching for the lodes of mineral we found two large hills on both of which were evident signs of other methods of labour—shafts made for the purpose of working at the extraction of mineral and for giving light and ventilation; others again, not for mineral, but made for the drainage of the works as they progressed.

"I found more than fifty of such shafts in and about this locality" [evidently that now known as "San Dionisis"—according to Figueroa]. "One of them had a depth of fifteen 'estados' or 'estadales,'"

[165 feet], "and close to it, about eight paces away, starts another stream" [now known as the "Tintillo,"] "similar in character to the other stream, the 'Rio Tinto.'

"Many other things in this locality were left unascertained or undetermined owing to the dense growth of brushwood and the broken and very rough state of the country.

"Search was then made to find the sites of the old refining works or furnaces, to ascertain, if possible, if the ancients worked in silver or other metal, but I could not find any traces of them, again owing to the density of the 'monte'" [scrub]. "But we found on the top of the highest hills ruins and indications of old edifices, and on further search and excavation, discovered a small quantity of lead at a depth of one 'estado,'" [eleven feet] "from which I deduced *that the ancients possessed, and worked in, lead ores, and that their object in view in treating such ores, was to obtain silver.*"

Here reference is undoubtedly made to the ruins of the "Castillo de Salomon," the foundations of which were seen by the writer in 1885, and are now almost obliterated. In the year 1887, whilst searching in the—apparently—four basement rooms, little larger than cells about eight feet square, the drainage of them was found to have been provided for. The earthenware tiles, semi-circular, forming the "piping" for the drainage, of which, concealed in the loose earth, a few still remained entire, were of a large size. From this place too, several Roman sarcophagi are said to have been obtained. The statements of Delgado as to the discovery by him

of the ancient workings in the mineral are very important (he wrote in 1556) as they go far to prove the working of the mines by the Romans or others, and that the ruins of the castle on " Cerro Salomon " had been a provisional depôt of valuable products before transport to another place.

" The residents," continued Delgado, " on being questioned as to what they knew by report or otherwise of the old workings, replied that it was commonly believed in this district, and that history stated, that Spain gave to the Romans certain tribute of silver and gold, and that it came from this place.

" Having done everything possible to procure full information about the mine, I returned to Aracena on the 12th of August, 1556, where Don Francisco de Mendoza was awaiting us. To him I gave a full account of our labours, explorations, and discoveries, at the same time handing to him the various samples of mineral I had obtained at Rio Tinto, for him to deal with them as he best saw fit, to ascertain their value." (Gonzalez : *Noticia Historica.*)

This report was submitted to the King, Philip the Second, who believed, on ascertaining its import, that another " Gaudalcanal " had been discovered. On September 1, 1556, he wrote to Mendoza as follows : " And after having made the ' ensayos ' " [assays] " of Valverde and *Zalamea* " [ore] " let me know how they turn out."

The ore from Valverde both now and at this period referred to, was probably obtained from the " Sotiel Coronada " mine, another of the many worked by the Romans in this part of the province.

The assays could not be made by Mendoza in consequence of his being called away to take charge of a high political mission, but on his starting for Flanders in October of the same year, he placed the realization of his charge in the hands of the same priest, Delgado, ordering him to dig and to search for the metal that had been found at Rio Tinto to ascertain if it contained any useful product, in which case to put 'the mine,' 'recado,'" [to licence it] "as had been ordered by the Council "de Hacienda."

This was the department of the Government then charged with the supervision and control of mines. But the numerous duties which then weighed upon it, not only those of an ordinary character, but those also created by the unfortunate condition of the country generally, impeded the minister from looking at this possibly great aid to the national wealth with that zeal and preference which it undoubtedly demanded; with the result that when the delegate of Mendoza moved in the matter, when he wrote again and again insisting on the great importance of the re-discovered mine, he had to lament equally the lenitude with which the Crown treated his urgent communications, and the indifference with which they looked at his, to them, extraordinary and ridiculous theories and propositions.

Probably the "Consejo de Hacienda"—Council of Finance—on receiving his statements from the King, did not see anything more in them than the petition of an indigent priest pointing out the existence of probable profit and advantage to the State in order that he himself might be recom-

pensed, or a vain exposition of erroneous information, chimeras of a disorganized brain even!

Still there were to be found in the midst of his, then apparently, extravagant "Utopian schemes," useful admonitions affecting the advancement and prosperity of the mining industry of the country, which Philip the Second probably had in mind two years later.

The last letter the priest Delgado wrote to the founder of the Escorial was dated June 10, 1557.

Accompanying it he sent three small buttons of silver, as to one of which he made the following explanation: "That it weighed 3½ grains and came from the vein of mineral at 'Zalamea la Vieja'" [Rio Tinto], "that it did not contain any lead, that there existed large quantites of the mineral from which it had been obtained, that the ancients had been proved to have procured much profit and wealth from the mine, and with that, *satisfied the tribute then paid by Spain to Rome.* In these parts I have discovered very important secrets."

This was the ultimate suggestion and admonition of Padre Diego Delgado concerning the Rio Tinto Mine.

The contemptuous indifference and neglect of the Ministro de Hacienda, Chancellor of the Exchequer, the silence of the King, to whom in despair he finally wrote and appealed, obliged him to abandon the mine of Guadalcanal where he had been vainly awaiting their determination.

As a final step he went to Vallodolid, the then residence of the Court, to endeavour in person to ventilate his pretensions, with the hope of bringing

about a definite and favourable result, but he failed completely in his project, and died at Vallodolid in the month of August, 1557. A few days afterwards, on the margin of his last supplicative letter, Philip wrote : " He is dead. This may be sent to Don Francisco in order that he examine into the matter and advise me if the place or mine is as alleged."

A year later Mendoza returned to Guadalcanal and subsequently re-visited the districts of Zalamea la Real, Aracena, Galaroza and others ; nothing is extant, however, to show what steps he ultimately took ; the shadow of " forgotten " once again covered the mine of Rio Tinto, and it was again to remain buried, for a considerable period, in silence and oblivion. Mendoza either failed to see any importance in the discoveries of Delgado, or if he did, said nothing about them in their favour, and the Crown apparently did nothing further in the matter.

This interregnum will serve to admit the mention of some of the more important mining laws made about this period.

The Princess Doña Juana, in the absence of her consort, Philip the Second, on June 10, 1559, again incorporated to the Crown all mines of gold and silver, and quicksilver and established regulations for the working of them. The preamble of this new piece of legislation deplored the circumstance that so few mines had been discovered or " denounced," in spite of the facilities conceded in that of John the First, in which, however, was noted amongst other matters the favours and privileges conceded to the governing classes—especially to the clergy and the

provinces—absorbing the wealth of the whole of the Peninsula, and thus interfering materially with its development and even with discovery (for the law of Briviesca provided for or exacted the previous licence of the proprietor of the land as well); all of notable prejudice to the Crown and patrimony, and consequent loss, damage, and impediment, to the individual and national prosperity.

The new statute of Vallodolid cancelled all those grants and privileges which had been such serious obstacles in the way of the mining industry, revoked those concessions in favour of the general interest and welfare, reverted to the sovereign the ownership of all minerals in the subsoil, to grant them anew freely and indifferently to all who were willing to search for, and labour in, mines and their products, with the end that both Crown and subject might be mutually benefited. "Porque el reducir é incorporar los dichos mineros in Nos y en nuestro real patrimonio . . . es nuestro intencion y voluntad, que los nuestros subditos y naturales participen y hayen parte en los dichos mineros y se ocupen en el descrubrimento y beneficio de ellos." (*Novis Recop.* lib. ix. tit. xviii., leg. iii.)

This new legislation was received with some enthusiasm, to judge from the increased number of denunciations and registrations that followed, but stagnation and indifference almost immediately supervened, when the ambitious hopes of easy fortune and treasure were not instantly realized. This spasmodic interest could only endure a brief period; the law itself was an obstacle to the development of the interests which it really attempted to create and foster.

The onerous charges demanded or conditions imposed damped the aspirations of the energetic and forbade the free employment of capital. Its vague meaning, with respect to the principles of property and of right, left a door wide open for the admission of abuses by the same authority, in that it contained no phrase or clause distinctly giving the necessary protection to the interests and life of the miner—not one single paragraph definitely determining an ownership or property in the industry. The fortune of the " spontaneous explorer " was exampled in that of the owners of the mine of Guadalcanal already referred to, which had, in consequence of the report of the Marquis de Falces, who had been appointed to make an assessment of the value of it for taxation and tribute, been taken forcible possession of by the Crown, without any respect or consideration being shown; ultimately, and only as a special favour, conceding a small gratuity to one Martin Delgado, who was held by the Crown to be worthy of it as having been the real re-discoverer of the mine.

The official work and exploration by Mendoza and Diego Delgado having then been forgotten or discountenanced no others ventured to explore further at Rio Tinto, no doubt fearing the ambiguity of the law and the abuses possible under it exampled in the case of the mine just referred to—not far removed from Rio Tinto.

Four years afterwards, in 1563, the law made by the Sovereign-Princess was slightly varied in some small unimportant respects, but remained intact alike in its spirit, its ambiguity, and its tendencies.

On September 20, 1569, some thirteen years after the determined but ineffectual attempts of Padre Delgado to excite an interest in this locality, one Juan de Cabrera registered a mine at the proper offices in Madrid, then styled the chief office of accounts," situated in the district of Zalamea, below the old castle, in an ancient cave, of red mineral or metal," and on January 13, 1570 registered also, before the royal authorities at Guadalcanal another mining right, "of the 'escoriales' existing at the 'Dehesa' [north lode], "Gangosa, and Llanos del Valle." Four days later similarly Cabrera denounced " a mine of whatever kind of mineral in the district of Zalamea, at the places called 'Venta de Gangosa,' and 'Puerto Rubio,' also 'Cimada de Rio Tinto.'"

On June 13, 1570, one Francisco Perez de Canales, acting on behalf of Diego Blanco, of Valencia, registered a claim to " certain large and small deposits of 'escoriae' in the district of Zalamea, from the sources or origin of the Rio Tinto and the cave called 'Salitre,' to the place or house called 'de los Franceces,'" and at the same time registered the said cave of "Salitre," which is near to the source of the Rio Tinto, and also referred to 'escoriales' "situated in front of the Caves 'Sobial' and 'Murcielago,' where a road or path leads from the 'Huerta de la Cana,' to the 'Casa de los Francisco.'." On the same day, month and year, and before the referred to officials at Gaudalcanal, Diego Blanco, again through the agency of Francisco Perez de Canales, reproduced or reaffirmed the registration first made by him so as to comprehend " all the escoriales" of the district of Zalamea.

Further, on June 17, 1570, Bartolome Hernandez through the agency of Juan del Valle, repeated a previous registration of " a mine of whatsoever kind of mineral in the district of Zalamea at the site called ' Puerto Rubio, or ' Cimada di Rio Tinto.' " (Gonzalez : *Registro historico.*)

It would thus seem that public attention had been brought to bear on the so long hidden and forgotten lodes of Rio Tinto. But the movement proved to be but merely spasmodic and ineffectual in producing any practical or substantial good, and throughout Spain the mining industry languished in spite of all the efforts of individuals, and of the ostensible " aid " of special legislation, the personal interest of the Crown, and of able writers like Diego Delgado and Bernardo Perez de Vargas (1569); none of them individually or collectively were sufficient or able to promote a genuine and thorough opening up and development of an industry, which, however important, appeared shortly to be tame, sterile, and insignificant, in spite of those who saw the " galleons " arriving from the New World of Cristobal Colon, laden with substantial treasure of immense quantities of gold and silver.

The opening of the seventeenth century saw a heavy blow dealt to the domestic and industrial enterprise and to the prosperity of the Peninsula in the determined efforts of the Castilian Government to procure the complete expulsion of the Moorish population of Spain ; although, in some slight compensation further legislation promulgated in the years 1584, 1607, and again in 1624, attempted, or was created with the avowed purpose of giving,

greater assistance and a fresh impulse to it. The edicts of expatriation of Philip the Third and Philip the Fourth did more than nullify the effects of the perhaps well-intended legislation in favour of mining.

On June 16, 1624, a Council of Mines was created, which, issuing further and more attractive regulations, to some extent re-awakened public interest and freshly aroused private energy; to such an extent, indeed, that Gallardo Fernandez (cap. vi. par. 1) says that during the time of Carranza, in the year 1629, there existed upwards of 13,000 registrations of mines, "of which no less a number than 8,000 were made in respect of ancient mines."

Naturally, the attention of the Council was attracted to the enormous ruins and "escoriales" of the Rio Tinto Mine, and as a consequence on November 1, 1627, Philip the Fourth directed a resolution that this mine should *again* be examined and tested, appointing Don Gregorio Lopez Madera a "Licenciado" and one of the Mining Council, to carry out the charge and duly to report. His instructions in the matter were contained in the following interesting despatches:—

"The King: To Licenciado Gregorio Lopez Madera, of my Council, who has also been appointed by me to be of the Council of Mines. . . . You will take with you Captain Tomàs de Cardona, Master of my Chamber or Household, and Fiscal of the Council of Mines, who has much knowledge of the metal and its locality, and go with him to the town

of Zalamea and site of Rio Tinto, and to all other places necessary, and examine fully the mines, minerals, hills, 'montes,' forest or scrub, caves, adits and 'escoriales' . . . and freely report thereon."

That of the Royal Council of Mines was as follows :—

"Firstly you will set out from the City of Madrid as soon as possible, taking with you Don Tomàs de Cardona, Master of the Royal Household and Fiscal of the Royal Council of Mines, who is in possession of much valuable information as to the metals and the sites in which they are to be found, and is, as well, skilful and practical in these and similar matters.

"At the same time you will take with you officials and workmen, smelters and assayists, as you may require and find necessary for the purpose.

"After having inspected the mines at Guadalcanal you will proceed to Zalamea la Sierra (Real) and the place called 'Rio Tinto' and to all other places that may be convenient to examine and inspect all mines, metals, veins, lodes, outcrops, caves, drivages and pits, to be found thereabouts: what quantity of the metal 'campanil' (escoria) there is in sight, and of what quality.

"Also the cost, approximately, of smelting and of coining money from it per quintal, for that purpose and end making such smeltings and assays, both on a large and on a small scale, and all such other proofs and proper demonstrations, which, to the miners, smelters, officials, and other practical persons of satisfaction and confidence, may be expedient and necessary, in order that they may,

with all clearness, security, and accuracy, be able to determine and state the truth of the matter, of so much importance to His Majesty the King, in this concern.

" And whereas there exists at the City of Sevilla, generally working, a large foundry, for the manufacture of artillery, shot, bells, and other labour in copper, alloyed with tin, and it being the expedient of the experts that this metal (of Rio Tinto) might be useful and applicable to those uses, and possibly save the blending with tin, you will make all such tests and smeltings as may be necessary, and inform the Council of Mines of the result.

" You will also bring with you to Madrid examples of all such minerals as you may discover in order that further test may be made for further confirmation and proof." (Gonzalez: *Relacion general, Tomo* II.)

It is very evident from this that the Government possessed some detailed information about Rio Tinto, but it is difficult to say if it proceeded from or was indirectly the result of the labours of the unfortunate Delgado, 70 years previous to the epoch now under citation.

Apparently the latter injunction was duly attended to, for the Council received some specimens of mineral and procured an analysis as appears by the following document, quoted by Gonzalez in the work just quoted.

" At Aranjuez, *1st May*, 1628.

" Cedula of His Majesty the King, that the Receiver of Mines pay to Geronimo del Vado 34,000

maravedis for the labour and cost of assaying and smelting new ores from Zalamea, and of making money, mortars, bells, and other pieces, from them."

But the full report to which all the above gave place and which was undoubtedly made and published, is not extant or available—only the opinion of Don Tomàs de Cardona and his officials, is. According to that, the " white metal " (" metal blanquillo ") of Zalamea " was practically a new metal," and he was in favour of it not only being employed in the coinage of money, but also in the making of cannon-balls, church bells, etc., as a result of the experiments and analyses he had made.

The Royal Council of Castilla, to whom this question was then submitted, issued, in opposition to that report, a " statement of doubts " (" papel de dudas "), which again, in due course, was combated by Cardona. Finally it seems to have been determined, and correctly too, that this " white metal " was nothing but a special kind of " escoria " without any intrinsic merit or value.

It may be here mentioned that a modern analysis of samples of this special " escoria," or white metal, shows no traces of gold or silver and only a very small percentage of copper. Whatever may have been the methods of smelting employed, the extraction of all valuable or useful contents was very thorough.

The following analysis of a sample obtained from amongst some heaps of ancient " escoriae " near to the spot known as " Malaño," shows plainly enough its actual value:—

Metallic iron	63·9	Sulphur	2·7
Oxide of iron	3·4	Copper	1·3
Arsenic	18·8	Silica	·3
Antimony	6·7	Lime	·5
Lead	2·4	Bismuth	·07

From the period of this interesting controversy until the end of the seventeenth century, according to official records, three further and separate attempts were made to beneficially work the Rio Tinto Mine.

The first dates from August 3, 1637, on which date the Crown conceded a "cedula" authorizing "the Captain Francisco Moreno de Busto *to again work* in certain mines at a place called Rio Tinto, Province of Sevilla" [sic] "the adits ('socabones') of which are known to be filled with water, and are located, one on the 'Cerro del Castillo Viejo (Cerro Salomon), on its eastern side, the other on the western side near to a shoulder of the same hill, and called 'Puerto Rubio,' and the caves known as 'del Salitre' and 'Murcielagos.'"

Another "cedula" or licence was issued on March 21, 1661, of very considerable interest and importance, granting authority to Don Alvaro Alonso de Garfias for that, "with the water forming the origin of the Rio Tinto, and the 'escoriales' and 'metal blanquillo' or 'white metal' of Zalamea la Real and the village of Rio Tinto, he might precipitate (cuajar) sulphate of iron (caparrosa) and convert iron into copper by placing it into that water." In this grant, it is worth remarking, appears the first mention of the idea or process known to-day as that of "cementation," which has proved of such con-

siderable utility and profit to the present Company, and is so very generally practised in other copper mines throughout Spain. This idea had for its immediate object the saving of that perennial stream of copper in solution which, for centuries untold, unchecked, has been finding its way to the Atlantic.

Again, Gonzalez, in his *Registro de Minas*, records that on May 16, 1695, another "cedula" was granted by King Charles the Second, conceding licence to Don Roque de Salas y Ulloa, authorizing him "to benefit the waters of the Rios Tinto and Tintillo, to fabricate different metals."

The wording of the first of these three concessions would seem to convey the impression that those who granted them were fully aware of the fact that these mines had been worked by the ancients.

The issue of these "cedulas," one after the other, without reference the one to the other, would but seem to indicate the sterility of result which marked their issue.

The Royal Council of Mines was not, however, destined to be the means to call into existence and to regenerate that industry which Celts had founded, both Phoenicians and Carthaginians fomented, and Romans had later developed on such an immense scale as to defy the efforts of time to obliterate them; and the special powers and attributes of that body were absorbed and vested in the Department of "Hacienda" (Finance) about the year 1643.

True it is that from December, 1677, until 1700, this Council of Mines was again seen directing all that related to mining; but the close of the century

witnessed that matter relegated to the direct authority of the Crown.

Thus had passed 150 years in vain and seemingly endless attempts to re-open the mysterious lodes and reveal the hidden wealth of the Rio Tinto Mine; and the eighteenth century dawned with silence and oblivion once more resting on the locality.

CHAPTER III

FROM 1700 TO 1740—A FOREIGNER RE-HABILITATES THE MINES —LIEBERT WOLTERS—HIS "MANIFESTO"—PROJECT OF A COMPANY—AN EARLY MINING EXPERT'S REPORT—ROBERT SHEE—EFFORTS OF WOLTERS AND TIQUET—LEASE TO LADY MARY TERESA HERBERT

IN the series of centuries that passed between the evacuation of Boetica by the Roman legions and the period now arrived at—1700—absolutely nothing can be seen of any vigorous or solid attempts to open out the hidden yet suspected wealth of the Rio Tinto Mine, and during those thirteen centuries the place may be said to have remained deserted and forgotten, save only when the determined if unsuccessful and despairing efforts of the unfortunate Padre Delgado interrupted for a moment the long period of total paralysis.

The emissaries of Philip the Second and of Philip the Fourth who visited this district to investigate, to prove the existence of its suspected treasure, were only detained on the summit of "Cerro Salomon" by a sense of awe and admiration of the imposing aspect, afforded by the series of ruins of the works and industry of an indefatigable generation that appeared on all sides in such quantities. The dissolving instability of the various tribunals

created to deal successfully with the mining industry —as has been demonstrated—caused them utterly to fail in their purpose and object, and the commencement of the eighteenth century saw the unfortunate country once again convulsed with the horrors of civil war—of a " War of Succession "—and which, in the course of the long period it endured, seem to shake its institutions to pieces, and to have resulted in the complete exhaustion of its human forces. Spain was once again to be the " Campo de Bologna " for the settlement of political European duels.

When the struggle, which ended in a change of dynasty, terminated, the Peninsula found its power practically exhausted, its treasury empty, its administration disorganized, art, industry and commerce paralyzed, if not destroyed, and the country almost a desert.

But, fortunately, on the conclusion of a peace, the history of the Rio Tinto Mine was to be made luminous by the enterprise of a foreigner whom probably the spirit of adventure had attracted to Spain, if he was not called to its shores as many others had been, for reasons presently to be seen.

The presence of foreigners at the head of the mining industry in Spain for the next three centuries need not altogether be considered as remarkable. After the discovery of the famous mine at Guadalcanal in 1551, one of its administrators, Don Augustin de Zàrate, wrote to the government indicating the necessity which existed of procuring 200 or more Germans, or " labourers from the North," skilled in mining and metallurgy. The experiment

apparently had already been made on a limited scale. In the year 1556, at Guadalcanal there were working some ninety-three Germans, of which number some twelve or thirteen were officials, the rest being skilled workmen in mining.

Previous to this date, Mark and Cristobal Fuggars, rich business men, citizens of Augsburg, lessees of the already famous and important quicksilver mine of Almaden, in the year 1525, had brought into this country a numerous body of intelligent miners and smelters, whose descendants were still working at Guadalcanal also in the year 1632, and who eventually saw that mine worked out and practically exhausted.

Spain required, and fortunately had brought from the Erzegebirge, the then classical mining school of Europe, those who were destined to bring to light the long-hidden treasures of its sub-soil, and to establish on a true and substantial basis the industry which has always been of such vital importance to it and which to-day is its national pride. The fruit of this intelligent invasion was soon seen to be instanced in the labours of Zedler and Suren at Guadalcanal, Worth and Verger at Linares, Starr and Höppensack at Almaden, and of Wolters, Tiquet and Wert at Rio Tinto.

With the name, then, of an Anglo-Saxon, commences the modern history of this mine, and appropriately enough this work is written in sight of a street in the mine itself, properly named after Wolters to perpetuate his memory.

Liebert Wolters, a native of Stockholm, was living in Spain about the year 1720, earning a pre-

carious existence through the influence of the Ambassador of Bavaria, who had known him at Vigo, in the north of Spain, to be a deserving person of excellent character and repute. At Vigo, Wolters had worked as a diver, having been engaged in attempts to raise treasure reported or believed to have been sunk in that harbour, and the reasons which led Wolters to transfer his attention to mining and to Rio Tinto in particular, are set out in a "Manifesto" published at Madrid in 1725, at his instigation.

The pamphlet is styled, "Manifesto by Liebert Wolters Vonsihielm, a native of the Kingdom of Sweden, in which is set out and made public the Contract he has made with His Majesty the King, for the term of 30 years, regarding the mines of gold and silver of Guadalcanal, Rio Tinto, Cazalla, Aracena, and Galaroza, in the Provinces of Andalucia and Extramadura; and also the project and company to be formed by those persons desirous of entering into it to benefit their interests, and the various conditions imposed and expressed."

In it Wolters stated "that he was aware that in various provinces of Spain" [those just mentioned] "there had been worked mines of gold, silver, and other valuable metals, as abundant and as rich as any others in Europe, particularly at Guadalcanal, Rio Tinto, etc." He alleged "that the Condes de Fuggars, Germans, had held a contract ('asiento') with his Catholic Majesty King Philip the Second, and that with only the one mine which they had opened out and worked, that at Guadalcanal, they had made an immense fortune from the gold and

silver obtained from thence; and that they, being suspicious that the King, jealous of their successes, was thinking of rescinding the contract, deliberately had inundated the mine, and so spoiled it for everybody."

It is plain that Wolters was mistaken in his opinion and statement. His ideas, however, were held by many others, and led to large sums of money being spent in vain endeavours to drain the mine and to re-discover the lodes. Neither could the Condes de Fuggars have obtained from the mine in question their immense fortune in so short a period as four years, 1632–36, for during almost the whole of that period they were chiefly engaged in draining the mine, and at the time of their leaving it had not even succeeded in accomplishing that entirely. It is much more probable that the capital acquired by them arose out of profits obtained from the Mine of Almaden and the many and lucrative contracts, other than those concerning these mines, which they had made with the government.

"I am not ignorant," said Wolters, "of the fact that from this mine of Rio Tinto as much as 2,700 ducados of gold per day had been obtained from them, and that, although now full of mineralized water, they could be very easily drained and put into proper working order again." Nor did he fail to note "that many others, eager and desirous of emulating the success of the Condes de Fuggars, had already obtained grants from the Crown to extract gold and silver from them, but not being in possession of the necessary intelligence, knowledge, and proper

mechanical appliances and machinery, had been obliged to desist from their enterprises without having obtained any benefit or advantage."

Wolters doubtless alluded to the propositions of Don Juan Luis Ladron de Guevara, in 1714, and of Don Nicolas Vaillant in 1719, both of which had fallen through.

The petition to the king was dated or presented on August 16, 1724, and the royal warrant containing the "asiento" or contract with Wolters was dated June 16, 1725, contained eighteen clauses, and very fully sets out various conditions, prerogatives, privileges and exceptions.

At the same time Wolters published his "*Bases para la formacion de una Compañia,*" his scheme of forming a joint stock company, with a capital of about £20,000, of 2,000 shares of 50 doblones, each of two gold escudos, reserving to himself 700 fully paid shares, free of all liability. The articles of association were contained in sixteen clauses, and this very interesting and early instance of public mining company flotation is dated at Madrid, September 4, 1725.

Briefly, it may be mentioned, *inter alia,* that the form of subscription for each share was 5 doblones on application, 10 doblones on May 31, 1726, 10 doblones on July 1, 1726, and the balance of 25 doblones as and when might be found to be necessary and convenient.

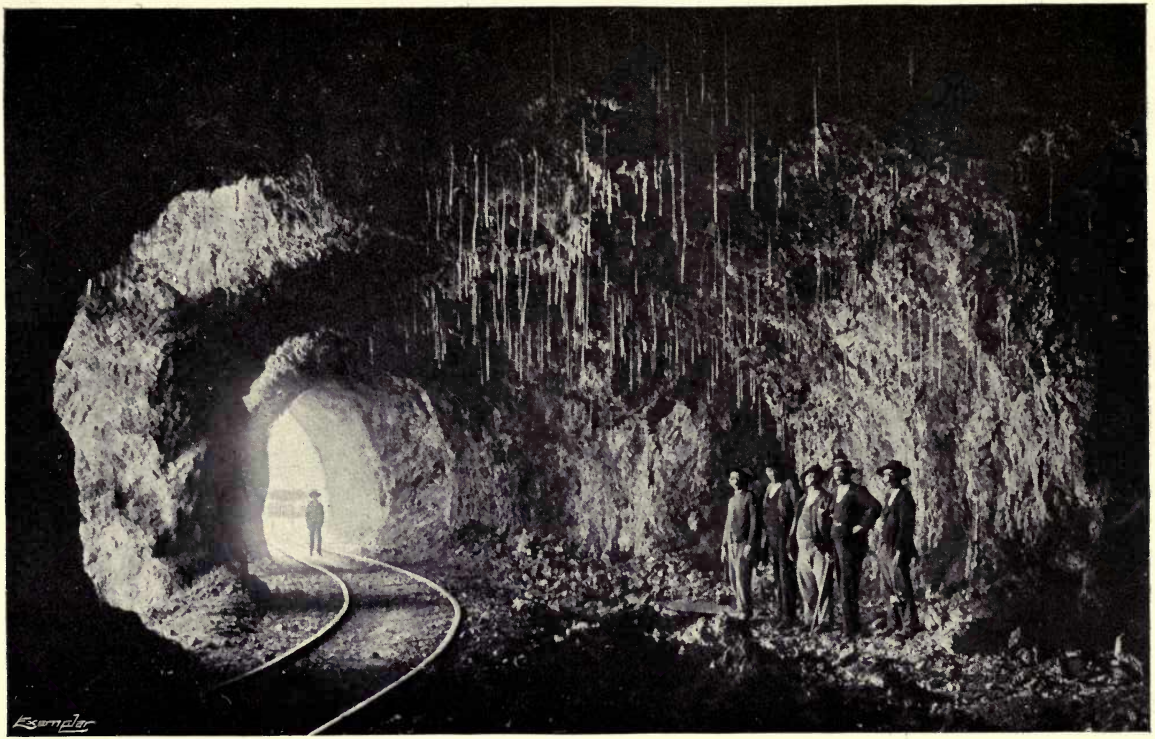
The power of voting at meetings was determined on the principle of one vote for every 20 shares, there being reserved to Wolters in respect of his 700 free shares, six votes only. To Wolters also was

reserved the right or privilege of being president of the company, and also the power of nominating, at pleasure, any other member or shareholder to fill that very important position.

In respect of his 700 free shares he was also entitled to an equal pro-rata distribution of the earnings with the other shareholders, after satisfaction of the one-fifth royalty reserved to the Crown, and the payment of all working costs and other expenses. Powers of transfer and forfeiture on non-payment of calls were also provided, and the shareholders were not to be liable, under any circumstances, to any further calls than those already stipulated to be paid.

As a result of the publication of the " Manifesto " and of the condition of the Corporation, some 60 persons were induced to become shareholders, " *several of them being ladies of the Royal Household,*" and the company was forthwith duly declared to be formed and constituted. It is very probable that amongst those ladies of the Court subscribing was the Englishwoman who very shortly was to be found in possession of these mines, and as to which matter full reference will be found elsewhere.

The project of Wolters was received by the press and the public with the harshest criticism, incredulity, and contempt. Numerous " folletins " were published, which, whilst strongly ridiculing the enterprise, were more particularly violent in their personal attacks on the author of the project. He was variously styled liar, swindler, and heretic. The most curious and ribald of these " brochures " were those published in Madrid in 1726 by Francisco



INTERIOR WORKINGS, MODERN ; SOUTH LODE.

Antonio de Ojeda, Jorje Dasildoiz, and Jorge Brito de Almansa.

Notwithstanding this very embittered opposition and the many and very persistent attempts to destroy his praiseworthy scheme, early in the following year, 1726—the project was made public in September, 1725—Wolters found himself in the satisfactory position, under the circumstances, of being able to count upon a subscription of upwards of 10,000 doblones, about £2,000, and was thus emboldened and enabled to write to Sweden and Germany for skilled miners, mechanics, and machinery, to enable a practical start to be made. According to Gonzalo Tarin he introduced 14 Swedes from Upsala.

The society or company, which there is reason to believe was named "La Española," again, no doubt at the instigation of Wolters, commissioned an engineer and "mining expert" to visit, inspect, and report upon the various mines granted under the concession; that is to say, after the shareholders had "paid up" they found that they required to know the real facts of the matter. To-day, after centuries of experience in this direction, *we do exactly the same.*

The expert selected was one Robert Shee; nothing is said of his antecedents. The "report" issued by him was strictly in conformity with what, judging from common experience in this direction, we should expect it to be—it was favourable; it contained many of the quite usual exaggerations so common, and perhaps necessary, in this class of "expert" document and business, especially when, along with unmistakable evidence of great mineral wealth,

tradition, rumour, and wild imagination conjured much more.

The "report" was duly published by him on March 23, 1726, and although not possessing any special merit, in a technical sense, it is perhaps on account of its considerable antiquity worth quotation, as it undoubtedly holds a place in the history of the Rio Tinto Mine.

Omitting so much of the first part of the report as dealt with the other mines of Guadalcanal, Cozalla, Galaroza, and Aracena (he apparently held a general commission to report), it runs as follows:

"Report of Don Roberto Shee of the 23rd of March, 1726, to the Council and individuals of the Company.

"RIO TINTO."

"In the District of Zalamea la Real is the mountain and locality known in these days as the 'Castillo Viejo,' where are still to be seen walls and ruins, remains of buildings created by the ancients, on its summit, and which appear to have once been part of a castle or fortress. From its elevated situation it was difficult of approach, and commanding; a good view of the country below and surroundings was obtained, and it must have been of some strength.

"From this hill, in two different places, on the north and south sides, exude streams of strongly discoloured and mineralized water, highly charged with foreign matter, and appropriately named at their junction and continuation the 'Rio Tinto.' This same name is also given to an 'aldea' or village of some eighty houses, distant about five

leagues from Aracena, twenty leagues from Guadalcanal, twelve from Sevilla, and two from Zalamea la Real. This latter town is a place of some 1,000 houses, with plenty of good water and fertile soil, and having an excellent situation and climate. Its people are industrious and well-to-do, having a considerable business in pigs, hides, honey, and wax.

"The village of Rio Tinto is somewhat contiguous to the hill referred to, which extends some 3,000 yards, at a considerable elevation above the country below. The south-western part, or slope, of it has been traversed by a road" ['camino,' 'carretera'] "still to be seen or identified in part, here and there—undoubtedly built by the Carthaginians or Romans for the transport of the products of these mines to the port and places of embarkation named San Juan del Puerto, situated some nine leagues distant from Rio Tinto. Near to this port is a castle or tower, now called the 'Castillo de Salomon' or 'Torre de Salomon,' in which (tradition says) the ancients stored the products of the Mines until an opportunity occurred for conveniently embarking these treasures to their destination."

NOTE.—There is some confusion manifest here; but that is the way the matter occurs in the copy of the report as given by Figueroa, *Ensayo* (p. 150). There is no record or even tradition or any tower or castle ever having existed at the town of San Juan del Puerto. Probably the confusion may be explained in this way: "The 'carretera' or cart road referred to evidently started from a place at the foot of the 'Cerro Colorado,' called then, as now,

'*Puerto* Rubio'; above it is, of course, the site of the old castle or tower referred to, and known as the 'Castillo de Salomon,' already mentioned. The site 'Puerto Rubio' has been confused with 'Puerto San Juan.' The word 'puerto' is very commonly used in this province to denote a neck or saddle between two mountains—a 'col' or 'collado.'

"So much exploration and work was performed at one part of the 'Cordillera,' that the 'escoriae,' resulting from the smelting furnaces, form huge mounds, many of them being equal in proportions to small hills, at and about the foot of the 'Cordillera,' and have received, or been the subject of, the greatest admiration, and have deeply impressed all those who have visited the place and seen them.

"It is very certain that the many different heaps, 'escoriales,' ancient and modern, which are elsewhere to be found, and even including those of the Indies, do not together equal these, proving undoubtedly this site to be the one most abundant and prolific in minerals known to the ancients in this kingdom, and a sufficient testimony to the riches, profit, and utility they experienced in the extraction and assaying of them.

"This is verified and substantiated, apart from what is indicated, if not proved, by the evidence of labour, subterranean and superficial, especially in the hills of 'escoriae,' and in the ruins of a rather considerable town, to which tradition has given the name of 'Gran Bitania,' to be found widely scattered on the lower slope of the north side of the hill, on which the tower or castle of Salomon in former times stood.

" Here and there remains of huge columns of cut stone, of an iron conglomerate, indications and remains of foundations and other parts still remaining as they fell centuries and ages ago, amply demonstrate, beyond any shadow of doubt, the size and importance of the place—that it has once been a large, prosperous, and important ' colony.'

" The Saracens also worked in this, the north side of the mines, and they, being skilful in such labour, constructed an aqueduct on the southern side at a much lower level than that of the site selected for working by the ancients on the north side. By it they worked towards the centre of the mine, with the objectof being able to work at lower levels in procuring a natural drainage, without having to have recourse to any artificial means ; and although to-day we find large deposits of vitriolized waters in the interior of this mountain, I believe that, as all might be made to drain out without the use of artificial means, it can be easily and quickly done ; and in that manner, at small cost, we can discover all the old, grand and important interior workings and riches.

" It is evident that the obstruction to the free exit of the water from the interior of the mine by that drain or aqueduct—for that is its present condition—is a stone of very large proportions, which, in my opinion, has been maliciously placed at the mouth of the eleventh shaft or ventilator of the aqueduct, in consequence of which the exit from the interior parts is interrupted, and there is no doubt but that the Saracens, *who were the last to work in these mines*, finding themselves hard pressed and obliged to retire from this place, adopted this

means of preventing the Spaniards from any easy adoption of the benefit of their own and earlier labours and explorations.

"The tradition is commonly current in this neighbourhood that in the various hollows and caves of this 'hill,' in its subterranean works, exist hidden treasure in great quantity, either in money or in metal; but what foundation or probability exists for such I cannot well understand, unless it be that, because of the sudden exodus of the Saracens after a long and prosperous occupation of the place, they must have been compelled to bury and leave behind, hidden, a certain quantity of treasure."

NOTE.—In the written history extant of the occupation, for upwards of seven centuries, of Andalucia by the Saracens, little or no mention is made of this part of the ancient Province of Boetica, although the Caliphate, or kingdom of Niebla, whose semi-ruined city-capital still stands not far from Huelva (about sixteen miles) occupies a rather prominent position, and to-day furnishes abundant proof of their residence in this district.

"For better explanation as to the aqueduct or drain referred to, it will be proper for me to state, your Excellencies, that it is so large as to permit the easy entrance of a person to work in it, and that, from its aperture at the foot of the hill to its conclusion, there are twenty-two shafts serving for light and ventilation, at a regular distance from each other of twelve yards; thus, the total length of this gallery is 264 yards.

"In the mouth of the eleventh ventilating shaft

there is placed the very large stone already referred to, which detains and arrests the free exit and drainage of the water from the interior and from the lodes. By it is formed a large lake of highly vitriolized water, very clean and translucent, so much so that the bottom can easily be distinguished, as well as the obstructing stone in its place.

"I had the curiosity to measure the depth of the water, and ascertained it to be about twelve estados" [about 132 feet]. "The highest of these ventilating shafts, that is, the last of them going up the hill, is some thirty 'estados' in depth, fifteen estados being in water.

"Of what particular kind of metal these ores are most abundant in, whether of gold or silver, it is not very easy to ascertain, but all indications lead it to be inferred that *gold is the principal item*"! [the opinion of the '*Expert*'!]. "But, apart from indications so patent (*sic*), which I have derived and deduced from documents of undoubtedly high authority, are the notices given by a most eminent subject on the working and treating of the metals obtained in Peru, and under whose guidance and teaching they are to-day being worked in the two kingdoms of the Indies.

"He came to this kingdom with two of the most expert assistants that could be found, under an order of King Philip the Fifth, and from the year 1648 until 1651 they were employed in the study and inspection of various mines" [some eighty years previously!]. "In that of Rio Tinto they were for some time employed, and after many and various experiences, discovered the method of separating the

mineral. In the memorial that he wrote of what he had done, he maintained that His Majesty had, in these works and in the 'escoriae,' immense treasure, having found but little silver, but a considerable part of gold; but as His Majesty wished to charge all the expenses in relation to the matter to the 'Hacienda'" [the treasury], "and remain interested in all produced, nothing resulted, partly because of the inefficient administration and large costs, and because there also existed at the same time the war with Portugal; the ultimate result and end being that this site and its abundant minerals remained forgotten.

"The metals which are herein indicated and referred to are not those as given or as extracted from these mines, but are those which had already suffered a first treatment by the ancients, and were by them left deposited and hidden, with the intention of returning again, to treat and assay them at a convenient time and opportunity. They are composed of many metals and different kinds of minerals, abounding in antimony, arsenic, sulphur, and iron; for which reason, in order to abstract the richer parts contained in them, it will be necessary to prosecute the method of extraction no doubt ascertainable in the archives of the year alluded to—of 1651—and there are many men of great skill able to extract and separate pure metal from impure, in the different kingdoms of the north." [Probably alluding to Germany or Sweden.]

"I know from my own personal knowledge that there are many persons well skilled in this art of extraction and separation elsewhere, and

do not doubt but that they will also be met with in Spain.

"I am unable to specify definitely and clearly what are or will be the pure metals to be obtained from these mines, but from all that I have referred to, the existence of the deposits of vitriolized waters in the interior, the copious quantities of 'vermellon' and 'caparrosa,' natural and fine, that are also so much in evidence, and of which I send samples to your Excellencies; all, in my judgment, undoubtedly indicate the abundance of and the superior value of the metals to be found there.

"At what period of antiquity and history, or under what particular government, the first attempts were made to extract and assay these minerals, I am quite unable to ascertain and certify, but, undoubtedly, operations have more or less continuously been carried on here for very many centuries; for the present I will simply take the evidence of pieces of money and medallions, casually found by 'pastores'" [herdsmen] "and others in and about the ruins of that ancient city of Gran Bitania" [alluding to those still to be seen near the village of the Dehesa, on the north side of the mines] "and of the old castle on the hill (Salomon), already referred to, which I have been able to acquire and hand to His Majesty the King. One is a piece of silver, a coin distinctly showing the bust and name of the Emperor Vespasian; another, of copper, of Julius Caesar; another, of copper and gold, rather worn, probably of Augustus Caesar; and also others, which, from their form, make, and similitude to others, I judge to be of the Caesars, Trojan and Tiberius, also of

copper and gold. Another, again, obtained from a stone sarcophagus, is very distinctly new, as though but recently coined; but, as the characters impressed upon it are in Arabic, I cannot pretend to determine to what period it may be ascribed.

"Although it is not at all necessary in this instance to determine or ascertain exactly how, when, or by whom these evidently ancient works were commenced and abandoned, I maintain that the art of extracting and smelting minerals, and the drainage of mines, is obliged no whit to the ancients; on the contrary, within a recent period the genius, industry, and application of the peoples of the different kingdoms have been materially developed and advanced by the ingenious discovery of so very many admirable mechanical appliances, instruments, and furnaces for the saving of labour in mines, and working in minerals and metals generally, and which to-day are beyond the comprehension of very many artificers and miners, who have not yet made use of them or had any practical acquaintance with their application.

"This, Sirs, I maintain, is all pertinent to the matter and very much in favour of it and to your advantage; in which supposition I conclude, supplicating that you will continue to be stimulated to and determined on the prosecution of this grand work. Providential signs are not wanting in your favour, as already a mine has been found abundant in 'carbon de fierro,' as to the quality of which expert opinion has been taken at the town of Guadalcanal, and I assert that it does not yield in character or favourable conditions to any of the very famous mines of England.

" At Cazalla, too, a no less valuable mine of 'azogue' "[quicksilver] " has been discovered, the use, importance, and value of which, in furnaces and in the separation and assaying of metals in general, is so notorious that I am excused from further praising them.

" Your company is not to be at the cost and charge of the government nor under the charge of its vassals ; you are neither contractors nor lessees of royal revenue, nor will your agents cause trouble or disturbance to the population of the district affected by your operations ; you do not pretend to form treasure palaces or castles at the cost of others or of the public ; finally, you do not propose to create certain offices that may become a burden or charge to the state revenues : on the contrary, animated by a valour and zeal most noble and profitable to the sovereign and his country generally, you employ your own capital and resources in the extraction from the bowels of the earth of a treasure and common benefit to all.

" From this industry that you seek to re-establish may be hoped and awaited the alleviation of the vassal, the help and succour of the necessitous, and the consolation of the widow and the orphan; all which considerations invite Spain in general to contribute to and promote the happy success of it, which may reasonably be anticipated under the beneficence of the Almighty Power, the favour and assistance of our renowned and pious monarchs, Philip and Isabella, the support of your illustrious company, and of the intelligent directorate. In this confidence I continue, desirous of other and

greater occasion to be able to employ my poor zeal and talents for the common good. Madrid, 23rd of March, 1726. D. ROBERTO SHEE."

Thus the rambling and peculiar phraseology of one of the earliest modern "Mining Expert's Reports." How many others, published since its date, better conceived and dictated, have led to greater or happier results than the opening-out, development, and success of the Rio Tinto Mine, at present giving direct and indirect employment to some 30,000 souls in Spain, and undoubtedly to many thousands elsewhere!

The issuing of this report was immediately followed by a general scramble for the administrative posts amongst the shareholders and their friends; disputes and discord were fomented, the capital was spent and wasted in other than the legitimate and proper objects for which it had been subscribed; the government was harried and pestered with petitions and suggestions as to procedure, which rather tended to increase the state of confusion than to re-establish order and procure a business-like control and conduct of affairs amongst the ill-advised shareholders.

In that unfortunate condition of matters, then, arrived the date, December 18, 1726, when practical operations were to have been commenced for carrying into effect the various conditions and stipulations contained in the "asiento" or concession of June 16, 1725.

In the midst of all the disorder Wolters on several occasions himself appealed to the king, who dictated several fresh directions, modifying to some extent

the original organization of the company, and instituting some rather severe measures against those members or shareholders causing the disorder and strife which were, apparently, supervening to paralyze all practical and beneficial work. But even these measures were insufficient or inefficacious. The General Committee of Management, believing that they held within their grasp the administration of enormous riches and treasure—either according to the asseverations of the Swedish adventurer, the report of Robert Shee, or from private or other sources —saw with but ill-concealed jealousy a wealthy foreigner, who held a large number of free shares, and enjoyed immunities and other privileges, placed at the head of, and possessed of almost entire direction of this colossal enterprise, without assisting with his own means the venture and hazard of the others in the result of the undertaking.

They connived, then, at his forcible removal from the head of affairs of the company, at the same time that he was engaged in procuring an equitable arrangement of the shareholders' interests, especially in relation to the better working of the widely-placed interests or mines, devoid of any roads or any means of convenient intercommunication. This was finally arranged, and on July 4, 1727, His Majesty resolved "that the company be divided and separated into two enterprises, and that of the five different mines belonging to it, those known as Rio Tinto and Aracena, under the rules and regulations already established, should be adjudicated to Don Liebert Wolters for his one-third *of the total number of shares*" [which are with but a slight differ-

ence the seven hundred allotted to him integrally for his own benefit as "free-shares"], "to which end they be segregated from the other mines appertaining to the company, in order that Wolters, in absolute independence of the 'Junta,' or council of the parent company, and of the Minister of 'Hacienda' (exchequer) might freely exploit and develop his own mines and interests, the mines of Cazalla, Guadalcanal, and Galaroza, remaining to the company, and the management, both governmental and economical, that had been conceded to Wolters under the first and original 'asiento,' or concession, being left separately to each of the new corporations, now created."

At the same time, under this decree one of the two "maquinas" purchased and brought by the company from "the North" was conceded to Wolters for him to utilize at Rio Tinto, and the other to the company, together with such of the foreign artificers and workmen as should be deemed necessary for the prosecution of the works; a legitimate preference and allocation, as the company had incurred the costs and charges of engaging and bringing them to Spain.

The separation having been carried into effect—putting an end to the acrimonious discussions and disagreements of the shareholders, and consolidating the hopes of the Swedish contractor—active steps were taken by him to proceed with the exploration and drainage of the Rio Tinto Mine, which undoubtedly occupied his attention in preference to the other mines.

Unfortunately, Wolters was unable to recover or receive any benefit from his labours; he died—shortly

after entering upon his newly constituted rights —on July 26, 1727, at Rio Tinto, and was there interred.

The royal decree, which gave effect and authority to the reconstruction, was dated and issued at the palace of San Lorenzo del Escorial on November 14, 1727; and there was included in the same order a resolution recognizing and determining the passing and transfer of all the rights, privileges and benefits of Don Liebert Wolters Vonsishielm, to his nephew, Samuel Tiquet—Wolters having made a will and nominated him to be his heir and successor.

Nor was the new and legally constituted possessor of the lease or concession of the Rio Tinto Mine free from trouble during the term for which he held it, on account of the partly successful annexation of this mine by the owners of those of Guadalcanal—trouble apparently ended by the decree of July 7, 1727; but the annexation was assiduously and very determinedly solicited and insisted upon by the lessees of the company to which had been allotted the mines of Guadalcanal, Cazalla, and Galaroza.

After the separation or division already indicated an Englishwoman, Doña Maria Teresa Herbert appears as contractor or lessee of this group; she is described as a daughter of the "Duke of Powis," peer of England, and, on December 12, 1727, made a contract or treaty with the original company of Wolters, named the "Española" from the date of his enforced retirement, and of the division, for the drainage of the mine of Guadalcanal, in consideration of the cession of two-fifths of the products —nett—indemnity of expenses, costs, etc.

Further information as to the details of this rather important and interesting document have not been met with nor are obtainable. Doña Maria may have been one of those "Dames" already referred to as having been amongst the first subscribers to Wolters' project in Madrid; she very probably represented some substantial interest hidden in this way, by the use of her name; it is not at all improbable that the British Embassy at Madrid at the time knew something of the matter.

The contractor apparently fulfilled her undertaking, completing the drainage of the mine (Guadalcanal) towards the end of June, 1732; but in spite of the technical report affirming it, and of the notifications duly conveyed, the company obstinately refused to carry out its share of the contract, although a call had actually been made upon the shareholders for the settlement and payment of the costs and amounts admittedly due by it to the English contractor.

This questionable conduct on the part of the company, which was very harshly described and stigmatized by various writers of the time—but without explaining it — gave occasion to a notorious law-suit—to the justifiable claims of Lady Mary Teresa Herbert, originating and bringing about ultimately its dissolution and disappearance. This was actually decreed on March 7, 1740, and as a consequence the ownership or right to work the mines of Guadalcanal "*and its aggregations*" was placed in her hands. This step, as will now be seen, brought Lady Herbert into possession of the

Rio Tinto Mine; it seem strange to find that English interests were largely at stake here, so long as 160 years ago.

By a Royal Charter, dated April 24, 1742, it was decreed and declared that "she, her heirs, successors, and assigns, might enjoy, and be in the possession of" the mines, so long as they were cultivated and explored, *with the same privileges and advantages conceded to Wolters in his cedula of the year* 1725; and that the time or period within which she might thus enjoy and benefit these mines be thirty years, to date from the day of the signing of this "asiento."

In virtue of this Royal Cedula, on June 26, 1742, Lady Herbert was ordered to be placed in possession of the "Mines of Guadalcanal, *Rio Tinto*, Cazalla, Galaroza and Aracena."

This, however, was not at all final, or by any means the ending of the matter, but only gave place to the claims of Samuel Tiquet, who had had his rights to the Mine of Rio Tinto consolidated, not only by the ratification and confirmation of the treaty or concession conceded to his uncle, Liebert Wolters, but also by virtue of the capital he had invested and spent in the drainage of some parts of the mine—by the introduction of foreign skilled labour and mechanical appliances, and by labour and capital expended in the treatment of the vitriolized waters.

His complaints and claims, notwithstanding their being well founded and equitable, were not favourably listened to, and on October 9, 1742, another decree appeared, determining that he, Samuel Tiquet,

together with his uncle, Liebert Wolters, had absolutely forfeited their rights to these mines; affirming that the Doña Maria Teresa Herbert should be maintained and sustained in possession and use of *all of them* in the way and manner prescribed in her asiento or lease, and refusing to admit against her, on the part of Tiquet or any other person whatever, any further claim.

This sentence was ratified and confirmed in another contract formulated and executed at the "Pardo," in Madrid, in her favour on March 7, 1743, the terms whereof being as follows:—

"Having regard to the non-fulfilment by Don Liebert Wolters of the obligations and stipulations contained in his lease of June 16, 1725, as to the drainage, development, and working of the mines of Guadalcanal, Rio Tinto, Cazalla, Aracena and Galaroza, and also to the similar non-fulfilment by the company of shareholders, named 'Española,' which afterwards was formed, confining itself to the working of the mines of Guadalcanal, Cazalla, and Galaroza, whilst Wolters undertook that of the Rio Tinto and Aracena mines—which arrangement resulted without effect and cancelled the titles and concessions—the leases having completely failed to comply with and carry out that which was expressly stipulated and agreed to in their leases:—I give and declare both Don Liebert Wolters and the company 'Española' and all its members to be totally excluded from any rights they, or any of them, might have acquired under their leases or contracts in the benefits and profits of the said five mines, or in any action at law they might have in this question, and

order that neither now nor at any other time may they be heard, nor any claim be admitted at any time for any reason, presented from whatever cause, title or reason, either from them or any other person or persons claiming by, through, from, or under them," etc., etc.

All this contentious matter is fully set out by Larruga in his *Memorias, etc.*, vol. xxxvii.

In this way is seen how in those days the rights in mining property were respected—rights which were unstable by reason of the unstability of those institutions formed to foster and develop them, and whose titles and grants apparently were dissipated, evaded, and audaciously destroyed by the breath, or at the instance of, favouritism and malicious intrigue.

In spite of this heavy blow to his prospects of success—this outrageous and utterly illegal spoliation authorized by the head of the state—in those days an authority autocratic and final—Tiquet courageously appealed again to the "Consejo de Hacienda," and after bitter and costly litigation between him and the strongly supported and determined lessee, Lady Herbert, that tribunal—which on other occasions had been against him—now dictated and gave *a decree in his favour*, confirming his right to those mines allotted to his deceased uncle, Wolters, at the time of the dissolution and reconstruction of the company of shareholders—the "Española"—and to Doña Maria Teresa Herbert the ownership of the others, which until then had been the "remora" of those explorations to which the Swedish contractors had dedicated

themselves with so much preference and assiduity.

Our history now demands the concentration of attention on the Rio Tinto Mine alone: the rights of its occupation and exploration having been consolidated by repeated legal determinations, we must now leave so much as concerns those other mines to be dealt with elsewhere.

CHAPTER IV

FROM 1750 TO 1800—CONCESSION TO SANZ—INTRODUCTION OF SMELTING—OF CEMENTATION—FIRST STATEMENTS OF PRODUCTION AND COSTS—EXPIRY OF CONCESSION—GOVERNMENT ADMINISTRATION—ZALAMEA LA REAL—OPEN-AIR CALCINATION

THIS equitable determination and judgment of the "Consejo de Hacienda"—the Government—excited Tiquet to demand further the renewal of the lease or concession granted to his uncle, Liebert Wolters, and he petitioned that he should be conceded a new lease to benefit "copper, vitriol, and copper solution, *the only products which could be obtained from these mines*"—a petition which was agreeably entertained, and the lease asked for was duly granted, in view of the benefits which would follow to the country generally in the establishment of such a desirable class of industry, and because also the local abundance of the products of these mines would obviate the necessity of seeking for them or purchasing them abroad, and so prevent the loss of capital to Spain.

This new "asiento," with its various "*gracias*" and exceptions and stipulations, was approved on July 27, 1746, its term being for thirty years, and proroguing the time of the primitive "asiento" until its expiry merged in the new one.

By it Tiquet was specially conceded (having in mind the considerable expenses hitherto incurred by him in the drainage of the mine) the introduction of, and payment of salaries to, the engineers and skilled labourers obtained from foreign countries, and in respect of which the value of all of the 700 free shares granted to Wolters in the original company had been employed and consumed; and the faculty and power to create 700 other free shares, without which resource and assistance it would have been impossible for him to have proceeded further with the working and development of the mines. These 700 new shares were to be issued, in the first place, if they elected to take them, to the original shareholders, and if not, then Tiquet was to be free to seek new subscribers (clause 8). Of this new "asiento" it will be sufficient to observe that the thirteen clauses composing it set out in full detail the history of the previous transactions between the Crown and Wolters—already related in substance.

Amongst these new shareholders and associates with Tiquet the man destined to rediscover practically the vast wealth so many centuries hidden from the light of day, and almost entirely forgotten, to found that colony of miners, to develop those works, to establish on a firm basis that industry which to-day is still in progress, to exhume, in fact,

the mummified and rigid body of the mining industry, and to reanimate and rejuvenate it with the breath and force of his zeal and intelligence, was fated to appear.

This veritable reformer of the condition of things in this part of Spain was one Francisco Tomàs Sanz, whom tradition describes as " from Valencia," where he had occupied a humble place in the world's affairs, and whom caprice or Providence had directed to Rio Tinto to offer his limited fortune to assist Tiquet, and also aid him with the not inconsequential co-operation of his abilities.

Promptly the lessee recognized the worth of his new associate, seeing him attend to all parts of the works with unceasing activity, and observing the correct impulses stimulating his labours and which characterized his conduct. Soon the simple shareholder was raised to the degree of confidant, and in the humble tailor of Valencia was presently to be discovered the administrator and rejuvenator of the Royal Mine of Rio Tinto.

But a short time passed ere he was found to be at the head of, and actually directing and controlling the enterprise—this being brought about by the death of Tiquet on September 11, 1758, Sanz being nominated trustee and administrator (" albacea ") of the deceased " asentista," and his substitute in the administration of these mines—recognized as existing by virtue of clause 9 of the " asiento " or lease of 1746.

The following are some of the clauses of Tiquet's will :—

" Be it known by this letter of testament that I,

Samuel Manuel Tiquet, bachelor, of Stockholm, capital of the kingdom of Sweden, Asentista (lessee) of the Royal Mine of Rio Tinto and Aracena, lawful son of Samuel Tiquet, deceased, and of his wife, Ester Wolters Vonsishielm, natives also of the said city and kingdom, being sick and lying ill in bed of a bodily infirmity which it has pleased his Divine Majesty to inflict upon me, and sound in judgment, speech, memory, and understanding, which He has been pleased to retain to me," etc., etc.

"4. I bequeath and give to Francisco Tomàs Sanz, my companion, all the furniture, linen, and clothes that I may possess in these royal mines, as also all silver-plate that there may be, in recognition of the esteem I hold for him, for the true friend and faithful companion that he has been to me."

"7. I declare, that for the maintenance of the mines referred to, their works and factories, I have contracted several debts, and that several amounts are due and owing to me from the mines as the fruit of the application of those monies and for other reasons, for all of which proof exists in the various writings and accounts in my possession, and in that of my creditors; and it is my wish and order that our mutual debts and claims should be paid, satisfied, and discharged."

"9. I declare that in virtue of the last, and existing, 'asiento'" [lease], "executed and issued by His Majesty the King (whom God preserve), there was graciously conceded to me faculty to create 700 shares, the which, together with other 99 of the old 'asiento,' now belong to me. In considera-

tion of, and bearing in mind the great care and interest taken by Jacob Constantine Keersse in my work in these mines—which I hope and believe he will continue to exercise, and which I rely on him to do—and for other and substantial reasons, I bequeath to his wife, Antonia Vigne 50 of the said shares, the corresponding values thereof to be received and disposed of by her in the way and manner she may think fit and convenient.

"10. I declare that from the year 1747 I have held, and still conserve, a faithful correspondence or relation with the said Francisco Tomàs Sanz, who has assisted and assists me in all my work, and in all that entrusted to his care, with the best energy, diligence, and disinterestedness (the which is but proper and right to bear in mind and reward), to such an extent that he is fully acquainted with, and understands all that in any way refers to or concerns these mines and their products, and also with all that which concerns its administration; in virtue of all which it is my wish and direction that if, in the duration of the 'asiento,' or any extension or prorogation thereof that may be generously conceded me, I should die, he should be nominated, and I hereby nominate and appoint the said Francisco Tomàs Sanz in my place, state, and representation, and confer upon him the same faculties powers, and rights that in me exist, for that, in my name and representation, he direct and administer these mines, substituting me in that care and responsibility: for all of which I possess full confidence in him, that he will see to the liquidation of all existing debts and obligations until they

are extinguished, giving full and sufficient account of all to my heirs, proceeding with all the due care, clearness, and integrity accustomed, keeping in correspondence and in touch with them, who shall not in any way have power to molest or disturb him in the free administration of that which I now leave to his care and control.

"And for the time he shall be engaged in the discharge of his obligations whilst in charge of these mines, and for such administration, he shall be paid the sum of twenty reals daily" [about eight shillings] "for his costs, expenses, and maintenance. The costs of actions-at-law, claims, and other such matter to be charged to, and to be paid out of the masa" [principal], "and at the conclusion of the undertaking and responsibility he shall be entitled to and be paid out of the one-half of the value of all my assets to which I might have been entitled, if I had lived.

"11. And to satisfy, pay, and discharge this my Testament, its charges and obligations, I appoint as my Albaceas Testamentarias, Jacobo Constantino Keersse, citizen of Sevilla, and Francisco Tomàs Sanz, jointly and severally.

"And, this my Testament, and all which therein is contained and directed, discharged, paid, and fulfilled in the rest, residue, and remainder of all my goods, chattels, and effects, real and personal, debts, rights, shares, and other things which I may have or may belong or appertain to me at the time of my decease, I institute, name and appoint to be my sole legitimate and universal heir, the said Ester Wolters Vonsishielm; and if she should have pre-

deceased me, to Juana Tiquet, the lawful wife of Jacobo Brounya, and to Carlota Tiquet, the lawful wife of Joaquin Estral, both being my sisters and citizens of the city of Stockholm referred to, in equal half parts, share and share alike," etc. etc. . . . "in all of which heretofore set out, by virtue of the faculties and powers conferred and conceded to me in the 'asiento' I hold of these mines, I name and appoint my heirs as successors to hold it under the conditions and terms as set out in this my Testament; and I supplicate that His Majesty the King will graciously be pleased to concede his approbation and consent thereto.

"Signed before the Escribano Publico of the town of Zalamea da Real the 9th day of September 1758; being witnesses thereto—Manuel Fernandez Berjarano, priest, curate of the parish of Rio Tinto. Martin de los Canos and Alonso Garcia Plaza, residents of these Royal Mines. Samuel Manuel Tiquet. Matias Garcia Maldonado, Escribano."

With this change in the administration a new epoch is arrived at in the history of the mine not altogether free from considerable and unfortunate tribulation and hindrance to progress.

Indifference to, if not despair of success, had become rooted and generalized amongst the shareholders, and, in view of the impossibility of placing or negotiating the 700 new shares conceded to him in the extension and amplification of his contract or lease, Tiquet was obliged to give many away, others again being forfeited by reason of the death or insolvency of their owners. Thus the strength and capital of the company was being slowly but surely under-

mined, and the doubts and adverse prognostications of those who had from the first criticized adversely the stability of the concern were found to be not entirely unfounded.

The optimistic but persecuted and villified Wolters had really done but little or nothing in the way of discovering and making known the hidden masses of mineral—such a vast formation should hardly be named a *lode*—and Tiquet entered upon his inheritance with but a limited number of suitable workmen established or resident in the village of Rio Tinto.

The long and costly litigation sustained with Lady Mary Teresa Herbert had considerably attenuated the capital and strength of the company; the difficulties met with in the treating and smelting of the mineral discovered in, and extracted from, the east side of the Cerro Salomon—obstacles which the German or Swedish smelters were unable to overcome until the years 1748–50—compelled the shareholders carefully to consider their interests, and from 1737, when copper was first produced under the lease to Wolters of 1725, attention and expenditure were chiefly confined to the treatment of the vitriolized waters obtained from the interior of the mine by means of the various shafts—called "pozos amargos"—and adits, one of the more important of them being known as the "Galeria Alta del Esosado del Carmen," or "de San Roque." By these means some inconsiderable amount of copper was obtained, not exceeding forty arrobas—about ten quintals = 1,000 pounds, annually, which was remitted either to the arsenal at Sevilla for the making of

cannon, etc., or to the Royal Mint for coinage. Of that quantity one-sixtieth reverted to the King as his royalty.

The problem of smelting having at last, but to some limited extent only, been solved in 1750, a foundry or furnace was erected at the site now called "Los Planes" in which *matte* and other forms of product obtained from an old form of furnace were further treated and refined. This new furnace was then known as "The Chorrito"; afterwards, from 1859 until recently, as "Santa Maria."

The product of this new furnace, or refinery, was called "cobre negro" (black copper),—and part of it was sent to the factor and agent at Sevilla, Don Constantino Keersse, where it was treated and refined again under his personal supervision.

The style of furnace, or refinery, then in vogue was still in use at the end of the eighteenth century, and they were called "Copelas Alemanas"; others of a small size and slightly different type were then substituted and were in use there at the time of the sale of the mine. This, on the authority of an old smelter who has worked there from 1850 to the present day. He further states that they were specially constructed for the refining of the "cobre negro" obtained by the first furnace treatment of the "cascara," or precipitate, as it is to-day called, obtained by the process of "cementation."

The "charge" varied from 200 to 500 pounds weight of "cascara" for each operation, and the product of fine copper per furnace every twenty-

four hours was from eight to fifteen quintals. Afterwards these furnaces were devoted solely to the production of "cobre negro"; each charge consisted of some seven or eight quintals of "cascara," or preicpitate, yielding a regulus of sixty-two to sixty-five per cent. of fine copper. This operation was repeated five or six times every twenty-four hours, and the total quantity of "cobre negro" thus produced was about thirty-five quintals per "horno," or furnace, per day.

A full description of these furnaces and the various processes are given in an article by the engineer, Fernando Bernaldez, published in the *Revista Minera*, vol. iv. p. 253 (1853), entitled "The Metallurgy of the Copper of Rio Tinto." Copious extracts and details are also to be found in an excellent work by Rua Figueroa, *Estudios*, p. 78, cap. 5 (1868). They were abolished on the Government taking over the administration of the mines at the end of the century, and others of another type were then substituted.

According to Elhnyar, in an article in the *Revista Minera*, vol. v. p. 109, it would appear that in 1803 the quantity of mineral treated in each furnace every twenty-four hours was 117 arrobas—about one and a half tons, consuming some eighty-five arrobas—about one ton—of vegetable charcoal, and resulting in about six arrobas = 150 pounds, of "cobre negro," or black copper. The fine copper percentage of this latter production oscillated between seventy-five and eighty per cent. Again, according to the same authority, during the year referred to, the average daily yield of "cobre negro"

SOUTH LODE OPEN-CUT, LOOKING WEST.

from each furnace was about 4·75 arrobas—about 120 pounds.

Many examples of these furnaces in a fair state of preservation were to be found, until recently, scattered throughout the province. At a comparatively recent date a supposed Roman furnace was brought to light at the Tharsis Copper Mine in a good state of preservation.

The work of extraction of the mineral by means of the "pozos amargos" mentioned was directed by a master miner, named Sacre Motard, who died in 1753, and whose position was occupied by one Juan Wert, progenitor of a family which to-day has representatives and direct descendants engaged in various responsible posts in these mines.

The attention of the company was now directed to the more thorough examination of the known or discovered mass or "criadero," the South Lode, the cleaning and draining of the "galerias" of San Pedro and San Roque (all traces of which and of many other works of later date and origin have been totally obliterated in the progress and development of the huge "Open-Cut" on the South Lode), and of the shafts and ventilators which on the surface indicated the route of the underground operations; and, in 1752, the accumulated vitriolized waters of the latter "galeria"—"San Roque"—were at length utilized, "cementation" tanks—"balsas"—were also constructed, canalization to them provided, and iron "planchas," from Vizcaya in the North of Spain, were used to effect the precipitation of the copper contents.

At this period the furnaces and smelting operations were under the direction of Jorge Ester, a native of the province of Galicia, who, dying in 1754, was substituted in that post by the brothers Miquel and Simon Forster, copper refiners by profession, and " the master-smelter," Juan Peringuer.

With the general development of exploration and work the general expenses of the establishment also increased, and it is interesting to note from the unmistakable evidence of the official accounts—some few of which have fortunately been preserved—that some practical realization had actually been made of the valuable assets so long lying untouched, but always believed to be in existence.

In the Appendix (Tables A to G) will be found statements showing the various products obtained, together with the costs between the years 1737 and 1872, an excellent register or indication in itself of the slow but sure development of these Mines in that period, and also clearly demonstrating the great importance of them even in those days.

The following statement shows the costs and production of copper whilst the mines remained under the direction of Tiquet, from 1747 to 1758. As to what took place under that of Wolters—as appears by Table A—it may be said that only exploratory work was attempted. Smelting was probably not attempted until 1749–50 (but no precise *data* are at hand) under the Wolters-Tiquet *régime*.

STATEMENT SHOWING THE QUANTITIES OF COPPER PRODUCED AT RIO TINTO DURING THE TIME OF TIQUET.

Year.	"Rosetta" copper obtained.			Paid to the King, his $\frac{1}{10}$.		Mines Costs.		Obs.
	Arrobas.	lb.	oz.	lb.	oz.	Reales.	Mds.	
1747	24	2	—	357	—	—	—	—
1748	3	15	—	186	8	—	—	—
1749	54	2	8	298	—	—	—	—
1750	283	2	—	276	8	68,815	—	—
1751	248	7	—	—	—	154,826	17	—
1752	536	9	—	—	—	192,104	—	—
1753	1,561	1	4	—	—	208,461	8	—
1754	896	18	8	—	—	190,227	17	—
1755	2,075	13	8	954	8	230,714	17	—
1756	3,066	6	4	986	—	227,895	17	—
1757	2,108	17	—	871	8	293,757	—	—
1758	2,051	11	—	854	12	140,650	—	to Sept. 30 only
Total	12,945	5	—	4,782	12	1,707,458	8	
Tons	163			60			—	£170,000

The "arroba" being equal to about 11½ kilos. or 25 pounds, the total quantity of copper produced was therefore about 162 tons of 2,000 pounds, costing apparently over £100 per ton, estimating the real at its normal value = 100 to the £; but if the "real da plata" is indicated, then the cost must have been over £200 per ton! These accounts, therefore, are not much to be relied on for the purposes of comparison.

The result of those operations apparently was that the products of the mines then were not by any

means sufficient to cover the costs of production, and at the time of the death of Tiquet, in 1758, the debts he had contracted in the prosecution of his labours of exploration and development on behalf of the company exceeded the sum of £6,000, whilst he left in property or personal assets only a very insignificant amount—said to be worth not more than £5.

The actual financial condition of the "Española" company on September 11, 1758, was as follows:—

Debts and liabilities of more than £6,000; and by way of assets:—

12 Houses		Several shafts and galleries;
1 Smelting furnace		and
1 Refining	„	Two kitchen gardens!

all in a state of considerable deterioration.

The 1,400 free shares conceded to the lessee had been distributed and were held in the following way:—

By Tiquet	799 shares
By the public	601 „
Total	1,400 Shares

But of these 601 shares supposed to be held by the public, no less than 207 had become forfeited.

At his death the 799 shares of Tiquet remained distributed:—

As legacy to Antonia Vigne	50 shares
To Francisco Tomàs Sanz, as his heir at-law .	374½ shares
To the other heirs-at-law	374½ shares
Total	799 shares

Such, then, was the lamentable financial condition in which Don Francisco Tomàs Sanz received these

mines on the death of Tiquet; and it is but proper to place on record that it was due to his indefatigable energy, intelligence, and activity alone, that the mines and their vast hidden wealth were not again allowed to be interred in the sepulchre of industrial paralysis and historical silence.

Want of confidence in, and indifference to, the success or failure of the enterprise had been thoroughly disseminated and established amongst the few remaining shareholders; the large debts contracted, the numerous exactions by the Government and its officials, the long period of illusory hope, the comparative insignificance of the products actually obtained, the sterility of their labours and efforts, incited a large proportion of the shareholders to abandon their shares and interests, and the new administrator, helped only by a son, remained almost alone to endeavour to carry out the dreams and plans of his predecessors Wolters and Tiquet.

Singularly enough, not far removed from the locality, and at the mouth of the river whose very sources were being utilized, the Rio Tinto—nearly three centuries previously, another determined and persevering adventurer, such as Sanz, was attempting another apparently chimerical enterprise, promising to reveal the existence of another world of riches in another hemisphere; and similarly his projects were styled as extravagant and hopeless follies, and he too experienced the greatest difficulty in uniting the necessary means for the development of the ideas and schemes "that burned in his brain."

The same scene was now reproduced at the sources

of the same river. Analogous hopes surged in the mind of Sanz, the same difficulties arose and beset him, equal paucity of practical assistance in the carrying out of his plans and proposals barred his progress. But in spite of all difficulties and obstacles Cristobal Colon revealed to an incredulous and amazed Christendom the outlines of a New World far beyond the horizon of the ocean, and Sanz was the means of opening out to modern industry the almost inexhaustible lodes of wealth and national prosperity buried and so long forgotten in the heart of the "Montes Marianaes," or mountains of Turdetania.

The new administrator, Sanz, finding himself almost alone, acquired such shares as he could from his associates and carried on the works and operations as best he could at his own cost. He sold the little property remaining to him in his native city of Valencia, dedicating everything, not only to the actual exploration of the Rio Tinto Mine, but also to the fulfilment of the charges and duties the testament of Tiquet had imposed upon him.

With the assistance of the mutilated and fragmentary documents that remain of the various official archives, it is possible, with more or less exactitude, to follow the development of the mines whilst under the administrations severally of Wolters, Tiquet, and Sanz. A reference to Tables A and B of the Appendix will show what was actually done by them in the way of copper production from 1732 to 1776.

A review of the operations by them up to this very important period in the mine's history shows that Wolters obtained little or no copper, that Tiquet

did not obtain full or free possession of them until 1746, nor obtain any substantial product as a result of his labours until 1748–9, about which time he had been enabled, to some extent, to solve the difficulty which had previously existed with regard to smelting and refining of the ordinary ores, and had constructed refineries and buildings equal to the production of about 350 metric tons of fine copper per annum. (Gonzalo Tarin, 9, 271, vol. ii. *Descripcion Minera, Provincia de Huelva.*)

But these improvements had but shortly been put into successful operation when the unfortunate Tiquet, upon whom strife, privation, and suffering had hardly pressed, died, leaving the further development of the work he had so actively and intelligently commenced and so diligently prosecuted in a favourable way for his successors, in some respects at least.

There do not appear to be in existence or available any records or information which refer to the then known formation or condition of the lodes as worked by Tiquet; it is only known, according to him, that they were " immense in size and that from them all that was desired could be obtained " ; that he had also shown that the irregular percentages of the copper contents of the mineral was a very considerable obstacle in the way of determining the problem of " treatment," because, requiring for the furnaces or smelters mineral containing more than four per cent. of copper, and not finding that average to prevail in the greater part of the mass, he was driven to extract a very large quantity of mineral of poor quality, useless in those days for

ordinary purposes, such at any rate as were known to him.

Such a circumstance and difficulty then obliged him to seek and follow the richer veins of mineral in the lodes as much or as closely as possible, this resulting as a matter of course in a state of great irregularity and confusion in the underground exploration, shortly afterwards very strongly complained of and condemned in the special report made by Don Francisco Angulo—referred to elsewhere—as being one of the most troublesome and objectionable features in the condition of the mine.

By virtue of a royal decree dated October 24, 1758, Don Francisco Sanz took formal possession of the mine, and entered upon his task of assisting at the re-discovery and development of it under conditions and circumstances more or less unfavourable to a successful issue.

His personal holding and administration of it lasted from that date until July 27, 1776, about eighteen years, on which date his concession from the Crown was definitely terminated, and the mine once again reverted to direct governmental administration, Sanz, however, being retained in charge of it as manager until he was finally released from all connexion with it in the year 1784.

According to Aldana his administration was "anything but successful and left much to be desired," but Rua Figueroa (1857)—an earlier and very competent authority to speak on this matter—in his admirable work on these mines, so very much made use of in this compilation, speaks or writes in

no indifferent terms of his application, energy, and faithful adherence to the difficult and very responsible task delegated to him as lessee and heir-at-law.

Before going further into the details of his work it will be seen on reference to Tables A and B that he had not only maintained but materially increased the output of fine copper and added substantially to the producing power of the furnaces and other works, as in 1761, within three years of his assuming charge, they yielded upwards of 6,000 arrobas (about seventy-five tons) of fine copper per annum.

It may be observed too that from very early in the eighteenth century the history of the mine has sensibly been made clearer and simpler in the preservation of the records quoted. However incomplete or inexact they may be in many important ways, they present an almost unbroken series of events for nearly 200 years.

The energies of Sanz were, by preference, dedicated to the investigation and exploration of the mass or lode, already partly discovered and worked, situated on the south side of the Cerro Salomon, known then also as the "Nerva" mass, later on, in 1874, the first object of attack and development by the present company, and the eastern portion of which to-day has been very considerably reduced in size on the upper levels, a huge pit upwards of 700 metres in length and 250 metres in width alone remaining to indicate its existence and its proportions.

The ancient exploratory works materially assisted and guided Sanz, although they must all have been

in a very ruinous condition after so many centuries of absolute abandonment and disuse.

With the object of procuring better ventilation in the interior works and the easier extraction of the mineral, in 1765 Sanz inaugurated the driving of an adit ("socabon") at the site called "Crucijada," and later, "Santa Barbara," communicating with a shaft also of that name. This adit or tunnel also was then called "Contramina," and that name still applies generally to the underground works here at the "San Dionisio" and at the "North Lode" masses.

According to Figueroa, in 1857 there still existed on the wall of the mouth or entrance of this "adit," "socabon," or "contramina," a lead tablet bearing the following inscription :—

MDCCLXV.
REINANDO el S.D. CARLOS III.
Spṽe aug: spṽe feliz. SIENDO
Su Adm: de estas REALES MINAS el
S.D. FRAN. THOMAS SANZ. se
hizo esta CONTRAMINA. P.S.P.

The name of "Nerva" was given to this "south lode" or mass, as that is called which lies beneath the southern slope of the "Cerro Salomon," it having been that of the earliest of the Roman emperors of whom positive and historical record had been found having relation to the mine. This tablet has unfortunately disappeared.

Encouraged and urged by the success of his efforts in this part of the mine, the indefatigable Sanz sought to thoroughly investigate it, and made

search for other lodes, making use of an ancient adit at the site in question to ascertain the extent of them in the very bowels of the "Cerro Salomon." He then discovered the tablet to Nerva referred to. But at the moment of the discovery of such an encouraging indication, of such good augury and hope, another fatal accident to some of the men engaged in working there caused a complete paralyzation of further exploration—such cessation apparently then being the custom. It would appear that at several different parts of the mine similar fatal occurrences invariably brought about a cessation of work at the spot for some considerable time. A fall of earth in the adit caused the death of two miners, and no one cared or dared to proceed further at the particular site under such "funestos" auspices.

As the subterranean exploration and development proceeded the zealous administrator was careful to create and provide the necessary elements for the treatment of the mineral to be opened out and extracted, and to his energy was due the construction of many furnaces, offices, and other works, which a century afterwards were admitted by the then administrator, Figueroa, to be of considerable utility, and well designed and constructed.

He cleared away the dense thickets of "monte bajo" (scrub or brushwood) which covered the slopes of the "Cerros" "Colorado" and "Salomon," and prepared a site for the calcination of the poor mineral —a position which to-day exists and is dedicated to that same particular purpose; he built four smelting furnaces, naming them "San Gabriel," "San José," "San Francisco de Paula," and "Nuestra

Señora del Rosario" ; forges, powder deposits, timber and refined copper stores ; established a service of water for use in the works and for the workmen ; and built roads and bridges at convenient sites for the easier transport of the mineral to the different sections of the works.

He took steps to provide for the material comfort of his workmen and their families, to attract and encourage them to become permanent residents and so to avoid the not inconsiderable trouble of periodical emigration, customary even to-day at certain seasons of the year all through Spain, especially at the times of the gathering of the grain, wine, and olive harvests.

With that object he built upwards of forty cottages and a church, a public bakery, etc., and conceived and studied the project, never carried out, however, of bringing into the village—the mine's township—by canalization and gravitation the excellent if somewhat inconsequential and intermittent water supply yielded by the spring or source called " La Fuente del Mal Año."

Bearing in mind too that sooner or later the necessity for having a sufficient supply of timber at hand of a suitable character for the mine's works, would perforce arise, and that, too, the near presence of forest growth would exercise a very beneficent influence upon the health of those living in the locality, he converted the almost barren slopes of the " Cerro de San Dionisio," " Mesa de los Pinos," " Pie de la Sierra," and other places near to into dense pine groves, and in like manner created oak forests at the " escorial " (north lode), " Barranco

del Campillo," and other sites in the immediate neighbourhood.

The Fathers Fray Gabriel, and Fray Pedro Mohedanos, of the Order of San Francisco de Granada, who visited Rio Tinto about the year 1780, during the administration of Sanz, have written some interesting matter concerning this. At the same time that they lamented the indifference with which the intelligent writers of their time had laboured at the history of the mine, they eulogized the energy and discretion of Sanz in his attempts at forest culture, and after referring to the general abandonment in Spain of this very necessary and highly important matter to the nation since the time of the expulsion of the Arabs, wrote as follows :

" In the neighbourhood of the Mine of Rio Tinto oak trees are found, but the greater part of the locality is covered with a dense and useless scrub or brushwood—' jarales.' Not a single pine hitherto had existed, but Don Francisco Tomàs Sanz, principal administrator of the mines, obtained from Niebla a supply of seed (*Pinuspinaea*) and sowed them broadcast. To-day already a handsome ' pinar ' is created, and later on it will without doubt serve as an important source of supply of timber for all the purposes of the establishment. These efforts at cultivation we have witnessed with much satisfaction, and we also understand from several persons intelligent in this matter that the copper obtained from this mine is of good quality, and not much blended with iron, as has been falsely stated with notable prejudice to the material and best interests of Spain. In this locality too we

noticed abundant evidence of antiquity, *of which until to-day nothing has been written*, but which certainly merits the attention of, and should be closely studied and informed upon by, some of our intelligent compatriots. The obligation under which we labour to continue with the main substance of our task, must suffocate the ardent desire we are possessed of to treat of these matters with sufficient amplitude. Referring, however, to the subject of the 'plantations' which have newly been created by Sanz at Rio Tinto, they demonstrate the advantages which would arise if similar undertakings were created or established in very many other parts of this country." (*Hist. lit. de España*, tomo viii. Madrid, 1781.)

As repeated observation has been made of the very barren and desert-like appearance of the mines and of the immediate neighbourhood owing to the absence of any vegetation or plant life, especially so to-day, it will not be out of place to mention that at other epochs a very different condition of things prevailed, and the following table will show that in spite of the rather unfavourable conditions of soil and climate, vegetation was neither inferior in quantity nor in quality. Of the greater plants there existed—

Ulmus campestis	Linn.	Vulg.	Alamo
Populus licumla	,,	,,	Chopo
Quercus ilex	,,	,,	Encina
Quercus suber	,,	,,	Alcornoque
Pinus pinaea	,,	,,	Pino del pais
Pinus hispanica	,,	,,	Pino gallego

Of "arbustos" or "monte-bajo" scrub plants—

Cistus ladaniferous	Linn	Vulg.	Jara
Cistus monopeliensis	,,	,,	Jaguarzo
Pistacia lentiscus	,,	,,	Lentisea
Pistacia terebinthus	,,	,,	Cornicabra
Mirtus comunis	,,	,,	Arrayan
Arbustus unedo	,,	,,	Madroño
Calluna vulgaris	Salisb	,,	Brezo
Phillirea augustiplia	Linn.	,,	Ladierna
Phillirea media	,,	,,	Labiernago
Nerium oleander	,,	,,	Adelfa
Quercus Coecifera	,,	,,	Coscoja

Of industrial plants—

Chamocrops humilis	Linn.	Vulg.	Palmito

plants of agricultural cultivation and utility—

Citrus amangium	Linn.	Vulg.	Narango
Persica vulgaris	Mill.	,,	Melocotonero
Prunus domestica	,,	,,	Cirolero
Pyrus malus	,,	,,	Manzano
Punica granatum	,,	,,	Granado
Olea enropea	,,	,,	Olivo
Ficus carica	,,	,,	Higuera
Vitus vinifera	,,	,,	Parra
Ipomœa batatas	,,	,,	Batata

Such were found to be in existence here at the period of the determination of the government to sell the Rio Tinto Mine in the year 1870.

The following observations are, for reference and convenient information, abstracted from the joint and several report and valuation of the engineers, published on May 11, 1871.

"In the various 'barrancos' or gullies, various kinds of acacia and mulberry are found acclimatized, and in the kitchen gardens" ["huertas"] "are cultivated the 'convolvulus batata'" [sweet potato] "many varieties of vegetable, and again, in favourable situations, wheat, barley, oats, and rye."

The growth of the pine exceeds that of the same tree in other parts of Spain; they were sown by Sanz a century ago, and excel even those of the "Landes" of the Gironde in the south of France. Of the larger examples many exceed 55 feet in height, having a circumference of upwards of 5 feet.

Generally speaking, the locality seems to favour the growth of the genera "pinus," "quercus," "cistus," and "calluna."

In the midst of such and various other tasks the active administrator also found time to pay attention to the necessity for procuring a proper and official definition and demarcation of the estate conceded under the lease or concession, with the object of putting an end, at once and for always, to the intrusions and abuses frequently emanating from or through the ayuntamiento or municipality of the town of Zalamea la Real, and of its inhabitants. These were of incessant occurrence almost from the date of the first concession to Wolters in 1725, and even in spite of the warnings and fines by the Crown of which such irregularities and abuses had been the cause, and which are more fully dealt with elsewhere.

The outlay by Sanz in the many works and labours of exploration and development was considerable, the total amounting, according to an authentic account, to the sum of 2,106,103 reals, exclusive of the sum of 472,329 reals, about £50,000 in all; supposing the real to be the real de plata, 5*d*., paid by Sanz to the various creditors of Tiquet. This expenditure covered the period 1759 to March, 1773;

THE "HUERTA ZUMAJO." TYPICAL ORCHARD AND FARM.

no records or accounts are available of the expenses or costs of the establishment from 1773 to 1783, when Sanz finally ceased to have anything to do with the mine, whether as lessee, or administrator for the government.

With this increased expenditure a substantial improvement took place in the production of copper, and whilst during the last five years of Tiquet's administration the average annual production of fine copper was only about 25 tons, that of the five years 1768–72 reached to about 80 tons.

Insignificant as these totals are compared with the output of 130 years later, over 30,000 tons per annum, they demonstrate the diligence of those early workers at the rejuvenation of the mine in the latter part of the eighteenth century, and show that the re-discovery of the mine had led to solid and practical result.

Whatever may have been the actual technical processes or treatment of the mineral at this period, it is now somewhat difficult to distinguish or describe them with only the assistance of such insufficient data as are now available, and which have survived the various moral shipwrecks the early modern "adventurers" of the Rio Tinto Mine suffered; moreover, it is not proposed to deal in detail with such technical matter—the history of the development of the processes of treating the ores of Rio Tinto must be undertaken by a much more competent writer.

In addition to the work already referred to in this connexion—that of Fernando Bernaldez—reference should be made to other treatises by Rua Figueroa, *Estudios*, Coruña, 1868; *Revista Minera* (vol. x.

Madrid, 1859; vol. iv. 1853; vol. xv. 1864; and vol. iii. 1852).

But perhaps it may not be out of place to say that about this period a considerable development took place in the extraction and first treatment of the mineral; in some measure a solution was reached of some of the problems which had hitherto existed in the smelting or refining of the products. Apparently four several kinds of fine copper were produced, the material treated being chiefly the "cascara" or "precipitate" obtained by the "cementation" process; the first, and poorest, "cobre negro," containing about 90 per cent., "cobre rosita" about 94 per cent., the "punto de martillo" about 96 per cent., and "cobre fino" about 98 per cent.

At this period (1750–70), according to an authority, and until the middle of the following century, no attempts were made to smelt the ores, excepting by way of experiment. Attention was chiefly directed to the treatment of the stores of vitriolized waters in the interior of the mine. The utilization of the cupriferous solutions to obtain the copper contents by means of the processes then and now named "cementation," the product being called "cascara" or "precipitate," appears to have been first put into practice at Rio Tinto in the year 1752, when some 120 arrobas—about one and a half tons—of Viziayan iron were used; but there does not appear to be any record extant of the amount of "cascara" or precipitate produced thereby.

It should be borne in mind, too, that some such process of "cementation" *was known* and was referred to in the licence or patent (?) granted by

the crown to Don Alvaro Alonso de Garfias in the year 1661, already alluded to in an early passage of this work. It has been variously claimed, on the authority of French and German authors, to have been an invention in these countries at the end of the eighteenth century, and as far as can be seen no reference is or has been made by them to this licence of 1661.

No records are available of the annual production of precipitate until the year 1788 is reached (table C), nor are there extant any records of the annual extraction of mineral until the year 1849, excepting that now given—

Year.	Mineral Extracted. — Arrobas.	Calcinal Mineral Smelted. — Arrobas.	"Cobre Negro" obtained. — Arrobas.	"Cobre Fino" obtained. — Arrobas.	Obs.
1779	374,140	123,331	9798·50	7106·3	
1780	348,600	130,419	9739·50	8070·3	
1781	360,680	137,591	9913·50	7958·15	
1782	269,540	125,084	8474·50	6642·9	
1783	321,464	205,263	13572·75	8418·9	
Totals	1,674,424	721,668	51498·75	38195·14	Arrobas
Totals	20,900			477	Tons

From this statement it will be apparent that the annual extraction of mineral was about 20,000 tons only. The general expenses reached about £9,000 per annum, from which it would appear that the cost of production of fine copper of the various types indicated, of about 97 per cent., was about £95 per ton of 2,000 pounds.

Such then is a very general outline of the operations carried out under the concession to Tiquet, and after his decease, under the administration of Sanz, which terminated on July 27, 1776; and whilst they do not appear to have effected any sudden important development of the mines, enough was done to show that the determined and energetic efforts and administration of Wolters, Tiquet, and Sanz, in spite of almost superhuman difficulties, endless opposition, and malicious obstruction, had proved this locality to contain enormous deposits of mineral wealth, and that for once tradition, history, and romance had not lied.

Sanz continued at the head of affairs directly under the government from 1783 until he was finally relieved and pensioned off on December 8, 1786, with a salary of £240 per annum. What may have been the actual motive for his dismissal cannot be ascertained; he was variously charged with fraud and incompetence, but was not without the aid of those who defended him. He died shortly afterwards at Triana, a part of Sevilla, neglected and almost forgotten.

His efforts to develop the Rio Tinto Mine have been summed up by one adverse critic as follows:—

"The result of the administration under the direction of Sanz was a labyrinth of labours without any arrangement, system, or order, occasioning sinkings and ruins which, years afterwards, seriously impeded the progress and development of the mines."

But this, written a century later, can hardly be held to be a fair or equitable opinion or judgment,

as from the time of his death, in 1786, until the middle end of the nineteenth century, when that opinion was dictated, there had elapsed time enough for others to have occasioned and brought about the chaos predominating in the underground workings, and which had a considerable influence in the determination of the Crown to sell the mine.

On the determination of the administration under the concession in 1776, the Department of State to which it then corresponded, the Council of Mines, Commerce, and Money, assumed charge of the estate and its affairs, and on October 14 in that year, as a result, issued a notification "that it would be highly inconvenient that operations should cease at the mine, and that until the determination or direction, Sanz should continue to be at the head and in 'charge of affairs,' as previously stated."

On August 3, 1778, the General Council of Mines presented a report on the pretensions of the heirs of Tiquet, and of Sanz, in view of which, on November 20, in the same year, the king made the following order:—

"I declare these Mines to be vacant and returned to the Crown, from the 27th of July, 1776, as indicated or suggested in the first part of the Report of the Council of Mines, which Council shall in consequence direct the proper authority, the 'Juez Conservador,' to make an inventory of the buildings, chattels, and other effects, with an estimate of their value, after giving due notice to the heirs of Tiquet, the administrator Sanz, their creditors, the shareholders, and to the agent of the 'Hacienda'" [exchequer or treasury]. "The

Council will furnish me with that inventory together with a note of the shares and other claims and debts which these mines are responsible for, as near as possible, and explaining the pertinence or application to which they correspond, according to the contract, the testament, and the obligations contracted by Tiquet. It is my idea that after this is all done a lease of these mines for the term of ten years be offered for sale by public auction, to be awarded to the highest bidder, or for a longer term if the Council should think fit or deem advantageous, obliging the tenant or lessee to pay annually a certain fixed rent to the Exchequer, he remaining with all the copper and mineral obtained from them. To this end the Council may make and publish to the public the leasing of the mines to the highest tenderer or bidder" [mejor poator]; "and in the meantime I direct that the administration of them shall continue as approved and determined by me at the meeting of the Council of the 12th of September, 1776, when I also nominated and appointed Don Juan Antonio de Cianca as 'contador-interventor'" [accountant] "in place of the son of Sanz, at a salary of 600 ducados per annum."

At a Council of the Board of Mines held on February 12, 1781, the king was informed by them of their opinion on the several points he had submitted to them, and further they reported the condition of the mines in the month of March, 1779, and produced an inventory of the buildings and other effects then existing. The king accordingly again, on January 27, 1783, confirmed the reversion of the mines to the State, ordering that the adminis-

tration by the State should take effect from the 1st of February following, Don Francisco Tomàs Sanz remaining as administrator with a commission of 5 per centum on the products until other arrangement and decision should be made.

To carry out these directions, at the end of January, 1783, an inventory was taken of the mineral then extracted; the coke ("carbon vegetal") timber, mules, horses, and other effects belonging to Sanz and the other shareholders; the total value of them being returned as about £13,500. On March 24, 1783, an order was issued by the Administrator-General of the Rents of the Province of Sevilla for the payment of that amount to those entitled to it. The value of the smelted copper ("cobre negro") however, was not included in that inventory and valuation, and as litigation ensued for very many years between the shareholders and the Crown as to "an indemnity by the State for certain materials stored," it may be inferred that the order for payment was not at once complied with and that the shareholders were not quite satisfied with the inventory taken or the valuation above quoted.

The retention of Sanz at the head of the administration on the part of the Crown, at a very liberal salary, would seem to signify his acquiescence in the course of affairs, but undoubtedly the value of the assets and rights taken over by the government amounted to a very considerable sum: probably the shareholders had good reason *not* to be satisfied with the award of £13,500.

Before closing the account of the operations at the mine at this period it will be convenient to

glance at the course of affairs as regards legislation affecting mining, and Rio Tinto in particular, from 1700, when the "Council of Hacienda" (exchequer) was still possessed of full powers for the administration of all that related to and concerned mines in Spain.

That department of the State retained those powers until the year 1742, when, by royal order dated October 9, King Philip the Fifth ordered the constitution of a "Board of Mines to specially deal with the administration of the Mines of Rio Tinto, Aracena, Guadalcanal, Cazalla, Galaroza and Puertoblanco," vehement proof of the interest taken in this locality so far back.

These efforts appearing to be ineffectual in bringing about any material development of the industry and consequent augmentation of the Crown revenues, as was anticipated and intended, and their great importance having already become patent on April 30, 1747, Ferdinand the Seventh decreed that the charge and direction of those mines should again revert to and be vested in the "Council of Money, Commerce, and Mines," and strictly prohibited any interference with its affairs by any other State department or authority; but the close of the century saw the Crown hampered with a charge it was absolutely unable successfully to deal with, in spite of the special legislation created to assist and foster it, and the determined and fairly successful efforts of Wolters, Tiquet, and Sanz.

Well might the trite saying of Adam Smith be applied to the official administration of State business affairs in Spain: "There are no two characters

more incompatible than those of the man of business and the Sovereign." In those days it was, and, though to a lesser extent, even to-day it may be, "apropositó" and applicable.

CHAPTER V

CROWN RESUMES ADMINISTRATION IN 1784—HISTORY OF "CEMENTATION" PROCESS—STATISTICAL RETURNS—CLAIMS BY ZALAMEA LA REAL—DEFINITION OF MINE ESTATE—INDEPENDENT MUNICIPAL AUTHORITY

FOLLOWING the course of events in their order of occurrence, it should be mentioned that at the end of the year 1784 or very early in the beginning of the following year, Don Manuel Aguirre y Horcasitas was nominated to the post of administrator-in-chief of the mine, replacing Sanz as senior officer of the establishment, and being the first government official appointed to that post at this epoch. That appointment was, of course, immediately followed by an outburst of rivalry and acute antagonism between them, resulting, as has been before stated, in the complete retirement of Sanz early in the year 1787.

The years 1785, 1786, and 1787 saw, in addition to the ordinary works of exploration, the rehabilitation of several of the furnaces and other buildings which had fallen into a state of great disrepair, and also attempts to better the methods of repairing the copper.

In the year 1786, at the instance of Aguirre, attempts were made to treat the "tierras" (?) slag,

produced by the "hornos" (furnaces) for calcining mineral by smelting, but they were barren of good result, practically corroborating the tentative experiments already made in that direction by the master-smelter, Peringuer, with the same object. On this matter Figueroa (*Ensayo*, 1857) makes an interesting note (p. 185, footnote); "The question of this system of treatment (of calcined ores) has frequently been reproduced during the past century," and adds, "At the foot of the report of Don Roberto Shee" [referred to in a previous chapter] "I have read the following lines, the origin of which I cannot ascertain, but which I certainly think may be placed on record: 'M.M. Peringuer, Angulo, Stulz, etc., ont fait plusieurs tentatives mais ils n'ont pas pu reussir pour proffiter les mêmes minerais grillés et non grillés à Rio Tinto.'"

On March 1, 1787, a Royal Decree was issued authorizing the construction of houses and offices and, what was of much greater importance, declaring that "all pirites and vitriolized mineral, the product of this mine, should be conducted to the ports, or from port to port, free of all ordinary and extraordinary taxes, charges, and duties." Reference was also contained in that decree to the necessity for creating nurseries and new plantations and forests, to secure in the future a full and sufficient supply of timber and wood for the mine's works.

The administration of Aguirre was but of short duration: it appears that owing to his incompatability of temper and want of tact, he was supplanted in his office by Don Melchor Jimenez on December 29, 1786.

The necessity of re-establishing and putting into a proper working condition the works of the processes of "Cementation," which at this date were in a very ruinous condition, partly because of the very abandoned and useless state of the "Galerias de desagüe," or adits by which the vitriolous waters, to-day commonly styled "copper liquor," exuded, or were obtained from the interior of the mines, and also by the failure to secure sufficient supplies of iron for the precipitation of copper, gave occasion to the appointment, also at this date, of Don Francisco de Angulo, Director-General of Mines, with two assistants, to visit and examine the Rio Tinto Mine, and to then direct Jimenez as to the course they though best to be pursued for the better progress and profitable development of them.

As a tangible result of this inspection, on July 17, 1787, an order was given for the putting into repair of the "galerias de desagüe" (adits) and the providing of the iron necessary for the process of "cementation."

It will be opportune here to deal with the history of this process of "cementation," or precipitation of the copper contents of the cupriferous waters on iron, or more exactly speaking, by submerging the iron in them in tanks, the product to-day being generally called "cascara" or "precipitate."

The process is not by any means a modern institution or discovery, as is not infrequently asserted.

In the *Anales de Minas* (vol. ii.), published at Madrid in the year 1841, in an article contributed by Esquerra del Bayo, and in various reports edited by other administrators of this mine, it

is stated that the process called "cementacion natural" was established at this mine by Angulo in 1788. Madoz also makes a similar blunder in his *Diccionario*.

Rua Figueroa, at one time also a director of the mine, in his admirable and frequently quoted work *Historia de Las Minas de Rio Tinto, Ensayo,* Madrid, 1859, demonstrates very clearly that this is a mistake, as, after noticing that this same process had been introduced by Tiquet in 1752, he quotes from a Register of the Archives of the Office at the Rio Tinto Mine, the following rather substantial and authentic evidence in proof of his assertion.

"Note of iron placed in the 'canales'" [or cementation channels or tanks as they are now named] "on the 9th day of May, 1752, at 12 o'clock noon—

	Arrobas.	lb.
"Planchuela de Vizcaya	24.1	"
"Hierro Viejo	6.21	"
"Dia 10. à las 11 del dia	2.7	"
" „ 15. à las 7 do la noche. Planchuela de Vizcaya	49.2	"
" „ 16. à las 10 de la manana. Planchuela de Vizcaya	3.14	"
" „ 19. à las 10 „ Planchuela de Vizcaya	23.24	"

Another account follows, giving the operations for the month of June.

The products obtained by this process are unknown and probably it was soon abandoned.

Basilio Valentin, who flourished early in the fifteenth century, in his work *Currus triumphalis Antimonii,* indicates this method for the extraction of the copper from the "pirites," and his is probably the earliest record of any knowledge of the process.

Alonso Barba, whose work was published in 1640, (*Arte de los Metales*, vol. iii. chap. 14), also refers to it.

There exists also undoubted evidence of its having been known as far back as 1661, allusion having been made to some such process in the "licence" (? patent) granted to Alvaro Alonso de Garfias.

Further, in 1695 a "licence" was granted by the Crown to Roque de Salas y Ulloa "to extract copper and other metals from the vitriolous waters of Rio Tinto and Rio Tintillo," this latter being a stream issuing from the north side of the "Cerro Colorado," at the site called "Fuente del Malaño."

Therefore that which was undoubtedly done by Angulo was to *re-establish* the process of "cementation," not to *discover* it, or be the first to apply it at Rio Tinto.

Opposition was soon forthcoming to the reforms proposed by Angulo, and particularly to that suggested in respect of the process of "cementation." In the year 1791 Gabriel Alejandro Sanz, a brother of the late administrator, and for some time the "contador" (accountant) of the mine, presented to Don Pedro de Lerena, at the time being the general superintendent of the Hacienda (exchequer) a memorial, in which he pretended and laboured to demonstrate "that the copper or 'precipitate' produced by this process of 'cementation' was nothing more nor less than iron, stained with copper, lamenting the discredit which would be attached to the previously good name of Spanish copper, and believing himself to be authorized and justified in stating what reasons he had for so believing and alleging," concluding by saying "that the

'cementation' of copper was but a curious chemical experiment from which no practical benefit or advantage could arise to the State."

A body named the "Royal Patriotic Society of Sevilla" took the matter up "in prô," and sought the opinion of an eminent scientist and professor of mathematics, one Don Pedro Henry. This was in due course formulated and laid before a meeting of the society on May 12, 1791; by it Sanz was pronounced to be "a presumptuous chartalan"; and after refuting all the absurd theories and ideas advanced by Sanz, Henry clearly and vigorously explained and proved the true facts of the matter with admirable vigour and precision.

At the same time several samples of the copper "precipitate" were submitted to analysis by Don Pedro Gutierrez y Bueno, an eminent "mining chemist" of Madrid, who, after testing them, declared that the copper produced or obtained by this process of "cementation" was equal in quality to that obtained by smelting. He at the same time prudently advised that the water employed in this process should after the first use be carefully tested to make certain that all the copper contents held in solution had been duly precipitated, to avoid loss. (*Anales de Minas*, vol. iii. p. 351. Article by Don Luis de la Escosura).

The report of Angulo as to this ran as follows:—

"The calcined earths, of which there are immense quantities awaiting treatment, will equally well give, by method of the employment of a 'lejia,' and consequent evaporation, considerable quantities of vitriolous waters, after having had the copper con-

tents partly extracted by iron. The water used for the ' cementation ' could again be employed after having been used for that same purpose.

" In resumption I have the idea (and experience and practice will prove the truth) that by the method of reducing the whole of the mineral of Rio Tinto (at any rate the small poor mineral abandoned and thrown aside as useless) to vitriol, by first burning or calcining it, then washing it, and then precipitating and separating the copper by means of old iron, a much greater advantage and profit will be obtained than that given by the process of smelting now in use; for not only would a considerable economy in carbon ' vegetal ' be made, but a considerable quantity of old iron, otherwise wasted, would with advantage be employed and be converted into ' cascara ' or ' precipitate.' "

This of course relates to the process of " artificial cementation."

Don Gabriel Montronier about this time also suggested the establishment at the Rio Tinto Mine of a " fabrica " or factory for the utilization of " vitriolo õ caparrosa."

In the face of the fact that these processes were known to be anything but a new matter or discovery, it is strange to find that later on, in 1857, nearly two centuries after they had become matters of public record, and that too in Spain, a " *privilege of invention* " should have been granted to one Manuel Aguirre.

The unfortunate Padre Delgado was on the brink of an interesting and very important discovery when he dealt with the—to him—simply curious fact

of the iron disappearing when placed in the waters forming some of the sources of the "Rio Tinto," so long ago as in the middle of the fifteenth century.

As the history of an industrial enterprise may be opportunely written, to some extent, in figures, it will be convenient to now refer to those on record (Table C), which show the quantity of "cascara" or precipitate produced at this period; these figures are the earliest available.

The quantitiy of precipitate produced in the first quinquennial was as follows:—

			Tons	cwt
1788	843 Arrobas	about	10	11
1789	1046 „	„	13	1
1790	1225 „	„	15	6
1791	904 „	„	11	6
1792	983 „	„	12	5

being equal to about 12 tons per month.

A reference to Tables D and C, etc., of the Appendix will show how important a branch of the copper-producing industry this method or process of "cementation" became from henceforward and until to-day; at once simple and comparatively inexpensive in detail and operation, it has been established and is now employed in many other mines in the Province of Huelva and elsewhere, with very great advantage and profit, where other means of treatment are not available or possible, either from the distance of the mine from its market, the absence of convenient and cheap transport of the crude material, or from the inability to procure capital and skilled labour to erect furnaces to smelt the ores or otherwise treat them.

The probably contemporaneous mines of "Castillo de las Guardas," some fifteen miles to the east of Rio Tinto, on the direct road to Sevilla, and the "Concepcion," some six miles to the north, are cases in point.

As undoubtedly, from the very earliest ages, ever since the formation of the Rio Tinto lodes, water highly impregnated with a solution of copper has been continuously pouring to waste into the ocean, what an enormous quantity of copper has thus been lost to mankind for always!

As to smelting operations at this period, the solitary official statement available, here reproduced, shows the quantity of material treated at refining furnaces, and the result of those operations in fine copper, from 1788 to 1792, inclusive. It is to be regretted that the amount of raw or crude material treated to produce the "cobre negro" cannot be ascertained. For convenience the copper produced by "cementation" is also shown, but the figures, which are given on the authority of Figueroa, do not quite harmonize with those given by a later writer, Gonzalo Tarin.

Year.	Cobre Negro Smelted. Tons.	Fine Copper Produced. Tons.	"Cascara" or Precipitate. Tons.	Total Copper Produced. Tons.	Costs. £.
1788	169½	117¾	10½	128½	12,339
1789	215	144	13	157	11,641
1790	225	149	15½	164½	13,442
1791	206½	172½	11½	183¾	17,476
1792	205½	143	12½	155½	17,337
Totals	1,021½	726¼	62¾	789	£72,235

The cost of the production of a ton of fine copper apparently was something like £91 10s., that is, if any reliability can be placed upon those figures; probably those as to total expenditure are approximately correct. As to the quantity of copper returned as having been produced and accounted for there was probably some leakage.

That operations were carried on at a considerable loss to the government seems beyond doubt, looking at the published accounts; and the repeated changes in the administration about this period, which prejudicial practice was continued almost uninterruptedly until the mine was sold to the present company, were made in the hopes and with the object of procuring, if not a profit, the prevention of waste and loss.

It may not be out of place before closing the history of events at the close of the eighteenth century to place on record the operations which resulted in the definite demarcation and establishment of the boundaries of the mine's property, of the freehold estate which passed to the lessees under the various concessions, and which still hold good, with but very insignificant modification. The constitution of a municipality, absolutely independent of that of Zalamea la Real, took place much later, within whose zone this latter municipality had no sort of authority or power of interference.

But this demarcation was not attained without having had to overcome the very determined resistance of the town of Zalamea la Real, whose chief inhabitants, keenly alive to the importance and material advantage of keeping some hold on what

had always in their eyes been an important and valuable part of the property and district over which they held municipal and other special jurisdiction and patronage, did not fail to raise every obstacle and difficulty within their power to prevent such a definite segregation and consequent loss of patronage and income.

They alleged even that the property of the mines actually belonged to the town of Zalamea by right of purchase from the Crown in the seventeenth century, and the occupation of the mines by Wolters was judged by this "small republic," jealous of and conceited by its fancied and assumed rights and privileges, as an attack upon its property—an invasion by the lessee upon dominion which they had always considered to be their own exclusive property. The more so as Wolters presented himself "as entitled to certain special privileges under Articles 4, 9, and 16 of his contract with the Crown, and which, in conformity with the Articles No. 49 and 50 of the Royal Mining Regulations of 1584, he enjoyed with other concessions."

The town of Zalamea la Real did not leave one step untrodden in order to destroy this new and independent body set up in its face, and in the midst of its property and dominion, as subsequent events will show, unscrupulously and ambitiously asserted its "previous ownership" and fixed determination to re-acquire it. Even in quite recent years there has been some indication that such a hope and idea is still alive, if conceded.

It ostensibly manifested this opposition and strong determination immediately after the death

of Wolters in 1727, for thereupon the Mayor of Zalamea, accompanied by the legal authorities of that town, went to Rio Tinto, seized and inventoried all that belonged there to the heirs of the deceased Swede, preventing by that very arbitrary act the further working of the mines by the successor of Wolters—Tiquet—and depriving him of the use of the monies, papers, and all other things which concerned the administration of the company.

This gross outrage, fortunately, was at once denounced and promptly punished by the Crown, it having been specially provided in Clause 9 of the Concession to Wolters of June 16, 1725, that no other tribunal but the Crown itself might take any such steps, and all legal institutions and other departments of the State were distinctly inhibited and restrained from interfering in any way whatever with the mines and the concession.

These dispositions were affirmed and again were emphasized in an order by which all the rights, powers, and privileges of the prior lessee, Wolters, were declared to exist and to be valid in favour of his successor and heir-at-law, Samuel Tiquet; and the town of Zalamea, seeing its attempt frustrated and overthrown, desisted for a time from further intrusion and attack, only to renew its efforts again with even greater vehemence and animosity some thirty years later.

Following shortly upon the death of Tiquet in 1758, the people of Zalamea la Real once again attempted to destroy the quasi independence of the Rio Tinto Mine, and laid before the Council of Commerce, Money, and Mines (the department of

State then possessed of the jurisdiction) frequent and bitterly determined charges and complaints against the new administrator Sanz.

By a memorial to that tribunal or department, dated July 9, 1765, Sanz was charged by the municipality of Zalamea with the waste and destruction of timber (any existing had been planted and created by Sanz himself), of having abrogated to himself power and authority not conceded to him under the concession or lease, and also of converting to his own use stores and material that should have been employed in the works.

The case coming on for hearing and determination Sanz was adjudged to be innocent of either waste or peculation, and the tribunal, fully convinced of the bad aims and tendencies of the people of Zalamea, aided and abetted by its authorities—"that endeavoured by all and any means possible to procure the paralysis and destruction of these mines,"—seeing the futility of previous warnings and the necessity for the prevention of such similar and further excesses, by Royal Decree dated December 10, 1765, ordered a fine of 300 ducados (about £30) to be imposed upon the authorities of Zalamea la Real, and also threatened them with heavier fine and punishment if they or their successors again ventured to assail the administrator of these mines, and further admonished them "that in the future they should proceed with greater good faith and legality." The original of this decree is extant, is a printed document, and at its foot appears in manuscript a record of the various steps taken under it consequently, showing that the terms of it

were finally complied with only on October 19, 1775, nearly ten years afterwards.

It is hardly possible now to determine the justice of their claim or the real reasons of this antagonistic conduct on the part of the town and inhabitants of Zalamea la Real, but to judge from the frequency of its attacks and the malicious nature of the steps they took, even to the extent of over-riding the terms and privileges of the Royal Concessions or Leases; on considering the more than energetic opposition to a new-born and struggling industry that requisitioned and gave daily employment to its own people and of all other villages near to, thus bringing prosperity and importance to its own doors;—one is almost obliged to estimate the motives impelling them so to act, though really in detriment to their own interests, as being of quite a disreputable character.

Accumulated and internal evidence goes to show that the Rio Tinto Mine, having been proved to be of almost inestimable wealth, the chief residents of Zalamea simply strived to become the owners and then work them only for themselves—for their own immediate advantage and profit. As one well-informed writer wrote of them truly, "they were filled with 'invidia y celos'" (jealousy and envy).

The decree of July, 1765, only had the effect of causing the people of Zalamea to vary their method of attack, not to abandon it, for on the 11th of October, 1775, *a few days even before the terms of it had been carried into effect*, one Juan Domingo de Albizu, an attorney or procurador, in the name and behalf of the town of Zalamea, duly authorized,

registered a "pedimento" or caveat in respect of the usufruct of a part of the mines estate—then, as now, called the "escorial," near to the north lode. This may be explained and easily made clear. The northern slopes and valleys of "Cerro Salomon" and "Cerro Colorado," were by this time thickly covered with oak-trees which would serve the people of Zalamea in having the control and disposition of the fattening of a considerable number of pigs —the annual crop of acorns being a matter of some substantial value, as well as the surplus timber, etc. They claimed that such and similar "usufruct" had not been included in any of the concessions.

In this memorial were actually reproduced the complaints previously made against Sanz, his assistants and servants, since the year 1765. On the terms of the claims being communicated to Sanz he rejoined with a formal contradiction of the allegations and denial of the pretentions, on February 1, 1776, maintaining, that in the year 1751 or 1752, although the demarcation of the estate leased had been decreed but had not been carried into effect for want of funds, the proper persons and authorities to carry it out had duly been cited or appointed, and so determined the boundaries and limits of the district and jurisdiction of the mine, in the terms of Clause 9 of the original "asiento" or concession of June 16, 1725.

Sanz maintained that according to this latter title, the extent of land conceded with the mines was defined as being a "circuit of half-a-league from the mouths of the various principal entrances into them," equally from those on the north and

south sides as from those at "San Dionisio" on the western extremity of the range, or from those at the eastern extremity—all well known and reputed to be such "principal entrances" —"bocas principales." He further held that this half-league should be taken to mean the ordinary measurement of "these parts"—and not the "legal" one—that for the purposes of the works even that quantity of land would be insufficient, that the land now claimed by Zalamea had always belonged to the Crown—was a "realengo," useless because it was nothing but a collection of heaps and hills of "escoriae"—hence the name given to this locality, "Escorial"; conclusively justifying his assertion, that the land in question was part of the jurisdiction of this mine and undoubtedly had been an integral part of it, and had been included and conveyed under the original concession and renovations.

He further called to account the gross injustice and utter unreasonableness of the claim, and declared it to be filled with malicious intent, inviting some severe punishment—at least the imposition of a fine and costs.

To this Zalamea replied by stating that the definition and demarcation of the mines estate should be proceeded with and measured off in the usual way, that the radius should be the half-league of 1,500 yards—"varas"—(the ordinary league of the locality being equal to about 5,000 metres) and not that claimed as the ordinary half-league, "that Sanz wished to have his case subjected to other than the usual interpretation of terms," and urged "that the

definition and measurement of the property should *radiate* from the mouth of the *principal entrance*" [adit] " to the mine by which the mineral was extracted, and *not* from each of the various mouths or entrances to the various adits and galleries on the north, south, east and west extremities of them."

It may here be interpolated that if this suggestion and measurement had been adopted, Sanz would have been deprived of some considerable part of the western section of the mines—the mass or lode known as " San Dionisio."

By Decree of September 17, 1776, this "Answer" was duly communicated to Sanz, who promptly rejoined with the prayer that instead of the " ordinary half-league," he should be conceded an " ordinary full league measured from the mouths or entrances of the principal adits and galleries. Further claim and rejoinder having again been made by the litigants concerned, the whole matter was summed up and referred to the King's Fiscal " for his superior and convenient determination."

As might have been anticipated, for a considerable length of time the question was allowed to lie undetermined in the hands of the " Board of Commerce, Money and Mines," in spite even of a very strongly termed appeal for its quick despatch presented by the administrator, Aguirre, on May 13, 1785, and formulated by him in consequence of the encroachment and trespass committed by a resident of the adjoining village of Campillo—situated about half-way between Rio Tinto and Zalamea—who had cleared the " monte " or brushwood from some five acres of ground, within the mine estate,

the burning of which brushwood might have occasioned the complete destruction of the pine-forest near to San Dionisio, "one of the valuable assets of the establishment," according to the original document now cited.

Nothing definite, however, was resolved on by the State until after the lapse of another four years, in 1789, when in consequence of further abuses Aguirre again manifested the urgency and genuine necessity of finally determining the boundaries of the estate corresponding to the mine under the concessions, as well as its jurisdiction as regards the municipality of Zalamea la Real. This step led to the issuing by the "Board of Mines, etc.," of a decree, dated January 11, 1790, authorizing certain steps to be taken.

The "ayuntamiento" or municipality of Zalamea, fearing an adverse result from the threatened litigation—all the steps already indicated being but preliminary to it—called a special meeting of its council and of some of the principal inhabitants, and, convinced of the advantage of making "a settlement out of Court," nominated and appointed a body of delegates to confer with the administrator Aguirre with the object of arriving at an agreement.

At length, at a conference held in the mine on February 27, 1790, when various persons appeared on behalf of the contending parties, an arrangement was come to and referred to the proper quarter for approval, and, this having been obtained, the actual definition and demarcation of the mine's estate was verified and carried out on

the days of November 2 and 5, 1790, under the personal direction and supervision of Don Andres de Cañete, surveyor to the City of Sevilla.

Thus some sixty-five years were consumed in the apparently very simple task of determining the land or estate conceded to Wolters and his assigns, under the "asiento" or contract of June 16, 1725.

On August 26, 1791, Cañete concluded his work and report and remitted the same, together with one of the three copies of the plan he made, to the Department of Commerce, Money, and Mines, which authority duly signified its approval and conformity in an edict dated September 7 in the same year. Of these three copies of the plan one only is now known to be in existence—that being in the possession of the Municipality of Zalamea la Real.

As all that relates to this question involved very important interests it may be as well to put on record the following data obtained in a casual way from an original and authentic unpublished document.

Distances between the various "mojones," or boundary-posts. From the first mark, placed on the highest of the peaks of the hill called "Pie de la Sierra," by levelling to the second mark, 493 yards; to the third, 340; to the fourth, 180; to the fifth, 113; to the sixth, by paces or steps, 324; to the seventh, 896; to the eighth, 100; to the ninth, 220; to the tenth, 600; to the eleventh, 400; to the twelfth 396; to the thirteenth, 176; to the fourteenth, 656; to the fifteenth, 244; to the sixteenth, by levelling, 728; to the seventeenth, 860; to the eighteenth, 335;

to the nineteenth, 434 ; to the twentieth, 140 ; to the twenty-first, 596 ; to the twenty-second, 2,066, this comprising the course here followed by the small stream called the " Rejondillo," the line being understood to take the centre of the stream ; to the twenty-third, 1,567 ; to the twenty-fourth, 444 ; to the twenty-fifth, 1,262 ; to the twenty-sixth, 320; to the twenty-seventh, 612 ; to the twenty-eighth, 698 ; to the twenty-ninth, 1,472 ; to the thirtieth, which is at the bridge over the Rio Tinto, 1,572 ; to the thirty-first, 1,280 ; and thence to the first, 1,140 yards."

Aguirre was not satisfied with this success. He now determined to raise the " status " of the mine to that of a town, to and obtain for it independent municipal authority; in effect, to completely detach it from any subjection to Zalamea; and on February 8, 1791, only three months after his victory in the matter of the demarcation of the estate, he forwarded a memorial to the government, addressing it to one of the Ministers, Don Pedro Lopez de Lerena, seeking his favourable influence and basing and justifying his claim on and by the substantial progress and prosperity of the mines, the fact that there were upwards of 120 houses, etc., and other necessary " conditions." He also solicited, that in case the memorial received a favourable consideration and its object be conceded, " His Majesty would be graciously pleased to allow the name of ' San Luis de Rio Tinto' to be given to the new municipality."

The government consulted with the corresponding Tribunal of Sevilla, which, in turn, sought for

information on certain points from the ayuntaimento or municipal council of Zalamea la Real. Of course the implacable rival to the mine's authorities at once strongly opposed the idea and pretension, and promptly presented a report condemning the proposal in the strongest terms, and alleging, not only that there were but eighty houses, not 120, as claimed, but that the locality did not in any way possess the conditions necessary to entitle it to the grant of independent municipal authority, and further, that the life and prosperity of the " establishment " was not all assured.

The opinion and influence of the town of Zalamea la Real for once prevailed, and the petition was not acceded to. Apparently nothing further was attempted by Aguirre or any other succeeding administrators—in this direction—until some fifty years later.

But the by no means crestfallen administrator was, however, very much more fortunate in another matter affecting the " status " of the mine, as in September, 1786, he had the satisfaction of seeing the formal and public ceremonial of the concession of a certain amount of independence to the " provisional village church " from the authority of the older one at the old mining town of Rio Tinto, now known as Nerva, situated to the south-eastern extremity of the works, and just beyond the boundaries of the estate.

Previously to this all registrations and other ceremonies connected with births, deaths, and marriages had to be arranged through the parish priest at Nerva, then " Rio Tinto "—a matter of very considerable inconvenience to all concerned.

There still remained undecided some questions concerning the individual powers and ecclesiastical authority of the two parishes respectively, one having reference to the tithes, "tenths," and "primages" of cereals and other products of the parishes, which questions were not finally disposed of even in the year 1806, when the "Supreme Council of Castilla" gave judgment in favour of the mine's township; for it appears that the sum and amount of those contributions being still the subject of further litigation and amounting to some £467, was, in the year 1810, seized by order of the Superior Tribunal of Sevilla—that body being then established—owing to the presence of the French troops at Sevilla—at the town of Ayamonte, situated at the mouth of the river Guadiana, at the Portuguese frontier. And so neither parish enjoyed that money.

In July, 1778, Jimenez was again nominated administrator of these mines, in the place of Aguirre, and on July 14, 1793, the new church, commenced by him in 1789, was duly consecrated with the usual public ceremony to the special satisfaction of the mine people.

Jimenez retained his post until 1798, when he was relieved by Vicente de Letona, having during the term of his administration witnessed a considerable improvement in the condition and prosperity of the mine, as the tabulated returns (Table C) for these years show. It is stated on the authority of Fausto Elhuyar and Rua Figueroa that there was an actual profit made in the quinquennial period of 1794–8, of some £51,073; and undoubtedly this was

the most flourishing period of the mine during the century.

From the *Boletin Oficial de Minas*, vol. i. p. 33, (Madrid, 1844), an isolated return for the period indicated, giving interesting details of the copper produced, 1794–8, and the costs, has been extracted. Figueroa states that at this period the price of copper was about £148 per ton; there would, therefore, have been the profit on the figures quoted, as stated.

This, however, does not agree with the statements contained in an original document of the year 1796, in which it is distinctly affirmed " that the product of copper is inferior in value to the amount of the cost occasioned " in its production," although it was also remarked " that account should be taken of the very considerable profit lost to the Government in very many ways and through the waste and peculation of its servants."

Years.	Fine Copper " en punto de martinete."			Fine Copper " para bocas de fuego."			Total of fine copper.			Costs. — Reals.	Average cost per pound. — Reals.
	arr.	lb.	ozs.	arr.	lb.	ozs.	arr.	lb.	ozs.		
1794	5,030	18	12	6,608	22	8	11,639	16	4	1,108,037·26	3·27
1795	7,251	6	4	12,162	6	4	19,413	12	8	1,712,045·16	3·17
1796	4,631	6	4	10,831	6	4	15,462	12	8	1,622,788·8	4·4
1797	3,358	0	0	16,712	0	0	20,770	0	0	2,397,648·10	4·26
1798	6,381	13	8	11,801	0	0	18,182	12	8	2,280,307·	5·
	26,652	18	12	58,115	0	0	84,768	3	12	9,120,826·26	4·8

The " arroba " being equal to 25 pounds.
100 reals =£1.
34 maravedis =1 real.

With the advent of Vicente de Letona came an unfavourable change in the condition of affairs—serious obstacles to a successful administration: the presence of French troops in the near neighbourhood, consequent high prices of food supplies, charcoal, and an increased rate of wages—all these very heavily embarrassed him in his operations.

In 1798 the furnaces were closed down for two and a half months for want of charcoal, and Letona complained bitterly—but without avail—of having to keep on the men—idle—thus incurring much loss. Apparently there were some eighty-two men employed there altogether.

But the attention of the Spanish Government was much more closely engaged elsewhere—on matters of very pressing importance. The country was overrun by the French, the government itself may be said to have been in exile, its armies and fleets were fully occupied in taking their part and share in the "Peninsular War," and naturally, all industry and commerce were in a state of paralysis, if not of ruin.

Yet the close of the eighteenth century saw more than a partial justification and verification of the hopes, the legends, and the history that had always shrouded and involved this locality.

Unable, through want of the aid of those possessed of technical skill, proper mechanical appliances, and competent and trustworthy officials, to procure any very striking result in the way of a very large—increased—production of copper, the various lessees and administrators had nevertheless certainly proved the existence of huge deposits of mineral—how im-

mense the various lodes were constituting the whole had not by any means been determined—and had discovered and brought to light the startling and welcome fact, that the whole of the place had been pierced, worked, and explored by a race or races of people—of whom even Roman writers had no information—not even a shadowy knowledge.

The persistent efforts of Wolters, Tiquet, and Sanz, were attended with but little immediate success or reward. But how much indeed is Spain indebted to them. Their names must ever be associated with the extraordinary success of the largest copper mine in the world, the prosperity of which is a national pride; and a grateful posterity certainly should see that they are not entirely forgotten in any history of the commercial and industrial prosperity of their country.

CHAPTER VI

FROM 1800 TO 1850—FRENCH INVASION OF SPAIN—OCCUPATION OF RIO TINTO MINE AND SEVILLA—PARALYSIS OF WORK—LEASE TO THE MARQUIS DE REMICA—OPEN-AIR CALCINATION—TALERAS—RIO TINTO GRANTED A CORPORATION—ONCE AGAIN UNDER STATE ADMINISTRATION—PATENT FOR 'CEMENTATION' PROCESS.

THE inauguration of the nineteenth century was attended by almost fatal consequences to the progress and prosperity of the Rio Tinto Mine—the only mine then being explored and worked in the Province of Huelva, in this part of Andalucia.

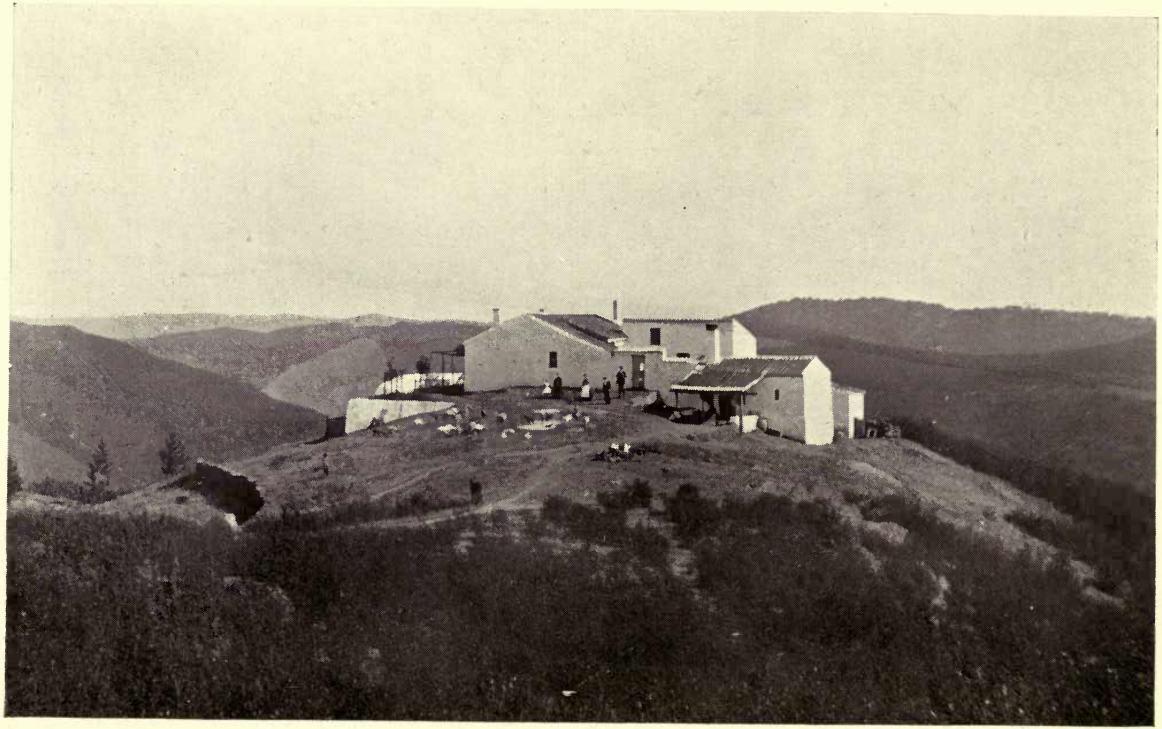
The scarcity of cereals and other articles of food occasioned by the occupation by the French of the great grain-producing districts of Estramadura and Sevilla (Province)—wheat then being about thirty shillings per bushel; the increased price of labour, and the insufficient allowance of capital by those in charge of the administration;—occasioned a notable decadence in the exploitation of the mines and dimunition of its products, and then a conversion of the previous profitable workings into substantial losses.

And although the energies of the administrator—Letona—saved—and perhaps prevented the total abandonment and consequent ruin of all the works,

interior and exterior, the first twenty-five years of the century witnessed an almost absolute paralyzation of work, with the furnaces closed, buildings public and private abandoned; and, as appears by Table D, small quantities of copper were obtained by the process of natural "cementation" only. As an instance of the hopeless state of affairs at this period it may be sufficient to note the following circumstance :—

On March 30, 1802, the Government sent this communication to the Administrator Letona : "And it not being possible to provide your Excellency with the 300,000 reals (=£3,000), which you state represent the outstanding debts, nor even the 200,000 reals (=£2,000), as a monthly consignation to enable you to carry on under the present difficult circumstances . . . it is obvious that you must carry on the necessary operations for the moment, in the best way possible. . . ."

In that hopeless condition Letona managed to keep the establishment together until 1810, when an absolute stoppage of operations took place. In that year, Letona, in view of the close proximity of a large body of the French troops and of the order he had received from the general in command, the Baron de Marancin, to hand over the stock of fine copper then in the mines, acted with promptitude, if with questionable tact and prudence, and sent some thirty-one tons of it to Cadiz by way of Ayamonte or Huelva. The French General on the non-compliance with his orders and demands, arrived at these mines on December 12, 1810, with a portion of his troops and transport, but was only able to



"LOS FRAILES."

discover something less than six tons of copper in stock there.

For a period of five years work at the Mine absolutely ceased—from 1811–14 and again in 1816. The population of miners firmly established there for upwards of sixty years remained, therefore, without employment, or even means of existence—for the very barren precincts of the mine produced nothing worth consideration, and these unfortunate people were soon converted into groups of mendicants—compelled to leave the locality and invade and molest the towns and villages in the near neighbourhood to procure the means of bare subsistence.

This complete emigration of the inhabitants was naturally followed by failure to maintain the works and buildings in a sufficient state of repair, and by the year 1817 they were all once again converted into heaps of ruins. The efforts of Letona to save the mine from complete disaster—if not permanent ruin—were but ill-requited by those who should have been the first to proclaim his patriotic conduct during the occupation of the place by the French, for by an anonymous complaint some of his companions in trouble even endeavoured to procure his disgrace and dismissal!

Fortunately the agent of the government sent one Domingo Ibarrola to make an inquiry and examination into the matter, who saw clearly how unfounded and despicable were the allegations, and in his report strongly vindicated Letona's character and conduct.

The mission and visit of Ibarrola had also for its object the investigation of the circumstances and

condition of the mine with a view to ascertaining what methods could best be employed to rehabilitate the unfortunate establishment. He made an inventory of the few remaining useful assets and included in it a valuation of the pine plantations, which had been planted almost entirely by Sanz about the year 1760, and assessed their value at £18,798.

Nothing, however, was done of a practical nature to restore the mine to its previous prosperous condition, and although—as appears by Table D—occasionally some small quantities of copper were obtained by natural "cementation," from 1810 until 1825, the valuable copper-impregnated water exuding from the many exits of the mine was allowed to run to waste and thus was for ever lost in the waters of the ocean.

This complete abandonment seems all the more remarkable as the mints of Sevilla, Madrid, and Segovia had for many years been supplied from Rio Tinto with the quantities of copper required for the coinage of money and for other State purposes, and therefore the Government was obliged to seek for its material elsewhere—no doubt at a very considerable disadvantage as to price, as the cost of producing fine copper was then only about a shilling per pound—sometimes even less—and its market value was approximately £140 per ton.

The following account is given by Figueroa of the operations from 1800 to 1809 inclusive—useful as far as it goes, as it shows the proportion of fine copper given by the "cobre negro."

Year.	Black Copper Refined. — Arrobas.	Fine Copper Produced. — Arrobas.	Per cent. of Fine Copper Yielded.	"Cascara" or Precipitate. — Arrobas.	Iron consumed for 1 per cent. Cascara	Cost.	Cost per pound. — Reals.
1800	20,604	14363·	69·70	1078·	2·18	2,064,627	5·1
1801	15,131	9245·	60·90	888·18	2·47	1,791,301	7·
1802	7,000	4656·12	66·52	741·12	1·85	1,502,284	11·4
1803	12,023	8135·12	67·66	817·	2·28	1,605,915	7·5
1804	6,962	4324·14	62·12	741·18	1·84	1,340,107	10·19
1805	2,474	1973·7	79·76	238·	—	651,813	11·27
1806	4,184	2838·8	67·83	470·18	—	685,687	8·9
1807	780	422·2	54·11	1245·6	—	790,602	18·32
1808	8,836	6181·19	69·95	791	—	951,389	5·15
1809	9,074	6946·18	76·55	560	—	845,753	4·12
= Tons		738½		95¼		£122,294	

So that if these figures are honest and reliable, then the 834 tons of fine copper of both kinds (for the moment classifying "precipitate" as fine copper, which it is not) were obtained at the average cost of about £147 per ton—something more than its selling value.

With regard to the administration of the mine at this period certain incidents occurred which are perhaps worthy of relation and record, because of the influence they exercised upon the subsequent fate of the establishment.

On October 28, 1818, a subdivision of the administration took place, José Miaja Pingaron and José Martinez Marcos being appointed technical and assistant technical managers respectively, Letona remaining as administrative manager only.

None of the works undertaken in their time, especially in the direction of subterranean labour,

which had hitherto been surcharged with the weight of pernicious and indelible error and bad calculation, manifested intelligence or competency in those thus specially charged to see to and properly direct such a vitally important matter.

Proposals of Pingarron in 1819, and again particularly on July 4, 1820, to have these mines placed directly under the authority and management of the Mint at Jubia, for economical purposes, were refused.

The labours and energies of the establishment still continued to be in a paralyzed condition, save only that affecting the production by "cementation." In this direction Martinez Marcos introduced certain reforms, repairing the "canales" or conduit of the vitriolized waters proceeding from the interior of the mines by the "socabon" or adit called "San Roque," and substituting old scrap iron for use in that process instead of the more costly "planchuela de Vizcaya"—probably a class of sheet iron forged in and brought from the extreme north of Spain at considerable expense.

In spite of these endeavours and efforts at reform, as will be seen at a glance on reference to Table D, the quantity of copper precipitate produced, which in 1820 was about 30 tons, fell to only $5\frac{1}{2}$ tons in 1822, the cost of the precipitate apparently then being about £40 per ton.

The quantity of iron supplied and employed in this process of "cementation," and which amounted approximately to about 40 tons per annum, was quite insufficient to produce or "precipitate" all the copper that, in a state of solution, was annually

yielded from the interior of the mine from natural sources, and so notorious was the loss and waste in consequence that in 1822 a resident of Zalamea, Juan Santa Ana Bolaños, one of its well-to-do "caciques," solicited and obtained a grant or permission "to again utilize the water after it had passed through the various 'cementation' channels and tanks. He was to pay to the Crown the sum of £5 per day, and was credited with having made a total profit of £4,000 in the four years 1824–27, although the official returns relating to this transaction credited him with having obtained only about 20 tons of precipitate altogether, worth probably about £1,400."

But little reliance can be placed on any of the official returns of this period: the quantities and figures must be taken as approximate only. But as far as they go, and for the sake of comparison, they may be held to be acceptable and useful, and worth placing on record. They also go to show how badly things were conducted.

In January 1823 the mine was visited, inspected, and reported on by Don Fausto Elhuyar, an eminent engineer of mines, formerly Director of the Tribunal of Mines at Mexico, now Inspector of Mines and "Adviser" of his Department to Don Luis Lopez Ballesteros, then the actual minister of "Hacienda."

His highly interesting, complete, and faithful report on the whole matter was formulated on February 12, 1823 (*Relacion de las Minas de Cobre de Rio Tinto. Revista Minera*, vol. v. p. 1), and resulted in a Royal Decree that had for its object

and mission the complete reorganization of the unfortunate establishment.

"It calls for compassion," Elhuyar wrote, "to see an establishment which had arrived at such a florescent state, with hopes of a certain future progress, so many buildings and works constructed at such a great cost, and a population of 500 people, created and grown up in it and under its 'sombra,' all reduced to inaction, many of its principal 'fabricas' dismantled, the people reduced to the greatest want and misery, and their number surely diminishing through the greater number of them being obliged to seek work in other districts. The mine itself has suffered greatly in the long periods of paralysis, abandonment, and neglect to maintain even the most necessary work of conservation. Lastly, the towns and villages within a 'perimeter' of 30 miles have resented equally, and not to a trifling degree, the want of constant employment for its inhabitants and market for their fruits and products.

"All in consequence clamour for the immediate rehabilitation of this mine and the beneficent labours they afforded to so many without resources, but always confident in the certain prosperity of the establishment."

But in spite of the excellent directions it contained, the instructions and suggestions of Elhuyar were not attended to, and the government failed to extricate the mine from the unfortunate condition into which it had fallen, although they no doubt had been made clearly to understand the cause and origin of so much leakage and loss.

In 1824 the deplorable condition into which the

mine had fallen, the general conviction that the government would be utterly helpless and incompetent to rehabilitate it, urged some business people presenting themselves under the name or style of "Jorge Rollac and Company" to offer to lease the establishment for a term of years; but the Crown, by a royal decree dated January 1, 1825, extended under the direction of Ballesteros, declared "that the Royal Mine of Rio Tinto should not be so disposed of nor sold or otherwise alienated, but should continue to be developed and worked by the government until the hope was absolutely lost of being able to manage it successfully under the Crown."

This decree, contained in some thirty-six articles, was a recapitulation of the proposals of Faustino Elhuyar; it was accompanied by all the necessary instructions for its immediate application, gave directions to the various establishments of the State elsewhere in Spain to use only copper obtained from the Rio Tinto Mine, and, what was of substantial import, ordered the Treasury to advance funds during the year 1825 to the extent of £9,886, in addition to a further amount of £6,000, to be advanced at the rate of £1,000 per month during the first six months of the year referred to. It also particularly directed the purchase of such quantities of vegetable charcoal and iron as were required for the year's working, the reconstruction of furnaces fallen into disuse, and the erection of a refining furnace for the production of fine copper of the special quality known as "punto de martinete," or sheet copper. And, further, it also authorized the new administration to proceed to sell

the quantity of fine copper in stock—some 57 tons —and apply the proceeds to the satisfaction of immediate and pressing necessities.

Under this decree Don José Martinez Marcos Miaja Pingarron, now retiring from the direction of affairs—was appointed to carry out forthwith all the necessary and duly authorized works, assuming the character and office of " Special Commissioner," and as a proof of the energy with which a start was made, it may be noted that about eighty tons of fine copper were produced in the course of the year 1825 (see Table D).

But although the two following years saw augmented production of fine copper, both from the process of " cementation " and from the furnaces, and consequently proof of the greater capacity of the mine, the government, however reluctantly, came ultimately to be convinced of the impossibility of carrying on a successful administration of the establishment, and the determination to lease the mine for a term of years was, by decree of December 6, 1827, duly carried into effect. The convenience or necessity of leasing the mines resolved on, the following edict was published by the Director-General of Mines, Elhuyar, although such a step must have been repugnant to him, especially after his previous and emphatic opinion as to the advantage of the administration of the mine by the State.

" Office of the General Administration of Mines.

" It having been determined and decreed by Royal Order of the 6th of December last that the Royal Mine of Rio Tinto with its dependencies should be leased, this determination is hereby made public, so

that both foreigners as well as the inhabitants or citizens of this country may tender. Offers must be presented before the last day of August of this year at the offices of the General Management of Mines, where applicants may obtain full details of the conditions of the lease or contract; it being understood that the tender offering the most favourable terms to the Crown will be accepted—subject to the due approbation of His Majesty.

"Madrid, 21st of April, 1828.

"ELHUYAR."

The conditions of the proposed lease were duly published, and went to make a document containing some eighteen clauses dated April 3, 1828. The lease was for a period of twenty years, to date and to take effect from the day the successful tenderer should be placed in actual possession of the mine, which, it was stipulated in clause 16, was to be effected within one month of the execution of the contract; and under the last, or clause 18, the lessee was to bring in and deposit, as security for his faithful compliance with its terms, the sum of £5,000.

It will now be opportune to refer to the contents of Table D, which gives the results of the working operations for the first twenty-nine years of the century, whilst the mine was under the direct administration of the government—for the new lessee did not take possession of them until April 24, 1829—until the mine was once again handed over to the tender mercies of a lessee. By it is seen that from 1810 until 1825 the smelting and refining furnaces were entirely shut down, and that although

expenses were somewhat reduced the value of the "precipitate" obtained was insufficient to cover them. The items of cost or expenditure for the four years 1821–24 are also absent, although the excessively large amount figuring for the year 1825—£9,965—was very probably the aggregate of the expenditure during those five years.

On April 27, 1828, Joaquin Esquerra was charged with a commission to make all necessary plans, estimates and inventories of the establishment, its property and effects. This report is not available, but was formulated forthwith, and Esquerra is reputed to have furnished, at the same time, a statement of observations on the condition of the labours of exploration, with some suggestions as to future procedure. At the same time a gang of "shaftsmen" and miners accustomed to underground works was obtained from the mines of Almaden to put certain works in order in these mines.

As far as can be ascertained only three tenders were presented. The first, deposited on August 11, 1828, was made on the part of José Infante Vallecido; the second, filed on August 22, was made on the part of Juan Villar Oyos; and the third, which was the one accepted, was lodged at the instance of Gaspar, Marquis de Remisa, on the 30th of the same month.

As to the first tender, Infante accepted, in general terms, the eighteen conditions as laid down and published, but, for his part, with the addition of certain modifications or amplifications. He offered to pay annually the sum of £1,000 for the first five years of the lease, then £1,400 per annum until the

end of it, the Crown undertaking to purchase copper for their mints at Jubia and Segovia to the extent of fifty tons per annum, at the fixed price of five reals—about a shilling—per pound, about £100 per ton of 2,000 pounds.

By way of amplification, Infante Vallecido offered to lease the mines for the term of his life, paying an extra £600 per annum after the expiry of twenty years on the government undertaking to purchase, in addition to the fifty tons per annum for Jubia and Segovia mints, a further quantity of fifty tons per annum for the establishment at Sevilla on the same conditions as to price. Coupled with this also was the stipulation that the government should absolutely prohibit the importation of copper from abroad into Spain so soon as the total production of fine copper from the Rio Tinto mine reached the quantity of 1,125 tons annually, that being, he estimated, about the extent of the total consumption of fine copper throughout Spain!

Ultimately he demanded that in case his tender should be accepted, he should be considered to be in the service or employ of the government, not a simple lessee, and entitled to all the advantages which would arise from a recognition of his degree and position as such.

The second tender, that of Villar Oyos, was to pay annually to the Crown the sum of £400 and 25 per centum of the actual profit on the sales of the copper produced and manufactured.

The tender of the Marquès de Remisa was to pay £2,600 per annum for the first ten years, and then £3,100 per annum for the remainder of the term,

accepting the conditions as laid down by the Government in the document already referred to of April 3, 1828.

In his tender to lease the mine, Remisa made ample reference to the history of his endeavours to place the mines of Guadalcanal also on a prosperous footing, and alleged that he had sunk some £14,000 in that task, and had not been entirely successful. He also made reference to the " previous concessions of the mines of Guadalcanal and Rio Tinto to Wolters in 1725, and to Doña Maria Teresa Herbert, Duquesa de Powis, in 1742, under which those persons had probably been enabled to recoup any losses in working the former of the two mines by profits made on the other enterprise : that such an alternative would not now be open to him, and that consequently, owing to the unfortunate condition of the Rio Tinto Mine, he was running a very great risk."

The Director-General of Mines, on remitting the tenders to the proper quarter, reported " that he judged the first tender to be inadmissible ; the second, by no means adequate to meet the views and wishes of the Crown as conveyed in the decree and conditions of the lease ; but that as to the third tender he was of opinion that it might fairly be entertained and considered to be sufficiently advantageous in terms. He was also of opinion that the limited number of tenders presented was due to the short notice given, only four months, rendering it quite impossible that residents in other countries could have had time and occasion to study the condition of the mine and prepare their tender ; and he

added that if His Majesty was not satisfied even with the offer of Remisa, he would do well to keep the offer open for a further period of three months."

The tender of Remisa was, however, approved of in due course by the proper authorities, and was carried into effect; the deposit of £5,000 was duly made, and the lease, in accordance with the terms published, was executed on January 17, 1829.

Consequently the Royal Mine of Rio Tinto was formally and plenally handed over to the lessee on April 24 following, Don Rafael Cobanillas, secretary of the Director-General of Mines, being commissioned to act in that transaction on behalf of the Crown, Don José Garcia Rodrigo representing the Marquis de Remisa. This being carried out, the deputies returned to Madrid, the lessee appointing as manager Don Alejandro Vicente Espeleta, a retired Commissary of War, whilst Don José Martinez Marcos remained as representative of the Crown and Inspector of Mines of the district, to observe the faithful fulfilment of the terms of the lease by the lessee.

As to the forest timber on the estate it was estimated that there were in existence some 444,000 pines (all dating their growth from the time of Sanz), valued at £15,000, as well as some 1,700 oak trees and about 300 poplars, valued at £2,110.

Extracted crude mineral was also handed over to the value of £249.

The various furnaces, smelters, and other works were in a bad state of preservation generally, but that at the site called "Los Planes" had been completely ruined by Martinez Marcos in 1827, either through ignorance or "mala fē." To judge

from a contemporary report (*Minas de Rio Tinto :* " Memoria, showing their condition on the Conclusion of the Lease from 1829 to 1849," Casiano de Prado, Madrid, 1856), the new lessee was not too scrupulous in his compliance with the terms of his contract, and, as is always to be found in such cases, sought to obtain the greatest amount of benefit and profit with as little an outlay on " capital " account as he possibly could.

Under the Remisa *régime*, however, certain advancement in procedure was introduced.

On August 3, 1831, under the direction of Alejandro Espeleta, the first "reverberatory furnace" for the refining of copper. was built and put into operation.

Another important matter, too, was the adoption of a new system or method of treating the poor ores by calcination. Don Ignacio Goyanes is to be credited with having substituted the old treatment of roasting these ores in small furnaces—" hornos " —with, or by, a simpler and more effectual and economical procedure.

He built up a basement of, first, a course or platform of large stones, then a layer of heavy, and again smaller firewood, on the top of which were placed the large prisms of mineral, then, and to-day also, called " teleras," from their resemblance to a class of bread common to certain parts of Andalucia, and thus named.

This led to a very large increase in the quantity of mineral thus tested—" that is, by open-air calcination "—causing very considerable damage to all vegetation in the near neighbourhood, and especially to the large and valuable pine forests. The pine, it

OPEN-AIR CALCINATION "TELERAS."

may be remarked, of all trees, is particularly sensitive to the influence of sulphurous fumes.

This process or form of calcination in the " open air " was subsequently adopted and used by the government on the expiry of the Remisa lease, and was in active operation when the mine was sold to the present company in 1873.

On October 17, 1830, Don Bernardo de Larrea y Villavicencia was appointed representative of the government. He had had experience in the copper mines of Peru, and had studied under the noted mineralogist, Baron de Norden.

Larrea has been credited with having discovered a satisfactory method of treating the vitriolous waters of the " Cueva del Lago," which had hitherto been left untouched and allowed to run to waste because of their containing but a low percentage of copper, and considered not to be amenable to the ordinary process of " cementation."

But Larrea can hardly be thus credited fairly, inasmuch as the existence of copper in these particular waters had certainly been known to Melchor Jimenez in the last century, and more recently had been treated by Martinez Marcos. At any rate, on October 22 official testimony of his discovery was forwarded to the Office of Mines at Madrid, and in consequence he was duly authorized to continue his experiments and obtain the copper contents of these waters.

Nothing appears to be said of Remisa's position in this matter.

Apparently there was nothing new in the question of the treatment. Don Ignacio Goyanes, in a letter

to Don Casiano de Prado on May 28, 1837, about the treatment of the vitriolous waters from the "Cueva del Lago," expressed himself as follows: "Cementation of them is easily effected, and I suspect that if the experiments made by Don Bernardo" [Larrea] "and the lessee did not give any satisfactory results, it was because they had not given the 'canales'" [channels conveying the water] "*the proper inclination.*" (*Minas de Rio Tinto*, Casiano de Prado, Madrid, 1856.)

A reference to Table E, which is a *résumé* of the operations during the twenty years' lease to Remisa —from 1829 to 1849—shows that as soon as the "cementation" processes were in full working order, the quantities of mineral treated at the furnaces were undoubtedly considerably reduced, by reason of its greater simplicity affording a larger margin of profit.

The representatives of the Remisa enterprise undoubtedly took advantage and made practical use of the suggestions and information contained in the various reports and documents existing in the archives of the mine's offices, especially those regarding this matter of cementation. They studied particularly the "Memoria" of Elhuyar already referred to, in which reference was made to the possibility of profitably "treating the 'tierras' or small mineral and 'vitriolos' from the interior of the mine by washing them"—the process of "artificial cementation." (*Revista Minera*, vol. v. p. 51.)

Apparently the right to carry on this new process of artificial cementation was delegated to Vicente Lopez Trebe by Remisa, and he formed a second

corporation to construct the necessary works, selecting as a site for them that known—then as now—as "Los Planes."

These were established in 1839, without Remisa having consulted with the government as to his right to make this arrangement, which was not mentioned in the terms of his lease, and opposition was soon forthcoming. The leading Corporation of the Province, the "Deputacion Provincial," seated at Huelva, took the matter up, and made a strong protest, alleging that what had been done by Remisa in this matter of artificial cementation was absolutely illegal. Remisa, however, was possessed of sufficient influence at Madrid to prevent any interference with his plans and work in that dircetion, and the application of the body referred to, to have the lease cancelled, was refused by "Royal Order" dated May 29, 1839.

Remisa is credited with having been most successful in his operations to obtain copper by the cementation processes. In a "Memoria" by Don Roberto Kith, inserted in the *Anales de Minas* (vol. iv.), it is alleged that the quantity of "tierras" (small mineral) and "vitriolos" extracted by Remisa from the interior of the mine up to the year 1846 reached the total of 3,500,000 arrobas, about 43,750 tons; but the Table "E" gives the quantity of fine copper produced.

The year 1841 witnessed the creation of a local Municipal Government, due without doubt to the influence of the Marquis de Remisa, to whom such a body or authority could not but be of considerable use, as the appointment of all its officers and

members would be under his immediate patronage, and thus an important official institution would be directly amenable to his discipline.

This, with but a single exception, was a final blow to the interference of the authorities of Zalamea la Real. With what bitter feelings the inhabitants of that town must have looked upon the complete segregation of what they and their forefathers from time immemorial had, considered and believed to be a part of their dominion, use, and profit!

The final, and perhaps a harder blow and loss—considered financially—was the subsequent separation and formation into an independent municipality of the old town of "Rio Tinto," under the name of Nerva. This was effected chiefly through the determined efforts of Don Domingo Gil Valez, supported in Madrid by the Marquès de Oliva, in the year 1885.

This left Zalamea la Real patron of only some few small villages and a very much reduced municipal territory or "termino"; the towns thus newly created, parts hitherto of its own corporation, were soon to more than rival it as well in population as in wealth and importance. But a continuance of the subjection of such a valuable and already important mining industry to the caprice and obstructive dominance of the few principal proprietors of a small agricultural town would have been an incongruity, a hardship, and a positive misfortune for all concerned.

Some very curious and interesting notices about the matter, edited by Ezquerra, were published in volume x. of the *Revista Minera* (p. 37).

Having regard to the technical march of events at

Rio Tinto, reference must now be made to the granting, on September 9, 1845, of "a *privilege of invention*" to one Felipe Prieto, of Sevilla, for a term of fifteen years "in respect of a chemical discovery for utilizing the 'minerales cobrizos piritosos' of inferior grade."

The "discovery" which this patent or "privilege of invention" covered was nothing more nor less than the extraction of the copper contents of the small mineral, accumulating in the interior of the mines as the works progressed, by washing and precipitation through iron—by the process of "cementation" already referred to as having been known in the fifteenth century! and certainly practised in this same locality by Samuel Tiquet as long before as 1752—nearly a century previous.

This "privilege of invention," then, had already been in practice in this mine, and was actually conveyed to Remisa under his lease. It is true that if it had been specifically conveyed to Remisa *as* a "privilege of invention," it would not have run for the whole term of the lease—twenty years, as by Article 3 of the Royal Decree of March 27, 1826, the term of any "privilege of invention" was limited to fifteen years; but Remisa had not taken the matter over in that way; the process came to him as part of the going concern, as well as the furnaces and smelting works, and he neither needed nor obtained nor was granted a "patent or privilege" either for the one or the other.

Alonso Barba thus refers to this "invention" in the *Arte de los metales*, lib. iii. cap. xiv., published in the year 1640: "The stones of copper have to be

roasted until they lose all their lustre" ["el brillar que tienen"], "then washed, thus obtaining the copper contents . . . then iron is placed in the solution; this disappears, and is turned into fine copper."

Reference is also made to this process, in addition to other works already referred to in a previous chapter, in a work edited by Schlutter, *De la fonte des mines* (vol. ii. chaps. lxxxv., cv. and cvii., Paris, 1753); and again by Hermann, Erster Theil, *Naturgeschichte des Kupfers*, Vienna, 1861.

Of course the Remisa concession made free use of this "privilege of invention," and without doubt made large profits under it, the last ten years of the lease showing an average extraction from this source alone of about 200 tons of "precipitate" per annum; he had actually been extracting the copper from the "vitriolos"—copper crystals formed in the interior of the mine by water percolating through the lodes, of which very large quantities had accumulated in the old workings since the year 1839.

Rubio, in a treatise published by him in the year 1853, *Tratado Completo de las Fuentes minerales de España*, gives the following analysis of the vitriolous waters obtained from the interior of the Rio Tinto mine, made in the year 1849, at the instance of the Marquis de Remisa by Don Antonio Moreno.

"Analysis of two pounds weight of 'cementation water' from the Mine of Rio Tinto.

"Free Sulphuric Acid			
" „ Arsenious	„	. . . .	.90 grains
" „ Silicic	„	. . . .	1·50 „
"Ferrous	„	. . . .	80·71 „

"Cupric	Acid	9·96	grains
"Zinc	,,	3·99	,,
"Glucinium	,,	4·56	,,
"Aluminium	,,	5·01	,,
"Calcium	,,	2·40	,,
"Magnesium	,,	5·87	,,
"Yttrium	,,	5·99	,,
"Cerium	,,	1·74	,,
"Lithium	,,	5.66	,,"

More modern analyses, however, give quite different details, and are more likely to be exact.

The expiry of the lease to the Marquis de Remisa left standing, as an "incubus" upon the place, the "privilege of invention" granted to Felipe Prieto; this took the shape of a "company," and was called the "Compañia de los Planes," and it is not easy to conceive why the government should have permitted this, as if it intended working the mine by direct administration it was manifestly depriving itself of the certain secure and profitable part of the undertaking; and in case of its determining to further lease the mine, then the existence of this "company" with the "privilege of invention" rendered the obtaining of favourable terms for the remainder of the mine very difficult and problematical.

The granting of the "privilege of invention" might, of course, have been connived at by Remisa himself, on purpose to make difficult any dealings with another intending lessee or administrator.

As will be seen on reference to Table E, the total quantity of copper obtained by the Marquis de Remisa during the twenty years of his lease was about 5,321 tons of 2,000 pounds; but no returns are available showing the actual quantity of mineral extracted during the period under notice.

CHAPTER VII

FROM 1850 TO 1873—LEASE OF THE "CEMENTATION" WORKS. TO THE COMPANY DE LOS PLANES: TO CERDA—TRIPLE ARRANGEMENT FOR WORKING THE MINE—ROYAL COMMISSION APPOINTED TO DETERMINE OPERATIONS—OPEN-CUT SYSTEM PROPOSED—RAILWAY TO SEA-PORT—DETERMINATION TO SELL THE MINE OUTRIGHT—ITS CONDITION AT THE TIME—THE RIO TINTO COMPANY, LIMITED, ACQUIRES THE PROPERTY AND COMMENCES OPERATIONS—CONCLUSION

THE period now under review covers that of the final attempts of the government to carry on the system of direct administration of the mine previous to its absolute sale; and their later and ultimate efforts proved to be as unsuccessful as their earlier ones.

On the expiration of the Remisa lease in the year 1849, Don Casiano de Prado, an engineer of mines, was entrusted by the government with the task of taking over the works from the lessee and of continuing operations until other arrangements should be made on its behalf. His report, already referred to, amply demonstrated the very abandoned condition in which he found the works and buildings, and also how little the government actually assisted him in his efforts to put the establishment into better working order or supported his endeavours to make a profitable start possible.

He wrote (*Memorias*, p. 11): "On the 24th of April (1849) the contract for leasing the mine terminated. On the day following I put into working order and operation all sections of the works as on account and on behalf of the government, without being able to count upon or being furnished with the necessary funds for even the most urgent and important matters, although I did not anticipate that many days would pass without such being sent to me.

"But I was mistaken, and if the labours in the mine and all the works and offices did not suffer any interruption, that was due only to my determination and to my occasionally procuring funds and loans from Sevilla, obtained, however, under my own personal guarantee and employing my own private means, sometimes even remaining without any money at all."

An eloquent illustration of the conduct and efforts of the department of State concerned to elevate the establishment to the condition and importance it merited, because of its ascertained and exceptional conditions and capacity! But as though the experience gained by the results of the expiring concession or lease had served as no lesson at all, on January 25, 1849, actually three months before the expiry of the Remisa lease, the Crown granted another to Don Filipe Prieto, the sub-contractor of Remisa, for the term of about eleven years, this being practically the remainder of the unexpired term of fifteen years conceded under the "privilege of invention" of September 9, 1849, already referred to.

To this enterprise was given the formal title of "Company of Los Planes"—"Planes" being the

name given to the site—it is still to-day thus known—where the " cementation " works were established.

Under this arrangement Prieto, or the Company, was to supply about 18½ tons of fine copper per month during the term of its continuance, at the fixed price of £45 per ton, whilst on the other hand the government undertook to facilitate and supply to him 1,500 tons of small mineral per month " at the mine's mouth " ; whilst all the other (and they were many) important conditions were strongly in favour of the lessees, at the expense of the proper working and development of the mine.

And yet, as though the granting of one concession at a time was not sufficient, a few months later saw the issuing of another, with regard to the process of " cementation," a preference being given to Don Mariano de la Cerda, at one time a priest attached to the mine's church.

He apparently secured his concession under the pretext—surely some justification was necessary—of being the author and inventor of a " new process for the extraction of the copper contents of the mineralized waters, exceeding in merit all others then known," and styled it " the electro-chemical " process. For it he was conceded the corresponding privilege for the term of fifteen years.

With this, then, three separate interests were set up in the mine : the extraction of the mineral directly at the cost of the government, and the two processes of "cementation" being worked by Prieto and de la Cerda respectively and independently.

The operations of Cerda were commenced and

carried on at that part of the mine now close to the terminus of the main line of railway from Huelva, and the locality is at the present moment called "Cerda," some part of his works still being in existence there.

Hardly, however, had this second enterprise commenced active operations, than it became patent and clear to all that the two "processes" of Prieto and de la Cerda were one and the same thing. "Privileges of invention" had been granted for a process that had actually been continuously in existence and working on the spot since the year 1752!

The discovery of the anomaly led to dispute and to grotesque incidents, and also to a lively correspondence between the technical manager of the government and the reverend inventor and patentee, and the matter, becoming public, gave occasion to many satirical articles and sharp criticism in the newspapers of the day.

As was to be expected, the priest, de la Cerda, could not long continue in his assumption and imposition, however strong his position was under his "patent," and in 1857 his concession was formally rescinded, and the other patentee, Prieto, or the "Company de los Planes," continued alone developing the works of "cementation," and increasing the amount of mineral under process of open-air calcination, greatly, however, in this latter respect, to the detriment of all vegetation near.

The "electro-chemico" process and invention of Cerda was introduced by him shortly afterwards at the mine of "San Miguel," situated some nine miles

to the north-west of Rio Tinto, only to be abandoned a short year after it had been established there, and completely forgotten. No details of the process have been published so far as has been ascertainable.

At the conclusion of the term of the "Planes" concession in 1862 (vide Table F), it is seen that the not inconsiderable quantity of 200,000 tons of mineral had been extracted from the mine for treatment at that section of the works, yielding about 3,700 tons of "precipitate" or "cascara," very large profits no doubt accruing to the enterprise.

In some of the latter years of the period just alluded to, 1849 to 1862, and shown in Table F, the production of copper under the direct administration of the government, that obtained by the various smelting processes or methods, received a certain favourable impulse, and was augmented, notably during the years 1859–62 inclusive. It is probable that very much more satisfactory results would have been forthcoming if the government had not in the year 1854 "made another post"—created a superior chief of the establishment under the imposing name of "Comisario Regio" (Royal Commissary), which had no other effect than but to render more sluggish and cumbersome the already too clumsy and unequal administrative machine, and to destroy or obliterate the more or less competent technical direction of the mine.

Irregularities and abuses—to use a light term—set in and continued thenceforward on an increasing scale. Administrative charges and working costs

were raised to excessive and impossible standards, the usefulness, or even actual worth, of the mine itself was rendered almost problematical; and such was the chaotic state of the administrative operations, that a commissioner, specially appointed and sent to investigate carefully and fully all that was taking place at Rio Tinto, found ample proof of the grave irregularities suspected, and in his report made downright charges of "peculation, dishonesty, and corruption" against the officials in charge.

It was not at all unlikely that the chief technical officer of the government resident there was aware of what was taking place, and would have remedied matters had he been possessed of the power to do so; but probably the simplest innovation or recommendation propounded by him would have been useless because of the objections and difficulties —without number—which would have been set up by the various administrative heads, it having apparently availed nothing that the government had issued, by a royal decree, the "Report and Suggestions" of Anciola and Cossio in 1856, ordering the mine workers to observe them carefully in their future working and development

The radical reforms counselled by them, amongst others the substitution of the "open-cut"—commonly styled also "open-cast"—system of extraction of the mineral, so very highly advantageous and indispensable even under the condition existing of the interior works of these mine, for that of the subterranean "column and chamber" method then, and unfortunately hitherto, practised; —were relegated to oblivion, until—and let it be

recorded in honour of the "Memoria" or report of Anciola and Cossio, officials esteemed as much for their diligence and zeal as for their known intelligence, capacity, and integrity—a powerful corporation, free from "red-tape" and official hindrance, twenty years afterwards put into practice and proved the correctness of their opinions and plans.

But the central administration at Madrid, troubled by frequent disagreeable communications, urged repeatedly by the Superior Council of Mines, and desirous of putting an end to such a hopeless and unprofitable state of affairs, at length decided to, or rather was compelled to, investigate and ascertain the true state of matters at Rio Tinto and determine upon the best methods by which to place the establishment in a proper and workable condition, and obtain some benefit from the—even then—apparently solid and ever-increasing richness of the partially discovered masses.

To that end, in the year 1867 a new commission of engineers was nominated by royal decree, of which Gomez Salazar was the president, and Cossio, who had on a previous occasion acted in a similar capacity, one of its number.

Their report is very much too prolix to quote in its entirety. Its many and diverse details are contained in a very extensive "Memoria" duly extended by them, and laid before the Minister of Hacienda, in whose archives it has remained unedited and unpublished; fortunately Gonzalo Tarin, in the course of his researches (*Memorias*, vol. ii. p. 291) was enabled to extract its chief points, and

it will not be out of place to enumerate some of the more essential parts of it, especially those having relation to that which was afterwards taken in hand and carried out by the present company some ten years afterwards.

1. Rehabilitation of the adit called " San Luis," and of the corresponding interior floors, for the establishment of a " viaferrea " which, connected with others at the exterior, would facilitate and greatly economize the transport of mineral from one part of the mine to the other.

2. Substitution of the open-cut system of extracting the mineral in lieu of the subterranean column and chamber method.

3. Adoption of the method of treating the mineral by furnaces in preference to the process of " cementation artificial," as suggested by Cossio in the year 1856, which, whilst in effect reducing the cost of fabrication, would have the effect of raising the output of fine copper from 1,100 to 1,800 tons per annum.

4. Development of a better general system of working the mine based on the construction of a large adit or tunnel projected to reach and traverse all the masses or lodes at the level of 196 meters below the mouth of the Santa Ana shaft, some 95·65 metres below the level of the present railway station; such tunnel to have its exit on the north-west side to the River Tintillo, passing through soft rock, and therefore of economical construction.

From this point (near San Dionisio workings) to construct a narrow-gauge railway of some 69 kilometres, about 42 miles in length, which, following

nearly the course of the River Odiel, passing the towns of Zalamea and Valverde del Camino, would place the mine in direct and rapid communication with the capital of the province, the seaport of Huelva.

The time fixed by the commission for carrying out these alterations was six years. No indications are given or any suggestions made as to their probable cost.

According to Gonzalo Tarin the cost of production of a ton of fine copper was then (1867) about £44; and that was proposed to be reduced, on the carrying out of the first and second suggestions of the commission, to £32 per ton; on the establishment of the first, second, and third suggestions to £28 per ton; and on the adoption of all four suggestions to only £25 per ton.

Several or part of several of these suggestions were apparently carried out, such as the alteration to the San Luis tunnel and the putting in order of a small section of the interior galleries and workings. An extensive series of "cementation" tanks and channels on the lines suggested by Cossio were constructed, as well as new furnaces. And ultimately, in 1870, the making of a new shaft, called "San Inocente," was commenced, and, what was of much greater importance, the first steps were taken towards the making of the "open-cut" (Gonzalo Tarin, p. 293).

Before entering upon the task of appending a "resumen" of the changing circumstances, fortunes, and *modus operandi*, of the mine, indifferently indicated in the preceding passages and chapters,

from the time of Liebert Wolters in 1725, until the date now reached, that is, the sale of these mines to the present joint stock company, a reference to Tables F and G will enable an estimate to be made of their condition, potency, and productiveness, as well as the great importance their possession had brought to the government, even in spite of the extraordinary series of difficulties, blunders, and adversities—already recounted in outline—which the establishment had experienced.

The government at Madrid must have been hardly pressed and deeply despairing indeed to sell, absolutely, an enterprise of such solidly hopeful promise, declared utility, and evident *national* importance; but its election to sell the mine outright, in the hope of procuring for it that practical and sufficiently honest treatment which they, in *centuries* past, had been unable to meet with, even at the hands of their own countrymen, was amply justified by the splendid addition to its national prosperity which was the direct and immediate consequence.

And it may not be altogether out of place to assume that had such a step not been adopted, the Rio Tinto mine would never, in the hands of governmental administration, have reached a much improved condition—never have been the huge source of prosperity it now is—directly to the dual mining townships of Rio Tinto and Nerva, with a combined population of some 25,000 people, and undoubtedly indirectly to an unknown "world" of others.

The figures of working results for the previous eighteen years, from 1854 to 1872, show but very

slight progress and development, and without a radical alteration in the technical administration and the employment of large capital under well directed and skilful labour, but little could have been possibly expected.

Probably the whole of the exploratory work, certainly that connected with the opening-out and extraction of mineral, was confined to the mass or lode then called " Nerva lode," but later and to-day known as the " Filon Sur " or south lode: the vitriolous waters exuding from the north side of the two hills—really one, with two semi-distinct peaks respectively called " Cerro Salomon " and " Cerro Colorado," more for topographical reasons than for any real necessity of giving the one mountain two names—were for centuries permitted to run to waste.

The total interior labours in this south lode during the period under review—from 1725 to 1873—resulted in two sytems of galleries and drivages, which crossed and recrossed each other to the extent of some 850 metres in longitude, *entirely in mineral*, although, as now indicated, not always developed in a manner convenient for future exploration and development.

These were contained in nine floors or levels, although at the time of purchase of the mine, in 1873, only the eighth and ninth floors were being worked, this latter again corresponding to the level of the adit or tunnel of " San Luis," by which the drainage of the mine at this point was effected, the adit being also used for the taking out of the mineral.

The extent and condition of the work as then done or existing, in those nine floors or levels, is fully set out and lucidly explained in the statement furnished by Gonzalo Tarin in his many times referred to admirable work, *Descripcion Fisica, Geologica, y Minera de la Provincia de Huelva, tomo II.*, Madrid, 1888, and are also shown in Plan 2, taken from the same source and authority.

At the outset it should be observed that from the point at which the shaft called "San Gabriel," is (or was) situated, the exploration from the first to the sixth floors was divided into two zones or sections, denominated respectively the eastern and the western, according to their divergence from that shaft.

The second—the western section—where exploratory work was commenced early in the eighteenth century, under Wolters, contained much irregular distribution of labour and exploration in the short distance or depth of 30 metres which separated the first from the sixth floors; and in the first—the eastern section—no attempt at procuring and maintaining uniform levels had been made.

It may not be uninteresting to place on record the condition of these floors at this date as given by Tarin:—

First Floor.—Access to this was had by means of the "socabone" or adit called "Santa Barbara," now no longer existing, having been completely absorbed and obliterated in the progress and development of the "open-cut," locally called "corta" or "trabajos à cielo abierto," the extent of the exploration reaching some 27,000 square metres.

The western part of this "floor" was at a slightly higher level than that in the corresponding extension in the eastern section, the less extensively developed, and at a short distance to the east of the shaft called "Santa-Ana" was united or connected with the second floor by an inclined shaft or gallery.

Second Floor.—Was placed some seven metres below the first floor, measured at the last mentioned shaft, "Santa Ana," the western section consisting of a series of irregular galleries and cross-cuts having a total length of some 200 metres. The eastern section was comprehended between the shafts "San Gabriel" and "Santa Ana" just alluded to, and its level corresponded with the third floor of the western section. Its extension was not inconsiderable, reaching some 1,500 metres in longitude, and in both these two sections the total of the exploratory labours was about 29,700 square metres.

Third Floor.—This was started some nine metres below the level of the second floor. The work of exploration or extraction in the western section was very much more irregular than that in the eastern, in which also occurred several galleries of communication with the second floor, and extending farther in the western extremity, these formed the fourth floor (modern) beyond the shaft called "Sagunto."

The exploratory and development works performed in the eastern section of this floor were of very considerable extent. Altogether they extended to some 51,800 square metres, whilst the total length of all these galleries exceeded 5,700 metres.

According to analyses procured by the engineers, Anciola and Cossio, from this locality or part of the south lode a rather richer class of mineral was extracted, the average of the copper contents having been about 4·50 per cent.

In the north-western part of this floor some rather important Roman workings were cut into at the site called " Cueva (cave) de San Andrés."

Fourth and Fifth Floors.—In the western section only inconsiderable work was carried out in the fourth floor, whilst that done in the fifth but slightly exceeded it, and both of them terminate in the neighbourhood of the shafts " Santa Barbara " and " San Carlos." In the western section several galleries of communication were opened between the third and fourth floors. In the eastern section communication with the surface was opened up also by means of a shaft called " Brujaluni," situated at its eastern extremity.

It was in this section of the " south lode " that the richer class of mineral was obtained, and the total longitude of the galleries opened out was about 10,000 metres.

The disordered and confused state of all the work now under description is at once manifest. Part of such irregularity may undoubtedly be ascribed to the need of obtaining mineral containing, on an average, about 4·50 per cent. of copper, a percentage greater than the average of the whole of the mass or lode under exploration, to meet the requirements of the smelting furnaces.

For this reason the miners, at the end of the eighteenth century, engaged, perforce, in the explor-

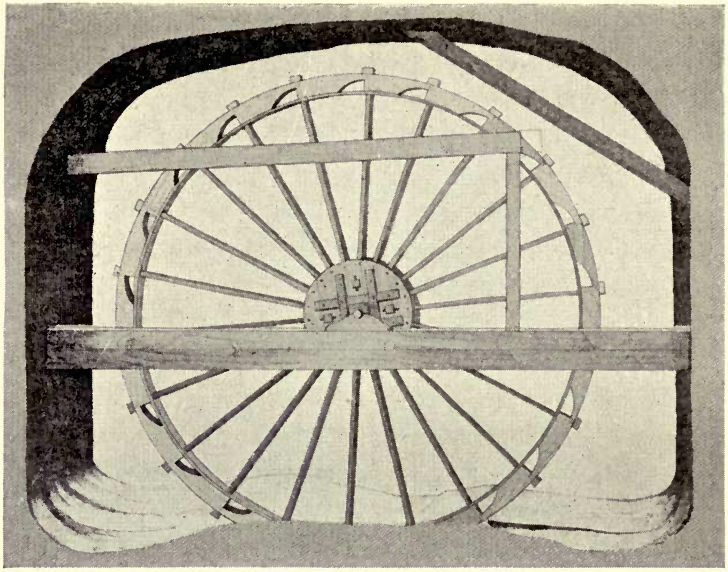
ation and extraction of the richer veins of mineral contained in the mass, and, as its distribution was neither regular, continuous, nor constant, their labours resulted in distinct and various sections, in complete disorder, and were consequently gravely prejudicial to the future economical and even secure progress and development of the mine.

More than one hundred samples of the masses of poorer mineral thus left untouched, analyzed between the years 1869–72, showed an average of of 1·93 per centum only of copper contents.

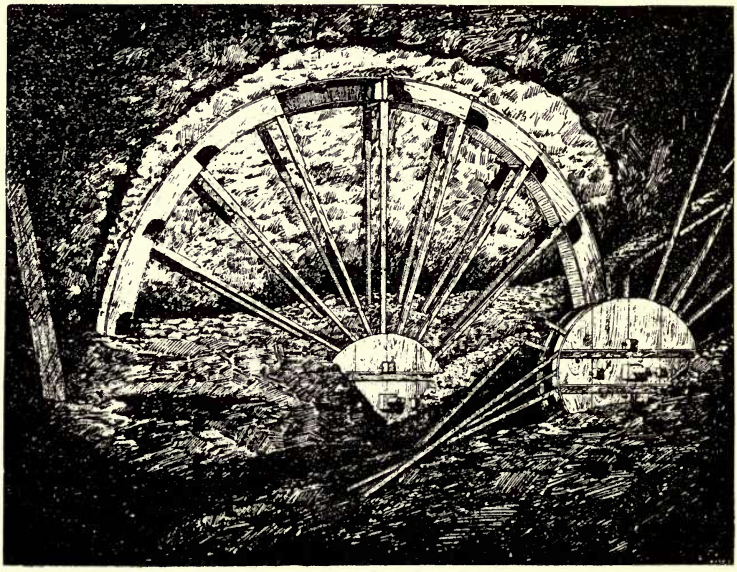
Sixth Floor.—Here the face of the workings revealed the following of a more systematic method and operation, in some degree subservient to the drainage obtained by the "socabone" or adit of "San Roque," which was situated or established some 55·70 metres above the level of floor No. 2; also later called "the tunnel," when further developed and improved by the present proprietary company.

This floor extended from the "Sagunto" shaft to the "Brujaluni" shaft, a longitude of about 600 metres, the principal galleries generally following the direction of the mass or lode, these again being cut and intersected at right angles by another system of inferior galleries, locally called "traviseas" or cross-cuts, resulting in a system of "pillars and chambers." Considerable development was obtained in this way, the total longitude of both great and small galleries being upwards of 7,800 metres.

According to Anciola and Cossio, the mineral thus extracted averaged 4·44 per centum of copper,



ROMAN WATER-WHEEL.



ROMAN WATER-WHEELS—IN SITU.

whilst that taken out later between the years 1869–72 from this section did not show anything better than 1·77 per centum in fifty-two analyses.

Seventh Floor.—In superficial extent the development work here quite equalled that of the sixth floor, and a similar regular system of work evidently prevailed on the whole. The total longitude of exploration reached to more than 8,190 metres.

Some considerable disturbance and irregularity in the workings was occasioned in the north-west part or section of the mass or lode near to and at the east of the "Lepanto" shaft, caused by cutting into several immense Roman workings — huge chambers or caverns known as the "Cuevas de Crispulo," "San Joaquin," "La Veinteuna," and "Pudente." These caverns or chambers were all in mineral, but have disappeared with the recent extension of the open-cut at its western end.

It was in these and in other similar workings—especially in the "north lode" section of the mines (another has just been brought to light there—October 1900), that money, tools, rope, water-wheels and other substantial evidences were found, forming proof that they had been made and left there by the Romans during the period of their occupation of Spain some 2,000 years ago. The two illustrations given are from photographs taken of the water-wheels, evidently used in place of pumps, immediately they were brought to light during the progress of mining. At a very short distance from the second of those shown, a third was brought to light, but in a dilapidated condition.

It is somewhat curious to reflect that these well-

preserved instances of the industry of another generation have been lying there as they were left some twenty centuries away back in the dawn of history, untouched and forgotten of man!

They are, of course, built entirely of wood, the timber apparently being of a kind unknown to-day in this locality; and as far as instances have occurred they are all of exactly similar dimensions. This, however, has been referred to in a previous chapter.

From some 420 analyses of mineral taken from this section of the mine (the seventh floor), it has been ascertained that the average copper contents was 2·95 per centum.

Eighth Floor.—Situated some 7·40 metres below the level of the last "floor," it was also developed to a considerable extent, some 8,000 metres representing the longitude of the various galleries contained in it. This level or floor was drained by the "socabone" or adit called "San Luis," placed some 14·40 metres below the level of the last or seventh floor. To the south-east of the "Santa Ana" shaft two large Roman chambers or caves were cut into, undoubtedly corresponding to those found in the seventh floor, although partly refilled with rubble. As the result of some 1,049 samples of mineral analyzed, taken from this level, the average copper contents was given at about 3·81 per centum.

Ninth Floor.—The little distance left between the "San Luis" socabone or adit and the eighth floor did not allow of any greater altitude than two metres to be given to the galleries in this floor. The work of exploration and development was inferior in importance to that of the seventh and eighth

floors—it was in process of development at the date of the transfer of the mine to the present company. The total longitude of the various galleries was about 4,000 metres; some few Roman coins are said to have been found in it. The average copper contents of some 204 samples was 3·47 per centum.

From this very superficial description even it will be at once seen that the underground exploratory work done, up to this period, was neither unimportant nor devoid of proof of the immense mass of mineral untouched.

The more modern labours, in particular those executed since the year 1830, have been adapted to some extent, as will have been observed, to the system of chamber and pillar, the square pillars or columns of mineral left being from 5 to 6 metres in height, with an average thickness of 4 metres.

The excavations were commenced from "pozos" or shafts sunk at convenient sites, the principal galleries being 2 m. by 2 m., whose parallel arcs were distant about 8 m. from each other.

From this brief and superficial summary of the condition of the underground exploratory work in this mine at the time the government found itself obliged to sell it (1870), it may be gathered that from its extent and importance there could have qeen no doubt of its enormous national importance and value; unable to work it at a profit, the government had at least every confidence in finding a purchaser for it at home or abroad.

The absolute and unreserved sale of the Rio Tinto Mine was determined upon and authorized by a

Special Act of Legislation passed by the Cortes on June 25, 1870; and on July 1 following, the Regent of the kingdom, Francisco Serrano Dominguez, afterwards more popularly known as the Duke de la Victoria, acting under the direction of and in the name of the Cortes then administering the government of Spain, the country being then in a state of civil war, appointed a commission of four engineers to value and determine the amount for which the mine should be offered for sale to the public at large.

The commissioners appointed were two engineers of the Department of Mines, Escosura and Zabala, an engineer of the Department of Forests, Luis Latorre; and an architect and engineer, Joaquin Hernandez; and their very lengthy and detailed report and valuation was duly presented and published in a special number of the official gazette on May 11, 1871.

The sale value of the mine and estate was estimated by them at 104,357,769 pesetas=about £4,160,000, made up in the following way:—

		Pesetas
Value of the mineral		103,062,880—
Land and timber (growing)	65,841—	
Houses	590,475—	
Works and buildings	243,286—	899,602
Mineral under treatment, furnaces. stores, stables, live stock, hospital,. laboratory		395,287
Total, Pesetas		104,357,769

The valuers apparently based the value of the

mineral on an estimation of the " life " of the masses at 400 years with an annual extraction of 500,000 tons.

Four tenders only were presented as a result of the first announcement of sale, and a second attempt to make a sale at the amount indicated was equally ineffectual; this led the government to consider its position, and on February 14, 1873, the tender of an English or London banking house, Matheson & Co., was accepted, the sale being arranged with them on behalf of the owners, the Rio Tinto Company, Limited, at the price or value of 92,800,000 pesetas=about £3,712,000; and the contract for sale and purchase was forthwith carried into effect, to the material advantage of all concerned.

The freehold estate sold with the mine as part and parcel of it, and already referred to as that which comprised the area within which the local municipality held jurisdiction, was 1,922 hectarcas, 39 areas, and 47 centiareas, about 4,750 acres.

Another very important concession was that authorizing the construction of a railway to the chief seaport and capital of the province, Huelva, duly constructed and opened on July 24, 1875.

An equally valuable development forthwith undertaken by the new proprietary company was the construction of an iron pile three-floored pier at Huelva, to provide loading berths for at least four steamers at a time, so as to facilitate the exportation of mineral on a very large scale.

Incidentally it may be mentioned that the total quantity of mineral extracted under govern-

mental auspice during the last year its officers had charge of the mines, in 1872, was only 62,220 metrical tons = about 260,0000 rdinary tons.

This very imposing construction is built on a curve, and extends some 579 metres seaward, of which 517 metres are built of iron, the remainder being of timber. Upwards of 2,000 tons of iron were used in its construction, as well as some 6,000 cubic metres of creosoted timber. The lower of the three floors is 3.50 m. above mean tide mark, the intermediate floor is 9.30 m., and the superior floor is 13 m. above it.

At the same time very active steps were taken with regard to the construction of a large reservoir, or " dique," in the near neighbourhood, to secure a full and constant supply of water equal to all the wants of the establishment, when mounted on a large scale and in full working order. Its capacity is about $2\frac{3}{4}$ million cubic metres = about 600,000,000 gallons.

Another principal item in the new programme was the immediate opening out of the upper section of the south lode by an " open-cut." This was at once put in hand, and operations were conducted on such a large scale that in the course of a very few years the huge mass of mineral contained between the old shafts—" Lepanto " and " Brujaluni "—was completely exposed and available for cheap and easy extraction.

So that within the short period of two years of the formation of the joint stock company, which to-day holds such an important and prominent

GENERAL VIEW OF NORTH LODE OPEN-CUT.

position in the industrial world, the whole of the plans designed for the exploitation and development of the Mine of Rio Tinto on a scale commensurate with its merits and capability, were completed and brought into successful operation.

The extraordinarily successful development of the concern has reached a scale of gigantic and national importance, and some inadequate conception of its utility, worth, and vastness may be obtained by considering the circumstance that the joint populations of the towns of Rio Tinto, Nerva, and Huelva reach a total of some 50,000 souls, almost the whole of that number being directly and indirectly dependent upon the prosperity of the once bankrupt but royal mines of San Luis de Rio Tinto.

Reference should not be omitted, even if only in outline, to a second huge open-cut commenced and carried out within the last few years, to expose and by that means expeditiously and conveniently extract the mineral contained in the "mass" or lode situated on the north-western side of the "Cerro Salomon," and locally called the "north lode," which had practically been left unexplored and unworked by the government, but which undoubtedly had been the chief centre of the underground operations of the Romans, and probably too of their predecessors.

In the course of its development, as was to be expected, many articles were brought to light buried in the surface débris—evidence of the Roman period of occupation and exploration. In addition to coins, ingots of silver, tools, &c., recently a very perfect "amphora" has been brought to the surface, being only slightly embedded. It is apparently

built of the red earth of a clayey nature common in the locality, measures some 1·06 m. in height, at its greatest girth ·94 m. in width, and its mouth is ·15 m. in diameter.

Another equally interesting discovery has recently been made in this locality. Buried in the loose soil and débris some short distance below the base of the pinnacle upon which the "Castillo de Salomon" was built, on the northern slope of the "Cerro" of that name, two very curious stone heads or images were discovered, in the course of the development of the western end of the upper benches of the open-cut just referred to. The material in which they are hewn is the ferruginous conglomerate covering the whole of the mountain range forming the "Mine of Rio Tinto."

They would appear to be rather crude and inartistic representations of the goddess Ashtaroth, a popular divinity with the Phoenicians, but faintly discernible in the sketch given; it will be noticed that from the extremities of the forehead spring the two "horns" that are, or should be, present in such case, these being more clearly defined in the larger of them. They probably formed part of the ornamentation of the old castle, but from their rough workmanship it is difficult to believe that they were the labour of a Roman artist; probably their origin dates from a much earlier period in history, and may have been the work of a Phoenician artist taken or translated from the traditional temple, huge scattered ruins of which are still in evidence, supposed to have once existed at the site now called "Escorial" and "Dehesa"—already referred to

STONE HEADS, PROBABLY PHOENICIAN ? ASHTAROTH

as having been the "locus in quo" of the reputed Celto-Iberic city, "Gran Bitania" or "Betulia," antecedent to the Roman occupation of Boetica.

Similarly a further extension of the "South Lode" "open-cut" has been in course of progress during the last few years—west of the now old work—to the not inconsiderable advantage of the company, and enabling the labourer to perform his arduous task under safe and healthy conditions.

But the working operations and development work undertaken by the present company since they became its owners in the year 1873, however full of interest, can hardly be considered to have yet entered into the condition of "historical matter"; nor are there any signs of a near diminution in the high prosperity of the corporation. A detailed record of the progress, development, and creditable activity of the last twenty-nine years of the "history" of the Rio Tinto Mine must remain to be written therefore by another and better instructed person.

It is sincerely hoped, however, that in the preceding pages something has been shown justifying this attempt to place on record, in our language, the curious matters and circumstances which spread over such a lengthy period of time, and which are surely entitled to a place in the histories of industrial enterprises, having been, and still being, of such moment, interest, and concern to state and subject.

Of the influence of this magnificent instance of the extraordinary value and importance of a successful mining and metallurgical industry upon the prosperity of Spain, much could be written; it, too,

has served as a lesson in that country ; others stimulated by a desire to be equally successful in a similar class of enterprise in other parts of the peninsula, have not failed, and the whole character of the country and of its inhabitants has, perforce, materially altered and obviously improved. Whilst agriculture is still, in many provinces, the chief concern of the inhabitants, the mining industry and its coadjutor—mechanical art—are receiving general attention and proper consideration, resulting in rapid development on all sides.

The State, too, has not been idle. The institution of technical colleges and schools of instruction in the chief centres of population; the creation of a highly instructed and competent body or department of State mining engineers; the encouragement given by the Crown to the individual worker and seeker of valuable metals and minerals in the concession of easy terms of right to search and acquire; the development of the railway systems; the construction of roads; and the very general establishment of electric communication;—have all tended to bring about an immense improvement in the general domestic welfare and prosperity of the country, and that happy development has abundantly proved the superior prosperity of an industrial as compared with an agricultural interest.

Possessed of the unusual advantage of a rich food-producing soil, even in the near neighbourhood of many of its principal mining centres ; enjoying a very salubrious climate, in which manual labour is not at all hampered or limited, situated so near to the best markets of the world for all its

products, and having the very great advantage of many first-class natural harbours and seaports—north, south, east, and west—more so than perhaps any other European country—it is quite impossible to figure the limits or form an estimate of the future of the Iberian Peninsula.

Spain has never been so prosperous as now, despite the manifold allusions extant to its "glorious state of might and wealth in the Middle Ages." On what practical or intimate knowledge of the country and of its inhabitants those opinions were based and formulated, and historians have pronounced, it is difficult now to estimate; but it is very certain that neither the State archives of the country nor of its cities, nor the general appearance and condition of the inner life of the people and of the cities and towns, seem to assist one in the belief that it ever was so.

Spain has been for upwards of twenty centuries simply an agricultural country, until but recently without any export or foreign trade of importance, unless wine be excepted; its inhabitants have grown sufficient food, and have not been much concerned in "opening out" new fields of enterprise and prosperity, or of occupying themselves much in "business"; the general appearance of its old cities and towns leads one to infer that for many centuries the people have been more or less content, and that even if they have not progressed, they have not suffered the terrible relapse from the high state of national prosperity and civilization even, so authoritatively stated to have been the condition of Spain and its peoples in the Middle Ages.

The evidence available, carefully and impartially examined, goes rather to establish the contrary.

There seems to be a general striking indifference to accuracy in English literature and books anent Spain. In a recently published edition (1898) of the *Encyclopædia Brittanica*—in the article headed "Agriculture in Spain"—there appears the following odd statement:—

"The produce 'per acre' just indicated places Spain among the countries of Europe in which the return (of grain) is least, which is probably fully accounted for by the backward state of cultivation generally, *and in particular by the small expenditure in manure. As a rule, in fact, the straw left on the ground is the only manure which the ground receives.*" This would be true speaking of modern agricultural colonies such as Canada, Australia and other British settlements.

It will be news to the Spaniards themselves and to those Englishmen who have resided in that country, and are intimately acquainted with the methods of cultivation of cereals of all kinds (and they are very many) in actual practice in the Provinces of Andalucia and Estramadura—two of the principal grain-growing districts of Spain.

There, at any rate, the people engaged in agricultural pursuits, chiefly small proprietors and "colonos," whilst very ignorant and without resource as a whole, in many districts and provinces, are exceedingly good "farmers" or cultivators, and are very well acquainted with the necessity and advantage of adding "abonos" or manure to the soil, and of the advantage, value, and necessity

of cultivation by "rotation crops"—and have been so for centuries—before the introduction of such a system even in England.

Their tools and agricultural appliances are, in general, ridiculous in form and complete in their apparent insufficiency; their methods of cultivation in many details quite "quixotic"; but apparently they have, for many centuries, been accustomed to obtaining some 20 bushels an acre of wheat, from 30 to 35 of barley, and from 40 to 80 of oats, referring always, of course, to ordinary good soil and property; for in cases of poor country, land is only sown once in from seven to twenty years ["tierras de monte-bajo"].

On the other hand they have failed to exact the full advantage obtainable, by reason of their ignorance of the existence of better class methods and appliances.

This diversion from the main subject of this work is perhaps hardly called for or necessary; it may even seem to be only a tirade against the opinion of others on a matter arising out of it only very indirectly; but it is the view of one who has had a very large and practical experience in the matter.

With a better knowledge of its peoples and looking to its soil, climate, and undoubted hidden mineral wealth and possibilities, Spain may—will—yet become a favourite ground for the English capitalist and investor, and will certainly see a further and enormous development of its general prosperity; that of its mineral wealth will surely be attended with corresponding advantage to its agricultural interests and population.

On leaving a country so fortunate in soil and

climate, one is bound to feel that the keen and bitter regret of the Moor was indeed genuine and heartfelt—" el ultimo suspiro del Moro " was—is —indeed a deeply meaning sentiment and picture, is surely a picture full of real meaning to those who know the " Vega de Granada " and the rich plains of Andalucia; the people of Spain should undoubtedly be proud and fond of their country—no better or happier-conditioned by nature exists on the face of the earth: it truly has infinite possibilities.

Those legions of slaves and their Roman masters of nearly twenty centuries ago engaged here—as to-day freemen are—would indeed be astonished at the change wrought in the ordinary conditions of life, and at the magnitude of the mines they not impartially nor ineffectually explored; little did they dream, or the historians of their day figure, that so far off in the future as a period of upwards of 2,000 years " the dust *they* trod upon would once again be alive," a real civilization be established, and the apparently vain speculations of fiction, romance and legend realized in a veritable splendour of commercial prosperity—in a high development of the mechanical and metallurgical arts and of science.

Alike through the long vista of 3,000 years the Celto-Iberian, the Roman, and the later inhabitants of this peninsula have been engaged in the extraction of the riches concealed within this locality, but it has remained to the Anglo-Saxon to prove the vastness of the national prosperity embodied in it, and to illustrate to the world at large the noble and beneficial influence of the Mechanical Arts, the advantages of the application of human energy in the

proper direction of technical skill, industry and labour; and it is the Anglo Saxon who has undoubtedly demonstrated and proved the unlimited prosperity awaiting a country and people whose soil is favoured by nature in the liberal possession of such magnificent resources as in the last thirty years have been brought to light at the once " Royal Mine of San Luis de Rio Tinto."

FINIS.

APPENDIX

DETAILS OF COINS OF THE ROMAN PERIOD FOUND IN THE ANCIENT WORKINGS OF THE MINE OF RIO TINTO.

1. *Obverse.* A head in gala dress with wings. Inscription, ROMA.

   Reverse. A figure of Victory in a two-horsed "biga" or chariot, holding a crown in the dexter, and the reins in the sinister hand. Between the limbs of the horses, L. FLAMIN, and in the "exergo," CILO.

This piece of money was coined at Rome in honour of the family of Flaminia, Lucius Flaminis Cilio at that period being Commissary of Money, Questor or "Intendente Monetal," and was probably coined before the Fall of the Republic and the Creation of the Empire.

2. *Obverse.* A woman's head, wings on shoulders, a collar of pearls on the neck, and a small star at the throat.

   Reverse. Mars carrying trophies; in the dexter hand a triple-barbed lance, in the sinister a military insignia; to the left of the figure an ear of wheat ("espiga"), and on the right an "apice pontifical." Inscription: L. VALER. FLACCI.

This coin was probably issued at the instance of a member of the family of "Valeria" named Lucio Valerio Flacoo, to whom Caesar had granted the Eighth Prefecture of Rome.

3. *Obverse.* A fish, placed horizontally; above, a moon in the fourth quarter; below, an inscription in Roman characters, ILIPENS.

   Reverse. An ear of corn, placed vertically.

According to Florez, *Memorias de la Academia de Bellas Letras de Sevilla*, vol. 2, p. 269) the signs on both sides may be taken to signify the fertility of the District, " Ilipense," " Ilipa " being a city of Boetica the exact locality of which has been the subject of much dispute. The coin was probably issued at Niebla, at one time known as " Ilipa," and later the capital of an Arab Caliphate or kingdom. The half-moon Florez attributes to Isis, as the " Goddess of Winds and Navigation."

4. A coin on one of whose sides appears a monogram composed of the letter " N " with a horizontal line as in " A " joining the first two strokes of the letter, and " O " between the other two strokes. It is probable that this, being unravelled, may mean " Onuva," in which case it would be a piece of money of Gibraleon, a town near to Huelva, also reputed to have been a Roman colony, and as having had a " coinage."

   The other inscription is indecipherable.

5. *Obverse.* A head without ornament. Around it is the inscription : COLONIA ROMVLA AVGVSTA.

   Reverse. Head of a woman without ornament. Inscription : IVLIA AVGVSTA GENETRIX ORBIS.

Apparently this coin was issued in adulation of Livia, wife of Augustus Caesar, when she had changed her name for that of Julia, probably at Sevilla, which city had then acquired the right and status of a " colony," with the title of " Romula," Romulea, or Romulense (*Memorias, etc., de Sevilla*, p. 296).

6. *Obverse.* Head of a young man crowned with a diadem. Inscription : CONSTANTINVS NOB. CAES:

   Reverse. Two standard bearers. Inscription : GLORIA EXERCITVS.

This coin was probably issued in edification of, or by, the Younger Constantine, and coined in honour of this Caesar or his forces on the rout of the Sarmatians, Goths, or Franks.

7. *Obverse.* A head crowned with a diadem of pearls. Inscription : DN. GRATIANVS. PF. AVG:

Reverse. An erect figure, sustaining in the sinister hand a " victoriola," and extending the dexter hand to a kneeling woman. Inscription: REPARATIO REIF.

This coin clearly corresponds to the Emperor Gratian, issued to commemorate a victory obtained over the Franks, Goths, and Sarmatians, near Strasburg; the prostrate figure may mean to signify the soliciting of Peace by the vanquished.

8. *Obverse.* An erect military figure; at its dexter hand, a globe, and at its sinister side, a lance, and the letter P. Inscription: VIRTVS. AVG:

A piece of money coined at the time of Galiens, *circa* 260 A.D., and which, to judge from the character and condition of this Emperor, and of the situation of the Empire at the time, was simply a tribute of adulation on the part of the coiners.

9. *Obverse.* Head with a crown of rays and the inscription: GALIENVS AVG:

Reverse. The figure of a woman, seated, holding a branch or spray in the dexter hand, and in the sinister, a sceptre. Inscrption: PAX PVBLICA.

10. *Obverse.* Similar to the last described.

Reverse. The figure of a woman, standing, holding in the sinister hand a " cornucopia," and in the dexter, apparently, a whip. In the close space is an unintelligible letter. Inscription: FORTVNA REDVX:

11. *Obverse.* The head of an Emperor, with crown of rays. Inscription: IMP. CCLAVDIVS. AVG.

Reverse. An upright desunded figure, holding in the dexter hand a " Cornucopia." Inscription: FIDEX EXERCITVS:

12. *Obverse.* Unadorned male head. Inscription, adding some undecipherable letters: TI. CLAVDIVS CAESAR. PM. TRI. P.P.

Reverse. An erect figure, dressed as for " gala," the dexter hand held aloft, and in the sinister hand a land; in the area or clear space, S.C. Inscription:

CONSTANTIAE. There is also faintly visible a kind of " paludamento," attached to the shoulders.

This coin corresponds to Claudius Tiberius, according to the obverse side, the inscription reading, ' Tiberio Claudio Caesar, Pontifice Maximo, Tribunicia potestad, Padre de la Patria."

The reverse shows an allegorical picture of the qualities the Head of the State ought to possess, and the letters S.C. imply the formula SENATVS CONSVLTO.

13. *Obverse.* The head of an Emperor, with a crown of pearls. Inscription: CONSTANTINVS AVGVSTVS.

Reverse. In the centre is shown the door of a city, above it, a planet or orb. Inscription: PROVIDENTIAE AVGG:

This coin apparently corresponds to Constantine the Younger, by the letters AVGVSTVS instead of MAXIMO, by which term his father was usually described. PROV. AVGG. may perhaps be taken to indicate the " providence " of his founding Constantinople.

Many other coins are also available for reference, but the bulk of the inscriptions are almost undecipherable, athough it is certain that some of them correspond to the Emperors Trajan, Vespasian, Antoninus, Aurelius, Galba, and Honorius. The work of Antonio Augustin, *Dialogos de medallas*, p. 59, Madrid, 1741, is full of interesting details on this matter.

RAINFALL AND TEMPERATURE.

METEOROLOGICAL RECORDS FOR 1894–5–6.

Elevation of Mines Station, 1,350 feet above sea-level.
Latitude, 37·43° N.
Longitude, 6·52° W.
Distance from sea-coast, Huelva, direct, 36 miles.

RECORD FOR 1894. AN AVERAGE YEAR.

Months.	Temperature, Fah.				Rainfall.	
	Mines.		Hulva.			
	Mean.	Coldest.	Mean.	Coldest.	Mines. — Inches.	Huelva. — Inches.
January .	46°	30°	51°	32°	2·49	2·51
February	52°	38°	54°	37°	·62	1·24
March .	54°	31°	56°	34°	3·17	5·04
April . .	55°	—	58°	—	3·41	2·87
May . .	62°	—	60°	—	2·40	1·05
June . .	73°	—	70°	—	·39	·02
July . .	81°	—	76°	—	—	—
August .	81°	—	78°	—	—	·04
September	69°	—	71°	—	·66	·09
October .	61°	—	66°	—	7·39	7·38
November	54°	—	59°	—	3·44	5·16
December	48°	33°	54°	35°	3·87	3·76
					27·84	29.16

OBSERVATIONS.

Rio Tinto.

Mean of four coldest months . . . . . 30·50°
,, four hottest ,, ... 76°
,, year . . . . . 61·34°
Hottest day, 3 p.m. . . . . 147°
Coldest day, 9 a.m. . . . . 30°

Huelva.

Mean of four coldest months . . . . . 34·50°
,, four hottest ,, ... 74°
,, year . . . . . 62·75
Hottest day, 3 p.m. . . . . 145°
Coldest day, 9 a.m. . . . . 32°

RECORD FOR 1895. A VERY WET SEASON.

Months.	Temperature, Fah.				Rainfall.	
	Rio Tinto.		Huelva.		Rio Tinto.	Huelva.
	Mean.	Coldest.	Mean.	Coldest.	Inches.	Inches.
January .	44°	29°	51°	32°	6·82	5·17
February	51°	31°	57°	36°	12·83	6·20
March .	51°	37°	56°	34°	3·13	4·67
April .	58°	—	62°	—	3·56	3·
May . .	64°	—	68°	—	2·23	1·18
June . .	71°	—	73°	—	1·92	1·42
July . .	77°	—	76°	—	—	—
August .	79°	—	79°	—	—	—
September	72°	—	77°	—	1·29	2·03
October .	64°	—	70°	—	8·84	7·44°
November	58°	—	63°	—	4·78	2·80
December	50°	30°	58°	39°	2·53	2·10
					48·13	36·01

OBSERVATIONS.

Rio Tinto.

Mean of four coldest months . . . . . 31·75°
„ four hottest „ . . . . . 75°
„ year . . . . . 61·60°
Hottest day, 3 p.m. . . . . 145°
Coldest day, 9 a.m. . . . . 29°

Huelva.

Mean of four coldest months . . . . . 35·25°
„ four hottest „ . . . . . 76°
„ year . . . . . 65·84°
Hottest day, 3 p.m. . . . . ·145°
Coldest day, 9 a.m. . . . . 32°

RECORD FOR 1896. A VERY DRY YEAR.

Months.	Temperature.				Rainfall.	
	Rio Tinto.		Huelva.		R. T.	Huelva.
	Mean.	Coldest.	Mean.	Coldest.	Inches.	Inches.
January .	50°	28°	55°	31°	1·08	·98
February	49°	31°	56°	34°	·78	1·
March .	56°	39°	62°	45°	·08	—
April . .	63°	—	64°	—	2·10	2·06
May . .	63°	—	66°	—	1·05	·87
June . .	70°	—	73°	—	—	—
July . .	78°	—	79°	—	—	·01
August .	75°	—	71°	—	—	—
September	74°	—	71°	—	—	—
October .	56°	—	61°	—	2·60	2·46
November	51°	—	53°	—	4·21	3·29
December	49°	33°	51°	37°	4·70	3·
					16·60	13·67

Observations.

Rio Tinto.

Mean of four coldest months . . . . . 32·75°
„ four hottest „ . . . . . 74·25°
„ year . . . . . 61·20°
Hottest day, 3 p.m. . . . . 140°
Coldest day, 9 a.m. . . . . 28°

Huelva.

Mean of four coldest months . . . . . 37°
„ four hottest months . . . . . 73·5°
„ year . . . . . 63·5°
Hottest day, 3 p.m. . . . . ·140°
Coldest day, 9 a.m. . . . . 31°

Mean temperature for three years—Rio Tinto 61·38° F.
„ „ „ „ —Huelva . 64°
Average rainfall „ „ —Rio Tinto 30·85 in.
„ „ „ „ —Huelva . 26·28 „
Greatest cold since 1874, Nov., 1890 . . . 23°
„ heat „ „ August, 1902 . . 181°

TABLE A.

Statement showing the quantity of copper produced, and the cost of its production, under the administrations of Wolters and Tiquet, from 1737, until the death of the latter in 1758.

Year.	Refined Copper.			Tons.	Cost. — Reales.	Observations.
	Arrobas.	lb.	oz.			
1737	26	4	—	$\frac{1}{3}$	—	No records
1738–41	—	—	—	—	—	
1742	26	4	—	$\frac{1}{3}$	—	
1743–46	—	—	—	—	—	
1747	602	—	—	$7\frac{1}{2}$	—	
1748	57	17	8	$\frac{2}{3}$	—	
1749	54	2	8	$\frac{2}{3}$	—	
1750	283	2	—	$3\frac{1}{2}$	68,818	
1751	284	7	—	$3\frac{1}{2}$	154,826	
1752	536	9	—	$6\frac{5}{8}$	192,104	
1753	1561	1	4	$19\frac{1}{2}$	208,461	
1754	896	18	8	$11\frac{1}{2}$	190,227	
1755	2,075	13	8	26	230,714	
1756	3,066	6	4	$38\frac{3}{8}$	227,895	
1757	2,108	17	—	$26\frac{1}{2}$	293,757	
1758	2,058	11	—	$25\frac{1}{2}$	140,650	Until Sept. 11 only
	13,637	13	8	170	1,707,458	=About £17,000

TABLE B.

Statement showing the quantity of copper produced at the Rio Tinto mine under the administration of Sanz, from 1758 until the expiry of his lease in 1776.

Year.	Refined Copper.			Observations.
	Arrobas.	lb.	oz.	
1759	3,182	8	0	
1760	5,271	6	0	
1761	6,112	0	0	
1762	4,681	1	0	
1763	7,366	1	0	
1764	5,680	12	8	
1765	4,062	12	0	
1766	4,508	0	0	
1767	5,394	18	0	
1768	6,833	0	0	
1769	5,577	13	0	
1770	5,665	1	0	
1771	6,675	0	0	
1772	7,210	0	0	
1773	6,428	0	0	
1774	6,921	0	0	
1775	8,020	0	0	
1776	8,100	0	0	
	107,687	22	8	= About 1,350 tons of 2,000 lb.

TABLE C.

Production and cost from the expiry of the concession to Sanz in 1776 until the end of 1799.

Year.	From Smelters, Tons of 2,000 lb.	Precipitate.	Total Fine Copper.	Sent to Arsenal and Mint, Sevilla.	Sent to Soria, Madrid, etc.	Cost. — Reals.
1777	117½	—	117½	—	—	
1778	115	—	115	—	—	
1779	92½	—	92½	—	—	
1780	100¾	—	100¾	—	—	
1781	100	—	100	—	—	
1782	83	—	83	—	—	
1783	120	—	120	40	66	11,916·00
1784	133¼	—	133¼	60	16½	10,523·00
1785	169½	—	169½	128¾	38½	11,188·00
1786	121½	—	121½	50	16	11,076·00
1787	89½	—	89½	60	9½	12,192·00
1788	117¾	10½	128¼	65½	14	12,339·00
1789	144	13	157	52	7	11,641·00
1790	149	15½	164½	251	12¾	13,442·00
1791	172½	11¼	183¾	159½	13¼	17,476·00
1792	143	12½	155½	105½	14½	17,337·00
1793	166	14	180	146	18½	19,056·00
1794	145¼	14¾	160	132	6	17,395·00
1795	223	19½	242½	169½	13	15,514·00
1796	175½	17¾	193¼	160	24½	20,033·00
1797	228	22½	250½	251	7	24,346·00
1798	210	17¼	227¼	205½	1½	21,518·00
1799	100¼	16½	116¾	130¾	8	19,172·00
Totals	3,216¾	185	3,401¾	2,167	226½	£266,164

TABLE D.

Production of copper and cost from 1800 to 1829, under the administration of the Government.

Year.	From Smelters.	Precipitate.	Total Fine Copper. Tons.	Cost. — Reals.	Observations.
1800	180	13½	193½	2,064,627	
1801	115	11	126	1,791,301	
1802	58	9¼	67¼	1,502,284	
1803	101	10¼	111¼	1,605,915	
1804	54	9¼	63¼	1,340,107	
1805	24½	3	27½	651,813	
1806	35½	6	41½	685,687	
1807	5¼	15½	20¾	790,602	
1808	77¼	10	87¼	951,339	
1809	86¾	7	93¾	815,753	
1810	23¾	—	23¾	269,724	
1811	—	—	—	147,927	
1812	—	—	—	68,321	
1813	—	—	—	116,963	Paralysis of Works.
1814	—	—	—	182,540	
1815	—	1¾	1¾	194,716	Salaries and Wages of Employés in charge.
1816	—	—	—	134,357	
1817	—	9¼	9¼	185,308	
1818	—	5¾	5¾	106,684	
1819	—	1	1	119,834	
1820	—	30	30	183,532	
1821	—	30	30	?	
1822	—	28½	28½	?	
1823	—	13	13	?	
1824	—	44½	44½	?	
1825	57	41½	98½	996,503	
1826	75	64	139	?	
1827	47½	65	112½	?	
1828	½	50	50½	?	
1829	¼	18½	18¾	?	Until April 24 only.
Tons	941¼	497½	1438¾	14,905,887	=£149,058

TABLE E.

Production of copper from 1829 to 1849, during the concession to the Marquis de Remisa.

Year.	Smelted Copper. Tons.	Precipitate. Tons.	From 'Vitriolos.' Tons.	Total Fine Copper. Tons.	Observations.
1829	38¼	41¼	—	79¾	
1830	102¼	86¾	—	188¾	
1831	90	80	—	170	
1832	300	61	—	361	
1833	209	43¾	—	252¾	
1834	145½	34	—	179½	
1835	171	28¾	—	199¾	
1836	195	33¼	—	228¼	
1837	136½	26¾	—	163¼	
1838	150	43½	—	193½	
1839	90	39	—	129	
1840	141¼	77	20	238¼	
1841	61	69½	59½	190	
1842	73	77¾	128¼	279¼	
1843	106	51½	227½	385	
1844	54½	55½	269	379	
1845	45½	56½	265½	367½	
1846	14½	55	257½	327	
1847	13½	52½	360½	426½	
1848	5	53½	410	468½	
1849	13	8½	93½	115	Until April 24 only.
	2,154¾	1,075¼	2,091½	5,321½	Tons of 2,000 lb.

TABLE F.

Production of copper under the Government and concessions to Prieto and La Cerda.

Year.	Mineral extracted. Tons.	Fine Copper produced.			
		Government.	"Los Planes."	"La Cerda."	Total Fine Copper. Tons.
1849	15,587	192¼	60	—	252¼
1850	27,033	217	195¼	—	412¼
1851	32,792	277¾	338	21¾	637½
1852	30,982	233¼	304½	201	738¾
1853	26,863	141½	318	130½	590
1854	42,941	226	399¼	169½	794¾
1855	40,963	251	406½	206½	864
1856	41,280	312	271½	234	817½
1857	41,414	236	242½	236	714½
1858	49,132	294	240½	206½	741
1859	64,244	3,701	922	—	1,048½
1860	78,512				948½
1861	88,015				1,249½
1862	83,263				1,376½
Tons	663,021	6,081¾	3,698	1,405¾	11,185½

TABLE G.

Production during the last ten years of Governmental administration, 1863–1872.

Year.	Mineral extracted.	Fine Copper.	Last 10 years of Rio Tinto Company, Ltd.		
	Metrical tons.	Metrical tons.	Year.	Mineral extracted. Tons.	Copper produced at Mine. Tons.
1863	89,694	1,335	1893	1,332,002	20,887
1864	74,234	1,046	1894	1,387,095	20,606
1865	66,156	1,025	1895	1,372,376	20,762
1866	62,312	1,135	1896	1,437,332	20,817
1867	50,480	879	1897	1,388,026	20,826
1868	52,036	1,123	1898	1,465,380	20,486
1869	60,530	974	1899	1,649,844	20,230
1870	67,075	1,012	1900	1,894,504	21,120
1871	55,600	860	1901	1,928,776	21,100
1872	62,220	804	1902	2,000,000	22,000
	640,337	10,193	Tons	15,800,000	208,834
= Tons	2,720,000	42,500			

INDEX

Butler & Tanner, The Selwood Printing Works, Frome, and London.